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Productivity Effects of Viet Nam's Rice Land Restrictions*

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Abstract: *Viet Nam's 1986 programme of market-oriented economic reforms did not include the freedom of farmers to choose their crops independently. Large areas of land remain restricted to rice production. This paper studies the effects of this policy on agricultural productivity, using panel data from the Viet Nam Access to Resources Household Survey (VARHS), covering the years 2008 to 2016. The econometrics uses fixed effects methods with and without the additional use of instrumental variable methods to allow for the possible statistical endogeneity of the restrictions. The findings are that the crop choice restrictions reduced the overall productivity of annual crop land by about 5%, reduced the overall productivity of farm labour by about 8% and reduced the mean incomes of farm households by 5%–6%, implying increased levels of rural poverty. Moreover, rice output would have been no lower if the restrictions were removed.*

Keywords: land restrictions, productivity, rice production, land policy

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1. Introduction

'Productivity isn't everything, but in the long run it is almost everything.'
Paul Krugman, 1994

Many international studies have estimated the productivity-enhancing effects of structural transformation. These effects derive primarily from reallocating resources, especially unskilled and semi-skilled labour, from low productivity agriculture to higher productivity non-agricultural sectors (Timmer, 2002; World Bank, 2007; Gollin, 2010; Fuglie, 2020). In Viet Nam, this source of productivity gain has apparently been a major contributor to economic growth (Tarp, 2017b). Agricultural employment declined from 72% of total employment in 1991 to 37% in 2019 (World Bank, 2020), one of the most rapid structural transformations ever recorded for any country. The structural change was facilitated by a set of market-oriented economic reforms, commencing in 1986, called *doi moi*.

In Viet Nam's case, an additional source of potential productivity gain arises from reallocating labour and land *within* agriculture. Conversion of land from paddy[1] rice production to other crops or to aquaculture is restricted by government policy, even if farmers wish to undertake this conversion (Tien, 2006; Markussen, 2011). These land use restrictions are administered by local government officials and predate the *doi moi* reforms. They are intended to maintain rice production and were initially justified by concerns about national food security, interpreted to mean non-dependence on imported rice (Nguyen and Warr, 2019; Nguyen 2020; Chu, 2021). Subsequently, as rice became a significant export during the 1990s, this concern was replaced, at least partly, by the desire to maintain the foreign exchange earned from rice exports. The policy preoccupation with maintaining rice production remains and continues to be a sensitive political issue (Giesecke, 2013; Nguyen, 2019).

The restrictions have a potential cost. They impede farmers' flexibility in responding to changing market signals. If the marginal product value of the agricultural land that is restricted to paddy rice farming is higher in other forms of agricultural production, productivity gains could be achieved by relaxing the restrictions. In addition to these static productivity-reducing effects, the restrictions may reduce the incentives

[1] By 'paddy' we mean farm-level production of rice, whether irrigated or non-irrigated.

of farm households to undertake productivity-enhancing innovations and investments in new capital inputs because they reduce the economic benefits these innovations produce.

The objective of this study is to use household and plot level data for Viet Nam to estimate the extent to which the land-use restrictions have achieved the stated objective of raising rice production, relative to what would have happened without them. We also estimate the potential magnitude of the static productivity gains, if any, that might have been achieved without the restrictions. The analysis is backward-looking in the sense that it compares past data on actual outcomes with counterfactual estimates of what those outcomes would have been in the absence of the restrictions. The policy implications are forward-looking in that they suggest the gains potentially available from removing the restrictions.

We undertake the empirical analysis using a unique household level panel dataset assembled at 2-yearly intervals, covering the years 2008 to 2016, derived from the Viet Nam Access to Resources Household Survey (VARHS). Two analytical methodologies are used in answering the above questions. The first uses fixed effects regression, treating the land use restrictions as an exogenous variable and the second combines this framework with instrumental variables methods to allow for the possible endogeneity of land use restrictions.

Whether the land use restrictions should actually be relaxed is partly a political matter, but it seems clear that the impact that restrictions on conversion of paddy land have on their stated objectives and the magnitudes of the productivity gains that might result from relaxing them are relevant for these decisions. The remainder of the paper is organised as follows. Section 2 reviews the policy context. The dataset and the variables used are summarised in Section 3. Section 4 describes the fixed effects and instrumental variables regression methodologies used to answer the research question. Estimation results are presented in Section 5 and Section 6 summarises the estimated magnitude of the impacts. Section 7 concludes our study.

2. Policy Background and Earlier Studies

Studies of Viet Nam's impressive economic growth over the past three decades have emphasised the productivity-enhancing role of the *doi moi* programme of economic reforms. These reforms, initiated by the Communist Party of Viet Nam in 1986, were designed to facilitate the transition from a command economy to a 'socialist-oriented market economy' (Lim, 2013). The objective was to raise productivity by expanding the role of market incentives in determining the allocation of resources. Che (2006) used data for the early part of the reform period to argue that more competitive markets and secure property rights contributed to an increase in agricultural productivity, facilitating Viet Nam's transition from a large net importer of rice in the early 1980s to one of the world's largest exporters two decades later.

A key component of the *doi moi* reform programme was the transfer of agricultural land use rights from collectives to individual households.[2] This, together with further policy shifts in 1993 gave households the right, in principle, to sell, rent, exchange, mortgage and bequest their plots (Markussen, 2017), subject to the plot concerned being covered by a Land Use Right Certificate (LURC). Do and Iyer (2008) reported that by the year 2000 nearly 11 million land titles had been issued under this programme, making it one of the largest land titling programmes ever recorded in a developing country, not only in scale but also in speed of implementation. The period of this use right was 20 years in the case of annual crops and 50 years in the case of perennial crops. In 2013, when the 20-year limit for annual crops was about to expire, the Land Law 2013 extended all LURCs for a further 30 years (Bellemare, 2020).

Markussen (2017) reported the results of a study of land use rights using a unique dataset called the Viet Nam Access to Resources Household Survey (VARHS), also used in the present study.[3] Markussen found that around 80% of plots are held with a Land Use Right Certificate (LURC) and that this proportion was relatively constant

[2] For extensive reviews of land reforms in Viet Nam since the early 1980s, see MacAulay (2006), Ravallion and van de Walle (2008) and Nguyen and Warr (2019).

[3] The VARHS survey was conducted by CIEM (Central Institute of Economic Management of the Ministry of Planning and Investment), the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) of the Ministry of Agriculture and Rural Development (MARD), the Institute of Labour Science and Social Affairs (ILSSA) of the Ministry of Labour, Invalids and Social Affairs (MOLISA), and the Development Economics Research Group (DERG) of the University of Copenhagen, together with the Danish aid agency, DANIDA, since 2006.

during the period of his data (2006–2014). Nevertheless, the proportion varied by region and by the wealth of the household. In the Northern Uplands 45% of plots were untitled, whereas in the southern Mekong Delta region that share was only about 2%. Better-off households were significantly more likely to hold titled plots. Markussen also found that the holding of LURC rights promoted investment in irrigation. Bellemare (2020) similarly found that the 2013 extension of the period of LURCs promoted investment in irrigation and soil conservation in annual crop production.

Despite the reforms, all land remains formally owned by the state of Viet Nam. In legal terms, the LURC is a usufruct right – a right to use something, under specified conditions, but which falls short of full ownership. Local authorities are responsible for renewing LURCs or issuing new ones. But these land use rights do not guarantee the farmer's right to choose the crops grown (Markussen, 2017), particularly on land officially designated for paddy rice production.[4] These restrictions may apply whether the land is covered by LURC title or not. They originated in the central planning practices preceding the *doi moi* reforms of 1986 (Dang, 2018). In retaining these pre-reform restrictions, the government was concerned that removal of all restrictions on the conversion of paddy land to other uses, including alternative annual crops, perennial crops and aquaculture, might threaten food security, interpreted to mean national rice self-sufficiency (Kompas, 2012; Giesecke, 2013).

The possibility that unrestricted market-driven decisions might lead to significant dependence on imported rice for domestic consumption was considered unacceptable. The volatile international rice market (Timmer, 2012) was viewed as an unreliable source for this crucial staple (Nguyen, 2019). In subsequent years, as rice became a significant export, the crop choice restrictions remained but meeting government planning targets for rice exports and the foreign exchange they generated seemingly became their dominant motivation (Markussen, 2011; Nguyen, 2017). The policy has

[4] The most important measure is Resolution 26/NQ/TW on agriculture, farmers and rural development, issued on 5 August 2007. It states that proper land for rice cultivation must be maintained. Article 74 of the 2013 Land Law, states that rice producers are prohibited from converting paddy land without the permission of relevant government officials from the communal level to the provincial level. Other applicable measures include Resolution 63 (2009) on ensuring national food security, and Decree 42 (2012), Decree 35 (2015), and Decree 62 (2019) on management and use of paddy land. These measures are intended to keep rice cultivation at 3.8 million hectares until 2030.

often been called 'Rice first'.[5] It is important to note that the objective was to influence the composition of agricultural output, in favour of rice, but that the instrument employed was regulation of a single major input into rice production, land.[6]

As domestic market conditions have changed, farmers have increasingly wished to convert paddy land to other uses in response to changing rates of return (Tran, 2013; World Bank, 2016). Although the reallocation of land away from paddy production and towards other crops potentially conflicts with the land designation policy, significant diversification has occurred (McPherson, 2012; World Bank, 2016; Ayerst, 2020). Marsh (2006) provided an overview of typical land use patterns, including standard rice, specialised rice and other annual crops such as vegetables, soybeans and specialised non-rice crops. They find higher returns from cropping patterns that include potato, cabbage, tomato, squash, cucumber, beans and peas than from food grains alone. The rotation of rice and other crops always gives a higher income than monoculture rice land. These findings help explain the desire of many farmers to avoid land use restrictions.

Markussen and Zille (2017) provided a helpful description of the restrictions as they existed in 2014, when 44% of all non-residential land plots were subject to formal restrictions on the choice of crops. Higher income households were more likely to be subject to the restrictions, possibly because they were perceived by local authorities to be holding plots more important for rice production.[7] The remaining crop choice restrictions appear to be a binding constraint on land conversion for many farming households, with potential productivity-reducing effects (Kompas, 2012; Markussen, 2017; Bellemare, 2020). The restrictions do not apply uniformly to all rice-producing farmers. Markussen and Tarp (2014) showed that the likelihood that a particular household would be subjected to these restrictions depends in part on the extent of that

[5] It has been argued that Viet Nam's concentration on intensive rice production has been excessive in agronomic terms, threatening long-term sustainability of agriculture (Barton, 2015). Input usage has increased rapidly and environmental degradation has become a major concern in maintaining long-term rice productivity and quality (McPherson, 2012; World Bank, 2016).

[6] Restrictions of this kind are not uncommon in transition economies. Markussen (2011) reported similar restrictions on crop choice in China, Myanmar, and several countries of the former Soviet Union in Central Asia.

[7] Markussen and Zille also noted that in 2014 plots covered by a Land Use Right Certificate (LURC) were less likely to be restricted than those not covered. The findings of the present study confirm that finding.

household's contacts with local government officials. Insofar as the permission of officials at both the communal and district levels is required for legal conversion of paddy land, this finding is perhaps unsurprising.

The continued policy sensitivity of crop choice restrictions was illustrated in 2015 by a new government decree describing the limited circumstances under which farmers could apply to local authorities for approval to convert part of their paddy land to other agricultural crops or to aquaculture. The decree also mandated that local authorities monitor subsequent conversion of land to ensure farmer compliance with the terms of any such approvals.

In their review of agricultural reform in various economies making the transition from collectivised agriculture to more household-based and market-oriented structures, Swinnen and Rozelle (2006: 445) argued that the primary criterion for evaluating the welfare effects of this transition should be agricultural productivity, rather than agricultural output. Because the reforms frequently start from a position of severe sectoral price distortion, in Viet Nam's case operating against agriculture, the effects of price reform and institutional reform are conflated when agricultural output is used as the performance criterion.

None of the studies cited above quantify the productivity losses resulting from Viet Nam's crop choice restrictions. An ambitious analysis by Giesecke (2013) attempted something close to that, using a dynamic general equilibrium model of the Vietnamese economy, drawing on a similar model of the Australian economy. The study estimated that elimination of the restrictions would raise aggregate real private consumption in Viet Nam by 0.35% per year. These findings are interesting but rest heavily on the assumed values of elasticities of transformation indicating the ease with which land can be converted from rice to other forms of agricultural production. But the assumed values of these elasticities lack an empirical foundation within the context of Vietnamese agriculture. The present paper uses a more direct approach. It applies econometric methods to Vietnamese data to estimate the productivity effects of the restrictions. As the earlier discussion shows, output effects, particularly rice versus other crops, are politically important in Viet Nam. We study them as well, in addition to the effects the restrictions have on the incomes of agricultural households.

3. Data and Preliminary Findings

An empirical estimate requires detailed measures of inputs and outputs for farming households, the production unit of analysis. The data used are from the Viet Nam Access to Resources Household Survey (VARHS).[8] Data was collected from rural households and communes in 12 provinces of Viet Nam, assembled every two years from 2008 to 2016. The study focuses on the annual crops sector, which generates the bulk of farm income for rural households throughout the period. We do not consider perennial crops or aquaculture.

The VARHS surveys collect a wide range of information on household characteristics such as employment, demographics, rural enterprises, land property rights and restrictions, saving and investment, social investment and agricultural investment. In communal surveys, in addition to communal characteristics, there is a module that surveys land administrative procedures such as property rights and land conversion (Markussen, 2011; Markussen and Tarp, 2014; Tarp, 2017; and Dang, 2020). These data provide the control variables used in our fixed effects empirical analysis. The VARHS data also includes a module capturing households' political connections through family links and friendships, which will be used in our construction of instrumental variables to deal with the possible statistical endogeneity of land use restrictions.

3.1. Rolling 2-Year Panel

The VARHS data includes a rolling panel data component lasting two years. This means that a randomly selected subset of all households sampled in 2008 was also sampled in 2010, giving the 2008–2010 panel sample. Then a randomly selected subset of all households sampled in 2010, not restricted to those included in the 2008–2010 panel sample, was also sampled in 2012, giving the 2010–2012 panel sample, and so on. That is, the households included in the 2008–2010 panel sample were the same in these two years, 2008 and 2010. Those included in the 2010–2012 panel sample were also the same in those two years, but not necessarily the same as those included in the

[8] See CIEM (2009) for further information on surveys and background details. The sampled provinces are, by all regions in Viet Nam: Red River Delta: Ha Tay; North East: Lao Cai, Phu Tho; North West: Lai Chau, Dien Bien; North Central Coast: Nghe An; South Central Coast: Quang Nam, Khanh Hoa; Central Highlands: Dak Lak, Lam Dong; and Mekong River Delta: Long An.

2008–2010 panel sample. The attrition rate in the sample was relatively low. The rolling 2-year panel feature means that within the 2008–2010 panel sample component of the data, the changes occurring between 2008 and 2010 do not include those changes in household characteristics that are stable over time. The same applies to the 2010–2012 panel sample, and so on. The data are summarised in Appendix Tables A1 (2008–2010) to A4 (2014–2016).

3.2. Land Restriction Variables

The VARHS questionnaire asks three key questions about land use restrictions:

(i) 'Would the authorities allow you to convert to non-agricultural use?';

(ii) 'Are there any formal restrictions on your household's choice of crops?';

(iii) 'Which restrictions apply to your choice of crops?'

These questions relate to individual plots of land, and not just to individual households, since the restrictions apply at a plot level. The areas of these plots are recorded. Most farming households access several plots, although the plots may be quite small. Within VARHS most economic variables, such as agricultural outputs and inputs, are collected at the household level and not for individual plots. Exceptions are production of rice and area sown to rice, which are collected at both the household level and the plot level, for both restricted and unrestricted plots. Since we know the areas of both restricted and unrestricted plots, we are able to develop a measure of land use restrictions at the household level – the proportion of the household's total crop area consisting of plots restricted to rice production. Regarding question (iii), different types of formal restrictions include: (a) the requirement to grow rice in all seasons; (b) the requirement to grow rice in some reasons; (c) others. Table 1 shows that these restrictions have consisted mainly of prohibition of uses other than rice, increasingly applying to all seasons. Crop choice restrictions other than the requirement to grow rice are minor and are not considered in this study.

Table 1: Restrictions and Non-agricultural Use Conversion, Plot Level (%), Full Dataset

	Formal Restrictions on Crop Choices	Types of Restrictions on Crop Choice			Conversion to Non-agricultural Use Not Allowed (%)
		Rice All Seasons	Rice Some Seasons	Others	
2008	44.8	42.5	50.4	7.1	81.0
2010	31.6	24.7	69.9	5.4	79.7
2012	45.2	56.1	38.4	5.5	66.9
2014	44.2	52.4	39.1	8.5	67.3
2016	40.6	49.8	40.4	9.8	69.5

Note: Tables 1 to 3 were assembled from the component of the VARHS dataset consisting of rural households producing annual crops, not confined to the panel component used throughout the paper except in these three tables.
Source: Authors' calculations from VARHS data.

It is convenient for interpretation of the results to define variables in logarithmic form. For the purpose of the quantitative analysis in this paper, we form the variable

$$R_{ijt} = \ln(1 + S_{ijt}), \quad (1)$$

where S_{ijt} is, for household *i* in commune *j* in year *t*, the share of that household's total crop land that is subject to crop restrictions.[9]

Table 2 shows that the mean number of plots per household is around 4.7. Just under half of all plots are subject to crop choice restrictions and this is true of both irrigated and non-irrigated plots. These proportions have declined only marginally over time but the decline is larger on non-irrigated plots. Around three quarters of all plots have Land Use Right Certificates (LURCs) and about half of all restricted plots have them. Plots subject to crop choice restriction are less likely to have an LURC, so possession of an LURC seemingly reduces the likelihood of restriction. The mean size of restricted plots is smaller than unrestricted plots, whether the plots are irrigated or not.

[9] Because S_{ijt} varies between 0 and 1, inclusive, $1 + S_{ijt}$ varies between 1 and 2 and R_{ijt} varies between $\ln(1) = 0$ and $\ln(2) = 0.693$.

Table 2: Comparison of Restricted and Unrestricted Rice Plots, Full Dataset

	2008	2010	2012	2014	2016
All plots					
Number of plots	9,750	9,087	9,926	9,814	9,628
Mean area of annual plots restricted to rice (sq m)	885	931	951	1,021	1,175
Mean area of annual plots unrestricted to rice (sq m)	1,077	945	1,152	1,217	1,399
Percentage of annual crop plots restricted to rice	44.8	31.6	45.2	44.2	40.6
Percentage of annual crop area restricted to rice	40.0	31.5	40.3	39.6	36.2
Percentage of planted rice area restricted to rice	48.1	35.6	46.9	48.0	47.6
Irrigated plots					
Number of plots	7,059	6,821	7,941	8,048	8,087
Mean area of annual plots restricted to rice (sq m)	933	974	1,027	1,086	1,115
Mean area of annual plots unrestricted to rice (sq m)	1,130	1,031	1,222	1,306	1,437
Percentage of annual crop plots restricted to rice	47	33.4	49	51	47
Percentage of annual crop area restricted to rice	41.8	32.9	44.3	46	40.2
Percentage of planted rice area restricted to rice	49.5	44.8	53.4	57.7	55.2
Non-irrigated plots					
Number of plots	2,691	2,266	1,985	1,766	1,541
Mean area of annual plots restricted to rice (sq m)	837	888	875	956	1,235
Mean area of annual plots unrestricted to rice (sq m)	1,024	859	1,082	1,128	1,361
Percentage of annual crop plots restricted to rice	43	30	41	37	34.2
Percentage of annual crop area restricted to rice	38.2	30.1	36.3	33.2	32.2
Percentage of planted rice area restricted to rice	46.7	26.4	40.4	38.3	40.0
Memo items: *All plots*					
Total number of households	2,065	2,067	2,356	2,756	2,669
Mean agricultural land area per houshold (sq m)	8,252	7,861	8,072	8,122	8,197
Mean annual crop land area per household (sq m)	4,161	3,724	4,055	4,230	4,607
Mean area restricted to rice per household (sq m)	1,645	1,173	1,638	1,672	1,669
Mean rice land per household (sq m)	3,460	3,298	3,488	3,492	3,503
Mean agricultural plot size (sq m)	1,649	1,682	1,759	1,807	1,843
Mean annual crop plot size (sq m)	991	931	1,067	1,143	1,316
Percentage of annual crop plots with LURC	77	72	80	78	82
Percentage of restricted annual crop plots with LURC	47	34	53	45	56

Note: See note to Table 1 regarding the set of households included in the above data.
'Mean area of annual plots unrestricted to rice' relates to the mean area of unrestricted plots where rice is the chosen crop, not to all unrestricted plots, which would include plots not sown to rice.
'Percentage of planted rice area restricted to rice' means the total area of plots that must grow rice in all seasons relative to total area planted to rice.
Source: Authors' calculations using data from VARHS Survey.

Table 3 draws attention to an important difference between plots restricted to rice and those not restricted but where rice is still the chosen crop. Rice yields on the unrestricted plots are significantly higher. In 2016 plots restricted to rice accounted for 47.6% of the total area planted to rice (Table 2), but they produced 34.8% of total rice output (31.8% from irrigated plots and 3% non-irrigated). The yield difference is significant for both irrigated and non-irrigated plots, considered separately. The aggregate yield difference does not arise from differences in the extent of irrigation – in fact, crop restrictions are more frequent on irrigated plots.

3.3. Political Connection Variables

As shown by Markussen and Tarp (2014), a household's political connections are a potentially significant determinant of the likelihood of being subject to land use restrictions. Detailed data on these connections are contained in the VARHS dataset. The instrumental variables analysis below will utilise these data. Following the data categories used in the VARHS survey (Module 10), we write D_{ijt}^{rm} for a binary [0,1] dummy variable, where the subscripts refer to household *i* in commune *j* at time *t*, superscript *r* represents the nature of the social relationship between that household and a public office holder and superscript *m* describes the position held by that office holder.

We write $r = 1$ to indicate a member of household *i* holding a public office, $r = 2$ a relative outside household *i* holding a public position and $r = 3$ a personal friend holding a public office; $m = 1$ denotes a district leader, $m = 2$ a district official, $m = 3$ a commune leader, $m = 4$ a commune official, $m = 5$ a mass organisation leader and $m = 6$ an 'other' official. When a family or personal connection of type *rm* exists for household *i* in commune *j* at time *t*, $D_{ijt}^{rm} = 1$ and when no such relationship exists, $D_{ijt}^{rm} = 0$. For example, $D_{ijt}^{23} = 1$ would indicate that a relative outside this household is a commune leader, while $D_{ijt}^{23} = 0$ would indicate that for this household there is no relative holding that position. Appendix Tables B1 to B4 summarise the data on political connections.

Table 3: Rice Yields on Restricted and Unrestricted Plots Sown to Rice, Full Dataset

	2008	2010	2012	2014	2016
All plots					
Mean rice yield restricted plots (kg per ha)	4,094	4,099	4,164	4,452	4,975
Mean rice yield unrestricted plots (kg per ha)	5,477	5,120	5,458	5,477	5,703
t-statistic for hypothesis: true means are equal	5.74***	7.07***	1.40	3.62***	7.44***
p-value of above *t*-test	0.000	0.000	0.12	0.000	0.000
Irrigated plots					
Mean rice yield restricted plots (kg per ha)	4,826	4,666	4,955	5,427	5,897
Mean rice yield unrestricted plots (kg per ha)	6,068	6,277	6,342	6,538	6,681
t-statistic for hypothesis: true means are equal	4.51***	3.84***	1.92*	4.55***	6.05***
p-value of above *t*-test	0.000	0.0004	0.062	0.000	0.000
Non-irrigated plots					
Mean rice yield restricted plots (kg per ha)	3,362	3,532	3,373	3,477	4,053
Mean rice yield unrestricted plots (kg per ha)	4,886	3,963	4,574	4,416	4,725
t-statistic for hypothesis: true means are equal	2.45**	3.66***	1.84*	5.03***	4.92***
p-value of above *t*-test	0.055	0.000	0.071	0.000	0.000

Note: See note to Table 1 regarding the set of households included in the above data.
These data draw upon the answers to question (ii) in the text: 'Are there any formal restrictions on your household's choice of crops?'. The row 'Rice yield of unrestricted plots (kg per ha)' refers to mean rice yield on unrestricted plots where rice is the chosen crop.
Result of *t*-tests: *, ** and *** denote significant difference at 90%, 95% and 99% confidence levels.
Source: Authors' calculations from VARHS data.

4. Methodology

4.1. Fixed Effects Model

Our fixed effects empirical strategy estimates the equation:

$$Y_{ijt}^{k} = \alpha^{k} + \beta^{k} R_{ijt} + \gamma^{k} L_{ijt} + \delta^{k} N_{ijt} + \theta^{k\prime} C_{jt} + \vartheta^{k\prime} X_{ijt} + \mu_i + v_j + \varepsilon_{ijt}^{k}\,, \qquad (2)$$

where, for household *i* in commune *j* during year *t*, Y_{ijt}^{k} denotes productivity measure *k* on a farm operated by household *i* in commune *j* during year *t* (the productivity measures are discussed below); R_{ijt} is a logarithmic measure of land restrictions applying to plots operated by household i in commune *j* during year *t*, as given by equation (1) above; L_{ijt} is the share of the household's land that is covered by Land Use Right Certificates; N_{ijt} is the logarithm of the value of all purchased crop inputs (seeds, fertiliser, pesticide and hired labour and rental value of machinery) per hectare of crop land,[10] C_{jt} and X_{ijt} denote commune and household characteristics at time *t*, respectively; μ_i and v_j denote household and commune fixed effects, respectively; and ε_{ijt}^{k} denotes a column vector of the error terms corresponding to each of the productivity equations.

The parameter β^{k} captures the estimated effect that land restriction has on the productivity outcome *k* and the other estimated parameters are denoted $\gamma^{k\prime}$, $\delta^{k\prime}$, μ_i and v_j. The six productivity measures, *k*, include the logarithm of the real value of total crop output per hectare of crop land and the logarithms of five other measures, as summarised in the first six rows of Appendix Tables A1 to A4. The rationale for the choice of these measures will become clear in the discussion of the results, below.

As described above, the VARHS data set contains a rolling 2-year panel component to capture the dynamics of policy impacts. Comparing 2008 with 2010 and then 2010 with 2012 and so forth, using these rolling panel datasets makes it possible to control for the effects of unobserved time invariant fixed effects operating at the household or commune levels, removing their possible confounding effects through omitted variable bias. We apply this fixed effect approach to obtain panel regression estimates for each of the four intervals 2008–2010, 2010–2012, 2012–2014 and 2014–2016.

[10] The VARHS data specify the total of all purchased inputs, including hired labour and the rental value of machinery used, but not the individual components of this total.

Other studies using fixed effects models with the VARHS data set include Markussen and Tarp (2014) and Dang (2020). In addition, Markussen (2011) applied the household level fixed effect model to estimate the effect of crop choice restrictions on household labour supply and income from crop agriculture. The latter study concludes that rice production comes with significant costs in terms of labour allocation but no loss of household income, but does not estimate the productivity impacts caused by crop choice restrictions. The potential productivity benefits of a more diversified cropping pattern have not yet been effectively quantified.

4.2. Simulations Using the Estimated Fixed Effects Model

Consider what the counterfactual value of Y_{ijt}^{k} would be if the farm household was not subject to restrictions on the choice of crops for any of the plots it operates. This counterfactual value is not observed, but our analysis will estimate it. An intuitive explanation is as follows. First, we use all the estimated coefficients and the estimated error term of equation (2) for each household, together with the unchanged observed values of all the dependent variables used in the estimation except the land restriction dummy variable. Second, for this latter variable we substitute the value R_{ijt} = 0, corresponding to no restriction,[11] for each household in place of the values of R_{ijt} calculated from the data for this variable and used to estimate equation (2). Third, we use this modified equation to simulate the counterfactual value of the dependent variable for each household.

For any counterfactual set of values of R_{ijt}, denoted R_{ijt}^{*}, let Y_{ijt}^{k*} denote our estimate of the implied counterfactual value of Y_{ijt}^{k}. Then:

$$Y_{ijt}^{k*} = \alpha^{k} + \beta^{k} R_{ijt}^{*} + \gamma^{k} L_{ijt} + \delta^{k} N_{ijt} + \theta^{k\prime} C_{jt} + \vartheta^{k\prime} X_{ijt} + \mu_{i} + \upsilon_{j} + \varepsilon_{ijt}^{k} . \quad (3)$$

In equation (3) the values of all estimated parameters, the estimated household level error terms and the independent variables other than R_{ijt} are identical to those appearing in the estimated equation (2). But the counterfactual values of R_{ijt}, R_{ijt}^{*}, are used in place of the observed values. That is, equation (3) is not used to estimate parameters, but to simulate the implications of substituting the counterfactual values of the land restriction variables, R_{ijt}^{*} for the observed values of that variable, R_{ijt}, into the estimated

[11] From equation (1), $S_{ijt} = 0$ implies R_{ijt} = ln (1) = 0.

equation, holding everything else constant. The estimated error term ε_{ijt}^{k} in (2) appears unchanged in (3) because it is taken to indicate the estimated impact on household *i* of unobserved household-specific factors not included amongst the independent variables in (2).

If $R_{ijt}^{*} = 0$, the term $\beta^{k} R_{ijt}^{*}$ disappears from (3). Thus:

$$Y_{ijt}^{k*} = Y_{ijt}^{k} - \beta^{k}(R_{ijt} - R_{ijt}^{*}) = Y_{ijt}^{k} - \beta^{k} R_{ijt}. \quad (4)$$

Recall that Y_{ijt}^{k} and Y_{ijt}^{k*}, as used in the regression analysis, measure the logarithms of actual and counterfactual productivity. We are interested in the levels of productivity, the anti-logs of these variables. Denoting these anti-logs y_{ijt}^{k} and y_{ijt}^{k*}, respectively, the estimated impact that the restrictions have on the productivity of household *i* is now $y_{ijt}^{k} - y_{ijt}^{k*}$. Let the mean values across households of these levels be denoted $\bar{y}_{t}^{k}$ and $\bar{y}_{t}^{k*}$, respectively.[12] The estimated mean impact of the restrictions is now $\bar{y}_{t}^{k} - \bar{y}_{t}^{k*}$ and the estimated percentage impact is

$$100\ (\bar{y}_{t}^{k} - \bar{y}_{t}^{k*}) / \bar{y}_{t}^{k}\ . \quad (5)$$

4.3. Instrumental Variables Model

It seems possible that land use restrictions are statistically endogenous. For example, the farmers who perform best may be rewarded with fewer restrictions, or the best performing farmers may be able to buy their way (illegally) to fewer restrictions. If so, the land use restrictions may be correlated with the disturbance term in equation (2), potentially leading to biased and inconsistent estimates of the parameters of interest, including β^{k}. We therefore wish to find an instrumental variable that is correlated with the restrictions but not otherwise correlated with the dependent variable except through the channel of the restrictions.

Using the detailed information on family and personal political connections collected in the VARHS dataset, Markussen and Tarp (2014) found that households with such connections are less likely to be subject to the restrictions. Because land use restrictions

[12] An important computational point is that the mean levels of actual and counterfactual variables $\bar{y}_{t}^{k}$ and $\bar{y}_{t}^{k*}$ are obtained by taking the values of Y_{ijt}^{k} and Y_{ijt}^{k*} for each household, then calculating their anti-logs, y_{ijt}^{k} and y_{ijt}^{k*} and then calculating their means. The values of $\bar{y}_{t}^{k}$ and $\bar{y}_{t}^{k*}$ are not calculated by taking the anti-logs of the mean values of Y_{ijt}^{k} and Y_{ijt}^{k*}, because the mean of the logs is not equal to the log of the mean.

are set and administered by local officials, it seems plausible that a household with political connections is less likely to be restricted. But because political connections do not directly affect productivity, we expect that they are not otherwise correlated with productivity, except through the channel of land use restrictions, the main channel through which local officials are capable of influencing household-level productivity. It follows that data on these connections are potentially capable of serving as an instrumental variable (IV) for land use restrictions (Angrist and Krueger, 2001; Murray, 2006).

The Two-Stage Least Squares (IV) procedure is now:

(i) Estimate the first-stage equation, where the dependent variable is the land use restrictions variable R_{ijt} and the independent variables are the full set of control variables, including fixed effects, appearing in equation (2) except for the land use restrictions, together with the full set of political connection dummy variables defined above:

$$R_{ijt} = \alpha + \gamma L_{ijt} + \delta N_{ijt} + \theta' C_{jt} + \vartheta' X_{ijt} + \mu_i + v_j + \sum_{r=1}^{3}\sum_{m=1}^{6} \pi_t^{rm} D_{ijt}^{rm} + \varepsilon_{ijt}, \quad (6)$$

where terms are defined as above. The 18 new coefficients relating to political connections, π_t^{rm} (r = 1, 2, 3; m = 1, …, 6) are parameters to be estimated.

(ii) Estimate the second-stage equation by re-estimating equation (2) above, but replacing the observed values R_{ijt} with the predicted values $\hat{R}_{ijt}$ from the first stage, equation (6).

$$Y_{ijt}^{k} = \alpha^{k\#} + \beta^{k\#}\hat{R}_{ijt} + \gamma^{k\#} L_{ijt} + \delta^{k\#} N_{ijt} + \theta^{k\#\prime} C_{jt} + \vartheta^{k\#\prime} X_{ijt} + \mu_i + v_j + \varepsilon_{ijt}^{k\#}. \quad (7)$$

where the superscript # is used to distinguish the magnitudes of the parameters and error terms estimated in (7) from those estimated in (2).

4.4. Simulations Using the Estimated Instrumental Variables Model

The quantitative implications of the estimated instrumental variables model can now be simulated with the same method applied to the fixed effects model above, but using the estimated parameters and error terms estimated from the second-stage equation (7) instead of those used in equation (3):

$$Y_{ijt}^{k*\#} = \alpha^{k\#} + \beta^{k\#} R_{ijt}^{*} + \gamma^{k\#} L_{ijt} + \delta^{k\#} N_{ijt} + \theta^{k\#\prime} C_{jt} + \vartheta^{k\#\prime} X_{ijt} + \mu_i + v_j + \varepsilon_{ijt}^{k\#}. \quad (8)$$

It is now apparent that the estimated counterfactual value of Y_{ijt}^{k}, is

$$Y_{ijt}^{k*\#} = Y_{ijt}^{k} - \beta^{k\#}(\hat{R}_{ijt} - R_{ijt}^{*}) = Y_{ijt}^{k} - \beta^{k\#}\hat{R}_{ijt}, \quad (9)$$

since the counterfactual value of the restrictions remains $R_{ijt}^{*} = 0$.

5. Regression Results and Interpretation

5.1. Fixed Effects Results

Fixed effects regression results based on equation (2) are provided in the four Appendix Tables C1 to C4. The results of greatest interest relate to the variable 'Land restriction' (equation (1)). These results, shown in bold font in the first row of each of these tables, are qualitatively similar for the four pairs of years. These results imply that the crop choice restrictions:

(i) significantly raise the share of crop land devoted to paddy rice production (column (1));

(ii) significantly reduce the value of total crop output per unit of total crop land (column (2));

(iii) have no significant effect on the value of rice produced per unit of total crop land (column (3));

(iv) significantly reduce the value of rice produced per unit of paddy land sown to rice (column (4));

(v) significantly reduce the value of non-rice crops produced per unit of total crop area (column (5));

(vi) significantly reduce the value of total crop output per unit of farm labour input (column (6)); and

(vii) significantly reduce farm household income per capita (column (7)).

We interpret these findings as follows. Result (i) indicates that the policy achieves the intended re-allocation of crop land away from other crops and towards paddy. This finding is expected because the allocation of land can be and is monitored by local authorities to ensure compliance with the crop choice restrictions. Result (ii) means that restricting farmers' choice of crops reduces the measured productivity of their crop land. This result is also expected if we assume that farmers are able to judge the most productive use of their land, measured in commercial terms, in turn implying that many farmers would change their land allocation, away from rice, if they were free to do so.

Result (iii) is perhaps the most surprising and most important because it implies that the policy objective of the land-use restrictions – raising rice output, relative to what would otherwise have occurred – is not achieved. The land use restrictions do not control inputs other than land, such as labour, fertiliser and machinery, whose allocation cannot be effectively monitored by local authorities. Because the restrictions reduce the value of the marginal products of these inputs on restricted plots, farmers respond by reducing their inputs of these factors on those restricted plots. The control of land inputs does not correspond to an increase in rice output. Result (iv) is consistent with this interpretation and with the finding in Table 3 above, that mean yields on restricted plots are lower than those on unrestricted plots where rice is the chosen crop.

Result (v) confirms the expected implication of the above account: the crop use restrictions reduce the value of crops other than rice produced per unit of crop land. Result (vi) similarly confirms that the productivity of farm labour, measured as the value of output produced per unit of labour, is reduced by restricting crop choice. Finally, result (vii) implies that household incomes per household member are reduced by the restrictions, potentially increasing measured rural poverty incidence relative to what would have happened in their absence.

5.2. Instrumental Variables Regression Results

The first-stage regression results are summarised in Appendix Tables D1 to D4. They indicate that the instrumental variables strategy was successful. The standard Stock-Yogo *F*-test for the null joint hypothesis that the true coefficients for all instruments are zero exceeds the critical value at a 95% confidence level in every year.[13] The instruments are not weak. The most significant political connection varies somewhat, but in most years, it is having a relative or friend who is a commune official.

The second-stage regression results (Appendix Tables E1 to E4) are qualitatively similar to the fixed effects results and the qualitative story emerging from them is very similar to that described above for fixed effects.

[13]Angrist and Pischke (2015: 145) stated that a popular rule of thumb is that a minimum acceptable value for this statistic is about 10. Our estimates well exceed this value in every year.

6. Magnitude of Estimated Productivity Impacts

The fact that an intervention has estimated effects that are statistically significant means that we can be relatively confident (depending on the significance level) that the productivity effects are non-zero. But we also wish to know their expected magnitudes and not just whether they are non-zero. Especially when these regression results are based on a large sample of households, estimates can be produced with low standard errors. Statistically significant findings do not necessarily mean that the effects are quantitatively 'large'.

6.1. Fixed Effects Simulation Results

We now use equation (3) and the regression results summarised in Appendix Tables C1 to C4 to simulate the magnitude of the effects that the land restrictions have on the *levels* (not the logarithms of the levels) of each of the productivity-based dependent variables.[14] These are the dependent variables appearing (as logarithms) in the fixed effects regressions (equation (2). The results reflect simulations based on the estimated parameters of equation (2), together with the estimated residuals, as described in Section 4.2 above. The results for each 2-year interval are summarised in Appendix Table F1. All monetary amounts are calculated in constant prices. The significance tests, indicated by the asterisks on the variables 'Difference (observed – counterfactual)' and 'Percentage difference' reflect the estimated significance levels of the variable 'Land restriction share (0 to 1)'. The findings are qualitatively consistent across years. Table 4 summarises the findings by showing the mean of the four 2-year intervals.

Compared with the counterfactual of no restrictions, the estimated effect of the restrictions is as follows:

(i) the value of crop output per unit of crop land is reduced by 4.6%;

(ii) the value of rice output per unit of total crop land is unaffected (the estimates for each 2-year are negative but not significantly different from zero);

(iii) the value of rice output per unit of paddy land is reduced by 3%;

(iv) the value of other crops is reduced by 4.4%;

(v) the value of crop output per unit of farm labour is reduced by 7.1%; and

[14]This means those shown in columns (2) to (7) of these tables, but not column (1), 'Log of paddy land over total crop land', because this is not a measure of productivity.

(vi) household income per household member is reduced by 5.6%.

6.2. Instrumental Variables Simulation Results

Appendix Table F2 (again, all monetary amounts are in constant prices), summarised in Table 5 presents estimates of impacts comparable with Appendix Table F1 and Table 4, but based on the instrumental variables regression results summarised in Appendix Tables E1 to E4. They are qualitatively similar to the fixed effects estimates summarised above.

Table 4: Fixed Effect Model: Simulated Impact of Land Use Restrictions, Mean of All Years

Variable	*Dependent Variables*					
	Log value crop output / ha total crop land	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Mean of all years						
Mean of observed data	45,273	32,213	33,643	13,424	6,480	18,170
Mean of counterfactual simulation	47,366	33,317	34,652	14,011	6,940	19,192
Difference (observed – counterfactual)	–2,093	–1,104	–1,009	–587	–460	–1,022
Percentage difference	–4.62	–3.43	–3.00	–4.37	–7.10	–5.63

Note*:* The above results are based on the panel dataset described in the text.
See Appendix Table F1 for results for each of the four 2-year intervals.
Source: Authors' calculations from VARHS data.

Table 5: IV Model: Estimated Impact of Land Use Restrictions, Household Level, Mean of All Years

	Dependent Variables					
Variable	**Value of crop output / ha total crop land**	**Value of rice output / ha total crop land**	**Value of rice output / ha paddy land**	**Value of other crops / ha total crop land**	**Value of crop output / farm labour input**	**Value of hh. income / household member**
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of observed data	45,273	32,213	33,643	13,424	6,480	18,170
Mean of counterfactual simulation	47,367	33,738	34,752	14,162	7,029	19,068
Difference (observed – counterfactual)[a]	–2,094	–1,525	–1,109	–738	–549	–898
Percentage difference	–4.63	–4.73	–3.30	–5.50	–8.47	–4.94

Note: The above results are based on the panel dataset described in the text.
See Appendix Table F2 for results for each of the four 2-year intervals.
Source: Authors' calculations from VARHS data.

7. Conclusions

Beginning in 1986, Viet Nam implemented an ambitious programme of market-based economic reform that has greatly increased economic productivity. The reforms expanded the freedom of farming and non-farming enterprises to choose their inputs and outputs independently. An important exception was the continued restriction on reallocation to other crops of land currently used for rice cultivation. A little under half of all plots devoted to crop production remain restricted in this way. The restrictions have been applied to both irrigated and non-irrigated plots, but especially the former. As economic circumstances have changed, many farmers have judged it profitable to switch from rice production to other crops, but large numbers have been prevented from doing so by the restrictions. This paper estimates the effects that the restrictions have had on agricultural productivity.

Our analysis studies the effects the restrictions have had on six different measures of agricultural productivity. It draws upon the 2-year rolling panel data component of the Viet Nam Access to Resources Household Survey (VARHS), covering the years 2008 to 2016. The econometrics uses fixed effects methods with and without the additional use of instrumental variable methods to allow for the possible statistical endogeneity of the restrictions. Data on the political connections of households proved to be a strong instrument for the restrictions. Nevertheless, the findings using fixed effects and instrumental variables methods were not greatly different. The sign patterns were the same and the magnitudes were similar. That is, the results indicate that endogeneity of land restrictions is real but that allowing for it does not change the qualitative findings.

According to our findings, the crop choice restrictions reduced the overall productivity of crop land by about 5%. The productivity of farm labour was reduced by about 8 and the incomes of farm households was reduced by 5% to 6%, implying increased levels of rural poverty. It is important that these estimated effects are not one-off, but continuing, as long as the restrictions remain in place.

The objective of the crop choice restrictions is to maintain the production of rice. But our results imply that this objective has not been achieved. Rice output would have been no lower if the restrictions were removed. When a farm household is restricted from switching its (monitored) use of land from rice to non-rice production, despite their

wish to make this change, the household responds by reducing its (unmonitored) labour and material inputs on these restricted plots and uses them elsewhere, where their return is greater. A reflection of this response is that rice yields on restricted plots are substantially lower than those on unrestricted plots where rice is still the chosen crop. In the case of labour, this impact includes off-farm use. By reducing the productivity of on-farm labour, the crop choice restrictions encourage the exit of labour from agricultural production.

The above estimates do not take account of dynamic effects of crop choice restrictions, including reductions in the incentive to invest in productivity-raising machinery, improvements to irrigation systems or other innovations, because they reduce the benefits they generate. Long-run impacts of this kind, which seem likely, would reinforce the short-run productivity-reducing effects demonstrated in this paper.

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Statistical Appendix

Section A (A1 to A4): Summary of household level statistics, panel data

Section B (B1 to B4): Summary of political connection variables, panel data

Section C (C1 to C4): Fixed effects model: Regression results at household level

Section D (D1 to D4): IV model: First stage regression results at household level

Section E (E1 to E4): IV model: Second stage regression results at household level

Section F (F1 to F2): Estimated productivity impacts of land restrictions

Appendix Table A1: Summary of Household Level Statistics, Panel Data, 2008–2010

Variables	Mean	Std. Dev.	Min.	Max.
Dependent variables				
Log paddy land over total crop land	0.235	0.359	0	4.74
Log value agricultural output per ha total crop land	9.953	1.768	0	17.223
Log value rice output per ha total crop land	9.18	2.489	0	16.929
Log value rice output per ha paddy land	9.894	2.289	0	17.479
Log value other annual crops per ha total crop land	0.292	0.368	0	3.64
Log value of agricultural output per unit farm labour	8.217	0.943	0.405	13.202
Log of total income per capita	9.34	0.80	5.94	13.161
Independent variables				
Share restricted land area over total crop land	0.23	0.34	0	1
Log crop inputs per ha total crop land	9.18	2.71	0	16.86
Share household's land with land-use right certificates	0.50	0.45	0	1
Log working days on farm per ha total crop land	4.60	1.38	0	7.21
Ethnicity of the head (Kinh = 1; others = 0)	0.57	0.50	0	1
Mean education of working age men	7.60	8.43	0	55.50
Mean education of working age women	7.64	8.80	0	61.40
Dependency ratio (%)	0.38	0.26	0	1
Age of household head	49.1	13.8	14	109
Gender household head (male = 1; female = 0)	0.85	0.36	0	1
Member working on household's business (yes = 1; no = 0)	0.37	0.48	0	1
Member working in private sector (yes = 1; no = 0)	0.06	0.24	0	1

Note: Number of observations: 2,602 households in each of the two years, 2008 and 2010.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table A2: Summary of Household Level Statistics, Panel Data, 2010–2012

Variables	Mean	Std. Dev.	Min.	Max.
Dependent Variables				
Log paddy land over total crop land	0.283	0.380	0	4.741
Log value agricultural output per ha total crop land	9.714	2.609	0	14.042
Log value rice output per ha total crop land	8.877	3.285	0	13.149
Log value rice output per ha paddy land	9.691	2.973	0	13.788
Log value other annual crops per ha total crop land	0.308	0.426	0	3.640
Log value of agricultural output per unit farm labour	8.379	0.952	0.405	13.202
Log of total income per capita	9.42	0.840	5.610	13.684
Independent Variables				
Share restricted land area over total crop land	0.27	0.365	0	1
Log crop inputs per ha total crop land	9.66	2.54	0	16.01
Share household's land with land-use right certificates	0.52	0.44	0	1
Log working days on farm per ha total crop land	4.51	1.36	0	7.21
Ethnicity of the head (Kinh = 1; others = 0)	0.58	0.49	0	1
Mean education of working age men	7.72	6.77	0	52.25
Mean education of working age women	7.88	7.42	0	59.20
Dependency ratio (%)	0.40	0.26	0	1
Age of household head	49.9	13.4	14	107
Gender household head (male = 1; female = 0)	0.43	0.49	0	1
Member working on household's business (yes = 1; no = 0)	0.41	0.49	0	1
Member working in private sector (yes = 1; no = 0)	0.08	0.27	0	1

Note: Number of observations: 2,111 households in each of the two years, 2010 and 2012.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table A3: Summary of Household Level Statistics, Panel Data, 2012–2014

Variables	Mean	Std. Dev.	Min.	Max.
Dependent Variables				
Log paddy land over total crop land	0.345	0.378	0	4.190
Log value agricultural output per ha total crop land	10.315	1.719	0	14.221
Log value rice output per ha total crop land	9.502	2.768	0	13.136
Log value rice output per ha paddy land	10.299	2.080	0	13.788
Log value other annual crops per ha total crop land	0.325	0.456	0	3.675
Log value of agricultural output per unit farm labour	8.515	0.946	3.891	13.023
Log of total income per capita	9.82	0.822	5.68	15.053
Independent Variables				
Share restricted land area over total crop land	0.34	0.373	0	1
Log crop inputs per ha total crop land	9.84	2.86	0	16.01
Share household's land with land-use right certificates	0.52	0.44	0	1
Log working days on farm per ha total crop land	5.16	1.75	0	10.10
Ethnicity of the head (Kinh = 1; others = 0)	0.60	0.48	0	1
Mean education of working age men	7.73	6.21	0	52.25
Mean education of working age women	7.52	6.68	0	59.20
Dependency ratio (%)	0.17	0.25	0	1
Age of household head	51.4	13.6	18	100
Gender household head (male = 1; female = 0)	0.41	0.49	0	1
Member working on household's business (yes = 1; no = 0)	0.46	0.49	0	1
Member working in private sector (yes = 1; no = 0)	0.11	0.31	0	1

Note: Number of observations: 2,202 households in each of the two years, 2012 and 2014.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table A4: Summary of Household Level Statistics, Panel Data, 2014–2016

Variables	Mean	Std. Dev.	Min.	Max.
Dependent Variables				
Log paddy land over total crop land	0.334	0.352	0	4.250
Log value agricultural output per ha total crop land	10.693	1.594	0	15.042
Log value rice output per ha total crop land	9.502	2.768	0	13.136
Log value rice output per ha paddy land	10.308	2.110	0	14.117
Log value other annual crops per ha total crop land	0.405	0.427	0	3.898
Log value of agricultural output per unit farm labour	8.644	0.911	3.78	14.106
Log of total income per capita	9.93	0.851	5.98	15.471
Independent Variables				
Share restricted land area over total crop land	0.368	0.376	0	1
Log crop inputs per ha total crop land	9.80	2.71	0	16.01
Share household's land with land-use right certificates	0.53	0.44	0	1
Log working days on farm per ha total crop land	5.29	1.75	0	10.09
Ethnicity of the head (Kinh = 1; others = 0)	0.60	0.49	0	1
Mean education of working age men	7.74	6.22	0	52.47
Mean education of working age women	7.58	6.71	0	59.56
Dependency ratio (%)	0.17	0.24	0	1
Age of household head	51.2	13.42	18	101
Gender household head (male = 1; female = 0)	0.42	0.49	0	1
Member working on household's business (yes = 1; no = 0)	0.48	0.47	0	1
Member working in private sector (yes = 1; no = 0)	0.13	0.32	0	1

Note: Number of observations: 2,140 households in each of the two years, 2014 and 2016.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table B1: Summary of Political Connection Variables, Panel Data, 2008–2010

Variable	Mean	Std. Dev.	Min.	Max.
D^{11} (hh. member is a district leader)	0.001	0.031	0	1
D^{12} (hh. member is a district official)	0.005	0.069	0	1
D^{13} (hh. member is a commune leader)	0.011	0.104	0	1
D^{14} (hh. member is a commune official)	0.020	0.141	0	1
D^{15} (hh member is a mass organisation leader)	0.015	0.120	0	1
D^{16} (hh. member is 'other')	0.010	0.100	0	1
D^{21} (relative is a district leader)	0.013	0.112	0	1
D^{22} (relative is a district official)	0.045	0.206	0	1
D^{23} (relative is a commune leader)	0.038	0.192	0	1
D^{24} (relative is a commune official)	0.116	0.320	0	1
D^{25} (relative is a mass organisation leader)	0.009	0.095	0	1
D^{26} (relative is 'other')	0.005	0.072	0	1
D^{31} (friend is a district leader)	0.012	0.107	0	1
D^{32} (friend is a district official)	0.026	0.159	0	1
D^{33} (friend is a commune leader)	0.043	0.202	0	1
D^{34} (friend is a commune official)	0.065	0.246	0	1
D^{35} (friend is a mass organisation leader)	0.017	0.128	0	1
D^{36} (friend is 'other')	0.001	0.037	0	1

Note: Number of observations: 2,602 in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table B2: Summary of Political Connection Variables, Panel Data, 2010–2012

Variable	Mean	Std. Dev.	Min.	Max.
D^{11} (hh. member is a district leader)	0.001	0.034	0	1
D^{12} (hh. member is a district official)	0.004	0.065	0	1
D^{13} (hh. member is a commune leader)	0.012	0.110	0	1
D^{14} (hh. member is a commune official)	0.024	0.154	0	1
D^{15} (hh member is a mass organisation leader)	0.018	0.134	0	1
D^{16} (hh. member is 'other')	0.011	0.103	0	1
D^{21} (relative is a district leader)	0.008	0.091	0	1
D^{22} (relative is a district official)	0.044	0.205	0	1
D^{23} (relative is a commune leader)	0.016	0.127	0	1
D^{24} (relative is a commune official)	0.135	0.342	0	1
D^{25} (relative is a mass organisation leader)	0.000	0.000	0	0
D^{26} (relative is 'other')	0.000	0.000	0	0
D^{31} (friend is a district leader)	0.013	0.111	0	1
D^{32} (friend is a district official)	0.020	0.141	0	1
D^{33} (friend is a commune leader)	0.054	0.226	0	1
D^{34} (friend is a commune official)	0.096	0.295	0	1
D^{35} (friend is a mass organisation leader)	0.032	0.177	0	1
D^{36} (friend is 'other')	0.004	0.061	0	1

Note: Number of observations: 2,111 in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table B3: Summary of Political Connection Variables, Panel Data, 2012–2014

Variable	Mean	Std. Dev.	Min.	Max.
D^{11} (hh. member is a district leader)	0.001	0.033	0	1
D^{12} (hh. member is a district official)	0.006	0.077	0	1
D^{13} (hh. member is a commune leader)	0.010	0.100	0	1
D^{14} (hh. member is a commune official)	0.025	0.155	0	1
D^{15} (hh member is a mass organisation leader)	0.016	0.126	0	1
D^{16} (hh. member is 'other')	0.006	0.076	0	1
D^{21} (relative is a district leader)	0.007	0.085	0	1
D^{22} (relative is a district official)	0.041	0.198	0	1
D^{23} (relative is a commune leader)	0.015	0.121	0	1
D^{24} (relative is a commune official)	0.132	0.339	0	1
D^{25} (relative is a mass organisation leader)	0.007	0.095	0	1
D^{26} (relative is 'other')	0.006	0.072	0	1
D^{31} (friend is a district leader)	0.008	0.090	0	1
D^{32} (friend is a district official)	0.021	0.144	0	1
D^{33} (friend is a commune leader)	0.057	0.231	0	1
D^{34} (friend is a commune official)	0.080	0.271	0	1
D^{35} (friend is a mass organisation leader)	0.031	0.173	0	1
D^{36} (friend is 'other')	0.004	0.060	0	1

Note: Number of observations: 2,350 in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table B4: Summary of Political Connection Variables, Panel Data, 2014–2016

Variable	Mean	Std. Dev.	Min.	Max.
D^{11} (hh. member is a district leader)	0.001	0.032	0	1
D^{12} (hh. member is a district official)	0.007	0.081	0	1
D^{13} (hh. member is a commune leader)	0.007	0.083	0	1
D^{14} (hh. member is a commune official)	0.022	0.146	0	1
D^{15} (hh member is a mass organisation leader)	0.015	0.120	0	1
D^{16} (hh. member is 'other')	0.003	0.053	0	1
D^{21} (relative is a district leader)	0.006	0.075	0	1
D^{22} (relative is a district official)	0.041	0.197	0	1
D^{23} (relative is a commune leader)	0.016	0.125	0	1
D^{24} (relative is a commune official)	0.157	0.364	0	1
D^{25} (relative is a mass organisation leader)	0.012	0.125	0	1
D^{26} (relative is 'other')	0.021	0.116	0	1
D^{31} (friend is a district leader)	0.006	0.079	0	1
D^{32} (friend is a district official)	0.023	0.150	0	1
D^{33} (friend is a commune leader)	0.054	0.227	0	1
D^{34} (friend is a commune official)	0.068	0.252	0	1
D^{35} (friend is a mass organisation leader)	0.020	0.140	0	1
D^{36} (friend is 'other')	0.001	0.032	0	1

Note: Number of observations: 2,140 in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table C1: Fixed Effects Model: Regression Results at Household Level, 2008–2010

Independent Variables	*Dependent Variables*						
	Log ratio of paddy land to total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction	**0.606*** **	**–0.126** **	**–0.025**	**–0.092***	**–0.087*** **	**–0.143** **	**–0.103***
Log of crop inputs per ha of crop land	0.006*	0.476***	0.439***	0.178***	0.148***	0.251***	0.065**
Share of household's land with LURC	–0.035***	0.186***	0.188***	0.174**	0.062***	0.122*	0.108**
Log of family labour per ha of crop land	0.011**	0.209***	0.372***	0.854***	0.0245**	0.182***	0.082**
Ethnicity of head (Kinh = 1, others = 0)	0.012**	0.121*	0.425	0.240	–0.05	0.465	0.098
Mean education of working age men	0	0.003	0.003	0.002	0.002*	0.001	0.004
Mean education of working age women	0	0	0.005	0.004	0	–0.000	0.004
Dependency ratio (%)	–0.019	–0.114	0.050	0.019	0.041	0.115	–0.400***
Age of household head	0	–0.007	0.001	0.001	–0.003**	–0.008	0.003*
Gender of head (male = 1; female = 0)	–0.04	0.216	0.140	0.176	–0.004	–0.045	–0.203
With member in household's business	–0.002	–0.026	–0.114	0.019	–0.039***	–0.049	0.090**
With member in private sector	0.009	–0.088	0.089	0.087	–0.028	–0.120	0.209***
Farm assets	0.024*	0.016	0.019	0.038***	0.003	0.016	0
Disasters in commune	0.002	–0.041	–0.043	0.011	0.011	–0.038	–0.017
Access to asphalt road	–0.026	–0.005	0.008	–0.013	–0.046	–0.004	–0.031
Having market in commune	0.007	0	0	0.001	–0.001	0	0
Share of land irrigated in commune	0.004	0.003	0	–0.002	0.01	–0.011	0.009
Constant	–0.082***	0.458***	0.148***	–0.098**	0.277***	0.372***	0.312***
N	2,602	2,602	2,602	2,602	2,602	2,602	2,602
R^2	0.667	0.599	0.425	0.526	0.273	0.326	0.282
F (17, 2,385)	238.4	238.4	238.4	252.3	253.4	129.8	91.2

Note: 'Land restriction' means R_{ijt} as calculated from equation (1) in the text.
N means the number of observations in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table C2: Fixed effects model: Regression results at household level, 2010–2012

	Dependent Variables						
Independent Variables	**Log of paddy land over total crop land**	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction	**0.599*** **	**–0.112** **	**–0.087**	**–0.146** **	**–0.068***	**–0.145***	**–0.109** **
Log of crop inputs per ha of crop land	–0.005**	0.208***	0.266***	0.211***	0.272***	0.224***	–0.081*
Share of household's land with LURC	0.021**	0.143**	0.120***	0.082*	0.058***	0.373***	0.014**
Log of family labour per ha of crop land	0.018*	0.127***	0.088***	0.064**	0.062***	0.117***	0.197***
Ethnicity of head (Kinh = 1, others = 0)	0.061**	0.067	0.216	0.379	0.141*	0.099*	0.009
Mean education of working age men	0	0.012*	–0.003	–0.002	0	0.005	0.038
Mean education of working age women	0	0.001	–0.002	–0.001	–0.002**	–0.003	0.072*
Dependency ratio (%)	0.034*	0.164	–0.061	–0.083	–0.02	0.131	–0.148**
Age of household head	–0.001	0.002	–0.002**	–0.005**	0	0.003*	0.098*
Gender of head (male = 1; female = 0)	0.012	–0.064	–0.038	0.034	–0.047***	–0.239***	0.172
With member in household's business	–0.011	0.05	–0.088*	–0.122	–0.031***	–0.015	0.104*
With member in private sector	0.015	0.013	0.123	0.072	–0.036*	0.143	0.068
Farm assets	0.002	0.021	0.031	0.021	–0.05	0.038***	0.030*
Disasters in commune	0.025	0.016	0.019	0.012***	–0.002	0.018	–0.111**
Access to asphalt road	–0.046	–0.044	–0.029	0.02	–0.018	–0.011	0.006
Having market in commune	–0.001	–0.004	0.011	–0.011	–0.071	0	0.001*
Share of land irrigated in commune	0.01	0	0	0	–0.002	0.007	0.019
Constant	–0.081***	0.181**	0.103	–0.118*	0.316***	0.169***	0.511**
N	2,111	2,111	2,111	2,111	2,111	2,111	2,111
R^2	0.632	0.463	0.478	0.502	0.187	0.34	0.342
F (17, 2094)	148.5	162.9	246.3	303.8	301.2	189.6	98.4

Note*:* 'Land restriction' means R_{ijt} as calculated from equation (1) in the text. *N* means the number of observations in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table C3: Fixed Effects Model: Regression Results at Household Level, 2012–2014

Independent Variables	*Dependent Variables*						
	Log of paddy land over total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction	**0.582*** **	**–0.095** **	**0.087**	**–0.091** **	**–0.102*** **	**–0.126** **	**–0.112***
Log of crop inputs per ha of crop land	–0.002	0.411***	0.232***	0.218***	0.199***	0.469**	0.051*
Share of household's land with LURC	0.019*	0.131**	0.112***	0.164**	0.068**	0.106*	0.088**
Log of family labour per ha of crop land	0.023***	0.113**	0.107**	0.161***	0.424***	0.111**	0.09*
Ethnicity of head (Kinh = 1, others = 0)	0.08**	0.23	0.011**	0.455	0.27	0.48	0.231
Mean education of working age men	–0.002	0.025*	0.031	0.033	0.032	0.033	0.076
Mean education of working age women	0.003	0.008*	0.033	0.035	0.034	0.032*	0.078*
Dependency ratio (%)	–0.007	–0.217	–0.129	0.08	0.049	–0.234*	–0.329
Age of household head	0	–0.004*	0.029*	0.031*	0.031	0.027	0.147
Gender of head (male = 1; female = 0)	–0.008	0.058	–0.061	0.17	0.206	0.08	0.202
With member in household's business	–0.001	–0.065	0.044	–0.084	0.049	–0.184*	0.126**
With member in private sector	0.001	–0.105	0.066*	0.119	0.117	–0.081	0.098
Farm assets	0.023***	0.038*	0.028	–0.013	0.018	0.007	0.029*
Disasters in commune	–0.086	–0.005	–0.011	–0.006	–0.008	0.009	0.02
Access to asphalt road	–0.04	0.026	0.033	0.019	–0.078	–0.026	0.043
Having market in commune	0.012	0.017	0.021*	0.042**	0.001	0.081	0.019
Share of land irrigated in commune	–0.031	–0.052	–0.034	0.014	–0.002	0.003**	–0.001
Constant	–0.151***	0.471***	0.102*	0.121***	0.320***	0.227***	0.126**
N	2,202	2,202	2,202	2,202	2,202	2,202	2,202
R^2	0.626	0.285	0.585	0.635	0.274	0.308	0.256
F (17, 2,136)	14.5	43.6	246.3	303.8	301.9	89.6	77.2

Note: 'Land restriction' means R_{ijt} as calculated from equation (1) in the text.
N means the number of observations in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Table C4: Fixed Effects Model: Regression Results at Household Level, 2014–2016

Independent Variables	*Dependent Variables*						
	Log of paddy land over total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land restriction	**0.481*** **	**–0.108** **	**–0.072**	**–0.092** **	**–0.122***	**–0.115***	**–0.118** **
Log of crop inputs per ha of crop land	0.008	0.406***	0.263***	0.311***	0.365***	0.426***	–0.092*
Share of household's land with LURC	0.023*	0.127***	0.097***	0.075***	0.025**	0.133**	0.179*
Log of family labour per ha of crop land	0.011*	0.194*	0.126	0.197***	0.069**	0.187***	0.087
Ethnicity of head (Kinh = 1, others = 0)	0.019**	0.008	0.030**	0.009	0.007	–0.072	0.228**
Mean education of working age men	0.003	–0.006	0.021	0.014	0.023	0.032	0.073***
Mean education of working age women	0.004	0.038	0.027	–0.013	0.019	0.024	0.075**
Dependency ratio (%)	–0.012	–0.003	–0.01	–0.006	–0.008	0.158*	–0.332
Age of household head	0	0.022	0.032	0.024	–0.058	0.03	0.144**
Gender of head (male = 1; female = 0)	–0.009	0.015	0.019	0.038***	–0.003	–0.212**	0.199
With member in household's business	–0.004	0.077	–0.061	–0.095	–0.004	0.012	0.123
With member in private sector	0.008	0.04	0.15	0.099	–0.009	0.17	0.095
Farm assets	0.31*	0.038	0.028	–0.013	0.018	0.028	0.022*
Disasters in commune	–0.019	–0.005	–0.011	–0.006	–0.008	–0.009	–0.01
Access to asphalt road	–0.09	–0.042	–0.028	0.018	–0.011	0.014	0.111*
Having market in commune	0.034	–0.003	0.01	–0.011	–0.078	–0.012	0.008
Share of land irrigated in commune	0.012	0	0	0	–0.002	0	0.001*
Constant	–0.158***	0.129**	0.354***	0.222***	0.195***	0.221***	0.072**
N	2,140	2,140	2,140	2,140	2,140	2,140	2,140
R^2	0.601	0.465	0.570	0.581	0.304	0.378	0.267
F (17, 2123)	103.5	136.2	188.0	266.3	109.7	116.7	88.6

Note: 'Land restriction' means R_{ijt} as calculated from equation (1) in the text.
N means the number of observations in each of the two years.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table D1: IV Model: First Stage Regression Results at Household Level, 2008–2010

Dependent Variable: **Land Restriction**				
Independent Variables	**Coef.**	**Std. Err.**	***t* statistic**	**P>t**
Log of crop inputs per ha of crop land	–0.016	0.002	–7.740	0.000
Share of household's land with LURC	0.053	0.008	6.400	0.000
Log of family labour per ha of crop land	0.034	0.003	11.530	0.000
Ethnicity of the head (Kinh =1, others = 0)	0.145	0.009	15.510	0.000
Mean education of working age men	–0.001	0.000	–1.880	0.060
Mean education of working age women	–0.001	0.000	–2.600	0.009
Dependency ratio (%)	–0.018	0.014	–1.310	0.189
Age of household head	0.000	0.000	1.730	0.084
Gender of head (male = 1; female = 0)	–0.010	0.010	–0.990	0.321
With member in household's business	0.018	0.007	2.440	0.015
With member in private sector	0.020	0.015	1.340	0.179
Farm assets	0.002	0.000	10.720	0.000
Disasters in commune	0.000	0.000	–6.060	0.000
Access to asphalt road	0.000	0.000	6.900	0.000
Having markets in commune	0.000	0.000	–4.030	0.000
Share of land irrigated in commune	–0.001	0.010	–0.150	0.881
D^{11} (hh. member is a district leader)	0.066	0.131	0.500	0.615
D^{12} (hh. member is a district official)	0.036	0.042	0.880	0.381
D^{13} (hh. member is a commune leader)	0.010	0.025	0.400	0.690
D^{14} (hh. member is a commune official)	–0.028	0.018	–1.550	0.122
D^{15} (hh member is a mass organisation leader)	0.012	0.027	0.450	0.651
D^{16} (hh. member is 'other')	–0.009	0.029	–0.310	0.759
D^{21} (relative is a district leader)	–0.002	0.026	–0.080	0.933
D^{22} (relative is a district official)	0.030	0.016	1.880	0.060
D^{23} (relative is a commune leader)	–0.011	0.017	–0.640	0.524
D^{24} (relative is a commune official)	–0.007	0.010	–0.660	0.507
D^{25} (relative is a mass organisation leader)	0.040	0.044	0.920	0.359
D^{26} (relative is 'other')	–0.053	0.043	–1.210	0.226
D^{31} (friends is a district leader)	0.035	0.038	0.930	0.352
D^{32} (friend is a district official)	–0.013	0.021	–0.630	0.530
D^{33} (friend is a commune leader)	–0.017	0.017	–1.030	0.302
D^{34} (friend is a commune official)	0.037	0.014	2.690	0.007
D^{35} (friend is a mass organisation leader)	0.025	0.026	0.950	0.342
D^{36} (friend is 'other')	–0.015	0.077	–0.190	0.849
Constant	–0.001	0.023	–0.060	0.953
$F(12, 2459) = 58.62$				
Prob. > F = 0.0000				
Centered R^2 = 0.2068				
Uncentered R^2 = 0.4622				
Stock-Yogo F statistic (18, 5166) = 38.44				
Stock-Yogo weak ID test critical values at 5% = 20.34				
Hansen J statistic = 13.874				

Source: Authors' calculations using data from VARHS Survey.

Appendix Table D2: IV Model: First Stage Regression Results at Household Level, 2010–2012

Dependent Variable: **Land Restriction**				
Independent Variables	**Coef.**	**Std. Err.**	***t* statistic**	**P>t**
Log of crop inputs per ha of crop land	–0.024	0.003	–9.26	0.000
Share of household's land with LURC	0.069	0.010	7.1	0.000
Log of family labour per ha of crop land	0.037	0.004	9.94	0.000
Ethnicity of the head (Kinh =1, others = 0)	0.154	0.008	18.81	0.000
Mean education of working age men	–0.002	0.001	–3.08	0.002
Mean education of working age women	–0.001	0.001	–2.06	0.039
Dependency ratio (%)	–0.022	0.022	–1.000	0.317
Age of household head	–0.001	0.000	–5.06	0.000
Gender of head (male = 1; female = 0)	–0.036	0.012	–2.85	0.004
With member in household's business	0.019	0.008	2.47	0.013
With member in private sector	0.028	0.015	1.81	0.07
Farm assets	0.002	0.000	10.72	0.000
Disasters in commune	0.000	0.000	–6.06	0.000
Access to asphalt road	0.000	0.000	6.9	0.000
Having markets in commune	0.000	0.000	–4.03	0.000
Share of land irrigated in commune	–0.001	0.010	–0.15	0.881
D^{11} (hh. member is a district leader)	0.014	0.120	0.12	0.908
D^{12} (hh. member is a district official)	0.031	0.043	0.72	0.473
D^{13} (hh. member is a commune leader)	0.034	0.035	0.95	0.344
D^{14} (hh. member is a commune official)	–0.009	0.022	–0.4	0.69
D^{15} (hh member is a mass organisation leader)	–0.019	0.024	–0.81	0.419
D^{16} (hh. member is 'other')	–0.039	0.031	–1.26	0.207
D^{21} (relative is a district leader)	–0.008	0.038	–0.2	0.845
D^{22} (relative is a district official)	0.037	0.019	1.97	0.048
D^{23} (relative is a commune leader)	0.018	0.030	0.6	0.549
D^{24} (relative is a commune official)	–0.003	0.011	–0.27	0.783
D^{25} (relative is a mass organisation leader)	0.049	0.038	1.31	0.192
D^{26} (relative is 'other')	–0.006	0.026	–0.24	0.812
D^{31} (friend is a district leader)	0.049	0.038	1.31	0.192
D^{32} (friend is a district official)	–0.006	0.026	–0.24	0.812
D^{33} (friend is a commune leader)	0.000	0.018	–0.01	0.995
D^{34} (friend is a commune official)	–0.018	0.013	–1.38	0.168
D^{35} (friend is a mass organisation leader)	0.008	0.022	0.35	0.724
D^{36} (friend is 'other')	0.204	0.050	4.13	0.000
Constant	0.160	0.018	9.03	0.000
$F(37, 4184) = 61.05$				
Prob. > F = 0.0000				
Centered R^2 = 0.1883				
Uncentered R^2 = 0.4979				
Stock-Yogo F statistic (18, 5166) = 29.22				
Stock-Yogo weak ID test critical values at 5% =17.95				
Hansen J statistic = 13.874				

Source: Authors' calculations using data from VARHS Survey.

Appendix Table D3: IV Model: First Stage Regression Results at Household Level, 2012–2014

Dependent Variable: **Land Restriction**				
Independent Variables	**Coef.**	**Std. Err.**	***t* statistic**	**P>t**
Log of crop inputs per ha of crop land	–0.016	0.002	–6.69	0.000
Share of household's land with LURC	0.040	0.010	4.25	0.000
Log of family labour per ha of crop land	0.038	0.004	9.91	0.000
Ethnicity of the head (Kinh =1, others = 0)	0.142	0.008	17.19	0.000
Mean education of working age men	–0.004	0.003	–1.39	0.166
Mean education of working age women	0.004	0.003	1.64	0.101
Dependency ratio (%)	–0.004	0.022	–0.2	0.838
Age of household head	0.000	0.000	–0.67	0.504
Gender of head (male = 1; female = 0)	–0.013	0.013	–1.000	0.318
With member in household's business	0.031	0.008	3.99	0.000
With member in private sector	0.033	0.013	2.5	0.013
Farm assets	0.002	0.000	10.72	0.000
Disasters in commune	0.000	0.000	–6.06	0.000
Access to asphalt road	0.000	0.000	6.9	0.000
Having markets in commune	0.000	0.000	–4.03	0.000
Share of land irrigated in commune	–0.001	0.010	–0.15	0.881
D^{11} (hh. member is a district leader)	0.036	0.139	0.26	0.798
D^{12} (hh. member is a district official)	0.021	0.046	0.46	0.643
D^{13} (hh. member is a commune leader)	0.008	0.042	0.19	0.847
D^{14} (hh. member is a commune official)	0.009	0.024	0.38	0.702
D^{15} (hh member is a mass organisation leader)	–0.008	0.026	–0.3	0.764
D^{16} (hh. member is 'other')	–0.038	0.044	–0.86	0.388
D^{21} (relative is a district leader)	0.101	0.043	2.34	0.019
D^{22} (relative is a district official)	0.001	0.020	0.05	0.959
D^{23} (relative is a commune leader)	0.042	0.031	1.36	0.175
D^{24} (relative is a commune official)	0.043	0.012	3.46	0.001
D^{25} (relative is a mass organisation leader)	0.040	0.044	0.92	0.359
D^{26} (relative is 'other')	–0.053	0.043	–1.21	0.226
D^{31} (friend is a district leader)	–0.016	0.042	–0.37	0.713
D^{32} (friend is a district official)	0.052	0.027	1.92	0.055
D^{33} (friend is a commune leader)	0.021	0.018	1.2	0.232
D^{34} (friend is a commune official)	–0.047	0.016	–2.99	0.003
D^{35} (friend is a mass organisation leader)	–0.040	0.022	–1.83	0.067
D^{36} (friend is 'other')	0.185	0.050	3.7	0.000
Constant	0.102	0.015	6.63	0.000
$F(37, 4662) = 42.65$				
Prob. > F = 0.0000				
Centered R^2 = 0.1201				
Uncentered R^2 = 0.4537				
Stock-Yogo F statistic (18, 5166) = 27.15				
Stock-Yogo weak ID test critical values at 5% = 17.87				
Hansen J statistic = 21.253				

Source: Authors' calculations using data from VARHS Survey.

Appendix Table D4: IV Model: First Stage Regression Results at Household Level, 2014–2016

Dependent Variable: **Land Restriction**				
Independent Variables	**Coef.**	**Std. Err.**	***t* statistic**	**P>t**
Log of crop inputs per ha of crop land	–0.005	0.003	–1.7	0.089
Share of household's land with LURC	–0.022	0.012	–1.88	0.06
Log of family labour per ha of crop land	0.022	0.005	4.4	0.000
Ethnicity of the head (Kinh =1, others = 0)	0.131	0.012	10.75	0.000
Mean education of working age men	0.002	0.003	0.53	0.596
Mean education of working age women	0.008	0.003	2.94	0.003
Dependency ratio (%)	0.011	0.021	0.5	0.62
Age of household head	0.001	0.000	2.23	0.026
Gender of head (male = 1; female = 0)	0.006	0.014	0.47	0.637
With member in household's business	0.044	0.010	4.41	0.000
With member in private sector	0.039	0.017	2.28	0.022
Farm assets	0.002	0.000	10.72	0.000
Disasters in commune	0.000	0.000	–6.06	0.000
Access to asphalt road	0.000	0.000	6.9	0.000
Having markets in commune	0.000	0.000	–4.03	0.000
Share of land irrigated in commune	–0.001	0.010	–0.15	0.881
D^{11} (hh. member is a district leader)	–0.216	0.105	–2.06	0.039
D^{12} (hh. member is a district official)	0.041	0.061	0.68	0.495
D^{13} (hh. member is a commune leader)	–0.009	0.055	–0.17	0.867
D^{14} (hh. member is a commune official)	–0.004	0.035	–0.13	0.9
D^{15} (hh member is a mass organisation leader)	–0.001	0.040	–0.03	0.972
D^{16} (hh. member is 'other')	0.054	0.096	0.56	0.577
D^{21} (relative is a district leader)	0.068	0.056	1.22	0.222
D^{22} (relative is a district official)	–0.012	0.026	–0.46	0.645
D^{23} (relative is a commune leader)	0.010	0.039	0.27	0.786
D^{24} (relative is a commune official)	0.081	0.018	4.6	0.000
D^{25} (relative is a mass organisation leader)	0.040	0.044	0.92	0.359
D^{26} (relative is 'other')	–0.053	0.043	–1.21	0.226
D^{31} (friend is a district leader)	–0.105	0.060	–1.74	0.083
D^{32} (friend is a district official)	0.027	0.036	0.76	0.45
D^{33} (friend is a commune leader)	0.014	0.024	0.59	0.556
D^{34} (friend is a commune official)	–0.020	0.024	–0.84	0.402
D^{35} (friend is a mass organisation leader)	–0.104	0.033	–3.19	0.001
D^{36} (friend is 'other')	–0.074	0.076	–0.97	0.331
Constant	–0.019	0.033	–0.57	0.568
$F(37, 44242) = 43.72$				
Prob. > F = 0.0000				
Centered R^2 = 0.1143				
Uncentered R^2 = 0.4860				
Stock-Yogo F statistic (18, 4242) = 27.15				
Stock-Yogo weak ID test critical value at 5% = 18.87				
Hansen J statistic = 13.874				

Source: Authors' calculations using data from VARHS Survey.

Appendix Table E1: IV Model: Second Stage Regression Results at Household Level, 2008–2010

Independent Variables	*Dependent Variables*						
	Log of paddy land over total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction – predicted	**0.088*** **	**–0.131** **	**–0.061**	**–0.092**	**–0.148***	**–0.026***	**–0.070***
Log of crop inputs per ha of crop land	0.013**	0.559***	0.420***	0.178***	0.069***	0.574***	0.385***
Share of household's land with LURC	–0.032*	0.285***	0.868***	0.174**	–0.096***	0.107	–1.122***
Log of family labour per ha of crop land	–0.013	0.257***	0.657***	0.854***	–0.082***	–0.069	–0.640***
Ethnicity of head (Kinh = 1, others = 0)	–0.122***	–0,297***	–0.314	0.240	–0.256***	–0.927***	0.921
Mean education of working age men	0.000	0.003	0.003	0.002	0.001	0.010***	0.010
Mean education of working age women	0.000	0.000	0.001	0.004	0.000	0.005*	0.018**
Dependency ratio (%)	0.020	–0.093	–0.287*	0.019	–0.012	–0.378***	–0.214
Age of household head	0.000	–0.004*	–0.001	0.001	–0.002***	–0.008***	0.006
Gender of head (male = 1; female = 0)	0.013	0,038	0.205*	0.176	0.038**	0.087	0.270
With member in household's business	–0.036***	–0.077**	0.011	0.019	–0.080***	–0.235***	0.045
With member in private sector	–0.023	0.046	0.270*	0.087	–0.113***	–0.218**	–0.021
Farm assets	0.001**	0.003	0.007*	0.038***	0.001	0.001	0.041***
Disasters in commune	0.000**	0.001	0.002	0.011	0.000**	–0.001	–0.043***
Access to asphalt road	–0.000**	0.000**	0.001	–0.013	0.000***	0.000**	0.000
Having market in commune	0.000***	0.006**	0.012**	0.001	–0.002*	–0.002	0.000
Share of land irrigated in commune	–0.024**	0.130***	0.276***	–0.002	–0.060***	–0.052	–0.024***
Constant	–0.077***	0.458***	0.482***	–0.098**	0.287***	0.492***	0.312***
N	2,602	2,602	2,602	2,602	2,602	2,602	2,602
R^2	0.547	0.509	0.399	0.526	0.526	0.326	0.328
F (20, 5183)	114.97	406.36	132.2	278.87	30.24	100.11	314.35
Hansen J statistic	13.361	14.782	20.051	18.833	23.209	16.328	20.204

Note*:* 'IV model' means Two-Stage Least Squares using instrumental variables. The above are the second stage results. See note to Appendix Tables B1 to B4. 'Land restriction – predicted' means $\hat{R}_{ijt}$, the value of R_{ijt} predicted by the first-stage equation.

Source: Authors' calculations using data from VARHS Survey.

Appendix Table E2: IV model: Second Stage Regression Results at Household Level, 2010–2012

Independent Variables	*Dependent Variables*						
	Log of paddy land over total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction – predicted	**0.525*** **	**–0.044** **	**–0.33***	**–0.088**	**–0.153**	**–0.068***	**–0.053***
Log of crop inputs per ha of crop land	0.008	0.652***	0.352***	0.166***	0.068***	0.562***	0.035
Share of household's land with LURC	–0.006	0.563***	1.346***	0.159**	–0.076**	0.390***	–0.230***
Log of family labour per ha of crop land	0.004	0.336***	0.663***	0.744***	–0.070***	0.095	–0.013
Ethnicity of head (Kinh = 1, others = 0)	–0.048	–0.266	–0.607**	0.019	–0.210***	–0.620***	0.124
Mean education of working age men	0.000	0.006	0.005	0.004	0.002	0.013***	0.046
Mean education of working age women	0.000	0.000	0.004	0.006	–0.001	0.001	0.048***
Dependency ratio (%)	0.031*	–0.15	–0.291	0.021	–0.070**	–0.475***	–0.392**
Age of household head	0.000	–0.003	–0.009**	0.001	0.000	–0.004	0.115
Gender of head (male = 1; female = 0)	0.007	–0.079	0.226	0.167	0.001	–0.045	0.788
With member in household's business	–0.032***	0.098	0.135	0.022	–0.055***	–0.101*	0.055
With member in private sector	–0.017	0.135	0.457***	0.077	–0.088***	0.069	–0.011
Farm assets	0.003**	0.005	0.012*	0.025***	0.001	0.003	0.033***
Disasters in commune	0.002**	0.003	0.005	0.044	0.000**	–0.004	–0.043***
Access to asphalt road	–0.000**	0.000**	0.003	–0.019	0.000***	0.000**	0.000
Having market in commune	0.000***	0.008**	0.011**	0.002	–0.002*	–0.007	0.000
Share of land irrigated in commune	–0.024**	0.112***	0.137***	–0.007	–0.060***	–0.048	–0.024***
Constant	–0.103**	0.165***	0.097***	–0.098**	0.263***	0.774***	0.018
N	4,222	4,222	4,222	4,222	4,222	4,222	4,222
R^2	0.698	0.608	0.357	0.488	0.161	0.449	0.344
F (20, 5183)	208.45	487.54	345.93	223.14	63.59	243.78	399.3
Hansen J statistic	23.42	18.21	28.07	16.72	45.62	12.34	49.29

Note: 'IV model' means Two–Stage Least Squares using instrumental variables. The above are the second stage results. See note to Appendix Tables B1 to B4. 'Land restriction – predicted' means $\hat{R}_{ijt}$, the value of R_{ijt} predicted by the first-stage equation.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table E3: IV Model: Second Stage Regression Results at Household Level, 2012–2014

Independent Variables	*Dependent Variables*						
	Log of paddy land over total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction – predicted	**0.348*** **	**–0.046***	**–0.339**	**–0.079***	**–0.127***	**–0.531**	**–0.179**
Log of crop inputs per ha of crop land	–0.005**	0.795***	0.460***	0.165***	0.073***	0.694***	0.072***
Share of household's land with LURC	0.023**	0.263***	0.875***	0.182**	–0.073***	0.185**	–0.069
Log of family labour per ha of crop land	0.017***	0.146***	0.589***	0.744***	–0.092***	–0.115*	–0.115***
Ethnicity of head (Kinh = 1, others = 0)	–0.01	–0.683***	–0.664***	0.18	–0.274***	–0.924***	–0.408***
Mean education of working age men	0.002	0.015	0.008	0.004	0.002	–0.014	0.431***
Mean education of working age women	0.003	–0.024	–0.032	0.011	–0.008*	–0.033*	0.455***
Dependency ratio (%)	0.012	–0.154	–0.375	0.022	–0.104***	–0.481***	2.112***
Age of household head	0.000	–0.003	–0.001	0.005	0.000	–0.002	0.072***
Gender of head (male = 1; female = 0)	–0.016	0.099	0.182	0.148	0.054***	0.170*	1.744***
With member in household's business	–0.031***	0.06	0.229**	0.031	–0.048***	–0.068	0.034
With member in private sector	–0.016	–0.028	0.19	0.066	–0.050**	–0.044	0.078
Farm assets	0.004**	0.006	0.007*	0.029***	0.012	0.004	0.026***
Disasters in commune	0.000**	0.011	0.002	0.027	0.001**	–0.008	–0.043***
Access to asphalt road	–0.000**	0.000**	0.001	–0.044	0.000***	0.002**	0.000
Having market in commune	0.000***	0.005**	0.012**	0.003	–0.002*	–0.015	0.000
Share of land irrigated in commune	–0.061**	0.122***	0.276***	–0.011	–0.060***	–0.077	–77.000
Constant	–0.034**	0.408***	1.289***	–0.105**	0.334***	0.338***	0.291**
N	4,700	4,700	4,700	4,700	4,700	4,700	4,700
R^2	0.732	0.729	0.479	0.488	0.198	0.572	0.379
F (20, 5183)	198.13	163.8	763.69	225.11	101.98	431.67	330.94
Hansen J statistic	17,086	21,253	26.39	17,244	36,215	22,038	28,283

Note: 'IV model' means Two Stage Least Squares using instrumental variables. The above are the second stage results. See note to Appendix Tables B1 to B4. 'Land restriction – predicted' means $\hat{R}_{ijt}$, the value of R_{ijt} predicted by the first-stage equation.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table E4: IV Model: Second Stage Regression Results at Household Level, 2014–2016

Independent Variables	*Dependent Variables*						
	Log of paddy land over total crop land	**Log value crop output / ha total crop land**	**Log value rice output / ha total crop land**	**Log value rice output / ha paddy land**	**Log value other crops / ha total crop land**	**Log value crop output / farm labour input**	**Log hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Land restriction – predicted	**0.336*** **	**–0.107***	**–0.196**	**–0.108**	**–0.066** **	**–0.515**	**–0.071***
Log of crop inputs per ha of crop land	–0.011***	0.836***	0.493***	0.166***	0.083***	0.796***	0.114***
Share of household's land with LURC	0.045***	0.238**	0.796***	0.205**	–0.085***	0.181**	0.106
Log of family labour per ha of crop land	0.023***	0.090*	0.534***	0.782***	–0.114***	–0.284***	–0.190***
Ethnicity of head (Kinh = 1, others = 0)	–0.027	–0.643***	–0.629**	0.19	–0.264***	–0.803***	–0.25
Mean education of working age men	0.004**	0.001	–0.025	0.006	0.002	–0.044**	0.343***
Mean education of working age women	0.006***	–0.062***	–0.094***	0.019	–0.007	–0.101***	0.298***
Dependency ratio (%)	0.031**	–0.155	–0.526**	0.033	–0.090***	–0.616***	0.708***
Age of household head	0.000	–0.005*	–0.007*	0.011	0.001	–0.006**	0.026***
Gender of head (male = 1; female = 0)	–0.007	0.051	0.142	0.164	0.067***	0.08	0.195
With member in household's business	–0.028***	0.015	0.214	0.055	–0.036*	–0.144*	–0.555***
With member in private sector	–0.025**	–0.005	0.28	0.092	–0.059**	–0.151	0.099
Farm assets	0.012**	0.013	0.023*	0.029***	0.021	0.081	0.038***
Disasters in commune	0.004**	0.106	0.102	0.041	0.001**	–0.004	–0.105***
Access to asphalt road	–0.000**	0.001**	0.006	–0.026	0.000***	0.000**	0.003
Having market in commune	0.007***	0.009**	0.025**	0.005	–0.002*	–0.011	0.002
Share of land irrigated in commune	–0.024**	0.224***	0.188***	–0.007	–0.060***	–0.039	–0.037**
Constant	–0.045**	0.431***	0.617***	–0.125**	0.261***	0.531***	0.437***
N	4,280	4,280	4,280	4,280	4,280	4,280	4,280
R^2	0.77	0.655	0.524	0.488	0.207	0.647	0.109
F (20, 5183)	155.72	188.04	672.4	236.91	80.87	520.75	28.17
Hansen J statistic	13.585	21.332	25.432	16.772	21.536	19.036	77.746

Note: 2SLS (IV) means Two Stage Least Squares (Instrumental Variables). The above are the second stage results. See note to Appendix Tables B1 to B4.
'Land restriction – predicted' means $\hat{R}_{ijt}$, the value of R_{ijt} predicted by the first–stage equation.
Source: Authors' calculations using data from VARHS Survey.

Appendix Table F1: Fixed Effects Model: Estimated Productivity Impacts of Land Use Restrictions, 2008–2010 to 2014–2016

Variable	*Dependent Variables*					
	Value of crop output / ha total crop land	**Value of rice output / ha total crop land**	**Value of rice output / ha paddy land**	**Value of other crops / ha total crop land**	**Value of crop output / farm labour input**	**Value of hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
2008–2010						
Mean of observed data	40,391	28,254	29,460	12,137	3,350	12,474
Mean of counterfactual simulation	42,544	29,835	30,170	12,819	3,501	13,276
Difference (observed – counterfactual[)]	–2,153**	–1,581	–710*	–682***	–151**	–802*
Percentage difference	–5.33	–5.60	–2.41	–5.62	–4.51	–6.43
2010–2012						
Mean of observed data	40,252	28,156	31,190	12,096	4,035	16,296
Mean of counterfactual simulation	42,614	29,465	32,511	12,466	4,160	17,221
Difference (observed – counterfactual)	–2,362**	–1,309	–1,321**	–370*	–124*	–925**
Percentage difference	–5.87	–4.65	–4.24	–3.06	–3.08	–5.68
2012–2014						
Mean of observed data	49,497	35,493	36,218	14,003	8,539	21,227
Mean of counterfactual simulation	51,614	35,925	37,120	14,499	9,388	23,003
Difference (observed – counterfactual)	–2,118**	–432	–902**	–495***	–848**	–1,776*
Percentage difference	–4.28	–1.22	–2.49	–3.54	–9.93	–8.37
2014–2016						
Mean of observed data	50,953	36,949	37,702	15,459	9,995	22,683
Mean of counterfactual simulation	52,691	38,042	38,806	16,260	10,711	23,268
Difference (observed – counterfactual)	–1,738**	–1,092	–1,104**	–801*	–716*	–586**
Percentage difference	–3.41	–2.96	–2.93	–5.18	–7.16	–2.58

Note: Levels of significance attached to 'Difference' reflect the variable 'Land restriction' shown in Appendix Tables C1 to C4, columns (2) to (7).
*, ** and *** denote results of t-tests and indicate significant difference at 90%, 95%, and 99% confidence levels, respectively.
All monetary amounts are in constant prices.
Source: Authors' calculations from VARHS data.

Appendix Table F2: IV Model: Estimated Productivity Impacts of Land Use Restrictions, 2008–2010 to 2014–2016

Variable	*Dependent Variables*					
	Value of crop output / ha total crop land	**Value of rice output / ha total crop land**	**Value of rice output / ha paddy land**	**Value of other crops / ha total crop land**	**Value of crop output / farm labour input**	**Value of hh. income / household member**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
2008–2010						
Mean of observed data	40,391	28,254	29,460	12,137	3,350	12,474
Mean of counterfactual simulation	43,632	30,034	31,055	12,924	3,421	13055
Difference (observed – counterfactual)	–3,241**	–1,780	–1,596	–787*	–71*	–580*
Percentage difference	–8.02	–6.30	–5.42	–6.49	–2.12	–4.65
2010–2012						
Mean of observed data	40,252	28,156	31,190	12,096	4,035	16,296
Mean of counterfactual simulation	42,115	29,852	31,856	13,106	4,195	17,005
Difference (observed – counterfactual)	–1,863**	–1,696*	–666	–1,010	–159*	–709*
Percentage difference	–4.63	–6.02	–2.14	–8.35	–3.95	–4.35
2012–2014						
Mean of observed data	49,497	35,493	36,218	14,003	8,539	21,227
Mean of counterfactual simulation	51,033	36,315	37,089	14,612	9,397	23,106
Difference (observed – counterfactual)	–1,537*	–822	–871*	–608*	–858	–1,880
Percentage difference	–3.10	–2.31	–2.40	–4.34	–10.04	–8.86
2014–2016						
Mean of observed data	50,953	36,949	37,702	15,459	9,995	22,683
Mean of counterfactual simulation	52,688	38,752	39,007	16,005	11,104	23,104
Difference (observed – counterfactual)	–1,736*	–1,803	–1,304	–546**	–1,108	–422*
Percentage difference	–3.41	–4.88	–3.46	–3.53	–11.09	–1.86

Note: Levels of significance attached to 'Difference' reflect the variable 'Land restriction – predicted' shown in Appendix Tables E1 to E4, columns (2) to (7).
*, ** and *** denote results of t-tests and indicate significant difference at 90%, 95%, and 99% confidence levels, respectively.
All monetary amounts are in constant prices.
Source: Authors' calculations from VARHS data.

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