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Essays on Culture, Institutions, and Economic Development

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For my wife!

Contents

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The present thesis is an observable product of an exciting adventure that lasted for one twentieth of a century. I would like to take this page to express my gratitude to all the people who have influenced its shape and content.

Spring 2015, when I was wondering whether I should spend more time to develop the vague idea of the first chapter, Ola Olsson (in a *fika*, of course) nudged me forward by saying "go with the flow". Spring 2017, when I was nervous about running my first experiment ever in the field, Peter Martinsson followed me (through Skype) in every step to make sure that I would not miss a single detail in the preparation (for a typical example, how to deal with the risk of walking around in the field with a bag full of cash). Ola and Peter, I have been very lucky to have you as my supervisors. I have learned so much from working with you, not only knowledge and skills, but also attitudes. Your enthusiastic supervision and co-authorship have made my adventure so enjoyable and rewarding. Nevertheless, I believe that your friendship, unmeasurable though it is, is the key confounding factor. I hope that it will stand the test of time.

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To sum up, readers should keep in mind that everything was done to ensure that the remaining errors are irredeemably my own.

Gothenburg, August 2019.

Introduction

The present thesis consists of three independent chapters, examining different questions related to culture, institutions, and economic development. In each study, the theoretical analysis is subject to an empirical investigation that utilizes the context of Vietnam. As a result, the three chapters are connected not only through the general theme of development, but also through the empirical context.

In the first chapter, Ola Olsson, Peter Martinsson, and I study the origins of cultural divergence along the individualism-collectivism dimension, which has been shown to be a powerful predictor of economic development (Gorodnichenko and Roland 2011, 2017). In particular, we propose a selective migration hypothesis, positing that cultural differences along the individualism-collectivism dimension are driven by the out-migration of individualistic people from collectivist societies to frontier areas, and that such patterns of historical migration are reflected even in the current distribution of cultural norms. We empirically examine this hypothesis by exploiting the southern territorial expansion and mass migration in historical Vietnam. Gaining independence in 939 after 1000 years of Chinese colonization, historical Vietnam occupied the region that is now north Vietnam with a centralized government and a collectivist social organization. From the 11^{th} to the 18^{th} centuries, historical Vietnam gradually expanded its territory southward to the Mekong River Delta through various waves of conquest and migration. Using a household survey and a lab-in-the-field experiment, we demonstrate that areas annexed earlier to historical Vietnam are currently more prone to collectivist norms, and that these cultural norms are embodied in individual beliefs. In addition, relying on many historical accounts, together with various robustness checks, we argue that the southward out-migration of individualistic people during the eight centuries of the territorial expansion is an important driver, among many others, of these cultural differences. We believe that our study provides a valuable input for understanding long-run cultural divergence. First and foremost, migration patterns in the distant past have played a crucial role in explaining cultural differences across modern societies. As time goes on, similar processes may

continue to enhance cultural differences across societies. These cultural differences may, in turn, have important implications for the future of comparative economic development.

In the second chapter, I study the emergence of private property rights, a key variable in the history of economic development (North and Thomas 1973). In particular, I present a theory to account for the emergence of land rights in a subsistence agricultural economy. An important feature is that, to maximize tax revenue, an authoritarian state must devise land rights to overcome the informational constraint in registering the population for tax collection. It can do so, given the state capacity is sufficiently high, by owning land and assigning cultivation rights (but not sale or transfer rights) to landless peasants to tie them to their land. The theory gives rise to a testable hypothesis, positing that private ownership of land is less prevalent in areas where population density is higher. In the early 19^{th} century, the new Nguyen Dynasty of historical Vietnam carried out a land registry to establish formal land rights in the whole country. Because the Nguyen Dynasty had to take into account the level of population density among other things in its decision to grant private ownership of land, this historical experiment rules out the potential reverse influence of private land rights on population density. Exploiting this land registry, I discover that private ownership of land is less prevalent in areas where population density is higher. Furthermore, primary accounts and related historical studies show that the mechanism at work is in line with the proposed theory. Thus, the theory in question and the associated empirical evidence show that a strong state could reverse the general process in economic history whereby societies moved toward private land rights as population density increased and land became scarcer. This study also corroborates the general view that the state has a central role in explaining the emergence of private property rights, as advocated by North (1981). The key lesson to take away is that insecure land rights (rights to cultivate but not sale or transfer), which were often found in historical societies, were devised by authoritarian states to tie the peasants to their agricultural land, for the benefit of the states, and more secure land rights have arisen only when the interests of the states dictate so. This lesson is useful for understanding the origins and evolution of land rights in authoritarian countries that are trying to shift labor from agriculture to manufacturing in order to speed up industrialization and generate more tax revenue.

In the third chapter, I examine the relationship between private property rights and economic development. Although this question has been investigated by numerous cross-country studies (Acemoglu, Johnson, and Robinson 2001, 2002; Acemoglu and Johnson 2005), aggregate measures of private property rights have limited the ability of cross-

country studies to identify the specific institutions governing private property rights that policy reforms should consider. Using a within-country setting, I investigate the impact of private land tenure on economic development, exploiting the 1993 nationwide land privatization in Vietnam. 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 to 50 years. The most significant change is that the new law allowed land-use certificates to be transferred, exchanged, leased, mortgaged, and inherited. This nationwide 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. I combine a comprehensive conceptual framework to examine the endogenous nature of private land tenure in the context of this land reform with different empirical approaches to deal with both observed and unobserved confounding factors. Using a random sample of more than 2000 (out of around 8000) rural communes across Vietnam, I find that the prevalence of private land tenure has a positive 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 modest. This modest impact is consistent with 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 in Vietnam. The key lesson is that a limited version of private land tenure did not boost 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.

Chapter I

Chapter I

The Origins of Cultural Divergence: Evidence from Vietnam

(with Peter Martinsson and Ola Olsson)

Abstract

Cultural norms diverge substantially across societies, often within the same country. We propose and investigate a *self-domestication/selective migration hypothesis*, proposing that cultural differences along the individualism-collectivism dimension are driven by the out-migration of individualistic people from collectivist core regions of states to peripheral frontier areas, and that such patterns of historical migration are reflected even in the current distribution of cultural norms. Gaining independence in 939 after about a thousand years of Chinese colonization, historical Vietnam emerged in the region that is now north Vietnam with a collectivist social organization. From the 11^{th} to the 18^{th} centuries, historical Vietnam gradually expanded its territory southward to the Mekong River Delta through various waves of conquest and migration. Using a household survey and a lab-in-the-field experiment, we demonstrate that areas annexed earlier to historical Vietnam are currently more prone to collectivist norms, and that these cultural norms are embodied in individual beliefs. Relying on many historical accounts, together with various robustness checks, we argue that the southward out-migration of individualistic people during the eight centuries of the territorial expansion is an important driver, among many others, of these cultural differences.

Keywords: Culture; Selective Migration; Vietnam.

JEL Classification: N45; O53; Z1.

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1 Introduction

Economic research has uncovered strong associations between many cultural traits and various indicators of individual behavior and institutional and economic development (e.g., Guiso, Sapienza, and Zingales 2011; Fernández 2011; Algan and Cahuc 2014; Doepke and Zilibotti 2014; Alesina and Giuliano 2014, 2015). Among the cultural traits, the individualism-collectivism dimension has been found to be a powerful predictor of economic and democratic development in a large sample of countries (Gorodnichenko and Roland 2011, 2015, 2017).[1] These empirical findings lead us to an important question: Why are some societies more or less collectivistic or individualistic than others?

In the present paper, we hypothesize that cultural differences along the individualism-collectivism dimension across modern societies can be traced back to repeated processes of territorial expansion and migration that happened in historical times. In particular, we advance a *selective migration hypothesis*, consisting of three building blocks. First, in regions where settled agriculture and states arose early, collectivist societies emerged through a process of *self-domestication* as communities made the transition from hunter-gatherer strategies of food procurement, which were characterized by individualism, to agricultural food production, resulting in a gradual strengthening of "civilizing" collectivism. Second, these collectivist societies triggered the out-migration of individualistic members toward peripheral areas. This pattern then repeated itself as the individualistic migrants inhabited and developed these peripheral areas into less collectivistic societies compared to the ones they left behind, which in turn induced more individualistic members to migrate toward more peripheral areas. Eventually, these migration processes gave rise to cultural differences along the individualism-collectivism dimension across societies. Third, owing to the slow-moving nature of culture, these differences have persisted over time and constitute an important feature of the cultural landscapes exhibited in modern times. As a result, the time elapsed since the collectivist transformation can predict the strength of collectivism across modern societies.

Testing the selective migration hypothesis requires a historical setting where there was a large out-migration of people from a collectivist society in the core region to settle down in new regions with a similar biogeography as in the core region, and that this migration

[1] Some other notable traits include trust, family ties, generalized morality, and attitudes toward work and the perception of poverty. The individualism-collectivism dimension is also the single most relevant dimension in cultural psychology (Gorodnichenko and Roland 2012). For a survey on the theory and measurement of the individualism-collectivism dimension in social psychology, see Triandis (1995).

repeated over time once collectivism was gradually strengthened in the new regions. We find such an ideal setting in the process of territorial expansion and migration in historical Vietnam. Gaining independence from the colonization of imperial China during the first millennium, historical Vietnam initially governed the region of what is now north Vietnam with a centralized government and a collectivist social organization. At the same time, the territory in the south of historical Vietnam was sparsely populated by many ethnic tribes that did not have a centralized government. From 968 to 1757, historical Vietnam gradually expanded its territory southward to the Mekong River Delta to establish the country as it is today (see figure 1). This process happened through successive waves of state conquest followed by civil migration, resulting in the displacement of most of the population of local ethnic tribes. Applying the logic of the selective migration hypothesis, we argue that the time elapsed since annexation to historical Vietnam is an important predictor of the strength of collectivism across regions within contemporary Vietnam.

To test the selective migration hypothesis, an ideal empirical strategy would consists of three integral parts. The first part should demonstrate that some early agricultural states were characterized by collectivism, and that people who migrated to the new territories following state expansions were less collectivistic or more individualistic than those who stayed. The second requires historical data to prove that these selective migrations gave rise to early cultural differences along the individualism-collectivism dimension between the initial regions and the new territories. Finally, the third part involves using present-day data to conduct an empirical analysis on the relationship between the time elapsed since the collectivist transformation and the strength of collectivism.

To match this ideal empirical strategy in the context of Vietnam, we first present qualitative accounts to demonstrate that the initial society of historical Vietnam was characterized by strong collectivist norms. Second, we examine available primary records on the territorial expansion of historical Vietnam to identify the categories of people who migrated to the new annexed territories. In addition, we provide qualitative accounts and descriptive statistics to show that cultural differences along the individualism-collectivism dimension across regions were already present in Vietnam in the 17^{th} century. Third, we provide empirical evidence for a positive relationship between the time elapsed since an area was annexed to historical Vietnam and various indicators of collectivism in the present day. Using different robustness checks, we further show that these empirical findings are consistent with the self-domestication/selective migration hypothesis.

To capture the strength of collectivism, we focus on the societal ability to solve collective action problems, which is the main feature of collectivism studied in related

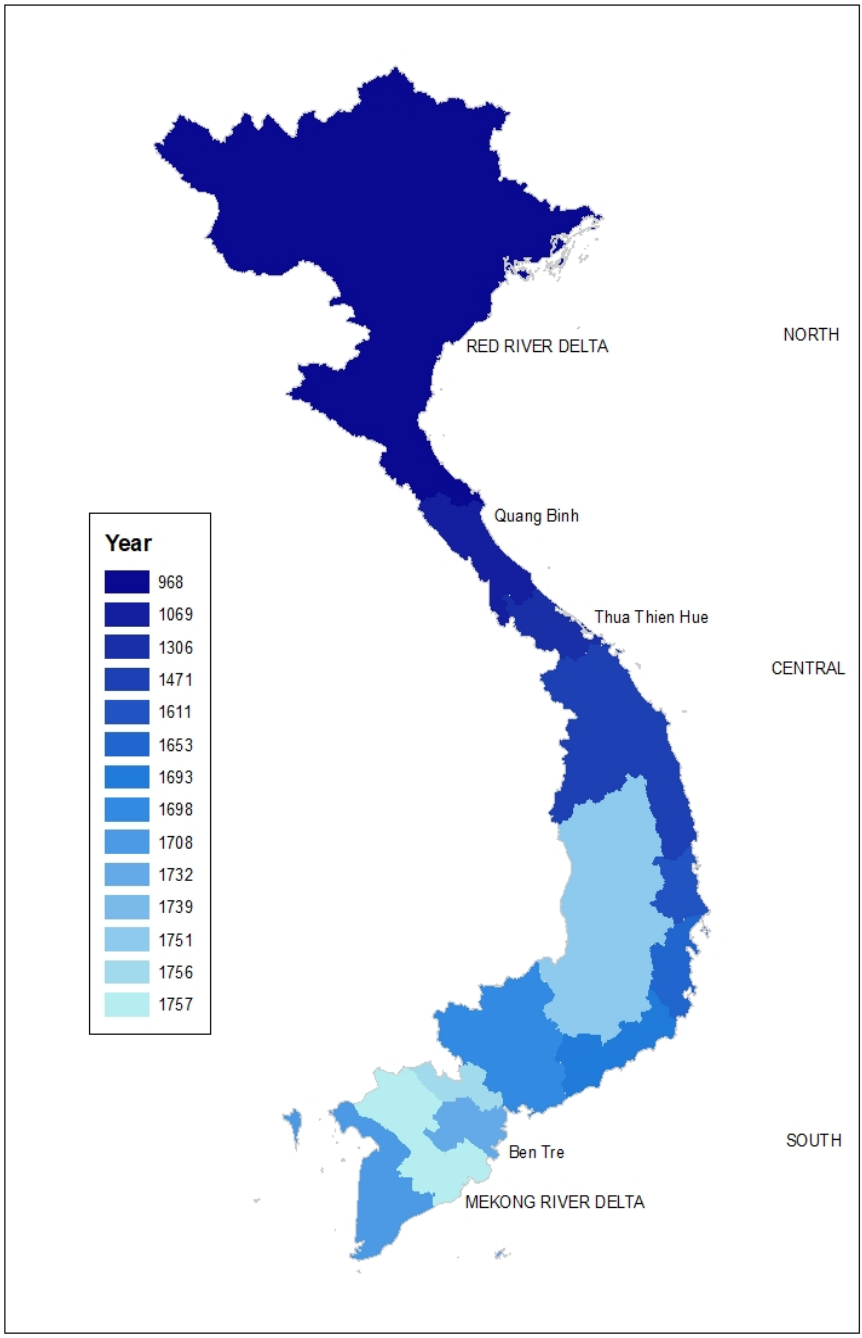


Figure 1. The Vietnamese Southern Advance

Note: The year at which a district was annexed into historical Vietnam. See appendix A for data sources.

economic models (Gorodnichenko and Roland 2015, 2017). What constitutes a collective action, of course, varies significantly across societies. In Vietnam, labor contribution to public goods production is a typical collective action (Adams and Hancock 1970). In particular, every year households in a local area send their members to work without payment to build or repair local public infrastructure such as roads, wells, irrigation, schools, and health clinics. Because collectivist societies are considered to be better at solving collective action problems, it should be able to mobilize a larger amount of voluntary labor contribution to public goods production from their in-group members.

Using data on voluntary labor contribution to public goods production from the Vietnam Household Living Standard Survey, we construct three related indicators at the district level: (i) the percentage of households contributing labor, (ii) the average number of persons per household making labor contributions, and (iii) the average number of labor days contributed per household. We find that districts annexed earlier to historical Vietnam currently have higher percentages of households contributing labor, more members per household making labor contributions, and more labor days contributed per household. The estimated effects are economically and statistically significant, and robust to the inclusion of potential confounding factors, various sub-samples, and omitted-variable bias, among other checks.

To examine in-group cooperation in more detail, we conduct a lab-in-the-field public goods experiment with high school students from the same local areas in an earlier-annexed district and a later-annexed district. This is a subject pool old enough to be aware of the cooperative norms in their communities, but not yet significantly exposed to other external influences. The advantage of the experiment is that the institutional setting can be kept constant, which helps ruling out the influences of informal institutions on cooperation behaviors. More importantly, the experimental design allows us to examine if the difference in the contribution to public goods between the two chosen districts is driven by a difference in preferences for cooperation or a difference in beliefs about the cooperative behaviors of others. We find that subjects from the earlier-annexed district contribute substantially more in the public goods experiments compared to subjects from the later-annexed district, and that the result is mainly driven by the belief about the contribution levels of the other subjects. Thus, the experimental findings corroborate the survey data analysis and further suggest that cultural differences across Vietnamese regions are embodied in individual beliefs.

Our research relates to a growing multidisciplinary literature examining the origins

of cultural differences along the individualism-collectivism dimension.[2] Theories based on ecological context posit that some forms of production in subsistence economies (e.g., farming) require more functional interdependence than others (e.g., hunting), which gave rise to collectivism as an adaptation mechanism (e.g., Vandello and Cohen 1999; Talhelm et al. 2014). In a recent paper, Buggle (2018) documents that societies where irrigation agriculture was practiced tend to have stronger collectivist norms (and a lower degree of innovative activities) even today. In related research, Bentzen, Kaarsen, and Wingender (2017) show that historical irrigation is also associated with autocratic governance. Litina (2016) argues further that lower level of natural land productivity increased the return to public agricultural infrastructure, which generated higher incentives for cooperation to solve the problem of collective action.[3]

Motivated by the history of settlement in the United States and its highly individualist culture, Kitayama et al. (2006, 2009) proposed the *voluntary settlement hypothesis*, asserting that settlers in frontier areas are likely to have highly autonomous, independent, and goal-oriented mindsets. Bazzi, Fiszbein, and Gebresilasse (2017) expand on this theme and study the cultural legacy of the 19$^{\text{th}}$ century westward expansion in the United States. The authors show that contemporary individualism is stronger in historical frontier areas and that a selective migration of individualists to the periphery explains part of this pattern, along with the particular characteristics of wilderness and isolation in the west. Knudsen (2019) finds a similar pattern of selective migration among Scandinavian migrants to the United States in the 19$^{\text{th}}$ century, using uncommonness of first names as a proxy for the degree of individualism. Knudsen (2019) also documents that the out-migration of strong individualists made the home regions more collectivist in the long run. Giavazzi, Petkov, and Schiantarelli (2019) study the evolution of preferences among European immigrants to the United States and find that the persistence in cultural attitudes is substantial across the spectrum of values. Using a similar line of argument as in the current paper, Olsson and Paik (2016) show that collectivism is stronger in regions across western Eurasia that adopted agriculture earlier during the Neolithic Revolution.

[2] The modernization hypothesis, arguing that societies become more individualistic as they reach higher levels of economic development, essentially focuses on the convergent tendency toward individualism, rather than pre-existing cultural differences across modern societies (Inglehart and Baker 2000).

[3] See also Fincher et al. (2008) who argue that societies with historically greater prevalence of disease-causing pathogens are currently more prone to collectivist norms, because the emphasis on the in-group/out-group distinction could serve as an anti-pathogen defense function.

The present paper builds on and adds to this literature in various ways. To the best of our knowledge, no studies on the origins of cultural differences along the individualism-collectivism dimension have examined the societal ability to solve the problem of collective action, especially using a combination of survey and experimental data. Furthermore, most studies so far have either employed cross-country comparisons or concentrated on currently developed societies. Because these societies have gone through the modernization process to a greater extent, the reduction of the traditional cultural landscapes makes it harder to study the historical origins of cultural differences. By comparing different regions within a single and biogeographically homogenous developing country that experienced a relatively recent economic modernization, our research is able to overcome these limitations.

Our research also fits into a literature in economics examining the persistence of various cultural traits as an important channel through which historical processes could influence contemporary economic development (Nunn 2012, 2014; Spolaore and Wacziarg 2013). Some notable traits are gender equality (Alesina, Giuliano, and Nunn 2013; Hansen, Jensen, and Skovsgaard 2015), trust and cooperation (Nunn and Wantchekon 2011; Becker et al. 2016; Bigoni et al. 2016, 2018; Guiso, Sapienza, and Zingales 2016; Litina 2016), anti-Semitic attitudes (Voigtländer and Voth 2012), time preference (Galor and Özak 2016), civic values (Lowes et al. 2017) and norms favoring hard work (Fouka and Schläpfer 2019). The theoretical basis for understanding intergenerational and other types of cultural transmission was pioneered by Bisin and Verdier (2001) and Richerson and Boyd (2005).

In a related recent study, Dell, Lane, and Querubin (2018) use a border regression discontinuity design (BRD) along a border segment in southern Vietnam which they claim was a stable demarcation between historical Vietnam and tributary polities to the Khmer Empire from 1698 to the 1830s. The main hypothesis is that the presence of a centralized historical state should crowd in local collective action, which in turn was beneficial for subsequent economic development. The authors show that living standards are currently higher in the border areas governed for a longer period of time by the centralized states of historical Vietnam. As one potential mechanism for this result, Dell, Lane, and Querubin (2018) explore whether historical institutions contributed to a greater ability of collective action, measured by participation in civil society organizations.

Our paper differentiates from Dell, Lane, and Querubin (2018) in the following ways. First, our emphasis is on a mechanism of selective migration rather than on crowding in of norms by a powerful state. In the sections below, we argue that our mechanism

has strong support in the historical literature on Vietnam, as well as reflecting a general pattern throughout Southeast Asia (Scott 2009). It should be recognized though that the two hypotheses are strongly linked and that the true historical process probably had elements of both crowding in and selective migration. Second, our main outcome variable is cultural norms of collectivism-individualism rather than indicators for economic development. We would argue our research is complementary since it investigates a different cultural dimension for understanding long-run economic development. Third, rather than using a BRD as in Dell, Lane, and Querubin (2018), our main empirical strategy is to exploit a country-wide sample of districts across all of Vietnam. Our basic rationale for this strategy is that our coding of the official chronicles of historical Vietnam suggests a more or less continuous process of state expansion that was completed in 1757.[4]

The remainder of the present paper is organized as follows. The next section discusses in detail the conceptual framework behind the selective migration hypothesis. Section 3 provides the historical background of the southward territorial expansion of historical Vietnam and the accompanying migration process, with a focus on the three building blocks of the selective migration hypothesis. Section 4 presents the empirical analysis with survey data. Section 5 describes the sample selection, experimental design, and corresponding results. Section 6 closes the paper with some concluding remarks.

2 Conceptual Framework

In this section, we first define the individualism-collectivism dimension in the cultural repertoire of a population. We then outline a theory of *selective migration* and cultural divergence along the individualism-collectivism dimension. This theory is the backbone of the selective migration hypothesis.

2.1 Individualism versus Collectivism

Research on the individualism-collectivism dimension of culture was first initiated within social psychology. Many of the key insights were summarized by Triandis (1995) and in subsequent cross-country empirical research by Hofstede (2001). In this voluminous literature, *collectivism* is considered to be characterized by a strong focus on the goals of

[4] See appendix A for a detailed account and motivation of our coding decisions regarding the Vietnamese southern advance. A further discussion of our coding of the southern advance in relation to Dell, Lane, and Querubin (2018) is available upon request. Our investigation does not support an extended delay in this advance at the border of 1698, which is a key identifying assumption in Dell, Lane, and Querubin (2018).

a collective that forms the in-group boundary. In other words, the goals of the individual are subordinate to the goals of the collective, and the individual willingly makes costly sacrifices for the group. The individual typically has low self-expression and self-esteem, and an interdependent sense of agency. Family, duty, honor, and respect for the elders are central for collectivists. On the macro level, collectivist societies are typically characterized by a highly stratified or autocratic leadership (sometimes referred to as *vertical collectivism*) and hostility towards out-groups.

Individualism is the opposite of collectivism on all the features mentioned above. There is a strong focus on the goals of the individual, and the in-group identity is weak. The goals of the individual are superior to the goals of the collective, and the individual is typically unwilling to make costly contributions to the group at the expense of himself or herself. The individual has a strong sense of personal agency, high self-expression and self-esteem. The extended family does not play a central role, and individual preferences and fulfillment are more important than duty and honor. Individualists tend to live in egalitarian societies, are not very loyal to their fellow in-group members, and are willing to cooperate with out-group members (Triandis 1995).

How do these cultural norms translate into economic behaviors? This issue has recently been studied in a series of papers by Gorodnichenko and Roland (2011, 2017). The authors outline a hypothesis and demonstrate empirically that societies characterized by individualism are less bound by rules and authority, reward personal achievement, and hence tend to be associated with fewer constraints and stronger incentives for *innovation*. Analogously, the strong norms towards in-group cooperation, combined with subordination of the self to the goals of the collective, give collectivists a comparative advantage for *collective action* and *public goods production* that under certain circumstances might be necessary for the in-group to survive. Individualistic societies are thus more loosely held together but are on the other hand more dynamic, whereas collectivist societies have tight social ties and effective cooperation but limited growth potential in the longer run.[5]

2.2 Selective Migration and Cultural Divergence

To develop the self-domestication/selective migration hypothesis, we build on Triandis (1995) and Olsson and Paik (2016), and assign a crucial role to the rise and consolidation of the early agricultural states. Before the first transition to agriculture about 12,000

[5] Buggle (2018) provides evidence that regions that practiced irrigation agriculture historically have a more collectivist contemporary culture and also tend to have less innovations and more routine-intensive occupations.

years ago, all societies relied on hunting-gathering-fishing where the household of core family members was often the main unit of social organization. Households only stayed in larger camps during shorter periods but then splintered in order to avoid crowding and social tensions. In some environments, hunting required greater coordination, which sometimes led to larger and semi-sedentary social groups, but whenever possible, the basic tendency in pre-agricultural societies was autonomous households without stronger bonds or obligations to other in-group members (Johnson and Earle 2000).[6]

The first agricultural societies emerged in regions such as Mesopotamia and China. In these regions, a highly productive irrigation agriculture gave rise to a dense and sedentary population, living in crowded villages and depending on the cultivation of a few domesticated crops and animals. Compared to hunter-gatherer households in pre-agricultural societies, these early farming villages were characterized by a much greater degree of collectivism, where the goals of the collective were far more important than individual aspirations. The survival of such villages often required sophisticated public goods such as irrigation canals, protective walls, military defense, public granaries, and deep wells. Such projects were initiated, coordinated and supervised by a social elite that managed to control the great majority of the population.

By the 4th millennium BCE, the first states arose from such complex farming communities in Mesopotamia, and soon after that, also in Egypt (Borcan, Olsson, and Putterman 2018; Scott 2017). As has recently been studied by Mayshar, Moav, and Neeman (2017) and Mayshar et al. (2019), the ability of the elite to economically exploit the great majority of farmers depended to a great extent on the transparency and appropriability of agricultural production. Mayshar et al. (2019) argue that crops such as wheat and rice were more appropriable for taxation purposes than tubers like potatoes. In a related paper, Mayshar, Moav, and Neeman (2017) contend that the greater reliability of the Nile floods in comparison to those of Euphrates and Tigris, explains why Egypt had a more centralized and more durable state organization during antiquity than the various state formations that repeatedly emerged and collapsed in Mesopotamia. Comparing the attitudes of people from Chinese areas dominated by highly labor- and coordination-intensive rice production with areas dominated by wheat cultivation, Talhelm et al. (2014) find that collectivist norms are stronger in rice areas. Thus, even among communities where a sedentary population practiced a cultivation of domesticated plants, there were great differences in the strength of individualism-collectivism depending on the specific character

[6] See, for instance, Johnson and Earle (2000)'s description of the contemporary Kung people of the Kalahari, a society which has been considered a modern remnant of prehistorical social organization.

of the agricultural production process.

It has been argued by Johnson and Earle (2000), Scott (2017) and others that the new type of social organization in dense agricultural communities and states was only possible through a gradual *self-domestication of humans* whereby the natural inclinations towards family-level social units was overcome through a strong selective pressure favoring individuals and groups who could more successfully adapt to the new lifestyle in the farming villages, with a higher pathogen load, more toil and work hours in the fields, a new diet with more carbohydrates and less protein, and more children per woman. In addition to these changes, we argue that there must have been a very strong pressure towards the adoption of collectivist norms. It is well known that social stratification expanded with agriculture and the goals of the individual were suppressed for the benefit of the common good, involving larger and larger collective action projects such as irrigation, city walls, the construction of cult centers, and even massive burial complexes for divine rulers (Diamond 1997). This kind of social organization would not have been possible without a great increase in the proliferation of collectivist norms. In the official narrative of this process, chroniclers of the early states would typically describe it as the introduction of *civilization* to an environment populated by previously primitive or barbaric tribes.

We argue that the civilizing self-domestication process discussed above first emerged in regions with favorable conditions for agriculture, but it then repeated itself all around the world when farming replaced hunting-gathering and states arose from the dense farming communities. This self-domestication process probably included several related mechanisms. *Evolution* provides a selective advantage for individuals with genes that helped them cope with the physiological, psychological and cultural challenges of intensive farming. In addition, there were presumably *push factors* such as a conscious "weeding out" of individualists who did not adapt to the new collectivist norms. Social exclusion or ostracism might be one mechanism whereby individualists were pushed from the collectivist core to peripheral areas.

There were surely also *pull factors*, inducing individualists to leave the collectivist core voluntarily in order to have a freer life at the periphery. In his description of the history of state formation in Southeast Asia, Scott (2017) describes the very conscious escape of population groups from the rice-growing core areas of the different states as "an art of *not* being governed". For these people, a withdrawal to peripheral areas was a key feature of their strategy of *state evasion*. Such a "pioneer spirit" was emphasized in Turner (1920)'s work on the westward expansion of settlers in North America, and more recently studied by Bazzi, Fiszbein, and Gebresilasse (2017). It is also similar

to Kitayama et al. (2006, 2009)'s notion of *voluntary settlement* of peripheral areas by individualistic people. As discussed by Bazzi, Fiszbein, and Gebresilasse (2017), the adaptation to the living conditions in the "rugged frontier", where a strong sense of individual agency most likely was necessary for survival, surely also contributed to a greater degree of individualism even among people with collectivistic inclinations. As shown by Knudsen (2019), the out-migration of individualists probably contributed to making the culture in the core even more collectivist than before.

Typically, the peripheries to the original agricultural core region were sooner or later colonized by a collectivist farmer-state through territorial expansion. Evolutionary adaptation, push and pull forces then played out in a similar manner, making the peripheral population more collectivistic as well. The exact nature of these adaptations would depend importantly on the biogeographical characteristics of the settled peripheral areas, which in turn would determine the specific technology of agricultural production. But as described by Olsson and Paik (2016) in their application of the selective migration logic to the expansion of Neolithic agriculture throughout the Western hemisphere, the most individualistic people in the periphery would soon once again take off towards more peripheral areas in repeated frontier colonizations.

Scott (2009) provides a narrative account of how rice-based states gradually expanded across Southeast Asia and provoked marginal population groups to settle the highlands or the more peripheral parts of the lowland plains. The core areas of the early states in contemporary Myanmar, Thailand, Cambodia and Vietnam were generally characterized by highly productive irrigated rice cultivation in the lowland valleys of major rivers such as the Irrawaddy (Myanmar), the Mekong (Cambodia) and Red River (Vietnam). Historical Southeast Asia had a much lower population density than India and China, which meant that the periphery was often a feasible alternative for population groups who, for different reasons, wanted to evade the influence of the central governments. There were many different strategies used and reasons for trying to evade the influence of the expanding states in the region. In Scott (2009, p. 326)'s words:

> *"Those who for whatever reason wished to evade incorporation as subjects had to place themselves out of range either on the plains at greater remove from the core or in the less accessible hills. … it is clear that the hills were populated increasingly by pulses of migration by state subjects fleeing valley kingdoms for any one of several reasons - corvée labor, taxes, conscription, war, struggles over succession, religious dissent - all having directly to do with state making."*

Despite this unwillingness to be subjects of the expanding states, the populations in the periphery were often willing to engage in mutually beneficial trade. Their societies were non-hierarchical and fluid and often based on foraging or swiddening agriculture. The officials of the rice states typically considered the peripheral populations as uncivilized and barbaric (Scott 2009). In the terminology of our framework above, we might describe them as non-domesticated individualists.

Since self-domestication, just like evolution, is a function of time, the penetration of collectivist norms was typically also an increasing function of the time elapsed since the "civilizing" collectivist transformation. In this manner, a gradient arose with the greatest degree of collectivism in the oldest regions and the highest degree of individualism in the youngest territories of the farmer-state. The slow-moving nature of culture implied that, centuries or even millennia after the first settlement of individualistic farmers, signals from these early migration processes are still visible in contemporary cultural record.[7]

Nevertheless, as already argued by Triandis (1995), the Industrial Revolution in Europe, with innovation as a key driving factor, once again turned the tables and gave individualism an economic advantage in north European countries such as Britain and the Netherlands. Thus, we might expect that the collectivist legacy of the transition from hunting-gathering to farming should be weaker in countries where an industrial economy has existed for a longer period of time. In addition, Western colonization of regions outside Europe might change the indigenous cultural landscapes to a large extent. In some developing countries that only experienced industrialization recently and had strong indigenous states, the cultural imprint from the historical expansion of the collectivist farmer-state is more likely to be observable in the present day.

3 Historical Background

In the previous section, we outlined a theory of self-domestication, selective migration and cultural divergence along the individualism-collectivism dimension. In this section, we survey historical materials to examine three building blocks of our theory in the context of Vietnam: (i) the initial region of historical Vietnam was home to a collectivist society; (ii) individualistic people migrated southward as the country expanded its territory, eventually giving rise to cultural differences along the individualism-collectivism dimension; and (iii) these cultural differences have persisted to the present day.

[7] For instance, Olsson and Paik (2016) show that peripheral Scandinavia and other North European countries still have much stronger individualistic norms than people in the old agricultural regions in the Middle East.

3.1 Core Region of Historical Vietnam Was a Collectivist Society

Archaeological evidence indicates that ancient populations had settled down in the Red River Delta with rice agriculture around 2000 BCE during the Neolithic Revolution (Nguyen, Pham, and Tong 2004). These populations lived together, without a centralized state, in the region that is now north Vietnam (see figure 1). From 111 BCE to 939, the whole region was brought under the colonization of the centralized bureaucracy of imperial China. During this period, "the Vietnamese evolved from a preliterate society within a "south-sea civilization" into a distinctive member of the East Asian cultural world" (Taylor 1983, p. xvii).

After the victory over historical China in 939, the first unified state of historical Vietnam was founded in 968 and inherited a centralized bureaucratic system from the Chinese colonizer (Taylor 2013, p.51-77). Thus, in terms of the theory discussed above, we might argue that Vietnamese society was domesticated to a large extent into a collectivist social organization by an external agent. Subsequent dynasties governing historical Vietnam continued to build stronger structures and orders into the society, which emphasized the values of social groups above the needs and desires of its constituent members (Whitmore 1984, 1997). The collectivist nature of historical Vietnam was best exemplified by its village-based administrative system and family organization. The village was the lowest administrative level, which was responsible for regulating almost all aspects of the daily living of its members (Nguyen 2003). Two important responsibilities of the village were to allocate public land under its management to its members (Dao 1993), and to organize unpaid labor for public goods production such as irrigation facilities, roads, and communal buildings (Adams and Hancock 1970). With respect to the family, parents had absolute authority over their children in almost all aspects of life (e.g., education, marriage, and housing), while children had to serve and obey their parents with the utmost respect throughout their lives (Haines 1984).

The area bordering historical Vietnam in the south, which is now central Vietnam (see figure 1), was inhabited by various ethnic groups that formed the Champa Kingdom. Next to the Champa Kingdom in the south, which is now south Vietnam (figure 1), was the land belonging to the Khmer Empire. In contrast to the centralized state of historical Vietnam, both the Champa Kingdom and Khmer Empire were basically networks of small political entities (Hall 2011, p.67-102, 159-210). The Champa Kingdom in the south was traditionally a trading-oriented nation integrated in the south Asian spice trade. Available historical materials do not allow us to draw any comparison between

these societies and historical Vietnam along the individualism-collectivism dimension. However, in the terminology of Scott (2009), it is clear that southern Vietnam, over long periods populated mainly by Cham and Khmer ethnic groups, was a periphery to the more centralized states in the core areas of historical Vietnam and the Khmer Empire. The fact that the Champa Kingdom was less centralized and more open contact with foreigners, probably made it a relatively attractive refuge for more individualist people during the Vietnamese southern advance.

3.2 Selective Migration and Cultural Divergence

From 968 to 1757, historical Vietnam expanded its territory southward along the coast to the Mekong River Delta. This so-called Vietnamese *Southern Advance* (*Nam Tien*) took place gradually through various annexations and was completed in 1757, by which time the border of Vietnam was established as it is today (see appendix A). Historical Vietnam first annexed the land from modern Quang Binh to modern Binh Dinh from 968 to 1471. This land was effectively governed by the Nguyen Lords since the early 16^{th} century, when the fight to control the throne erupted between them and the Trinh Lords in the initial core region. From 1611 to 1757, the Nguyen Lords continued to expand the country southwards to the Mekong River Delta to establish the border as it is today. Compared to the initial region, the annexed region under the government of the Nguyen Lords was more open towards foreign trade (Tana 1998, p. 59-98).

After historical Vietnam conquered an area, Vietnamese migrants started to settle in. A few records from the two official chronicles of historical Vietnam, *Dai Viet Su Ky Toan Thu* (from 204 BCE to 1675) and *Dai Nam Thuc Luc* (from 1558 to 1888), indicated that Vietnamese migrants to the annexed region ranged from landless farmers to rich adventurers, who took advantage of the opportunities in the new land, and from exiled criminals to recruited soldiers, who were sent to the new land by the government (see appendix B). There are no records available to identify who were the dominant settlers, let alone their cultural characteristics.[8] Regarding the local ethnic groups, most of their populations moved to more distant peripheries such as the highlands (Scott 2009), while

[8] Historians seem to be in agreement that these migrants were not recognized as true members of the collectivistic society in the initial region. Such a migrant "lacked standing in a social group, like the family or the village, was less than a full person and could hope for no better future in traditional village society" (Tana 1998, p. 111), or even was "marginal and undesirable" (Taylor 2013, p. 211). One may recall the analogous image of European immigrants to the United States during the age of mass migration (Abramitzky, Boustan, and Eriksson 2012). In a related study, Alesina and Giuliano (2010) also find that people with weak family ties are more likely to migrate.

those who decided to stay were acculturated to the Vietnamese culture (Wook 2004).[9] The logic of the selective migration hypothesis discussed in the previous section implies that areas annexed earlier to historical Vietnam were initially more collectivistic and would become even more so as a result of the selective out-migration of individualists.[10] The historical evidence presented below is in support of this prediction.

Within historical Vietnam, cultural differences along the individualism-collectivism dimension between the annexed region and the initial region were already remarkable as early as the 17$^{\text{th}}$ century. For example, Tana (1998, p. 99-116) provides many historical accounts to demonstrate that the social environment in the annexed region was characterized by greater openness, mobility and autonomy compared to the core region. Available statistics of land allocation in the early 19$^{\text{th}}$ century also illustrate this cultural divergence. In the core region, land was only allocated to or owned by village members (Nguyen 2003). In the annexed region, however, the in-village/out-village distinction was loosened and land was commonly allocated to or owned by people from other villages. For example, studies on the land registries (cadastres) in the annexed region in the early 19$^{\text{th}}$ century show that the proportions of land allocated to or owned by people from other villages were 20-30 percent in the southernmost provinces (Nguyen 1994f) compared to 8-15 percent in more northern provinces (Nguyen 1997c, 2010b, 1996a, 1996c).

Besides the selective migration of individualistic people as proposed by our theory, there are certainly other potential explanations for the cultural differences along the individualism-collectivism dimension between the annexed and core regions of historical Vietnam as described above. First, the frontier environment in the annexed region (e.g., sparsely populated) might have induced Vietnamese migrants to be more individualistic. Second, Vietnamese migrants might have been influenced by the cultural characteristics of the Champa Kingdom and Khmer Empire, which in turn might be more individualistic than historical Vietnam. Finally, Vietnamese migrants to the annexed region might have picked up individualistic traits from foreigners because of the open trade policy of the Nguyen Lords, which in turn was a continuation of the trade orientation of the Champa Kingdom. The main difference between our theory of selective migration and these explanations is that our theory predicts cultural differences even within the annexed region, i.e., areas annexed earlier are predicted to be more collectivistic.

[9] In modern times, their descendants only constituted minor fractions in the total population of Vietnam; for example in 1999, the Cham were 0.17% and the Khmer were 1.38% (General Statistics Office of Vietnam 2001, p. 167).

[10] See Knudsen (2019) for an account of how parts of Scandinavia became more collectivistic as a result of the sizeable out-migration of individualists.

3.3 Cultural Differences Have Persisted to the Present Day

The last block of the selective migration hypothesis argues that the cultural differences across regions of historical Vietnam found around the 17^{th} century have persisted and made up a key characteristic of the cultural landscape of modern Vietnam.[11] In other words, the time elapsed since annexation to historical Vietnam is an important predictor of the strength of collectivism within contemporary Vietnam. The north-south cultural differences along the individualism-collectivism dimension in modern Vietnam have been documented in details in many anthropological studies, e.g., Hickey (1964), Rambo (1973), and Luong (1992). This north-south cultural divergence is also a typical characteristic that is normally mentioned in descriptions about modern Vietnam.[12]

To sum up, the north-south cultural differences along the individualism-collectivism dimension were already in place as early as the 17^{th} century and are currently a central theme of Vietnam. Our theory of selective migration discussed in the previous section predicts that areas annexed earlier to historical Vietnam are currently more prone to collectivist norms, and this relationship holds even within the annexed region. We now turn to investigate these predictions empirically using survey data in section 4 and experimental data in section 5.

4 Survey Data Analysis

4.1 Empirical Model

In this section, we use survey data to investigate the proposed theory of selective migration in the context of Vietnam. The key argument of the theory is that collectivist societies triggered the out-migration of individualistic members toward peripheral areas,

[11] The French colonization started in 1858 and ended with the Vietnamese victory in the First Indochina War (1946-1954), during which the French colonizers concentrated most of their activities in south Vietnam. Following the French defeat was the American intervention in south Vietnam (i.e., the Second Indochina War, commonly known as the Vietnam War), which ended with the reunification of the country in 1975. Meanwhile, Communism started to develop in north Vietnam in the early 20^{th} century and gained control of this part of the country since 1954.

[12] Ending his Vietnamese history, Taylor (2013, p. 624) notes that "northerners are more disciplined to accept and to exercise government authority" and "southerners are more individualistic, egalitarian, entrepreneurial, interested in wealth more than in authority". Although regarding collectivism as the main cultural theme in their practical guide to Vietnam, Ashwill and Diep (2005, p. 71-72) note that "northerners are considered to be more intelligent, conservative, austere, serious, and frugal, ..., [and] are more apt to save for a rainy day", while "southerners are perceived as fun-loving, easy-going, open people who rarely think of saving for a rainy day".

and, owing to the slow-moving nature of culture, these differences have persisted over time. Our empirical strategy revolves around regressing a measure capturing the strength of collectivism on the time elapsed since a district was annexed to historical Vietnam, while controlling for potential confounding factors. The core regression model takes the following form:

$$Collectivism_i = \beta TimeSinceAnnexation_i + \gamma X_i + \epsilon_i. \quad (1)$$

In this equation, $Collectivism_i$ is a measure of the strength of collectivism in district i, $TimeSinceAnnexation_i$ is the time since annexation to historical Vietnam, X_i is a set of potential confounding factors, and ϵ_i is a random error term. Our hypothesis postulates that β is positive with respect to the strength of the collectivist measure, i.e., the longer the time since annexation, the stronger the collectivist norms.

Ideally, our main independent variable should capture historical migrations from the core area. Unfortunately, we have not been able to find such a direct measure of selective migration. Our main variable $TimeSinceAnnexation_i$ is an indirect proxy for historical migrations in the sense that we should expect that regions annexed last should host the greatest amount of population groups seeking to evade the influence of the northern state. To what extent would an estimated coefficient of $\beta > 0$ rule out other potential hypotheses regarding the persistent cultural impact of historical states? In particular, does our main explanatory variable allow us to distinguish between (i) selective migration, (ii) a crowding-in of collectivist norms by a strong state, and (iii) migrants' adoption of individualist norms that were already strong in the southern periphery?

We argue that a $\beta > 0$ would be consistent with our selective migration hypothesis, but that it would not disprove the two other hypotheses. In fact, as discussed earlier in our theoretical framework, we recognize that there is a significant overlap between the three hypotheses, and that they are to some extent reflections of the same underlying process. For instance, a strong crowding-in of norms by a collectivist state will *push* individualists to migrate to the periphery, and the absence of a strong state and a culture of individualism in the south will *pull* an even greater number of individualist migrants to the periphery.

4.2 Variables

The Individualism-Collectivism Trait

In the present paper, we follow the conventional definition of culture in economic re-

search as "decision making heuristics or 'rules of thumb' that have evolved given our need to make decisions in complex and uncertain environments" (Nunn 2012, p. S109).[13] Based on this definition, many observable outcomes have been used in the literature to capture different aspects of the individualism-collectivism trait, such as extended family structure, marriage stability, and inventiveness (Vandello and Cohen 1999; Talhelm et al. 2014) or unusual names (Bazzi, Fiszbein, and Gebresilasse 2017; Knudsen 2019).[14] We argue that an outcome variable must satisfy two conditions to be a good measure of the individualism-collectivism dimension. First, it must capture an aspect of the individualism-collectivism trait that is theoretically relevant to understand individual behaviors or economic development. Second, it must feature as a traditional practice of the society in question, i.e., it captures a decision making heuristic in daily living.

In the present paper, we use voluntary labor contribution to public goods production to capture the strength of collectivism. We argue that this measure satisfies the two conditions mentioned above. First, the ability to solve collective action problems such as public goods production is the main feature of collectivism in related economic models (Gorodnichenko and Roland 2015, 2017). Because collectivist societies are considered to be better in this respect, they should be able to mobilize a larger amount of voluntary labor contribution to public goods production from their in-group members. Second, labor contribution to public goods production is a traditional activity in Vietnam (Adams and Hancock 1970). In particular, every year households in a local area send their members to work without payment to build or repair local public infrastructure such as roads, wells, irrigation, schools, and health clinics. These labor contributions are not paid, and hence are arguably voluntary. Thus, the decision to contribute labor to public goods production should capture a decision making heuristic in daily living.

Our main dataset is the Vietnam Household Living Standard Survey (VHLSS) in 2002, which covers almost 30000 households in 607 (out of 630) districts (roughly 50 households per district) across all 61 provinces in Vietnam and is the only survey round that contains detailed information about voluntary labor contribution to public goods production. We measure cultural norms at the district level by aggregation of household

[13] This definition is closely related to another prominent one proposed by Guiso, Sapienza, and Zingales (2006, p. 23): "customary beliefs and values that ethnic, religious, and social groups transmit fairly unchanged from generation to generation."

[14] Other studies also use value survey such as the World Value Survey to capture the individualism-collectivism trait (Olsson and Paik 2016; Buggle 2018). In the context of Vietnam, these surveys only include a small sample of respondents (around 1000) across a small subset of districts (around 10 to 20) in Vietnam. In addition, respondents' locations are not provided owing to data policy.

data.[15] In particular, we construct three related variables based on voluntary labor contribution to public goods production. First, we calculate the percentage of households contributing labor in the district to measure the prevalence of labor contributions. Second, we calculate the average number of persons making labor contributions per household. Finally, we calculate the average number of labor days contributed per household. These last two variables capture the intensity of labor contributions.

Table 1 shows that, in 2002, around 31% percent of households contributed labor to public goods production, whereas the average number of persons making labor contributions per household is 0.55 and the average number of labor days contributed per household is 4.05. To avoid missing data for non-surveyed districts on the map, we calculate the average values of each of the three variables at the province level and depict them in figure 2. A visual comparison with figure 1 suggests that districts annexed earlier to historical Vietnam currently have higher percentages of households contributing labor, more members per household making labor contributions, and more labor days contributed per household.

The Time since Annexation to Historical Vietnam

As previously mentioned, our main explanatory variable is the time elapsed since an area was annexed to historical Vietnam. Following the historical background discussed earlier, we choose the first unified state of historical Vietnam in 968 as the beginning year, while the terminal year is set to 1990. In our analyses, we measure the time since annexation in centuries (100 years) to make the estimated coefficients easy to read in the reported tables. The descriptive statistics in table 1 show that the annexations took place between 2.33 to 10.22 centuries before the terminal year of 1990.

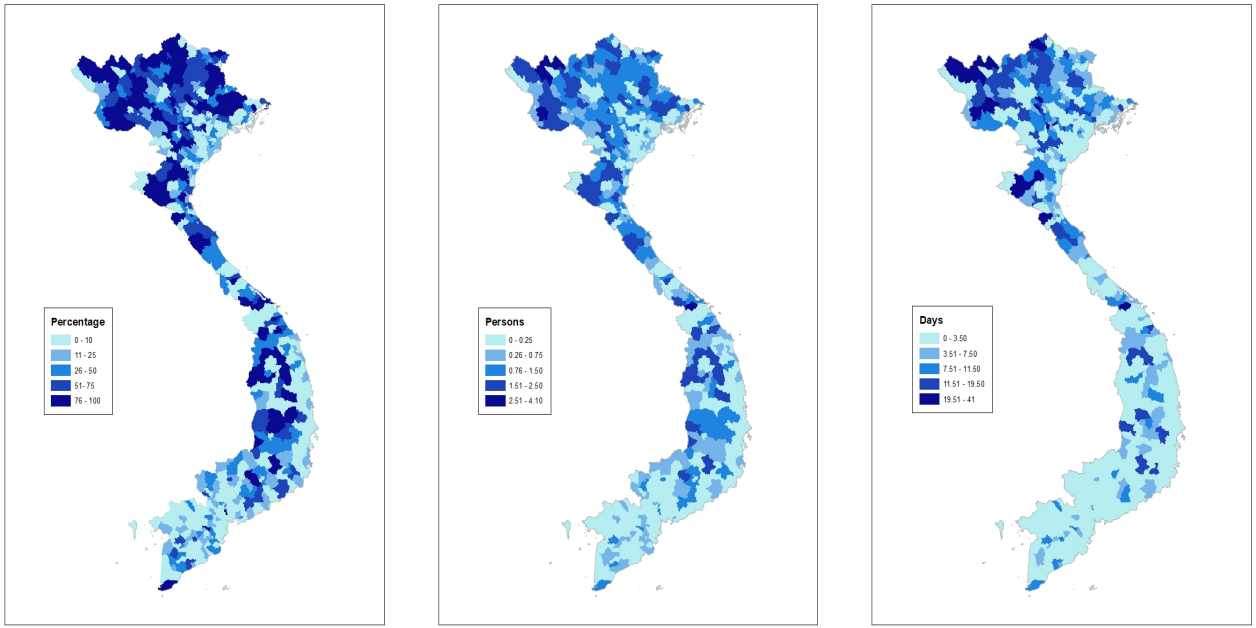
To construct the time since annexation to historical Vietnam for each modern district, two dimensions are needed: (i) the district's corresponding area in historical Vietnam and (ii) the year that this area was annexed. For the year that a historical area was annexed, we rely on two official chronicles of historical Vietnam, *Dai Viet Su Ky Toan Thu* (2012) and *Dai Nam Thuc Luc* (2002a), recording events from the beginning to 1675 and in the 1558-1888 period, respectively. These chronicles were written by state officials of historical Vietnam to keep track of events and, to the best of our knowledge, constituted the primary sources for Vietnamese histories. We code an area as having been annexed when there is a record in the chronicles demonstrating that this area was under the control of

[15] There is certainly individual heterogeneity within a society, but in aggregation one can observe what social psychologists call the "cultural syndrome" of each society (Triandis 1995). This is also a standard exercise in economics (Alesina and Giuliano 2015).

Table 1. Variable Description

Variable	Description	Mean	SD	Min	Max	N
Main Variables						
Having contributed	Percentage of households contributing labor	0.31	0.33	0	1	607
Members contributed	Average no. of persons per household making contributions	0.55	0.65	0	4.10	607
Days contributed	Average no. of days contributed per household	4.05	5.63	0	41	607
Time since annexation	Number of centuries since annexation into historical Vietnam	6.77	3.57	2.33	10.22	607
Control Variables						
Caloric suitability	Average yield (million kilo calories per km^2 per year)	25.08	2.50	15.88	31.74	607
Distance to coast	Shortest distance to the coastal line (100 km)	0.73	0.81	0	4.30	607
Elevation	Average height above sea level (km)	0.20	0.30	0.001	1.56	607
Ruggedness	Average topographic heterogeneity (10000 km)	1.14	1.43	0	6.27	607
Irrigation suitability	Average suitability for irrigation, not suitable (0) and suitable (1)	0.09	0.25	0	1	607
Am climatic zone	Equatorial monsoonal	0.19	0.39	0	1	607
Aw climatic zone	Equatorial winter dry	0.47	0.50	0	1	607
Cfa climatic zone	Warm temperature, fully humid, hot summer	0.01	0.11	0	1	607
Cwa climatic zone	Warm temperature, winter dry, hot summer	0.32	0.47	0	1	607
Distance to Quang Binh	Walking distance to Quang Binh (100 km)	8.43	3.52	0	13.49	311

Note: All variables are measured at district level. See the main text for more detail.



A. Percentage of Households B. Number of Persons per Household C. Number of Days per Household

Figure 2. Labor Contribution to Public Goods Production

Source: VHLSS 2002.

historical Vietnam. To link historical areas to their modern counterparts, we rely on two seminal works of Vietnamese historians: Dao (2005) and Phan et al. (2011). All details on the coding procedure are presented in appendix A.

Control Variables

To tackle the endogeneity of the time since annexation into historical Vietnam, we identify a set of potential confounding factors, i.e., factors that might influence both the time since annexation to historical Vietnam and the strength of collectivism. A necessary condition for a variable to be a confounding factor is that it must have existed before the annexation to historical Vietnam. Variables that came to exist after the annexation such as demographic characteristics in the modern day might be caused by the annexation, and hence are bad controls (Angrist and Pischke 2009). Nevertheless, as shown in the following subsection, our empirical results are also robust to the inclusion of numerous bad controls. Below, we describe the set of potential confounding factors in detail.

First, agricultural suitability might have both attracted historical Vietnam to conquer a region and promoted the development of collectivism. We control for natural land productivity, which has been argued to influence the incentive to cooperate in the production of public infrastructure in the subsistence agricultural economy (Litina 2016). Second, geographical conditions might affect the difficulty in conquering a region. Isolated areas are also conducive to the development of a collectivist culture (Triandis 1995). We control for distance to the coast, elevation, and ruggedness to capture geographical isolation. Third, we also control for irrigation suitability, because irrigation agriculture has been shown to be conducive to the development of collectivism (Buggle 2018). In addition, we control for climatic zones to capture any potential influence of climatic conditions on the development of collectivism.

Natural land productivity is measured by caloric suitability constructed at 5 arc-minute resolution by Galor and Özak (2016), who make their calculation based on data from the Global Agro-Ecological Zones project of the Food and Agriculture Organization. This index measures the average potential yield (million kilo calories per squared kilometer per year) attainable in each grid cell given the set of crops that are suitable for cultivation in the post-1500 period. To capture the natural component of land productivity, the production conditions are set at a low level of inputs and rain-fed agriculture based on agro-climatic conditions, which are unaffected by human intervention. Distance to the coast is measured by the shortest (bird-fly) distance to the coastal line. Elevation is taken from the Global 30 Arc-Second Elevation Dataset (GTOPO30) provided by

the Earth Resources Observation and Science Center. The terrain ruggedness index was originally devised by Riley, DeGloria, and Elliot (1999) to quantify topographic heterogeneity in wildlife habitats providing concealment for prey and lookout posts. This index is calculated by Nunn and Puga (2012) based on the GTOPO30 dataset.

The Food and Agriculture Organization of the United Nations (FAO) defines irrigation suitability as the potential increase in agricultural output that can be obtained by fully exploiting irrigation compared to rain-fed agriculture, and classifies irrigation suitability into five classes: (1) only suitable for rain-fed agriculture, (2) output yield increases by 0-20%, (3) output increases by 20-50%, (4) output increases by 50-100%, and (5) output increases by more than 100% (Fischer et al. 2002). Following Buggle (2018), we classify an area to be suitable for irrigation if agricultural output increases by at least 50%. Climatic zones are defined by the Köppen-Geiger classification, and are constructed using precipitation and temperature data in the period of 1901-1925 (Rubel and Kottek 2010). Descriptive statistics of all variables can be found in table 1.

4.3 Baseline Results

For the baseline results, we estimate regression model (1) using the ordinary least squares (OLS) estimator and robust standard errors. In a later robustness check, we also examine standard errors adjusted for spatial autocorrelation.

To begin with, we regress the percentage of households contributing labor in a district on the time since a district was annexed to historical Vietnam, controlling for potential confounding factors as discussed above. Table 2 shows that the estimated coefficients of the time since annexation are positive and significant, whether or not all control variables are included. Thus, districts annexed earlier to historical Vietnam today have a higher percentage of households contributing labor on average. Relative to the mean value of the dependent variable, the marginal effect is economically significant. When all control variables are included, for example, a one century increase in the time since annexation is associated with an additional 1.9% of households contributing labor, which is more than 6% of the mean value of the variable. The reduction in the magnitude of the estimated coefficient of the time since annexation when control variables are added indicates that these variables do confound the impact of the time since annexation on the prevalence of collectivism to some extent. The time since annexation accounts for almost 10% of the variation in the percentage of households contributing labor.

The estimated coefficient of caloric suitability is negative and significant (column 2), suggesting that a higher natural land productivity is associated with a lower percentage

Table 2. The Prevalence of Collectivism

	Percentage of households contributing labor							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time since annexation	0.028***							0.019***
	(0.003)							(0.005)
Caloric suitability		-0.036***						0.007
		(0.005)						(0.008)
Distance to coast			0.184***					0.073**
			(0.016)					(0.031)
Elevation				0.483***				0.175*
				(0.045)				(0.098)
Ruggedness					0.108***			0.045**
					(0.009)			(0.020)
Irrigation suitability						-0.266***		-0.032
						(0.039)		(0.040)
Aw climatic zone							-0.044	0.036
							(0.032)	(0.032)
Cfa climatic zone							-0.079	-0.116
							(0.118)	(0.099)
Cwa climatic zone							0.146***	-0.004
							(0.038)	(0.042)
Constant	0.122***	1.213***	0.179***	0.215***	0.190***	0.338***	0.288***	-0.133
	(0.024)	(0.135)	(0.015)	(0.013)	(0.013)	(0.015)	(0.027)	(0.228)
Mean dep. var.	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
R^2	0.094	0.075	0.203	0.195	0.219	0.040	0.067	0.286
Observations	607	607	607	607	607	607	607	607

Note: OLS estimator, robust standard errors are in parentheses. The base climatic zone is Am.
* p<0.1, ** p<0.05, *** p<0.01

of households contributing labor, which concurs with Litina (2016). In line with Triandis (1995), the estimated coefficients of distance to the coast, elevation, and ruggedness are all significant and positive (columns 3 to 5), indicating that areas farther from the coastal line, more highly elevated and rugged have higher percentages of households contributing labor. The estimated coefficient of irrigation suitability is negative and significant (column 6), while only the dummy for Cwa climatic zone has a significant and positive estimated coefficient. When all control variables are added together, their estimated coefficients decrease substantially in magnitude, which is expected given that these variables are correlated (table D1 in appendix D). The estimated coefficients of caloric suitability, irrigation suitability, and climatic zones are now not different from zero (column 8). Together, these control variables account for nearly 20% of the total variation in the percentage of households contributing labor.

Table 3 reports the results of similar regressions for the two other dependent variables measured at the district level, i.e., the average number of persons per household making labor contributions (panel A) and the average number of labor days contributed per household (panel B). With respect to both variables, the estimated coefficients of the time since annexation are significant and positive, whether or not all control variables are included. Districts annexed earlier to historical Vietnam currently have more members per household making labor contributions and more labor days contributed per household on average. For both dependent variables, the marginal effects are economically significant, i.e., more than 7% of the respective mean values. The time since annexation accounts for approximately 10% of the total variations in both dependent variables, while control variables altogether account for another 20%.

4.4 Robustness Analysis

Sub-sample Analysis

As discussed earlier in the historical background, we recognize that there might be various characteristics in the annexed region (i.e., harsh living conditions, openness to trade, and existing individualist norms of the Cham and Khmer) that certainly play a role in explaining the cultural differences along the individualism-collectivism dimension between the annexed and the initial regions. In order to examine if our selective migration hypothesis differentiates itself from these channels, we investigate the relationship between the time since annexation to historical Vietnam and the strength of collectivism within the sub-sample of the annexed areas. As can be seen in panel A of table 4, the estimated coefficients of the time since annexation to historical Vietnam remain positive

Table 3. The Strength of Collectivism

A.	Average number of persons making contributions per household							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time since annexation	0.056***							0.040***
	(0.007)							(0.010)
Caloric suitability		-0.071***						0.016
		(0.011)						(0.016)
Distance to coast			0.379***					0.139**
			(0.038)					(0.067)
Elevation				1.037***				0.409**
				(0.102)				(0.194)
Ruggedness					0.230***			0.101**
					(0.020)			(0.040)
Irrigation suitability						-0.531***		-0.048
						(0.067)		(0.067)
Aw climatic zone							-0.095	0.088
							(0.063)	(0.064)
Cfa climatic zone							-0.179	-0.269
							(0.201)	(0.181)
Cwa climatic zone							0.278***	-0.020
							(0.077)	(0.082)
Constant	0.174***	2.339***	0.274***	0.339***	0.288***	0.600***	0.508***	-0.448
	(0.043)	(0.280)	(0.030)	(0.024)	(0.023)	(0.029)	(0.055)	(0.470)
Mean dep. var.	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
R^2	0.094	0.076	0.222	0.230	0.255	0.041	0.066	0.322
Observations	607	607	607	607	607	607	607	607

Table 3. The Strength of Collectivism (cont.)

B.	Average number of days contributed per household							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time since annexation	0.533***							0.302***
	(0.058)							(0.077)
Caloric suitability		-0.828***						-0.121
		(0.104)						(0.150)
Distance to coast			3.362***					1.297**
			(0.382)					(0.601)
Elevation				7.695***				1.673
				(1.034)				(1.676)
Ruggedness					1.840***			0.884***
					(0.195)			(0.331)
Irrigation suitability						-3.845***		0.217
						(0.556)		(0.566)
Aw climatic zone							-0.158	0.776
							(0.478)	(0.485)
Cfa climatic zone							-2.207***	-2.606***
							(0.666)	(0.677)
Cwa climatic zone							3.056***	0.139
							(0.641)	(0.656)
Constant	0.443	24.797***	1.595***	2.483***	1.946***	4.409***	3.167***	2.341
	(0.317)	(2.676)	(0.259)	(0.223)	(0.218)	(0.253)	(0.394)	(4.334)
Mean dep. var.	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05
R^2	0.114	0.136	0.232	0.168	0.217	0.028	0.073	0.308
Observations	607	607	607	607	607	607	607	607

Note: OLS estimator, robust standard errors are in parentheses. The base climatic zone is Am.
* p<0.1, ** p<0.05, *** p<0.01

Table 4. Robustness to Different Sub-Samples

A. Annexed region	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.028***	0.038***	0.065***	0.078***	0.389***	0.435***
	(0.011)	(0.013)	(0.023)	(0.026)	(0.150)	(0.167)
Mean dep. var.	0.22	0.22	0.37	0.37	2.24	2.24
Control variables	NO	YES	NO	YES	NO	YES
R^2	0.030	0.214	0.043	0.246	0.032	0.139
Observations	311	311	311	311	311	311
B. Lowland region	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.027***	0.017***	0.052***	0.035***	0.467***	0.226***
	(0.004)	(0.005)	(0.007)	(0.010)	(0.054)	(0.080)
Mean dep. var.	0.28	0.28	0.46	0.46	3.37	3.37
Control variables	NO	YES	NO	YES	NO	YES
R^2	0.097	0.265	0.104	0.273	0.123	0.240
Observations	478	478	478	478	478	478

Note: Robust standard errors are in parentheses. Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant. Panel A only includes districts in the annexed region. Panel B excludes districts in Ha Noi and Ho Chi Minh City and districts whose elevations are above 500 meters.
* p<0.1, ** p<0.05, *** p<0.01

and significant with respect to all three dependent variables, whether or not all control variables are added. We argue that this finding is consistent with our hypothesis that selective migration of individualistic people in the past is an important driver behind the contemporary cultural differences across Vietnam.

Next, historical Vietnamese immigrants (the Kinh ethnicity) often inhabited the coastal plain with their traditional rice agriculture. At the same time, the highland areas were mainly inhabited by various ethnic groups. After the Reunification in 1975, the Kinh started to migrate to the highland areas on a large scale through state-sponsored programs under the central planning economy to establish new production zones (Hardy 2003). These later migrations, therefore, might be different from those that happened in historical times. To examine this issue, we exclude from the estimation all districts in the highland areas, i.e., where the average elevations are above 500 meters (the results are robust to other values such as 400 and 600 meters).[16] Furthermore, we also exclude two provinces, Ha Noi (in the north) and Ho Chi Minh City (in the south), which are the two biggest venues for immigrants in modern times. Panel B of table 4 shows that the estimated coefficients of the time since annexation remain economically and statisti-

[16] This definition of highland is taken from Wikipedia: https://en.wikipedia.org/wiki/Highland

cally significant with respect to all three dependent variables, whether or not all control variables are added.

Omitted-Variable Bias

One notable pattern found in the baseline results is the reduction in magnitude of the estimated coefficients of the time since annexation when observed confounding factors are added. This instability of the estimated coefficient indicates that there might be a potential bias from unobserved confounding factors. To examine this potential bias, we conduct an instrumental variable (IV) estimation. Although many factors might influence the annexation of an area, we argue that the north-south geographical order is given by nature, and hence exogenous to the annexation. In other words, from the Red River Delta in the north, one could not conquer the Mekong River Delta in the south without annexing all areas located in between.[17] Thus, within the sub-sample of the annexed areas, the north-south geographical order can serve as an instrument for the time since an area was annexed to historical Vietnam. The key assumption behind the validity of this instrumental variable is that the north-south geographical order only affects the strength of collectivism through its effect on the time since annexation. We argue that this is a reasonable assumption, at least for the purpose of a robustness check, and provide a detailed discussion in appendix C.

We propose to use the distance from an annexed area to a northern reference point as a measure of the north-south geographical order. Quang Binh (see figure 1), the first area that was annexed to historical Vietnam, is arbitrarily chosen as the northern reference point (the result is robust to other choices), and the walking distance along the coast (instead of the geodesic, "bird-fly" distance) is calculated to capture the military route in historical times. Distance is measured in 100 kilometers using the district centroids, where district borders are taken from the Global Administrative Unit Layers. The walking distance from Quang Binh to the farthest district in the south is roughly 1350 kilometers. Table 5 reports the results of the instrumental variable estimation using the two-stage least squares (TSLS) estimator. The estimated coefficients of the time since annexation remain economically and statistically significant with respect to all three dependent variables, whether or not all control variables are added. The first-stage results ensure that the walking distance to Quang Binh is a strong predictor of the time since

[17] Theoretically, one could conquer an area in the Mekong River Delta by traveling either along the coastline in the east or over the mountainous band in the west separating Vietnam from Laos and Cambodia. Both strategies were infeasible given the logistical and transportation technologies in historical Vietnam. Indeed, we do not find any attempt to do so in the historical accounts.

Table 5. Robustness to An Instrumental Variable

	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.064***	0.054***	0.139***	0.110***	0.674***	0.485**
	(0.013)	(0.015)	(0.026)	(0.027)	(0.171)	(0.198)
Mean dep. var.	0.22	0.22	0.37	0.37	2.24	2.24
Kleibergen-Paap F statistic	287	221	287	221	287	221
Control variables	NO	YES	NO	YES	NO	YES
Observations	311	311	311	311	311	311

Note: Robust standard errors are in parentheses. Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant. All regressions only include districts in the annexed region. Walking distance to Quang Binh is employed as an instrumental variable for the time since annexation into historical Vietnam; see the main text for more detail.
* p<0.1, ** p<0.05, *** p<0.01

annexation, i.e., it has significant and negative estimated coefficients and large F statistics (full results are available upon request).

Sampling Weights and Spatial Autocorrelation

We also conduct two other robustness checks. In the first one, we incorporate sampling weights in constructing our three dependent variables. In the second check, we employ the estimation method developed by Conley (1999) to adjust the standard errors for spatial autocorrelation. Tables D2 and D3 in appendix D report that the estimated coefficients of the time since annexation remain significant at conventional levels.

Bad Controls

There are numerous factors that came to exist after the annexation into historical Vietnam that might influence the strength of collectivism. For example, big cities in the annexed region such as Hoi An and Sai Gon were built after the annexation, the concentration of French colonizers and American intervention in south Vietnam (the latest region to be annexed into historical Vietnam), and various demographic characteristics in the modern day. These factors are bad controls, and should not be included in the regression (Angrist and Pischke 2009). Nevertheless, table D4 in appendix D reports that the estimated coefficients of the time since annexation to historical Vietnam remain qualitatively intact when the shortest distance to big cities, a dummy variable for south Vietnam, and various district demographic characteristics such as percentage of households with male head, average head age, average schooling years of head, percentage of urban households, percentage of Kinh households, average household size, and per capita expenditure are added to the regression model.

4.5 Discussion

The survey data analysis so far has demonstrated that voluntary labor contribution to public goods production is both more prevalent and more intensive in districts annexed earlier to historical Vietnam, and this result is robust to a battery of checks. Although the VHLSS provides naturally occurring data that are available for almost all districts across Vietnam, the biggest drawback is that it cannot help us examine further why the more collectivist societies in districts annexed earlier to historical Vietnam could mobilize a larger amount of voluntary labor contribution to public goods production from their in-group members. Was that because these societies developed informal institutions that punished non-contributing members? Or because they have a large fraction of members with strong cooperative preferences? Or because their members share a strong belief that other people would also contribute labor to public goods production?

To complement the survey data analysis, we conduct a lab-in-the-field public goods experiment. Although it is impossible to run the experiment in all districts across Vietnam, the advantage of the experiment is that it allows us to examine deeper why the more collectivist societies in districts annexed earlier to historical Vietnam could mobilize a larger amount of voluntary labor contribution to public goods production from their in-group members. First, the experiment holds the institutional setting constant, eliminating the possibility that there are informal institutions that punish non-contributing members. Second, as discussed in detail below, we adopt an experimental design that allows us to measure preferences for cooperation and beliefs about the contributing behaviors of other members. In turn, we can investigate whether preferences or beliefs that drive individual contributions to public goods production.

5 Experimental Data Analysis

5.1 Sample Selection

To capture in-group cooperation, we recruit subjects who come from the same local areas. A crucial aspect is the selection of experimental sites in such a way to minimize differences between the selected sites. First, we focus on the annexed region to rule out differences in the historical frontier environment. Second, we select provinces, and rural districts in them, located along the coast, which was the typical route of migration and settlement of historical Vietnamese. Finally, we choose provinces, and rural districts in them, that were historically inhabited mainly by the Kinh ethnicity (historical Vietnamese) and whose populations have been living there for many generations, i.e., neither

any significant immigration nor emigration from these places. Thus, this procedure leaves us with coastal, rural, and Kinh-dominated districts in the annexed region. From this sub-sample, we randomly select one of the districts with the longest time since annexation to historical Vietnam and one of the districts with the shortest time. This process narrows our selection to randomly choose one rural district in Thua Thien Hue province and one rural district in Ben Tre province; the former is located more to the north and thus has a longer time since annexation (see figure 1).

We use high school students as our subjects in the experiment since they are old enough to embody the cultural environments of the places where they grew up, but not yet affected by living outside their communities, which potentially could make it harder to capture the local cultural norms.[18] Our proposed selective migration hypothesis predicts that subjects in Thua Thien Hue (henceforth the "northern site") share stronger norms of in-group cooperation, and hence on average contribute at a higher level compared to subjects from Ben Tre (henceforth the "southern site"). Each rural district in Vietnam has three to five high schools. To keep similarities between the selected districts, we randomly selected one school located in the center of the district among the schools that had at least six classes for the oldest age cohort, which means that students come from a larger catchment area where they have attended different secondary schools. The latter requirement was imposed to avoid measuring cooperation norms within a specific class, which might have developed its own norms, when we are aiming at measuring norms in the society in which they lived.

5.2 The Public Goods Experiment

We build our experimental design on the one-shot linear public goods experiment developed by Fischbacher, Gächter, and Fehr (2001).[19] We begin by describing the general features of a public goods experiment before discussing the specific features of the design in Fischbacher, Gächter, and Fehr (2001).

The basic idea of a public goods experiment is to create a social dilemma situation, where there is a conflict between the social and private optima. In our setting, the

[18] This strategy of focusing on high school students has also been used earlier in the literature on public goods experiments when investigating cultural differences, e.g., Kocher, Martinsson, and Visser (2012).

[19] For other experiments using this specific design, see Kocher et al. (2008), Herrmann and Thöni (2009), Fischbacher and Gächter (2010), Fischbacher, Gächter, and Quercia (2012), and Martinsson, Villegas-Palacio, and Wollbrant (2015) among others. For a general discussion on public goods experiments, see Zelmer (2003) and Chaudhuri (2011).

subjects are randomly assigned to groups of three, where each member comes from a different class at the high school, and this was clearly stated in the instructions of the experiment. This feature of the design was chosen to avoid having subjects allocated to groups consisting of classmates with whom subjects might have developed a specific norm of behavior, reducing the possibility of measuring norms of cooperation in the places where they reside. All subjects receive an endowment of 20 tokens and must decide simultaneously how much of their endowments to invest in a public good, and the residual is kept for themselves, which is labeled as a private good. The marginal per capita return ($MPCR$) from the public good is 0.5, which means that each token contributed to the public good by a group member results in 0.5 token to all group members, including the member who contributes the token. If a subject is rational and selfish, then a $MPCR$ below 1 leads to a dominant strategy to free ride (i.e., to contribute zero to the public good), because the return from the public good is lower than the return from the private good. Nevertheless, it is socially optimal to contribute the whole endowment if $MPCR \times n > 1$, where n is the number of group members. Thus, our choice of the $MPCR$ of 0.5 generates the conflict between private and social optima that characterizes a public good. The payoff for subject i consists of two components: (i) the amount of the endowment that is not invested in the public good (i.e., what is kept as a private good), and (ii) the return from the public good. The payoff function for subject i is given by:

$$\pi_i = (20 - c_i) + 0.5 \sum_{j=1}^{3} c_j.$$

Each token earned in the experiment is exchanged for money at the exchange rate of one token equals 3000 Vietnamese Dong. This experiment is calibrated, partially based on pilot studies, such that each student on average receives a monetary payoff worth roughly three meals at the local restaurants. They receive no show-up fee for participating in the experiment.

The specific feature of the public goods experiment developed by Fischbacher, Gächter, and Fehr (2001) is that it is based on the strategy method. In their design, each subject makes two types of contribution decisions to the public good: (i) unconditional contribution and (ii) conditional contribution. In the unconditional contribution decision, which is the standard public goods experiment described above, each subject states how much he or she would like to contribute to the public good from his or her endowment of 20 tokens. The additional feature of the design of Fischbacher, Gächter, and Fehr (2001) is the introduction of the contribution table in which subjects make contribution decisions conditional on the other group members' average contributions. In a contribution table,

which includes all possible average contributions of the two other players in the group, rounded to integers and ranging from 0 to 20 points, a subject indicates how much he or she would contribute to the public good if these were the average contributions to the public good by the other two group members. The contributions reported in the table are referred to as conditional contributions. The final feature of the design of Fischbacher, Gächter, and Fehr (2001) is to ensure that all decisions, i.e., both unconditional and conditional contributions, are incentive compatible by using the following approach. For two randomly selected group members, it is the unconditional contribution to the public good that is pay-off relevant. For the third member, the average unconditional contribution of the other two group members is calculated, and the contribution of the third member is then determined from her conditional contribution given the average contribution of the other two group members. Thus, when a subject makes his or her decisions, he or she does not know which of all the decisions will be pay-off relevant, and hence has no incentive to choose anything other than the preferred option. After the experiment, we also elicited beliefs by asking a subject what he or she thought that the other two group members had contributed unconditionally on average. We pay subjects for the accuracy of their guesses to create incentives for truthful revelation.[20]

The strength of the strategy method is that subjects can be categorized into different contributor types based on their 21 conditional contribution decisions to the public good, i.e., how much they decided to contribute to the public good conditional on the average contribution of the other two group members for all integers in the range 0 to 20. These contributor types capture the preferences for cooperation. We use the same classification as proposed in the original paper by Fischbacher, Gächter, and Fehr (2001). A subject is classified as a "conditional cooperator" if his or her conditional contribution increases weakly monotonically with the average contribution of the other group members or if the relationship between his or her conditional contribution and the average contribution of the others is positive and significant at the 1% significance level, using a Spearman rank correlation coefficient. A "free rider" is a subject who contributes zero to the public good for all levels of the average contribution by others. A "hump-shaped" contributor is characterized by a subject who shows weakly monotonically increasing contributions or a positive Spearman rank correlation coefficient at the 1% significance level, which is the same classification strategy as applied to a conditional contributor, but it only holds up to an inflection point. For average contribution levels by others above this

[20] For a discussion on using incentivized guesses in a public goods experiment to increase guess accuracy, see, e.g., Gächter and Renner (2010).

level, the subject's own conditional contributions decrease weakly monotonically or show a significant and negative Spearman rank correlation coefficient at the 1% significance level. Those who cannot be categorized based on any of the above criteria are referred to as "others".

At the beginning of the experiment, subjects received written instructions for the experiment and the instructions were also read aloud.[21] Before the experiment began, various examples were given to facilitate understanding of the experiment and the subjects also completed some exercises. When the experiments were finished, subjects answered a short survey about basic socio-economic information. Finally, subjects were called one at a time for payment done in private. Subjects were recruited by teachers, and the participation rates of students are similar across schools: 70% in the northern site (140 out of 200) and 73% (235 out of 320) in the southern site. In accordance with our expectation, around 97% of the subjects were born in the sampled districts, while the others were born in other districts in the sampled provinces.[22] Table D5 of appendix D summarizes other socio-economic characteristics (gender, household size, and a wealth index), which will be controlled for in the following regression analysis.

5.3 Results

Table 6 shows that subjects from the northern site and southern site on average unconditionally contributed 7.50 tokens and 6.58 tokens respectively out of the endowment of 20, and the difference is statistically significant (p-value = 0.024, Mann-Whitney U test).[23] Thus, subjects from the northern site on average contribute higher than subjects from the southern site by 0.92 tokens, which is 13% of the mean level of contribution in the sample. Previous studies have indicated that a large fraction of subjects are conditional cooperators, i.e., their contributions are positively correlated with contribution levels by others. We also elicited guesses about the average contributions by the other two group members, in which subjects from the northern site and southern site on average guessed 8.25 tokens and 7.60 tokens respectively (p-value = 0.053, Mann-Whitney U test). At the

[21] Details on the experimental instructions can be found in appendix E. The public goods experiment is the first experiment out of two, and the second experiment is pay-off independent from the first one. To eliminate potential spillover between experiments, the subjects were informed about the second experiment only after completing the first experiment.

[22] The following results are robust to the omission of subjects who were not born in the sampled district. Details are available upon request.

[23] The contribution levels are similar to what has been found in the literature of public goods experiments (Zelmer 2003; Chaudhuri 2011).

Table 6. Distribution of Types, Unconditional Contribution, and Belief

	NORTHERN SITE ($n = 138$)			SOUTHERN SITE ($n = 235$)		
	Distribution (%)	Av. Un. Con. (Tokens)	Belief (Tokens)	Distribution (%)	Av. Un. Con. (Tokens)	Belief (Tokens)
All subjects	100	7.50 (3.92)	8.25 (3.46)	100	6.58 (4.07)	7.60 (4.11)
Conditional cooperators	57.12	7.29 (3.20)	8.19 (3.72)	54.04	6.39 (3.35)	7.88 (4.07)
Free riders	3.62	0.60 (0.55)	6.20 (4.55)	5.53	2.69 (3.88)	6.54 (3.55)
Hump-shaped cooperators	5.80	10.50 (5.45)	8.38 (3.42)	4.26	6.90 (5.92)	6.70 (5.19)
Others	38.41	7.98 (4.03)	8.49 (2.98)	36.17	7.42 (4.51)	7.44 (4.15)

Note: Standard errors are in parentheses. Av. Un. Con. = average unconditional contribution. Belief = belief about the average unconditional contribution of other two group members.

aggregate level, the results indicate conditional cooperative behavior. It is common that guesses about the average contribution by others are higher than own contribution levels because, on average, people are imperfect conditional cooperators, and there is also a fraction of free-riders.

The innovative part of the design developed by Fischbacher, Gächter, and Fehr (2001) is that it allows us to classify subjects into different contributor types. The lower panel of table 6 shows the distribution of types. By far, conditional cooperators are the most frequent type both in the northern site (52.17%) and in the southern site (54.04%), while the fractions of free riders are low (3.62% and 5.53% in the northern and the southern site, respectively).[24] We indeed cannot reject the null hypothesis that the compositions of contributor types in the northern site and the southern site are drawn from the same distribution (p-value = 0.930, Pearson's χ^2 test), indicating that cooperative preferences are not significantly different between the two sites. Furthermore, table 6 shows that, except for free riders, other types in the northern site on average have higher levels of unconditional contribution and guesses about the average contribution of other group members compared to their counterparts in the southern site. The largest contributor type is the conditional cooperators, and this type is considered the key group for contributions to public goods. The average unconditional contributions are 7.29 and 6.39 with guesses of 8.19 and 7.88 respectively in the northern and southern sites. These findings suggest that the north-south difference in contribution behaviors is driven by beliefs about the contributing behaviors of other people rather than cooperative preferences.

We use regression models to examine the unconditional contribution behaviors further and the results are reported in table 7. In all models, we include a dummy variable if a subject comes from the northern site. In line with the descriptive statistics, the estimated coefficient of the northern site dummy is positive and significant when entering the regression alone (column 1). In the next regression model, we add belief about the average contribution of the other two group members and find that its estimated coefficient is positive and significant (column 2). In the same regression, the estimated coefficient of the northern site dummy is reduced substantially in magnitude, indicating that higher levels of contribution in the northern site are mainly driven by higher beliefs about the average contribution of the other two group members. These estimated coefficients remain positive and significant when the socio-economic characteristics (gender, household size, and a wealth index) are also added to the regression (columns 3 to 6).

To summarize, the experimental findings corroborate the tendency found in survey

[24] This distribution of types is also similar with previous findings in the literature (Chaudhuri 2011).

Table 7. Unconditional Contribution: Regression Analysis

	Unconditional contribution					
	(1)	(2)	(3)	(4)	(5)	(6)
North	0.921**	0.728*	0.808**	0.686*	0.735*	0.789*
	(0.426)	(0.403)	(0.405)	(0.405)	(0.407)	(0.410)
Belief		0.297***	0.299***	0.290***	0.297***	0.294***
		(0.060)	(0.060)	(0.059)	(0.060)	(0.059)
Male			0.376			0.378
			(0.437)			(0.440)
Household size				0.118		0.131
				(0.130)		(0.137)
Wealth					-0.011	-0.046
					(0.125)	(0.133)
Constant	6.579***	4.324***	4.138***	3.877***	4.318***	3.618***
	(0.266)	(0.494)	(0.517)	(0.745)	(0.491)	(0.805)
R^2	0.012	0.093	0.095	0.095	0.093	0.098
Observations	373	373	373	373	373	373

Note: OLS estimator with robust standard errors in parentheses. The sample includes 138 subjects from the northern site and 235 subjects from the southern site.
* p<0.1, ** p<0.05, *** p<0.01

data that districts annexed earlier to historical Vietnam currently have stronger norms for cooperation, and further suggest that cultural differences across Vietnamese regions are embodied in individual beliefs.

6 Conclusion

The individualism-collectivism dimension has been found to be a powerful predictor of economic and democratic development in a large sample of countries (Gorodnichenko and Roland 2011, 2015, 2017). Thus, why some societies have become more collectivistic or individualistic than others is a crucial question in understanding long-run comparative development. In the present paper, we propose and investigate the selective migration hypothesis, stating that cultural differences along the individualism-collectivism dimension are driven by the out-migration of individualistic people from collectivist societies to settle down in frontier areas, and that such patterns of historical migration are reflected even in the current distribution of cultural norms. We use the territorial expansion of historical Vietnam from the 11^{th} to the 18^{th} centuries as an ideal setting to empirically examine this hypothesis. During this period, historical Vietnam gradually expanded its territory southward along the coast from the Red River Delta to the Mekong River Delta

through various waves of conquest and migration to form the country as it is today.

We examine the ability to solve collective action problems, which is the main feature of collectivism in related economic models, by using both survey and experimental data on voluntary contributions to public goods, which is the most typical collective action in daily living in Vietnam. Using household survey, we find that areas annexed earlier to historical Vietnam currently have higher levels of voluntary labor contribution to public goods production in terms of not only prevalence, but also intensity. Conducting a public goods experiment with high school students, we find that subjects from areas annexed earlier to historical Vietnam contribute substantially more to the public good compared to subjects from areas annexed later, and that the result is mainly driven by the belief about the contributions of other subjects. Relying on various Vietnamese historical accounts, together with various robustness checks, we show that the southward out-migration of individualistic people during eight centuries of territorial expansion of historical Vietnam is an important driver behind these cultural differences.

Despite our efforts, we recognize, however, that in the current study, it is empirically challenging to completely isolate the effects of selective migration from a crowding-in of collectivist norms by a strong state or the pre-existence of individualist norms in the periphery. We leave it for future research on other areas, with access to more detailed data on historical migration patterns and attitudes, to potentially shed further light on the relative contributions of each of these interrelated mechanisms.

We believe that the present paper makes a contribution by offering an extended conceptual framework and an empirical strategy combining survey and experimental evidence for understanding long-run cultural divergence. First and foremost, the migration patterns in the distant past played a crucial role in explaining cultural differences across modern societies. As time goes on, similar processes may continue to enhance cultural differences across societies. These cultural differences may, in turn, have important implications for future levels of comparative development.

Appendix A. Constructing the Time since Annexation

In this appendix, we present the construction of the time since annexation to historical Vietnam in chronological order, relying on the official chronicles of historical Vietnam, i.e., *Dai Viet Su Ky Toan Thu* (from 204 BCE to 1675) and *Dai Nam Thuc Luc* (from 1558 to 1888). We also provide many secondary sources in English that are in agreement with these primary sources that the Southern Advance (Nam Tien) of historical Vietnam ended in 1757, by which time the border of Vietnam was established as it is today.

The Dinh Dynasty

In 938, Ngo Quyen defeated the Southern Han Kingdom and ended a millennium of being colonized by historical China (*Toan Thu* p. 118). Nevertheless, his dynasty was short-lived and followed by civil wars among 12 independent feudal lords. Only in 968 was Dinh Bo Linh able to pacify these feudal warlords and establish the first unified state of historical Vietnam (*Toan Thu* p. 127). The territory of this state included the whole area that is now north Vietnam (Dao 2005, p. 114-118). We code all districts in the modern north, i.e., from the border with China down to Ha Tinh province, as having been annexed in 968.

The Ly Dynasty

In 1069, Ly Nhat Ton attacked the former Champa Kingdom to retaliate against a territorial intrusion (*Toan Thu* p. 197). After being defeated and captured, the Champa King ceded the former Bo Chinh, Dia Ly, and Ma Linh to compensate for his release. *Toan Thu* notes that Bo Chinh and Dia Ly were the north and south of modern Quang Binh province, while Ma Linh was the north of modern Quang Tri province. Dao (2005, p. 162) further notes that Ma Linh included the northern area of modern Quang Tri province down to Thach Han River. We code all districts in modern Quang Binh province and in the north of Thach Han River in modern Quang Tri province (Vinh Linh, Gio Linh, Cam Lo, Dong Ha, and Huong Hoa) as having been annexed in 1069.

The Tran Dynasty

In 1306, Tran Anh Tong fulfilled a promise made by his father to arrange a marriage between Princess Huyen Tran of historical Vietnam and King Che Man of the former Champa Kingdom (*Toan Thu* p. 340). In return, King Che Man submitted the former O and Ly as wedding presents. The former O was in the south of Thach Han River in modern Quang Tri province, while the former Ly was modern Thua Thien Hue province (Dao 2005, p. 163-164). We code all districts in the south of Thach Han River in modern Quang Tri province (Trieu Phong, Quang Tri, Da Krong, and Hai Lang) and in modern Thua Thien Hue province as having been annexed in 1306.

The Le Dynasty

In 1471, Le Tu Thanh mobilized a military campaign against the former Champa Kingdom in response to its attack on historical Vietnam one year before (*Toan Thu* p. 659-

662). The campaign was a victory in which historical Vietnam annexed the former Dai Chiem and Co Luy.[25] These areas correspond to a territory from modern Hai Van Pass to modern Cu Mong Pass, where former Dai Chiem was modern Quang Nam province while former Co Luy comprised the modern provinces of Quang Ngai and Binh Dinh (Dao 2005, p. 201-203). Historical Vietnam also had control over the highlanders down to modern Binh Dinh province, in which modern Kon Tum province can be said to be included (Dao 2005, p. 203). We code all districts in the modern provinces of Quang Nam, Quang Ngai, Binh Dinh, and Kon Tum as having been annexed in 1471.

The Nguyen Lords

In 1611, responding to a territorial intrusion by the former Champa Kingdom, Nguyen Hoang attacked and annexed what is now modern Phu Yen province (*Thuc Luc* p. 36). We code all districts in modern Phu Yen province as having been annexed in 1611.

In 1653, King Ba Tam of the former Champa Kingdom invaded modern Phu Yen province. Nguyen Phuc Tan retaliated and annexed a new area down to Phan Rang River (*Thuc Luc* p. 62). This area corresponds to modern Khanh Hoa province and the north of modern Ninh Thuan province. We code all districts in modern Khanh Hoa province and in the north of Phan Rang River in modern Ninh Thuan province (Bac Ai, Ninh Hai, and Phan Rang-Thap Cham) as having been annexed in 1653.

In 1692, King Ba Tranh of the former Champa Kingdom raided the border of historical Vietnam (*Thuc Luc* p. 106). In 1693, Nguyen Phuc Chu conquered and annexed the final territory of the former Champa Kingdom (*Thuc Luc* p. 107). This area included the south of Phan Rang River in modern Ninh Thuan province (Ninh Phuoc and Ninh Son) and modern Binh Thuan province. We code all districts in these areas as having been annexed in 1693.

After annexing the whole former Champa Kingdom, historical Vietnam gradually expanded its territory into the land of the former Khmer Empire in the far south. Already in 1658, King Ponhea Chan of the former Khmer Empire invaded the border of historical Vietnam. Following his defeat, King Ponhea Chan had to adopt a tributary position towards historical Vietnam and allow Vietnamese migrants to move in and exploit the Khmer land in the far south of Vietnam (*Thuc Luc* p. 72). In 1698, historical Vietnam officially established two new provinces in this land, Tran Bien and Phien Tran, to regis-

[25] Under the Ho Dynasty, historical Vietnam already controlled these regions from 1402 to 1407 (*Toan Thu* p. 436-437). When the Ming Dynasty of historical China conquered historical Vietnam, the former Champa Kingdom took them back. Thus, we do not count this event as an annexation.

ter land and collect tax, as well as to mobilize more Vietnamese migrants to settle down (*Thuc Luc* p. 111). In *Thuc Luc* (p. 111), Tran Bien and Phien Tran provinces are described as corresponding to Bien Hoa and Gia Dinh provinces under the Nguyen Dynasty, i.e., the time when this chronicle was written. Based on *Dai Nam Nhat Thong Toan Do*, the official map of historical Vietnam produced by the Nguyen Dynasty in 1838, this new territory corresponds to the south-east region of modern Vietnam (Nguyen 1994f, p. 64). We code all districts in the modern provinces of Binh Phuoc, Dong Nai, Ba Ria-Vung Tau, Ho Chi Minh City, Binh Duong, and Tay Ninh as having been annexed in 1698.

During the Qing conquest of historical China, a Chinese refugee named Mo Jiu ran away and successfully maneuvered himself into the court of the former Khmer Empire and was appointed to govern a coastal area in the Mekong River Delta. In 1708, Mo Jiu ceded his land to historical Vietnam and received an appointment to govern this territory, i.e., the former Ha Tien (*Thuc Luc* p. 122). This territory roughly corresponds to the modern provinces of Kien Giang, Ca Mau, and Bac Lieu (Phan et al. 2011, p. 448). We code all districts in these provinces as having been annexed in 1708.

In 1731, some inhabitants in the former Khmer Empire raided the south of historical Vietnam. In 1732, historical Vietnam invaded the former Khmer Empire to track down these raiders. King Ang Chey of the former Khmer Empire proposed a cease-fire and promised to deliver the raiders. Historical Vietnam then established its administration in the former Long Ho (*Thuc Luc* p. 141-143). This area roughly corresponds to the modern provinces of Vinh Long, Ben Tre, and Tien Giang (Phan et al. 2011, p. 448). We code all districts in these provinces as having been annexed in 1732.

In 1755, the former Khmer Empire attacked historical Vietnam. Following successful retaliation by historical Vietnam, King Ang Sngoun of the former Khmer Empire ceded the former Tam Bon and Loi Lap in 1756 as compensation (*Thuc Luc* p. 164-165). This area roughly corresponds to modern Long An province (Phan et al. 2011, p. 448). We code all districts in this province as having been annexed in 1756.

In 1756, King Ang Sngoun of the former Khmer Empire died, which ignited a fight for the throne between different royal forces. After one side asked for help in 1757, historical Vietnam intervened in return for more land, i.e., the former Tra Vinh, Ba Thac, and Tam Phong Long (*Thuc Luc* p. 166-167). These areas roughly correspond to the modern provinces of Dong Thap, An Giang, Can Tho, Soc Trang, and Tra Vinh (Phan et al. 2011, p. 448). We code all districts in these provinces as having been annexed in 1757.

For the modern provinces of Gia Lai, Dak Lak, Lam Dong, and Dak Nong in the Central Highland Region, we code 1751 as the year they were annexed as it was the first

recorded year that the highlanders came to pay tribute (*Thuc Luc* p. 157). Historical studies have also argued that this is the time when historical Vietnam started collecting taxes from the highlanders (Tana 1998).

Secondary Sources on the Vietnamese Southern Advance

Below, we provide extracts from a standard Vietnamese history and some related historical studies in English that are in agreement that the Southern Advance (Nam Tien) of historical Vietnam ended in 1757, by which time historical Vietnam had gained control over the territory as it has today.

Taylor (2013, p. 336): "One year later, in 1757, Chei Chéttha IV died. ... . Vietnamese armies were again mobilized to intervene. ... . As part of the final settlement, Outeireachea III ceded more territories along the borders of Ha Tien to Mac Thien Tu, who then passed them along to Phu Xuan. With this, the Khmer-Viet border was drawn more or less as it exists today."

Briggs (1947, p. 358): "Thus, by infiltration and by occupation, the Annamites acquired most of the lower delta, early in the seventeenth century. From that time, Cambodia was forced to pay Annam a regular tribute. By the end of the century, the Annamites had absorbed all the lower delta east of the Mekong and had organized it into Annamite administrative units. In 1758, they completed the occupation of the entire delta and fortified it."

Nguyen (1999b, p. 18): "This *Nam Tien*, which was spearheaded by individuals, families, and now by the authorities, reached its end toward the middle of the eighteenth century in the Transbassac region, dangerously close to the Khmer Kingdom."

Engelbert (1994, p. 173): "By the end of this conquest the Vietnamese occupied the two areas situated between the mouths of the Mekong and the Bassac River: Bassac (Ba Thac, i.e., Soc Trang) and Tra Vinh, which the Nguyen got as late as in 1757 (or 1758)."

Appendix B. Historical Accounts of the Migrants

There are various records of the types of immigrants that can be found in the chronicles and other primary sources. In this appendix, we provide some examples.

Landless peasants

Dai Nam Thuc Luc, the chronicle recording events from 1558 to 1888, reported that after the 1698 annexation, landless peasants from the north came and settled down in the new

annexed region (*Dai Nam Thuc Luc*, p. 111).

Rich adventurers

Phu Bien Tap Luc, a report about the society and economy of the annexed region circa 1776, prepared by Le Quy Don, a high-level mandarin of the Le Dynasty, recorded that: "people with rich resources from Quang Nam, Dien Ban, Quang Ngai, and Quy Nhon [the southern part of the central of modern Vietnam] come and exploit the land of Dong Nai, Gia Dinh [the south of modern Vietnam]. These people cut down trees and create large areas of flat and productive land" (Le 1974 [1776], p. 441).

Criminals

Lich Trieu Hien Chuong Loai Chi, the first encyclopedia of Vietnamese dynasties, prepared by Phan Huy Chu, a high-level mandarin of the Nguyen Dynasty, reported that in 1474 (three years after the 1471 annexation), the state decided to send criminals to the new annexed region (Phan 1957, p. 531).

Soldiers

Dai Nam Thuc Luc also reported an order from the King in 1648 to send soldiers to the new annexed region: "At the moment, the land from Thang Dien region to the south is the old territory of Champa, and is sparsely populated, if we put the soldiers on this land and give them the resources to clear new land for cultivation, within a few years, we can collect taxes, and after 20 years of fertility, we will have a new generation of population to add to the army" (*Dai Nam Thuc Luc*, p. 59).

Appendix C. The Validity of the Instrumental Variable

As discussed in the main text, we argue that although many factors might influence the annexation of an area, the north-south geographical order is given by nature, and hence exogenous to the annexation. In other words, from the Red River Delta in the north, one could not conquer the Mekong River Delta in the south without annexing all areas located in between. Thus, within the sub-sample of the annexed areas, the north-south geographical order can serve as an instrument for the time since an area was annexed to historical Vietnam. We propose to use the walking distance along the coast to Quang Binh, the first area that was annexed to historical Vietnam, as a measure of the north-south geographical order. The key assumption that ensures the validity of

our instrumental variable is that the walking distance to Quang Binh only affects the strength of collectivism through its effect on the time since annexation. In this appendix, we address some common concerns that the walking distance to Quang Binh might affect the strength of collectivism through other variables other than the time since annexation.

Initial cultural differences along the North-South axis

As discussed in the paper, there were clear initial cultural differences between the core region of historical Vietnam in the Red River Delta and the area in the south ruled by the Champa Kingdom and the Khmer Empire, which was later annexed into historical Vietnam. But within the area in the south ruled by the Champa Kingdom and the Khmer Empire, initial cultural differences were not significant. Without a centralized state, both the Champa Kingdom and Khmer Empire were basically networks of small political entities that were directly influenced by Indic traditions (Hall 2011, p. 67-102, 159-210). In addition, the land governed by the Champa Kingdom and Khmer Empire in the south of the core region of historical Vietnam was a place for people evading the reach of the centralized states (Scott 2009). In other words, initial cultural differences between the Champa Kingdom and the Khmer Empire were not significant, and can be thought to be more individualistic than the core region of historical Vietnam. Thus, within the annexed region, we argue that the walking distance along the coast to Quang Binh (the first area annexed to historical Vietnam) does not correlate with initial cultural differences along the North-South axis.

The influence of northern culture or institutions

The distance to Quang Binh might capture the extent to which the centralized state in the Red River Delta influence cultural norms in the annexed region with a southward spatial decay, posing a threat to the exclusion restriction. The strength of the state influence on cultural norms of the annexed region could be reflected through the time since annexation and the distance to the centralized state in the Red River Delta. Here, we are willing to make a further assumption that the time since annexation captures most of the influence of the state, and the distance to the centralized state in the Red River Delta only played a negligible role. The reason is that once an area was annexed, a whole new administrative system was established to impose the same institutions and inprint the same cultural norms as in the Red River Delta. To make sure this happened, the centralized state always sent its officials and soldiers to the annexed region to carry out the works. As a result, we argue that the distance to the centralized state in the Red

River Delta did not bring about a significant difference in the state influence. In other words, the distance to Quang Binh only affects cultural norms through its effect on the time since annexation.

Market access

We argue that the walking distance along the coast to Quang Binh should not correlate with market access. The reason is that trade (and thus interaction with other cultures) happened along the coastal line, which stretches from the north to the south of Vietnam (Hall 2011). Thus, market access should correlate with distance to the coastal line, but not distance to Quang Binh.

Economic activitities

There were certainly differences with respect to the types of economic activities between the core region of historical Vietnam in the Red River Delta and the area in the south ruled by the Champa Kingdom and the Khmer Empire, which was later annexed into historical Vietnam. All societies relied on wet-rice agriculture, but to different extents. Wet-rice agriculture dominated in the core region of historical Vietnam in the Red River Delta. Handicraft, fishery, and trade were more important in the land in the south ruled by the Champa Kingdom and the Khmer Empire (Hall 2011; Scott 2009). But within the area in the south ruled by the Champa Kingdom and the Khmer Empire, differences in the types of economic activities were insignificant and hardly can be found in historical materials. Thus, it is reasonable to assume that, within the annexed region, distance to Quang Binh does not correlate with the types of economic activities.

Geography

The walking distance along the coast to Quang Binh might correlate with other geographical characteristics such as natural land productivity, distance to the coast, elevation, ruggedness, irrigation suitability, and climatic zones. Our argument is that the location of a district, thus its distance to Quang Binh, and its geographical characteristics are all determined by nature, giving rise to potential correlations among these variables. Therefore, correlations do not mean that the distance to Quang Binh of a district causes its geographical characteristics. Because we have included these geographical characteristics in the set of control variables, we believe that the assumption that distance to Quang Binh only affects the strength of collectivism through its effect on the time since annexation is a reasonable assumption.

Appendix D. Additional Tables

Table D1. Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Time since annexation	1.00										
(2) Caloric suitability	-0.510	1.00									
	(0.000)										
(3) Distant to coast	0.358	-0.604	1.00								
	(0.000)	(0.000)									
(4) Elevation	0.112	-0.209	0.684	1.00							
	(0.000)	(0.000)	(0.000)								
(5) Ruggedness	0.295	-0.365	0.655	0.825	1.00						
	(0.000)	(0.000)	(0.000)	(0.000)							
(6) Irrigation suitability	-0.370	0.155	-0.209	-0.230	-0.245	1.00					
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)						
(7) Am climatic zone	-0.188	0.224	-0.161	0.103	0.114	-0.097	1.00				
	(0.000)	(0.000)	(0.000)	(0.011)	(0.005)	(0.017)					
(8) Aw climatic zone	-0.430	0.056	-0.254	-0.312	-0.377	0.309	-0.461	1.00			
	(0.000)	(0.165)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
(9) Cfa climatic zone	-0.048	0.120	-0.040	0.043	0.074	0.034	-0.057	-0.109	1.00		
	(0.239)	(0.003)	(0.329)	(0.293)	(0.068)	(0.397)	(0.165)	(0.007)			
(10) Cwa climatic zone	0.629	-0.279	0.417	0.236	0.288	-0.256	-0.337	-0.652	-0.080	1.00	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.049)		
(11) Distance to Quang Binh	-0.914	0.377	-0.242	-0.173	-0.312	0.450	-0.030	0.482	0.006	-0.491	1.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.461)	(0.000)	(0.883)	(0.000)	

Note: Pearson's correlation coefficients, p-values are in parentheses. The sample includes 607 districts in Vietnam. See the main text for information about data sources.

Table D2. Sampling Weights

A. Full sample	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.028***	0.021***	0.056***	0.043***	0.525***	0.324***
	(0.004)	(0.005)	(0.007)	(0.010)	(0.059)	(0.079)
Control variables	NO	YES	NO	YES	NO	YES
R^2	0.094	0.290	0.092	0.324	0.107	0.299
Observations	607	607	607	607	607	607
B. Annexed areas	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.028**	0.038***	0.062***	0.076***	0.373**	0.449**
	(0.011)	(0.013)	(0.023)	(0.026)	(0.157)	(0.181)
Control variables	NO	YES	NO	YES	NO	YES
R^2	0.028	0.225	0.038	0.252	0.028	0.153
Observations	311	311	311	311	311	311
C. Lowland areas	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.027***	0.019***	0.052***	0.039***	0.462***	0.243***
	(0.004)	(0.006)	(0.007)	(0.011)	(0.055)	(0.083)
Control variables	NO	YES	NO	YES	NO	YES
R^2	0.098	0.259	0.101	0.256	0.118	0.221
Observations	478	478	478	478	478	478
D. IV	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.064***	0.051***	0.136***	0.102***	0.667***	0.451**
	(0.012)	(0.015)	(0.026)	(0.027)	(0.176)	(0.214)
Control variables	NO	YES	NO	YES	NO	YES
Observations	311	311	311	311	311	311

Note: OLS estimator, robust standard errors are in parentheses. Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant. Panel B and D only include districts in the annexed region. Panel C excludes districts in Ha Noi and Ho Chi Minh City and districts whose elevations are above 500 meters. Walking distance to Quang Binh is employed as an instrumental variable for the time since annexation into historical Vietnam; see the main text for more detail.
* p<0.1, ** p<0.05, *** p<0.01

Table D3. Spatial Autocorrelation

A. Full sample	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.028 [0.006]*** (0.009)***	0.019 [0.007]*** (0.008)**	0.056 [0.012]*** (0.017)***	0.040 [0.012]*** (0.015)***	0.533 [0.094]*** (0.130)***	0.302 [0.099]*** (0.118)**
Controls	NO	YES	NO	YES	NO	YES
R^2	0.525	0.626	0.473	0.606	0.417	0.544
Observations	607	607	607	607	607	607
B. Annexed areas	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.028 [0.012]** (0.014)**	0.038 [0.013]*** (0.014)***	0.065 [0.025]*** (0.027)**	0.078 [0.025]*** (0.025)***	0.389 [0.176]** (0.189)**	0.435 [0.174]** (0.190)**
Controls	NO	YES	NO	YES	NO	YES
R^2	0.410	0.522	0.361	0.496	0.301	0.378
Observations	311	311	311	311	311	311
C. Lowland areas	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.027 [0.006]*** (0.008)***	0.017 [0.007]** (0.008)**	0.052 [0.011]*** (0.015)***	0.035 [0.013]*** (0.016)**	0.467 [0.088]*** (0.114)***	0.226 [0.104]** (0.126)**
Controls	NO	YES	NO	YES	NO	YES
R^2	0.498	0.592	0.459	0.561	0.418	0.495
Observations	478	478	478	478	478	478
D. IV	Percentage		No. of persons		No. of days	
	(1)	(2)	(3)	(4)	(5)	(6)
Time since annexation	0.064 [0.016]*** (0.019)***	0.054 [0.017]*** (0.015)***	0.139 [0.032]*** (0.038)***	0.110 [0.029]*** (0.032)***	0.674 [0.209]*** (0.220)***	0.485 [0.214]** (0.234)**
Controls	NO	YES	NO	YES	NO	YES
Observations	311	311	311	311	311	311

Note: OLS estimator, standard errors calculated following Conley (1999) with the assumption that autocorrelation decreases in the distance between district centroids and equals zero for districts that are more than 0.5 degree apart (in square brackets) and more than 1 degree apart (in parentheses). Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant. Panel B and D only include districts in the annexed region. Panel C excludes districts in Ha Noi and Ho Chi Minh City and districts whose elevations are above 500 meters. Walking distance to Quang Binh is employed as an instrumental variable for the time since annexation into historical Vietnam; see the main text for more detail.
* p<0.1, ** p<0.05, *** p<0.01

Table D4. Bad Controls

A.	Percentage of households contributing labor									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Time since annexation	0.026***	0.017**	0.012**	0.016***	0.026***	0.017***	0.018***	0.022***	0.014***	0.021**
	(0.009)	(0.008)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.010)
Distance to cities	-0.137									-0.350**
	(0.143)									(0.143)
South Vietnam		-0.025								-0.051
		(0.048)								(0.049)
Male household head (%)			0.619***							0.211*
			(0.099)							(0.125)
Average head age				-0.016***						-0.011***
				(0.003)						(0.004)
Average head schooling years					-0.020***					0.016
					(0.008)					(0.011)
Urban household (%)						-0.192***				-0.109**
						(0.031)				(0.047)
Kinh household (%)							-0.241***			-0.147**
							(0.058)			(0.061)
Average household size								0.095***		0.081***
								(0.027)		(0.028)
Ln per capita expenditure									-0.176***	-0.064
									(0.028)	(0.053)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.288	0.287	0.337	0.320	0.296	0.320	0.314	0.303	0.331	0.388
Observations	607	607	607	607	607	607	607	607	607	607

Note: Robust standard errors are in parentheses. Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

Table D4. Bad Controls (cont.)

B.	Average number of persons making contributions per household									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Time since annexation	0.074***	0.039**	0.027***	0.036***	0.057***	0.035***	0.038***	0.049***	0.030***	0.068***
	(0.018)	(0.016)	(0.010)	(0.010)	(0.011)	(0.010)	(0.009)	(0.010)	(0.010)	(0.020)
Distance to cities	-0.677**									-0.977***
	(0.288)									(0.288)
South Vietnam		-0.012								-0.112
		(0.093)								(0.094)
Male household head (%)			1.181***							0.427*
			(0.198)							(0.242)
Average head age				-0.020***						-0.016**
				(0.007)						(0.007)
Average head schooling years					-0.049***					0.015
					(0.015)					(0.021)
Urban household (%)						-0.330***				-0.152*
						(0.059)				(0.091)
Kinh household (%)							-0.416***			-0.205
							(0.120)			(0.126)
Average household size								0.289***		0.251***
								(0.072)		(0.080)
Ln per capita expenditure									-0.322***	-0.109
									(0.057)	(0.101)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.329	0.322	0.370	0.336	0.338	0.348	0.343	0.362	0.361	0.425
Observations	607	607	607	607	607	607	607	607	607	607

Note: Robust standard errors are in parentheses. Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

Table D4. Bad Controls (cont.)

C.	Average number of days contributed per household									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Time since annexation	0.441***	0.383***	0.207***	0.298***	0.427***	0.272***	0.295***	0.380***	0.246***	0.451***
	(0.152)	(0.117)	(0.075)	(0.079)	(0.091)	(0.075)	(0.075)	(0.080)	(0.077)	(0.160)
Distance to cities	-2.712									-3.016
	(2.465)									(2.408)
South Vietnam		0.827								0.331
		(0.718)								(0.769)
Male household head (%)			8.606***							5.027***
			(1.586)							(1.848)
Average head age				-0.022						0.010
				(0.059)						(0.056)
Average head schooling years					-0.369***					0.076
					(0.120)					(0.180)
Urban household (%)						-2.271***				-1.392*
						(0.514)				(0.793)
Kinh household (%)							-2.086**			-0.637
							(0.983)			(1.069)
Average household size								2.537***		2.073**
								(0.753)		(0.828)
Ln per capita expenditure									-1.831***	-0.088
									(0.479)	(0.868)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.309	0.309	0.341	0.308	0.319	0.324	0.315	0.348	0.324	0.373
Observations	607	607	607	607	607	607	607	607	607	607

Note: Robust standard errors are in parentheses. Control variables include caloric suitability, distance to the coast, elevation, ruggedness, irrigation suitability, Köppen-Geiger climatic zones, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

Table D5. Description of Experimental Sites

	NORTHERN SITE	SOUTHERN SITE
District characteristics		
Annexed region	YES	YES
Coastal area	YES	YES
Rural area	YES	YES
Number of subjects	138	235
Individual characteristics		
Male	0.225	0.443
	(0.419)	(0.498)
Household size	4.609	4.213
	(1.623)	(1.472)
Wealth index	0.311	0.263
	(0.096)	(0.137)

Note: Standard deviations are in parentheses. The wealth index is a normalized variable constructed by extracting the first principal component of six variables measuring the numbers of mobile phones, computers, motorbikes, refrigerators, gas cookers, and air conditioners that the households possess.

Appendix E. Experimental Instruction

In this appendix, we present the materials used to conduct the public goods experiment in the fields.

Welcome to the experiment and thank you for participating!

Please do not talk to other participants.

General

This is an experiment on decision making. During the experiment you can earn money that will be paid out to you in cash at the end of the experiment. The experiment will last approximately 120 minutes. If you have any questions, please raise your hand, and one of the experimenters will come to you and answer your questions privately. You are not allowed to communicate with any other participants during the experiment. If you do so, you shall be excluded from the experiment as well as from all payments. During the experiment, your income will be calculated in **tokens**. At the end of the experiment, all tokens that you earn will be converted into Dong at the exchange rate:

1 token = 3000 Dong

Anonymity

You will learn neither during nor after the experiment, with whom you interact(ed) in the experiment. The other participants will neither during nor after the experiment learn, how much you earn(ed). Your decisions will be anonymous. We never link names and decisions from experiments. At the end of the experiment you will be asked to complete a questionnaire and sign a receipt regarding your income which serves only as a proof for our sponsor. Please return the whole envelop with your ID number in exchange for your payment on your way out after the experiment.

Means of help

You will find a pen in your envelop which we ask that you, please, leave it back when the experiment is over. We will let you know how much time you have for each part of the experiment.

The Experiment

The experiment consists of two parts. **Your final income equals income from Part I plus income from Part II.** You will receive instructions for each part after the previous part has ended. These instructions will be read to you aloud. Then you will have an opportunity to study them on your own. The two parts are independent of each other.

Throughout the experiment, you will write down your decisions on separate pieces of paper (the decision forms), **which will be handed out during the experiment**. The forms will be collected by an experimenter once all participants have made their decisions.

Part I

The decision situation

You will learn how the experiment will be conducted later. Let us first introduce you to the basic decision situation. At the end of the description of the decision situation, you will find control questions that will help you understand the decision situation. You will be a member of a group consisting of **3 people from 3 different classes**. Each group member has to decide on the allocation of 20 tokens. You can put the 20 tokens into your **private account** or you can put them **fully or partially** into a **group account**. You have to use your entire endowment (= 20 tokens), which means that the tokens you put into the group account and the tokens you put into the private account have to sum to 20.

Your income from the private account:

You will earn one token for each token you put into your private account. For example, if you put 20 tokens into your private account (and therefore do not put anything into the group account), your income will amount to exactly 20 tokens out of your private account. If you put 6 tokens into your private account, your income from this account will be 6 tokens. No one except you earns something from your private account.

Your income from the group account:

Each group member will profit equally from the amount you put into the group account. Moreover, you will also get a payoff from the other group members' payments into the group account. The tokens for each group member out of the group account will be determined as follows:

Income from group account =
(1.5 x Sum of all group members' contributions to the group account) : 3

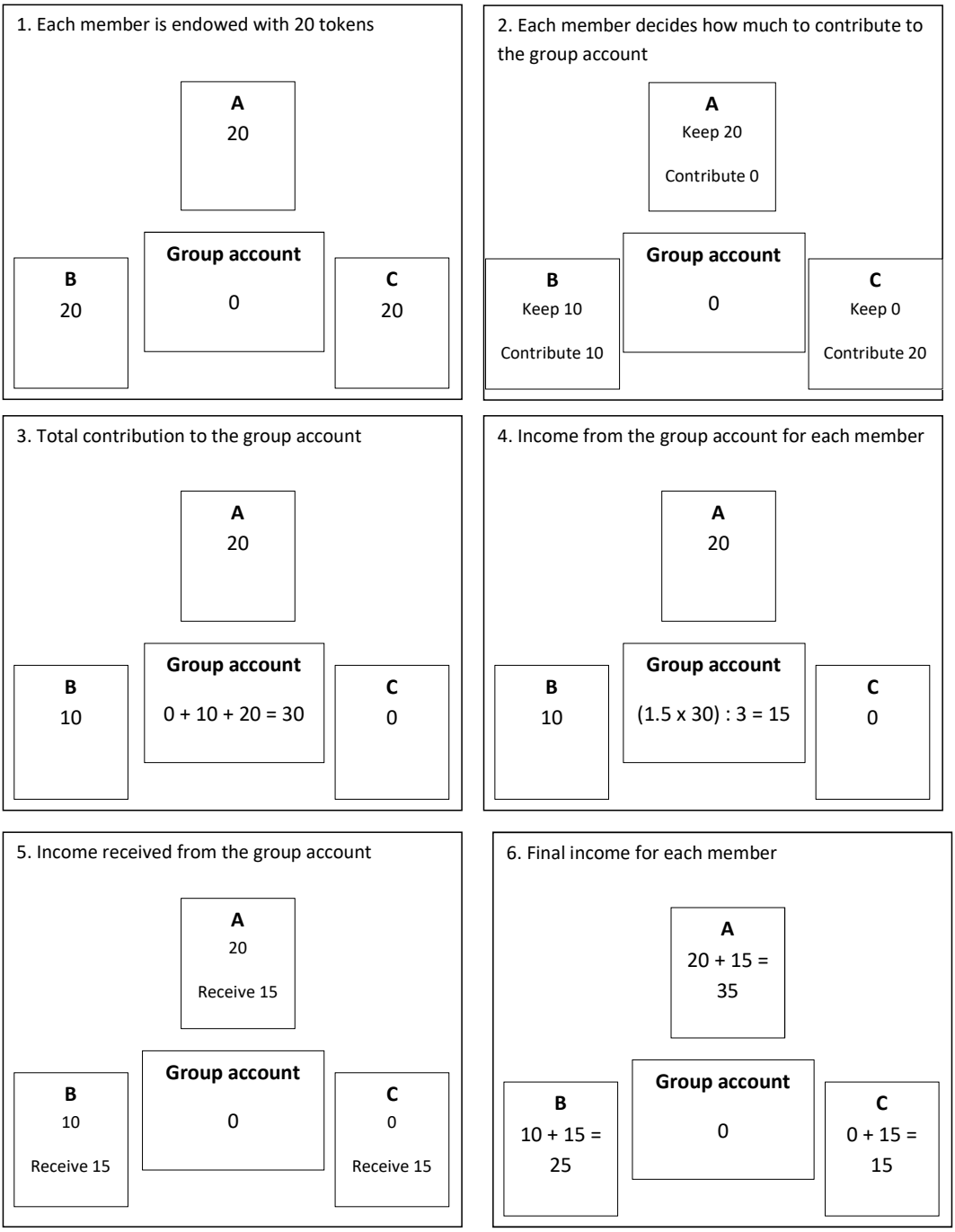
If, for example, the sum of all group members' contributions to the group account is 60 tokens, then you and the other members of your group will each earn (1.5 x 60) : 3 = 30 tokens out of this account. If the three group members contribute a total of 10 tokens to the group account, you and the other members of your group will each earn (1.5 x 10) : 3 = 5 tokens out of this account.

Total income:

Your total income is the sum of your income from your private account and that from the group account:

Income from your private account (= 20 – contribution to group account)
+ Income from group account (= (1.5 × sum of all contributions to group account) : 3)
= Total income

Below figure provides an example:



Control questions

Please answer the following control questions. They will help you gain an understanding of the calculation of your income, which will vary with how you choose to distribute your 20 tokens. *Please answer all the questions and write down your calculations.*

1. Each group member has 20 tokens. Assume that no one in the group (including you) contributes anything to the group account.
What will *your* total income be? _____
What will the total income of the *other* group members be? _____

2. Each group member has 20 tokens. You contribute 20 tokens to the group account. Each of the other two members of the group also contributes 20 tokens to the group account.
What will *your* total income be? _____
What will the total income of the *other* group members be? _____

3. Each group member has 20 tokens. The other 2 members contribute a total of 30 tokens to the group account.

a) What will *your* total income be, if you – in addition to the 30 tokens – contribute 0 tokens to the group account?
***Your* income** _____
b) What will *your* total tokens be, if you – in addition to the 30 tokens – contribute 8 tokens to the group account?
***Your* income** _____
c) What will *your* total tokens be, if you – in addition to the 30 tokens – contribute 15 tokens to the group account?
***Your* income** _____

4. Each group member has 20 tokens. Assume that you contribute 8 tokens to the group account.

a) What is *your* total income if the other group members – in addition to your 8 tokens – contribute another 7 tokens to the group account?
***Your* income** _____
b) What is *your* total income if the other group members – in addition to your 8 tokens – contribute another 12 tokens to the group account?
***Your* income** _____
c) What is *your* income if the other group members – in addition to your 8 tokens – contribute another 22 tokens to the group account?
***Your* income** _____

5. The below statement is right (R) or wrong (W)

a) You are not allowed to talk to other people during the experiment _____
b) You know who the other members in your group are _____
c) You are a member in a group of 4 _____
d) You will make decision in a separate sheet, not in the instruction sheet _____
e) Your final income equals total income from two parts _____
f) All members of your group come from different classes _____

Decisions of Part I

Part I includes the decision situation just described to you. The decisions in Part I will only be made **once**. As you know, you will have 20 tokens at your disposal. You can put them into your private account or you can put them into the group account. Each group member has to make **two types** of contribution decisions, which we will refer to below as the **unconditional contribution** and the **contribution table**.

- In the **unconditional contribution** case you will decide how many of the 20 tokens you want to put into the group account. Please write down your unconditional contribution in the box on the relevant decision form. Please insert integer numbers only. Your contribution to the private account is determined automatically by the difference between 20 and your contribution to the group account. The decision form looks as follows:

Your contribution to the group account is:	

- On the next decision form you will be asked to complete a **contribution table**. In the contribution table, please indicate **how much you would like to contribute to the group account for each possible average contribution of the other group members** (rounded to the next integer). Thus, you can condition your contribution on the other group members' average contribution. The contribution table looks as follows:

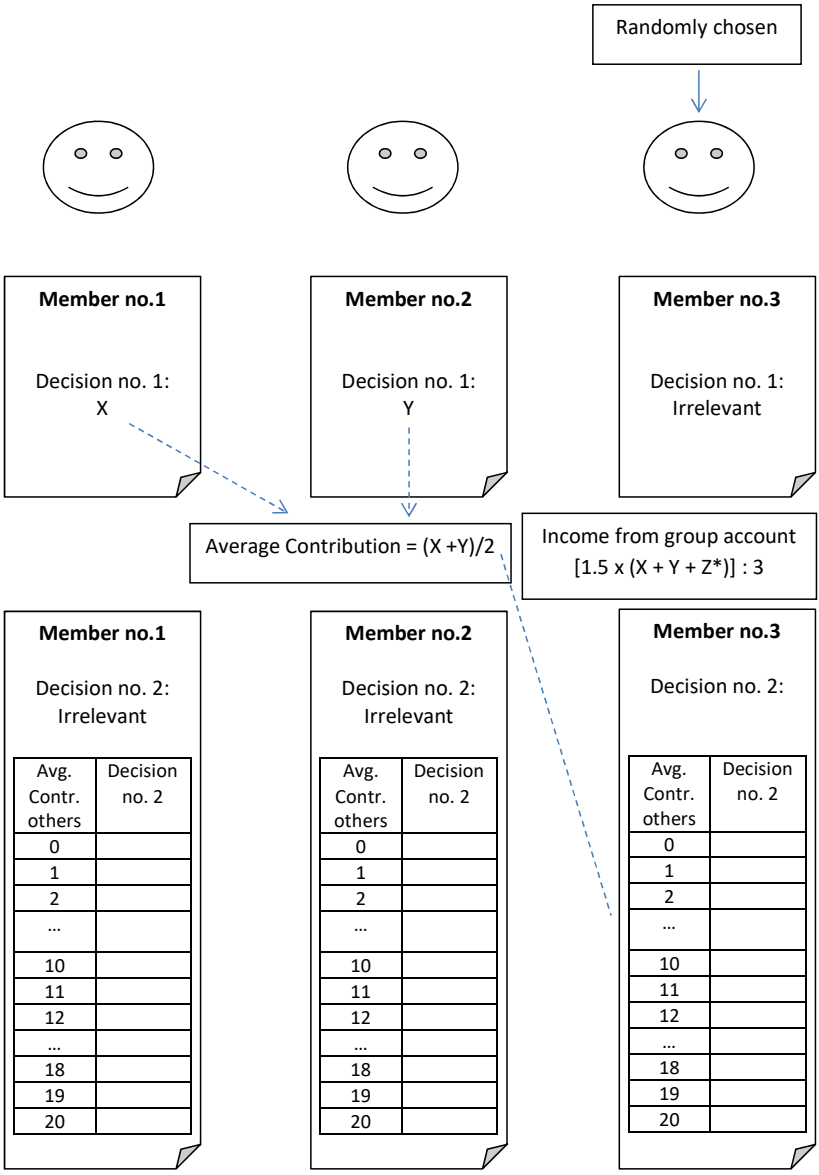
(Rounded) Average contribution of the other group members to the group account	Your contribution to the group account is
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

The numbers in the left column are the possible (rounded) average contributions of the **other** group members

The numbers in the left column are the possible (rounded) average contributions of the **other** group members to the group account. You will simply have to insert into each input box how many tokens you want to contribute to the group account – conditional on the indicated average contribution. **You have to insert a value in each input box**. For example, you will have to indicate how much to contribute to the group account if the others contribute 0 tokens to the group account on average, how much to contribute if the others contribute 1, 2, or 3 tokens on average, etc. You can insert any integer number from 0 to 20 in each input box.

Only **the contribution table** will be the payoff-relevant decision for **one randomly determined subject** in each group. Only the **unconditional contribution** will be the payoff-relevant decision for the **other two group members**. In each group, we will use a random mechanism to decide for whom the contribution table will be pay-off relevant decision. You will therefore have to think carefully about both types of decisions since either one may become relevant for you.

The following figure provides an illustration. Assume that the group member number 3 is chosen randomly hence his/her conditional contribution is payoff-relevant. For the other two group members, their unconditional contributions (X and Y) are payoff-relevant. Their average unconditional contribution is (X + Y) : 2. In the contribution table of the group member number 3, we look for his/her conditional contribution (Z*) when the average contribution of the other two members is (X + Y) : 2. This number is then added to X and Y to yield the total contribution to the group account: Z* + X + Y.


Randomly chosen
Member no.1
Decision no. 1:
X
Member no.2
Decision no. 1:
Y
Member no.3
Decision no. 1:
Irrelevant
Average Contribution = (X +Y)/2
Income from group account
[1.5 x (X + Y + Z*)] : 3
Member no.1
Decision no. 2:
Irrelevant
Member no.2
Decision no. 2:
Irrelevant
Member no.3
Decision no. 2:
Avg. Contr. others
Decision no. 2
0
1
2
…
10
11
12
…
18
19
20

Two examples should make this clear.

Example 1: Assume that **you are the randomly selected subject** in your group. **This implies that your relevant decision will be your contribution table**. The unconditional contribution is the relevant decision for the other two group members. Assume they made unconditional contributions of 0 and 4 tokens. The average rounded contribution of these three group members, therefore, is (0 + 4) : 2 = 2. If you indicated in your contribution table that you will contribute 1 token to the group account if the others contribute 2 tokens on average, then the total contribution to the group account is given by 0 + 4 + 1 = 5 tokens. All group members will therefore earn (1.5 × 5) : 3 = 2.5 tokens out of the group account plus their respective income from the private account. If, instead, you indicated in your contribution table that you would contribute 19 tokens if the others contribute two tokens on average, then the total contribution of the group to the group account is given by 0 + 4 + 19 = 23. All group members will therefore earn (1.5 × 23) : 3 = 11.5 tokens out of the group account plus their respective income from the private account.

Example 2: Assume that **you are not the randomly selected subject** in your group**,** implying that **the unconditional contribution is taken as the payoff-relevant decision** for you and one other group member. Assume that your unconditional contribution to the group account is 16 tokens and that of the other group member is 20 tokens. The average unconditional contribution of you and the other group member is therefore (16 + 20) : 2 = 18. If the group member who is the randomly selected subject indicates in her contribution table that she will contribute 1 token to the group account if the other three group members contribute on average 18 tokens, then the total contribution to the group account is given by 16 + 20 + 1 = 37 tokens. All group members will therefore earn (1.5 × 37) : 3 = 18.5 tokens out of the group account plus their respective income from the private account. If, instead, the randomly selected group member indicates in her contribution table that she would contribute 19 tokens to the group account if the others contribute on average 18 tokens, then the total contribution to the group account is given by 16 + 20 + 19 = 55 tokens. All group members will therefore earn (1.5 × 55) : 3 = 27.5 tokens out of the group account plus their respective income from the private account.

DECISION FORM – PART I

Unconditional contribution

Your choice:
Please insert an integer number **from 0 to 20**. This will be your contribution to the group account. Your contribution to the private account is determined automatically by the difference between 20 and your contribution to the group account.

Your contribution to the group account is:	

DECISION FORM – PART I

Contribution table

Your choice:
Please insert an integer number **from 0 to 20 in each input box**. This will be your contribution to the group account – conditional on the indicated average contribution of the other group members. Your contribution to the private account is determined automatically by the difference between 20 and your contribution to the group account.

(Rounded) Average contribution of the other group members to the group account	Your contribution to the group account is
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

The numbers in the left column are the possible (rounded) average contributions of the **other** group members.

Part II

We will now ask you to indicate your **expectation** about the **average unconditional contribution** to the group account (rounded to the next integer) by the **other two group** members in **Part I**. You will be paid for the accuracy of your expectation:

- If your expectation is exactly right (that is, if your expectation is **exactly** the same as the actual average contribution of the other group members), you will get **3 tokens** in addition to your other income from the experiment.
- If your expectation deviates by 1 token from the correct result, you will get 2 additional tokens.
- A deviation of 2 tokens still gives you 1 additional token.
- If your expectation deviates by 3 or more tokens from the correct result, you will get no additional tokens.

DECISION FORM – PART II

Expectation

Your choice:
This will be your **expectation** about the **average unconditional contribution** to the group account by the other two group members in Part I. Please insert an integer number **from 0 to 20**.

My expectation about their average contribution (**integer number from 0 to 20**):	

Chapter II

Chapter II

Tying Peasants to Their Land: The Rise and Fall of Private Property Rights in Historical Vietnam

Abstract

I present a theory to account for the emergence of land rights in a subsistence agricultural economy. An important feature is that, to maximize tax revenue, an authoritarian state must devise land rights to overcome the informational constraint in registering the population for tax collection. It can do so, given the state capacity is sufficiently high, by owning land and assigning cultivation rights (but not sale or transfer rights) to landless peasants to tie them to their land. The theory gives rise to a testable hypothesis, positing that private ownership of land is less prevalent in areas where population density is higher. In the early 19^{th} century, the new Nguyen Dynasty of historical Vietnam carried out a land registry to establish formal land rights in the whole country. This historical experiment rules out the potential reverse influence of private land rights on population density. Exploiting this land registry, I discover that private ownership of land is less prevalent in areas where population density is higher. Furthermore, primary accounts and related historical studies show that the mechanism at work is in line with the proposed theory. Thus, the theory in question and the associated empirical evidence show that a strong state could reverse the general process in economic history whereby societies moved towards private land rights as population density increased and land became more scarce.

Keywords: Land Rights; Population Density; Historical Vietnam.

JEL Classification: D02, Q15, N45.

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1 Introduction

Why did different regimes of property rights emerge in different countries, and often within the same country? An early theoretical approach focuses on market forces and argues that private property rights emerge when potential right holders perceive that the benefits to define and enforce such rights exceed the costs (Demsetz 1967; Alchian and Demsetz 1973). In this framework, higher population density makes land more scarce and valuable, and hence gives rise to private land rights (Anderson and Hill 1975).[1] This prediction is consistent with the general evolution of land rights towards privatization as population density increased throughout the course of human history (Lewis 1955; Boserup 1965). In his seminal work, North (1981) shows that efficient property rights brought about by market forces were unusual in history, and instead gives the state a central role in explaining the emergence of property rights. In particular, North (1981) argues that, to maximize its own benefit (or tax revenue in particular), the state devises a structure of property rights to gain support from powerful groups of constituents and to reduce the transaction costs of collecting taxes, i.e., monitoring and metering taxable objects. These theoretical approaches, appealing as they are, have so far received few empirical examinations.

In the present paper, I develop a theory of the emergence of property rights to land, following the approach advocated by (North 1981), and provide novel empirical evidence for the role of the state in accounting for the emergence of private land rights. In particular, I study an authoritarian state, whose objective is to maximize tax revenue, broadly defined, in a subsistence agricultural economy. The state collects production tax and various individual duties such as head tax, unpaid labor services, and military conscription. The key feature of the theory is that the state can collect production tax by simply visiting agricultural fields, but it has to know the taxpayer population in order to collect individual duties. The state can overcome this informational constraint in registering the taxpayer population by tying landless peasants to their agricultural fields, i.e., giving them cultivation rights (but not sale or transfer rights) to some land, so that they will lose their land if they hide away when the state officials visit to enumerate the taxpayer population. This feature of the theory captures the capacity of historical states

[1] See also North and Thomas (1973), Anderson and Swimmer (1997), Casari (2007), and Alston, Harris, and Mueller (2012) for some other studies following this theoretical approach. Models of the economics of conflict also predict that greater efforts are expended in defending rights over more valuable resources (e.g., Grossman and Kim 1995; Baker 2003).

to control and register the taxpayer population.[2]

The theory in question generates three main predictions. First, the state prefers to own all land units and assigns only cultivation rights to all peasants to tie them to their land, because doing so enables the state to collect more individual duties from landless peasants. This state ownership system is only feasible when the state capacity is sufficiently high. Second, when there is a new land area and the cost of migration plus land clearing is sufficiently high, the state prefers to grant private ownership of land to create incentives for peasants to migrate and exploit the new land for production, because doing so expands the production tax base. Third, when there are too many landless peasants in the new land, the state has an incentive to confiscate all land and assign only cultivation rights to landless peasants to tie them to their fields and collect more individual duties. State confiscation in the new land is considered to happen a long time after the migration so that peasants still have the incentives to migrate and exploit the new land, even when they anticipate the confiscation in advance. Because the number of landless peasants increases with the level of population density, the state is more likely to confiscate a new land area when its population density increases. Thus, a testable hypothesis posits that, at a point in time, private land ownership is less prevalent in areas where population density is higher.

Examining the theory in question requires rich historical materials of land tenure, which can be found in historical Vietnam. Since the end of the 10^{th} century, early states of historical Vietnam governed the land surrounding the Red River Delta (figure 1). These centralized states collected from their peasants production tax and individual duties such as head tax, unpaid labor services, and military conscription. Because people often hid away when the state officials visited to enumerate the population, state ownership of land was established and only cultivation rights were assigned to landless peasants to tie them to their fields to collect individual duties. From 1069 to 1757, historical Vietnam gradually expanded its territory southward to the Mekong River Delta to form a country as it is today (figure 1). To attract settlers to this new land, the state granted private ownership of land, giving rise to a large proportion of land owned by a majority of peasants, an unprecedented phenomenon in the course of the country history. A century

[2] The need to register and control the population was common in historical states. It might explain why the earliest states were characterized by state ownership of both land and people. In later states, where people were free, a typical tool to control their mobility was to tie people to their land by granting them cultivation rights (in exchange for tax payments), but not the rights to sell or contract the land. Thus, the word "real" in "real estate" has its origin in Spanish, literally means "royal" (Oxford English Dictionary). See Powelson (1988) for a world history of land tenure.

or more after a new region was annexed, the state confiscated private land in the region and assigned only cultivation rights to landless peasants. The motivation was to increase tax revenue, particularly to collect more individual duties.

From 1805 to 1836, right at the beginning of its rule, the Nguyen Dynasty of historical Vietnam carried out a land registry to establish formal land rights in the whole country. Given its details, this land registry provides the necessary data to empirically examine the influence of population density on the prevalence of private land ownership as hypothesized by the theory in question. Most importantly, because the Nguyen Dynasty had to take into account the level of population density among other things in its decision to grant private ownership of land, this land registry provides a setting that rules out the reverse influence of private land ownership on population density. Digitizing this huge archive, I find that the percentage of private ownership is lower in areas where population density is higher. The estimated effect is statistically and economically significant, and robust to the inclusion of potential confounding factors as well as a battery of checks.

Also adopting the theoretical approach advocated by North (1981), Mayshar, Moav, and Neeman (2017) study how the transparency of the production process influences the structure of property rights, and use the theory to explain property rights to land in the ancient civilizations of the Near East (Egypt and Mesopotamia). The authors posit that when transparency is sufficiently high, the state can dismiss farmers who exert low effort (an indicator for the lack of private land rights). Nevertheless, when there is sufficient opacity so that the cost of erroneous dismissal outweighs the benefit, the state gives up the option to dismiss, thereby granting farmers de facto title to the land they cultivate. The main differences in the present theory are that state ownership of land emerges as a solution to the problem of overcoming the informational constraint in registering the population for the collection of individual duties, and private ownership is granted to encourage the clearing of new land for production in order to expand the tax base. Moreover, the present theory also generates a hypothesis linking population density to the prevalence of private land ownership that can be tested empirically.

On the empirical front, there have been only a few studies investigating the emergence of private land rights, presumably because historical data on land ownership are not available. Studying the British industrialization, where Parliament operated a forum to reorganize rights to land and resources into private ownership, Bogart and Richardson (2011) show that Parliament increased the number of acts reorganizing land rights in response to increases in the returns to investments, which in turn were driven by real interest rate and the volume of international trade. Fenske (2013) conducts a descriptive

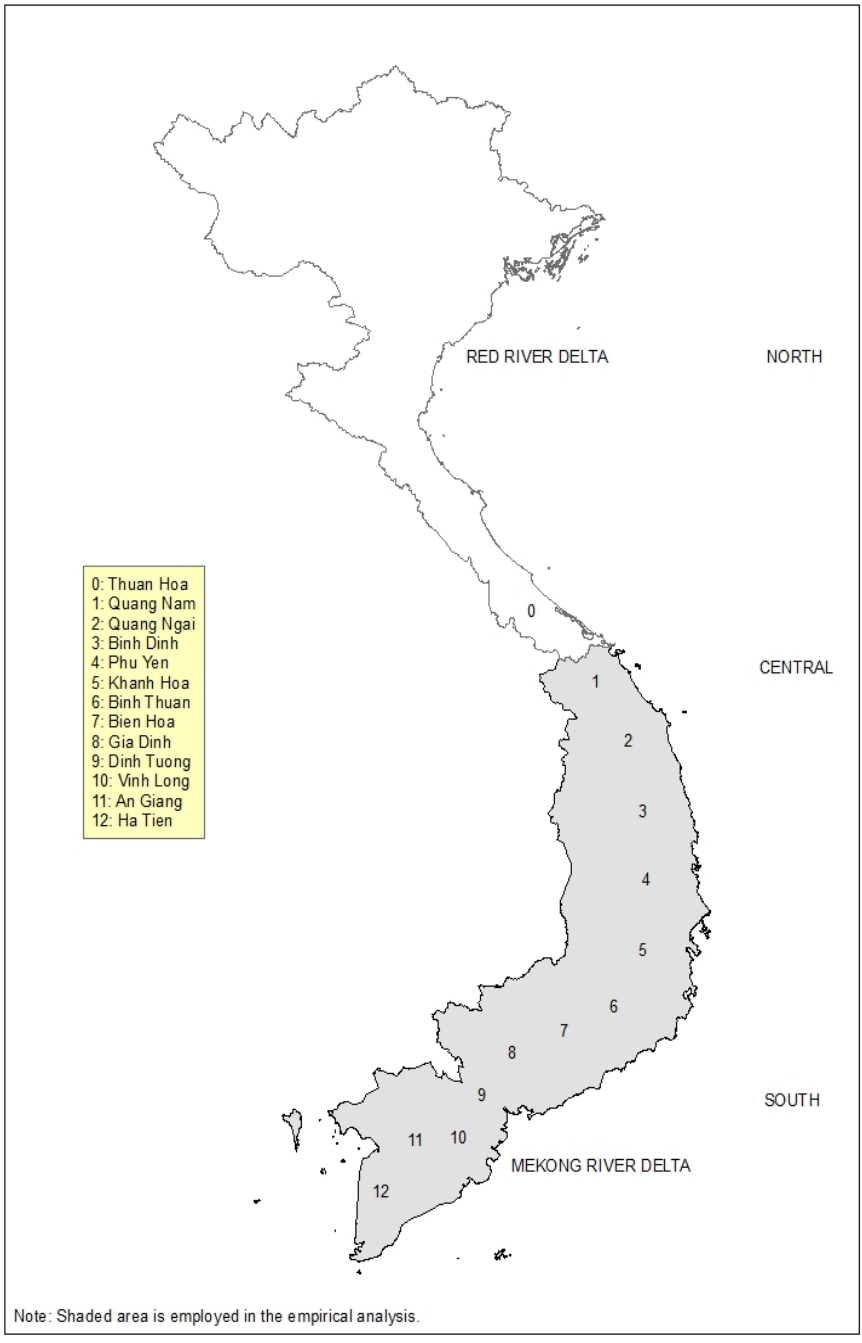

Figure 1. Vietnam in the 19th Century

investigation on the determinants of historical land rights, using data from the cross-section of global societies included in the Ethnographic Atlas constructed by Murdock (1967). The author finds that the groups in the sample were more likely to possess any rights over land where land was most scarce and more valuable, and that the theoretical approach put forward by Demsetz (1967) predicts differences across regions better than differences within regions.

In a recent work, Acemoglu and Robinson (2012) argue that extractive institutions compromising private property rights are the biggest obstacles to economic development. The present paper contributes a useful perspective to understand the origins and evolution of these extractive institutions in countries whose states want to control the population and tying people to their land is a typical strategy. In particular, recent research has discovered that secure land tenure encourages migration from rural to urban areas, for example, in the former Russian Empire (Chernina, Dower, and Markevich 2014), China (Mullan, Grosjean, and Kontoleon 2011), and Mexico (de Janvry et al. 2015). These empirical studies often take land tenure as given and argue that these authoritarian states should promote land tenure security in order to bring about a successful structural transformation and rural development. Nevertheless, the key lesson of the present paper suggests a different perspective, i.e., insecure land tenure is devised to tie peasants to the rural areas and the agricultural sector for the benefits of the authoritarian states.[3] As a result, these states will promote land tenure security only when its own interest dictates so, e.g., to generate sufficient labor supply for the development of the revenue-generating manufacturing sector.

The remainder of the present paper is organized as follows. The next section presents the theory in detail. Section 3 describes land tenure in historical Vietnam and provides qualitative evidence for the key assumptions and main predictions of the theory. Section 4 describes in detail the land registry of the 19^{th} century that is used to test the hypothesis linking population density to the prevalence of private land rights. Section 5 presents the baseline empirical results together with a battery of robustness checks. Section 6 closes the paper with some key lessons.

[3] See Fergusson (2013) for a theory that shares this viewpoint.

2 Theory

To begin with, the theory assumes an authoritarian state is already present and people are free.[4] The authoritarian state faces a problem of choosing a structure of land rights to maximize tax revenue, broadly defined, while taking into account the actions of the individual peasants. I first discuss the basic structure of the core economy and examine when the state ownership system is an optimal solution to the problem of the state. Next, I study how the state can use private ownership to create incentives for peasants to migrate to a new land area and clear land for production. Finally, I examine what will happen in the new land over time when population density increases.

2.1 The Core Economy

Consider an overlapping-generations economy governed by a Malthusian regime in the style of Galor and Weil (2011), with an exogenously given area of land. In every period, the economy produces a single homogeneous good using land and labor as inputs, in which labor supply is governed by household fertility in the preceding period.

Production

Production occurs over indefinite discrete time according to a constant-returns-to-scale technology in which output at time t in the core economy, $Y_{c,t}$, is:

$$Y_{c,t} = (AX_c)^{\alpha} L_{c,t}^{1-\alpha}, \qquad \alpha \in (0,1), \tag{1}$$

where X_c is the area of land, $L_{c,t}$ is labor employed in production at time t, and $A > 0$ represents the technological level. The technological level may capture land quality and agricultural techniques, thereby AX_c captures the productivity-augmented land area used in production. For the purpose of the present paper, the technological level is assumed to be constant over time. It follows that output per worker, $y_{c,t}$, is:

$$y_{c,t} = (AX_c/L_{c,t})^{\alpha}, \tag{2}$$

which shows that the larger the land area, the higher the output per worker.

[4] For theories on the origins of the state, see, e.g., Carneiro (1970), Baker, Bulte, and Weisdorf (2010), and Mayshar et al. (2019). For an attempt to model the transition from a stateless hunter-gather society to a slavery society (where state owns both land and people), then to a free-labor society (where state only owns land), see Lagerlof (2009).

Taxation

The state collects an exogenously given production tax, $\tau \in (0, 1)$, over each taxable output unit.[5] In addition, the state imposes duties on individuals, such as head tax, unpaid labor services, and military conscription. These duties are also exogenously given, and equivalent to a fixed amount of money, κ, per worker. To collect production tax, the state simply needs to visit the agricultural fields. But to collect individual duties, the state must be able to register the taxpayer population. People who have land to cultivate must show up when the state officials visit to register the taxpayer population, otherwise they will lose their land. In other words, they are tied to their land. Landless peasants, however, can hide away at no cost, making it impossible for the state to register them.

Under a private ownership system, in which the state allows the individuals to freely own as much land as they can, tax revenue at time t in the core economy, $R_{c,t,p}$, is:

$$R_{c,t,p} = \tau Y_{c,t} + \pi \kappa L_{c,t}, \tag{3}$$

where $\pi \in [0, 1]$ is the fraction of land owners in the economy.[6] Because the state simply lets the individuals occupy land, the cost of running the private ownership system is negligible. For simplicity, I set the cost of running the private ownership system to zero. Under a state ownership system in which the state owns all land units and assigns only cultivation rights to all individuals to tie them to their fields, tax revenue at time t in the core economy, $R_{c,t,s}$, is:

$$R_{c,t,s} = \tau Y_{c,t} + \kappa L_{c,t} - C X_c, \tag{4}$$

where C is a fixed administrative cost per one unit of land area required to run the state ownership system, relative to the private ownership system. Compared to the private ownership system, running the state ownership system requires an extra cost of assigning cultivation rights and monitoring the use of land. A lower level of C reflects a stronger state capacity.

The simple tax revenue specified above highlights the importance of having peasants

[5] Since the purpose is to examine under which conditions private ownership of land is optimal for the state in terms of tax revenue maximization, exogenous tax rate is chosen to simplify the analysis. Treating tax rate as endogenous will not change the conclusions of the theory.

[6] For simplicity, I take the fraction of land owners in the economy as given. Understanding the process that determines the fraction of land owners in a subsistence agricultural economy is of course an important topic for future research.

tied to their land. Three implicit assumptions are involved. First, individual duties are assumed to be delivered outside the time of production. This is not only preferred by the state, but also feasible in a subsistence agricultural society where production is only seasonal. Second, to simplify the analysis, all benefits from individual duties are modeled in monetary units as a direct source of tax revenue. Of course, some types of duties may affect tax revenue indirectly through their impacts on output. For example, unpaid labor services used for irrigation and road construction might increase land quality or the technological level, both of which can be captured by a larger constant A.[7] Third, tax revenue is assumed to be unaffected by the structure of land rights. Of course, private ownership might improve the allocative efficiency through the land market and induce more investments in land because of stronger tenure security, leading to a higher constant A. This increase, however, is small if cultivation rights are secured and the allocative inefficiency is low under the state ownership system. Relaxing these assumptions does not change the conclusions of the theory, as long as the efficiency gain in the private ownership system is not too large relative to the efficiency gain in the state ownership system discussed above.

Labor Supply

In each period t, a generation consisting of $L_{c,t}$ identical individuals joins the workforce. Each individual has a single parent and lives for two periods. In the childhood period, $t-1$, they are supported by their parents. In the parenthood period, t, they inelastically supply their labor, which generates a before-tax income that is equal to the output per worker, $y_{c,t}$. After paying tax, they allocate the after-tax income, $i_{c,t} = (1-\tau)y_{c,t}$, between their own consumption and raising their children.

Each individual obtains utility from his or her consumption and number of children:

$$u_t = (c_t)^{1-\gamma}(n_t)^{\gamma}, \qquad \gamma \in (0,1), \tag{5}$$

where c_t is consumption and n_t is the number of (surviving) children of an individual in generation t. The budget constraint is:

$$c_t + \rho n_t \leq i_{c,t}, \tag{6}$$

[7] Another important benefit of assigning cultivation rights and having landless peasants under control is the reduction in rebellion risk because (i) each peasant has a basic livelihood and (ii) local lords are prevented from accumulating land and building up their own armies.

where ρ is the cost of raising a child.

Steady-State Equilibrium

With a positive level of the initial population, $L_{c,0} > 0$, there exists a unique and stable steady-state equilibrium in the core economy in which the adult population, $\bar{L}_c$, is:

$$\bar{L}_c = \left[\frac{\gamma(1-\tau)}{\rho}\right]^{1/\alpha} AX_c, \tag{7}$$

and the after-tax income per worker at the steady-state equilibrium, $\bar{i}_c$, is:

$$\bar{i}_c = \frac{\rho}{\gamma}. \tag{8}$$

See appendix A for the derivation.

These results reflect the standard dynamics of a Malthusian economy. At the steady-state equilibrium, after-tax income per worker depends only on the cost of raising a child and the relative importance of the number of children to individual utility. This is because the steady-state level of population adjusts to different values of production tax rate, technological level, and land area.

State Ownership at the Steady-State Equilibrium

To choose between different systems of land ownership in the core economy, the state compares the resulting amounts of tax revenue. Following equations (3) and (4), the difference in tax revenue at time t between the state ownership system, $R_{c,t,s}$, and the private ownership system, $R_{c,t,p}$, is:

$$R_{c,t,s} - R_{c,t,p} = (1-\pi)\kappa L_{c,t} - CX_c, \tag{9}$$

where $(1-\pi)\kappa L_{c,t}$ captures the benefit of the state ownership system compared to the private ownership system, i.e., the state can collect individual duties from the fraction of landless individuals. The larger the adult population, the higher the benefit. To decide whether or not to participate in the system of land ownership chosen by the state, each individual compare the resulting after-tax income with their outside option. For simplicity, assume that each individual requires a subsistence level, θ, in each period to survive, and that there is no better outside option.

PROPOSITION 1. *If* $(1-\pi)\kappa(\bar{L}_c/X_c) > C$ *and* $(\rho/\gamma) > \theta$*, then it is optimal in terms*

of tax revenue maximization for the authoritarian state to institute the state ownership system in the core economy at the steady-state equilibrium.

PROOF. From equation (9), the state prefers the state ownership system at the steady-state equilibrium if the benefit of collecting individual duties from the fraction of landless individuals, $(1-\pi)\kappa\bar{L}_c$, is larger than the administrative cost of running the state ownership system, CX_c. Divided both sides by X_c gives us $(1-\pi)\kappa(\bar{L}_c/X_c) > C$. Intuitively, this condition is more likely to be satisfied when population density, $\bar{L}_c/X_c$, is higher, given that state capacity is sufficiently high to keep the unit cost of running the state ownership system, C, reasonably small. If state capacity is too low, and hence C is exceedingly high, then it is not beneficial for the state to set up the state ownership system, even if there are many landless peasants in the economy hiding away and not paying individual duties. Under the state ownership system, each individual is granted a quantity of land to cultivate that generates an after-tax income at the steady-state equilibrium equal to ρ/γ. If this level of after-tax income is larger than the subsistence level, θ, the individuals prefer to participate in the state ownership system. Thus, the state ownership system is optimal at the steady-state equilibrium, and the corresponding tax revenue, $\bar{R}_{c,s}$, is:

$$\bar{R}_{c,s} = \tau\bar{Y}_c + \kappa\bar{L}_c - CX_c. \tag{10}$$

2.2 The New Land

At time t, consider new added land with an exogenously given area of X_n, which may come from previously uncleared land or a newly conquered territory. For simplicity, assume that the core economy is at the steady-state equilibrium at time $t-1$, i.e., it has $\bar{L}_c$ workers, $\bar{i}_c$ after-tax income per worker, and the state ownership system with $\bar{R}_{c,s}$ tax revenue. Also assume that migrating and clearing the new land incur a fixed cost per person, η. Now the problem of the state is to bring this new land into production to broaden the tax base, thereby increasing tax revenue. To do so, the state needs the individuals to migrate and clear the new land.[8] In other words, it has to decide on the structure of land rights in the new land to maximize total tax revenue, subject to the individual decisions to migrate and clear this land. This is a standard sequential game that can be solved by backward induction. In particular, the individual decision to migrate and clear the new land under each ownership system is first examined, and the

[8] Another important benefit of having people migrating and settling in the new land is to enhance the state's defense against invaders.

resulting total tax revenue from the two systems is then compared to find the optimal solution to the problem of the state.

Under the state ownership system, the state owns all land units in the new land in addition to those in the core economy and assigns only cultivation rights to all individuals, resulting in a larger amount of land per worker. Thus, the after-tax income at time t of a worker who migrates to the new land, $i_{n,t}$, is the same as of those who stay in the core economy, $i_{c,t}$. Because the adult population at time t is assumed to be at the steady-state equilibrium level, $\bar{L}_c$, it follows that:

$$i_{n,t} = (1-\tau)\left[\frac{A(X_c+X_n)}{\bar{L}_c}\right]^{\alpha} = \frac{\gamma}{\rho}\left(1+\frac{X_n}{X_c}\right), \tag{11}$$

where the second equality follows from inserting equation (7). If no individuals migrate and clear the new land, the core economy stays at the steady-state equilibrium in which the after-tax income per worker is $\bar{i}_c$. Individuals thus migrate and clear the new land at time t as long as the after-tax income per worker obtained in the new land, $i_{n,t}$, is higher than what they receive by staying in the core economy, $\bar{i}_c$, plus the fixed cost of migrating and clearing the new land, η, i.e., $i_{n,t} > \eta + \bar{i}_c$. If the fixed cost η is too high, so that $i_{n,t} < \eta + \bar{i}_c$ or:

$$\frac{\gamma}{\rho}\left(1+\frac{X_n}{X_c}\right) < \eta + \frac{\rho}{\gamma}, \tag{12}$$

then no individuals migrate and clear the new land under the state ownership system, and the state collects production tax and individual duties only in the core economy. In that case, total tax revenue at time t under the state ownership system in the new land, $TR_{t,s}$, is only equal to tax revenue in the core economy, which is assumed to be at the steady-state equilibrium level, $\bar{R}_{c,s}$.

Under the private ownership system, the state grants the rights to own land to all individuals who are willing to migrate and clear the new land. Because individuals can now own as many land units as they wish in the new land, what matters for their decisions is the marginal after-tax income, $m_{n,t} = (1-\tau)\partial Y_{n,t}/\partial L_{n,t}$, instead of the average after-tax income, as in the core economy under the state ownership system. Thus, at time t, a number of individuals, $L_{n,t}$, migrate and clear the new land as long as the marginal after-tax income in the new land, $m_{n,t}$, is higher than the average after-tax income in the core economy, $\bar{i}_c$, plus the fixed cost η, i.e., $m_{n,t} > \eta + \bar{i}_c$. As long as the new land is large, which should be the case in practice, this condition is always satisfied at some specific level of $L_{n,t}$. As individuals migrate, the average after-tax income in the core economy at time t also increases from the steady-state equilibrium level, $\bar{i}_c$, to a new

level, $i_{c,t}$, because each staying person is now assigned a larger area of land to cultivate. Migration thus stops when the marginal after-tax income in the new land equals the average after-tax income in the core economy plus the fixed cost η:[9]

$$m_{n,t} = \eta + i_{c,t}. \tag{13}$$

Thus, the larger the new land, the more land owners it can absorb.

When individuals migrate and clear the new land under the private ownership system, the state collects production tax and individual duties in both the core economy and the new land, and only incurs the cost of running the state ownership system in the core economy. Because $L_{n,t}$ individuals who migrate and settle in the new land are all land owners, the state is able to collect individual duties from them. The state is also able to collect individual duties from $L_{c,t}$ individuals who stay in the core economy and are tied to their land under the state ownership system. Thus, the state is able to collect individual duties from all the workers available at time t, which is assumed to be at the steady-state equilibrium level, $\bar{L}_c$. Thus, total tax revenue at time t under the private ownership system in the new land, $TR_{t,p}$, is:

$$TR_{t,p} = \tau(Y_{c,t} + Y_{n,t}) + \kappa(L_{n,t} + L_{c,t}) - CX_c = \tau(Y_{c,t} + Y_{n,t}) + \kappa\bar{L}_c - CX_c. \tag{14}$$

PROPOSITION 2. *If η satisfies equation (12), then it is optimal in terms of tax revenue maximization for the authoritarian state to institute the private ownership system in the new land at time t.*

PROOF. See appendix A for the proof.

Recall from above that if the fixed cost η is too high, so that equation (12) is satisfied, no individuals migrate and clear the new land under the state ownership system. Total tax revenue is then only equal to tax revenue in the core economy, which is assumed to be at the steady-state equilibrium level, $TR_{t,s} = \bar{R}_{c,s}$. Thus, the state prefers the private ownership system in the new land at time t if total tax revenue obtained, $TR_{t,p}$ as specified in equation (14), is larger than total tax revenue received under the state ownership system in the new land, $\bar{R}_{c,s}$. Appendix A shows that this is true. Hence, if the fixed cost η is sufficiently high so that no individuals migrate and clear the new land

[9] In practice, the first peasant comes and cultivates as large a land area as he or she can. Then the second peasant comes and cultivates a smaller land area. Then the third and so on until the leftover land area is small enough to satisfy the condition.

under the state ownership system, then private ownership in the new land is the optimal solution to the problem of tax revenue maximization by the state.

2.3 Evolution in the New Land

What happens in the new land over the long run? When the private ownership system is instituted in the new land at time t and a number of individuals, $L_{n,t}$, migrate and clear the new land, the marginal after-tax income in the new land is larger than the steady-state equilibrium level. Thus, $L_{n,t}$ individuals in the new land can now afford more children, and hence population in the new land will increase to the steady-state equilibrium level. Similarly to the core economy, the population at the steady-state equilibrium ($\bar{L}_n$) in the new land is:

$$\bar{L}_n = \left[\frac{\gamma(1-\tau)}{\rho}\right]^{1/\alpha} AX_n, \tag{15}$$

and the after-tax income per worker at the steady-state equilibrium, $\bar{\bar{i}}_n$, is:

$$\bar{\bar{i}}_n = \frac{\rho}{\gamma}. \tag{16}$$

There are also $(1-\pi)\bar{L}_n$ landless peasants in the new land, where π is the fraction of land owners in the economy. Will the private ownership system be stable under the steady-state equilibrium?

At the steady-state equilibrium under the private ownership system in the new land, the state cannot collect individual duties from $(1-\pi)\bar{L}_n$ landless peasants. Thus, the benefit of switching to a state ownership system is $(1-\pi)\kappa\bar{L}_n$. On the other hand, running a state ownership system in the new land incurs an administrative cost of CX_n. If the gain in tax revenue is smaller than the cost of running the state ownership system, then the private ownership system in the new land is a stable equilibrium. Otherwise, the state has an incentive to establish a state ownership system in the new land, i.e., confiscating all land units and assigning only cultivation rights to landless peasants, thereby tying them to their fields and collecting more individual duties. In other words, the state ownership system emerges in the new land at the steady-state equilibrium if $(1-\pi)\kappa\bar{L}_n > CX_n$, or:

$$(1-\pi)\kappa\frac{\bar{L}_n}{X_n} > C. \tag{17}$$

Thus, the state is more likely to establish a state ownership system in the new land when population density ($\bar{L}_n/X_n$) is higher, given that state capacity is sufficiently high

to keep the unit cost of running the state ownership system, C, reasonably small. As in the core economy, each individual in the new land receives an after-tax income per worker of ρ/γ under the state ownership system at the steady-state equilibrium. Thus, the individuals prefer to participate in the state ownership system if there is no better outside option than the subsistence level θ, and $(\rho/\gamma) > \theta$.

An important issue arises, will the individuals still migrate and settle in the new land at time t if they anticipate that there is a possibility that the state will confiscate the new land at the steady-state equilibrium? The answer is yes in the present setting. This is because: (i) individuals are assumed to be myopic and only care about their own consumption, which is reasonable in a subsistence agricultural economy; (ii) each individual gains a marginal after-tax income by migrating to the new land that is larger than what obtained by staying in the core economy plus the fixed cost η; and (iii) when a confiscation happens in the new land at the steady-state equilibrium, people in the new land still receive the same average after-tax income as those people who stay in the core economy. Even if the utility function (5) is extended to also include the consumption of the next generation, it is still optimal for the individuals to migrate and settle in the new land at time t. This is because each individual has a higher level of after-tax income at time t, and even when a confiscation happens in the new land at the steady-state equilibrium, their children still receive the same average after-tax income as the children of those people who stay in the core economy. Thus, the whole family is better off.

In summary, the theory discussed above posits that the state prefers to own all land units and assign only cultivation rights to landless peasants to tie them to their fields, thereby collecting more individual duties and maximizing tax revenue, broadly defined. The state grants private land rights to create incentives for migration and land clearing in the new land, but in the long run is likely to confiscate the new land when population density in the new land increases. As a result, there arises a testable hypothesis positing that, at a point in time, private ownership of land is less prevalent in areas where population density is higher. In an empirical context, the exact hypothesis states that the percentage of private land ownership is lower in areas where taxpayer density, i.e., the number of taxpayers per unit of cultivated land, is higher. Before testing this hypothesis using a cross-section of cantons in the nationwide land registry of historical Vietnam in the early 19^{th} century, the next section presents qualitative evidence for the key assumptions and predictions of the theory, drawing from primary accounts as well as related historical studies on land tenure in historical Vietnam.

3 Historical Evidence

3.1 State Ownership in the Early States

After 1000 years of colonization by historical China, the first unified state of historical Vietnam was established in 968 CE and governed the region surrounding the Red River Delta (figure 1) with a centralized government and an agriculture specializing in wet-rice plantation (Taylor 2013). The typical state of historical Vietnam raised its revenue primarily from production tax and individual duties of male adults such as head tax, unpaid labor services, and military conscription. Therefore, this revenue system depended on an effective strategy to register the land and the population of male adults. Because it was easy for landless peasants to hide away when the state officials visited to enumerate male adults, it was almost impossible to construct a complete registry of the taxpayer population (Tana 1998, p. 161-172).

Studying land tenure in historical Vietnam, the Vietnamese historian Truong Huu Quynh noted that the state only needed to visit agricultural fields to collect production tax, but it had to register and control the number of male adults to collect individual duties such as head tax, unpaid labor services, and military conscription (Truong 2009, p. 249). As a result, the state ownership system of land was established in the early dynasties and was enhanced over time. Under this system, landless peasants were assigned cultivation rights (but not sale or transfer rights), which were revised regularly, normally every six years, to prevent any land being left uncultivated owing to death or migration (Truong 2009, p. 207). Because the same household was normally re-assigned the same land every six years, the incentive to invest in land might not be reduced to a significant extent. By tying the peasants to their fields, the state could register and control the number of male adults to collect individual duties (Truong 2009, p. 213).

3.2 Land Expansion and Private Ownership

To create incentives for peasants to clear new land for production, early states of historical Vietnam already granted private ownership to newly cleared land, normally with zero tax rate (Truong 2009, p. 120-146, 177-228). This fact implies that clearing new land for agricultural production incurred a substantial cost. The benefits of private land ownership in terms of output and tax revenue are not found in available historical sources, suggesting that they might be negligible. In contrast, selling and buying private land often led to the concentration of land in the hands of a small fraction of landlords (Truong 2009, p. 132-134, 237-240), and its negative impacts on output and tax revenue were

substantial. First, tax revenue was reduced because it was harder to register and control a large population of landless peasants, pushing the state to impose a production tax on previous tax-free private fields (Truong 2009, p. 390). Second, the dike and irrigation systems were not properly maintained, resulting in harvest losses and famines (Truong 2009, p. 158, 409). And third, landlords sometimes gathered enough dependents to form small armies, posing threats to the incumbent state itself (Truong 2009, p. 161).

From 1069 to 1757, historical Vietnam gradually expanded its territory southward to the Mekong River Delta to form a country as it is today (figure 1).[10] Because the cost of migrating and settling in this annexed region was substantial, private ownership of land had to be granted to create incentives. Le Quy Don, a state official and a leading scholar, in his famous work circa 1776, *Phu Bien Tap Luc*, documented that the state allowed people to occupy land freely (Le 1993, p. 126). Trinh Hoai Duc, another state official and leading scholar, in his famous work circa 1820, *Gia Dinh Thanh Thong Chi*, also explained that, in order to attract settlers, the state was easy, generous, and uncomplicated in bureaucratic matters with those who wanted to open up new agricultural fields, as long as they paid taxes (Trinh 1972, p. 2-17). These policies eventually gave rise to a large proportion of land owned by a majority of peasants, an unprecedented phenomenon in the course of the country history (Nguyen 1999a).

3.3 State Confiscation in the New Land

There were three records of state confiscation in the annexed region that can be found in the official chronicles of historical Vietnam, i.e., *Dai Viet Su Ky Toan Thu* and *Dai Nam Thuc Luc*. First, the territory from Thuan Hoa to Binh Dinh (figure 1) was annexed to historical Vietnam after three military conquests in 1069, 1306, and 1471 (*Dai Viet Su Ky Toan Thu*, p. 197, 340, 662). In 1669, the state conducted a land survey in this region, established state ownership, and assigned only cultivation rights to landless peasants (*Dai Nam Thuc Luc*, Volume 1, p. 82). It is recorded that the state continued to grant private ownership to owners of newly cleared land, and the area of new cleared land continued to increase after that. The second record of confiscation was created by the new Nguyen Dynasty right at the beginning of its rule. From 1805 to 1836, the Nguyen Dynasty conducted a land survey in the whole country to establish its ownership

[10] These new territories previously belonged to the Champa Kingdom and the Khmer Empire, which correspond respectively to what is now the central and the southern parts of Vietnam (figure 1). When historical Vietnam annexed these territories, most of the local inhabitants migrated away, while others stayed and submitted themselves to the new ruler.

over land. The southern part of historical Vietnam (figure 1), which was annexed from 1698 to 1757, was confiscated in 1836.

The third record was in Binh Dinh province in 1839, where the Nguyen Dynasty confiscated about 50% of private land and assigned only cultivation rights to landless peasants. With this confiscation, the general impact on tax revenue was reported to be positive because more head taxes were collected while the production tax rate was the same for both private and state fields (*Dai Nam Thuc Luc*, Volume 5, p. 608); see appendix B for more detail. The fact that the number of male adults being taxed increased after private fields were confiscated and cultivation rights were assigned to landless peasants confirms that head taxes, and presumably other individual duties, could only be collected when peasants were tied to their fields. The evolution of the production tax on private fields is also worth noting. From no production tax in earlier dynasties, the Nguyen Dynasty started to collect production tax on private fields, and finally applied the same tax rate to both state and private fields (*Dai Nam Thuc Luc*, Volume 4, p. 1002).

In summary, the historical materials discussed so far have shown that: (i) there were substantial benefits of registering and controlling the population for individual duties, which could only be collected if peasants were tied to their agricultural fields, and these benefits provide an explanation for the state ownership system and the assignment of cultivation rights in the early states of historical Vietnam; (ii) private ownership of land was used to create incentives for people to migrate and clear new land because migration and land clearing involved a substantial cost; (iii) after a long period of time (i.e., a century or more) when the new land was more densely populated, the state had an incentive to confiscate the new land and assign only cultivation rights to landless peasants to tie them to their fields, enabling the state to collect more individual duties. The next section presents an empirical investigation on the relationship between taxpayer density and the prevalence of private ownership of land, using data from the nationwide land registry, conducted by the Nguyen Dynasty in the early 19^{th} century.

4 Data

4.1 The Archive

In the beginning of its rule, the Nguyen Dynasty conducted a land survey in the whole country to establish its ownership over land. To fulfill this ambition, the officials in charge had to go to all provinces in the country to register land ownership for every acre

of land. The survey started in 1805 and was completed in 1836, during which time the Nguyen Dynasty instituted state ownership in the whole country at different scales in different places. Therefore, this nationwide land registry generated a variation in the prevalence of private ownership across places at a point in time, enabling an empirical investigation of the hypothesis in question. More importantly, the Nguyen Dynasty had to take into consideration taxpayer density among many other factors in its decision to confiscate land or to grant private ownership. As a result, this land registry rules out the potential reverse influence of private ownership on taxpayer density.

Because of its grand scale, the land registry of the Nguyen Dynasty is a huge archive. The Vietnamese historian Tran Van Giau once described: "If putting each page next to each other, the survey stretches almost 300 km" (Nguyen 1994f, p. 8). The volume of the work, together with the historical Vietnamese characters being used, makes it very costly to exploit this land registry. Fortunately, the Vietnamese historian Nguyen Dinh Dau has spent his academic life since the 1980s translating and summarizing this archive into more than 10000 pages of modern Vietnamese characters. In north to south order, table 1 lists 12 provinces (out of 29 in total) whose results have been published so far.[11] These provinces were annexed to historical Vietnam from 1471 to 1757, and constituted the southern half of 19$^{\text{th}}$ century Vietnam (figure 1). As mentioned earlier, the Nguyen Dynasty also confiscated land in Binh Dinh province another time in 1839. Thus, this province had two land surveys, in 1815 and 1839. In the following empirical analysis, I use the first 12 provinces in table 1 as the baseline sample. For a robustness check, I later add the 1839 land survey of Binh Dinh province.

4.2 Variables

In each studied province, Nguyen Dinh Dau reports the cultivated area for each canton (*tổng*) and breaks down the number into area owned by the state that was used to assign cultivation rights to landless peasants (*công điền công thổ*) and area owned by private individuals (*tư điền tư thổ*). Relying on these numbers, I calculate the percentage of private ownership in the cultivated area. Table 1 reports the number of cantons for each studied province, which was highest in Quang Nam and Vinh Long (44 and 45 cantons) and lowest in Phu Yen and Ha Tien (8 and 11 cantons). In total, the sample contains 251 observations. As can be seen in table 2, the cultivated area per canton was roughly 18 km^2 on average, and the average percentage of private ownership was around 80%.

[11] It took one month for the author of the present paper to read through and code these books into usable data. Unfortunately, it was also the hottest month in Ho Chi Minh City, Vietnam.

Table 1. Provinces Included in the Empirical Analysis

No.	Province	No. of Cantons	Survey Year	Source
1.	Quang Nam	44	1812	Nguyen (2010a)
2.	Quang Ngai	19	1813	Nguyen (2010c)
3.	Binh Dinh	13	1815	Nguyen (1996a)
4.	Phu Yen	8	1816	Nguyen (1997b)
5.	Khanh Hoa	17	1811	Nguyen (1997a)
6.	Binh Thuan	15	1836	Nguyen (1996c)
7.	Bien Hoa	22	1836	Nguyen (1994a)
8.	Gia Dinh	24	1836	Nguyen (1994c)
9.	Dinh Tuong	15	1836	Nguyen (1994b)
10.	Vinh Long	45	1836	Nguyen (1994e)
11.	An Giang	18	1836	Nguyen (1995)
12.	Ha Tien	11	1836	Nguyen (1994d)
13.	Binh Dinh	13	1839	Nguyen (1996b)

The number, however, varies from 0% in 12 cantons of Vinh Long and Ha Tien to 100% in 52 cantons across all provinces except Khanh Hoa, Dinh Tuong, and An Giang (see figure 2 for a full histogram). This variation indicates that the Nguyen Dynasty did not concentrate its confiscation primarily in any specific provinces.

Since there was no population census in historical Vietnam, probably because no one wanted to be taxed, it is impossible to calculate the exact population of taxpayers, i.e., the number of male adults. Historians studying the population of historical Vietnam normally have to rely on the number of villages, which was well recorded, to estimate the total number of taxpayers. Doing so requires critical information about the average number of households per village, assuming that there was one male adult in each household. In a seminal study on the population of historical Vietnam, Tana (1998, p. 161-172) shows that the state normally established a village based on 110 households, and uses this number to estimate the taxpayer population. The present paper follows this strategy to estimate the taxpayer population for each canton. On average, each canton had around 1800 taxpayers, or 700 taxpayers per one km^2 of the cultivated land (table 2). Figure C1 in appendix C plots the percentage of private ownership against ln taxpayer density, which shows a clear negative association.

Besides taxpayer density, the Nguyen Dynasty might have also had to take into account other factors in its decision to confiscate land. To the extent that these factors might also influence taxpayer density, they are potential confounding factors that should be accounted for in the empirical analysis. First, rice-growing areas might be more likely to be confiscated because rice agriculture was highly transparent, as discussed in

Table 2. Descriptive Statistics

Variable	Mean	SD	Min	Max	N
Cultivated area (km^2)	17.79	20.43	0.03	127.33	251
Taxpayer population (1000 persons)	1.77	1.67	0.11	14.19	251
Private ownership (%)	84.23	26.86	0	100	251
Taxpayer density (1000 persons per km^2)	0.72	2.82	0.01	37.18	251
Rice-growing land (%)	82.24	23.07	0	100	251
Coastal canton	0.24	0.42	0	1	251
Having national road	0.33	0.47	0	1	251
Uncleared land (%)	16.21	21.71	0	98.88	251

Note: See table 1 for information about data sources.

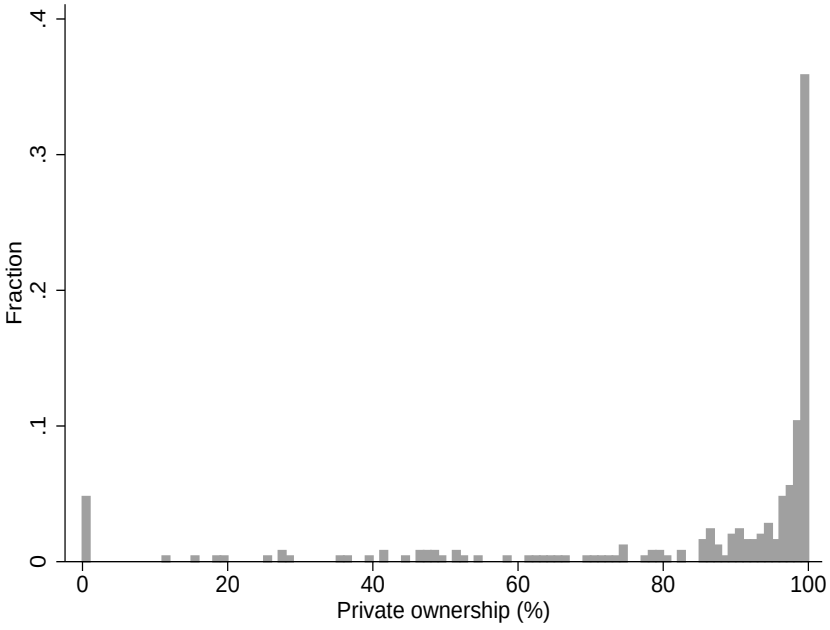

Figure 2. Private Ownership of Land

Mayshar, Moav, and Neeman (2017). To capture this relationship, I include the percentage of rice-growing land in the cultivated area. Second, private owners in areas with more valuable land might resist state confiscation more strongly. A dummy variable for coastal cantons is employed to capture higher land value, potentially owing to international trade as suggested in Demsetz (1967). Third, cantons that had better state capacity might be more likely to be confiscated because the unit cost of running the state ownership system might be lower, as discussed earlier. A high level of state capacity is captured by a dummy variable indicating whether or not there was a national road passing through the canton. Finally, to preserve incentives for land clearing, the state might be less likely to confiscate land where there was greater potential for land clearing. I use the percentage of uncleared land in the total area to capture the potential for land clearing. On average, rice-growing land constituted around 82% of the cultivated area, the percentage of uncleared land in the total area was around 16%, while 33% of cantons had a national road passing through and 24% of cantons were located along the coast (table 2).[12]

5 Empirical Evidence

5.1 Empirical Model

The empirical strategy revolves around regressing the percentage of private land ownership on the natural logarithm of taxpayer density and potential confounding factors discussed above. The empirical model takes the following form:

$$private_c = \alpha + \beta ln\, density_c + \gamma' \mathbf{X}_c + \epsilon_c, \tag{18}$$

where $private_c$ is the percentage of private land ownership in canton c, $ln\, density_c$ is the natural logarithm of taxpayer density, $\mathbf{X}_c$ is a vector of potential confounding factors discussed above, and ϵ_c is the error term. To establish the baseline results, I use the first 12 provinces in table 1 as the baseline sample. I then add the 1839 land survey of Binh Dinh province for a robustness check. In terms of inference, I use robust standard errors for the baseline results, and later do a robustness check to see if these results also hold with cluster standard errors at the district level.[13] Additional robustness checks are

[12] Because there is no available map of cantons in the early 19^{th} century Vietnam, I cannot merge the present data with geo-coded data such as elevation, terrain ruggedness, and land suitability. Nevertheless, the available variables discussed above should capture these factors to some extent.

[13] This choice is motivated by the argument of Abadie et al. (2017). In particular, the authors argue that cluster adjustments for standard errors should only be performed when the data were collected by cluster sampling (e.g., first taking a subset of districts, and then drawing a sample of cantons

conducted to examine missing data, outliers, and alternative functional forms.

5.2 Baseline Results

To begin with, table 3 reports the results from regressing the percentage of private land ownership on ln taxpayer density and potential confounding factors, using an ordinary least squares estimator. The estimated coefficients of ln taxpayer density are negative and significant, whether or not potential confounding factors are included (columns 1 and 6). In other words, the percentage of private land ownership on average is lower in cantons with higher levels of taxpayer density. In particular, a one percent increase in the taxpayer density is associated with nearly a six percentage points lower in the percentage of private land ownership on average. In addition, the variation in ln taxpayer density alone accounts for 7% of the variation in the percentage of private land ownership, while other explanatory variables together only account for another 1.5%.

How large is the marginal effect of taxpayer density on the percentage of private land ownership? To get a sense of this number, take an average canton for example. A one percent increase in the taxpayer density corresponds to an extra 18 taxpayers, and 6 percentage points lower in the percentage of private land ownership corresponds to almost one km^2 of private land. If one-half of these additional taxpayers are landless peasants, then each landless peasant is assigned around 110 m^2 of land to cultivate on average. In the early 19^{th} century Vietnam, a portion of land (*khẩu phần*) used in the land assignment under the state ownership system corresponded to nearly 50 m^2 (Nguyen 2010a, p. 46), and a decree in 1804 prescribed that a typical male adult was assigned 6.5 portions of land, which is roughly 320 m^2 (*Dai Nam Thuc Luc* 2002b, p. 599).

The estimated coefficient of the percentage of rice-growing land in the cultivated area is negative and significant whether or not all explanatory variables are included (columns 2 and 6), which indicates that private land ownership on average is less prevalent in cantons where rice production is more widespread. This result is in line with the expectation that rice agriculture was highly transparent and easy to tax, as suggested by Mayshar, Moav, and Neeman (2017). The estimated coefficient of the dummy variable for coastal cantons is not different from zero (column 3). The estimated coefficient of the dummy variable for having a national road passing through is significant when entering the regression model alone (column 4), but is not different from zero when all explanatory

from the sampled districts) or treatment occurs at a higher level of aggregation than the unit of observation. In the present paper, the sample contains all cantons and the treatment is also at the canton level.

Table 3. Baseline Results

	Percentage of Private Ownership in the Cultivated Area						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln taxpayer density	-4.894***					-5.901***	-5.861***
	(1.177)					(1.597)	(1.892)
Rice-growing land (%)		-0.086*				-0.103*	-0.324***
		(0.048)				(0.055)	(0.066)
Coastal canton			-0.481			4.458	7.680***
			(4.045)			(3.961)	(2.911)
Having national road				-7.986**		-4.496	-7.967**
				(3.496)		(3.884)	(3.442)
Uncleared land (%)					-0.083	0.134	0.170
					(0.072)	(0.099)	(0.115)
Constant	75.544***	91.292***	84.344***	86.872***	85.584***	80.455***	101.302***
	(3.182)	(3.789)	(1.934)	(2.100)	(2.149)	(5.057)	(7.610)
Province fixed effects	NO	NO	NO	NO	NO	NO	YES
R^2	0.072	0.005	0.000	0.020	0.005	0.097	0.415
Observations	251	251	251	251	251	251	251

Note: Ordinary least squares estimator, robust standard errors are in parentheses. The sample includes all cantons in the first 12 provinces listed in table 1.
* p<0.1, ** p<0.05, *** p<0.01

variables are added (column 6). Its negative sign indicates that the percentage of private land ownership on average is lower in cantons having a national road passing through, which is line with the theoretical prediction that private land ownership is less prevalent in cantons with a high level of state capacity. Finally, the estimated coefficient of the percentage of uncleared land in the total area is not different from zero (column 5).

There might be some unobserved characteristics at the province level that influence both taxpayer density and the prevalence of private land ownership. For example, the Nguyen Dynasty might have conducted the land registry in the north first because this region was in general more densely populated and the need for confiscation was greater. Thus, the confiscation in some provinces that were surveyed earlier might have generated repercussions for other provinces that were surveyed later. For example, private land owners in provinces that were surveyed later might have been better prepared to resist the state confiscation. As a consequence, the negative relationship between ln taxpayer density and the percentage of private land ownership found above might be confounded by the unobserved preparedness to resist the state confiscation. To investigate the influence of unobserved characteristics at the province level, I also add province dummies to the regression model. Column 7 of table 3 shows that the estimated coefficient of ln taxpayer density remains negative and significant, with a similar marginal effect as its counterpart in the regression model without province dummies (column 6). This result shows that unobserved characteristics at the province level do not confound the relationship between taxpayer density and the prevalence of private land ownership across cantons.

To sum up, the results presented so far have shown that private land ownership is less prevalent in areas where taxpayer density is higher, and that the relationship is robust to the inclusion of potential confounding factors. In the following subsection, I examine further the robustness of these results to many other issues.

5.3 Robustness Checks

Missing Registries

The archive of the land registry in the early 19^{th} Vietnam is far from perfect. Many wars happened in the country since the French colonizers took control in 1887, which burned a small portion of this land registry. Working with the archive, Nguyen Dinh Dau (1994) observes that there must be some parts of this registry missing. In particular, the author identifies the villages whose registries are missing by relying on information about the surrounding landscape of each village. As a result, relying on the available data to

measure taxpayer density for each canton does create some errors. Nevertheless, this is not a serious problem as long as the missing registries were destroyed by pure randomness, meaning the measurement errors do not correlate with taxpayer density. This should be the case because there is no evidence showing that the intention of fire and bomb were to destroy some specific parts of this land registry. The current data also confirm this fact. Table C1 in appendix C shows that no canton characteristics significantly predict the percentage of missing villages, and the variation of each variable accounts for nearly zero percent in the variation of the percentage of missing villages.

Nevertheless, the problem of random measurement errors in the explanatory variable is well-known to cause a downward bias in the magnitude of its estimated coefficient toward zero (Hausman 2001). To examine the influence of measurement errors in taxpayer density, I restrict the empirical analysis to cantons that have no missing registries. Table 4 reports that the estimated coefficient of ln taxpayer density remains negative and significant (columns 1 to 3). Moreover, the marginal effect increases substantially in magnitude compared to its counterpart in the full sample reported in table 3, which is in line with the expectation that taxpayer density is measured with errors. In the full specification (column 3 of table 4), a one percent increase in the taxpayer density is associated with a nine percentage points lower in the percentage of private land ownership on average. Following the above interpretation, each additional landless peasants in an average canton is assigned around 200 m^2 to cultivate on average. Compared to the baseline result discussed earlier, this number is closer to the 320 m^2 of land assigned to a typical male adult to cultivate under the state ownership system in the early 19^{th} Vietnam.

Southern Provinces

The next robustness check examines the influence of state ownership of land in the past, which is an unobserved confounding factor. Instead of setting up land ownership from scratch, it might have been the case that the Nguyen Dynasty simply re-established the state ownership created by previous dynasties. Thus, cantons with higher percentages of state land ownership in the past had lower percentages of private land ownership under the Nguyen Dynasty. If the prevalence of state land ownership in the past promoted the level of taxpayer density under the Nguyen Dynasty, then the coefficients of ln taxpayer density are overestimated. The land in the six southernmost provinces was annexed to historical Vietnam from 1698 to 1757, and the people were allowed to freely occupy the land ever since that time (Trinh 1972). Because the Nguyen was the first dynasty to

Table 4. Missing Registries and Southern Provinces

	Percentage of Private Ownership in the Cultivated Area					
	Missing Registries			Southern Provinces		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln taxpayer density	-6.858***	-7.436***	-9.229***	-6.904***	-10.382***	-14.670***
	(1.721)	(2.177)	(3.476)	(1.628)	(2.144)	(2.604)
Control variables	NO	YES	YES	NO	YES	YES
Province fixed effects	NO	NO	YES	NO	NO	YES
R^2	0.148	0.201	0.505	0.149	0.252	0.486
Observations	117	117	117	135	135	135

Note: Ordinary least squares estimator, robust standard errors are in parentheses. The sample includes all cantons in the first 12 provinces listed in table 1. Columns 1 to 3 only include cantons that have no missing registries. Columns 4 to 6 only include cantons in the six southernmost provinces. Control variables include the percentage of rice-growing land in the cultivated area, being a coastal canton, having a national road passing through, the percentage of uncleared land in the total area, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

officially survey and register this land in 1836, the influence of state ownership of land in the past should not be a concern within this sub-sample.

Table 4 reports the results of restricting the empirical analysis to the six southernmost provinces. The estimated coefficient of ln taxpayer density remains negative and significant (columns 4 to 6). Moreover, the marginal effect increases to a great extent compared to its counterpart in the full sample reported in table 3. In the full specification (column 6 of table 4), a one percent increase in the taxpayer density is associated with nearly a 15 percentage points lower in the percentage of private land ownership on average. Following the above interpretation, each additional landless peasants in an average canton is assigned around 440 m^2 to cultivate on average. An explanation is that, given the same level of taxpayer density, there might be more landless peasants in these provinces than in the rest of the sample, inducing the state to confiscate a larger fraction of private land to assign to these landless peasants. This explanation is consistent with the fact that land owners in the six southernmost provinces possessed much larger areas of land compared to their counterparts in the more northern provinces (Nguyen 1994f).

Binh Dinh 1839

As mentioned earlier, the Nguyen Dynasty confiscated about 50% of private fields in Binh Dinh province in 1839. Thus, land in Binh Dinh province was surveyed twice in 1815 and 1839, but the empirical analysis so far has only used the 1815 land survey. The historical evidence presented in appendix B shows that the confiscation in Binh Dinh in 1839 was driven by tax revenue maximization. In particular, the aim was to collect more head taxes by confiscating land and then assigning only cultivation rights to landless peasants to tie them to their land. The data also confirm the hypothesis in question. In particular, taxpayer density (1000 persons per km^2) in Binh Dinh province increased from 0.23 in 1815 to 0.27 in 1839, and the percentage of private land ownership decreased from 95% to 47%. In other words, a one percent increase in the taxpayer density is associated with nearly a three percentage points lower in the percentage of private land ownership.[14]

Following the theory presented earlier, cantons with higher levels of taxpayer density would have higher fractions of land confiscated, and hence would have lower percentages of private ownership. If this was the case in the 1839 confiscation in Binh Dinh province,

[14] Theoretically, a fixed-effects model can be used with the panel dataset containing cantons in Binh Dinh province in two survey years (1815 and 1839). In practice, two problems arise. First, cantons changed names between the two survey years, and the available information is not enough to match them. Second, there were only 13 cantons in Binh Dinh province, meaning only two observations per estimated parameter in the full regression model.

then adding the 1839 land survey to the empirical analysis as a separate province (the 13^{th} province in table 1) would not change the estimated impact of taxpayer density on the prevalence of private ownership to any significant extent. To see if this the case, I replicate the above regression models using the new sample that includes the 1839 land survey in Binh Dinh province. Table 5 shows that the estimated coefficient of ln taxpayer density remains negative and significant in all specifications. In each specification, the marginal effect is almost similar to its counterpart in the earlier results where the 1839 land survey of Binh Dinh province is not added.

Outliers

Figure 2 shows that there is a large number of observations with 100% private land ownership, which may drive the whole results. Dropping these outliers from the sample, table C2 in appendix C shows that the estimated coefficient of ln taxpayer density remains negative and significant (columns 1 to 3), and the marginal effect is even larger compared to its counterpart in the full sample reported in table 3.

Clustered Standard Errors

The empirical analysis so far has used robust standard errors. To address the concern that the error components are correlated within districts, I use standard errors clustered at the district level. There are 47 districts in the sample, which constitutes a number of clusters that is not too large for a precise estimation of clustered standard errors. Nevertheless, it is still good enough for a robustness check. Table C2 in appendix C (columns 4 to 6) shows that although the estimated standard errors increase substantially with clustering compared to their counterparts in the case of robust standard errors presented in table 3, the estimated coefficient of ln taxpayer density remains significant at conventional levels (the p-value is 0.056 in the full specification in column 6).

Fractional Responses

Because the percentage of private land ownership is essentially a fractional response (i.e, bounded by 0 and 1), a linear regression model might not be the right specification (Papke and Wooldridge 1996). To examine this issue, I employ fractional response models with both logit and probit estimators. Table C3 in appendix C presents the average marginal effects calculated from the estimated coefficients. The average marginal effects of ln taxpayer density are negative, significant, and slightly smaller in magnitude compared to their counterparts obtained from the linear regression model reported in table 3.

Table 5. Adding Binh Dinh 1839

	Percentage of Private Ownership in the Cultivated Area					
	Baseline Results			Missing Registries		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln taxpayer density	-5.142***	-6.129***	-5.893***	-7.043***	-7.531***	-9.249***
	(1.186)	(1.573)	(1.882)	(1.724)	(2.167)	(3.465)
Control variables	NO	YES	YES	NO	YES	YES
Province fixed effects	NO	NO	YES	NO	NO	YES
Survey-year fixed effects	NO	NO	YES	NO	NO	YES
R^2	0.073	0.116	0.468	0.149	0.215	0.533
Observations	265	265	265	123	123	123

Note: Ordinary least squares estimator, robust standard errors are in parentheses. The sample includes all cantons in the 13 provinces listed in table 1 (Binh Dinh province was surveyed twice in 1815 and 1839). Columns 4 to 6 only include cantons that have no missing registries. Control variables include the percentage of rice-growing land in the cultivated area, being a coastal canton, having a national road passing through, the percentage of uncleared land in the total area, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

6 Conclusion

In the present paper, I have proposed a theory to explain the emergence of land property rights in a subsistence agricultural economy. The basic setting involves an authoritarian state, devising a structure of land rights to maximize tax revenue, broadly defined. The key feature is that, to collect individual duties (such as head tax, unpaid labor services, and military conscription), the state has to tie landless peasants to their agricultural fields, i.e., giving them cultivation rights (but not sale or transfer rights) to some land, so that they will lose their land if they hide when the state officials visit to enumerate the taxpayer population. This strategy is optimal only if the state capacity is sufficiently high. The theory generates a testable hypothesis that, at a point in time, private ownership of land is less prevalent in areas where population density is higher. I find empirical evidence for this hypothesis, using the nationwide land registry of historical Vietnam in the early 19^{th} century and a historical setting that rules out the potential reverse influence of private ownership of land on population density. Moreover, primary accounts and related historical studies show that the mechanism at work is in line with the theory in question. Thus, the case of historical Vietnam shows that a strong state, with the objective of maximizing its own benefit, could reverse the general process in economic history whereby societies moved towards private land rights as population density increased (Lewis 1955; Boserup 1965).

To sum up, the theory in question and the associated evidence corroborate the general view that the state has a central role in explaining the emergence of different regimes of property rights, as advocated by North (1981). The key lesson to take away is that insecure land rights (rights to cultivate but not sale or transfer), which were often found in historical societies, were devised by authoritarian states to tie the peasants to their agricultural land, for the benefits of the states, and more secure land rights only arise when the interests of the states dictate so. This lesson is useful for understanding the origins and evolution of land rights in authoritarian countries that are trying to draw labors from agricultural to manufacturing sectors to speed up industrialization and generate more tax revenue for the states.

Appendix A. Derivations and Proofs

EQUILIBRIUM. This derivation shows that the core economy described in the main text has a unique and stable steady-state equilibrium.

The solution to the individual problem is obtained by maximizing the utility function in equation (5) subject to the budget constraint in equation (6). In particular, individuals of generation t in the core economy devote a fraction $(1-\gamma)$ of their after-tax income, $i_{c,t}$, to consumption and a fraction γ to child rearing:

$$c_t = (1-\gamma) i_{c,t}; \tag{A.1}$$

$$n_t = \frac{\gamma i_{c,t}}{\rho}. \tag{A.2}$$

The evolution of the adult population is determined by its initial size, $L_{c,0} > 0$, and the number of (surviving) children per adult, n_t. In particular, the adult population size in period $t+1$ in the core economy is given by:

$$L_{c,t+1} = n_t L_{c,t} \tag{A.3}$$

Combining (A.2) and (A.3) yields:

$$\begin{aligned} L_{c,t+1} &= \frac{\gamma}{\rho} i_{c,t} L_{c,t} \\ &= \frac{\gamma}{\rho}(1-\tau) y_{c,t} L_{c,t} \\ &= \frac{\gamma}{\rho}(1-\tau)\left(\frac{AX_c}{L_{c,t}}\right)^{\alpha} L_{c,t} \\ &= \frac{\gamma}{\rho}(1-\tau)\left(AX_c\right)^{\alpha}\left(L_{c,t}\right)^{(1-\alpha)} \\ &= \Phi(L_{c,t}; A). \end{aligned}$$

It follows that:

$$\Phi'(L_{c,t}) = \frac{\gamma}{\rho}(1-\tau)(1-\alpha)\left(AX_c\right)^{\alpha}\left(L_{c,t}\right)^{(-\alpha)} > 0; \tag{A.4}$$

$$\Phi''(L_{c,t}) = (-\alpha)\frac{\gamma}{\rho}(1-\tau)(1-\alpha)\left(AX_c\right)^{\alpha}\left(L_{c,t}\right)^{(-\alpha-1)} < 0; \tag{A.5}$$

$$\Phi(0; A) = 0; \tag{A.6}$$

$$\lim_{L_{c,t}\to 0} \Phi'(L_{c,t}) = \infty; \tag{A.7}$$

$$\lim_{L_{c,t}\to \infty} \Phi'(L_{c,t}) = 0. \tag{A.8}$$

Hence, for a given level of technology A and an initial adult population $L_{c,0} > 0$, there

exists a stable and unique steady-state level of the adult population in the core economy, $\bar{L}_c$, which is given by:[15]

$$\begin{aligned} \bar{L}_c &= \frac{\gamma}{\rho}(1-\tau)\left(AX_c\right)^{\alpha}\left(\bar{L}_c\right)^{(1-\alpha)} \\ \Leftrightarrow \quad \bar{L}_c &= \left[\frac{\gamma(1-\tau)}{\rho}\right]^{1/\alpha} AX_c. \end{aligned} \tag{A.9}$$

The evolution of output per worker is determined by its initial level, $y_{c,0} > 0$, and the number of (surviving) children per adult, n_t. In particular, the output per worker in period $t+1$ in the core economy is given by:

$$\begin{aligned} y_{c,t+1} &= \left(\frac{AX_c}{L_{c,t+1}}\right)^{\alpha} \\ &= \left(\frac{AX_c}{n_t L_{c,t}}\right)^{\alpha} \\ &= \frac{y_{c,t}}{n_t^{\alpha}}, \end{aligned} \tag{A.10}$$

where the second equality follows from (A.3).

Combining (A.2) and (A.10) yields:

$$\begin{aligned} y_{c,t+1} &= \frac{y_{c,t}}{\left(\frac{\gamma}{\rho} i_{c,t}\right)^{\alpha}} \\ &= \frac{y_{c,t}}{\left(\frac{\gamma}{\rho}(1-\tau) y_{c,t}\right)^{\alpha}} \\ &= y_{c,t}^{1-\alpha}\left(\frac{\rho}{\gamma(1-\tau)}\right)^{\alpha} \\ &= \Psi(y_{c,t}; A). \end{aligned}$$

Similar to the case of adult population derived above, it can be shown that $\Psi'(y_{c,t}) > 0$, $\Psi''(y_{c,t}) < 0$, $\Psi(0) = 0$, $\lim_{y_{c,t}\to 0} \Psi'(y_{c,t}) = \infty$ and $\lim_{y_{c,t}\to\infty} \Psi'(y_{c,t}) = 0$. Hence, for a given technology A and an initial income per adult $y_{c,0} > 0$, there exists a stable and unique steady-state level of income per adult in the core economy, $\bar{y}_c$, which is given by:[16]

$$\begin{aligned} \bar{y}_c &= \bar{y}_c^{1-\alpha}\left(\frac{\rho}{\gamma(1-\tau)}\right)^{\alpha} \\ \Leftrightarrow \bar{y}_c &= \frac{\rho}{\gamma(1-\tau)}. \end{aligned} \tag{A.11}$$

[15] The trivial steady state, $\bar{L}_c = 0$, is unstable. So, for a given $L_{c,0} > 0$, this equilibrium will not be an absorbing state for the population dynamics.

[16] The trivial steady state, $\bar{y}_c = 0$, is unstable. So, for a given $y_{c,0} > 0$, this equilibrium will not be an absorbing state for the income per adult dynamics.

It follows that the steady-state level of after-tax income per adult in the core economy, $\bar{i}_c$, is:

$$\bar{i}_c = \frac{\rho}{\gamma}. \tag{A.12}$$

PROPOSITION 2. This proof shows that as long as the fixed cost of migrating and clearing the new land is so high that no individuals do so under the state ownership system, then the private ownership system in the new land is the optimal solution to the problem of tax revenue maximization of the state.

It has been shown in the main text that if the fixed cost η is too high, so that equation (12) is satisfied, then no individuals migrate and clear the new land under the state ownership system, and hence tax revenue obtained from the new land is zero. Total tax revenue at time t under the state ownership system in the new land, $TR_{t,s}$, is then only equal to tax revenue in the core economy, which is assumed to be at the steady-state equilibrium level, $\bar{R}_{c,s}$. What left to be shown is that total tax revenue at time t obtained under the private ownership system in the new land, $TR_{t,p}$, is greater than total tax revenue receives under the state ownership system, $TR_{t,s} = \bar{R}_{c,s}$.

Under the private ownership system in the new land, a number of individuals $L_{n,t}$ migrate and clear the new land. First note that, as individuals move out of the core economy at time t, each person staying in the core economy is now assigned a larger area of land, and hence the average after-tax income in the core economy increases from the steady-state equilibrium level, $\bar{i}_c$, to a new level, $i_{c,t}$, which means:

$$i_{c,t} > \bar{i}_c. \tag{A.13}$$

The migration to the new land stops when the marginal after-tax income in the new land, $m_{n,t}$, equals the average after-tax income in the core economy, $i_{c,t}$, plus the fixed cost η, which means:

$$\begin{aligned} m_{n,t} &= i_{c,t} + \eta \\ \Leftrightarrow (1-\tau)(1-\alpha)(AX_n)^{\alpha} L_{n,t}^{-\alpha} &= i_{c,t} + \eta \\ \Leftrightarrow (1-\tau)(1-\alpha) y_{n,t} &= i_{c,t} + \eta \\ \Leftrightarrow (1-\alpha) i_{n,t} &= i_{c,t} + \eta \end{aligned} \tag{A.14}$$

Second, under the private ownership system in the new land at time t, the number of

workers who migrate and clear the new land, $L_{n,t}$, plus the number of workers who stay in the core economy, $L_{c,t}$, must equal the total number of workers at time $t-1$, which by assumption is at the steady-state equilibrium level $\bar{L}_c$.

At time t, total tax revenue under the private ownership system in the new land, $TR_{t,p}$, is larger than total tax revenue under the state ownership system in the new land, $TR_{t,s} = \bar{R}_{c,s}$ if and only if:

$$\begin{aligned}
& \tau(Y_{c,t} + Y_{n,t}) + \kappa(L_{n,t} + L_{c,t}) - CX_c > \tau\bar{Y}_c + \kappa\bar{L}_c - CX_c \\
\Leftrightarrow \quad & \tau(Y_{c,t} + Y_{n,t}) + \kappa\bar{L}_c > \tau\bar{Y}_c + \kappa\bar{L}_c \\
\Leftrightarrow \quad & Y_{c,t} + Y_{n,t} > \bar{Y}_c \\
\Leftrightarrow \quad & y_{c,t}L_{c,t} + y_{n,t}L_{n,t} > \bar{y}_c\bar{L}_c \\
\Leftrightarrow \quad & (1-\tau)y_{c,t}L_{c,t} + (1-\tau)y_{n,t}L_{n,t} > (1-\tau)\bar{y}_c\bar{L}_c \\
\Leftrightarrow \quad & i_{c,t}(\bar{L}_c - L_{n,t}) + i_{n,t}L_{n,t} - \bar{i}_c\bar{L}_c > 0 \\
\Leftrightarrow \quad & (i_{c,t} - \bar{i}_c)\bar{L}_c + (i_{n,t} - i_{c,t})L_{n,t} > 0. \qquad \text{(A.15)}
\end{aligned}$$

From equation (A.13), it is clear that $i_{c,t} - \bar{i}_c > 0$. Equation (A.14) says that $(1-\alpha)i_{n,t} - i_{c,t} = \eta > 0$, which means that $i_{n,t} - i_{c,t} > \eta > 0$ since $\alpha \in (0,1)$. Hence, as long as (A.13) and (A.14) are true, (A.15) is also true. Q.E.D.

Appendix B. The Land Confiscation in Binh Dinh in 1839

In 1839 in Binh Dinh province, the Nguyen Dynasty confiscated about 50% of all private land and assigned only cultivation rights to landless peasants. In this appendix, I translate and examine an extract from the report to the king prepared by the mandarin in charge (*Dai Nam Thuc Luc*, Volume 5, p. 608), which demonstrates that (i) tax revenue maximization by the state was the primary motivation of this land confiscation and assignment, and (ii) its impact on total tax revenue was positive, in particular more head taxes could be collected by assigning only cultivation rights to landless peasants.

The King asked:

> "Regarding the land confiscation and assignment in Binh Dinh, what is the change in total tax revenue this year compared to last year?"

This question clearly demonstrates that tax revenue is the foremost concern of the king in this act of land confiscation and assignment.

The mandarin reported:

> "That province, in the old registry [1815], the area of state fields is around

> 6000 to 7000 acres, while the area of private fields is more than 90000 acres. Now half of the area of private fields is confiscated, the area of state fields thus increases to around 40000 acres. In general, tax revenue from land decreases, but revenue from head taxes increases. Since the beginning, in provinces in the southern half, tax rates on state fields and private fields were equal, while the tax rate on mandarin fields was higher. Recently, mandarin fields have been changed to state fields, hence although the area of state fields increases, tax revenue decreases. Before the land confiscation and assignment, revenue raised from head taxes on peasants with assigned state fields was higher than revenue raised from head taxes on those without assigned state fields. Now that more state fields are assigned so that more peasants have land, revenue raised from head taxes increases."

Mandarin fields (*quan điền*) are agricultural fields assigned to state officials and soldiers as a form of salary. The Nguyen Dynasty later on abolished this system and paid salaries directly in money. Therefore, mandarin fields did not exist in provinces that were surveyed in 1836.[17] Because the tax rate on mandarin fields was higher than that on state fields, changing mandarin fields into state fields decreased the tax revenue from land in total. Without this change, tax revenue from land should have been the same after the land confiscation and assignment, because tax rates on state fields and private fields were the same. The above report from the mandarin in charge demonstrates clearly that, by assigning state fields to landless peasants, the state could collect more head taxes.

The king, with his foremost concern about the impact of the land confiscation and assignment on tax revenue, as shown above, now surprisingly turned:

> "The land confiscation and assignment is purposed to share the benefits to all peasants, so whether total tax revenue increases or decreases is not worth paying a calculation."

If this statement of the king is to be taken as evidence that the primary function of the state ownership system in historical Vietnam was to bring about economic equality, then an answer must be provided to the question why the king did not ask in the first place if the land confiscation and assignment were successful in providing every landless peasant a basic livelihood.

[17] For provinces that were surveyed earlier, I do not include mandarin fields in the empirical analysis because their primary purpose was not to tie the peasants to their fields.

Appendix C. Additional Figures and Tables

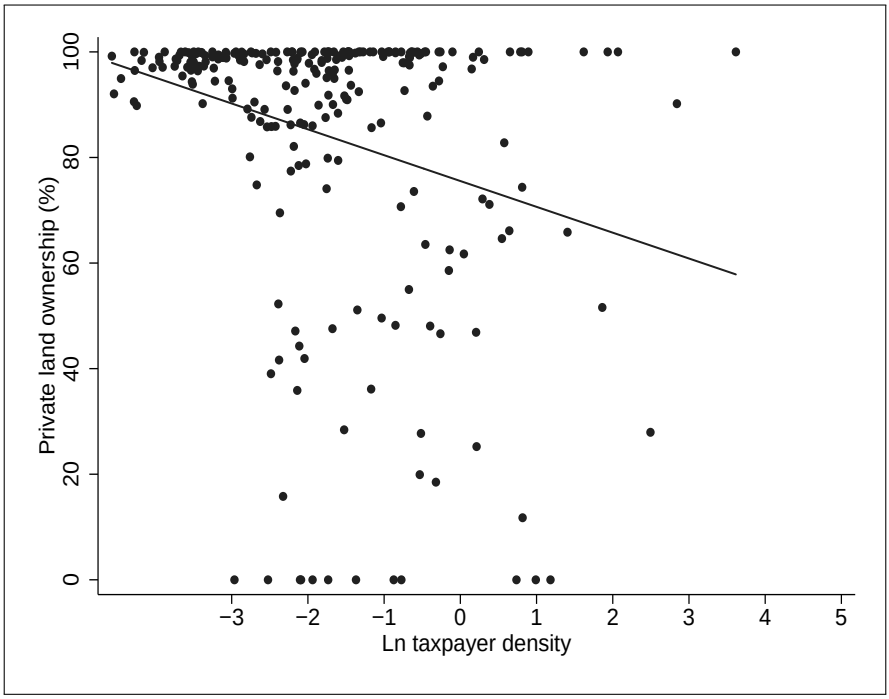

Figure C1. Taxpayer Density and Private Ownership

Note: Each dot represents one canton, and the number of observations is 251. The line depicts the predicted values of percentage of private ownership obtained from regressing the percentage of private ownership on ln taxpayer density, and the estimated coefficient is -4.894 with a p-value of 0.000.

Table C1. Canton Characteristics and Missing registries

	Percentage of Missing Villages				
	(1)	(2)	(3)	(4)	(5)
Ln taxpayer density	-0.347				
	(0.316)				
Rice-growing land (%)		0.005			
		(0.026)			
Coastal canton			0.625		
			(1.156)		
Having national road				0.224	
				(0.997)	
Uncleared land (%)					0.007
					(0.021)
Constant	5.544***	5.715**	6.014***	6.086***	6.040***
	(0.727)	(2.259)	(0.569)	(0.636)	(0.640)
R^2	0.004	0.000	0.001	0.000	0.000
Observations	251	251	251	251	251

Note: Ordinary least squares estimator, robust standard errors are in parentheses. The sample includes all cantons in the first 12 provinces listed in table 1.
* p<0.1, ** p<0.05, *** p<0.01

Table C2. Outliers and Cluster Standard Errors

	Percentage of Private Ownership in the Cultivated Area					
	Outliers			Cluster Standard Errors		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln taxpayer density	-8.423***	-8.801***	-10.517***	-4.894**	-5.901**	-5.861*
	(1.324)	(1.877)	(2.218)	(1.906)	(2.817)	(2.986)
Control variables	NO	YES	YES	NO	YES	YES
Province fixed effects	NO	NO	YES	NO	NO	YES
R^2	0.170	0.181	0.484	0.072	0.097	0.415
Observations	199	199	199	251	251	251

Note: Ordinary least squares estimator, robust standard errors (columns 1 to 3) and standard errors clustered at the district level (columns 4 to 6) are in parentheses. The sample includes all cantons in the first 12 provinces listed in table 1. Columns 1 to 3 drops 52 cantons with 100% private land ownership. Control variables include the percentage of rice-growing land in the cultivated area, being a coastal canton, having a national road passing through, the percentage of uncleared land in the total area, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

Table C3. Fractional Response Models

	Fraction of Private Ownership in the Cultivated Area					
	Logit			Probit		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln taxpayer density	-0.044***	-0.054***	-0.050***	-0.046***	-0.056***	-0.049***
	(0.010)	(0.013)	(0.013)	(0.010)	(0.013)	(0.014)
Control variables	NO	YES	YES	NO	YES	YES
Province fixed effects	NO	NO	YES	NO	NO	YES
Observations	251	251	251	251	251	251

Note: Average marginal effects, robust standard errors are in parentheses. The sample includes all cantons in the first 12 provinces listed in table 1. Control variables include the percentage of rice-growing land in the cultivated area, being a coastal canton, having a national road passing through, the percentage of uncleared land in the total area, and a constant.
* p<0.1, ** p<0.05, *** p<0.01

Chapter III

Chapter III

Land Tenure and Economic Development: Evidence from A Nationwide Land Reform

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, 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 sensitive to both observed and unobserved confounding factors, and modest. This modest impact is consistent with 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 in Vietnam.

Keywords: Land Tenure; Privatization; Economic Development; Vietnam.

JEL Classification: 011, P48, Q15.

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1 Introduction

Private property rights have long been assigned an important role in the history of economic development, notably since the seminal contribution of North and Thomas (1973). The theoretical convention posits that secure property rights promote private investments and the most efficient allocation of property, leading to a higher level of economic development (Besley 1995; Besley and Ghatak 2010). 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, and Robinson 2001, 2002; Acemoglu and Johnson 2005). Nevertheless, available measures of private property rights at the country level are constructed by either relying on the perceptions of businesses and individuals (e.g., risk of state expropriation or government effectiveness) or using the summation of many legal rules and procedures (e.g., constraints on the executive). As a result, these aggregate measures have prevented cross-country studies in general from identifying the specific rules and procedures governing private property rights that policy reforms should consider (Pande and Udry 2006).

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. Many within-country studies have investigated the impacts of various measures of private land tenure on a wide variety of outcomes such as investments, agricultural productivity, credit access, and land value, at the household and land-plot levels.[1] Nevertheless, no study so far has exploited the advantage of the within-country setting to investigate the overall impact of private land tenure on economic development at the sub-national level. The reason might be that such a study requires two important features: (i) a massive land reform that generates enough variation in private land tenure across sub-national administrative units, and (ii) a good measure of economic development at the sub-national level.

The present paper studies the impact of private land tenure on economic development at the sub-national level by combining a nationwide land reform in Vietnam and an innovative measure of economic development. First, up until 1993 the Vietnamese government

[1] Important contributions are, among others, Besley (1995), Sjaastad and Bromley (1997), Banerjee, Gertler, and Ghatak (2002), Brasselle, Gaspart, and Platteau (2002), Ravallion and van de Walle (2006), 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.

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 to 50 years. The most significant change is that the new law allowed land-use certificates to be transferred, exchanged, leased, mortgaged, and inherited. This nationwide land reform generates a concrete measure 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, and Weil 2012; Michalopoulos and Papaioannou 2013, 2014; Hodler and 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 driving 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 also 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.

Many empirical studies have also examined the economic consequences of private land tenure brought about by the 1993 land reform in Vietnam. Ravallion and van de Walle (2006) have shown that private land tenure increases the efficiency of the distribution of agricultural land relative to the inefficient distribution under the central planning economy, but the speed of adjustment is slow (see also Deininger and Jin (2008)). Ravallion and van de Walle (2008) have also found no evidence that the associated increase in rural landlessness is poverty-increasing in aggregate, as measured by a consumption-based poverty line. 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. Therefore, the modest impact of private land tenure on economic development across rural communes found in the present study is consistent with the findings of previous empirical studies. The most reasonable explanation for this modest impact is the limited nature of private land tenure in Vietnam, i.e., the lingering insecurity that usage rights can be revoked by the state (Markussen and Tarp 2014; United Nations Development Program 2016) and the relatively high taxes and time cost of land transactions (Childress 2004).

Land is a crucial resource to the lives of many people in developing countries, who often earn most of their income from agricultural activities. As a result, land reform has been one of the most active areas of discussion in the developing world during the past decades (Deininger and Binswanger 1999). The large literature of within-country studies so far has found that the economic impacts of private land tenure vary across contexts, and depend on the details of the land reform, the pre-existing systems of land tenure, as well as the measurement and empirical strategies employed (Pande and Udry 2006; Place 2009; Fenske 2011). 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. In

particular, around 11 million titles had been issued to rural households by 2000 (Do and Iyer 2008). Thus, the findings in the present paper are of interest not only to Vietnam with its future land reform, but also to other developing countries contemplating the privatization of agricultural land.

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. Finally, section 6 discusses the main findings and 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 predictions 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 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 1994f).

When the French colonization ended (1858-1954), Vietnam was divided into two regions along the 17^{th} 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 because wage was fixed. The collectivization in the north was relatively rapid, and almost all farmers joined cooperatives by 1986 (Pingali and 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 and Xuan 1992). Unlike 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 and 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 and 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 and 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 usage rights 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. In addition, all land transactions had to pay taxes. It is reported that both the cost of time and taxes in land transactions were higher in Vietnam compared to other countries in the East Asian region (Childress 2004). 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. Following this reform, overall productivity in rice production continued to increase (Kompas et al. 2012).

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 Development

In theory, private land tenure might lead to more economic prosperity in the rural sector through two primary channels (Besley 1995; Besley and 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 high cost of time and taxes of land transactions, as described above. These costs might hinder the realization of the highest level of allocative efficiency of the distribution of agricultural land. For example, 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 and van de Walle 2006).

The second factor that might restrain the effect of private land tenure on economic development in the context of rural Vietnam is the risk of state expropriation. Because land is still officially owned by the state, usage rights can be revoked (normally with compensation not based on market values) when the usage periods are ended.[2] This lingering insecurity of private land tenure might prevent private investments in agricultural land from increasing to the highest possible levels. For example, Do and Iyer (2008) have found that the reform did increase long-term investments, as proxied by the percentage of cultivated area devoting 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 devoting to perennial crops. In addition, the authors have found no significant increase in household borrowing.[3]

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

[3] Because the state regulates land use, some households also face restrictions on their choices of crops. Nevertheless, Markussen, Tarp, and Broeck (2011) have found that crop restrictions are widespread

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. Below, I derive a simple theory to shed light on the endogenous nature of private land tenure in rural 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). In the context of Vietnam, the state already granted land-use certificates. Thus, 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. 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 and Hill 1975). I adopt this approach for the task at hand.

Figure 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, figure 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 figure 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

in Vietnam, but do not decrease household income.

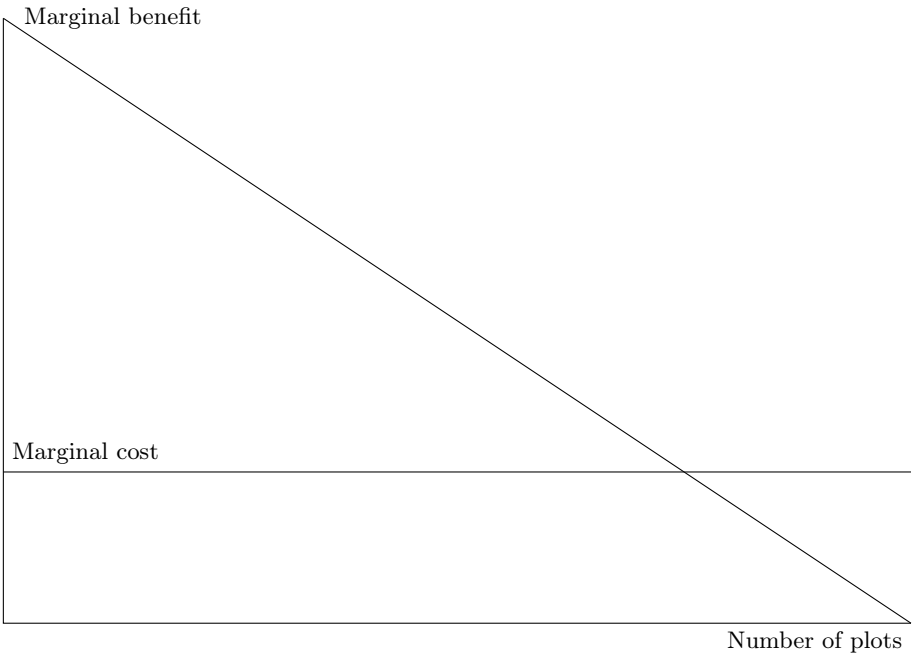

Figure 1. A theory of Endogenous Land Tenure

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.

marginal cost and benefit structures are different.[4]

The simple theory presented in figure 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 (figure 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.[5] 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. And at the same time, these geographical characteristics are likely to increase the costs of transportation, making them unfavorable to economic development.

Figure 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.

[4] 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.

[5] Other potential candidates driving the benefit and cost structures of obtaining land-use certificates are administrative capacity and demographics, of which data at the commune level are not available. 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.

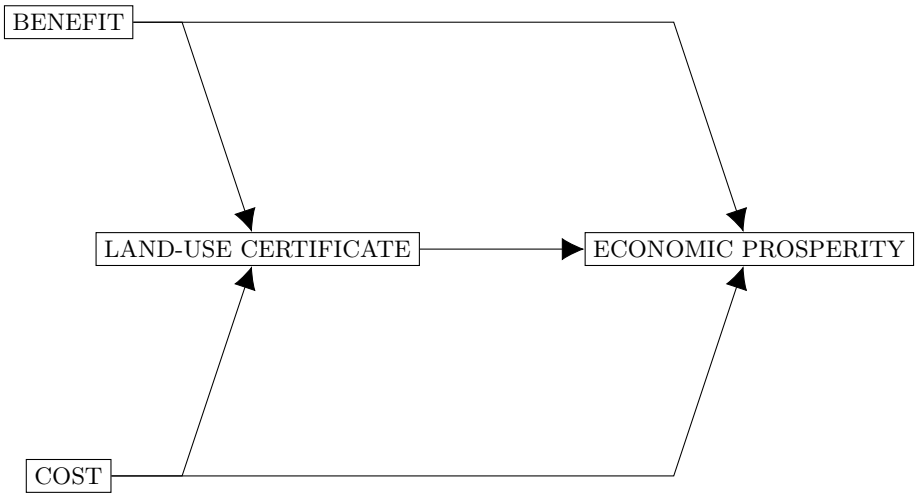

Figure 2. Conceptual Framework

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 shows that the average percentage of agricultural land area having land-use certificates in the sample is 74.41%. Figure 3 presents the spatial distribution of land-use certificates across the surveyed communes. The general impression is that the

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.

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.[6] 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

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

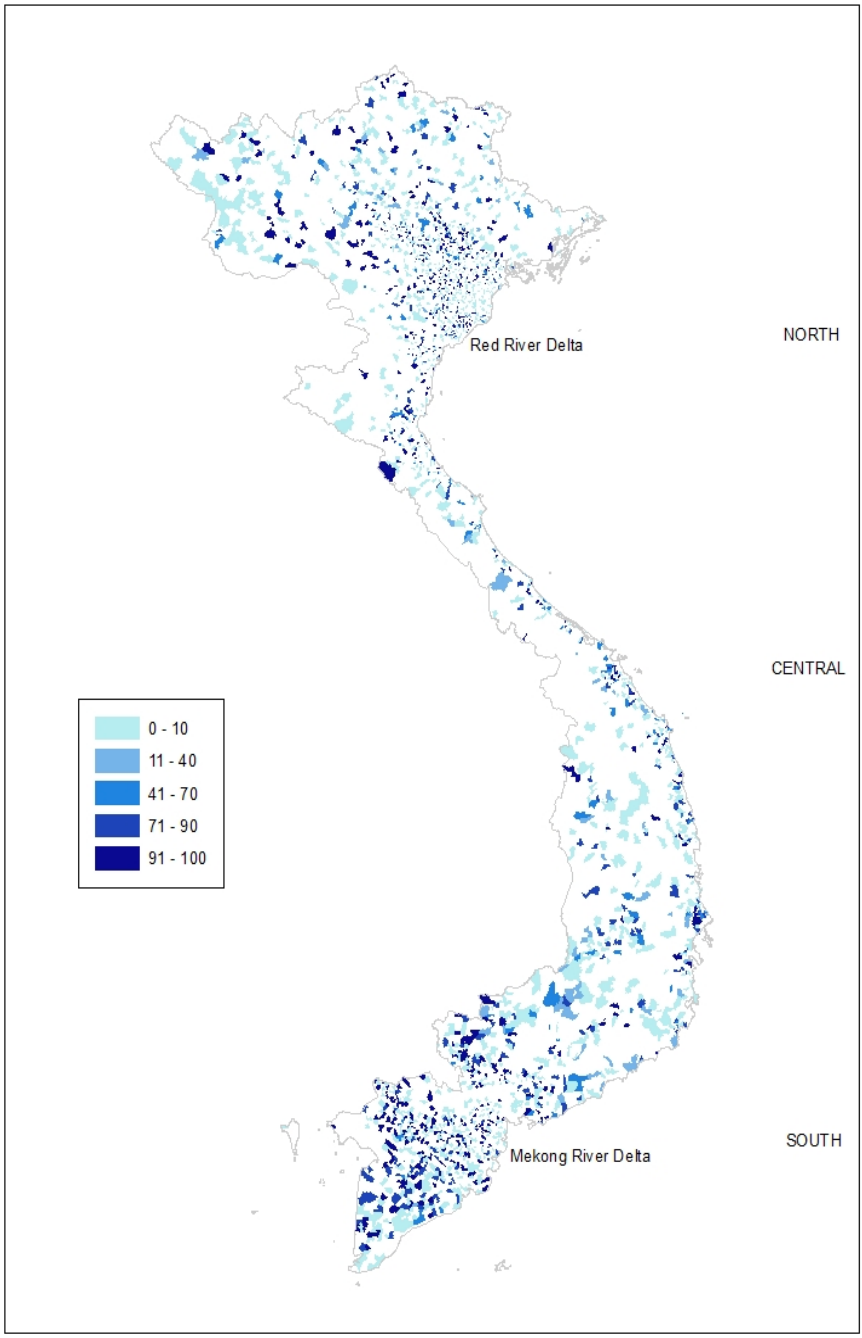

Figure 3. Private Land Tenure

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.

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, and Weil 2012; Michalopoulos and Papaioannou 2013, 2014; Hodler and Raschky 2014). As a result, there are strong correlations at the country and sub-national levels between nighttime light intensity and GDP (Henderson, Storeygard, and Weil 2012; Hodler and Raschky 2014) as well as other indicators of economic development (Michalopoulos and 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 (figure A1 in the appendix), i.e., the Pearson's correlation coefficient is 0.73 (p-value = 0.000).[7]

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

[7] 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).

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. Figure 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 hence do 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 outliers (Henderson, Storeygard, and Weil 2012; Michalopoulos and Papaioannou 2013, 2014; Hodler and 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. 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 prediction, I focus on the cross section of communes surveyed in the VHLSS 2004. I use two variables to capture

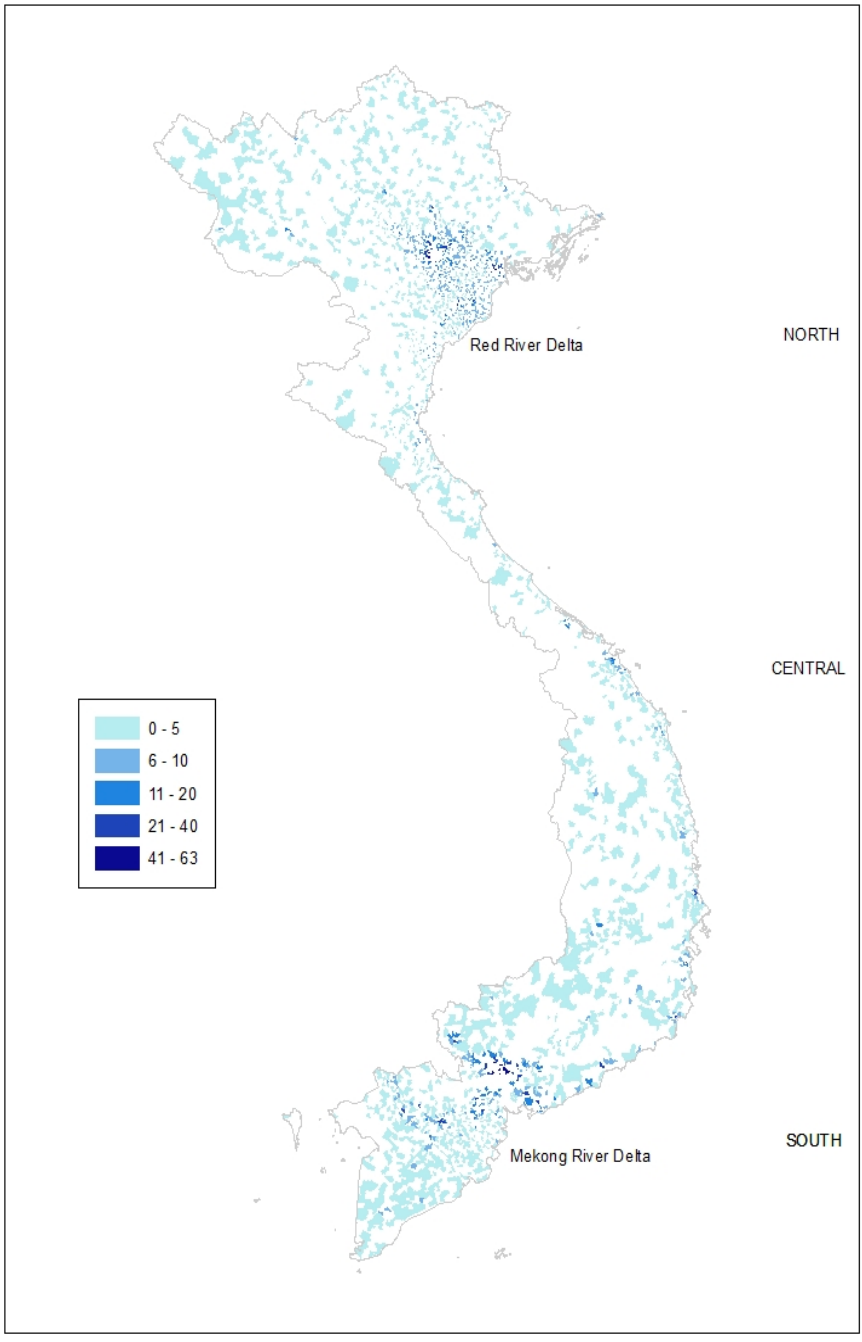

Figure 4. Nighttime Light Intensity

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

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). Because 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, belonging to the national electric grid and having a market are likely to influence households' decisions to obtain land-use certificates, but not vice versa. Thus, these variables should be interpreted as factors driving the percentage of agricultural land area having land-use certificates.

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,[8] 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

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

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:

$$Y_{ct} = \bar{\beta} X_{ct} + \alpha_c + \lambda t + \pi_{ct}, \tag{1}$$

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. 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 $\bar{\beta}$ to capture the causal effect of private land tenure on economic development, two main assumptions are required. First, there is a common trend in economic development among the communes, and it is the private land tenure brought about by the 1993 land reform that causes deviations from this trend. Second, there are no time-variant variables that influence both private land tenure and economic development. While the first assumption can be examined by looking at the trend before the 1993 reform, the second assumption is unlikely to hold. In particular, the theoretical framework discussed earlier suggests that there are potential time-variant variables, both observed and unobserved, that influence both private land tenure and economic development.

4.2 Cross Section

To examine the influence of time-variant confounding factors, I focus on the cross section of communes surveyed in 2004, and estimate the following regression models:

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

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

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^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 $\mathring{R}$ 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:

$$\beta^* = \tilde{\beta} - [\mathring{\beta} - \tilde{\beta}] \frac{R - \tilde{R}}{\tilde{R} - \mathring{R}}, \tag{6}$$

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. In addition, one can calculate the value of δ that gives rise to a zero impact ($\beta = 0$), given a specific value of R. This is similar to the Coefficient Ratio Test proposed by Altonji, Elder, and Taber (2005), who suggest to use $\delta = 1$ as a threshold, i.e., if the unobserved confounding factors must be more related to the treatment than the observed confounding factor to produce a zero impact, then the estimated coefficient is considered to be robust to omitted-variable bias.

Table 2. Panel Data

	Nighttime light intensity	
	Random-Effects	Fixed-Effects
	(1)	(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
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

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.[9]

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

[9] 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.

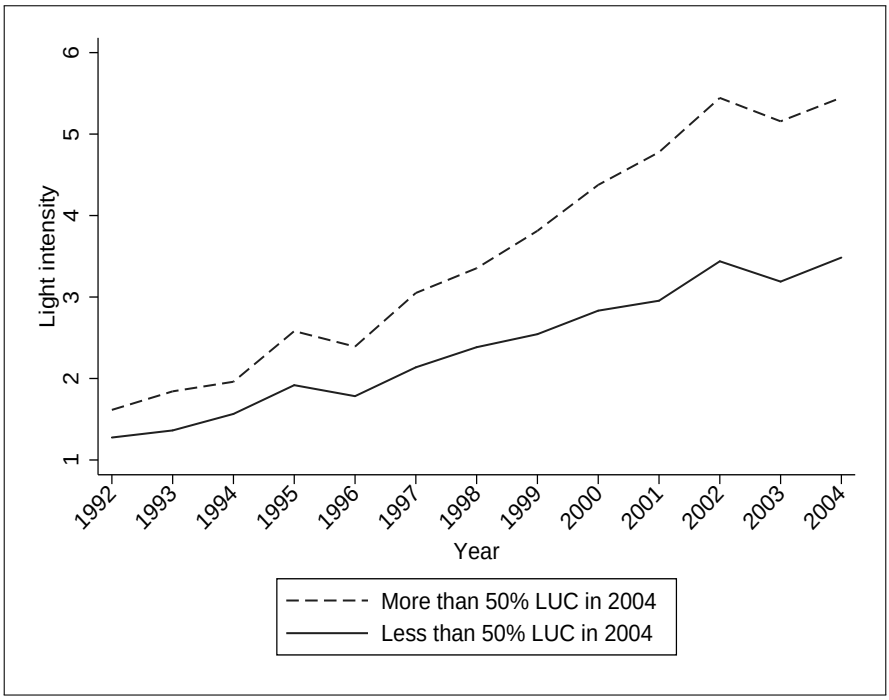

Figure 5. Trends in Nighttime Light Intensity

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.

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.[10] Figure 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.

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 $\mathring{\beta}$ 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 (belonging 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, I include all 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. 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

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

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

A. β^*	$R = 0.65$	$R = 0.70$	$R = 0.75$	$R = 0.80$
$\delta = 0.1$	0.006***	0.006***	0.006***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
$\delta = 0.3$	0.006***	0.005***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
$\delta = 0.5$	0.005***	0.005***	0.004**	0.003*
	(0.001)	(0.001)	(0.002)	(0.002)
$\delta = 0.7$	0.005***	0.004**	0.003*	0.001
	(0.001)	(0.001)	(0.002)	(0.002)
$\delta = 0.9$	0.005***	0.003**	0.002	-0.000
	(0.001)	(0.002)	(0.002)	(0.002)
B. $\beta = 0$	$R = 0.65$	$R = 0.70$	$R = 0.75$	$R = 0.80$
δ	4.454	1.896	1.204	0.882

Note: The sample includes 2205 communes surveyed in 2004. Panel A 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. Panel B reports the value of δ that corresponds to a null effect ($\beta^* = 0$), under different values of R.

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, 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). Altonji, Elder, and Taber (2005) and Oster (2019) recommend to use $\delta = 1$, 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 from zero to 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.[11]

Panel A of table 4 shows that, in the most optimistic scenario ($\delta = 0.1$ and $R =$

[11] 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.

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 ($\delta = 0.9$ 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. Panel B reports the value of δ that corresponds to a null effect ($\beta = 0$). When $R < 0.8$, δ must be larger than one to obtain a null effect, meaning the unobserved confounding factors should be more important in explaining the percentage of agricultural land area having land-use certificates than the observed confounding factors. When $R = 0.8$, however, δ is smaller than one (i.e., 0.882). 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 modest in magnitude.

5.3 Robustness and Heterogeneity

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

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. 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.

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.

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.

Sub-sample Analysis

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 17^{th} 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 sub-sample (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 sub-sample (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.

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.

6 Discussion and Conclusion

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 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 and Udry 2006).

Second, when both observed and unobserved confounding factors are accounted for by different methods, the impact of private land tenure on economic development across rural communes in Vietnam is found to be sensitive and modest. Thus, 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, and Robinson 2001, 2002; Acemoglu and Johnson 2005). Nevertheless, this finding is in line with the theoretical prediction discussed earlier, and is also consistent with the modest impacts of private land tenure on households' investments (Do and Iyer 2008) and the allocative efficiency of the land market (Ravallion and van de Walle 2006) found in rural Vietnam. To be more specific, the Vietnamese 1993 land reform only brought

about a transition from collective tenure (with intermittent reallocation) to incomplete private tenure. In other words, land is still officially owned by the state, and usage rights can be revoked (normally with compensation not based on market values) when the usage periods are ended. This lingering insecurity of private land tenure (Markussen and Tarp 2014; United Nations Development Program 2016), together with the relatively high taxes and time cost of land transactions (Childress 2004), are likely to be the main drivers of the modest impact of private land tenure on economic development found in the present paper.

In summary, 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.

Appendix. Additional Figures and Tables

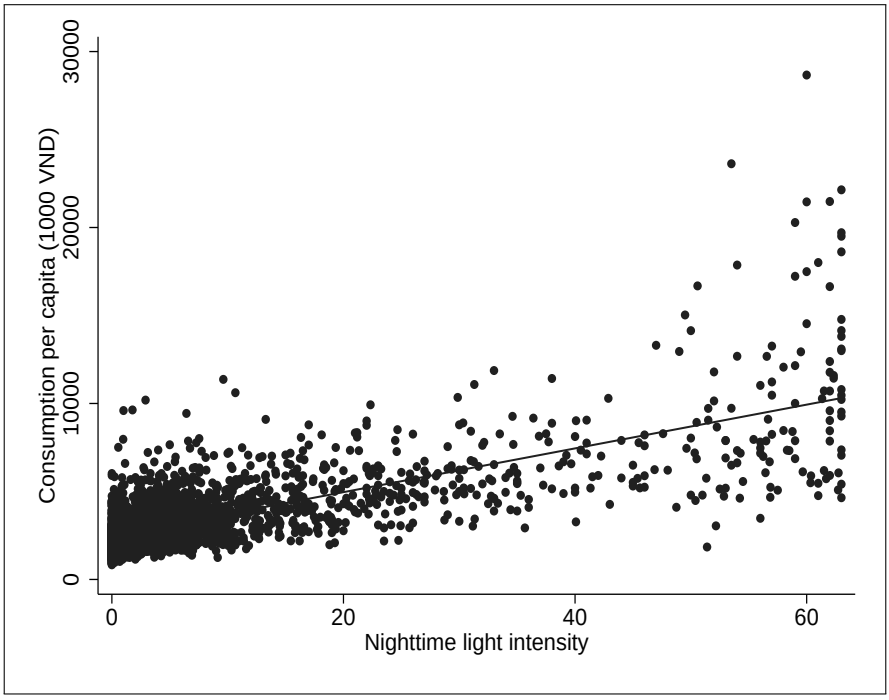

Figure A1. Nighttime Light Intensity and Consumption Per Capita

Note: The Pearson's correlation coefficient is 0.73 (p-value = 0.000). The sample includes 2205 communes surveyed in 2002. See the main text for information about data sources.

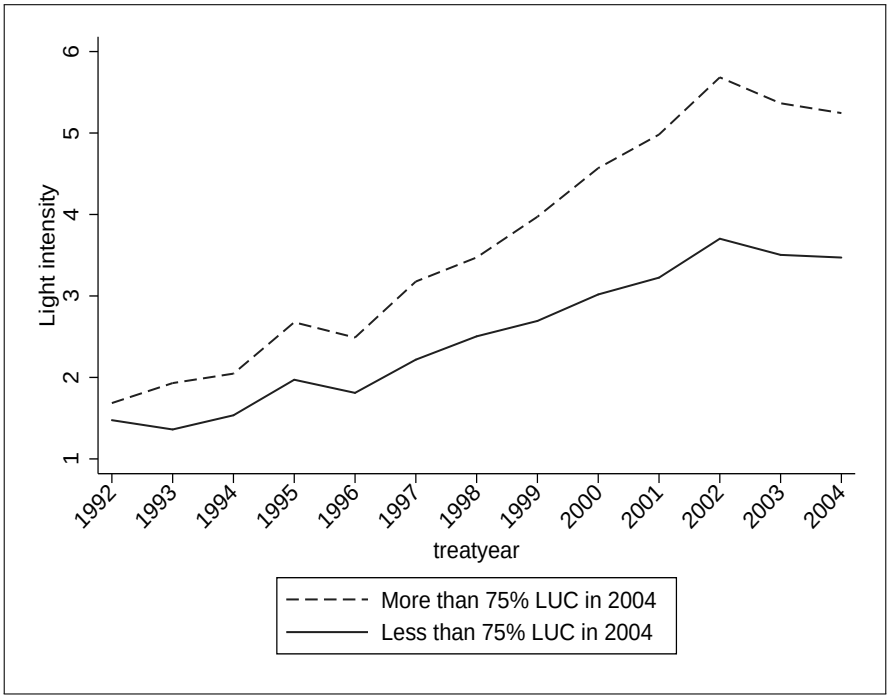

Figure A2. Trends in Nighttime Light Intensity

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	0.306 (0.000)	1					
Agricultural suitability	0.296 (0.000)	0.262 (0.000)	1				
Belong to electric grid	0.120 (0.000)	0.117 (0.000)	0.209 (0.000)	1			
Have market	0.082 (0.000)	0.083 (0.000)	0.125 (0.000)	0.088 (0.000)	1		
Elevation	-0.278 (0.000)	-0.263 (0.000)	-0.584 (0.000)	-0.341 (0.000)	-0.222 (0.000)	1	
Ruggedness	-0.309 (0.000)	-0.265 (0.000)	-0.620 (0.000)	-0.375 (0.000)	-0.179 (0.000)	0.774 (0.000)	1

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 2827 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***
	(0.001)	(0.001)	(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 1992			-0.518***	-0.695***
			(0.012)	(0.016)
Province fixed effects	NO	YES	NO	YES
Control variables	NO	YES	NO	YES
R^2	0.023	0.419	0.402	0.674
Observations	2205	2205	2205	2205

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 Comparison

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 17^{th} parallel, Panel B includes all provinces below the 17^{th} 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)
Province fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.527	0.524	0.516	0.610	0.563	0.619
Observations	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 (LUC) is the percentage of agricultural land area having land-use certificates.
* p<0.1, ** p<0.05, *** p<0.01

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