

# Fiscal Legibility and State Development: Theory and Evidence from Colonial Mexico<sup>\*</sup>

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## Abstract

We examine how fiscal legibility, the ability of central authorities to observe local economic conditions for the purposes of taxation, shapes political centralization and state development. When rulers lack information about the periphery, they may cede autonomy to tax-collecting intermediaries to encourage fiscal performance. As information quality improves, rulers are better able to monitor and sanction local officials, allowing them to tighten control over taxation and establish more direct state presence. Centralization encourages additional investment in improving fiscal legibility, leading to long-term divergence in state development. We study the consequences of a technological innovation that dramatically improved the Spanish Crown's fiscal legibility in colonial Mexico: the discovery of the patio process to refine silver. We show that political centralization differentially accelerated in affected districts, that these areas saw disproportionate state investment in informational capacity, and that they were more resilient to institutional decline over a century later.

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## 1. Introduction

What enables political centralization? The consolidation of power under a central authority lays the foundation for the construction of state capacity and longer-term institutional and economic development, for better (e.g. Lange 2004; Osafo-Kwaako and Robinson 2013; Michalopoulos and Papaioannou 2013) or for worse (e.g. Iyer 2010; Ahmed and Stasavage 2020; Stasavage 2020). Though state centralization can be attractive for those in power, central authorities often lack the willingness or ability to seize political control from local elites in the periphery. Indirect forms of rule, which allow provincial elites to retain considerable autonomy, may allow rulers to extend political authority and extract revenue from areas that are distant, underdeveloped, or physically impenetrable (e.g. Gerring et al. 2011; Garfias and Sellars 2021).

The attractiveness of state centralization for rulers depends on fiscal legibility: the ability of central state authorities to independently observe, measure, and assess populations, their wealth, and their activities for the purposes of taxation and control (e.g., Kain and Baigent 1992; Scott 1998; Lee and Zhang 2017). When central authorities are unable to observe local conditions, it can be advantageous to delegate the task of controlling and administering territory to regional elites with better local information (e.g., Levi 1988; Mayshar et al. 2017; Balán et al. 2022). However, reliance on local intermediaries requires that central authorities sacrifice revenue and autonomy to these elites. As central rulers become better able to independently monitor and police activity across the territory, they may wish to exert more direct control over intermediaries to avoid these costs.

Building fiscal legibility is often difficult and constrained by geographic, social, technological, and political factors. We examine how a sudden exogenous increase in fiscal legibility influences political centralization and longer-term state development. Building on work by Scott (2017), Mayshar et al. (2017), and Stasavage (2020), our theory focuses on the interdependence between political centralization and long-term investment in state informational capacity. In areas of low fiscal legibility, exerting direct control over tax-collecting intermediaries is prohibitively costly. This is because without the ability to independently observe local economic conditions, a central ruler

cannot tell whether a disappointing tax receipt is due to poor conditions or poor intermediary performance. Rather than investing to improve monitoring capacity, rulers in low-information environments often rely on indirect forms of rule to encourage intermediary performance through increased autonomy and high compensation.

If fiscal legibility improves, however, it becomes easier for central authorities to identify poor performance and exert tighter control over intermediaries. This makes political centralization—the replacement of autonomous intermediaries with direct state agents—more attractive. Centralization in turn encourages rulers to invest in improving state informational capacity. Under direct rule, marginal improvements in fiscal legibility pay immediate dividends by making it easier to monitor intermediaries and identify poor performance. Under indirect rule, by contrast, the benefit of a small increase in informational capacity is minimal as rulers do not need to directly monitor the daily performance of intermediaries.

A single exogenous increase in state informational capacity can therefore lead to longer-term divergence in state development. As authorities centralize power and improve the fiscal legibility of affected areas, the benefits of direct rule increase, encouraging authorities to retain centralized control even when the costs of direct administration rise during later crises. In areas where legibility remains low, rulers will continue to rely on indirect rule and have little incentive to invest in state informational capacity.

We provide empirical support for our argument using subnational data from colonial Mexico. In the early colonial era, the Spanish Crown administered territory through the *encomienda*, an institution of indirect rule through which elites were granted broad rights to extract tribute and labor in exchange for maintaining local political order and collecting revenue for the government. Over time, the Crown sought to centralize authority, replacing *encomiendas* with *corregimientos*, a more direct form of rule through which local intermediaries were hired and fired by the center and paid a set wage. The timing of this transition differed across space. Some areas moved to direct rule within a generation of the Conquest, while others remained in *encomienda* for centuries.

We focus on the short- and longer-term consequences of a technological innovation in silver mining that suddenly improved fiscal legibility in some districts: the discovery of the patio process in the 1550s. This technique relies on mercury amalgamation to extract pure silver from mined ores, reducing the cost of processing the silver sulfides common to the Americas (Brading and Cross 1972; Bakewell 1984; Guerrero 2017). Importantly, the amalgamation process produces silver using mercury in a well-known ratio. Because mercury was only produced at scale in a handful of locations worldwide—and not in Mexico—the Crown was able to institute and enforce a monopoly over its sale and distribution. This gave central authorities a direct and reliable way to observe economic fluctuations in areas with mines, where silver extraction dictated economic activities even in non-mining sectors.

Using a differences-in-differences empirical strategy, we show that this increase in fiscal legibility led to an acceleration in political centralization. The proportion of *encomiendas* that transitioned to direct rule was around 8–13 percentage points higher in mining relative to non-mining districts and relative to before the discovery of the patio process. This result is empirically robust and substantively large, corresponding to about half of the within-district standard deviation in direct rule adoption over the period of analysis. We present additional evidence on the proposed mechanism by examining demand-driven price shocks in another important commodity, cochineal dye. The cochineal boom greatly increased the profitability of economic production and thus revenue potential, but, unlike the discovery of the patio process, it did not affect fiscal legibility and thus did not influence political centralization.

We then investigate how the shock to fiscal legibility shaped longer-term state development. We show that affected areas had improved access to state-run post offices (*estafetas*) by the end of the colonial period, a measure of state investment in facilitating communication and local legibility. We finally show that political control over affected areas remained more centralized in the face of a major governance crisis over a century later, when the Crown commodified and sold bureaucratic positions as a way of generating revenue. Because both fiscal legibility and political control were

higher in affected areas before office selling became commonplace, the Crown had less to gain from outsourcing administration of these districts to private actors, which insulated these areas from the negative consequences of office selling on official corruption (e.g., Pietschmann 1972; Guardado 2018; Garfias and Sellars 2020). Using information on the exhaustion of some 16th-century mines by the late colonial period, we can rule out that the observed long-term relationships are due to the effects of ongoing silver production.

This article builds upon an important line of research on state development. Scholars have shown how factors like demography (e.g., Carneiro 1970; Herbst 2000), external threats (e.g., Tilly 1990; Gennaioli and Voth 2015; Koyama et al. 2018), preexisting social and political structures (e.g., Boone 2003; Gerring et al. 2011), and domestic conflict (e.g., Slater 2010; Garfias and Sellars 2021) influence political centralization. Our focus is on the complementary role of fiscal legibility and the agency problems inherent in political rule, building on work by Scott (1998; 2017) and Mayshar et al. (2017). Asymmetric information, conflicts of interest, and commitment problems create agency costs for central rulers, shaping institutional development (e.g., Kasara 2007; Sng 2014; Gailmard 2017; 2019; Hassan 2020). The connection that we emphasize between information quality and political centralization has also been noted, for example, in work on ancient Egypt and Mesopotamia (Scott 2017; Mayshar et al. 2017), ancient and contemporary China (Stasavage 2020; Martinez-Bravo et al. 2022), early modern Europe (Johnson and Koyama 2014), and U.S. bureaucratic politics (e.g., Gailmard and Patty 2012; Patty and Turner 2021). We extend these arguments to consider the interdependence between political centralization and informational capacity and the connection between endogenous and exogenous fiscal legibility.

Existing work has demonstrated that inequality and redistributive considerations (e.g., Hollenbach and Silva 2019; Sánchez-Talanquer 2020; Suryanarayan and White 2021), political institutions (e.g., Ma and Rubin 2019; Brambor et al. 2020), electoral incentives (e.g., Christensen and Garfias 2021), and the design of government programs (e.g., Hunter and Brill 2016; Harbers 2020), among other factors, can encourage or discourage investment in fiscal legibility through efforts like conducting

censuses or constructing tax offices. Our argument highlights how these investment decisions also depend on existing informational capacity and the form of rule, connecting work on the *endogenous* determinants of state capacity with a complementary literature on its *exogenous* determinants like geography (e.g., Dal Bo et al. 2022; Fernández-Villaverde et al. 2020). There is little incentive to invest in improving the capacity of low-legibility areas, but a shock that suddenly increases legibility can shift incentives toward long-term investment in political centralization and state development. This divergence may explain why informational capacity acquired centuries ago can have a persistent effect on present-day fiscal outcomes (D’Arcy and Nistotskaya 2018).

Finally, this work makes an empirical contribution. Most existing evidence on the link between fiscal legibility and state development comes from analytic narratives and case studies (e.g., Johnson and Koyama 2014; Mayshar et al. 2017; Ma and Rubin 2019; Slantchev and Kravitz 2019; Stasavage 2020) or primarily cross-sectional research designs (e.g., Sng 2014; Ahmed and Stasavage 2020). The features of our context allow us to provide quasi-experimental evidence on this relationship by tracing how an exogenous shock to fiscal legibility within an existing state shaped the trajectory of subnational political centralization and state development over several centuries. Our focus on the connection between political centralization and investment in state informational capacity complements work examining “legibility” and the state from other perspectives, such as that of Mayshar et al. (2022), who connect the cultivation of cereals (which are easier to monitor and tax than other crops) with the rise of complex hierarchies across countries and societies, and Sánchez de la Sierra (2020), who examines how different commodity price shocks affect state-like functions among militias in the DRC.

## **2. Theory**

We examine the short and long-term consequences of a sudden increase in fiscal legibility on state development. Building on a seminal literature, notably the writing of James Scott (1998; 2017), we conceive of fiscal legibility as a central authority’s ability to independently observe local economic production for the purposes of taxation and political control. This informational capacity allows

rulers to contend with “exceptionally complex, illegible, and local social practices [...] and [create] a standard grid whereby [they can] be centrally recorded and monitored” (Scott 1998, p. 2). A ruler’s ability to do this depends both on the exogenous features of a district or territory—such as the characteristics of economic production, the ruggedness of the terrain, or the structure of human settlement—as well as on past and ongoing political decisions to improve informational capacity through efforts like administering censuses, creating cadastral records, or improving the communications network.

Our interest is in the interdependent relationship between fiscal legibility and political centralization. Political authorities in nearly every context rely on local intermediaries to collect taxes and administer territory. As many scholars have recognized (e.g., Levi 1988; Mayshar et al. 2017; Gailmard 2017; 2019; Balán et al. 2022), this presents a challenging agency problem. A central ruler generally lacks the ability to directly observe how much effort intermediaries put into completing the tasks that they have been delegated. The ruler thus has to design a contract to encourage intermediaries to complete assigned tasks in the absence of direct observation.

The institutional solutions to this agency problem have differed considerably across time and space. We compare two idealized contract types, which we call “indirect rule” and “direct rule.” These terms have been used to capture a variety of specific institutions (e.g., Gerring et al. 2011; Naseemullah and Staniland 2016). We focus on the characteristics of the contract between central rulers and tax-collecting intermediaries. Under indirect rule, local powerholders are granted wide-ranging political and fiscal autonomy in exchange for administering territory and collecting taxes. Intermediaries are generally given longer-term or indefinite contracts and frequently retain independent coercive authority. Examples include the contract between the monarch and lords under feudalism or the model of British indirect rule in much of Africa and South Asia, through which local authorities maintained considerable power and autonomy under the colonial state. Because it is costly and difficult to replace an intermediary under indirect rule, central authorities encourage compliance primarily through ceding revenue and autonomy to local intermediaries.

Under direct rule, by contrast, a central ruler exerts tighter control over tax-collecting intermediaries through an institutionalized bureaucracy, making it easier to fire and replace those who underperform. By leaning on monitoring and punishment, a central ruler can lower the amount of compensation offered to intermediaries, retaining a greater share of tax revenue. However, establishing and sustaining direct rule is costly. To transition to this more centralized contract, a ruler must not only seize power from local potentates in charge of tax collection, but also invest in creating and maintaining a bureaucracy to administer territory.

In deciding whether to centralize authority, rulers face a trade-off. Direct rule offers the promise of greater political control and revenue, but it is also costlier to establish and potentially costlier to maintain than indirect forms of rule that do not require them to bear the cost of monitoring and sanctioning intermediaries. Drawing on the insights of recent work (Johnson and Koyama 2014; Mayshar et al. 2017; Stasavage 2020; Martinez-Bravo et al. 2022), we argue that this trade-off depends critically on fiscal legibility, the quality of independent information available to the central ruler on conditions in the periphery.

When fiscal legibility is low, a ruler cannot discern whether disappointing outcomes (such as lower-than-expected tax revenue) are due to poor intermediary effort or bad conditions. This makes it difficult to directly monitor and sanction intermediaries. As fiscal legibility rises, a ruler is better able to tell when an intermediary's performance is poor, increasing the relative benefits of political centralization. Though the immediate cost of centralizing authority can be high given potentates' independent coercive power and the expense of setting up a direct bureaucracy (e.g., Gerring et al. 2011; Garfias and Sellars 2021), it may be worthwhile for the ruler to pay these costs once legibility rises beyond a certain point. A sudden rise in fiscal legibility should thus encourage political centralization.

Because fiscal legibility is a function not just of exogenous factors but also state-led efforts to collect and disseminate information, the interdependence between informational capacity and political centralization also has implications for longer-term state development. A central ruler is only willing to invest in improving fiscal legibility when the benefits of doing so exceed the costs.



Because intermediaries under indirect rule are granted broad autonomy to carry out their tasks on a permanent or semi-permanent basis, a ruler gains little from marginally improving his day-to-day monitoring capacity under these arrangements. By contrast, under more direct forms of rule, even a small increase in fiscal legibility is beneficial. Better information about local conditions improves the ruler's ability to monitor intermediaries under his supervision, allowing him to tighten control and increase the share of revenue that he can retain.

Political centralization and fiscal legibility thus go hand-in-hand. Direct rule is only beneficial for rulers when fiscal legibility is sufficiently high, and it is only when governance is organized under direct rule (or when an imminent transition to direct rule is expected) that investing in improving fiscal legibility is worthwhile. This interdependence leads to divergence in state institutions between areas of high or low initial legibility. Where legibility is very low, improving informational capacity to the point where it would be advantageous to centralize political control would require a substantial investment over a long period, which is often not worthwhile. Where legibility is high enough, the ruler will move to centralize authority and then invest in improving informational capacity, further reinforcing the benefits of centralization.

An exogenous increase in fiscal legibility can therefore have marked long-term consequences on the trajectory of political centralization and state development. A sudden improvement in fiscal legibility can induce a ruler to invest in centralizing power and then in further improving legibility. This enhances the benefits of direct rule, making it easier to retain centralized control even when the costs of direct administration rise. By contrast, areas where legibility remains low can become locked in a path of indirect rule and low state informational capacity over the long term.

## **2.1 Observable Implications**

In the remainder of this paper, we provide empirical evidence in support of this argument, focusing on the following observable implications.

1. An exogenous increase in fiscal legibility should encourage political centralization by improving the ruler's ability to monitor intermediaries and thus the benefits of direct rule.

2. Because of the interdependence between fiscal legibility and political centralization, this shock should also increase long-term state investment in informational capacity to improve the ruler's ability to directly monitor agents.
3. By inducing long-term investment in both centralization and improving informational capacity, a single increase in fiscal legibility can enable the ruler to retain centralized political control over the long term, even when the costs of direct administration rise under subsequent governance crises.

### **3. Context**

We examine the transition from indirect to direct rule in colonial Mexico around the time of a technological innovation that enhanced the Crown's ability to monitor local economic production in some areas.

#### **3.1 Indirect Rule in Early Colonial Mexico**

The Conquest and early political organization of New Spain relied on the cooperation of conquistadors and other elite intermediaries to extend political control over the distant territory. The institution of the *encomienda* was central to this arrangement. Under the *encomienda*, an elite intermediary (*encomendero*) was given the right to extract tribute and labor from the local population in exchange for bearing the cost of local tax collection, pacification, and Christian conversion. Like British indirect rule in Africa or South Asia, the *encomienda* was built using pre-existing institutions, most notably the tribute network of the Triple Alliance/Aztec Empire. This enabled the Crown to quickly extend its control over territory without having to invest in developing a centralized bureaucracy to monitor, tax, and police the periphery (Zavala 1973; Knight 2002; García Martínez 2011; Garfias and Sellars 2021).

In the early colonial period, when the Crown had little information about its holdings and limited control over the territory, much of the colony was administered via the *encomienda*.<sup>1</sup> However, this was costly for the Crown; by ceding revenue and autonomy to *encomenderos*, it created a

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<sup>1</sup>Some areas, notably Tlaxcala and areas of low pre-colonial settlement, never received *encomiendas*. These areas are excluded from our analysis.

class of powerful elites with independent coercive authority who could not be easily supplanted. Within a generation of the Conquest, the Crown had begun to centralize power, gradually replacing *encomiendas* with *corregimientos*, public offices with salaried officials who could be hired and fired by the central government (Zavala 1973; Hassig 1985; Knight 2002).

The contract for the holders of these public offices, the *corregidores*<sup>2</sup>, differed substantially from that of the *encomenderos*. Importantly, these officeholders were under more direct control of the Crown. Unlike *encomenderos*, who typically held their position for the duration of their lives and could even initially pass on the office to their heirs, *corregidores* were typically appointed for a single year by viceregal authorities (Gibson 1964, p. 84). They could be, and often were, replaced at the end of their term and dispatched to other districts (Gibson 1964). Also unlike *encomenderos*, the *corregidores* received a salary from the government.<sup>3</sup> The amount of compensation differed substantially from what was received by *encomenderos*, who were typically ceded a sizable share of local tax revenue.<sup>4</sup> As Gibson (1964) writes, for intermediaries “the smallest *encomiendas* yielded incomes larger than the best-paid *corregimientos*” (p. 83), leaving more surplus for the Crown.<sup>5</sup>

The move to *corregimiento* enabled the central government to exert greater control over intermediaries and retain more revenue. However, the transition to more centralized control was costly and difficult. *Encomenderos* controlled local coercive power, and they resisted attempts to centralize authority, at times by force (Gibson 1964; Yeager 1995; Knight 2002; Garfias and Sellars 2021). Moreover, the move to direct rule meant that royal officials would have to bear the cost of policing and

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<sup>2</sup>Other terms used for these local civil authorities included *alcaldes mayores*, *justicias*, and *subdelegados*. There were a few minor differences between these offices in the early colonial period but little substantive distinction (Gibson 1964, p. 82; Gerhard 1993a, p. 14).

<sup>3</sup>Salaries were initially drawn from locally collected tribute in a specified formula, though the compensation scheme evolved over time. There were more fundamental changes in this institution in the late 17th and early 18th centuries (Section 6.2).

<sup>4</sup>It was proposed that *encomendero* tribute revenues be subject to the royal fifth, a 20% tax (Zavala 1973, p. 48, 69). Though extent of early implementation is unclear, by 1537 *encomenderos* were indeed being taxed according to royal officials (Zavala 1973, p. 70).

<sup>5</sup>Tribute was extracted in similar ways under *encomienda* and *corregimiento*. Differences in the regulation of labor in this period were modest in practice, and there is no evidence that centralization entailed a major shift in local labor relations. Reliance on uncompensated labor through either institution became increasingly rare by the 1540s. The allocation of labor in tribute schedules was formally abolished in 1549 (e.g., Gibson 1964, p. 83, 223–6).

monitoring the local population, costly tasks that had previously been delegated to intermediaries with better local knowledge.

The transition to direct rule was uneven across space and time. Some *encomiendas* were dissolved by the early 1530s, while others were continuously reassigned to private holders, surviving for centuries until the end of the colonial period. Scholars have proposed several explanations for when, where, and why royal officials chose to centralize power, including differences in the value of holdings (Yeager 1995), in a district's strategic military importance (Pastore 1998), or in the threat of domestic conflict (Garfias and Sellars 2021). We examine the complementary role of fiscal legibility: the Crown's ability to observe local economic production.

The move to direct rule required the Crown to take on a stronger role in monitoring local officials, which required observing local conditions. As we argue in Section 2, the relative benefits of direct over indirect rule depend critically on a ruler's ability to independently observe local conditions. In places with high initial legibility, such as around Mexico City, direct rule would have been more attractive. By contrast, in frontier zones or places of ongoing insurgency, it would have been difficult for officials to independently evaluate whether an intermediary was underperforming. The Crown thus relied on indirect rule in low-legibility areas, allowing *encomenderos* to remain in their position indefinitely and retain the lion's share of tax receipts.

### **3.2 The Patio Process: An Exogenous Shock to Fiscal Legibility**

We examine the consequences of a technological innovation that dramatically increased the Crown's ability to observe economic production in mining areas: the introduction of the patio (mercury amalgamation) process in the mid-16th century. Silver was the most important commodity extracted from colonial Mexico. The discovery of extensive silver deposits during the Conquest of northern Mexico reshaped the economic structure of the colony toward extracting bullion (e.g., Brading and Cross 1972; Knight 2002, p. 62–64). After rich surface ores in places like Zacatecas and Guanajuato had been depleted, attention turned to mining deeper deposits of silver sulfides, which were considerably more difficult to process (Brading and Cross 1972; Guerrero 2017). The

primary processing technology available, smelting and cupellation, relied on heating ores to a high temperature and treating them with lead. This required a large amount of fuel and imported lead from England, limiting the profitability of processing ores of marginal quality (Brading and Cross 1972; Guerrero 2017).

The introduction of the patio process in the 1550s transformed Mexican silver production. This process relied on mercury amalgamation. Ores would be crushed using a stamp mill or other device and treated with salt and mercury, leaving the silver to form an amalgam with mercury that could be subsequently reheated to extract pure silver (e.g., Brading and Cross 1972, p. 552–6; Guerrero 2017, Ch. 4). This process encouraged the extraction of lower-grade silver sulfide ores common in the Americas (see Appendix Figure C.1), providing the basis for dramatically increasing local production (Brading and Cross 1972; Guerrero 2017).

Crucially, the shift toward refining silver through the patio process improved the Crown's ability to monitor economic production in mining areas. Processing ores required mercury, which had to be imported from Spain.<sup>6</sup> Starting in 1559, the Crown maintained a monopoly over the production, sale, and distribution of mercury, which enabled the Crown to directly observe the demand for the input across space and time. Because silver production used mercury in a known ratio—approximately one mark of silver per pound of mercury—officials could infer how much silver was being produced in different areas (Lang 1977; Brading and Cross 1972).<sup>7</sup> Control over the provision of mercury thus provided a simple and reliable way to cross-reference production figures in silver taxation (e.g., Brading and Cross 1972, p. 570–1; TePaske 2010, p. 105).

This also improved knowledge about economic fluctuations in other sectors tied to taxation. An increase in silver mining stimulated local economies by increasing demand for inputs like salt, fuel,

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<sup>6</sup>During this period, there were only three areas where mercury could be mined at scale, all within the Spanish Empire: Almaden and Idria in Europe, and Huancavelica in Peru. Peruvian mines used locally sourced mercury, but virtually all mercury in colonial Mexico originated in Europe (Brading 1971; Brading and Cross 1972, p. 562).

<sup>7</sup>The accuracy of this ratio, or *correspondencia*, depended in practice on the quality of the mercury and ore and on the skill of refiners. Miners could opt to refine silver through smelting and smuggle their production to avoid taxation, but this was generally unprofitable. See Guerrero (2017).

mining equipment, and especially labor, which accounts for a significant portion of the variable cost of smelting and amalgamation (Guerrero 2017, p. 315). Unlike in Peru, for example, laborers in the Mexican mining sector were generally compensated, even when labor was provided through the forced labor draft or *repartimiento* (Brading and Cross 1972, p. 557–8; Bakewell 1984, p. 123–5; Knight 2002, p. 65). An increase in mining production should therefore increase local wage payments and the demand for local agricultural products, making it easier for nearby communities to pay their tribute dues.

By observing the demand for mercury across space and time, the Crown could thus obtain useful information to determine whether a fall in locally collected tribute revenue was attributable to poor conditions or to intermediary underperformance. In distant areas with little pre-existing state presence, access to this independent source of information dramatically reduced the cost of monitoring and disciplining intermediaries, encouraging the adoption of direct rule. Though intermediaries could, and often did, resist efforts to centralize power, the decision to adopt the patio process was generally made by other actors—mining elites who profited handsomely from the new technology—which surreptitiously opened the door to political centralization. We systematically assess how the introduction of the patio process altered the trajectory of political centralization using subnational panel data and a difference-in-differences empirical strategy.

#### 4. Data

We digitize subnational data on institutions of indirect and direct rule (*encomiendas*) and *corregimientos*) from 1521 (ca. the Conquest) until 1650. Our data come from Gerhard (1993a;b), who compiles a list of *encomiendas* in the early colonial period in central and north-central Mexico (New Spain and Nueva Galicia) at the level of the 1786 administrative region (district). These data include the approximate dates at which each holding remained privately assigned to an *encomendero* or was centralized under Crown control. We calculate the proportion of holdings in each district that had transitioned to direct rule (i.e., *corregimiento*) by the end of each decade.<sup>8</sup>

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<sup>8</sup>We aggregate to the district level to merge with district-level mining data and other covariates. See Appendix A for a detailed description of how each variable was constructed.

Data on early colonial mines come primarily from Hillerkuss (2013), who lists the approximate starting decade of production for known silver and gold mines in colonial Mexico during the 16th century. Because Mexico’s main silver and gold deposits are geologically found in the same locations (Guerrero 2017), we include all mines as the decision to extract silver or gold may be endogenous. We digitize these data and geographically assign each mine to a 1786 administrative region. We code two indicators: whether a district includes a mine and whether the district includes a mine that reported production prior to the introduction of the patio process around 1550. Production often started prior to the dates reported in the Hillerkuss data, but we show results using the restrictive definition in Appendix Section B.2.

We also digitize a series of covariates for use in some specifications, including information on district climate, geographic position, decadal drought conditions, elevation, distance to Mexico City, and the approximate year of European contact. We explain how each of these variables was constructed in Appendix Table A.1. Finally, we digitize and geocode several measures of endogenous fiscal legibility and of the quality of later-colonial political institutions. We describe these data in Section 6.

## 5. Exogenous Shock to Fiscal Legibility and the Transition to Direct Rule

Our argument suggests that an exogenous increase in fiscal legibility should encourage political centralization. We use a difference-in-differences design to compare changes in the adoption of direct rule in districts with and without silver mines before and after the introduction of the patio process in the 1550s, which increased the Crown’s ability to monitor economic conditions in mining areas.<sup>9</sup> We estimate:

$$Direct\ Rule_{it} = \beta_1 Mine_i \times PostPatio\ Process_t + \Theta_t X_i + \Pi U_{i,t} + \lambda_t + \gamma_i + \varepsilon_{it}, \quad (5.1)$$

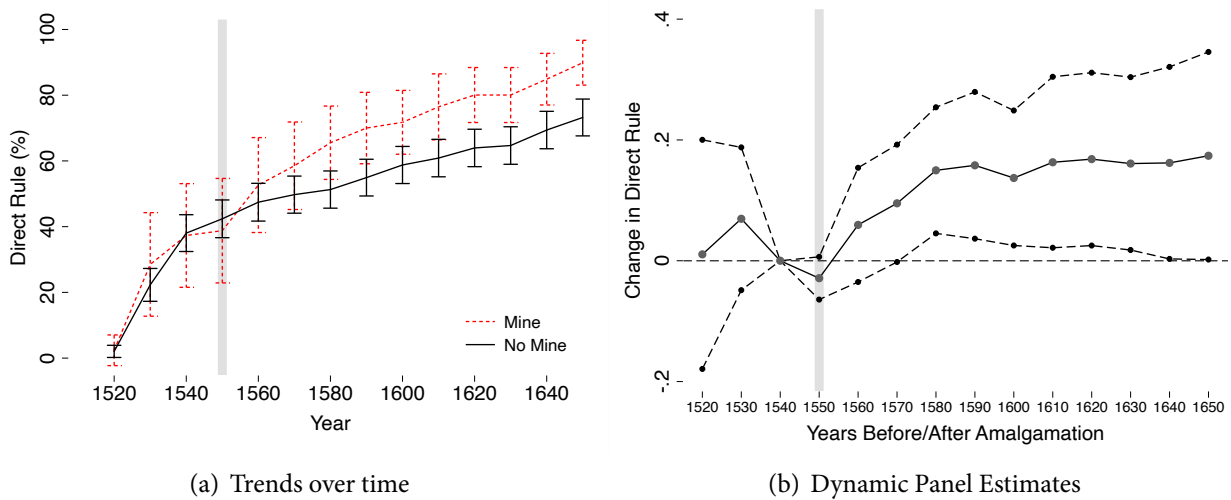
where  $Direct\ Rule_{it}$  is the proportion of *corregimientos* (direct rule) in district  $i$  by decade  $t \in [1520, 1650]$ ;  $Mine_i \times PostPatio\ Process_t$  is an indicator for having at least one silver mine in the district after the discovery of the patio process;  $\lambda_t$  and  $\gamma_i$  are decadal and district indicators respec-

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<sup>9</sup>In Appendix Table A.3, we report baseline covariate differences between mining and non-mining districts. Mining districts are more likely to be in malarial zones and be located in the west (see Appendix Figure A.1), but are otherwise similar on average to non-mining districts.

tively;  $X_i$  are district-specific controls (malarial zone, maize suitability, elevation, log surface area, log walking hours to Mexico City, year of Spanish contact, latitude, and longitude) interacted with each year indicator to allow the trajectory and the level of direct rule adoption to vary by these observables;  $U_{i,t}$  are time-varying climate covariates; and  $\varepsilon_{it}$  is an error term. We cluster standard errors at the district level and also compute Conley standard errors that allow for serial correlation within districts and spatial correlation between districts.

**Figure 1: Silver Mining, Patio Process, and Direct Rule**



The figure on the **left** plots the average proportion of holdings under direct rule with 95% confidence intervals for mining and non-mining districts in each decade. The figure on the **right** displays the point estimates and 95% confidence intervals of decade-by-mining district interactions from a panel regression that includes district and decade fixed effects (full results in Appendix Table ??).

In Figure 1, we present descriptive trends in the adoption of direct rule during this time period. In the left panel, we plot the proportion of *encomiendas* converted into *corregimientos* over the period of analysis for districts with (red) and without (black) mines. As noted in the historical literature, there is a steep increase in political centralization in the decades after the Conquest in both groups. This rapid initial centralization occurred primarily in areas that were previously controlled by the Triple Alliance, where fiscal legibility was plausibly higher as the new colonial administration took control of Mexica fiscal institutions and existing records. Following the discovery of the patio process in the 1550s, mining and non-mining areas begin to diverge as centralization continues at an accelerated



rate in districts with mines and slows in districts without mines.

The right panel of Figure 1 presents a similar pattern, plotting the coefficients of linear interactions between the mining district indicator and indicators for each decade from a panel regression with direct rule as the outcome including district and decade fixed effects. Relative to 1540 (the omitted category), there is no clear difference in direct rule adoption in districts with and without mines before the 1550s. After the introduction of the patio process, however, districts with mines experience a relative increase in the transition to direct rule.

**Table 1:** Patio Process and Direct Rule: Difference-in-Differences

	Direct Rule (% of District)			
	New Spain		New Spain & Nueva Galicia	
	(1)	(2)	(3)	(4)
Any Mine $\times$ Post-Patio Process	0.080** (0.032) {0.035}	0.12*** (0.045) {0.045}	0.13*** (0.040) {0.038}	0.13*** (0.042) {0.038}
Climate Controls	No	Yes	No	Yes
Controls $\times$ Year FE	No	Yes	No	Yes
Year of European Contact $\times$ Year FE	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Within-District Mean of DV	0.51	0.51	0.51	0.52
Within-District SD of DV	0.23	0.22	0.24	0.24
R sq.	0.80	0.84	0.78	0.82
Observations	1680	1624	2016	1960
Number of districts	120	116	144	140

OLS estimations. Unit of analysis is the district-decade. Standard errors clustered at the district level in parentheses. Standard errors allowing for serial correlation within districts and spatial correlation between districts within 500 km are in curly brackets. Time-varying climate data are not available for four districts, which are omitted in the estimations using covariates.

We present our difference-in-differences estimates in Table 1. The adoption of the patio process had a substantial effect on the transition to direct rule in affected areas. The relative increase in direct rule adoption in mining relative to non-mining areas after the sudden increase in fiscal legibility is

between 8–12 percentage points in New Spain (columns 1 and 2) and 13 percentage points across New Spain and Nueva Galicia (in columns 3 and 4). This amounts to between a third and a half of the within-district standard deviation in direct rule adoption. These estimates are statistically significant across specifications with and without the full vector of time-varying and time-interacted controls. Results are unchanged if we narrow the scope to mines that had documented production before the introduction of the patio process in 1554 (Appendix Section B.2).

Our theory generates additional observable implications that can be examined with these data as well. In Appendix Section B.1, we focus on two heterogeneous effects implied by our argument: the effect of the legibility shock should be higher where pre-shock legibility was lower (because the informational benefits of the shock should be greater) and lower where the cost of transition to direct rule was higher (because this should increase the barriers to political centralization). Consistent with our theory, we show that the increase in direct rule adoption was larger outside the pre-colonial Triple Alliance tribute network and farther from Mexico City, where the colonial state particularly lacked information, and in districts with a lower potential for rebellion, where the cost of transition was plausibly lower.

### **5.1 Evidence on the Legibility Mechanism**

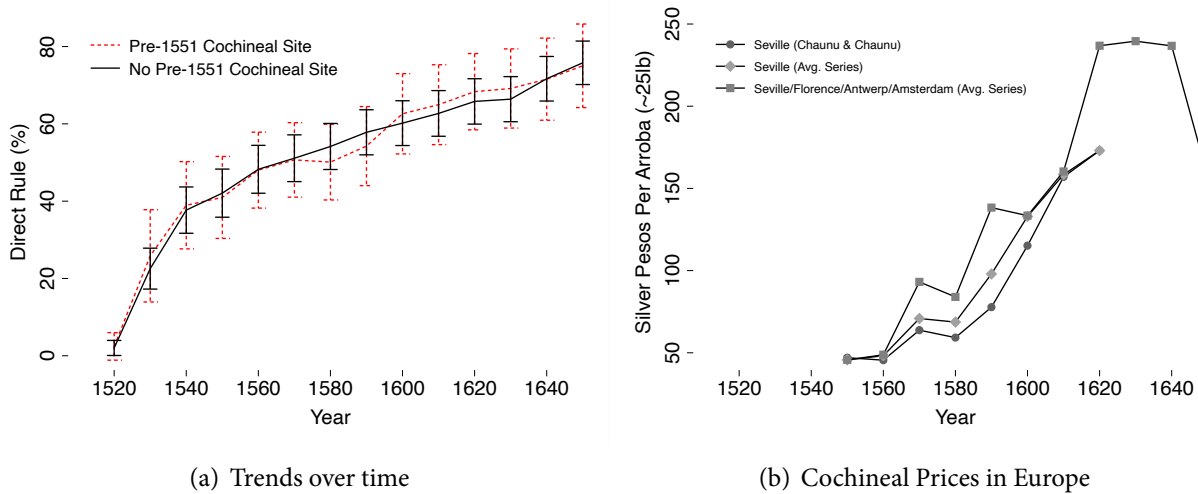
The results of the previous subsection are consistent with our argument. However, it is reasonable to wonder whether the observed increase in centralization in mining areas was due to a rise in fiscal legibility with the introduction of the patio process as opposed to other factors. In addition to enabling the Crown to better monitor production, the patio process increased the profitability of mining ores in much of Mexico (Guerrero 2017). We consider whether increased profitability or revenue potential, rather than fiscal legibility, might explain our findings.

Because there is little information on mining profits or payments across districts and over time, we adopt two indirect strategies to assess this alternative mechanism. In Appendix Section B.1, we show that the effect of the legibility shock on centralization was higher in areas *farther* from Mexico City and *outside* the tribute network of the Triple Alliance. This is consistent with our legibility-focused

argument and difficult to reconcile with the alternative mechanism as the value of increasing silver production should be lower (not higher) in areas farther from trade networks and Mexico City. We provide evidence further casting doubt on the profitability argument by examining the effects of a sudden increase in the value of another colonial commodity, cochineal dye, on the adoption of direct rule.

Cochineal was an important commodity extracted from the colony, arguably second only to silver in its importance. Between 1580 and 1620, the international market price for cochineal increased threefold, driven by a sharp increase in European demand. This led to a dramatic increase in the profitability of cochineal production—a much higher increase, in fact, than the estimated effect of the patio process on silver-extraction profitability (see Appendix Section C for a detailed comparison). We combine information on districts that were producing cochineal prior to this shock and European price trends to assess whether this rise in profitability led to a disproportionate increase in political centralization from *encomienda* to *corregimiento*.

**Figure 2:** Cochineal-Producing Sites, Cochineal Price Shock, and Direct Rule



The **left** figure plots the average proportion of holdings under direct rule with 95% confidence intervals for cochineal-producing and non-producing districts in each decade. The **right** figure displays a cochineal price series from various sources. See Appendix Section C for sources and a detailed description of the construction of the data.

Figure 2 compares the average proportion of holdings under direct rule in cochineal-producing

and non-producing districts around the time of the price shock (left) alongside a graph of European cochineal prices over time. As the figure shows, despite the dramatic climb in cochineal prices and demand in Europe beginning in the late 16th century, there was no corresponding acceleration in direct rule adoption in cochineal-producing districts. We present a more detailed analysis in Appendix Section C using a similar empirical strategy as in the previous section, now interacting an indicator for cochineal production in a district with the price of cochineal over time. We find that the remarkable increase in cochineal's profitability did not lead to a differential adoption of direct rule in cochineal-producing districts. Our estimates are not statistically distinguishable from zero in any specification and are very small in magnitude.

The cochineal boom greatly increased the revenue potential of cochineal-producing areas, but there was no corresponding increase in fiscal legibility as had occurred with the discovery of the patio process. Direct monitoring and taxation remained difficult in cochineal-producing areas, so this substantial economic boom did not increase political centralization. Alongside the evidence above and in the appendix (see Appendix Section B.1), these null findings results provide support for our proposed mechanism.

## **6. Long-Term State Development**

The prior section shows how the introduction of the patio process to refine silver facilitated political centralization in early colonial Mexico. Through its royal monopoly over the distribution and sale of mercury, the Crown gained insight into local economic conditions that would have been otherwise difficult to observe, which enabled a transition to direct rule. We explore a second set of empirical implications of our argument related to the dynamic interaction between fiscal legibility and political centralization.

Our theory predicts that political centralization should encourage investment in state informational capacity to improve monitoring capacity. Enogenous improvements in information capacity should in turn enable authorities to retain direct rule. An exogenous increase in fiscal legibility can therefore lead to longer-term divergence in state institutions. In affected areas, authorities will seek to centralize

authority, continue to invest in improving in fiscal legibility, and further centralize power. Areas where fiscal legibility remains low, by contrast, will remain under indirect rule and the ruler will have little incentive to invest in either political centralization or in improving fiscal legibility.

We assess this divergence argument in two steps. We first examine one investment made by the colonial state to increase fiscal legibility in the periphery: the establishment and placement of state-run post offices (*estafetas*).<sup>10</sup> We then explore the longer-term implications for state development, focusing on a period when many areas reverted to more indirect forms of rule.

### 6.1 Divergence in Fiscal Legibility

In addition to being a common measure of state capacity and public investment (e.g., Rogowski et al. 2022), post offices represent an important investment in local fiscal legibility by facilitating communication between the periphery and the center. Postal operations had been delegated to private agents (*Correos Mayores*) before being integrated into the fiscal administration in 1766. As the Marquis of Sonora noted in the 1770s, there were benefits in expanding postal access in underserved areas, “even if they [yielded] little revenue” (quoted in Velarde et al. 1908, p. 338) to expedite information transmission between private actors and the central government.

We examine the differential placement of post offices in areas that were and were not affected by the introduction of the patio process in the early colonial period. Our data come from Stangl (2019), who identifies the location of post offices at the end of the colonial period using archival records. We construct two variables: whether a district contained a post office by the early 19th century and the least-cost walking time from the district to the nearest post office based on colonial-era land cover, elevation, and terrain slope.<sup>11</sup> We also examine the present-day coverage of the Mexican postal service as our divergence argument suggests that baseline differences in fiscal legibility and state presence should persist despite substantial changes in postal administration.<sup>12</sup>

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<sup>10</sup>In Appendix Section B.3, we also examine a separate measure of state investment in local fiscal legibility: the construction of *Cajas Reales* or royal treasuries across space and time.

<sup>11</sup>See Appendix Section D for a description of the construction of our walking-time measures.

<sup>12</sup>We code a municipality as being exposed to the patio-process shock if it overlaps an affected colonial district as contemporary administrative boundaries do not nest in colonial political units.

We present conditional correlations between exposure to the legibility shock in the 1550s (i.e., districts with mines in the early colonial period) and longer-term investment in legibility in Table 2. We include the time-invariant covariates described in equation (5.1), also adding an indicator for early cochineal production. We report standard errors that are robust to heteroskedasticity and to spatial correlation between districts within 500 km of each other.

A potential concern is that mining districts may vary substantially from non-mining areas along a number of unobserved dimensions. To address this concern, we present an alternative comparison that seeks to more closely isolate the role of legibility (as opposed to ongoing profitability or other factors) in explaining long-term outcomes. We identify districts that had an active silver or gold mine in the 16th century, and were therefore affected by the introduction the patio process, but where mining activities had ceased prior to the mid-18th century due to resource depletion or other factors. We then compare these defunct mining districts to districts that did not have mines in either period to rule out ongoing mining as a factor to explain long-term institutional divergence. To construct this alternative comparison group, we use information from the 1746 *Theatro Americano*, as transcribed and organized by Commons and Coll-Hurtado (2002). The *Theatro* was an exhaustive and confidential official report that provided geographic, sociodemographic, and economic information of districts across the territory during the 1740s, including information on ongoing mining production.

The first four columns of Table 2 indicate that areas with 16th-century mines had substantially better access to post services by the end of the colonial period than those without. Districts with early colonial mines are between 70 and 90 percent closer to a post office relative to non-mining districts, and they are between 14 and 17 percentage points more likely to have a post office in the district (Panel A). The magnitude of coefficient estimates is very similar when excluding districts with ongoing silver mining by the 1740s (Panel B), though these estimates are not statistically significant at conventional levels when including the full set of covariates. Even today (columns 5 and 6), contemporary municipalities that overlap colonial districts with early mines are more likely to have

**Table 2: Divergence in Long-Term Fiscal Legibility and Institutional Resilience**

<b>Panel A:</b>	Districts in Regions with Indirect/Direct Rule Institutions							
	Walking Hours to Colonial Post Office (log)		Any Colonial Post Office (1766–1810)		Any Present-Day Post Office		Number of Office Sales (1702–1750)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
16th Century Mine	-0.90** (0.37) {0.47}	-0.73* (0.37) {0.38}	0.17*** (0.063) {0.082}	0.14** (0.064) {0.068}	0.28*** (0.027) {0.061}	0.060** (0.029) {0.043}	-1.15** (0.56) {0.76}	-0.59 (0.51) {0.49}
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Mean of DV	1.30	1.30	0.77	0.77	0.45	0.45	2.93	2.93
SD of DV	2.42	2.42	0.42	0.42	0.50	0.50	3.31	3.31
R sq.	0.019	0.17	0.022	0.17	0.047	0.30	0.016	0.29
Observations	196	196	196	196	1993	1993	196	196

<b>Panel B:</b>	Exhausted Mines vs Non-Mining Districts (Excluding Districts with Ongoing Mining by 1740)							
	Walking Hours to Colonial Post Office (log)		Any Colonial Post Office (1766–1810)		Any Present-Day Post Office		Number of Office Sales (1702–1750)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
16th Century Mine	-0.94* (0.57) {0.55}	-0.65 (0.64) {0.57}	0.19** (0.087) {0.084}	0.12 (0.10) {0.090}	0.30*** (0.037) {0.082}	0.13*** (0.039) {0.069}	-2.12*** (0.74) {0.72}	-2.10*** (0.71) {0.66}
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Mean of DV	1.38	1.38	0.75	0.75	0.42	0.42	2.96	2.96
SD of DV	2.47	2.47	0.43	0.43	0.49	0.49	3.37	3.37
R sq.	0.0098	0.17	0.013	0.16	0.033	0.31	0.027	0.30
Observations	177	177	177	177	1792	1792	177	177

OLS estimations. Unit of analysis is the colonial district in columns 1–4 and 7–8 and contemporary municipality in columns 5–6. Robust standard errors in parentheses. Standard errors that allow for spatial correlation between districts within 500 km of each other in curly brackets. Covariates include an indicator for cochineal production in the 16th century and malarial zone, maize suitability, elevation, log surface area, log walking hours to Mexico City (log distance for present-day outcomes), year of Spanish contact, latitude, and longitude.

a post office than those that do not, including when focusing only on districts where large-scale mining no longer took place by the 1740s. This evidence is consistent with the argument that the initial boost in fiscal legibility led to longer-term divergence in state development in affected areas, even in areas where mining had been abandoned, and even long after the colonial period.

## 6.2 Divergence in Institutional Resilience

We finally examine the longer-term institutional consequences of the introduction of the patio process. Our theory suggests that the earlier accumulation of information and consolidation of

authority should make it easier retain centralized control over intermediaries in affected areas, even when the state is revenue-constrained and may be tempted to outsource authority to private agents through indirect rule.

We assess this prediction using a similar cross-sectional research design and data on an institutional shift in colonial administration in the late 17th century. Mired in conflict in Europe, the Crown became increasingly unable and unwilling to invest in improving political control of New Spain (e.g., Knight 2002). To raise revenue, authorities began to commodify and sell colonial offices for short-term gain, including the office of *corregidor* in many districts.

Though maintaining the same name, the *corregimiento* of this period was a different contract and operated as a new form of indirect rule. Private individuals could bid for open positions through the *Cámara de Indias*, implicitly purchasing the right to extract economic resources from the district for a specified period of time. The Crown exerted little direct control over those who had purchased offices and ceased to pay direct salaries to *corregidores* (e.g., Pietschmann 1972). This implicit privatization had negative consequences for the quality of governance as officeholders sought to recoup their investment through various forms of corruption (e.g., Pietschmann 1972; Guardado 2018; Garfias and Sellars 2020). Not all offices were sold, however, and some districts remained under Crown control even during this period of imperial disinvestment.

We digitize data on office sales in central Mexico from 1702 to 1750 using archival information transcribed by Pietschmann (1972). We record the number of sales in each district, reflecting the willingness of the Crown to outsource district administration. Because earlier improvements in fiscal legibility and political control should reduce the relative benefits of outsourcing governance to private individuals, there should be fewer office sales in areas exposed to the 16th-century legibility shock.

The results on office selling (Columns 7 and 8 of Table 2) indeed suggest that districts exposed to the patio process shock were more resilient to institutional decline in the 17th and early 18th centuries. Areas with 16th-century mines were less likely to be sold at auction—up to half as often—between



1702 and 1750, remaining more often under Crown control. This relationship does not appear to be driven by a desire to maintain Crown control over silver production. If anything, the relationship appears to be amplified when restricting attention to areas without ongoing silver mining by the 18th century.<sup>13</sup> Given the well-documented connection between the practice of office selling and official corruption (e.g., Pietschmann 1972; Guardado 2018; Garfias and Sellars 2020), this result illustrates a connection between the legibility shock of the early colonial period and the quality of local governance over a century later.

## 7. Conclusion

How does a shift in fiscal legibility—the ability of central authorities to observe economic conditions for the purposes of taxation and control—alter a ruler’s incentive to centralize power and further invest in informational capacity? We argue that a ruler can be better off ceding autonomy and revenue to local elites in low-information environments as a way to encourage performance when the cost of monitoring is high. As fiscal legibility improves, it becomes easier for the ruler to discern when intermediaries are underperforming. This makes it possible for the ruler to tighten control over intermediaries and retain a greater proportion of tax revenues. Political centralization in turn encourages additional endogenous investments in improving fiscal legibility to make it easier for central authorities to monitor and sanction tax-collecting intermediaries in the periphery.

This relationship generates path dependence in fiscal legibility and the form of rule over time. Low initial legibility can set a region on a long-term path of persistently low state informational capacity, where the central authority relies on indirect rule and thus does not benefit from investing to improve local monitoring. A sudden increase in fiscal legibility has the potential to alter this trajectory by lowering the barriers to centralization and making it advantageous for the ruler to start investing in future legibility for an eventual transition to direct rule. A single shock to fiscal legibility can thus have important long-term consequences on institutional development.

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<sup>13</sup>The effect of ongoing silver mining on office sales is potentially ambiguous as the higher revenue potential of these areas would have attracted higher private bids for these positions, an important consideration for a revenue-constrained ruler.

We provide empirical support for the theory using subnational data from colonial Mexico. In the aftermath of the Conquest, the Spanish Crown yielded considerable authority to local elites as a way of maintaining political control over newly conquered territory. Efforts to centralize power differed considerably across space. An important technological innovation in silver refining, the introduction of the patio process in the 1550s, greatly increased the Crown's ability to independently monitor economic conditions in mining districts. Using a difference-in-differences empirical strategy, we show that mining areas saw a differential increase in centralization efforts following the introduction of the patio process. We provide evidence that the observed increase in political centralization was due to the informational consequences of the patio process (as opposed to the increase in potential revenue) by examining a major revenue shock in another important commodity, cochineal dye, which did not shift the trajectory of political centralization.

We then document some of the longer-term consequences of this shock to fiscal legibility. We show that affected districts saw disproportionate state investment in improving informational capacity through the establishment of state-run post offices, contributing to additional divergence in fiscal legibility. This divergence had important consequences for long-term institutional development, shielding affected districts from being outsourced to private rent-seekers during a key period of state disinvestment from colonial governance in the early 18th century. These long-term results persist even when restricting attention to areas without ongoing silver production by the 1740s. These results illustrate a connection between fiscal legibility, political centralization, and institutional development.

The features of our context allow us to provide quasi-experimental evidence on the link between fiscal legibility and political centralization, a link that others have examined theoretically, qualitatively, and cross-sectionally (e.g., Sng 2014; Ma and Rubin 2019; Ahmed and Stasavage 2020). The relationships that we document are not unique to colonial Mexico. Others have established that differences in the observability of local agricultural production in Egypt and Mesopotamia led to very different paths of state development, including via differing incentives for political centralization

(Scott 2017; Mayshar et al. 2017). Similarly, Stasavage (2020) suggests that the adoption of forms of legible agricultural production in ancient China led to the development of an early and relatively centralized bureaucracy. In early modern European polities, including the Dutch republic and France, the presence of highly heterogeneous and fragmented local economies has been linked to the persistence of indirect tax collection, in part to save on the high costs of monitoring agents (Johnson and Koyama 2014). Recent work on the rise and decline of local elections in China posits a similar connection between local informational capacity and incentives to centralize authority (Martinez-Bravo et al. 2022).

More generally, many scholars have examined how and why rulers might choose to enhance fiscal legibility over time to improve revenue collection and tighten political control. Stasavage (2020), for instance, highlights the role of endogenous technological innovations in legibility, such as writing, geometry, and land surveying techniques, which facilitated the development of early state bureaucracies. Building on these insights, our theoretical framework highlights when investments in fiscal legibility—such as conducting censuses, creating property registers, or constructing tax offices and post offices—are likely to be worthwhile depending on the trajectory of political centralization and on the initial level of legibility.

The dynamics that we highlight have important implications for long-term state development. In peripheral areas where initial fiscal legibility is very low, there may be little incentive for central authorities to move toward more direct forms of rule and thus little incentive to invest in state informational capacity. Indirect forms of rule may thus persist for long periods of time. In other areas, the dynamics can work in the opposite direction. A move toward political centralization can encourage investment in fiscal legibility, helping in turn to consolidate direct control over territory. A single shock that raises fiscal legibility can thus have far-reaching consequences, enabling central authorities to tighten control, retain more revenue, and build a more centralized state for the future.

## References

- Ahmed, Ali T. and David Stasavage. 2020. "Origins of Early Democracy." *American Political Science Review* 114(2):502–518.
- Bakewell, Peter. 1984. Mining in Colonial Spanish America. In *Cambridge History of Latin America*, Vol. 2, ed. Leslie Bethell. Cambridge University Press.
- Balán, Pablo, Augustin Bergeron, Gabriel Tourek, and Jonathan L. Weigel. 2022. "Local Elites As State Capacity: How City Chiefs Use Local Information To Increase Tax Compliance In The D.R. Congo." *American Economic Review* 112(3):762–797.
- Boone, Catherine. 2003. *Political Topographies of the African State*. Cambridge University Press.
- Brading, David A. 1971. *Miners and Merchants in Bourbon Mexico, 1763-1810*. Cambridge University Press.
- Brading, David and Henry E. Cross. 1972. "Colonial Silver Mining: Mexico and Peru." *The Hispanic American Historical Review* 52(4):545–579.
- Brambor, Thomas, Agustín Goenaga, Johannes Lindvall, and Jan Teorell. 2020. "The Lay of the Land: Information Capacity and the Modern State." *Comparative Political Studies* 53(2):175–213.
- Carneiro, Robert L. 1970. "A Theory of the Origin of the State." *Science* 169(3947):733–738.
- Christensen, Darin and Francisco Garfias. 2021. "The Politics of Property Taxation: Fiscal Infrastructure and Electoral Incentives in Brazil." *Journal of Politics* 83(4):1399–1416.
- Commons, Áurea and Atlántida Coll-Hurtado. 2002. *Geografía histórica de México en el siglo XVIII: Análisis del Theatro Americano*. UNAM.
- Dal Bo, Ernesto, Pablo Hernández, and Sebastián Mazzuca. 2022. "The Paradox of Civilization. Pre-Institutional Sources of Security and Prosperity." *American Political Science Review* 116(1):213–230.
- D'Arcy, Michelle and Marina Nistotskaya. 2018. "The Early Modern Origins of Contemporary European Tax Outcomes." *European Journal of Political Research* 57(1):47–67.
- Fernández-Villaverde, Jesús, Mark Koyama, Youhong Lin, and Tuan-Hwee Sng. 2020. "The Fractured-Land Hypothesis." *NBER Working Paper* .

- Gailmard, Sean. 2017. "Building a New Imperial State: The Strategic Foundations of Separation of Powers in America." *American Political Science Review* 111(4):668–685.
- Gailmard, Sean. 2019. "Imperial Politics, English Law, and the Strategic Foundations of Constitutional Review in America." *American Political Science Review* 113:778 – 795.
- Gailmard, Sean and John W. Patty. 2012. "Formal Models of Bureaucracy." *Annual Review of Political Science* 15(1):353–377.
- García Martínez, Bernardo. 2011. "Encomenderos españoles y British Residents. El sistema de dominio indirecto desde la perspectiva novohispana." *Historia Mexicana* 60(4):1915–1978.
- Garfias, Francisco and Emily A. Sellars. 2020. "Epidemics, Rent Extraction, and the Value of Holding Office." *Journal of Political Institutions and Political Economy* 1(4):559–583.
- Garfias, Francisco and Emily A. Sellars. 2021. "From Conquest to Centralization: Domestic Conflict and the Transition to Direct Rule." *Journal of Politics* 83(3):992–1009.
- Gennaioli, Nicola and Joachim Voth. 2015. "State Capacity and Military Conflict." *Review of Economic Studies* 82(4):1409–1448.
- Gerhard, Peter. 1993a. *A guide to the Historical Geography of New Spain*. University of Oklahoma Press.
- Gerhard, Peter. 1993b. *The North Frontier of New Spain*. Norman, OK: University of Oklahoma Press.
- Gerring, John, Daniel Ziblatt, Johan Van Gorp, and Julián Arévalo. 2011. "An Institutional Theory of Direct and Indirect Rule." *World Politics* 63(3):377–433.
- Gibson, Charles. 1964. *The Aztecs Under Spanish Rule: A History of the Indians of the Valley of Mexico, 1519-1810*. Stanford University Press.
- Guardado, Jenny. 2018. "Office-Selling, Corruption, and Long-Term Development in Peru." *American Political Science Review* 112(4):971–995.
- Guerrero, Saúl. 2017. *Silver by Fire, Silver by Mercury: A Chemical History of Silver Refining in New Spain and Mexico, 16th to 19th Centuries*. Brill.
- Harbers, Imke. 2020. "Legal Identity for All? Gender Inequality in the Timing of Birth Registration in Mexico." *World Development* 128(4):1–11.

- Hassan, Mai. 2020. *Regime Threats and State Solutions: Bureaucratic Loyalty and Embeddedness in Kenya*. Cambridge University Press.
- Hassig, Ross. 1985. *Trade, Tribute, and Transportation: The Sixteenth-Century Political Economy of the Valley of Mexico*. University of Oklahoma Press.
- Herbst, Jeffrey. 2000. *States and Power in Africa: Comparative Lessons in Authority and Control*. Princeton University Press.
- Hillerkuss, Thomas. 2013. "Las minas de la Nueva España en los mapas del Siglo XVI. ¿Un secreto del Estado?" *Apuntes* 26(1):10–25.
- Hollenbach, Florian and Thiago Silva. 2019. "Fiscal Capacity and Inequality: Evidence from Brazilian Municipalities." *Journal of Politics* 81(4):1434–1445.
- Hunter, Wendy and Robert Brill. 2016. "Documents, Please." *World Politics* 68(2):191–228.
- Iyer, Lakshmi. 2010. "Direct Versus Indirect Colonial Rule in India: Long-Term Consequences." *The Review of Economics and Statistics* 92(4):693–713.
- Johnson, Noel D. and Mark Koyama. 2014. "Tax Farming and the Origins of State Capacity in England and France." *Explorations in Economic History* 51(1–20).
- Kain, Roger J P and Elizabeth Baigent. 1992. *The Cadastral Map in the Service of the State: A History of Property Mapping*. University of Chicago Press.
- Kasara, Kimuli. 2007. "Tax Me If You Can: Ethnic Geography, Democracy, and the Taxation of Agriculture in Africa." *American Political Science Review* 101(1):159–172.
- Knight, Alan. 2002. *Mexico: The Colonial Era*. New York, NY: Cambridge University Press.
- Koyama, Mark, Chiaki Moriguchi, and Tuan-Hwee Sng. 2018. "Geopolitics and Asia's Little Divergence: State Building in China and Japan After 1850." *Journal of Economic Behavior & Organization* 155:178–204.
- Lang, M. F. 1977. *El monopolio estatal del mercurio en el México colonial, 1550–1710*. Fondo de Cultura Económica.
- Lange, Matthew K. 2004. "British Colonial Legacies and Political Development." *World Development* 32(6):905–922.

- Lee, Melissa M. and Nan Zhang. 2017. "Legibility and the Informational Foundations of State Capacity." *Journal of Politics* 79(1):118–132.
- Levi, Margaret. 1988. *Of Rule and Revenue*. University of California Press.
- Ma, Debin and Jared Rubin. 2019. "The Paradox of Power: Principal-Agent Problems and Administrative Capacity in Imperial China (and Other Absolutist Regimes)." *Journal of Comparative Economics* 47:277–294.
- Martinez-Bravo, Monica, Gerard Padró i Miquel, Nancy Qian, and Yang Yao. 2022. "The Rise and Fall of Local Elections in China." *American Economic Review* 112(9):2921–2958.
- Mayshar, Joram, Omer Moav, and Luigi Pascali. 2022. "The Origin of the State: Land Productivity or Appropriability?" *Journal of Political Economy* 140(4):1091–1144.
- Mayshar, Joram, Omer Moav, and Zvika Neeman. 2017. "Geography, Transparency, and Institutions." *American Political Science Review* 111(3):622–636.
- Michalopoulos, Stelios and Elias Papaioannou. 2013. "Pre-colonial Ethnic Institutions and Contemporary African Development." *Econometrica* 81(1):113–152.
- Naseemullah, Adnan and Paul Staniland. 2016. "Indirect Rule and Varieties of Governance." *Governance* 29(1):13–30.
- Osafo-Kwaako, Philip and James Robinson. 2013. "Political Centralization in Pre-Colonial Africa." *Journal of Comparative Economics* 41(1):534–564.
- Pastore, Mario. 1998. "Government, Taxation, Coercion, and Ideology: A Comment on Yeager." *The Journal of Economic History* 58(2):511–520.
- Patty, John W. and Ian R. Turner. 2021. "Ex Post Review and Expert Policy Making: When Does Oversight Reduce Accountability?" *Journal of Politics* 83(1):23–39.
- Pietschmann, Horst. 1972. "Alcaldes mayores, 'corregidores' und 'subdelegados': Zum Problem der Distriktsbeamtenschaft im Vizekönigreich Neuspanien." *Jahrbuch für Geschichte Lateinamerikas* 9:173–269.
- Rogowski, Jon C., John Gerring, Matthew Maguire, and Lee Cojocar. 2022. "Public Infrastructure and Economic Development: Evidence from Postal Systems." *American Journal of Political Science* 66(4):885–901.

- Sánchez de la Sierra, Raúl. 2020. "On the Origins of the State: Stationary Bandits and Taxation in Eastern Congo." *Journal of Political Economy* 128(1):32–74.
- Sánchez-Talanquer, Mariano. 2020. "One-Eyed State: The Politics of Legibility and Property Taxation." *Latin American Politics and Society* 63(3).
- Scott, James C. 1998. *Seeing Like a State*. Yale University Press.
- Scott, James C. 2017. *Against the Grain*. Yale University Press.
- Slantchev, Branislav L. and Tory A. Kravitz. 2019. "No Taxation Without Administration: Wealth Assessment in the Formation of the Fiscal State." *Working Paper*.  
**URL:** <https://www.wallis.rochester.edu/assets/pdf/walliseminarseries/no-taxation-without-administration.pdf>
- Slater, Dan. 2010. *Ordering Power: Contentious Politics and Authoritarian Leviathans in Southeast Asia*. Cambridge University Press.
- Sng, Tuan-Hwee. 2014. "Size and Dynastic Decline: The Principal-Agent Problem in Late Imperial China, 1700–1850." *Explorations in Economic History* 54:107–127.
- Stangl, Werner. 2019. "Post Offices of Spanish America, 1765-1808." *Harvard Dataverse* .
- Stasavage, David. 2020. *The Decline and Rise of Democracy: A Global History from Antiquity to Today*. Cambridge University Press.
- Suryanarayan, Pavithra and Steven White. 2021. "Slavery, Reconstruction, and Bureaucratic Capacity in the American South." *American Political Science Review* 115(2):568–584.
- TePaske, John J. 2010. *A New World of Gold and Silver*. Brill.
- Tilly, Charles. 1990. *Coercion, Capital, and European States, A.D. 990-1990*. Blackwell.
- Velarde, José, Manuel San Juan, and Justino Obregón M. 1908. *Apuntes y documentos para la historia del correo en México*. Imprenta de Ignacio Escalante.
- Yeager, Timothy J. 1995. "Encomienda or Slavery? The Spanish Crown's Choice of Labor Organization in Sixteenth-Century Spanish America." *The Journal of Economic History* 55(4):842–859.
- Zavala, Silvio A. 1973. *La encomienda indiana*. Porrúa.



## **Online Appendix**

### *Fiscal Legibility and State Development: Theory and Evidence from Colonial Mexico*

#### **Contents**

<b>A</b>	<b>Descriptives</b>	<b>1</b>
<b>B</b>	<b>Additional Evidence</b>	<b>5</b>
B.1	Heterogeneity by Transition Costs to Direct Rule and Lower Prior Legibility . . . .	5
B.2	Main Results with Pre-1554 Mines . . . . .	8
B.3	Spatial and Temporal Investment in Fiscal Legibility Using Royal Treasuries . . . .	8
<b>C</b>	<b>Revenue Potential as an Alternative Mechanism</b>	<b>15</b>
C.1	Evidence from a Cochineal Price Boom . . . . .	16
<b>D</b>	<b>Distance Measure Construction</b>	<b>19</b>
<b>E</b>	<b>Supporting Information References</b>	<b>21</b>

## A. Descriptives

**Table A.1:** Description of Variables

	Variable	Source	Notes
Main outcome	Direct rule	Gerhard (1993a;b)	We aggregate lists of <i>encomiendas</i> from 1521 to 1650 in central and north-central Mexico (New Spain and Nueva Galicia) at the level of the 1786 administrative region to the district level and calculate the proportion of holdings in each district that had transitioned to direct rule (i.e., <i>corregimiento</i> ) by the end of each decade. For the small number of <i>encomiendas</i> that alternate between private and Crown control, we code the status of that holding as of the end of the decade. When we are unable to verify the status of a particular holding at a given time point, we code its status as missing.
Treated districts	Mining Districts	Gerhard (1993a;b); Hillerkuss (2013)	
Time-invariant covariates	Latitude	Mexico's National Institute for Statistics and Geography (INEGI)	Elevation of < 1000 meters
	Longitude		
	Surface area (log)		
	Avg. elevation		
	Malarial zone		
Time-varying covariates	Avg. maize potential productivity	Food and Agriculture Organization's Global AgroEcological Zones	Potential yield of rain-fed, low-input maize.
	Avg. least-cost walking hours to Mexico City	INEGI; Goldewijk (2010); Weiss et al. (2018)	See Appendix Section D for details.
	Approximate year of European contact	Gerhard (1993a;b)	
	Space-weighted avg. of PSDI	Cook and Krusic (2004)	Source reports year-by-year estimates of soil moisture/drought conditions across space calculated using tree-ring chronologies. These data are reported at the level of 2.5 degree grid cells in terms of the Palmer Drought Severity Index (PDSI), a measure of soil moisture that is standardized to local conditions. We rasterize these data and extract the space-weighted average, minimum, and standard deviation of PDSI by district and by decade.
	Space-weighted minimum of PSDI		
Space-weighted std. deviation of PSDI			
	Epidemic climactic conditions		Severe drought followed by rainfall, as used by Garfias and Sellars (2021).

**Table A.2: Descriptive Statistics****Panel A: Direct Rule Sample (New Spain & Nueva Galicia): 1520–1650**

	N	Mean	Std. Dev.	Min.	Median	Max.
Direct Rule (%)	2016	0.51	0.36	0.00	0.50	1.00
Any Mine	2016	0.15	0.35	0.00	0.00	1.00
Any Early Mine	2016	0.12	0.32	0.00	0.00	1.00
Year of European Contact	2016	1522.40	6.27	1518.00	1521.00	1580.00
Malarial Zone	2016	0.64	0.48	0.00	1.00	1.00
Mean maize potential yield	2016	3644.82	1695.23	0.00	3422.03	8114.00
Avg. Altitude	2016	1560.03	736.02	25.79	1661.97	2904.21
Surface Area (log)	2016	7.64	1.19	4.68	7.80	10.03
Least-Cost Walking Time to Mexico City (log)	2016	8.73	0.94	5.16	8.93	9.97
Std. Dev. PDSI	1960	1.74	0.44	0.65	1.72	3.96
Avg. PDSI	1960	0.52	0.97	-3.10	0.39	3.38
Min. PDSI	1960	-2.16	1.24	-5.67	-2.12	1.28
Drought-Rain Around Known Outbreaks	1960	0.03	0.17	0.00	0.00	1.00
Cochineal Production Site	2016	0.19	0.40	0.00	0.00	1.00

**Panel B: Royal Treasuries Sample (New Spain & Nueva Galicia): 1520–1750**

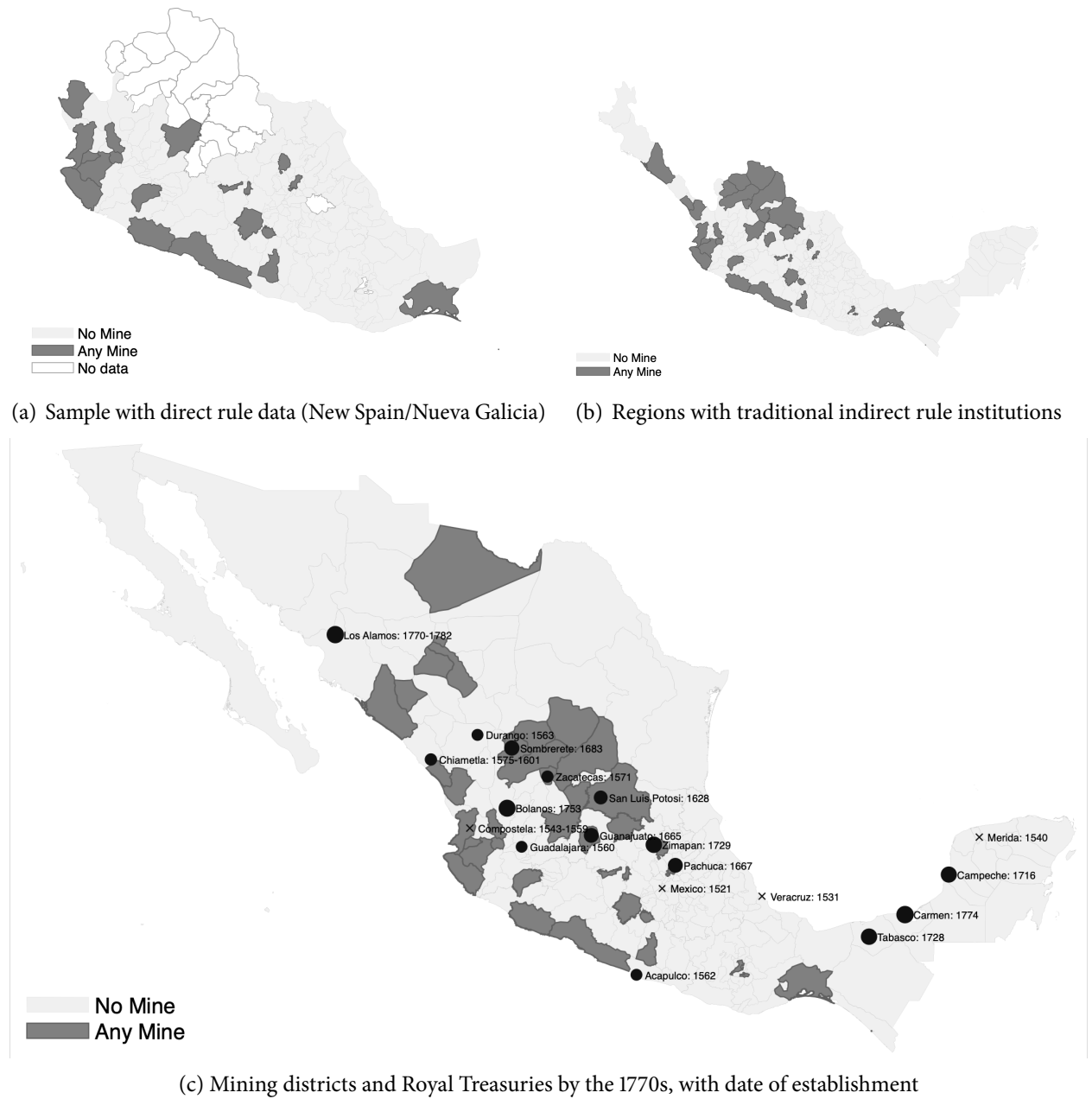
	N	Mean	Std. Dev.	Min.	Median	Max.
Least-Cost Walking Time to Nearest Treasury (log)	3588	7.40	1.79	0.00	7.84	9.88
Any Mine	3588	0.16	0.37	0.00	0.00	1.00
Any Early Mine	3588	0.13	0.33	0.00	0.00	1.00
Year of European Contact	3588	1522.98	7.13	1518.00	1521.00	1580.00
Malarial Zone	3588	0.63	0.48	0.00	1.00	1.00
Mean maize potential yield	3588	3642.40	1674.47	0.00	3432.09	8114.00
Avg. Altitude	3588	1573.96	726.56	25.79	1676.23	2904.21
Surface Area (log)	3588	7.68	1.19	4.68	7.83	10.08
Least-Cost Walking Time to Mexico City (log)	3588	8.75	0.93	5.16	8.95	9.97
Std. Dev. PDSI	3492	1.78	0.43	0.65	1.75	3.96
Avg. PDSI	3492	0.48	0.89	-3.10	0.36	3.38
Min. PDSI	3492	-2.32	1.38	-6.62	-2.14	1.28
Drought-Rain Around Known Outbreaks	3492	0.02	0.14	0.00	0.00	1.00

**Table A.3: Baseline Differences Between Mining and Non-Mining Districts**

	New Spain		New Spain & Nueva Galicia	
	Any Mine	Early Mine	Any Mine	Early Mine
	(1)	(2)	(3)	(4)
Year of European Contact	0.021 (0.022) {0.0081}	0.00070 (0.012) {0.0050}	-0.0045 (0.0084) {0.0044}	-0.0046 (0.0036) {0.0016}
Mean maize potential yield	0.000027 (0.000019) {0.000012}	0.000029 (0.000019) {0.000013}	0.0000056 (0.000018) {0.000017}	0.000022 (0.000017) {0.0000090}
Cochineal Production Site	-0.056 (0.079) {0.065}	-0.050 (0.079) {0.065}	0.0066 (0.080) {0.058}	-0.0066 (0.082) {0.057}
Malarial Zone	0.23** (0.11) {0.086}	0.19* (0.11) {0.075}	0.17 (0.10) {0.082}	0.12 (0.095) {0.063}
Avg. Altitude	0.000060 (0.000061) {0.000057}	0.000052 (0.000061) {0.000052}	0.0000052 (0.000062) {0.000066}	0.000018 (0.000055) {0.000046}
Least-Cost Walking Time to Mexico City (log)	-0.0011 (0.059) {0.033}	0.017 (0.056) {0.031}	-0.027 (0.047) {0.041}	-0.024 (0.043) {0.036}
Surface Area (log)	-0.015 (0.032) {0.021}	-0.0021 (0.029) {0.016}	0.017 (0.029) {0.023}	0.035 (0.026) {0.024}
Latitude	-0.020 (0.026) {0.018}	-0.028 (0.025) {0.016}	-0.019 (0.028) {0.014}	-0.041 (0.025) {0.017}
Longitude	-0.028 (0.025) {0.015}	-0.037 (0.024) {0.015}	-0.054** (0.021) {0.017}	-0.043** (0.020) {0.012}
Mean of DV	0.12	0.12	0.15	0.15
SD of DV	0.32	0.32	0.35	0.35
R sq.	0.14	0.12	0.14	0.11
Observations	120	120	144	144

OLS estimations. Unit-of-analysis is the district. Robust standard errors in parentheses. Standard errors that allow for spatial correlation between districts within 500 km of each other are in curly brackets.

**Figure A.1:** Maps of 16th Century Mining Districts and Sample Districts



## B. Additional Evidence

### B.1 Heterogeneity by Transition Costs to Direct Rule and Lower Prior Legibility

The theory generates additional observable implications that can be examined with these data. We focus on two heterogeneous effects that the theory would imply: the shock to fiscal legibility that came with the introduction of the patio process should have been lower where the cost of transition to direct rule ( $\kappa$ ) was higher and where pre-shock legibility was higher.

First, we assess whether the increased fiscal legibility provided by the discovery of the patio process had a higher impact on direct rule adoption in areas where the cost of centralizing power would have been lower (i.e., where  $\kappa$  is smaller). From the perspective of the Crown, an important advantage of the *encomienda* was that local intermediaries had a vested interest in maintaining local political order (because they expected to remain in their position over their lifetime) and extensive local knowledge that could enable them to keep the peace more effectively. In areas prone to rebellion, the transition to more direct forms of rule was therefore costly, forcing the Crown to lose the benefits of the *encomienda* for political order (Garfias and Sellars 2021). As our theory illustrates, increasing the cost of transition should direct rule adoption less likely following the increase in legibility.

We rely on two measures to examine this prediction. First, we construct an indicator for whether the district mounted a violent resistance to the conquest at first contact, which captures both the extent to which areas may have been able to overcome collective action problems in the past and the possibility of greater opposition to Spanish rule. Second, we use the number of towns in a district as of approximately 1786 as a measure of the difficulty of coordinating a large-scale rebellion against royal authority. We would expect collective action to be more difficult when populations are spread out among many small settlements rather than concentrated in larger towns. Using these measures, we estimate models similar to equation (5.1), now interacting  $Mine_{it} \times PostPatio Process_t$  with each measure of the cost of transition  $\kappa$ .

We present results on these heterogeneous effects in Table B.1. Columns 1 and 2 show that fiscal legibility leads to an increase in direct rule across districts, but the effect is muted in places that mounted a resistance to the Conquest. Coefficient estimates imply that the effect of the patio process was only around two-thirds as large in districts with organized resistance during the Conquest, though this difference not statistically significant. Columns 3 and 4 present estimates of the heterogeneous effects of the legibility shock by the number of towns in a district. As the number of towns in a district increases—and coordination between

**Table B.1:** Heterogeneous Effect of the Patio Process on Direct Rule: Difference-in-Differences

	Direct Rule (% of District)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any Mine × Post-Patio Process	0.17** (0.067)	0.17*** (0.061)	-0.016 (0.062)	0.052 (0.071)	0.19*** (0.046)	0.14** (0.055)	-0.86*** (0.32)	-0.017 (0.37)
Any Mine × Post-Patio × Resistance during Conquest	-0.060 (0.075)	-0.070 (0.059)						
Any Mine × Post-Patio × Number of Towns			0.017** (0.0068)	0.0084 (0.0068)				
Any Mine × Post-Patio × Former Triple Alliance					-0.17*** (0.049)	-0.027 (0.055)		
Any Mine × Post-Patio × (log) Hours to Mexico City							0.11*** (0.036)	0.015 (0.043)
Any Mine × Post-Patio + Resistance	0.11*** (0.04)	0.10*** (0.04)						
Any Mine × Post-Patio + Former Triple Alliance					0.017 (0.03)	0.11*** (0.04)		
Climate Controls	No	Yes	No	Yes	No	Yes	No	Yes
Controls × Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Year of European Contact × Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-District Mean of DV	0.51	0.52	0.51	0.52	0.51	0.52	0.51	0.52
Within-District SD of DV	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
R sq.	0.78	0.82	0.78	0.82	0.78	0.82	0.78	0.81
Observations	2016	1960	2016	1960	2016	1960	2016	1960
Number of districts	144	140	144	140	144	140	144	140

OLS estimations. Unit-of-analysis is the district-decade. Standard errors (clustered at district level) in parentheses.

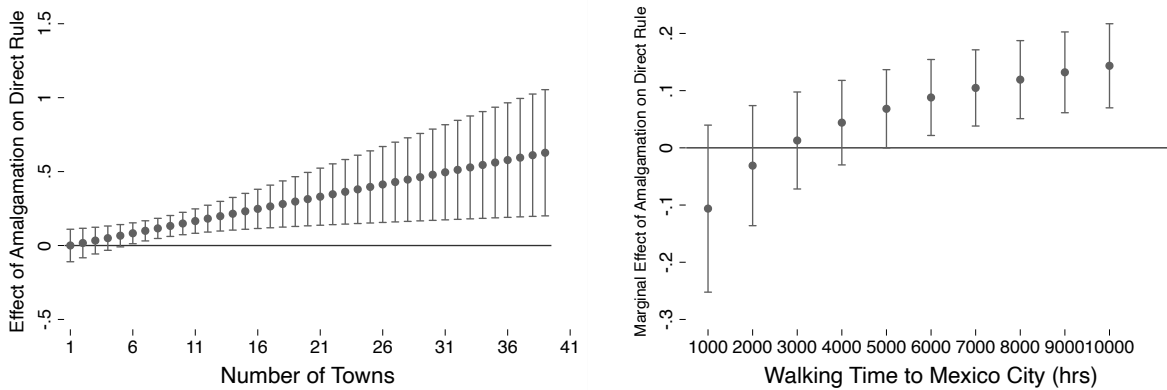
towns to organize large-scale resistance becomes more difficult—so does the effect of fiscal legibility. This effect is illustrated in the left panel of Figure B.1, which plots the effect of legibility on direct rule at different number of towns per district. Taking the estimates from column 3, at the 25th percentile of this variable, when the district is split into 5 towns, the legibility shock is estimated to increase direct rule adoption by 7 percentage points. At the 75th percentile (11 towns), the discovery of amalgamation increases direct rule adoption by 17 percentage points.

These results suggest that in districts where the cost of transition from indirect to direct rule would have been higher, the increase in fiscal legibility had a more limited impact on centralization. While these measures are not perfect (e.g., the number of towns in a district is captured at a later date and could induce post-treatment bias), the results provide additional suggestive evidence in support of the theory.

We also assess a second observable implication suggested by the theory: the discovery of the patio process should have an especially large effect in regions with a low initial level of legibility. We use two measures to

capture this. First, we record whether a district paid tribute to the Triple Alliance (Aztec Empire) prior to the Conquest. Upon the fall of the Aztec capital of Mexico-Tenochtitlan, the Spanish adapted the pre-existing tribute system of the Triple Alliance and expanded it to newly conquered territories. Through usurping Mexica institutions and records, the Crown gained access to information that would have been costly to acquire anew, such as earlier tribute records. The Crown therefore had a better sense of local conditions in mining areas that paid tribute to the Triple Alliance, even before the introduction of silver amalgamation.

**Figure B.1: Silver Mining, Amalgamation, and Direct Rule**  
Heterogeneous Effects



(a) By Number of Towns (1786)

(b) By Waking Hours to Mexico City

The figure on the **left** plots estimates and 95% confidence intervals of the differential change in direct rule following the introduction of the patio process for different number of towns (by 1786) per district. The figure on the **right** plots similar estimates for different least-cost walking hours to Mexico City.

We also examine walking distance to Mexico City as an alternative measure of pre-amalgamation legibility. Mexico City was the center of colonial administration in the Americas, and the Crown’s ability to directly observe and monitor nearby districts would have been high even before the discovery of the patio process. An additional increase in the observability of economic conditions should therefore not have had the same impact on the transition to direct rule as it did in more remote and less legible areas.

We estimate the heterogeneous effect of the introduction of the patio process by walking hours to Mexico City and by a district’s pre-colonial tributary status in columns 5-8 of Table B.1. Consistent with the theory, we find that the patio process increased direct rule by only a fraction in districts that were part of the tribute network of the Triple Alliance. However, this estimate is only significant in the specification without covariates (column 5), and its magnitude varies substantially. We also find supportive evidence in the heterogeneous

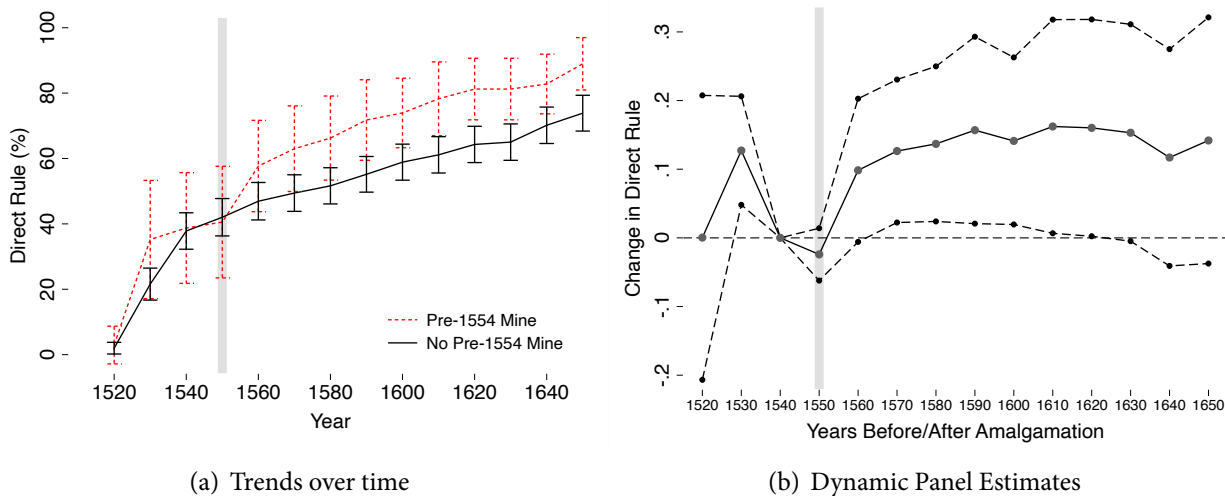


effect of the shock to legibility by walking distance to Mexico City (columns 7 and 8). Figure B.1 shows the heterogeneous effect of the legibility shock by distance to the capital. The discovery of the patio process has a small effect in districts in close proximity to Mexico City relative to more distant regions where there would have been less prior information on local economic and political conditions.

Taken together, the results provide additional empirical support for the theory. The discovery of the patio process led to a marked increase in the transition to direct rule, replacing the institution of the *encomienda* with the more direct monitoring and control of the *corregimiento*. Consistent with the theory, the increase in direct rule was larger in districts where the cost of transition was lower, those with a lower potential for rebellion, and in districts where initial legibility was very low, those outside of the pre-colonial centralized tribute network and farther away from Mexico City.

## B.2 Main Results with Pre-1554 Mines

**Figure B.2: Silver Mining, Patio Process, and Direct Rule; Early Mines**



## B.3 Spatial and Temporal Investment in Fiscal Legibility Using Royal Treasuries

In addition to examining the long-term divergence in fiscal legibility between areas affected and unaffected by the patio process, we also analyze a separate measure of state investment in local fiscal legibility: the

**Table B.2:** Patio Process and Direct Rule: Difference-in-Differences; Early Mines

	Direct Rule (% of District)			
	New Spain		New Spain & Nueva Galicia	
	(1)	(2)	(3)	(4)
Any Early Mine $\times$ Post-Patio Process	0.076** (0.033) {0.039}	0.13*** (0.040) {0.042}	0.11** (0.046) {0.046}	0.13*** (0.042) {0.042}
Climate Controls	No	Yes	No	Yes
Controls $\times$ Year FE	No	Yes	No	Yes
Year of European Contact $\times$ Year FE	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Within-District Mean of DV	0.51	0.51	0.51	0.52
Within-District SD of DV	0.23	0.22	0.24	0.24
R sq.	0.80	0.84	0.78	0.82
Observations	1680	1624	2016	1960
Number of districts	120	116	144	140

OLS estimations. Unit-of-analysis is the district-decade. Std. errors clustered at the district level in parentheses; errors that allow for serial correlation within districts and spatial correlation between districts within 500 km of each other in curly brackets.

construction of *Cajas Reales* or royal treasuries.<sup>14</sup> The royal treasuries were a network of fiscal institutions designed to oversee and administer the collection of taxes across the territory. These institutions had broad fiscal authority over their jurisdictions and remarkable autonomy from each other (TePaske and Klein 1986). Within their catchment areas, royal treasuries coordinated tax collection and provided funds for local expenditures, including officials' salaries as well as other administrative and military expenses. Each treasury was led by an accountant, who registered and certified transactions, and a royal treasurer, who collected taxes both directly from taxpaying individuals or institutions and indirectly from other specialized officials like *corregidores* (Sánchez Bella 1968; Yuste 2002).<sup>15</sup>

The establishment of a new treasury brought the fiscal bureaucracy closer to the surrounding districts. This increased the ability of the Crown to monitor local conditions. In addition to facilitating tax compliance, the establishment of a treasury allowed the Crown to assess nearby economic production more reliably and thus

<sup>14</sup>Chiovelli (2016) also uses the presence of treasuries as a measure of state capacity and link their location to existing levels of state development.

<sup>15</sup>Other positions included the *factor*, who conducted the treasury's business with other branches of the bureaucracy, the *veedor*, who assayed gold and silver and monitored its production, and a variable number of deputies. The Crown used a number of strategies to minimize agency problems with treasury bureaucrats, including regular inspections and on-site audits, reliance on independent auditing bodies to check accounts, and internal safeguards on fraud (Sánchez Bella 1968; TePaske and Klein 1986; Jáuregui 1999).

to better evaluate the effort of local agents—*corregidores* and *encomenderos*—tasked with the collection of tribute. The creation of a treasury in a remote area, even a relatively unproductive one, was thus sometimes warranted to enable the Crown to obtain more information and control over outlying regions (Sánchez Bella 1968). Given the economic and political costs of establishing royal treasuries, the Crown had to prioritize when and where to make this investment. The placement of the treasuries followed a clear territorial logic early on, with the establishment of treasuries in Mexico City, the capital; Veracruz, Mexico’s main port in the Atlantic; and Merida, a main trading center in the Yucatan. Given the importance of silver to the royal economy, it is perhaps not surprising that treasuries were sometimes established near mines following the discovery of productive deposits. This seems to have motivated the creation of early treasuries in Compostela, Durango, and Zacatecas, for example (Parry 1968; Bakewell 1971; Lacueva 2011).<sup>16</sup> Treasuries were eventually created to facilitate tax collection in the interior, but this investment was not made in all regions (Sánchez Bella 1968; Jáuregui 1999; Bertrand 2013).

We investigate how the early shock to fiscal legibility shaped Crown investment in treasury construction across space and time by examining how the least-cost walking hours from each district to the nearest treasury evolved from the 16th century until the end of the colonial period. Specifically, we construct a decadal panel of minimum walking times (in hours) from each district to the nearest royal treasury using the same least-cost analysis methodology as described in the previous section and information on the successive construction of new treasuries. We geolocate each treasury constructed over the colonial period and code its date of construction (Table B.3). We then construct a time-varying measure of the minimum and space-weighted average distance to the nearest *caja* at the district (1786 administrative region) level by decade.

Our interest is in whether districts affected by the legibility shock in the 1550s saw a differential increase in investment toward improving the Crown’s ability to observe and monitor local production through the construction of nearby treasuries. In Table B.4 we present difference-in-differences estimates from an equation similar to (5.1), now using minimum distance to royal treasury as the outcome. We extend the analysis from the Conquest period until the 1750s, when a major set of fiscal reforms shifted the pattern of treasury placement (see below). We present estimates with and without time-varying and time-interacted controls for the same two sub-samples as in Table 1: the core region of New Spain (columns 1 and 2) and the full sample of districts

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<sup>16</sup>Relatedly, the Crown also established treasuries along the coast to monitor contraband; the Carmen treasury is one example (TePaske and Klein 1986).

**Table B.3:** *Cajas Reales/Royal Treasuries in Colonial Mexico, 1520–1810*

Location	Region	Years	Source
Mexico City	New Spain	1521	TePaske and Klein (1986)
Veracruz	New Spain	1531	TePaske and Klein (1986)
Merida	Yucatan/SE	1540	TePaske and Klein (1986)
Compostela	Nueva Galicia	1543–1559	Bakewell (1971); Parry (1968)
Guadalajara	Nueva Galicia	1560	Bakewell (1971); Parry (1968)
Acapulco	New Spain	1562	Maniau y Torquemada (1794)
Durango	Nueva Vizcaya	1563	Lacueva (2011)
Zacatecas	Nueva Galicia	1571	Bakewell (1971); Parry (1968)
Chiametla	Nueva Galicia	1575–1601	Lacueva (2011)
San Luis Potosi	New Spain	1628	TePaske and Klein (1986)
Guanajuato	New Spain	1665	TePaske and Klein (1986)
Pachuca	New Spain	1667	TePaske and Klein (1986)
Sombrerete	Nueva Galicia	1681	Maniau y Torquemada (1794)
Campeche	Yucatan/SE	1716	TePaske and Klein (1986)
Zimapan	New Spain	1721	Maniau y Torquemada (1794)
Tabasco	Yucatan/SE	1728	TePaske and Klein (1986)
Bolaños	Nueva Galicia	1753	TePaske and Klein (1986)
Alamos	Sinaloa & Sonora	1770–1782	TePaske and Klein (1986)
Presidio del Carmen	Yucatan/SE	1774	TePaske and Klein (1986)
Rosario	Sinaloa & Sonora	1783–1806	TePaske and Klein (1986)
Chihuahua	Nueva Vizcaya	1785	TePaske and Klein (1986)
Michoacan/Valladolid	New Spain	1788	TePaske and Klein (1986)
Puebla	New Spain	1789	TePaske and Klein (1986)
Oaxaca/Antequera	New Spain	1790	TePaske and Klein (1986)
Arizpe	Sinaloa & Sonora	1791	TePaske and Klein (1986)
Saltillo	Coahuila	1794	TePaske and Klein (1986)
Cosala	Sinaloa & Sonora	1807	TePaske and Klein (1986)

Notes: Where no end date is noted, the treasury remains until the end of the colonial period. Because TePaske and Klein (1986) generally assign the dates establishment to the first year with available records—which could erroneously identify a treasury as being created years after its real establishment—we reviewed the secondary historical literature to verify the dates of treasury establishment. We keep the date from the most reliable source. We follow the formal criteria used during the period to identify a royal treasury: having an appointed treasurer and accountant. This sets main treasuries apart from smaller dependent offices that were staffed by these officials’ deputies. The only exceptions to this coding rule are the treasuries of Veracruz and Acapulco, both of which were dependent on the Mexico City treasury, but which were among the most important treasuries throughout the colonial period. TePaske and Klein (1986) speculate that the Tabasco treasury may have existed for a very brief period in the early 17th century (1605–1612) and then disappeared, but it is not clear whether it was merely a dependent office during those early years. Chiametla stopped operating briefly between 1587 and 1590; we consider it to be operative in the 1580 decade when we aggregate to the decadal level.

in New Spain and Nueva Galicia where institutions of indirect or direct rule were employed in a consistent way (columns 3 and 4).<sup>17</sup>

<sup>17</sup>We use the same vector of covariates as the estimations in Section 5: the time-varying climate measures and the time-invariant district characteristics (malarial zone, maize suitability, elevation, log surface area, log walking hours to

**Table B.4:** Patio Process and Walking Time to Nearest Royal Treasury (log):  
Difference-in-Differences

	Walking Hours to Treasury (log)			
	New Spain		New Spain & Nueva Galicia	
	(1)	(2)	(3)	(4)
Any Mine $\times$ Post-Patio Process	-0.73** (0.36) {0.34}	-0.63 (0.43) {0.40}	-0.12 (0.34) {0.39}	0.076 (0.41) {0.40}
Climate Controls	No	Yes	No	Yes
Controls $\times$ Year FE	No	Yes	No	Yes
Year of European Contact $\times$ Year FE	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Within-District Mean of DV	7.47	7.42	7.40	7.36
Within-District SD of DV	0.37	0.38	0.49	0.50
R sq.	0.83	0.86	0.80	0.83
Observations	3012	2916	3588	3492
Number of districts	126	122	150	146

OLS estimations. The unit of analysis is the district-decade. Districts with direct/indirect rule. Standard errors clustered at the district level are in parentheses. Standard errors that allow for serial correlation within districts and spatial correlation between districts within 500 km of each other are in curly brackets. Time-varying climate data is not available in four districts, which are not included in the estimations with covariates.

The results in Table B.4 provide mixed evidence that the introduction of the patio process encouraged endogenous investment in fiscal legibility. In New Spain, the introduction of the patio process led to a differential decrease in the minimum walking time to the nearest treasury in mining relative to non-mining districts of around 60 and 70 percent up to 1750, though this difference is not significant in the specification with covariates. When including Nueva Galicia, the decrease is smaller, not statistically different from zero, and flips signs when including covariates. While imprecisely estimated, the coefficient estimates are substantively large for the New Spain sample, equivalent to almost two within-district standard deviations of walking time. However, we cannot reject a null effect across all samples and specifications.

Because our theory focuses on the Crown's dual decisions of selecting a type of contract with intermediaries—indirect or direct rule—and the choice to invest in future legibility, we are most confident of its applicability in

Mexico City, year of Spanish contact, latitude, and longitude) interacted with each year indicator. In Appendix Section ??, we restrict attention to mines recorded as operational prior to 1550 and find similar results.

districts where standard institutions of indirect rule had existed in the early colonial period.<sup>18</sup> There is a tradeoff, however, in focusing solely on within-unit variation across the central governorships for regionally-defined outcomes like this one. The construction of a treasury targeted to a mining area would mechanically affect walking times to neighboring non-mining districts as well. In addition, because treasuries are an expensive investment, areas close enough to treasuries constructed in the early colonial period may see little or no change in walking time after the 1550s. To explore additional implications of our conceptual framework, we therefore broaden our focus to consider temporal and regional trends in treasury construction elsewhere in Mexico.

We consider two predictions. First, because improved access to information only benefits a ruler under direct forms of rule, we expect little investment in treasury construction in areas under indirect rule, especially those that have low initial levels of fiscal legibility (putting a future transition to direct rule out of reach). Second, only a sufficiently patient central authority should be willing to give up resources in the short term to invest in either improving the quality of monitoring under direct rule or investing in informational capacity to put districts on the path towards centralization.

We assess these predictions in Figure B.3. On the left panel, we plot the temporal trajectory of endogenous fiscal legibility (log hours to nearest treasury) alongside political centralization (percent of holdings under direct rule) for the colonial governments of New Spain and Nueva Galicia, the areas where we have disaggregated data on the transition to direct rule. Consistent with our argument, centralization and investment in fiscal legibility followed similar trends in the early colonial period. The concurrent steep decline in walking time to treasury and steep incline in direct rule adoption is especially notable in the middle of the 16th century around the time when the patio process had been discovered.

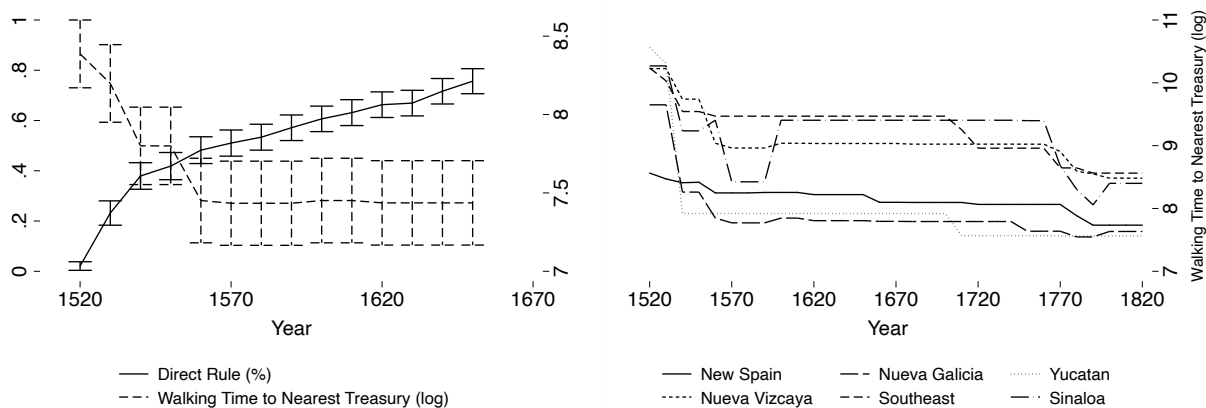
In the right panel of Figure B.3, we plot the average least-cost walking time (in log hours) to the nearest royal treasury by region and decade for the colonial period (1520s–1810s) using a larger sample including New Spain, Nueva Galicia, Nueva Vizcaya, Sinaloa, the Yucatán, and the southeast frontier (parts of what are now the states of Chiapas, Tabasco, and eastern Oaxaca)<sup>19</sup> As the figure illustrates, regions saw very different patterns in investment in fiscal legibility, particularly after the early wave of treasury construction in the 16th century. The core areas of New Spain and Nueva Galicia, which were already under solid control of the Empire, saw periodic improvements in fiscal legibility, while areas that were then frontier regions—Sinaloa and Nueva

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<sup>18</sup>The Crown relied on a more heterogeneous set of institutions in places where settlement patterns at European contact were not compatible with the establishment of classic *encomiendas*, such as areas inhabited by nomadic or semi-nomadic populations (Gerhard 1993b).

<sup>19</sup>See Gerhard (1993a;b;c) and Figure A.1).

**Figure B.3:** Trends in Walking Time to Nearest Treasury



(a) Direct rule adoption

(b) Long-term regional trends

The **left** figure plots average log least-cost walking time to nearest treasury over direct rule adoption from 1520 until 1700 for New Spain and Nueva Galicia. The **right** figure plots log least-cost walking time by region from 1520 until 1810 for areas with direct/indirect rule institutions. The full list of treasuries with date of construction can be found in Appendix Section B.3. See the text and Section D for information on construction of this measure.

Vizcaya in the north and the southeast region—saw little decrease in walking time between the early wave of treasury construction and the late 18th century despite being considerably farther from existing treasuries.<sup>20</sup>

The theoretical framework provides insight into why the Crown would have prioritized enhancing fiscal legibility in core areas under centralized control over attempting to penetrate low-legibility areas through treasury construction. In very low legibility zones, the payoff to gaining a small amount of informational capacity is minimal. The central ruler is better off simply ceding revenue and autonomy to local intermediaries to facilitate tax collection. In higher legibility areas under direct forms of rule, by contrast, even a marginal improvement in fiscal legibility can yield benefits by improving the ruler’s ability to monitor and sanction intermediaries in the short term. These frontier areas were not entirely economic backwaters; commodity-producing activities, such as cochineal in Oaxaca and silver mining in the northern regions, provided significant potential revenue. However, these distant areas had much lower ex ante informational capacity, which reduced the benefit of legibility investment until the very end of the colonial period. The temporal trends in the right side of Figure B.3 are also consistent with our theoretical predictions. The first 50 years of colonial rule saw a rapid decline in walking time in Nueva Galicia, New Spain, and the Yucatan through the construction of nine treasuries by the 1570s. After this, treasury construction slows down. Only four new treasuries were

<sup>20</sup>Sinaloa saw a short-term decline in walking time due to the temporary placement of a treasury in the northwest district of Chiametla between 1575 and 1601.

established over the next century, all in the core regions of New Spain and Nueva Galicia. Mired in conflict in Europe, the Crown was forced to divert spending to more immediate needs over most of the 17th and early 18th centuries (see Section 6.2). This decline in the Crown's patience for investment reduced its willingness to improve informational capacity in the Americas for longer-term gain. As we discuss in the paper, this corresponded with a general period of disinvestment in colonial institutions when trends toward political centralization arguably reversed as well (e.g., Knight 2002).

The Bourbon period saw a reversal in both trends. During the second half of the 18th century, as external conflict waned and Britain's threat in the Americas grew, the Crown embarked on a series of ambitious reforms to centralize authority and improve revenue collection. In moving toward more direct forms of rule, the value of obtaining better information about the local economy increased, and the Crown became more willing to invest in state informational capacity via the construction of treasuries. Political centralization and investment in fiscal legibility worked in tandem in the last decades of Spanish rule, as was true in the early colonial period and as would be suggested by our framework.

### **C. Revenue Potential as an Alternative Mechanism**

The discovery of the patio process led to an exogenous shift in the Crown's legibility of silver production due to its control over the supply of mercury, an essential input in this refining technique. At the same time, however, this new process increased the profitability of extraction in certain deposits. In particular, it enabled the profitable mining of ores with lower silver concentrations. Thus, it remains possible that this increased profitability, and not fiscal legibility, explains the results presented in Table 1.

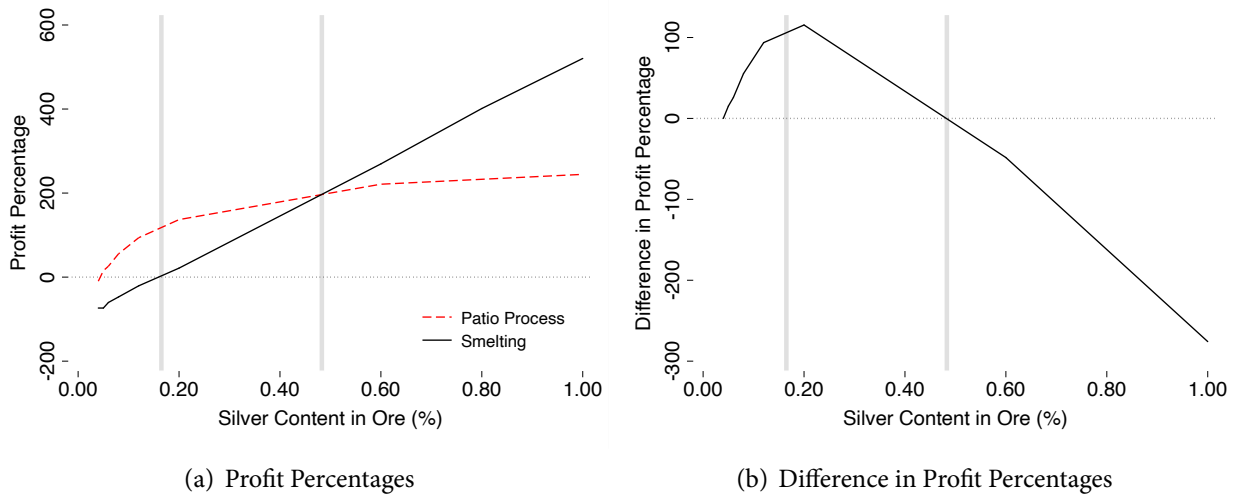
In the left panel of Figure C.1, we present estimates of the return on investment for processing silver using the patio process and the traditional method of smelting, based on detailed production information from the Hacienda Santa María de Regla in the XIX century and input prices for the second half of the XVII century, computed by Guerrero (2017). These estimates suggest that the introduction of the patio process affected production in two main ways. First, it enabled the profitable processing of ores of very low silver content—between around 0.04% and 0.16%—which were not economically viable via smelting. Above this threshold, and up to ores of a silver concentration of around 0.48%, amalgamation also offered a higher return on investment than smelting. For deposits with higher silver concentrations, however, amalgamation remains more profitable: this was the case because, while smelting processing costs remain fixed, the patio process requires additional mercury to effectively extract silver from even richer ores.<sup>21</sup>

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<sup>21</sup>Moreover, while amalgamation is effective for silver sulphide deposits, the most common in the Americas, smelting



**Figure C.1: Profitability Percentages for the Patio Process and Smelting**



The figure on the **left** plots the estimated profit percentage (*net profit/cost*) for processing silver using smelting (black solid line) and the patio process (red dashed line) at different levels of ore silver content. The figure on the **right** plots the difference in the profit percentages between the patio process and smelting. Cost estimates and effectiveness of silver extraction by method from Guerrero (2017).

Without detailed information about the silver-extraction processes in each district, including changes in profits following the introduction of amalgamation, we are unable to examine whether changes in profitability explain our findings, and so we cannot rule out this alternative mechanism directly. Instead, we assess additional observable implications from the legibility-based theory that are not explained by increased profitability in Table B.1 and Figure B.1. In this section, we pursue a second indirect approach. We focus on the role that a notable price shock to cochineal dye—one of the most important commodities produced in colonial Mexico at the time—had on the adoption of direct rule among Cochineal-producing districts. The cochineal price shock arguably induced a much larger increase in profitability than the introduction of the patio process. Depending on the time window and price series, the increase ranged from 180 to 420% (see Figure 2), and, given the type of artisanal production, it is unlikely that production costs changed drastically over the period.

### C.1 Evidence from a Cochineal Price Boom

Cochineal dye, produced from the cochineal insect, became a prized luxury good in European markets following the conquest. By the end of the 16th century, it was the third most important export commodity from colonial Mexico after silver and gold, accounting for almost 9% of the value of silver exports (Lee 1951). In Europe, the dye was considered of superior quality, due to its long-lasting deep red color—associated with the nobility and higher positions in the church (Marichal 2014). Following its introduction to European markets

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remained the only feasible method for argentiferous lead deposits.

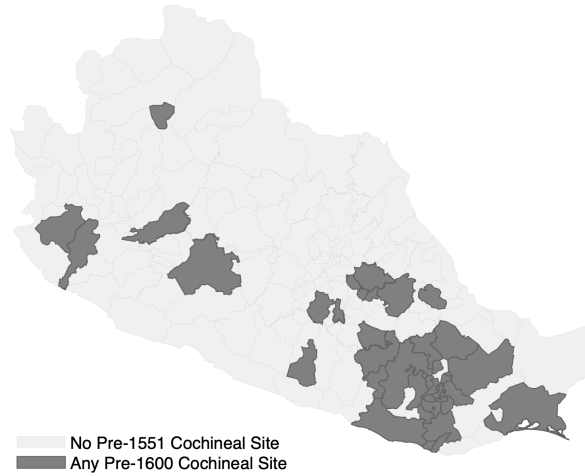
in 1526, imports primarily served the Spanish textile industry, but eventually found their way into the rest of the continent, including important textile centers in England, France, the Low Countries, and Italy, and later even into Asian markets (Lee 1951). This expansion fueled a demand-driven cochineal boom, which accelerated in the last decade of the 16th century.

To quantify this shock to cochineal external demand, we rely on a number of price series collected in different European markets, compiled and normalized to silver pesos per *arroba* ( $\sim 25\text{lb}$ ) by Serrano (2016). For each price series, we average prices per decade, ignoring missing years. This allows to sidestep year-to-year price fluctuations that are likely driven by short-term supply, as well as to match this data to our decadal panel on direct rule. We focus on three series: first, data from Chaunu and Chaunu (1956), who present the most complete series around the onset of the price hike, based on official import registries in Seville; second, an average of prices in Spain, composed of the Chaunu and Chaunu series, as well as spottier data from Sanz (1979) and Morineau (1969), also mostly based on official records; and an average of all available series, including the Spanish sources, scattered transaction prices at Antwerp and Florence, collected by Sanz (1979), as well as market prices at Amsterdam, compiled by Posthumus (1946), which become more complete beginning in the second decade of the 17th century.

The resulting series are presented in the right panel of Figure 2. Across series, there is a notable increase in the price of cochineal dye at the close of the 16th century, with an especially steep hike beginning in the 1590s. This timing may be related to the rise of Amsterdam as a new market for the dye, which in time facilitated its reach beyond western European markets, as well as to scarcity associated with the ongoing Spanish-English and Spanish-Dutch wars. The boom continued after these conflicts came to a halt—in 1604 and 1609, respectively—and lasted until at least the first few decades of the 17th century.

To examine whether this steep increase in the value of cochineal—with no changes to its fiscal legibility—led to a differential transition to direct rule, we compare centralization between cochineal- and non cochineal-producing districts around the years of the price hike. Since prehispanic times, cochineal production was concentrated in certain regions, due in large part to the specific environmental conditions that allow for its cultivation (see Figure C.2). To identify these cochineal-producing areas, we georeference a list of production sites compiled by Donkin (1977), based on primary sources that include the Triple Alliance’s *Matrícula de Tributos* for the prehispanic period, and the *Suma de Visitas*, and the *Relaciones Geográficas* for the 16th century.

**Figure C.2: Map of Pre-1551 Cochineal-Producing Districts**



**Table C.1: Cochineal-Producing Sites, Cochineal Price Shock, and Direct Rule: Difference-in-Differences**

	Direct Rule (% of District)					
	(1)	(2)	(3)	(4)	(5)	(6)
Cochineal Site	0.00038	0.00039				
× Seville Price (Chaunu & Chaunu)	(0.00034)	(0.00042)				
	{0.00031}	{0.00035}				
Cochineal Site			0.00035	0.00036		
× Seville Price (Avg. Spain)			(0.00035)	(0.00043)		
			{0.00032}	{0.00036}		
Cochineal Site					0.00017	0.00022
× Price (Avg. Seville/Florence/Antwerp/Amsterdam)					(0.00024)	(0.00028)
					{0.00023}	{0.00025}
Climate Controls	No	Yes	No	Yes	No	Yes
Controls × Year FE	No	Yes	No	Yes	No	Yes
Year of European Contact × Year FE	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Within-District Mean of DV	0.55	0.55	0.55	0.55	0.60	0.60
Within-District SD of DV	0.11	0.11	0.11	0.11	0.14	0.13
R sq.	0.86	0.88	0.86	0.88	0.84	0.86
Observations	1152	1120	1152	1120	1584	1540
Number of districts	144	140	144	140	144	140

OLS estimations. Unit-of-analysis is the district-decade. Std. errors clustered at the district level in parentheses; errors that allow for serial correlation within districts and spatial correlation between districts within 500 km of each other in curly brackets. All prices are in silver pesos per arroba of cochineal, as converted by Serrano (2016). Models 1 and 2 use the price series from Chaunu and Chaunu (1956); models 3 and 4 use an average of available Spanish series, from Chaunu and Chaunu (1956), Sanz (1979), and Morineau (1969); models 5 and 6 average across all available series, including the Spanish series, prices from Antwerp and Florence (Sanz 1979), and from Amsterdam (Posthumus 1946). Pre-1551 cochineal-producing sites from Donkin (1977).

We then assign these sites to the districts used in the main analysis. Because cochineal production seems to respond endogenously to prices, as noted by Diaz-Cayeros and Jha (2016), we focus on pre-1551 sites.

Using these data, we estimate a modified version of equation 5.1:

$$Direct\ Rule_{it} = \beta_1 Cochineal\ District_i \times Cochineal\ Price_t + \Theta_t X_i + \Pi U_{i,t} + \lambda_t + \gamma_i + \varepsilon_{it}, \quad (A1)$$

where *Cochineal District<sub>i</sub>* indicates whether a district contains pre-1551 cochineal-producing sites and *Cochineal Price<sub>t</sub>* is one of the cochineal price series described above. We present the estimates for specifications with and without climate *U<sub>i,t</sub>* and time-interacted geographic controls *X<sub>i</sub>* for the three price series in Table C.1. In all cases, the estimates are very small. A one standard deviation increase in price is estimated to increase direct rule by between 0.5 and 2 percentage points. The largest point estimate, from model 1, indicates that an increase in price from the pre-hike 1580 decade to the highest value in the Chaunu and Chaunu series—from 59.2 to 173 silver pesos per arroba of cochineal—is associated with a 4 percentage point increase in direct rule. The rest of the coefficients suggest even smaller associations including in models 5 and 6, which use a price series that reaches a global high of almost 240 silver pesos per arroba of cochineal in 1630. Moreover, in no case are these estimates statistically significantly different from zero.

In short, when using a different commodity—one of great importance in the colonial economy—we find no evidence that a sharp increase in its revenue potential led to differential changes in direct rule. Without a shift in fiscal legibility similar to the patio process for silver mining, on-site taxation of cochineal remained out of reach to the Crown, and cochineal districts did not experience the same transition from non-dismissal to dismissal contracts.<sup>22</sup>

#### D. Distance Measure Construction

We calculate distance to Mexico City, the nearest post office, and the nearest royal treasury in several ways. The simplest measure is the (minimum and space-weighted average) Euclidean distance (by decade for the treasuries). This measure ignores any barriers to travel, such as mountains or ocean, which is a potential concern given Mexico’s terrain. We therefore construct an alternative measure that incorporates terrain ruggedness, drawing on Least-Cost Analysis (LCA) methods from archaeology and using a 90-m digital elevation model (DEM) from INEGI and the procedure described in (White 2015). From this friction surface, we calculate the cumulative cost distance to the nearest treasury and extract the minimum and space-weighted average cumulative travel cost to the nearest treasury (in hours) by decade. (For comparability, we divide the

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<sup>22</sup>The Crown in fact floated different plans to appropriate part of the increasing value of cochineal, including monopolizing its trade by forcing all imports into the king’s account. Instead, a hefty Spanish export tax—of approximately 14 silver pesos per arroba—was enacted around 1608, on top of preexisting Mexican taxation, which included a tithe, sales taxes, export tariffs, and other levies. As Lee (1951) documents, this plan backfired: as the export tax was rolled out for all dye leaving Spain, cochineal-related revenue collapsed, and, as was recognized by the members of the council of hacienda, the black market for the dye exploded.

Euclidean distance measure in km for our analysis by the maximum Tobler walking speed of 5 km/hr.)

We also construct a cost distance measure that incorporates land cover and elevation as well as slope using the approach of Weiss et al. (2018), who estimate the typical walking speed (km/hr) across different terrain types (as classified by IGBP land cover classifications). The elevation and slope measures are calculated from the same 90-meter DEM. For the land cover analysis, we use the Goldewijk (2010) ISLSCP II Historical Land Cover and Land Use dataset, which provides an estimate of global land cover from 1700 to 1990 at a resolution of 0.5 degrees. Using the 1700 data as a base, we convert the ISLSCP II land cover measures to IGBP equivalents to use the walking speed multipliers in Weiss et al. (2018) (Table D.1). We verified these conversions using contemporary remote sensing data from NASA's MODIS.<sup>23</sup>

**Table D.1: Land Cover Walking Speed Multipliers**

ISLSCP II Land Cover Category	IGBP Equivalent	Weiss et al. (2018) Multiplier	Description
Ocean	See text	1.00/4.82	See text for description of alternate measures
Cultivated Land	Croplands	2.50	Seasonal croplands with a bare soil period
Pasture	Grasslands	4.86	Herbaceous cover; less than 10% tree and shrub cover
Warm Mixed Forest	Mixed Forest	3.24	Over 60% mixed tree cover, with height exceeding 2 meters
Grassland	Grasslands	4.86	Herbaceous cover; less than 10% tree and shrub cover
Hot Desert	Barren	3.00	Exposed soil, sand, and rocks, no more than 10% vegetated
Scrubland	Open Shrublands	4.20	Short (<2 m), woody vegetation, with 10-60% canopy cover
Savanna	Savannas	4.86	Herbaceous cover, 10-30% forest canopy cover
Tropical Woodland	Evergreen Broadleaf Forest	1.62	At least 60% broadleaf forest cover, with height exceeding 2 m. Year-round green vegetation.
Tropical Forest	Evergreen Broadleaf Forest	1.62	At least 60% broadleaf forest cover, with height exceeding 2 m. Year-round green vegetation.

Notes: See Weiss et al. (2018) for description of methodology. IGBP land cover category descriptions from the University of Oklahoma Earth Observation and Modeling Facility (EOMF).

<sup>23</sup>Because of the coarse resolution of the ISLSCP II data, some coastal/lakefront land is coded as ocean/open water, including a couple of coastal treasuries. We handle these overlapping areas by using the Weiss et al. (2018) speed multiplier for open water (1.00) as a conservative estimate of the speed needed to traverse these areas. We alternatively use a multiplier of 4.86, corresponding with grassland, pasture, or savanna. Virtually all of the land areas in overlapping ocean cells border one of these three land categories, which together make up over 42% of Mexico's land area in the original dataset. We believe that the faster speed more accurately reflects the cost of traversing coastal zones, which are at sea level and generally flat. However, we note that there is little difference between these measures in practice.

## E. Supporting Information References

- Bakewell, Peter. 1971. *Silver Mining and Society in Colonial Mexico. Zacatecas 1546–1700*. Cambridge University Press.
- Bertrand, Michel. 2013. *Grandeza y miseria del oficio: los oficiales de la Real Hacienda de la Nueva España, siglos XVII y XVIII*. Fondo de Cultura Económica.
- Chaunu, Huguette and Pierre Chaunu. 1956. *Séville et l'Atlantique 1504-1650*. Vol. VI–VIII Centre de Recherches Historiques.
- Chiovelli, Giorgio. 2016. “Pre-Colonial Centralization, Colonial Activities and Development in Latin America.” Working Paper.
- Cook, Edward R. and Paul J. Krusic. 2004. *The North American Drought Atlas*. New York, NY: Lamont-Doherty Earth Observatory and NSF.
- Diaz-Cayeros, Alberto and Saumitra Jha. 2016. “Conquered but Not Vanquished: Complementarities and Indigenous Entrepreneurs in the Shadow of Violence.” *Working Paper*.
- Donkin, Robin Arthur. 1977. “Spanish Red: An Ethnogeographical Study of Cochineal and the Opuntia Cactus.” *Transactions of the American Philosophical Society* 67(5):1–84.
- Garfias, Francisco and Emily A. Sellars. 2021. “From Conquest to Centralization: Domestic Conflict and the Transition to Direct Rule.” *Journal of Politics* 83(3):992–1009.
- Gerhard, Peter. 1993a. *A guide to the Historical Geography of New Spain*. University of Oklahoma Press.
- Gerhard, Peter. 1993b. *The North Frontier of New Spain*. Norman, OK: University of Oklahoma Press.
- Gerhard, Peter. 1993c. *The Southeast Frontier of New Spain*. Norman, OK: University of Oklahoma Press.
- Goldewijk, K.K. 2010. ISLSCP II Historical Land Cover and Land Use, 1700–1990. In *ISLSCP Initiative II Collection*. Available on-line [<http://daac.ornl.gov/>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAAC/967.
- Guerrero, Saúl. 2017. *Silver by Fire, Silver by Mercury: A Chemical History of Silver Refining in New Spain and Mexico, 16th to 19th Centuries*. Brill.
- Hillerkuss, Thomas. 2013. “Las minas de la Nueva España en los mapas del Siglo XVI. ¿Un secreto del Estado?” *Apuntes* 26(1):10–25.
- Jáuregui, Luis. 1999. *La Real Hacienda de Nueva España: su administración en la época de los intendentes, 1786-1821*. UNAM.

- Knight, Alan. 2002. *Mexico: The Colonial Era*. New York, NY: Cambridge University Press.
- Lacueva, Jaime J. 2011. "Marginalidad y marginación de la minería de Nueva Vizcaya (1563-1631)." *Historias* 78:39–72.
- Lee, Raymond L. 1951. "American Cochineal in European Commerce, 1526–1625." *The Journal of Modern History* 23(3):205–224.
- Maniau y Torquemada, Joaquín. 1794. *Compendio de la Historia de Real Hacienda de Nueva España*.
- Marichal, Carlos. 2014. Mexican Cochineal and European Demand for a Luxury Dye, 1550–1850. In *Global Goods and the Spanish Empire, 1492–1824*, ed. Bethany Aram and Bartolomé Yun-Casalilla. Palgrave Macmillan.
- Morineau, Michel. 1969. "Gazettes Hollandaises et trésors Américain." *Anuario de Historia Económica Y Social* 3(3):139–210.
- Parry, John H. 1968. *The Audiencia of New Galicia in the Sixteenth Century*. Cambridge University Press.
- Posthumus, Nicolaas Wilhelmus. 1946. *Inquiry into the History of Prices in Holland*. E.J. Brill.
- Sánchez Bella, Ismael. 1968. *La organización financiera de las Indias, Siglo XVI*. Escuela de Estudios Hispano-Americanos.
- Sanz, Eufemio Lorenzo. 1979. *Comercio de España con América en la Época de Felipe II - tomo I: Los Mercaderes y el Tráfico Indiano*. Institucion Cultural Simancas.
- Serrano, Ana Filipa Albano. 2016. The Red Road of the Iberian Expansion: Cochineal and the Global Dye Trade. PhD thesis Universidade Nova de Lisboa.
- TePaske, John and Herbert S. Klein. 1986. *Ingresos y egresos de la Real Hacienda de Nueva España*. INAH.
- Weiss, D. J., A. Nelson, H. S. Gibson, W. Temperley, S. Peedell, A. Lieber, M. Hancher, E. Poyart, S. Belchior, N. Fullman, B. Mappin, U. Dalrymple, J. Rozier, T. C. D. Lucas, R. E. Howes, L. S. Tusting, S. Y. Kang, E. Cameron, D. Bisanzio, K. E. Battle, S. Bhatt, and P. W. Gething. 2018. "A global map of travel time to cities to assess inequalities in accessibility in 2015." *Nature* 553(7688):333–336.  
**URL:** <https://doi.org/10.1038/nature25181>
- White, Devin Alan. 2015. "The Basics of Least-Cost Analysis for Archaeological Applications." *Advances in Archaeological Practice* 3(4):407–414.
- Yuste, Carmen. 2002. Las autoridades locales como agentes del fisco en la Nueva España. In *El gobierno provincial en la Nueva España, 1570-1787*, ed. Woodrow Borah. UNAM.