Reform, Rails, and Rice: Thailand's Political Railroads and Economic Development in the 20th Century

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Abstract

How do colonial threats influence a state's infrastructure development, and what are their economic consequences? In this paper, we look at Thailand's railroad projects in the late-nineteenth and early twentieth centuries as a primary example of a state's strategic response to colonial encroachment. By transporting government officials and establishing permanent administrative presence, the railways served to ensure Thailand's sovereignty over peripheral regions and bring them under direct governance. These regions, long considered economically unviable and disconnected from Bangkok, gained rail access due to their strategic importance and in turn witnessed urbanization and increased agricultural production. Given the government's limited budget and subsequent lack of infrastructure investment, however, the economic benefit remained localized to those who benefitted from the initial wave of infrastructure development.

Keywords: Centralization, State Formation, Colonization, Thailand, Railroads, Economic Development

Introduction

Throughout history, states under threat of colonization often implemented a variety of reforms with an aim to maintain sovereignty. The nineteenth century in particular was a period of rapid colonial expansion by the Western powers subjugating the states of Southeast Asia. In the case of Siam (presently Thailand), the French and the British colonial ambitions prompted King Chulalongkorn and his government to pursue several strategies to maintain Siam's sovereignty and gain territorial control over the peripheral reaches of the kingdom. In this paper, we discuss the development of Siam's early railways as a key initiative taken by the Siamese government in order to thwart colonial territorial ambitions of the British and French in the late-19th and early 20th centuries. We investigate how these "political railroads" in Siam – deemed as inefficient and costly relative to other development projects such as irrigation canals – contributed to local economic development in the peripheries of northern and northeastern Thailand in the 20th century, while serving the goal of maintaining kingdom's sovereignty. We discuss both the strategic and distributive economic effects of railway construction in the Siamese context, and present empirical results to support our claim.

In the 1880s, the British and French proposed to build railways connecting their respective holdings in Burma and Indochina to China. The proposed routes extended into Siamese territories in the east, northeast, and west that were under tenuous control by Bangkok. These British and French plans were summarily rejected by Siam, even if they made economic sense. The main concern was that the British and/or French would gain firm control over these peripheral areas and the railway would in turn facilitate further appropriation of lands by the colonial powers. The insistence of the British and French to build railways through areas under Siamese control was a major factor that pushed Siam to plan and build its own railways (Kakizaki, 2012). In order to achieve direct governance of strategic areas outside the immediate vicinity of Bangkok, the government decided to invest in a railway network to move people and information more efficiently across its territory.

Unlike the clear strategic and political importance of Siam's early railways, the economic value of the railways has largely been in question by both contemporary commentators and economic historians alike. In terms of large-scale infrastructure investment, railroads were perceived as a suboptimal choice from an economic perspective, especially relative to the expansion of the

irrigation canal network in the Central Plain (Van der Heide 1906; Feeny 1982; Ingram 1971).[1] Ultimately, however, the government decided to devote its limited resources to building the railway network rather than extend the canal network. In this paper, we show that by increasing industrial activities and agricultural expansion, Siam's "political railroads" led to urbanization in the peripheral areas that had previously been overlooked by Bangkok and suffered from inferior transportation options. This subsequent development of the northern and northeastern provinces was a largely an unforeseen consequence of Siam's state consolidation effort.[2] At the same time, we find that given the government's limited budget, the railways were built at the cost of other types of infrastructure development. The development was thus localized and economic benefit was limited to only those with direct rail access.

The lessons from the Siam case contribute to the works suggesting that large infrastructure projects, such as railways, roads, and canals, tend to have positive impacts on various local and national economic outcomes. In theory, the development of transportation networks increases market access and reduces the cost of transporting goods and people. Donaldson (2018) for example finds that in the case of colonial India, areas that gained direct access to railways during the colonial period saw decreased trade costs, which in turn led to increased interregional and international trade. Bogart and Chaudhary (2013) also find that the colonial railways in India led to increased total factor productivity between 1874 and 1912, and this can be largely explained by the complementarity between railways and industrial development. Tang (2014) shows that the development of the rail system in Japan led to industrial development and agglomeration economies along the newly built rail lines. Berger and Enflo (2017) show that in the 19th century Sweden, areas with railways built by the government due to military concerns saw more rapid population growth. In the case of the United States, counties that gained better market access due to the expansion of the rail network led to

[1] Kakizaki (2005) on the other hand argues that the opening of the northern and northeastern lines in particular resulted in more rice production and commodity flows. Contrary to earlier views that the railways were not important for transporting rice, official statistics do indicate that paddy and processed rice made up a large proportion of overall freight carried on the northern and northeastern lines up through World War II (See Appendix Figure 1A).

[2] Paik and Vechbanyongratana (2019) describe the long-term impact of Western colonial threat and Siam's centralization effort in more detail, showing that the regions that became centralized earlier continue to enjoy higher levels of development today.

increased agricultural land values (Donaldson and Hornbeck 2016). Atack and Margo (2011) further show that about one quarter of the increase in farmland in the American Midwest can be attributed to the building of the railways in the nineteenth century.

In this paper we similarly evaluate the impact of railways on the various aspects of economic outcomes, including both population and agricultural activity. Our main findings however show evidence of distributive local development under the unique Siamese context, in which external colonial threats played a critical role in the railway construction. We find that the economic benefits of the "political railways", while positive, remained relatively localized, and benefitted primarily the peripheral regions with direct rail access but not others.

Historical Background

Reform under Colonial Pressure

Up until the end of the nineteenth century, the governance system prevalent in much of Southeast Asia, including Siam, was one of indirect control over and tributary relationships with areas far from a kingdom's administrative center. Even up to the second half of the nineteenth century, Siam maintained tributary relationships with several distant kingdoms and principalities under Bangkok's influence since the end of the eighteenth century. The decentralized governance system meant that smaller kingdoms in the periphery of Siam's influence were at risk of appropriation by the colonial French and British administrations. In fact, the French and British progressively annexed land in Southeast Asia on the edges of Siam's influence, including areas in present-day Myanmar, Malaysia, Vietnam, Laos, and Cambodia.

French and British colonial ambitions and progressive colonization of peripheral territories under Siam's influence led King Chulalongkorn to pursue several strategies to thwart further annexations. He pursued diplomatic avenues to maintain its status as a buffer state between French and British holdings in Southeast Asia (Jeshurun, 1970); established territorial borders consistent with Western concepts of sovereignty and the nation-state (Winichakul, 1994); and adopted several Western institutions (for example, the Torrens system of land administration based on cadastral survey) to gain legitimacy in the eyes of international actors (Larsson, 2012). Possibly the most effective defense against colonial encroachment was the centralization of the

Siam's government and the integration of the peripheral tributary polities into the centralized governance system.

Siam, however, faced many challenges in its bid to centralize the government. Along with resistance to centralization by hereditary leaders (Bunnag 1977; Walker 2014), transportation to and communication with the peripheries posed a large practical problem to directly governing outside Siam's Central Plain. Sending people and supplies to places that lacked canals or coastlines was exceedingly difficult, especially in the northern and northeastern reaches of the kingdom. While waterways (canals and rivers) were the main forms of transportation in Siam throughout the nineteenth century, they were only navigable most of the year in the central region and not navigable at all during the dry season in the north and northeast. Regions with high mountainous terrain in particular had no navigable waterways allowing access to the rest of the country. The time-distances in Appendix Figure 2A demonstrates the difficulties of travel from Bangkok to distant principalities (*mueang*) in the north and northeast at the end of the nineteenth century. Figure 2A indicates that travel to larger towns in the north took upwards of two months, much of it over land under man and animal power (Kakizaki, 2005, pp. 156-7). The inability of the government to effectively directly govern distant principalities in addition to the need for better intelligence on French and British activities in the peripheries led to the decision to establish a railway network in Siam.

Siam's "Political Railways"

The three earliest major routes that the government chose to pursue in the 1890s include routes to the northeast to Khorat, north to Chiangmai, and south to the border with British Malaya. While built around the same period, the northeastern and northern routes in particular were planned for strategic purposes, aimed at facilitating the centralization of Siam's administration, strengthening its control over the periphery, and maintaining territorial integrity. The government did consider several proposed routes that would have made economic sense, connecting Siam's natural resources (i.e. teak, tin, etc.) and agricultural output (rice in particular) not only to Bangkok, but also to other centers of trade, such as Saigon, Singapore, and Moulmein (Whyte 2010; Kakizaki 2012). At the same time, although the newly organized Royal Railway Department had multiple rail line proposals and two complete railway surveys to the north and the northeast in hand, the government chose to pursue the northeastern route to the Khorat Plateau first, terminating, not coincidentally, in the first centralized administrative region of Nakhon Ratchasima. According to Whyte (2010, 12), this decision

was made for two reasons: 1) to effectively extend Bangkok's reach towards areas under French threat and 2) to bring the Khorat Plataeu, which was one of the most difficult areas in Siam to reach by traditional overland modes of transport, into direct communication with Bangkok.

The routes not only terminated in strategically important places, the route itself was carefully considered. For example, Whyte (2010, 12) notes that the government opted to route the northern line through Phitsanulok rather than the important teak town of Tak to accomplish connecting Siam internally north to south without antagonizing the British. Concern over annexation of peripheral areas is why the early railways did not extend to the northeastern tributary states or the economically important city of Battambang in present-day Cambodia (Kakizaki 2012, 24-25). In other words, railway routes selected by Siam's government went out far enough to ensure Bangkok's consolidation of power in outer lying provinces and the ability to communicate and send human resources quickly to the frontier, but not far enough for the rails to be used strategically by France and Britain to facilitate the annexation of additional areas under Siamese influence.

The importance of the early railways in facilitating the implementation of the centralized government administration was recognized early on. W. A. Graham, a former administrator and advisor to the Siamese government, notes that the economic returns to railway investments were still in question, but "[f]or purposes of administration the value of the railways cannot be overrated and, in fact, the present system of rural Government could hardly exist without them" (Graham, 1924, pp. 152-3). In support of this point, a recent study by Potjanalawan (2016) found that a notable impact of opening the railway line in the northern town of Lampang was the facilitation of the movement of civil servants originating from Bangkok and other provinces to take up posts within the *Thesapiban* administration in Lampang and adjacent Phrae and Nan provinces. Furthermore, Graham notes that areas that did not have rail infrastructure and remained difficult to reach both physically and administratively "received nothing at all in the way of social, economic or administrative benefit from the State" (Graham, 1924, p. 124).

Transportation Infrastructure Investment Constraints

Figure 1 depicts the expansion of the railway network between 1897 and 1995. One of the notable features from Figure 1 is that after the initial phase of railway construction between 1897 and 1919, there was relatively little additional expansion of the system even though large portions of the country remained effectively unconnected. The previous discussion points to

the success of the railways both in political and economic terms. Why, then, did the expansion of the railroad network slow significantly after the three main lines to the northeast, north, and south were (nearly) completed?

Railway investment was expensive. Spending on railway construction comprised around 10 percent of government expenditures between 1897 and 1920 (Bureau of General Statistics, 1933). With the exception of loans taken out in 1905, 1907, and 1909 for the specific purpose of building the early railroads, to a large extent, Siam avoided foreign loans to finance infrastructure projects and maintained a balanced budget policy through the mid-1950s out of a desire to remain free of Western interference (Ingram 1971, 189-190, 299). At the same time, Siam's capacity to raise revenues through taxation was constrained on two fronts. First, Siam's decentralized traditional governance system still in existence in the 1890s meant that the Bangkok government did not tax the peripheries directly. Hereditary leaders taxed their own populace and often did not forward the required share of taxes to Bangkok (Bunnag, 1977). Second, Bangkok could not raise significant funds from both internal and external trade because provisions in the 1855 Bowring Treaty with Britain limited import duties to 3 percent and exports could only be taxed once (i.e. inland tax, transit duty, or export duty) (Ingram, 1971). The Bowring Treaty became a template for subsequent treaties with other external trade partners, effectively closing off trade as a lucrative source of government revenues.

Constraints on government spending resulted in the slowing of rail infrastructure expansion after the 1920s, which meant that regions excluded from the early railways would largely remain without basic transportation infrastructure through the 1950s. Only by the 1960s did the country see the beginning of large-scale investments in roads and highways, particularly in areas of the northeast where early railways did not extend. Investments in paved roads outside the central region picked up in the 1960s and accelerated significantly in the 1970s (Kakizaki 2012). The development of Thailand's highway system managed to fill in the gaps left by the incomplete railway network and connected these initially neglected areas with the rest of the country.

Empirical Result

We estimate the impact of rail infrastructure built during the colonial period on various economic outcomes in 1947. Our analysis focuses on the northern and northeastern rail lines

in particular. The construction of these two lines was clearly motivated by political rather than economic aims during the colonial period, and the routes were determined in part by areas of British and French presence (Whyte 2010; Kakizaki 2012).[3] The benchmark year is chosen because 1947 comes shortly after the end of railway construction that can be traced directly back to the colonial period. The outcome variables used in the estimations include district-level population, rice cultivation, and garden crop cultivation. The first outcome variable, district population level, is a proxy for urbanization. The next outcome, the number of *rai* planted/harvested in rice, captures the impact of railways on integrating parts of the north and northeast into the international trade economy.[4] Given that rice was Thailand's main export crop throughout the twentieth century, expansion of rice cultivation in areas in close proximity to the railways is consistent with the railways facilitating integration of the north and northeast into the world market. Finally, garden crops (i.e. perishable vegetable crops) were grown for local consumption and intraregional trade. The expansion of cultivation of these locally consumed perishable crops would be consistent with the railways facilitating both population growth and intraregional trade.[5]

We run the following baseline OLS specification:

$$y = \beta_0 + \beta_1 NoRail + X'\gamma + \delta + \epsilon \quad (1)$$

The outcome variables, y, are the natural log of district-level population, rice cultivation/harvest measures, or garden crop cultivation in 1947. The variable *NoRail* is a dummy variable indicating that neither the northern line nor the northeastern line crosscut the district. The coefficient estimate can be interpreted as the average effect of a district not having direct access to any rail line by 1941. Since we hypothesize that railway access is positively correlated with economic outcomes, we expect the sign of the coefficient on the *NoRail* dummy variable to be negative for every outcome. We also include vector X, a set of district-level

[3] The southern rail line by comparison had been built under a different agenda. Although the government extended the rail line down south for the said strategic purpose (i.e. against the British claims in the bordering Malay), it also had much more commercial interest of connecting the southern regions, surrounded by the seas on both sides, to Bangkok. Furthermore, there remains little variation in rail access across different districts in the south given its long and narrow geography.

[4] A *rai* is a traditional Thai measure of land area equivalent to 0.16 hectares.

[5] In Appendix Table 1A we provide both the data sources and summary statistics.

geographic controls (longitude, latitude, area (km^2), agricultural suitability, mean elevation (m), standard deviation of elevation, distance to nearest river (km), distance to Bangkok (km), and an indicator for the provincial administrative center), to capture the economic potential of a district based on its exogenous geographic characteristic. Finally, δ is a set of provincial fixed effects.

We not only want to know whether being located directly on a railway line matters, but also whether or not a district's distance from the nearest railway access point matters for economic outcomes. Given the underdeveloped state of Thailand's transportation network and few existing connections with the railways in the first half of the twentieth century, we expect that the impact of the railways will attenuate with distance from rail access points. The variable *Dist2Rail* is the distance in kilometers from a district border to the nearest rail line.

$$y = \beta_0 + \beta_1 NoRail + \beta_2 Dist2Rail + X'\gamma + \delta + \epsilon \quad (2)$$

Since the impact of distance from the rail line may be nonlinear, we also run the following specification:

$$y = \beta_0 + \beta_1 10kmRail + \beta_2 20kmRail + X'\gamma + \delta + \epsilon \quad (3)$$

The variables *10kmRail* and *20kmRail* are indicator variables for districts located 10 to 20 kilometers and more than 20 kilometers from railway access points, respectively.[6] The excluded category is districts located less than 10 kilometers from either the northern line or the northeastern line. Given the lack of road infrastructure, especially in the early period, it is expected that economic impacts of the railways are most pronounced within a few kilometers of the stations, thus the negative impact of distance is expected to be more pronounced for districts located more than 20 kilometers from rail access points.

Table 1 presents results for the 1947 district population, rice cultivation, and garden crop cultivation outcomes. All reported specifications include a full set of geographic controls and provincial fixed effects. The first three columns report estimates on the impact of rail access on the natural log of district population. The first column includes only indicators for whether

[6] We adopt a strategy similar to Berger and Enflo (2017).

the district has no rail access. The coefficient estimate indicates that districts with no direct rail access have on average 29 percent lower population than districts located directly on the railways.

To estimate whether the impact of railways was localized, we include linear and non-linear measures of distance from the nearest railway lines in specifications (2) and (3). In Column (2), the coefficient estimate on the dummy variable for no rail access changes little (-0.324) and is still statistically significant with the addition of the linear distance. The coefficient on the linear distance, however, is negative but not statistically significant, suggesting that direct access to railways is what matters for urbanization. Column (3) reports the coefficients for a series of distance dummy variables to better understand whether the impact of distance from the rail lines on population is nonlinear. The coefficient on the indicator for districts located 10 to 20 kilometers from the nearest rail line is -0.20, which indicates that districts 10 to 20 kilometers from the nearest railway has on average 18 percent lower population than districts within 10 kilometers from the railway. Districts located more than 20 kilometers from the rail line have 24 percent lower population. These results are consistent with the early railways attracting economic opportunities and urbanization, but at the same time indicates that the economic benefits of the railways were fairly localized. Columns (4) through (6) report results for specifications that allow for the northern and northeastern rail lines to enter into the regressions separately. The results are similar to those in Columns (1) through (3), where no direct access to both the northern and northeastern railways is associated with approximately 28 and 27 percent lower population, respectively. The results suggest that the impact of the early rail lines on population are similar regardless of where the tracks were laid.

Columns (7) through (9) repeat the same exercise for a different dependent variable, the natural log of the number of *rai* planted with rice in each district. The results from this analysis are remarkably similar to the results for population, with lack of direct access to railways being associated with around 29 percent less *rai* planted in paddy. The results in Column (9) show that impact of distance is not linear. The amount of land devoted to paddy cultivation drops by about 24 percent for districts more than 20 kilometers from the nearest rail line compared to districts within 10 kilometers of the railway. The results are consistent with Kakizaki's (2005) observation that the opening of the railways resulted in increased rice cultivation and trade along the newly established railways.

The third outcome for 1947 is garden crop cultivation, which largely consisted of perishable vegetable crops. Because of their perishable nature, these crops are traded in domestic markets and not exported abroad. The advent of the railways potentially provided a means to quickly transport perishable goods to markets down the rail lines. The results in Table 1 Columns 13 through 15 show a strong relationship between railway access and the number of *rai* under vegetable cultivation, with districts off the railways having on average 37 percent fewer *rai* under cultivation. The specification that includes the linear distance from the nearest railway indicates that districts off the rail line have 32 per cent fewer *rai* under cultivation in garden products and that the number of *rai* under cultivation reduces 1 percent for every kilometer further a district is located from the rail line.

Given that garden crops are generally consumed locally, it is possible that the increased garden crop cultivation near the railways is a function of larger populations that are also located near the railways. While this may provide part of the explanation for the positive correlation between railway access and perishable crop cultivation, statistics on railway freight from 1917 to 1934 suggest that garden produce was increasingly transported by train. Garden produce freight transported on the northern and northeastern lines increased from 2,590 tons in 1917 to 22,130 tons in 1934, with much of the produce originating at and destined to smaller stations rather than Bangkok and major junctions (Department of General Statistics, Ministry of Finance 1922; Division of the Central Service of Statistics 1937). Thus, the rail impact on perishable produce cultivation is likely due in part to better access to regional markets through the rail lines.[7]

Next, although the historical narrative strongly suggests that the early rail lines were planned for political and not economic purposes, we are still concerned that the routes may have been systematically chosen based on unobservable characteristics correlated to economic outcomes.

[7] The analysis above includes all districts in the north and northeast. Although the routes of the rail lines were largely determined to meet political aims, the rail lines still passed through major regional population centers (i.e. the central, or *amphoe muang* districts). Since we are concerned that the central districts may drive the results, we exclude these districts from the analysis to see if the results still hold. Appendix Table 2A reports results for a specification that excludes provincial administrative centers. Regardless of whether the central districts are included or excluded, we find similar results where districts off the rail lines have smaller populations and less rice and vegetable cultivation.

To alleviate this concern, we run placebo tests based on planned but not completed rail lines similar to Donaldson (2018). The Thai government proposed additional lines in 1941 to better connect the north and northeast to Bangkok, as well as to connect Siam with neighboring countries (Kakizaki, 2012). However, due to budget constraints and World War II, the lines were never completed. The completed and planned lines as of 1941 are illustrated in Figure 2.[8] We run the regression specification given in Equation (2), but add controls for planned access and distance to two of the government's proposed but never built lines from the 1941 plan. Non-significant coefficient estimates on the planned lines would suggest that there are no systematic unobservable factors driving the placement of railways that could also be driving our main results.

For all three outcomes reported in Columns (1), (3), and (5) of Table 2, the coefficients on the access dummy and the distance variable for the planned Chiang Saen route are not statistically significant. The coefficients on access to and distance from the planned Paklai line reported in columns (2), (4), and (6) are not statistically significant in most specifications. However, the coefficients on the access dummy and the distance variable are *positive* and statistically significant in the population and rice cultivation regressions, respectively. The positive coefficient is likely the result of the Paklai planned route sitting directly between the northern and northeastern lines. That is, the districts further away from the proposed Paklai line would have *higher* levels of population and rice cultivation, because they were also within closer proximity to the northern and northeastern railways. Overall, the placebo tests support our claim that the positive economic benefits accrued to districts located on the rail line are due to the presence of the railway and not some other unobservable factors.

Finally, we test whether this positive association between the railways and economic outcomes persists after 1947. In Table 3A of the Appendix, we present results for 1966, nearly two decades after the end of railway construction under the colonial threat. We specifically choose 1966 as a benchmark year because it is during a period of alternative transportation development in the provinces (namely roads and highways), but before the government made

[8] Although there are four railway lines included in the 1941 plan that largely remained unbuilt, we use only the unbuilt Paklai and Chiang Saen lines for the placebo tests. This is because these two lines cut through areas without existing railways rather than being designed to connect existing rail lines, and hence were already "treated" for much of the planned routes.

systematic efforts to promote regional economic development and structural transformation of the economy in the 1970s and 1980s. We run the same main regressions and placebo tests with 1966 district population and harvested area of rice as the dependent variables.

The results for population in 1966 reported in Table 3A show similar results to what was found for 1947, suggesting that the urbanization as a result of rail construction is persistent. However, the coefficients for harvested rice area are attenuated compared to the results for 1947. The coefficients on the no rail access dummies remain negative, but are not statistically significant. Results in Column (6) show that districts more than 20 kilometers from rail lines had on average 27 percent less harvested *rai* of rice than districts within 10 kilometers of the railways. The overall attenuation of the coefficients from 1947 suggests that rice cultivation may have been more responsive to the availability of additional transportation options, particularly highway development in the northeast.

The placebo tests reported in columns (7) to (10) in Table 3A show that the coefficients on the distance to planned but unbuilt rail lines are not statistically significant for the planned Chiang Saen line. The coefficients on the planned access and distance variables for the Paklai line are also not significant, with the exception of the specification on rice cultivation, which is positive (rather than negative) and significant at the 10 percent level. Again, the placebo tests suggest that the negative impact of distance from the rail lines on both population and rice cultivation are likely not driven by unobservable characteristics driving both railway placement and economic outcomes.

Conclusion

Siam built its early "political railways" to the north and northeast as a means to achieve centralization and defend itself against progressive territorial encroachment by the French and the British colonial administrations. While the railways were built for political purposes, this paper shows that investments in the early railways in the peripheral regions did result in greater economic activity (proxied by population) and more rice and garden product cultivation in 1947 due to newly gained railway access. At the same time, the results also suggest that positive economic benefits of the railways were relatively localized, likely because of a lack of complementary transportation infrastructure connecting to the rail lines. The results for 1966 show that the earlier positive impacts of the railways on population are persistent even with the

introduction of the highway network in the 1950s and 1960s. This same persistence is not seen with harvested rice area. One explanation is that roads and highways represented new transportation options for trade, which in turn potentially incentivized agricultural households to cultivate rice and, as Kakizaki (2012) suggests, other cash crops such as corn, in newly connected areas off the early rail lines.

Our study provides complementary micro analysis to Paik and Vechbanyongratana (2019), in which the authors argue that the colonial threat in the nineteenth century led to long-run uneven economic development across Thailand. The railway expansion was a key initiative that Thailand took to centralize and maintain its sovereignty. In its process, the strategically located regions of north and northeastern Thailand witnessed economic development that persisted via direct rail access, arguably at the expense of other regions. The railroad case provides additional insight on how external colonial threats and internal reform may have a long-term impact on local economy.

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Tables

Table 1. Impact of Railway Access on Population, Rice Cultivation, and Vegetable Cultivation, 1947

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Natural Log District Population 1947 ('000)						Natural Log Paddy Planted (Rai)					
No Rail Access	-0.345***	-0.324***					-0.337***	-0.300***				
	(0.071)	(0.073)					(0.101)	(0.107)				
Distance to Nearest Railway (Km)		-0.002						-0.004				
		(0.002)						(0.003)				
District 10-20km from Nearest Railway			-0.196**						-0.125			
			(0.091)						(0.123)			
District >=20km from Nearest Railway			-0.269**						-0.272**			
			(0.104)						(0.128)			
No Northern Rail Access				-0.327***	-0.332***					-0.311**	-0.345***	
				(0.090)	(0.094)					(0.124)	(0.131)	
Dist to N 1941 (Km)					0.000						0.003	
					(0.002)						(0.003)	
No Northeastern Rail Access				-0.314***	-0.296***					-0.324**	-0.302**	
				(0.098)	(0.099)					(0.139)	(0.138)	
Dist to NE 1941 (Km)					-0.002						-0.003	
					(0.002)						(0.002)	
District 10-20km from Northern Railway						-0.129						-0.092
						(0.129)						(0.166)
District >=20km from Northern Railway						-0.282**						-0.239
						(0.135)						(0.163)
District 10-20km from Northeastern Railway						-0.244**						-0.181
						(0.105)						(0.137)
District >=20km from Northeastern Railway						-0.255*						-0.255
						(0.130)						(0.163)
Constant	-3.584	-6.256	-3.639	-2.533	7.764	-3.960	35.016	30.283	34.127	36.380	58.246*	34.948
	(15.335)	(15.282)	(15.611)	(15.456)	(19.489)	(15.695)	(24.023)	(24.002)	(23.213)	(23.967)	(29.513)	(23.679)
Provincial Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.597	0.599	0.570	0.593	0.590	0.569	0.709	0.712	0.699	0.707	0.708	0.695
Obs.	221	221	221	221	221	221	221	221	221	221	221	221

Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

Table 1. Impact of Railway Access on Population, Rice Cultivation, and Vegetable Cultivation, 1947 (Continued)

	(13)	(14)	(15)	(16)	(17)	(18)
	Natural Log Garden Crops Planted (Rai)					
No Rail Access	-0.465**	-0.380*				
	(0.217)	(0.223)				
Distance to Nearest Railway (Km)		-0.009				
		(0.005)				
District 10-20km from Nearest Railway			-0.322			
			(0.287)			
District >=20km from Nearest Railway			-0.756**			
			(0.298)			
No Northern Rail Access				-0.545*	-0.500*	
				(0.285)	(0.295)	
Dist to N 1941 (Km)					-0.005	
					(0.007)	
No Northeastern Rail Access				-0.269	-0.209	
				(0.266)	(0.261)	
Dist to NE 1941 (Km)					-0.006	
					(0.006)	
District 10-20km from Northern Railway						-0.464
						(0.391)
District >=20km from Northern Railway						-0.436
						(0.407)
District 10-20km from Northeastern Railway						-0.129
						(0.283)
District >=20km from Northeastern Railway						-1.056***
						(0.327)
Constant	50.074	39.169	45.715	48.075	64.419	53.790
	(55.663)	(57.021)	(56.045)	(55.927)	(72.628)	(57.155)
Provincial Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.371	0.377	0.378	0.368	0.367	0.387
Obs.	221	221	221	221	221	221

Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

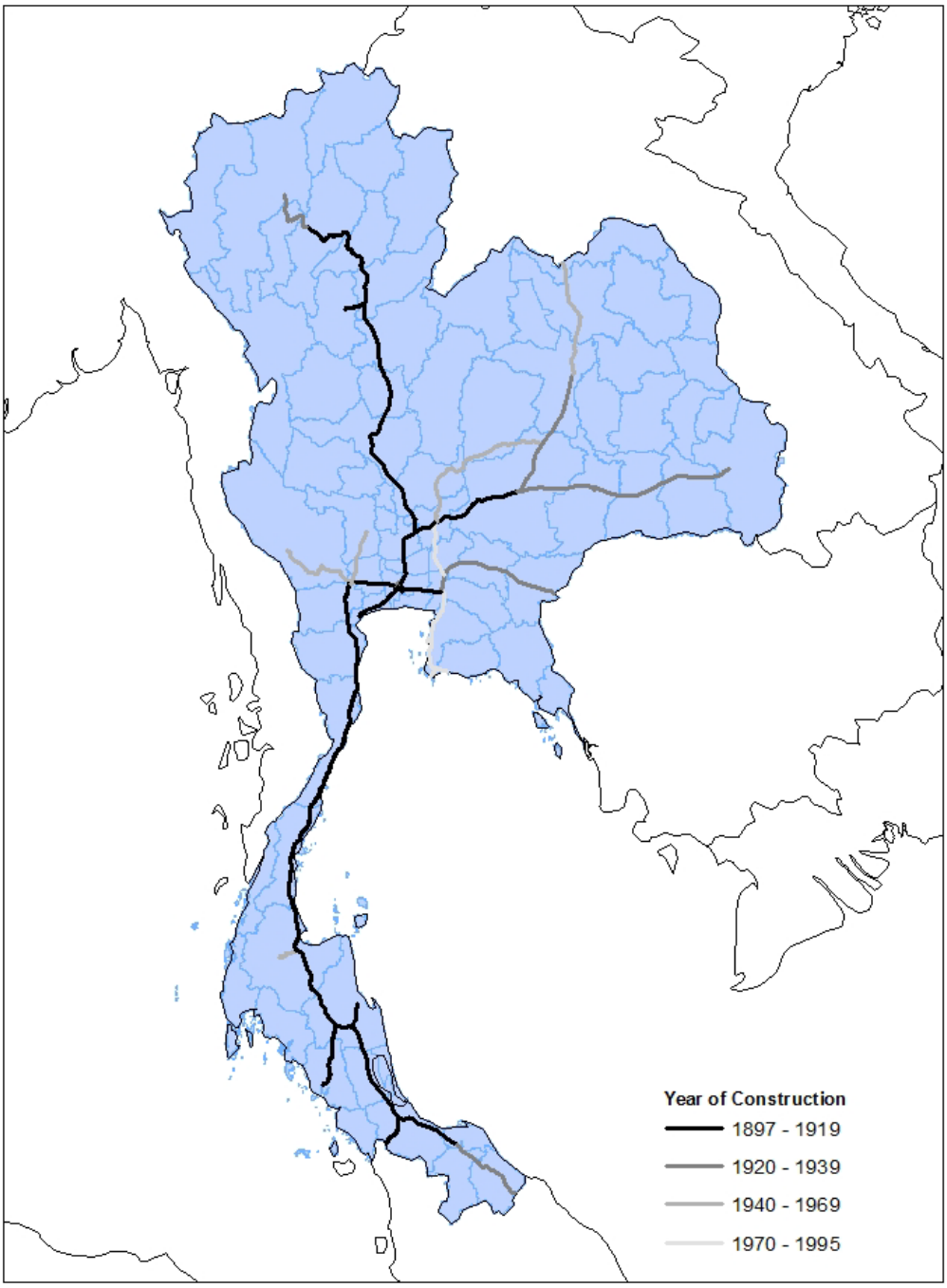
Table 2. Placebo Tests, 1947

	(1)	(2)	(3)	(4)	(5)	(6)
	Natural Log District Population ('000)		Natural Log Paddy Planted (Rai)		Natural Log Garden Crops Planted (Rai)	
No Rail Access	-0.329***	-0.317***	-0.303***	-0.290***	-0.367	-0.374*
	(0.072)	(0.071)	(0.107)	(0.108)	(0.225)	(0.224)
Distance to Nearest Railway (Km)	-0.002	-0.002	-0.004	-0.006**	-0.009*	-0.009*
	(0.002)	(0.002)	(0.003)	(0.003)	(0.005)	(0.005)
Not on Chiang Saen Proposed Route	-0.176		-0.189		0.489	
	(0.187)		(0.331)		(0.591)	
Dist to Proposed Chiang Saen Line (Km)	-0.001		0.001		0.004	
	(0.002)		(0.003)		(0.008)	
Not on Paklai Proposed Route		0.464*		0.099		0.410
		(0.258)		(0.279)		(0.360)
Dist to Paklai Line (Km)		0.000		0.006**		-0.000
		(0.002)		(0.003)		(0.006)
Constant	-5.303	-11.357	31.681	3.478	36.505	37.322
	(15.424)	(15.977)	(24.156)	(25.742)	(58.229)	(61.608)
Provincial Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.598	0.608	0.710	0.717	0.375	0.371
Obs.	221	221	221	221	221	221

Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

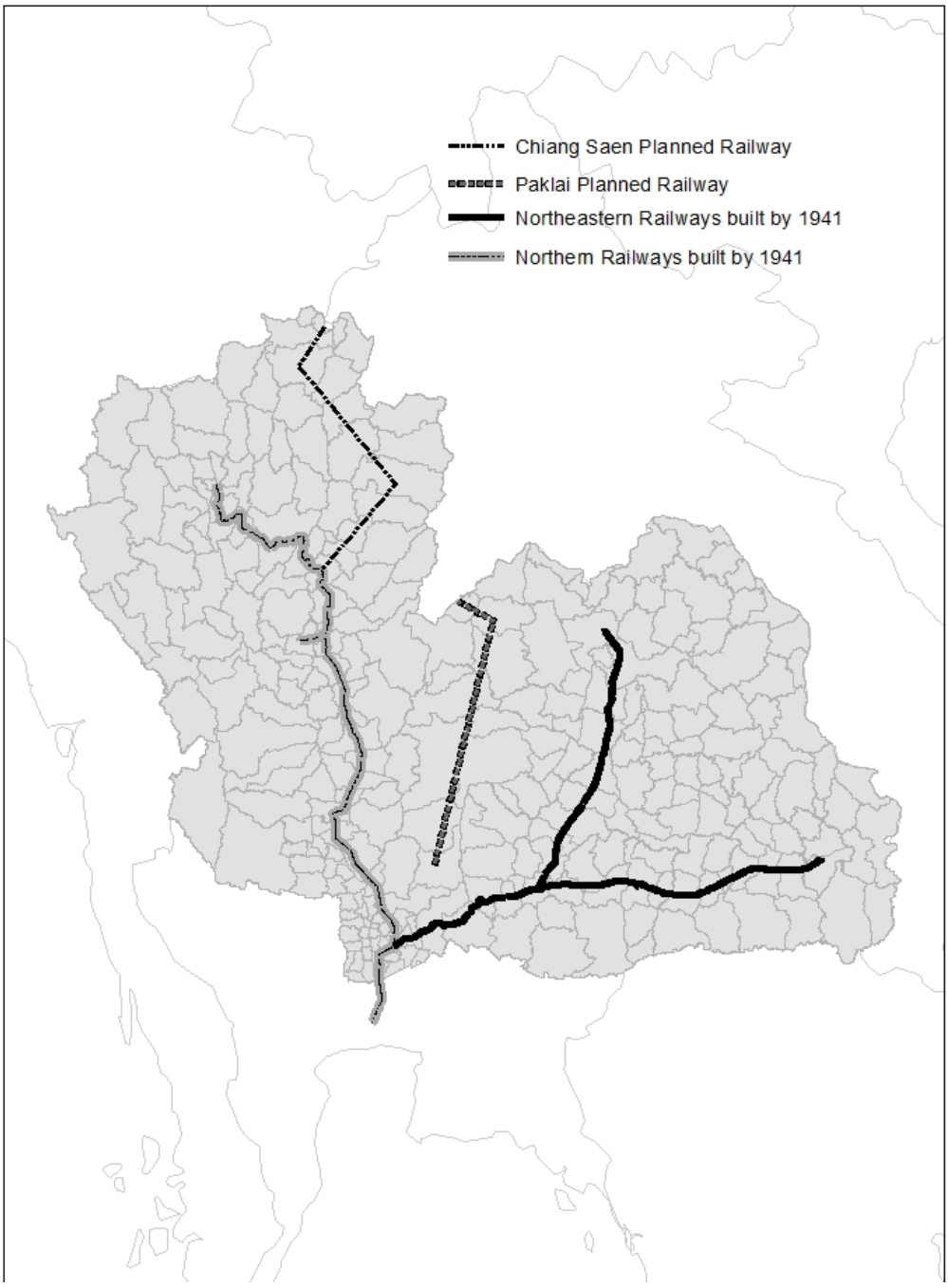
Figures

Figure 1. Railway Network Expansion, 1897-1995



Source: Compiled from Whyte (2010).

Figure 2. Planned and Completed Railways Lines in 1941



Source: Compiled from Whyte (2010) and Kakizaki (2012).

Appendix

Data Sources

1947: the data are derived from several sources. First, the locations of rail stations in 1941 (our benchmark year for the end of colonial rail construction) and timing of rail construction are from Whyte (2010). Various railway routes planned but not built by the Thai government are identified in Kakizaki (2012). The district-level outcome variables for 1947, including population, the number of *rai* cultivated in rice, and the number of *rai* cultivated in garden crops are collected from the 1947 Thai census reports. We also use a set of district-level geographical controls in order to capture the economic potential of a district based on its exogenous geographic characteristics: longitude, latitude, area (km^2), agricultural suitability, mean elevation (m), standard deviation of elevation, distance to nearest river (km), and distance to Bangkok (km).

1966: the 1966 Provincial Statistical Yearbooks only report area of harvested paddy and not planted paddy. Also, data on other crops cultivated at the district level are not available for this year. District-level population figures and the number of harvested *rai* of rice for 1966 are extracted from the 1966 provincial statistical year books, the first ever provincial-level compilation of statistics published by the Thai government. Note that there are 310 districts in 1966 compared to 221 districts in 1947. The government often split more populated districts into two or more districts during the mid-twentieth century. To check for sensitivity of the results to the boundary changes, the analysis for 1966 was run based on 1947 district boundaries. The results are qualitatively similar regardless of which boundaries are used.

Table 1A. Summary Statistics for 1947 and 1966

Year	1947		1966		Sources
Variable	Mean	Std. Dev.	Mean	Std. Dev.	
District Population ('000)	49.58	28.17	60.78	37.38	1947 Census; 1966 Provincial SYB
Planted Area of Rice (Rai)	114,848	86,286			1947 Census
Garden Crops Planted (Rai)	477.33	501.58			1947 Census
Harvested Area of Rice (Rai)			102,012	108,405	1966 Provincial SYB
No Rail Access	0.77	0.42	0.81	0.40	Whyte (2010); MoT
Distance to Nearest Rail	30.78	37.42	35.25	39.66	Whyte (2010); MoT
District <10km from Nearest Rail	0.40	0.49	35.25	39.66	Whyte (2010); MoT
District 10-20km from Nearest Rail	0.13	0.34	0.13	0.33	Whyte (2010); MoT
District >20km from Nearest Rail	0.47	0.50	0.54	0.50	Whyte (2010); MoT
No Northern Rail Access	0.87	0.34	0.90	0.30	Whyte (2010); MoT
Dist to Northern Rail 1941 (Km)	130.85	143.40	143.65	146.24	Whyte (2010); MoT
District 10-20km from N Rail	0.08	0.27	0.08	0.27	Whyte (2010); MoT
District >20km from N Rail	0.66	0.48	0.71	0.45	Whyte (2010); MoT
No Northeastern Rail Access	0.90	0.31	0.90	0.30	Whyte (2010); MoT
Dist to NE 1941 (Km)	136.45	142.10	137.47	143.98	Whyte (2010); MoT
District 10-20km from NE Rail	0.09	0.28	0.07	0.26	Whyte (2010); MoT
District >20km from NE Rail	0.76	0.43	0.77	0.42	Whyte (2010); MoT
Not on Paklai Proposed Route	0.96	0.20	0.97	0.18	Kakizaki (2012); MoT
Dist to Proposed Paklai Line (Km)	157.90	97.27	166.04	99.63	Kakizaki (2012); MoT
Not on Chiang Saen Proposed Route	0.96	0.21	0.96	0.20	Kakizaki (2012); MoT
Dist to Proposed Chiang Saen Line (Km)	261.53	161.40	271.87	163.31	Kakizaki (2012); MoT
Longitude	101.39	1.84	101.47	1.88	MoT
Latitude	16.51	1.57	16.49	1.56	MoT
Area (Km2)	1,581.75	1,286.27	1,144.96	893.28	MoT
Agricultural Suitability	0.35	0.14	0.34	0.14	Ramankutty et al. (2002)
Elevation Mean (m)	250.27	223.05	252.62	217.40	MoT
Elevation Stand. Dev.	102.01	108.40	98.52	105.05	MoT
Distance to River (Km)	3.58	9.04	5.38	11.07	MoT
Distance to Bangkok (Km)	350.68	167.24	357.91	165.93	MoT
Observations	221		310		

Notes: MoT = Ministry of Transport; SYB = Statistical Year Book

Data source references:

Bureau of General Statistics. (1933). *Statistical Year Book of the Kingdom of Siam B.E. 2474-75 (1931-33).* Bangkok: Ministry of Economic Affairs.

Central Statistical Office, Office of the National Economic Development Board. (1959). *Statistical Year Book Thailand No. 22 (Vol. 2) B.E. 2488 (1945) to 2498 (1955).* Bangkok: Railway Printing House.

Department of General Statistics, Ministry of Finance. (1922). *Statistical Year Book of the Kingdom of Siam 1922.* Bangkok: Ministry of Finance.

Division of the Central Service of Statistics. (1937). *Statistical Year Book of the Kingdom of Siam B.E. 2476-2477 (1933-1935).* Bangkok: Department of Secretary General of the Council.

Ramankutty, N., Foley, J., Norman, J., & McSweeney, K. (2002). The Global Distribution of Cultivable Lands: Current Patterns and Sensitivity to Possible Climate Change. *Global Ecology and Biogeography, 11*(5), 377–392.

Table 2A. Impact of Railway Access on Population, Rice Cultivation, and Vegetable Cultivation, 1947 (Excluding Provincial Administrative Centers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Natural Log District Population ('000)						Natural Log Paddy Planted (Rai)					
No Rail Access	-0.351***	-0.326***					-0.344***	-0.301***				
	(0.079)	(0.081)					(0.106)	(0.113)				
Distance to Nearest Railway (Km)		-0.002						-0.004				
		(0.002)						(0.003)				
District 10-20km from Nearest Railway			-0.203**						-0.237**			
			(0.101)						(0.120)			
District >=20km from Nearest Railway			-0.251**						-0.324**			
			(0.111)						(0.130)			
No Northern Rail Access				-0.322***	-0.323***					-0.226	-0.234	
				(0.100)	(0.103)					(0.138)	(0.142)	
Dist to N 1941 (Km)					-0.000						0.001	
					(0.002)						(0.003)	
No Northeastern Rail Access				-0.318***	-0.302***					-0.434***	-0.421***	
				(0.113)	(0.114)					(0.140)	(0.142)	
Dist to NE 1941 (Km)					-0.001						-0.001	
					(0.002)						(0.003)	
District 10-20km from Northern Railway						-0.106						-0.098
						(0.146)						(0.181)
District >=20km from Northern Railway						-0.256*						-0.257
						(0.144)						(0.175)
District 10-20km from Northeastern Railway						-0.288**						-0.325**
						(0.121)						(0.128)
District >=20km from Northeastern Railway						-0.209						-0.310*
						(0.146)						(0.170)
Constant	-3.643	-6.575	-2.995	-2.269	5.365	-3.624	27.400	22.284	27.397	31.393	39.854	27.915
	(16.361)	(16.006)	(16.511)	(16.568)	(21.491)	(16.552)	(25.459)	(24.540)	(24.586)	(25.493)	(31.714)	(25.054)
Provincial Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.511	0.513	0.476	0.504	0.498	0.474	0.710	0.714	0.703	0.709	0.705	0.699
Obs.	179	179	179	179	179	179	179	179	179	179	179	179

Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

Table 2A. Impact of Railway Access on Population, Rice Cultivation, and Vegetable Cultivation, 1947 (Excluding Provincial Administrative Centers) (Continued)

	(13)	(14)	(15)	(16)	(17)	(18)
	Natural Log Garden Crops Planted (Rai)					
No Rail Access	-0.415*	-0.325				
	(0.225)	(0.233)				
Distance to Nearest Railway (Km)		-0.009				
		(0.006)				
District 10-20km from Nearest Railway			-0.344			
			(0.316)			
District >=20km from Nearest Railway			-0.616*			
			(0.335)			
No Northern Rail Access				-0.417	-0.384	
				(0.297)	(0.307)	
Dist to N 1941 (Km)					-0.004	
					(0.008)	
No Northeastern Rail Access				-0.318	-0.239	
				(0.293)	(0.278)	
Dist to NE 1941 (Km)					-0.007	
					(0.006)	
District 10-20km from Northern Railway						-0.473
						(0.456)
District >=20km from Northern Railway						-0.142
						(0.448)
District 10-20km from Northeastern Railway						-0.161
						(0.324)
District >=20km from Northeastern Railway						-1.149***
						(0.355)
Constant	57.066	46.447	54.438	57.503	82.659	64.902
	(60.743)	(61.648)	(61.912)	(61.306)	(83.408)	(62.641)
Provincial Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.344	0.350	0.346	0.338	0.337	0.365
Obs.	179	179	179	179	179	179

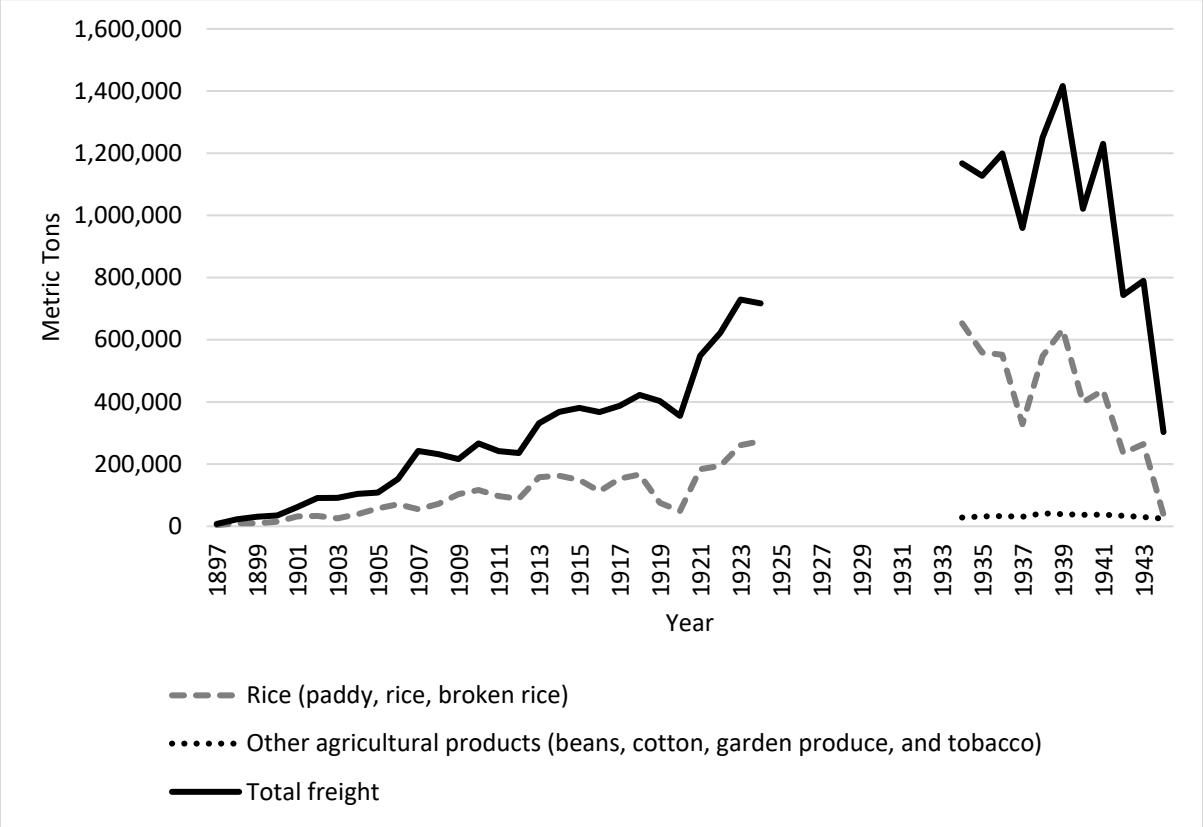
Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

Table 3A. Impact of Railway Access on Population and Rice Harvest, 1966

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
							Placebo Tests			
	Natural Log District Population ('000)			Natural Log Paddy Harvested (Rai)			Natural Log District Population ('000)		Natural Log Paddy Harvested (Rai)	
No Rail Access	-0.272***	-0.231***		-0.063	0.002		-0.233***	-0.231***	-0.002	0.009
	(0.066)	(0.067)		(0.130)	(0.134)		(0.067)	(0.067)	(0.129)	(0.133)
Distance to Nearest Railway (Km)		-0.003**			-0.006**		-0.003**	-0.003**	-0.006**	-0.007**
		(0.001)			(0.003)		(0.002)	(0.002)	(0.003)	(0.003)
District 10-20km from Nearest Railway			-0.182**			-0.137				
			(0.082)			(0.138)				
District More than 20km from Nearest Railway			-0.369***			-0.320**				
			(0.080)			(0.139)				
Not on Chiang Saen Proposed Route							-0.052		-0.489	
							(0.146)		(0.409)	
Dist to Proposed Chiang Saen Line (Km)							-0.002		0.000	
							(0.001)		(0.003)	
Not on Paklai Proposed Route								0.015		-0.041
								(0.152)		(0.334)
Dist to Paklai Line (Km)								-0.000		0.005*
								(0.001)		(0.003)
Constant	-24.570**	-26.065**	-23.502**	19.053	16.612	18.679	-24.575**	-25.753*	22.013	-6.006
	(12.080)	(11.482)	(11.564)	(26.377)	(24.935)	(26.061)	(11.420)	(13.814)	(24.824)	(25.454)
Provincial Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.601	0.610	0.610	0.569	0.577	0.576	0.609	0.607	0.580	0.579
Obs.	310	310	310	308	308	308	310	310	308	308

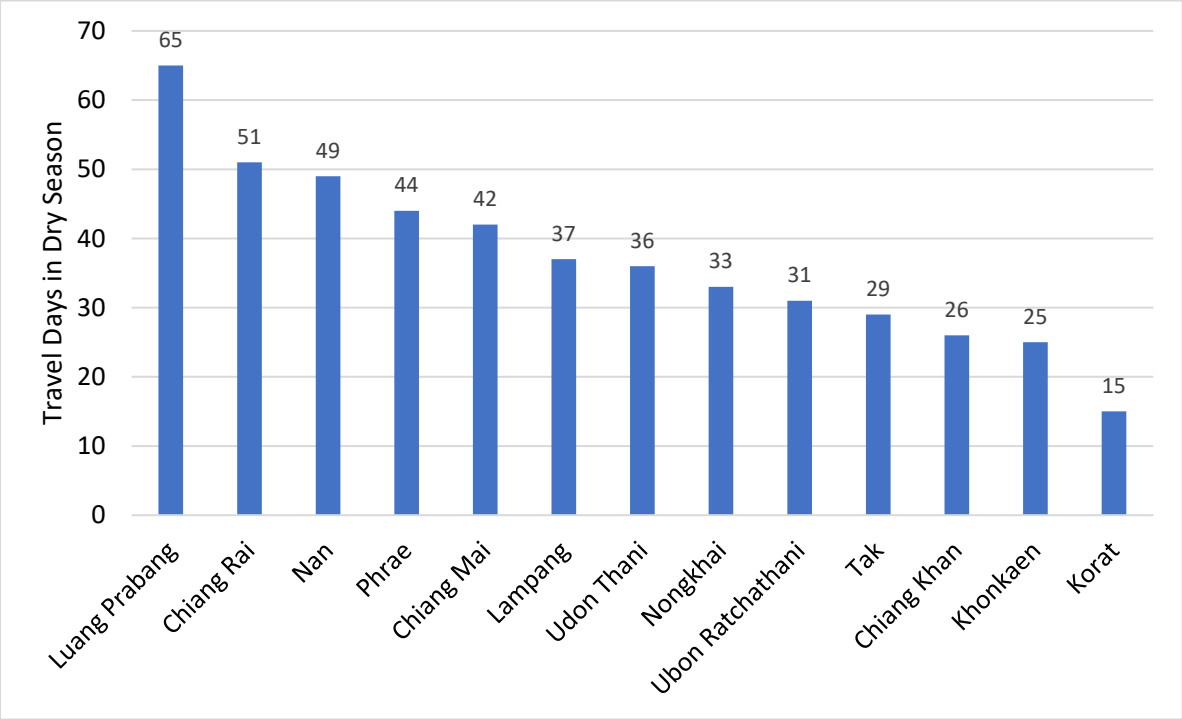
Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

Figure 1A. Rail Tonnage North and Northeastern Lines (Metric Tons), 1897-1944



Sources: Statistical Year Book of the Kingdom of Siam (1924-25); Statistical Year Book-Siam (1935-1937); Statistical Year Book Thailand (1937-1939); Statistical Year Book Thailand (1939-1944).

Figure 2A. Time-distances from Bangkok in Dry Season for Various Principalities (*Mueang*) in North and Northeastern Siam, 1890



Source: Compiled from Kakizaki (2005, 156-7).