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Land tenure and economic development: Evidence from Vietnam

Hoang-Anh Ho

University of Economics Ho Chi Minh City, 279 Nguyen Tri Phuong, District 10, Ho Chi Minh City, Viet Nam

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ABSTRACT

The relationship between private property rights and economic development has been investigated by numerous cross-country studies. Nevertheless, aggregate measures of private property rights have prevented cross-country studies in general from identifying the specific institutions governing private property rights that policy reforms should consider. The present paper investigates the impact of private property rights to land on economic development in a within-country setting, exploiting the 1993 nationwide land privatization in Vietnam. Using a random sample of more than 2000 rural communes across Vietnam, our study finds that the prevalence of private land tenure has a positive and significant impact on the level of economic development, as proxied by nighttime light intensity. The magnitude of the impact, however, is sensitive to both observed and unobserved confounding factors, and overall modest. The most plausible explanations for this modest impact are the lingering insecurity that land-use certificates can be revoked by the state and the relatively high taxes and time cost of land transactions in Vietnam. These lessons are of interest not only to Vietnam with its future land reform, but also to other developing countries contemplating the privatization of agricultural land.

1. Introduction

A series of influential cross-country studies has found strong empirical evidence for a positive effect of private property rights on economic development (Acemoglu, Johnson, & Robinson, 2001, 2002; Acemoglu & Johnson, 2005). Nevertheless, the aggregate measures of private property rights[1] have prevented cross-country studies in general from identifying the specific rules and procedures governing private property rights that policy reforms should consider. Complementing the cross-country evidence is a large literature of within-country studies, concentrating on private property rights to land in developing countries. The within-country setting, characterized by the homogeneous institutional environment, provides these empirical studies with concrete measures of private land tenure that can generate useful lessons for policy reforms (Pande & Udry, 2006).[2] Nevertheless, no study so far has exploited the advantage of the within-country setting to investigate the impact of private land tenure on economic development at the sub-national level.

A typical within-country setting that has been studied extensively is the nationwide land reform of Vietnam in 1993. Up until 1993 the Vietnamese government periodically allocated land to households for cultivation and no land transactions were allowed. During the transformation process from a central planning economy to a market economy starting in the late 1980s (the Doi Moi), the Vietnamese government issued a law in 1993, granting so-called land-use certificates to agricultural land for periods of 20–50 years. The most significant change is that the new law allowed land-use certificates to be transferred, exchanged, leased, mortgaged, and inherited. In the 1990s, around 80% of the Vietnamese population (or 55 million people) lived in rural areas (General Statistics Office of Vietnam, 2018), making the 1993 land reform one of the largest land privatization programs in developing countries.[3]

Many studies have examined the impacts of the Vietnamese 1993 land reform on the allocative efficiency of the land distribution and households' investments, which are two main theoretical channels linking private land tenure to economic development

E-mail address: anh.ho@ueh.edu.vn

[1] These measures are constructed by summing up either the perceptions of many businesses and individuals (e.g., risk of state expropriation or government effectiveness) or many legal rules and procedures (e.g., constraints on the executive).

[2] Important contributions are, among others, Besley (1995), Sjaastad and Bromley (1997), Banerjee, Gertler, and Ghatak (2002), Brasselle, Gaspart, and Platteau (2002), Field (2007), Goldstein and Udry (2008), and Hornbeck (2010). See Pande and Udry (2006), Place (2009), and Fenske (2011) for comprehensive reviews of the literature. See also Muchomba (2017) and Bambio and Agha (2018) for recent contributions.

[3] In particular, around 11 million titles had been issued to rural households by 2000 (Do and Iyer, 2008).

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(Besley, 1995; Besley & Ghatak, 2010). In particular, Ravallion and van de Walle (2006) have shown that private land tenure increases the overall efficiency of the distribution of agricultural land relative to the inefficient distribution under the central planning economy, but the speed of adjustment is slow. Do and Iyer (2008) have discovered that private land tenure promotes households' investments in perennial crops, but the effect is modest. In addition, the authors have detected no significant increase in household borrowing.[4] These findings warrant an examination of the overall impact of the Vietnamese 1993 land reform on economic development, which is one of the most important goals of land reform in general (Deininger & Binswanger, 1999).

Aiming at filling the gaps in the literature described above, the present paper studies the impact of private land tenure on economic development at the commune level by combining the Vietnamese 1993 land reform and an innovative measure of economic development. First, the Vietnamese land reform generates a concrete measurement of private land tenure in a rural commune, i.e., the percentage of agricultural land area having land-use certificates. Second, I use nighttime light intensity to capture economic development at the commune level, following a recent finding that nighttime light intensity is a good proxy for economic development, particularly when GDP data are not available (Henderson, Storeygard, & Weil, 2012; Michalopoulos & Papaioannou, 2013, 2014; Hodler & Raschky, 2014).

Because private land tenure is not randomly assigned, it is a challenge for empirical studies to estimate the impact of private land tenure in general, knowing that there are confounding factors that are likely to bias the result. In the context of the Vietnamese 1993 land reform, households might be more likely to take up land-use certificates for land plots with higher levels of profitability. As a result, factors that drive land profitability such as land productivity, public infrastructure, and geographical characteristics might confound the impact of private land tenure. I employ two empirical approaches to tackle the bias resulting from both observed and unobserved confounding factors. First, I construct a panel of data before and after the 1993 reform and use a fixed-effects model to examine the influence of time-invariant confounding factors. Second and most importantly, I adopt a novel empirical method advanced by Oster (2019) to estimate the bias resulting from unobserved confounding factors in general. The basic idea is to infer the bias resulting from unobserved confounding factors by using the sensitivity of the estimated impact of private land tenure to the inclusion of observed confounding factors. Compared to the instrumental variables approach often used in previous studies, this method enables the estimation of the causal impact under different scenarios of the correlation between unobserved confounding factors and private land tenure.

Using a random sample of more than 2000 (out of around 8000) rural communes across Vietnam in 2004, I find that the prevalence of private land tenure has a positive and significant impact on the level of economic development, as proxied by nighttime light intensity. Although this impact remains significant when time-invariant variables or observed confounding factors (land productivity, public infrastructure, and geographical characteristics) are accounted for, its magnitude is reduced to a large extent. This substantial drop in magnitude indicates that communes with more favorable conditions to economic activities had more households taking up land-use certificates, and at the same time experienced higher levels of economic development. Under the scenarios that (i) the unobserved confounding factors are relatively less related to the prevalence of private land tenure than the observed confounding factors and (ii) nighttime light intensity is measured with some errors, the impact of private land tenure remains significant, but the magnitude is modest. In a few conservative scenarios, however, the impact of private land tenure is not different from zero. Overall, it is reasonable to conclude that the impact of private land tenure on rural economic development in Vietnam is modest. The most plausible explanations for this modest impact are the lingering insecurity that land-use certificates can be revoked by the state and the relatively high taxes and time cost of land transactions in Vietnam.

The remainder of the present paper is organized as follows. The next section provides a brief history of land tenure in Vietnam and a description of the 1993 land reform. It also presents a conceptual framework describing the relationship between private land tenure and economic development, as well as analyzing the determinants of private land tenure in the context of the 1993 land reform. Section 3 describes the data and variables in detail. Section 4 presents the main empirical models used to examine the impact of private land tenure on economic development. Section 5 reports the empirical results and discusses the main findings. Finally, section 6 concludes the paper.

2. Background and conceptual framework

This section begins with a brief history of land tenure in Vietnam and a description of the land privatization program in 1993. The purpose is to provide sufficient contextual information to derive theoretical predictions and interpret the empirical results. Next, I present the theoretical framework linking private land tenure and economic development, and examine its prediction in the context of Vietnam. Finally, I derive a simple theory of endogenous land tenure to understand the determinants of private land tenure in the context of the 1993 reform, which in turn helps identifying factors that confound the impact of private land tenure on economic development.

2.1. Background

The economy of traditional Vietnam was characterized by wet-rice agriculture, and most of the land was placed under two types of ownership. The dominant type was state ownership, which was mainly concentrated in the northernmost and oldest region of Vietnam, i.e., the area surrounding the Red River Delta. State land was collectively managed by the village, the lowest administrative unit, in which cultivation rights (but not sale or transfer rights) were allocated periodically to landless peasants (Truong, 2009). This type of land was later known as communal land. To provide incentives for farmers to settle and bring in more land for cultivation, historical states of Vietnam also granted private ownership to newly cleared land in the frontier areas. As a result, private ownership was much more prevalent in the southernmost region (i.e., the Mekong River Delta), which was the final frontier to be annexed to historical Vietnam (Nguyen, 1994).

When the French colonization ended (1858–1954), Vietnam was divided into two regions along the 17th parallel during the Second Indochina War (1954–1975). In the north, the new Communist government carried out a thorough land reform in which land was confiscated from the landlords and assigned to the peasants (Wiegersma, 1988). Shortly after that, all land was taken away from individual peasants to form cooperatives through the process of collectivization. In this system, peasants pooled their land and productive assets to work under a unified management, and output was divided based on the number of hours working in production teams. The most pervasive problem of this system was incentives, i.e., each member had an incentive to shirk on their assigned tasks

[4] For other contributions, also see Deininger and Jin (2008), Ravallion and van de Walle (2008), Markussen, Tarp, and Broeck (2011), Kompas et al. (2012), and Nguyen (2020).

because wage was fixed. The collectivization in the north was relatively rapid, and almost all farmers joined cooperatives by 1986 (Pingali & Xuan, 1992).

In the south, consecutive governments supported by the United States also pursued land reform, but their policies were more in line with the interests of large landlords rather than those of tenants and small peasants (Callison, 1983). In 1970, a major land reform (Land-to-the-Tiller) was instigated, aiming to provide cultivators with ownership rights and limit the size of landholdings. Under this reform, private land was taken away from landlords, who were compensated, and distributed to farmers (Wiegersma, 1988). Soon after, following the reunification in 1975, the Communist government brought land redistribution and collectivization to the south, putting an end to its long history of private land tenure. Nevertheless, farmers in the south, particularly those in the Mekong River Delta, with their tradition of private land tenure, resisted this collectivization, and only a small fraction of farmers joined cooperatives by 1986 (Pingali & Xuan, 1992). Unlike in the north, farmers in the south continued to choose inputs and technology on their assigned land, although sharing of labor and productive assets became more common.

Overall, growth in rice productivity under collectivization was low and food deficits were recurrent (Pingali & Xuan, 1992). In 1981, the government introduced a contract system in which farmers had to sell to the cooperatives the contracted output at a fixed price and the excess output could be kept for consumption or sold to private traders. While the cooperatives continued to provide inputs and production facilities, farmers were responsible for crop management and husbandry on their land. And as of 1989, farmers were no longer required to sell a contracted output to the state. Following this reform, overall productivity in rice production increased substantially (Pingali & Xuan, 1992). To increase tenure security, the government passed a law in 1988, assigning land to the households from 10 to 20 years on the basis of renewable leases. Overall, this land assignment was found to be relatively equitable, with the poorest households absolutely better off in terms of consumption, and there was no evidence of systematically perverse behaviors of local authorities (Ravallion & van de Walle, 2004).

After allocating the collective land to individual households, the government issued a law in 1993, granting official land titles to the users, which were called land-use certificates (also known informally as red books). Although land was still officially the property of the state, the new law allowed land-use certificates to be transferred, exchanged, leased, mortgaged, and inherited (Vietnam National Assembly, 1993). In effect, land without land-use certificates is not allowed to be transacted, and its tenure is not secured. Nevertheless, transfers and exchanges of land with land-use certificates still had to be approved by the authorities, and all land transactions had to pay taxes. The new law also increased the lease term to 20 years for land devoting to annual crops and aquaculture, and 50 years for land devoting to perennial crops and forestry. Most importantly, previous practices of intermittent reallocation of land by the commune authorities to accommodate changes in household size and composition were prohibited.

The issuance of land-use certificates is decentralized to the provincial governments, and involves various administrative departments from the province to the commune levels (Vietnam National Assembly, 1993). First, the province must establish a land-use plan and construct cadastral maps for all districts and communes. Then, households are required to submit application forms, listing all the land plots for which they are applying for land-use certificates. These forms must be signed by the applicants and all neighboring households to make sure there are no disputes over the land listed in the application forms. Finally, the authorities scrutinize these forms and decide whether to issue land-use certificates to the land in question.

2.2. Private land tenure and rural economic development

In theory, private land tenure might lead to more economic prosperity in the rural sector through two primary channels (Besley, 1995; Besley & Ghatak, 2010). First, private ownership makes farmers the residual claimants of their yields, thereby provides incentives for farmers to invest in their land. These investments can take the forms of extra efforts (e.g., working hours), capital inputs (e.g., fertilizers), or technological adoption (e.g., new seeds) that increase outputs. In addition, well-defined ownership promotes the value of land as a collateral, enabling land owners to access credit needed to finance long-run capital investments. Second, well-written records enhance the certainty of land ownership, making land transactions less costly to implement. As a result, the liquidity of the land market increases, making it easier to transfer land from less to more productive farmers, thereby improving the allocative efficiency of the land distribution.

In the context of Vietnam, private land tenure is predicted to induce more private investments in agricultural land and increase the allocative efficiency of the distribution of agricultural land, thereby leading to higher levels of economic development in rural areas. Nevertheless, the effect in question is generated by a transition from collective land tenure to only incomplete private land tenure. Compared to the above theoretical prediction, there are two main factors that might restrain the effect of private land tenure on economic development in the context of rural Vietnam. The first factor is the cost of land transactions, including taxes and the time needed to complete the bureaucratic procedures. These costs might hinder the realization of the highest level of allocative efficiency of the distribution of agricultural land. The second factor is the risk of state expropriation. Because land is still officially owned by the state, land-use certificates can be revoked (normally with compensation not based on market values) when the usage periods are ended. This lingering insecurity of private land tenure might prevent private investments in agricultural land from increasing to the highest possible levels.

Although the theoretical framework discussed so far assumes that private land tenure is exogenous, it is widely believed in empirical research that private property rights in general are highly endogenous. In the context of Vietnam, land-use certificates are not imposed upon households through a random selection. Instead, households actively decide whether or not to apply for land-use certificates. As a result, there might be many factors that influence both private land tenure and economic development across rural communes. Any empirical analysis must account for these confounding factors to ensure that the estimated impact of private land tenure on economic development is credible. In the following subsection, I derive a simple theory to shed light on the endogenous nature of private land tenure in the context of Vietnam, and use it to identify important confounding factors.

2.3. Endogenous land tenure

In general, there are two theoretical approaches to analyze the determinants of private property rights. The first approach proposes that private property rights are granted by the state to maximize its own benefit (North, 1981). The second approach postulates that private property rights come to exist when potential right holders perceive that the benefits of defining and enforcing such rights are larger than the costs (Demsetz, 1967; Anderson & Hill, 1975). In the context of Vietnam, the state already granted land-use certificates. As a result, to understand why the percentage of agricultural land area having land-use certificates varies across

communes, one must look at the issue from the perspective of the individual land users. Thus, I adopt the second approach for the task at hand.

Fig. 1 presents a schematic representation of the determinants of the prevalence of private land tenure in a commune in Vietnam. The vertical axis represents the marginal cost and benefit of obtaining a land-use certificate for a land plot, and the horizontal axis shows the number of plots in a commune. For simplicity of exposition, Fig. 1 draws a flat marginal cost curve, meaning all land plots within a commune face the same time and money cost of obtaining a land-use certificate. The benefit of obtaining a land-use certificate is to protect the profits accrued to a land plot in the usage period. Because profitability is likely to vary across land plots, it is more beneficial to obtain a land-use certificate for one plot than another. Sorting land plots from the highest to the lowest in terms of profitability gives us a downward-sloping marginal benefit curve in a commune. It is clear from Fig. 1 that the intersection of the two curves determines the number of plots having land-use certificates in a commune. As a result, the percentage of agricultural land area having land-use certificates varies across communes because the marginal cost and benefit structures are different.[5]

The simple theory presented in Fig. 1 reveals that factors that are likely to shift the marginal cost and benefit structures of obtaining land-use certificates will determine the differences in the percentage of agricultural land area having land-use certificates across communes. Among these factors, those that are likely to have similar influences over the level of economic development are important confounding factors (Fig. 2). As a result, failing to account for these factors will lead to an overestimation of the impact of private land tenure on economic development. Three broad categories of such factors can be identified: public infrastructure, land quality, and geography.[6] In particular, better infrastructure and land quality are likely to shift the benefit curve upward, leading to an increase in the percentage of agricultural land area having land-use certificates, all else being equal. And at the same time, better infrastructure and land quality are also more favorable to economic development. Geographical characteristics such as elevation and terrain curvature are likely to shift the cost curve upward, i.e., more elevated and rugged terrain make it more costly to construct map and measure land, leading to a decrease in the percentage of agricultural land area having land-use certificates, all else being equal. At the same time, these geographical characteristics are likely to increase the costs of transportation, making them unfavorable to economic development.

Fig. 1 also suggests a way to find a credible instrumental variable to estimate the causal impact of private land tenure on economic development. A credible instrumental variable must satisfy two conditions: (i) strongly shifts the benefit or cost structures of obtaining land-use certificates and (ii) only affect economic development through its effect on the percentage of agricultural land area having land-use certificates. It is a daunting task, however, to find such a variable. As a result, the present paper has to rely on other approaches to estimate the causal impact of private land tenure on economic development. Before discussing the empirical strategy, the next section describes the available data.

[5] The theory does not rely on specific shapes of the cost and benefit curves. In any case, the percentage of agricultural land area having land-use certificates in a commune depends on the number of land plots for which benefits of obtaining land-use certificates are larger than costs.

[6] Other potential candidates driving the benefit and cost structures of obtaining land-use certificates are administrative capacity and demographics, of which data are not available at the commune level. In the context of rural Vietnam, however, Do and Iyer (2008) have shown that these two factors were not significant drivers of the proportion of households possessing land-use certificates at the province level.

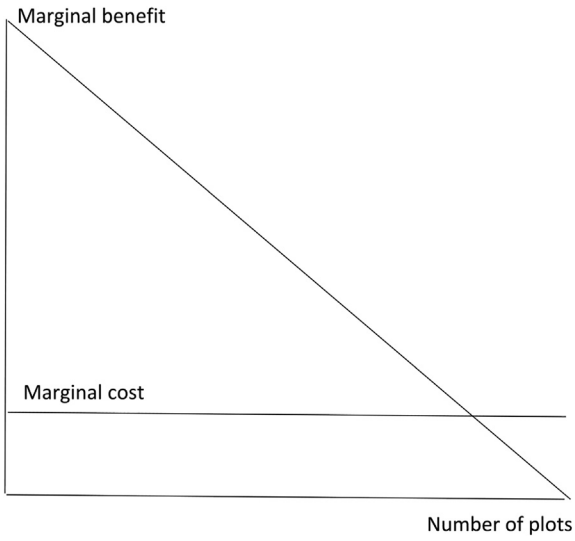

Fig. 1. A theory of endogenous land tenure. *Note*: The figure presents a schematic representation of the determinants of the prevalence of private land tenure in a commune in Vietnam. The vertical axis represents the marginal cost and benefit of obtaining a land-use certificate for a land plot, and the horizontal axis shows the number of plots in a commune. Plots are ordered from left to right with decreasing levels of benefit. The intersection of the two curves determines the number of plots, or the percentage of land area having land-use certificates in a commune.

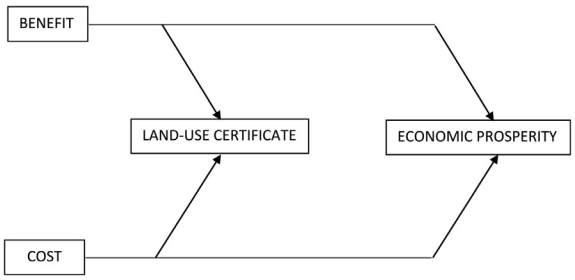

Fig. 2. Conceptual framework.

3. Data

3.1. Private land tenure

The Commune Module of the biennial Vietnam Household Living Standards Survey (VHLSS) in 2004 provides data on private land tenure. This survey covers a random sample of around 2200 (out of around 8000) rural communes across Vietnam, in which agriculture is the primary source of income. Private land tenure in a rural commune is captured by the percentage of agricultural land area having land-use certificates, which measures how large is the proportion of total land inputs to agricultural production has private land tenure. This measure carries the advantages of the within-country setting. First, the percentage of agricultural land area having land-use certificates contains concrete information about a specific institution that governs property rights to land, allowing the empirical analysis to provide concrete lessons for policy reforms. Second, because the percentage of agricultural land area having land-use certificates is constructed within the institutional framework of Vietnam, it has an identical and unambiguous meaning about private land tenure across communes. Although the empirical analysis is conducted within the context of Vietnam, these advantages make it easy for other developing countries to learn from the findings of the present paper.

Table 1
Variable description.

Variable	Mean	Std. Dev.	Min.	Max.	N
Nighttime light intensity (2005)	4.67	6.59	0	61.38	2205
Nighttime light intensity (1992)	1.55	2.91	0	36.63	2205
Land-use certificates (2004)	74.41	31.12	0	100	2205
Agricultural suitability	0.74	0.20	0	1	2205
Belongs to electric grid (2004)	0.96	0.19	0	1	2205
Having a market (2004)	0.62	0.49	0	1	2205
Elevation (km)	0.14	0.27	0.001	1.81	2205
Terrain ruggedness (100 km)	0.78	1.29	0	7.17	2205

Note: Land-use certificates is the percentage of agricultural land area having land-use certificates. See the main text for information about data sources.

Table 1 shows that the average percentage of agricultural land area having land-use certificates in the sample is 74.41%. Fig. 3 presents the spatial distribution of land-use certificates across the surveyed communes. The general impression is that the Red River Delta, the Mekong River Delta, and the coastal region in between have the highest percentages of agricultural land area having land-use certificates. The Mekong River Delta is clearly the top candidate in this aspect, probably reflecting the historical tradition of private land tenure in the region. In contrast, the highland areas in the northern and central parts of Vietnam possess the lowest numbers. Because land-use certificates did not exist in Vietnam before the 1993 reform, the percentage of agricultural land area having land-use certificates, by definition, was zero for all communes before 1993. This feature generates a panel of data before and after the 1993 reform, enabling the following empirical analysis to use a fixed-effects model to account for time-invariant confounding factors.

3.2. Economic development

As in many other developing countries, it is hard to find a good measure of economic development at the sub-national level in Vietnam. Gross domestic product (GDP) is not reported at the commune level, which is the focus of the present paper.[7] Moreover, GDP does not capture many self-employed agricultural activities, which is prevalent in developing countries. A better way to measure commune-level economic development is to estimate per capita consumption, using data from household surveys such as the VHLSS. This survey, however, only collects information about consumption from around 9000 households. As a result, when it comes to per capita consumption at the commune level, the estimation is only based on around three households. This is obviously not a large enough sample for a precise estimate. The only exception is the VHLSS 2002, in which around 10 households per commune were surveyed for information about per capita consumption. Unfortunately, the VHLSS 2002 does not contain information about land tenure, which is another key variable of the present paper.

Fortunately, recent studies have found that nighttime light intensity is a reasonable proxy for economic development, because consumption and production in the evening require light (Henderson, Storeygard, & Weil, 2012; Michalopoulos & Papaioannou, 2013, 2014; Hodler & Raschky, 2014). As a result, there are strong correlations at the country and sub-national levels between nighttime light intensity and GDP (Henderson, Storeygard, & Weil, 2012; Hodler & Raschky, 2014) as well as other indicators of economic development (Michalopoulos & Papaioannou, 2013, 2014). For the purpose of the present study, the main advantage of nighttime light intensity is the availability of data at the commune level with the same high quality for all communes in Vietnam. In addition, two further cross-validation checks in the context of Vietnam lend support to the use of nighttime light intensity as a proxy for economic development at the commune level. First, Min and Gaba (2014) have documented a strong correlation between the satellite images and actual nighttime lights on the ground in Vietnam, i.e., a one-point increase in the annual nighttime light intensity along the 0–63 scale corresponds to additional 240–270 electrified homes. Second, I use the VHLSS 2002, which covers around 10 households per commune, to estimate per capita consumption at the commune level, and find a significant correlation between nighttime light intensity and per capita consumption (Fig. A1 in the appendix), i.e., the Pearson's correlation coefficient is 0.73 (p-value = 0.000).[8]

Nighttime light intensity is provided by the National Oceanic and Atmospheric Administration (NOAA). Weather satellites from the United States Air Force circle the Earth and measure light intensity. To calculate annual nighttime light intensity, NOAA uses observations from 20:30 to 22:00 every night during the dark half of the lunar cycle in seasons when the sun sets early, but removes observations affected by cloud coverage or polar lights. In addition, NOAA processes the data by setting observations that are likely to reflect fires, other ephemeral lights, or background noise to zero (Baugh et al., 2010). The objective is to provide a measure of nighttime light intensity that only reflects man-made lights. NOAA reports nighttime light intensity for every year since 1992 at the grid cell level that corresponds to approximately one square kilometer at the equator. Annual nighttime light intensity is increasing on a scale from 0 to 63. Thus, when light intensity reaches higher than 63, it is top-coded.

Nighttime light intensity at the commune level is calculated by taking the average of the values of all cells belonging to each commune. The data year is 2005, which is chosen to avoid reverse causality since data on private land tenure were recorded in 2004. Because there were two satellites providing data on nighttime light intensity in 2005, nighttime light intensity at the commune level is calculated by first using data from each satellite. Then the average values of the two satellites are taken to provide the final data for the following empirical analysis. Fig. 4 plots nighttime light intensity in 2005 for the surveyed communes. The first impression is that Vietnam in general was a dark country at night in 2005. The average nighttime light intensity in the current sample is 4.67 (Table 1). Nighttime light intensity is highest in the Red River Delta and the Mekong River Delta, Ha Noi and Ho Chi Minh City in particular, followed by the coastal region in between. In addition, the highest value of nighttime light intensity in the current sample is 61.38 and only 3.6% of observations have values higher than 50. Thus, top-coded data are negligible and do

[7] In Vietnam, GDP reported by the sub-national governmental offices is notorious for being magnified to a significant extent. This phenomenon is known in Vietnam as the achievement disease (*b nh thành tích*).

[8] In their cross-validation check, Michalopoulos and Papaioannou (2013) derive the average wealth index across households for each enumeration area in the Demographic and Health Surveys, and find a significant correlation between nighttime light intensity and the composite wealth index (Pearson's correlation coefficient is around 0.70).

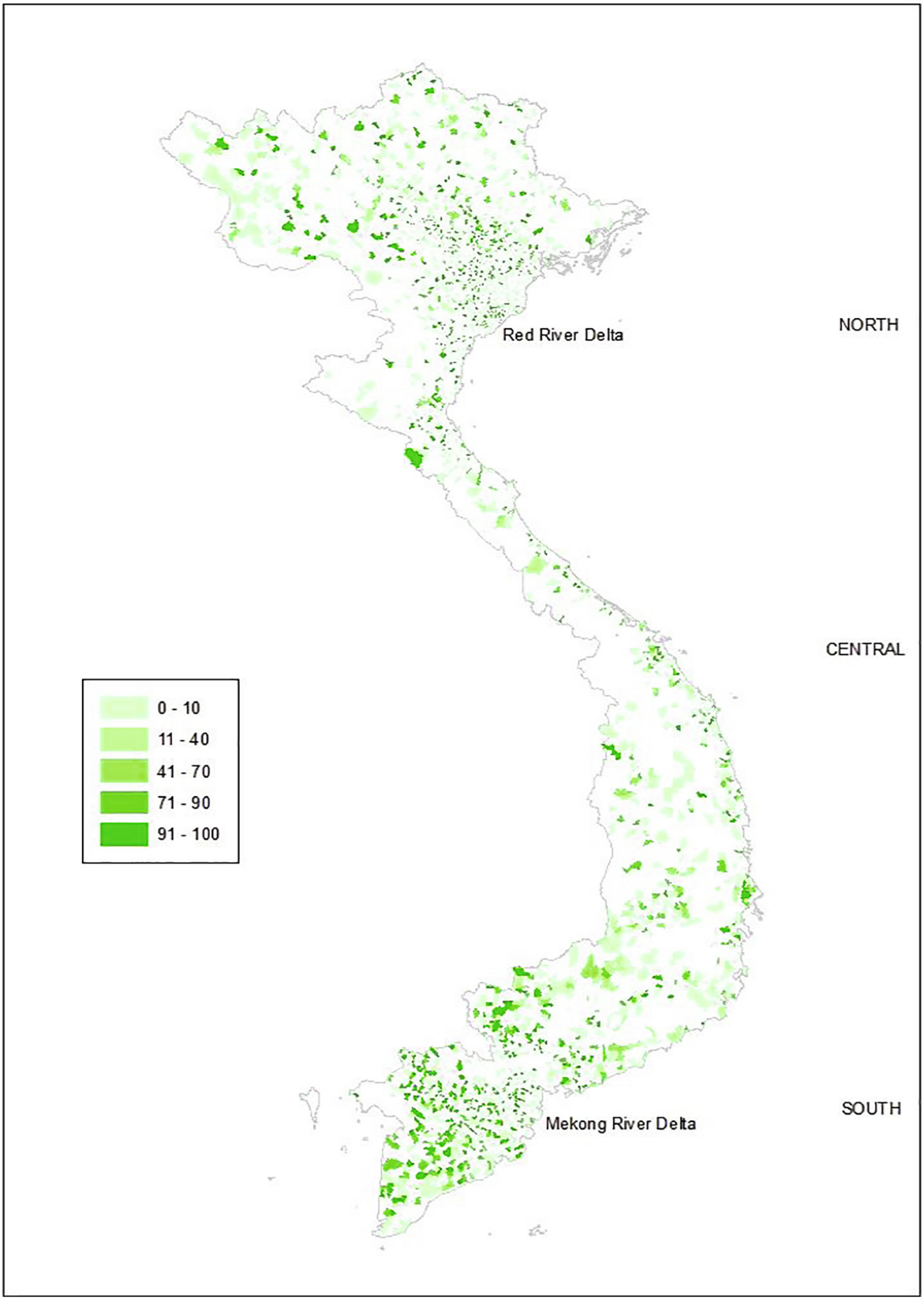

Fig. 3. Private land tenure. *Note*: Percentage of agricultural land area having land-use certificates in 2004 at the surveyed communes. See the main text for information about the data source.

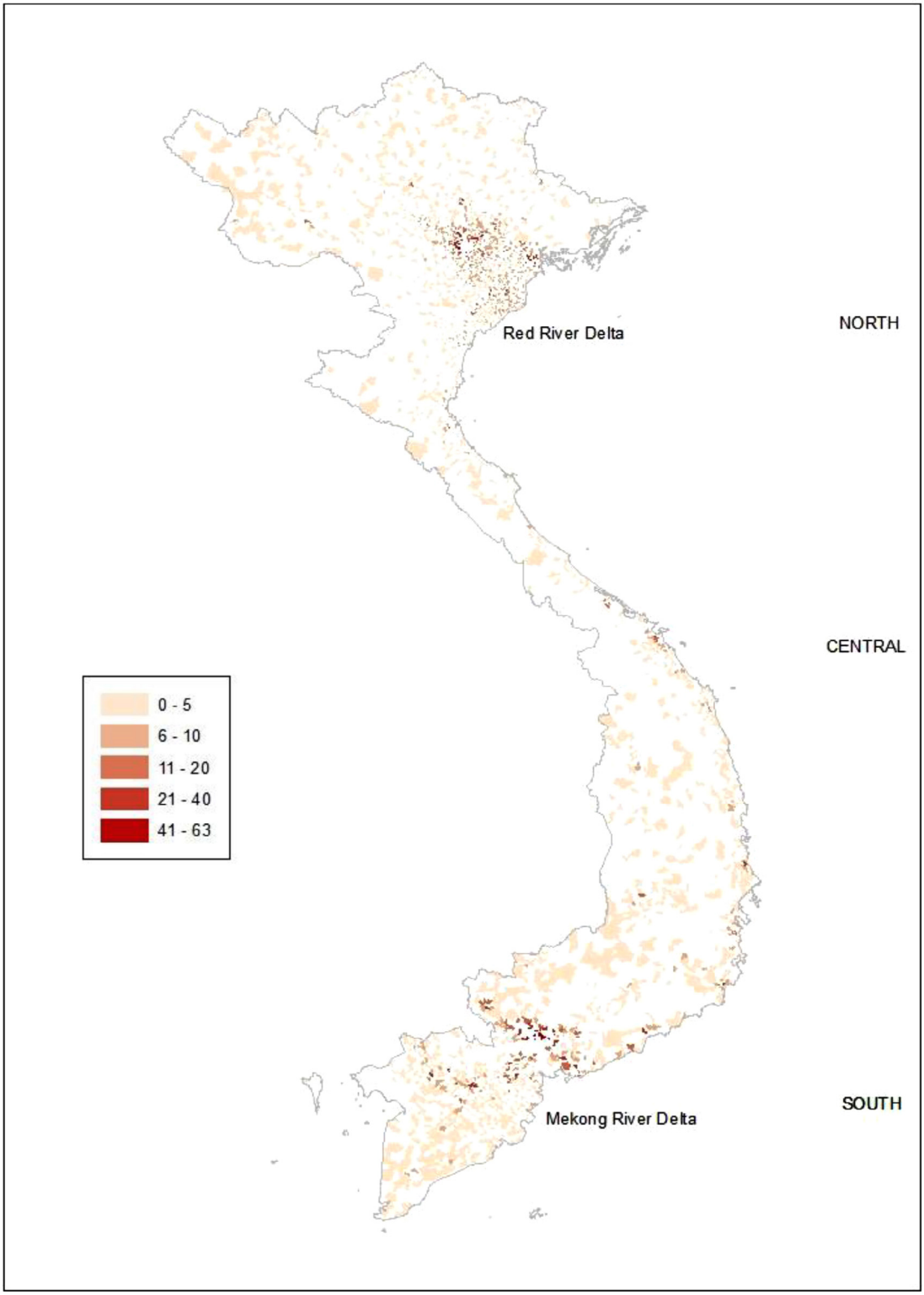

Fig. 4. Nighttime light intensity. *Note*: Nighttime light intensity in 2005 at the surveyed communes. See the main text for information about the data source.

not create a serious problem in the present setting. Before the 1993 land reform, the average nighttime light intensity is 1.55 in 1992, and the maximum value is 36.63 (Table 1).

In previous studies, nighttime light intensity is transformed into logarithmic scale to minimize the problem of outtableliers (Henderson, Storeygard, & Weil, 2012; Michalopoulos & Papaioannou, 2013, 2014; Hodler & Raschky, 2014). In order to retain observations with zero values, these studies take the natural logarithm of nighttime light intensity plus 0.01. This adjustment is defended on the ground that the zero value typically does not reflect no nighttime light at all, and certainly does not imply an absence of economic activities (given that all administrative areas are populated). It is instead an artificial product of the data collection and processing procedure. In particular, there were certainly man-

made nighttime lights in communes with zero values, but the levels might be too low to be detected by the satellites. Thus, the present paper follows the conventional practice to use the natural logarithm of nighttime light intensity plus 0.01 as the dependent variable.[9] As a robustness check, I also use only the natural logarithm of nighttime light intensity, i.e., dropping communes with zero values.

3.3. Confounding factors

The conceptual framework discussed earlier has identified three broad categories of confounding factors (i.e., public infrastructure, land quality, and geography), and posited that failing to account for these factors will lead to an overestimation of the impact of private land tenure on economic development. To examine this hypothesis, I focus on the cross section of communes surveyed in the VHLSS 2004, because information about public infrastructure are not available in 1992. I use two variables to capture the quality of public infrastructure in a commune. The first variable receives a value of one if a commune belongs to the national electric grid, and zero otherwise. Almost 96% of the surveyed communes belong to the national electric grid (Table 1), which is not surprising given the efforts of the Vietnamese government in bringing electricity to the whole country (Asian Development Bank, 2011). The second variable measures whether or not a commune has a communal or inter-communal market. In the current sample, 62% of communes have markets (Table 1). The national electric grid was built by the government, and most communal/inter-communal markets existed before the 1993 land reform or were built by the government. As a result, belonging to the national electric grid and having a market are likely to influence households' decisions to obtain land-use certificates because these public investments are highly complementary to agricultural productivity.

To capture land quality, I employ the agricultural suitability index constructed by Zabel, Putzenlechner, and Mauser (2014) for the period 1961–1990. The authors have computed the suitability to grow the 16 most important food and energy crops,[10] according to the climate, soil and topographic conditions at the grid cell level that corresponds to approximately one square kilometer at the equator. The index is increasing on a scale from 0 to 124. Agricultural suitability at the commune level is calculated by taking the average of the values of all cells belonging to each commune. I then normalize the index into the range [0, 1], to make the estimated coefficient easier to interpret. The average value of the index in the current sample is 0.74 (Table 1).

Elevation is taken from the Global 30 Arc-Second Elevation Dataset (GTOPO30), provided by the Earth Resources Observation and Science Center. Terrain curvature is measured by the terrain ruggedness index, which was originally devised by Riley, DeGloria, and Elliot (1999). Intuitively, the ruggedness level of a location is measured by the differences between the elevations of the location and its surrounding area. Based on the GTOPO30, this index has been calculated by Nunn and Puga (2012) at the grid cell level that corresponds to approximately one square kilometer at the equator. Elevation and terrain ruggedness at the commune level are calculated by taking the average of the values of all cells belonging to each commune. The average elevation and terrain ruggedness in the current sample are 0.14 (km) and 0.78 (100 km) respectively (Table 1). As described earlier, the issuance of land-use certificates was decentralized to the province government. To account for province characteristics that might influence both private land tenure and economic development, I also add province dummies to the set of confounding factors.

Table A1 in the appendix reports the correlations among the variables. All Pearson's correlation coefficients have the expected signs and are significant at the conventional levels, indicating that all confounding factors identified above are important. In particular, the percentage of agricultural land area having land-use certificates is positively correlated with nighttime light intensity. Agricultural suitability, belong to the national electric grid, and having a market are positively correlated with both the percentage of agricultural land area having land-use certificates and nighttime light intensity. In contrast, elevation and terrain ruggedness are negatively correlated with both the percentage of agricultural land area having land-use certificates and nighttime light intensity.

4. Empirical strategy

This section presents two empirical models used to estimate the impact of private land tenure on economic development, taking into account the influence of confounding factors. The first model exploits the panel of data before and after the 1993 land reform to examine the influence of time-invariant confounding factors. The second model uses the cross section of communes surveyed in 2004 to examine the influence of unobserved (both time-invariant and time-variant) confounding factors.

4.1. Panel data

Using the panel data, the regression model takes the following form:

$$Y_{ct} = \overline{\beta} X_{ct} + \alpha_c + \lambda t + \pi_{ct} \quad (1)$$

where Y_{ct} is the level of economic development (proxied by nighttime light intensity) of commune c at time t (1992 and 2005), X_{ct} is the prevalence of private land tenure (i.e., the percentage of agricultural land area having land-use certificates), α_c is the commune fixed effect that captures all time-invariant characteristics, t is a dummy variable for 2005 to capture the time trend, and π_{ct} is the error term.[11] There are two advantages of the panel data. First, the fixed-effects model can account for the time-invariant confounding factors such as geographical characteristics. Second, the endogeneity of private land tenure, driven by time-invariant confounding factors, can be tested indirectly by comparing the results from the fixed-effects model with the random-effects model, which assumes that α_c does not correlate with X_{ct}.

For $\overline{\beta}$ to capture the causal effect of private land tenure on economic development, two main assumptions are required. First, there is a common trend in nighttime light intensity across all communes, and it is the private land tenure brought about by the 1993 land reform that causes deviations from this trend. This assumption can be examined by comparing the trends of nighttime light intensity before the 1993 reform between communes with high and low percentages of agricultural land area having land-use certificates. Second, there are no time-variant variables that affect both private land tenure and nighttime light intensity. This assumption is unlikely to hold because nighttime light intensity are likely to be affected by time-varying economic activities that are not necessarily attributable to the 1993 land reform such as public investment activities in infrastructure and non-farm employment activities. Because these time-variant variables are also likely to influence the take-up of land-use certificates, the fixed-effect regression model in equation (1) will overestimate

[9] The results are qualitatively the same with respect to other values such as 1, 0.1, 0.001, etc.

[10] These crops are barley, cassava, groundnut, maize, millet, oil palm, potato, rapeseed, paddy rice, rye, sorghum, soy, sugarcane, sunflower, summer wheat, and winter wheat.

[11] Unfortunately, the fixed-effect regression in equation (1) does not control for time-variant variables because data of these variables in 1992 are not available.

the impact of private land tenure on nighttime light intensity. To examine the influence of these time-variant variables, I focus on the cross section of communes surveyed in 2004, which contains much richer data than what available in 1992.

4.2. Cross section

Relying on the cross section of communes surveyed in 2004, I estimate the following regression models:

$$Y_c = \dot{\beta} X_c + \upsilon_c \tag{2}$$

$$Y_c = \tilde{\beta} X_c + \Phi \omega_c^o + \eta_c \tag{3}$$

where Y_c is the level of economic development (proxied by nighttime light intensity) at commune c, X_c is the prevalence of private land tenure (i.e., the percentage of agricultural land area having land-use certificates), ω_c^o is a vector of observed (both time-invariant and time-variant) confounding factors discussed earlier, and υ_c and η_c are the error terms. Also denote the R-squared from regression model (2) as $\dot{R}$ and regression model (3) as $\tilde{R}$. For $\tilde{\beta}$ to capture the causal effect of private land tenure on economic development, it is required that there are no unobserved factors that influence both private land tenure and economic development. To investigate the influence of unobserved confounding factors, I adopt the method advanced by Oster (2019).

Assume that the true data generating process is defined as follows:

$$Y_c = \beta X_c + \Psi \omega_c^o + \Theta \omega_c^u + \epsilon_c \tag{4}$$

where ω_c^u is a vector of unobserved confounding factors and ϵ_c is the error term. Also denote the R-squared of this regression model by R. This model captures that fact that selection into treatment (the prevalence of private land tenure) is determined by both observed (ω_c^o) and unobserved (ω_c^u) confounding factors. Also define $W^o = \Psi \omega^o$, $W^u = \Theta \omega^u$, and the proportional selection relationship as:

$$\delta \frac{cov(W^o, X)}{var(W^o)} = \frac{cov(W^u, X)}{var(W^u)} \tag{5}$$

where δ is the coefficient of proportionality. If the observed and unobserved confounding factors are equally related to the treatment (the prevalence of private land tenure), then $\delta = 1$. If the unobserved confounding factors are less related to the treatment than the observed confounding factors, then $\delta < 1$.

With $\delta = 1$, Oster (2019) shows that:

$$\beta^* = \tilde{\beta} - (\tilde{\beta} - \dot{\beta}) \frac{R - \tilde{R}}{\tilde{R} - \dot{R}} \tag{6}$$

is a consistent estimator of β. Equation (6) captures the main idea behind the estimator adjusted for omitted-variable bias proposed by Oster (2019). The movement of the estimated coefficient of the treatment (the prevalence of private land tenure) when the observed confounding factors are added can be used to infer the bias resulting from the unobserved confounding factors under the assumption of proportional selection. But this movement must be scaled by how well the variances of the observed confounding factors can account for the variance of the outcome (the level of economic development). The bias resulting from the unobserved confounding factors can be large even when the estimated coefficient of the treatment is stable when the observed confounding factors are added. This happens when the observed confounding factors have low variances, and hence are less important in explaining the variance of the outcome.

Relaxing the restriction of equal selection, $\delta = 1$, Oster (2019) shows that β^* can be derived by using an additional information from the regression of the treatment (the prevalence of private land tenure) on the observed confounding factors. In particular, an estimate of β^* can be derived for each set of values of the coefficient of proportionality (δ) and the R-squared of the true data generating process (R) defined in regression model (4). Oster (2019) provides strong validations for this estimator, using both simulations and real data.

5. Results

In this section, I first present the empirical results obtained from the panel data, followed by the results from the cross section of communes surveyed in 2004. Next, I conduct some robustness checks and explore the heterogeneity of the impact of private land tenure. In terms of inference, I use robust standard errors as the baseline, and later examine the robustness of the empirical results to standard errors clustered at the district level.[12]

5.1. Panel data

Table 2 reports the results of estimating the impact of private land tenure on economic development using the panel data. With the assumption that the time-invariant variables do not correlate with private land tenure, the random-effects model produces a positive and significant estimated coefficient of the percentage of agricultural land area having land-use certificates (column 1). The marginal effect is substantial, a one percent increase in the percentage of agricultural land area having land-use certificates is associated with a 1.2% increase in nighttime light intensity on average. Allowing the time-invariant variables to correlate with private land tenure, the fixed-effects model also produces a positive and significant estimated coefficient of the percentage of agricultural land area having land-use certificates (column 2). The marginal effect, however, drops from 1.2% to 0.9%. This decrease indicates that there are time-invariant factors that influence both private land tenure and economic development. Indeed, the Hausman specification test rejects the null hypothesis that the random-effects estimator is consistent (p-value = 0.000), suggesting that there is a significant bias resulting from time-invariant variables.

As mentioned earlier, the fixed-effects model assumes a common trend in economic development among the communes, and it is the 1993 land reform that causes deviations from this trend. To examine this assumption, I arbitrarily divide the sample into two groups: (i) communes with less than 50% of agricultural land area having land-use certificates in 2004, and (ii) communes with more than 50% of agricultural land area having land-use certificates in 2004.[13] Fig. 5 plots the trends in the average nighttime light intensity of these two groups. The trends are relatively similar between the two groups up until 1994, during which the 1993 land reform presumably started to be implemented. After 1994, the average nighttime light intensity of the second group grows faster and diverges from the trend of the first group. These results suggest that the common trend assumption is reasonable in the current setting.

[12] This choice is motivated by the argument of Abadie et al. (2017). In particular, the authors show that cluster adjustments for standard errors should only be performed when the data are collected by cluster sampling (e.g., first taking a subset of districts, and then drawing a sample of communes from sampled districts) or treatment occurs at a higher level of aggregation than the unit of observation. In the present paper, the communes were sampled randomly from almost all districts in Vietnam and the treatment (private land tenure) also occurs at the commune level.

[13] The result is similar with other values such as 75%, see figure A2 in the appendix.

Table 2
Panel data.

	Nighttime light intensity	
	Random-Effects (1)	Fixed-Effects (2)
Land-use certificates	0.012***	0.009***
	(0.001)	(0.001)
Year = 2005	1.695***	1.944***
	(0.109)	(0.119)
Constant	−2.314***	−2.314***
	(0.059)	(0.024)
R^2	0.224	0.569
Number of observations	4410	4410
Number of communes	2205	2205
Hausman specification test (p-value)	22.02 (0.000)	

Note: Robust standard errors are in parentheses. The sample includes 2205 communes at one year before (1992) and one year after (2005) the 1993 land reform. Nighttime light intensity is the natural logarithm of nighttime light intensity plus 0.01. Land-use certificates is the percentage of agricultural land area having land-use certificates.
*p < 0.1, **p < 0.05, ***p < 0.01.

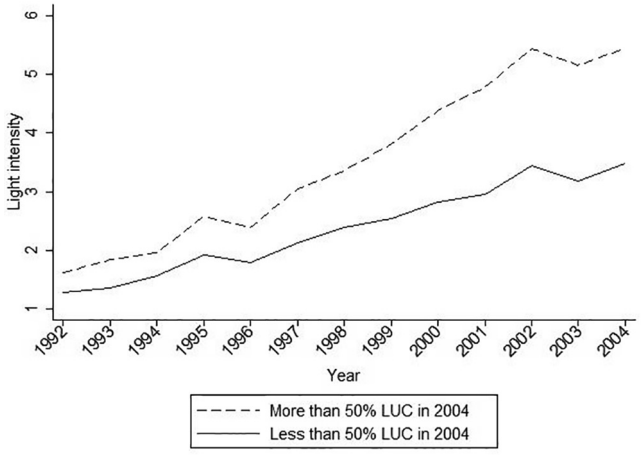

Fig. 5. Trends in nighttime light intensity. *Note:* The sample includes 2205 communes surveyed in 2004 and is divided into two groups: (i) communes with less than 50% of agricultural land area having land-use certificates in 2004, and (ii) communes with more than 50% of agricultural land area having land-use certificates in 2004. Each line represents the average nighttime light intensity for a group. See the main text for information about the data sources.

5.2. Cross section

Table 3 presents the results of estimating the impact of private land tenure on economic development using the cross section of communes surveyed in 2004. The first column shows that the estimated coefficient of the percentage of agricultural land area having land-use certificates is positive and significant when this variable enters the regression model alone, which corresponds to $\dot{\beta}$ in regression model (2). In particular, a one percent increase in the percentage of agricultural land area having land-use certificates is associated with a 1.7% increase in nighttime light intensity on average. The estimated coefficients of all confounding factors also have the expected signs and are significant at conventional levels when each variable enters the regression model alone (columns 2 to 6). In particular, higher levels of agricultural suitability and better public infrastructure (belong to the national electric grid and having a market) are all associated with higher levels of nighttime light intensity. In contrast, higher levels of elevation and terrain ruggedness are associated with lower levels of nighttime light intensity.

To see how the impact of private land tenure on economic development responds to the inclusion of the observed confounding factors into the regression model (column 7). The estimated coefficient of the percentage of agricultural land area having land-use certificates remains positive and significant, which corresponds to $\tilde{\beta}$ in regression model (3). Nevertheless, its magnitude is reduced to 0.006, meaning a one percent increase in the percentage of agricultural land area having land-use certificates is associated with a 0.6% increase in nighttime light intensity on average.[14] To illustrate the magnitude of this effect on the ground, take the commune with the average level of nighttime light intensity in the sample as an example. An increase of 0.6% then corresponds to an extra 0.03 point in nighttime light intensity. Using the estimate in Min and Gaba (2014), this point translates into an addition of roughly 7 to 8 electrified homes per square kilometer, which is modest. The estimated coefficients of all confounding factors remain significant with expected signs, except for the one of the agricultural suitability index, which is now not different from zero. All variables explain 61.7% of the total variation in nighttime light intensity.

To examine the influence of unobserved confounding factors (e.g., non-farm economic activities or government effectiveness), I apply the empirical model advanced by Oster (2019), as discussed in the previous section. In particular, I estimate the bias-adjusted coefficient of the percentage of agricultural land area having land-use certificates (β^*), for different values of the coefficient of proportionality (δ) and the R-square (R) of the true data generating process defined in regression model (1). Oster (2019) recommend to use δ = 1, meaning the observed and unobserved confounding factors are equally related to the treatment, as an upper bound on δ. In the context of the present paper, I consider a range of values of δ between zero and one. With respect to R, the theoretical value is one. In practice, however, outcome variables are in general measured with some errors, and hence R should be smaller than one. Oster (2019) recommends to use $R = 1.3\tilde{R}$ as the upper bound, which is 0.8 in the current setting. This bound is appropriate because nighttime light intensity is certainly measured with non-negligible errors.[15]

Table 4 shows that, in the most optimistic scenario (δ = 0.1 and R = 0.65), the estimated coefficient of the percentage of agricultural land area having land-use certificates remains significant with a magnitude of 0.006. In the most conservative scenario (δ = 0.9 and R = 0.8), however, it is not different from zero. Most of the scenarios in between deliver a significant estimated coefficient, but its magnitude can go down to 0.003. These results altogether suggest that the estimated coefficient of the percentage of agricultural land area having land-use certificates is sensitive to unobserved confounding factors and small in magnitude.

5.3. Robustness and heterogeneity

5.3.1. Clustered standard errors

The empirical analysis so far has used robust standard errors. Because all communes belonging to the same district share the same district-level economic variations, the error components might be correlated within the same district. To address this concern, I employ standard errors clustered at the district level. Table A2 in the appendix shows that the estimated coefficient of

[14] For a perspective, previous studies using nighttime light intensity as a dependent variable have found marginal effects of the explanatory variables of interest to be 18% (Michalopoulos and Papaioannou, 2013) and 2% (Hodler and Raschky, 2014).

[15] Min and Gaba (2014) find an R-square of 0.443 in a regression of satellite lights on actual lights across 200 villages in Vietnam, indicating that satellite lights are measured with considerable errors.

Table 3
Cross section.

	Nighttime light intensity						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land-use certificates	0.017***						0.006***
	(0.002)						(0.001)
Agricultural suitability		5.195***					−0.028
		(0.235)					(0.288)
Belong to electric grid			3.524***				0.861***
			(0.261)				(0.201)
Have market				0.868***			0.152**
				(0.104)			(0.069)
Elevation					−5.232***		−1.037**
					(0.209)		(0.434)
Ruggedness						−1.111***	−0.815***
						(0.032)	(0.070)
Constant	−0.971***	−3.546***	−3.094***	−0.241***	1.045***	1.163***	1.631***
	(0.150)	(0.196)	(0.257)	(0.088)	(0.040)	(0.040)	(0.375)
Province fixed effects	NO	NO	NO	NO	NO	NO	YES
R^2	0.054	0.214	0.087	0.034	0.370	0.393	0.617
Observations	2205	2205	2205	2205	2205	2205	2205

Note: OLS estimator, robust standard errors are in parentheses. The sample includes 2205 communes surveyed in 2004. Nighttime light intensity is the natural logarithm of nighttime light intensity plus 0.01. Land-use certificates is the percentage of agricultural land area having land-use certificates.
*p < 0.1, **p < 0.05, ***p < 0.01.

Table 4
Sensitivity to unobserved confounding factors.

	R = 0.65	R = 0.70	R = 0.75	R = 0.80
δ = 0.1	0.006***	0.006***	0.006***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
δ = 0.3	0.006***	0.005***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
δ = 0.5	0.005***	0.005***	0.004**	0.003*
	(0.001)	(0.001)	(0.002)	(0.002)
δ = 0.7	0.005***	0.004***	0.003*	0.001
	(0.001)	(0.001)	(0.002)	(0.002)
δ = 0.9	0.005***	0.003***	0.002	−0.000
	(0.001)	(0.002)	(0.002)	(0.002)

Note: The sample includes 2205 communes surveyed in 2004. The table reports the estimated coefficient, adjusted for omitted-variable bias (β^*), of the percentage of agricultural land area having land-use certificates on the natural logarithm of nighttime light intensity plus 0.01, under different values of the coefficient of proportionality (δ) and the R-square (R) of the data generating process defined in regression model (4). Bootstrap standard errors are in parentheses.

the percentage of agricultural land area having land-use certificates remains significant in regressions with the panel data and the cross section.

5.3.2. Intensive margin

The empirical analysis so far has included communes with zero nighttime light intensity. To examine the extent to which these zero-light communes drive the results, I focus only on communes that have some light to estimate the intensive margin.[16] Table A3 in the appendix shows that the estimated coefficient of the percentage of agricultural land area having land-use certificates remains significant in regressions with the panel data and the cross section. As above, the marginal effect also drops when observed confounding factors are controlled for. In the fixed-effects model (column 2) and in the regression with all observed confounding factors (column 4), the intensive margin is 0.003. This number says that, among the communes that have positive nighttime light, a one percent increase in the percentage of agricultural land area having land-use certificates is associated with a 0.3% increase in nighttime light intensity on average.

[16] The results are qualitatively similar when using a dummy variable denoting whether a commune has a zero or a positive value of nighttime light intensity as a dependent variable capturing economic development.

5.3.3. Nighttime light per capita

Nighttime light intensity is a measure of light per geographical unit. One may argue that nighttime light per capita should be a more appropriate measure of economic development. As a robustness check, I also consider nighttime light per capita. Nighttime light per capita in 2005 is calculated at the grid cell level by dividing nighttime light intensity plus 0.01 by population density in 2005. Nighttime light per capita at the commune level is the average of the values of all cells belonging to each commune. The Center for International Earth Science Information Network (2017) uses censuses from various years to calculate population density for every fifth year, which certainly involves some interpolations. The data are available at the grid cell level that corresponds to approximately one square kilometer at the equator. With respect to Vietnam, the 2009 census was used. Although it is not perfect, this is the only dataset of population density available at a small resolution, and hence is still of value for a robustness check.

Table A4 in the appendix presents the empirical results with respect to nighttime light per capita, using the cross section of communes surveyed in 2004. The estimated coefficient of the percentage of agricultural land area having land-use certificates is positive and significant, whether or not all observed confounding factors are added (columns 1 and 2). As above, the marginal effect also drops when observed confounding factors are controlled for. In the full specification (column 2), a one percent increase in the

percentage of agricultural land area having land-use certificates is associated with a 0.5% increase in nighttime light per capita on average. This marginal effect is almost similar in magnitude to the one found above with respect to nighttime light intensity.

5.3.4. Nighttime light growth

The empirical analysis so far has only looked at the level of economic development. In the context of the Vietnam, because all communes started with no land-use certificates before the 1993 land reform, communes that were faster to obtain land-use certificates should also experience stronger economic growth. To examine this hypothesis, I use the growth rate of nighttime light intensity in the period 1992 to 2005 as the dependent variable, which is approximated by taking the difference between the natural logarithm of nighttime light intensity in 2005 plus 0.01 and the natural logarithm of nighttime light intensity in 1992 plus 0.01. Table A4 in the appendix shows that the estimated coefficient of the percentage of agricultural land area having land-use certificates is positive and significant, whether or not all observed confounding factors are added (columns 3 and 4). As above, the marginal effect also drops when observed confounding factors are controlled for. In the full specification (column 4), a one percent increase in the percentage of agricultural land area having land-use certificates is associated with a 0.5% increase in nighttime light intensity in the period of 1992–2005. This marginal effect is almost similar in magnitude to the one found above with respect to nighttime light intensity. In addition, the negative estimated coefficient of nighttime light intensity in 1992 indicates a convergence in the level of nighttime light intensity, i.e., communes with lower levels of nighttime light intensity in 1992 experienced stronger growth in the period 1992 to 2005.

5.3.5. North–south differences

As discussed in the historical background, there was a stark north–south difference in terms of historical experiences with private land tenure. In general, the north had had a long experience with collective land tenure up to the 1993 land reform, while the south had had a long history of private land tenure. To examine if these historical experiences influence the economic impacts of the 1993 land reform, I split the sample into two sub-samples along the 17th parallel. Table A5 in the appendix reports the regression results with respect to each sub-sample, using both the panel data and the cross section. The estimated coefficient of the percentage of agricultural land area having land-use certificates is positive and significant in both sub-samples, except for the fixed-effects model in the northern subsample (column 2 of panel A). As above, the marginal effect also drops when time-invariant variables or observed confounding factors are controlled for. In addition, the estimated coefficient of the percentage of agricultural land area having land-use certificates is much smaller in magnitude in the northern sub-sample (panel A) compared to the southern subsample (panel B). These results indicate that there is a substantial north–south difference in the relationship between private land tenure and economic development, and that the long history of private land tenure in the south seems to be more conducive to the economic success of the 1993 land reform.

5.3.6. Heterogeneity

Is there a heterogeneity in the impact of private land tenure on economic development? To examine this question, I extend regression model (3) to include the interaction terms of the percentage of agricultural land area having land-use certificates and the observed confounding factors. Table A6 in the appendix shows that only the estimated coefficient of the interaction term containing having a market is significant. Its negative sign indicates that the marginal effect of the percentage of agricultural land area having land-use certificates is lower in communes that have markets on average. In the full specification (column 6), a one percent increase in the percentage of agricultural land area having land-use certificates is associated with a 0.6% increase in nighttime light intensity in communes with markets on average, compared to 1.2% in communes without markets. The insignificant estimated coefficients of other interaction terms indicate that the marginal effect of the percentage of agricultural land area having land-use certificates does not vary with these commune characteristics. The null hypothesis that the estimated coefficients of all interaction terms are equal to zero cannot be firmly rejected (p-value = 0.099). Overall, there is no strong evidence pointing to a substantial heterogeneity in the impact of private land tenure on economic development.

5.4. Discussion

The above empirical analysis has provided two main valuable insights. First, the prevalence of private land tenure has a positive and significant impact on the level of economic development across rural communes in Vietnam, as captured by nighttime light intensity. The magnitude of this impact, however, is reduced to a large extent when time-invariant variables or observed confounding factors (land quality, public infrastructure, and geography) are accounted for. This sizable drop in magnitude is consistent with the theoretical prediction discussed earlier that land profitability is likely to influence both the take-up of private land tenure in a commune and its level of economic development. In other words, communes with higher levels of land profitability had more households taking up private land tenure, and at the same time also experienced higher levels of economic development. This finding corroborates the general concern in empirical studies that private land tenure is endogenous, and failing to account for important confounding factors will lead to an overestimation of its impact on economic development (Pande & Udry, 2006).

Second, the impact of private land tenure on economic development across rural communes in Vietnam is sensitive to unobserved confounding factors and modest in general. In comparison, this finding deviates from the general finding of previous cross-country studies, which have found a large impact of private property rights on economic development (Acemoglu, Johnson, & Robinson, 2001, 2002; Acemoglu & Johnson, 2005). Nevertheless, it is in line with the theoretical prediction discussed earlier, and also consistent with the findings of previous studies pointing to modest impacts of the Vietnamese 1993 land reform on the allocative efficiency of the land distribution and households' investments. In particular, Ravallion and van de Walle (2006) have found that land allocation after the 1993 land reform did move toward greater allocative efficiency, but the speed was slow. The most credible estimate indicates that only 13% of the initial disparity in efficiency between the administrative allocation and the market allocation was eliminated over a period of five years, from 1993 to 1998 (Ravallion & van de Walle, 2006). Similarly, Do and Iyer (2008) have found that the reform did increase long-term investments, as proxied by the percentage of cultivated area devot-

ing to perennial crops, but the effect was modest. To be more specific, a one standard deviation increase in the proportion of households possessing land-use certificates resulted in a 0.09 standard deviation increase in the proportional area devoted to perennial crops. In addition, the authors have found no significant increase in household borrowing.

The main explanations of the modest impact of private land tenure on economic development across rural communes can be found in the limited nature of private land tenure in Vietnam. To be more specific, land is still officially owned by the state and land-use certificates can be revoked (normally with compensation not based on market values) when the usage periods are ended. As a result, this discretion of the state brings about a lingering insecurity of private land tenure. For example, Markussen and Tarp (2014) have estimated that around 4% of households were expelled from their land by the state in the period of 2006–2012.[17] In addition, transfers and exchanges of land with land-use certificates still have to be approved by the authorities and all land transactions had to pay taxes, all impose a high cost of time and money on land transactions. For example, it is reported that both the cost of time and taxes in land transactions were relatively higher in Vietnam compared to other countries in the East Asian region (Childress, 2004).

6. Conclusion

The present paper examines the impact of private land tenure on rural economic development by exploiting the nationwide land privatization in Vietnam in 1993. The empirical analysis combines three components to deal with confounding factors: (i) a comprehensive conceptual framework to understand the endogenous nature of private land tenure in the context of the Vietnamese reform, (ii) a panel of data before and after the 1993 reform to account for time-invariant confounding factors, and most importantly (iii) a novel empirical method advanced by Oster (2019) to estimate the bias resulting from unobserved confounding factors. Using a random sample of more than 2000 rural communes across Vietnam in 2004, I find that the prevalence of private land tenure has a positive and significant impact on the level of economic development, as proxied by nighttime light intensity. The magnitude of the impact, however, is reduced to a large extent when time-invariant variables or observed confounding factors are accounted for. Moreover, it is also sensitive to unobserved confounding factors in general.

The overall conclusion is that the impact of private land tenure on rural economic development in Vietnam was modest. This modest impact is likely to be the result of the lingering insecurity of private land tenure (i.e., the state can revoke the tenure) and the relatively high taxes and time cost of land transactions. The key lesson of the Vietnamese 1993 land reform is that a limited version of private land tenure did not boost rural economic development very much. Future land reforms must pay a serious consideration to a more complete version of private land tenure, i.e., granting people land ownership that lasts forever instead of time-limited land-use certificates. In addition, reducing taxes and the time cost of land transactions is another potential venue that policy reforms should look at in order to reap the greatest economic benefits of private land tenure. These policy lessons are also valuable for other transition (e.g., China) and developing countries (e.g., Ethiopia), in which the state is still the absolute authority in land distribution (Deininger et al., 2008, 2014; Deininger & Jin, 2006, 2009; Jacoby, Guo, & Rozelle, 2002).

[17] Land disputes are also among the most urgent issues in Vietnam, as reported by the citizens (United Nations Development Program, 2016).

Owing to data availability, the present paper has left three unanswered questions that warrant further research. First, how do the lingering risk of having land-use certificates revoked by the state and the high taxes and time cost of land transactions relate to the effectiveness of private land tenure (de facto property rights) in Vietnam? Second, one finding indicates that the long history of private land tenure in the south of Vietnam is more conducive to the economic success of the 1993 land reform, what are the exact mechanisms? Third, as some communes implemented the 1993 land reform earlier than the others, are there differences between the short-term and long-term effects of the reform? I believe that these questions are promising venues for future research with access to more data.

CRediT authorship contribution statement

Hoang-Anh Ho: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing - original draft, Writing - review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

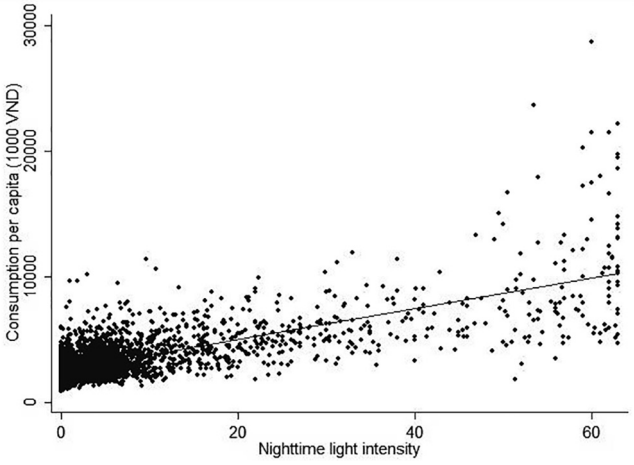

Fig. A1. Nighttime light intensity and consumption per capita. *Note:* The Pearson's correlation coefficient is 0.73 (p-value = 0.000). The sample includes 2827 communes surveyed in 2002. See the main text for information about data sources.

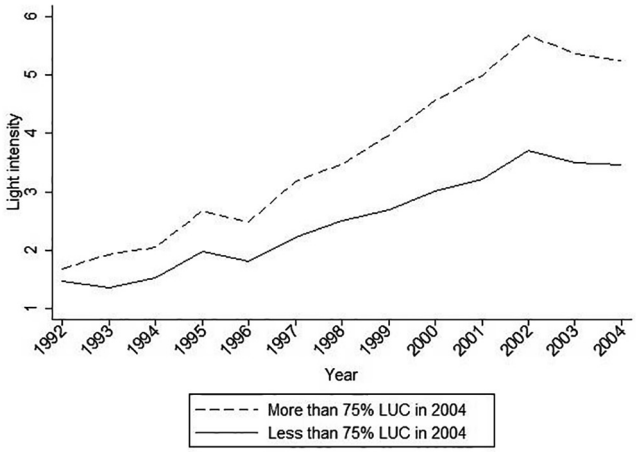

Fig. A2. Trends in nighttime light intensity. *Note:* The sample includes 2205 communes surveyed in 2004 and is divided into two groups: (i) communes with less than 75% of agricultural land area having land-use certificates in 2004, and (ii) communes with more than 75% of agricultural land area having land-use certificates in 2004. Each line represents the average nighttime light intensity for a group. See the main text for information about the data sources.

Table A1
Correlation matrix.

	Nighttime light intensity	Land-use certificates	Agricultural suitability	Belong to electric grid	Have market	Elevation	Ruggedness
Nighttime light intensity	1						
Land-use certificates	0.036	1					
	(0.000)						
Agricultural suitability	0.296	0.262	1				
	(0.000)	(0.000)					
Belong to electric grid	0.120	0.117	0.209	1			
	(0.000)	(0.000)	(0.000)				
Have market	0.082	0.083	0.125	0.088	1		
	(0.000)	(0.000)	(0.000)	(0.000)			
Elevation	−0.278	−0.263	−0.584	−0.341	−0.222	1	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
Ruggedness	−0.309	−0.265	−0.620	−0.375	−0.179	0.774	1
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Note: Pearson's correlation coefficients, p-values are in parentheses. Land-use certificates is the percentage of agricultural land area having land-use certificates. The sample includes 2205 communes surveyed in 2004. See the main text for information about data sources.

Table A2
Cluster standard errors.

	Nighttime light intensity			
	Panel Data		Cross Section	
	(1)	(2)	(3)	(4)
Land-use certificates	0.012***	0.009***	0.017***	0.006***
	(0.002)	(0.002)	(0.003)	(0.002)
Year = 2005	1.695***	1.944***		
	(0.109)	(0.119)		
Province fixed effects	na	na	NO	YES
Control variables	na	na	NO	YES
R^2	0.224	0.569	0.054	0.617
Observations	4410	4410	2205	2205

Note: The panel data include 2205 communes at one year before (1992) and one year after (2005) the 1993 land reform. The cross section includes 2205 communes surveyed in 2004. Random-effects model in column 1, fixed-effects model in column 2, OLS estimator in columns 3 and 4, standard errors clustered at the district level are in parentheses. Nighttime light intensity is the natural logarithm of nighttime light intensity plus 0.01. Land-use certificates is the percentage of agricultural land area having land-use certificates. Control variables include agricultural suitability, belong to the national electric grid, having a market, elevation, ruggedness, and a constant.
*p < 0.1, **p < 0.05, ***p < 0.01.

Table A3
Intensive margin.

	Nighttime light intensity			
	Panel Data		Cross Section	
	(1)	(2)	(3)	(4)
Land-use certificates	0.003***	0.003***	0.008***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Year = 2005	0.870***	0.843***		
	(0.055)	(0.077)		
Province fixed effects	na	na	NO	YES
Control variables	na	na	NO	YES
R^2	0.218	0.591	0.027	0.541
Observations	1872	1872	1912	1912

Note: The panel data include 2205 communes at one year before (1992) and one year after (2005) the 1993 land reform. The cross section includes 2205 communes surveyed in 2004. Random-effects model in column 1, fixed-effects model in column 2, OLS estimator in columns 3 and 4, robust standard errors are in parentheses. Nighttime light intensity is the natural logarithm of nighttime light intensity (without adding 0.01). Land-use certificates is the percentage of agricultural land area having land-use certificates. Control variables include agricultural suitability, belong to the national electric grid, having a market, elevation, ruggedness, and a constant.
*p < 0.1, **p < 0.05, ***p < 0.01.

Table A4
Alternative measures of nighttime light.

	Nighttime light per capita		Nighttime light growth	
	(1)	(2)	(3)	(4)
Land-use certificates	0.008***	0.005***	0.013***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Nighttime light intensity in 1992			−0.518***	−0.695***
			(0.012)	(0.016)
Province fixed effects	NO	YES	NO	YES
Control variables	NO	YES	NO	YES
R^2	0.218	0.591	0.027	0.541
Observations	1872	1872	1912	1912

Note: OLS estimator, robust standard errors are in parentheses. The sample includes 2205 communes surveyed in 2004. Nighttime light per capita is the natural logarithm of nighttime light intensity plus 0.01 divided by population density. Nighttime light growth is the difference between the natural logarithm of nighttime light intensity in 2005 plus 0.01 and the natural logarithm of nighttime light intensity in 1992 plus 0.01. Light intensity 1992 is the natural logarithm of nighttime light intensity in 1992 plus 0.01. Land-use certificates is the percentage of agricultural land area having land-use certificates. Control variables include agricultural suitability, belong to the national electric grid, having a market, elevation, ruggedness, and a constant.
*p < 0.1, **p < 0.05, ***p < 0.01.

Table A5
North-south differences.

A. North	Nighttime light intensity			
	Panel Data		Cross Section	
	(1)	(2)	(3)	(4)
Land-use certificates	0.005***	0.002	0.012***	0.003**
	(0.002)	(0.002)	(0.002)	(0.002)
Year = 2005	1.431***	1.669***		
	(0.128)	(0.142)		
R^2	0.107	0.415	0.029	0.751
Observations	2344	2344	1172	1172
B. South	Nighttime light intensity			
	Panel Data		Cross Section	
	(1)	(2)	(3)	(4)
Land-use certificates	0.020***	0.013***	0.027***	0.012***
	(0.002)	(0.003)	(0.003)	(0.003)
Year = 2005	1.931***	2.476***		
	(0.203)	(0.207)		
R^2	0.432	0.740	0.118	0.430
Observations	2018	2018	1009	1009
Province fixed effects	na	na	NO	YES
Control variables	na	na	NO	YES

Note: Panel A includes all provinces above the 17th parallel, Panel B includes all provinces below the 17th parallel The panel data include 2205 communes at one year before (1992) and one year after (2005) the 1993 land reform. The cross section includes 2205 communes surveyed in 2004. Random-effects model in column 1, fixed-effects model in column 2, OLS estimator in columns 3 and 4, robust standard errors are in parentheses. Nighttime light intensity is the natural logarithm of nighttime light intensity (without adding 0.01). Land-use certificates is the percentage of agricultural land area having land-use certificates. Control variables include agricultural suitability, belong to the national electric grid, having a market, elevation, ruggedness, and a constant.
*p < 0.1, **p < 0.05, ***p < 0.01.

Table A6
Heterogeneity.

	Nighttime light intensity					
	(1)	(2)	(3)	(4)	(5)	(6)
Land-use certificates	0.017***	0.010**	0.017***	0.007***	0.009***	0.012
	(0.005)	(0.004)	(0.002)	(0.002)	(0.002)	(0.009)
Agricultural suitability	2.709***					0.032
	(0.553)					(0.633)
LUC × Suitability	−0.008					−0.001
	(0.006)					(0.008)
Belong to electric grid		1.369***				0.898**
		(0.339)				(0.395)
LUC × Electric grid		0.002				−0.000
		(0.004)				(0.005)
Have market			0.807***			0.626***
			(0.217)			(0.190)
LUC × Market			−0.008***			−0.006***
			(0.003)			(0.002)
Ruggedness				−0.923***		−0.767***
				(0.083)		(0.163)
LUC × Ruggedness				−0.000		−0.001
				(0.001)		(0.002)
Elevation					−4.190***	−0.702
					(0.511)	(0.723)
LUC × Elevation					0.001	−0.006
					(0.005)	(0.009)
Constant	−0.321	0.668*	1.527***	2.502***	2.320***	1.150
	(0.470)	(0.363)	(0.223)	(0.180)	(0.187)	(0.708)

Note: OLS estimator, robust standard errors are in parentheses. The sample includes 2205 communes surveyed in 2004. Nighttime light intensity is the natural logarithm of nighttime light intensity plus 0.01. Land-use certificates (LUC) is the percentage of agricultural land area having land-use certificates.
*p < 0.1, **p < 0.05, ***p < 0.01.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.worlddev.2020.105275.

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