Income Taxation and State Capacities in Chile: Measuring Institutional Development Using Historical Earthquake Data

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Abstract

The central argument of this paper is that income taxation fostered, via spillover effects, state-consolidation over time in Chile. The paper contributes to the literature in two ways. First, it studies the relationship between taxation and state-building outside Europe. Second, the paper tests the theory using a novel approach. Exploiting the exogeneity of earthquake shocks, a novel hand-collected longitudinal dataset on Chilean earthquake death tolls was leveraged. Under reasonable assumptions, the capacity for enforcing and monitoring building codes throughout the territory is a reflection of a state's overall capacities. Using a Bayesian Poisson regression to test the effect of implementing the income tax law on death-tolls between 1900 and 2010, the paper shows that death-tolls decrease (that is, state capacity increases) once the income tax law is implemented in 1924. To control for unmeasured sources of variation, the model leverages also a fixed-effects approach. To explore the causal mechanisms at work, I discuss the Chilean case since the 1920s.

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Levi (1989, 1) has famously explained that "the history of state revenue production is the history of the evolution of the state." However, even when we have gained considerable knowledge of fiscal expansion in the European cases, the study of the public finances within a context of state consolidation in the developing world is lacking, especially in the presence of "new leading sectors" (Schneider 2012, 2). In fact, while there are a number of theories about state-capacity in Latin America, domestic explanations centered on the role of the economic structural transformation and taxation have been overlooked.[1] Besides this theoretical gap, there is also an empirical deficit. As Soifer (2012, 586) points out, most "scholarship on state capacity [...] lack[s] a satisfying conceptualization and measurement scheme for this concept." Moreover, while most state formation theories are situated during precolonial (Mahoney 2010), early (Kurtz 2013; Soifer 2015), or late (Bahamonde, n.d.) independent Latin America, we lack a measurement that corresponds *temporally* to the theories we have. In other words, most explanations of state-making are *historical* in nature. Yet, in practice, available measurements capture *contemporary* levels of *stateness*.

The paper contributes to the literature from a substantive perspective by explaining the positive relationship between income taxation and state-consolidation overtime. The historical evidence suggests that since the income tax law was an agreement among the elites, the institution had quasi-voluntary compliance. In turn, the argument outlines how income taxation had positive spillover effects over state institutions, increasing levels of state consolidation overtime. And finally, the mechanisms evidences how the presence of tax assessors and collectors throughout the territory increased norms of enforcement of state regulations more generally, fostering overall state-capacities overtime.

The paper also contributes to the literature from an empirical perspective. Exploiting the exogeneity of earthquake shocks, I leverage a novel hand-collected dataset on Chilean earthquake death-tolls between 1900 and 2010. Earthquakes are time-invariant, and importantly, orthogonal to economic development and regime type. Under reasonable assumptions, if the state's capacity for enforcing and monitoring building codes throughout the territory is a reflection of overall state capacity, then death-toll differentials should be mainly associated with state-capacities. Exploiting this variation via a Bayesian Poisson model with year fixed-effects, I find that death-tolls associated

1. A few exceptions are Gallo (1991, 7-8), Beramendi, Dincecco, and Rogers (2016) and Saylor (2014, 8) who consider elite conflicts to study state-making and fiscal development in the developing world. Dargent, Feldmann, and Luna (2017) focus on a "'challenger-based' causal mechanism" of state formation in Peru, however they concentrate their efforts on the role of exogenous economic shocks.

to earthquakes systematically decreased (that is, *state capacities increased*) after the income tax law was implemented in 1924. Importantly, these changes overtime are not correlated with economic growth nor industrialization levels. The empirical section also provides a qualitative case study.

what else do I got?

Additionally, the article outlines a theory that explains the *timing* of the implementation of the income tax. Given that industrialists were more dependent on capital (relative to landowners), they opposed import taxes, favoring the implementation of the income tax. These fiscal resources paid for public goods that benefited the industrial class in the long-run, such as roads and bridges. Leveraging sectoral outputs since 1900 for a sample of nine Latin American countries, including Chile, and employing a number of survival models, the evidence suggests that the emergence of the industrial sector *accelerated* the implementation of the income tax. Also, using vector auto-regressive models and Granger-causality tests, the paper also challenges the stereotypical idea that Chilean landowners and industrialists conformed a single entrepreneurial elite with assets scattered throughout several spheres of investment. These tests strongly suggest that both sectors were, in fact, in constant opposition, and that levels of inter-sectoral asset diversification were weak.

In more detail, the paper argues that the emergence of the industrial sector caused higher levels of sectoral conflicts, triggering the implementation of the income tax, which in turn, fostered state development overtime via spillover effects (Figure 1). The paper not only builds on the fiscal sociology literature (Musgrave 1992), but on the sectoral politics approach too (B. Moore 1966; Stephens, Rueschemeyer, and Stephens 1992; Ansell and Samuels 2014; Boix 2003; Acemoglu and Robinson 2009). In particular, it argues that elites whose assets are allocated in different sectors of the economy have different preferences over direct taxation, and consequently, state centralization (Acemoglu and Robinson (2009, 289), Best (1976, 50), Mamalakis (1971, 109)). The framework follows Mamalakis (1969, 1971), who introduced the sectoral conflict approach for the Latin American cases, but also Hechter and Brustein (1980, 1085) who explain that "state formation will be most likely to the degree that powerful individual actors form two groups on the basis of divergent economic and political interests." And such, this article is an attempt to provide an alternative explanation of state-development to the bellicist approach (Tilly 1992; Dincecco and Onorato 2016), and extended to the Latin American case by Thies (2005), Thies, Chyzh, and Nieman (2016), and Kurtz (2006) (but see Centeno (2002)).

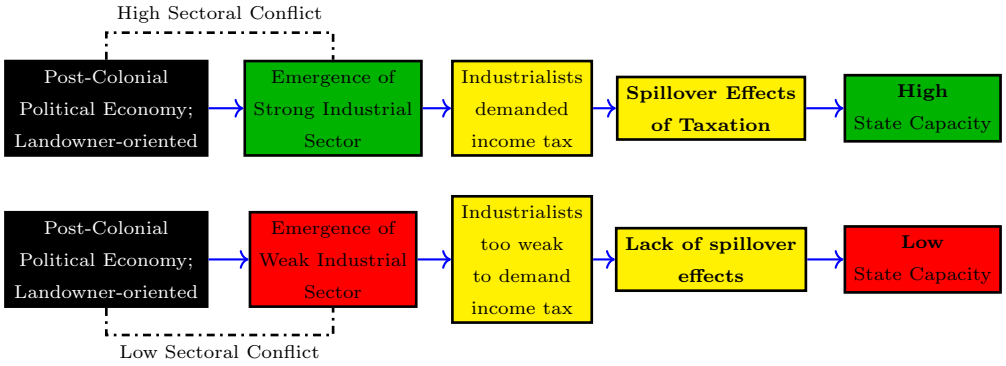

Figure 1: Causal Mechanism.

I. Sectoral Conflicts, and Income Taxation

The landed Latin American elites were an economic hegemonic group protected by norms and institutions that originated during colonial times (Keller 1931, 13). Not only that, the post-colonial institutional and economic orders were designed to give an unfair advantage to the agricultural sector. Mamalakis (1971, 99) is well-known for describing how an agriculture-government coalition was formed in Chile beginning with the colonial period. Several historians also point out that "[i]n those areas where the government did interfere in the countryside, the effect was to strengthen the position of the landowning class"(Bauer 2008, 118). In fact, the little public infrastructure that existed benefited mostly the agricultural sector (Rippy 1971; Marichal 1989; Zeitlin 1984; Bauer 2008). By extension, the landowning class controlled most of the politics too (Wright (1975, 45-46), Zeitlin (1984, 13), Bauer (2008, 45), Baland and Robinson (2008, 1748), Best (1976, 56), Rippy (1971) and Marichal (1989)). For example, Collier and Collier (2002, 106) explain that the Chilean "national government was dominated by the central part of the country, with owners of large agricultural holdings playing a predominant role."[2]

However, when the "structural transformation" happened—a process by which there is a "secular decline of agriculture and substantial expansion of manufacturing" (Johnston and Mellor 1961, 567)—it imposed tight constraints on the way politics was run by the incumbent landowning class. Given the foundational advantage of the landed elites, the secular emergence of the industrial sector

2. Similarly, McBride (1936, 15) explains that "Chile's people live on the soil. Her life is agricultural to the core. *Her government has always been of farm owners. Her Congress is made up chiefly of rich landlords.* Social life is dominated by families whose proudest possession is the ancestral estate." My emphases.

generated political, economic, and military threats to the landed elites.[3] For instance, before the civil war, *salitreras* (nitrate towns) in northern Chile were so prominent that they were considered "a state within the state" (Barros 1970, 500). Industrial bosses had to approve decisions on whether public employees could be fired, whether public works could be developed, and on whether politicians could give public speeches. *Salitrera* industries also coined their own currency, and had their own particular local laws. All in all, these set of practices posed credible threats to the agricultural political and economic orders.

The preferences over fiscal policy of the expanding industrial sector clashed with the ones of the agricultural class. On the one hand, land fixity increased the risk premium of the landed elite's main asset (Robinson 2006, 512), so they systematically resisted taxation. However, as capital could be reinvested in nontaxable sectors (Hirschman (1970), R. Rogowski in Drake and McCubbins (1998, ch. 4); however, see Bates and Lien (1985, 15)), industrialists' preferences toward taxation were more elastic. Consequently, the emergence of a strong industrial class led to heavier pressures for the implementation of the income tax law. As industrialists depended more on infrastructure implemented at the local level—such as roads, railroads, and bridges—the industrial classes in Latin America "[*preferred*] to shoulder a higher tax burden through progressive direct taxation" (Beramendi, Dincecco, and Rogers 2016, 18). In fact, in 1924 Chilean industrial elites accepted to be income taxed by agriculturalist incumbents *in exchange* for having more state services and being included in state politics. As others have explained, the non-agricultural sector "accepted taxation, while demanding state services and expecting to influence how tax revenues were spent [...] Consultation and cooperation were relatively institutionalised between the two sides" (Carmenza Gallo, in Brautigam, Fjeldstad, and Moore (2008, 165)).[4] Since both elites agreed on implementing the income tax, compliance was high. Institutionalist economists find that optimal institutional choices result from political settings where all involved actors "had a voice in the choice of institutions" (Aghion, Alesina, and Trebbi 2004, 566), essentially contributing to an equilibrium of quasi-voluntary

3. As Boix (2015) explains, lower levels of inter-elite economic inequality are tied to similar degrees of military capabilities. Under these circumstances, war is most likely to exhaust all existent assets without producing positive outcomes for either sector (Richard Salvucci, in Uribe-Uran 2001, 48), leading to heavier pressures to reach agreements instead of engaging in armed conflicts. In Chile, while initially both "antagonistic elites" (Keller 1931, 37-38), confronted each other in two bloody civil wars between a "large landed property [elite against a] productive capital[ist] [elite]" (Zeitlin 1984, 23), due to low levels of inequality, war was not sustainable overtime. For instance, while *Balmacedistas* managed to secure the support of the army, *congresistas* (the anti-Balmaceda group) gathered support from the navy. Similarly, in the subsequent years of the civil war, there were a number of *aborted* coups, in 1907, 1912, 1915, and 1919 (in Collier and Collier 2002, 109), suggesting an equilibrium where no elite was the leading elite.

4. My emphases.

compliance (Levi 1989).

II. Positive Externalities of Income Taxation on State Centralization

Indirect taxes were easier to levy, and hence, this kind of revenue is generally considered "unearned income" (M. Moore 2004a, 304) or "easy-to-collect source of revenues" (Coatsworth and Williamson 2002, 10). Since customs administrations have always been concentrated in a few critical locations—especially ports—tariffs and customs duties often times did not require an elaborate fiscal structure (Bertola and Ocampo 2012, 132). Given the relatively lower costs states have to incur to collect them, indirect taxes had a very low impact on state-building (M. Moore 2004b, 14). In fact, when early Latin American states depended heavily on trade taxes, the state apparatus tended to be less developed (Campbell 1993, 177).

Fiscal sociologists, however, explain that direct taxation fostered state consolidation. Musgrave (1992, 98-99) and M. Moore (2004a, 298) explain that transforming private incomes into public property fostered state expansion. Particularly, since taxation (especially on incomes) requires such a high degree of state penetration, the study of public finances offers also a theory of state-building.

The mechanism through which the positive spillover effects of taxation on state-building occur, is based on the endogenous accumulation—and transmission—of knowledge. Particularly, the mechanism considers situations where the stock of know-how accumulated in the revenue service, spread to other state institutions, such as institutions related to the counting of individuals, policing, the enforcing of public security, contracts, building codes, zoning laws, among others. The state-building literature has also considered these kinds mechanisms before. For instance, Soifer (2013, 2012) and Bahamonde and Trasberg (2018) proxy state capacity by considering a cumulative count of censuses taken in a particular country. The understanding is the same: as early states learn to count their inhabitants (or tax them, in my account), they also learn to perform other state tasks. This paper explains that direct taxation, via a learning-by-doing process, produced *technical complementarities*[5] between the state's existing stock of know-how and fiscal capacities. In simple, implementing the tax lowered the marginal costs of adding an additional layer of state*ness* onto the territory. Krasner (1985, 46) explains that "tariffs and export taxes are easier to obtain than direct

5. These are are situations in which "an increase in the output of [a] commodity [...] lowers the marginal costs of producing [other] commodity" (Hirschman 1958, 67).

taxes, *which require high levels of bureaucratic skill and voluntary compliance*."[6] This paper argues that it is this *bureaucratic effort* (contingent on elite-led fiscal pacts) what fostered state consolidation overtime. For instance, it was necessary to send official emissaries to check on accounting books of the refinery in the north, the winery in the central valley, and the *hacienda* in the south. Eventually, these delegations became more complex—and at lower marginal costs—increasing the density of state presence in the territory.

While there exists a tension between the *intention* to tax, and the *capacity* to actually do it, it is important to remember that the elites *wanted* to implement a system of income taxation, fostering an equilibrium of quasi-voluntary compliance. The literature, in fact, finds that *introducing* the income tax has been associated with improvements in efficiency and expansion of the scope of a number of other state tasks. For instance, Kaldor explains that the revenue service is the "point of entry." Once this institution is secured, securing the rest is marginally easier (in Brautigam, Fjeldstad, and Moore (2008, 15)). In turn, Besley, Ilzetzki, and Persson (2013) explain that *implementing* the income tax law is "associated with investments in public administrative structures that support tax collection" in a number of countries, including Chile, while Dincecco and Troiano (2015, 3) find "a positive and significant relationship between the introduction of the income tax and (1) per capita total expenditures, (2) per capita education expenditures, and (3) per capita health expenditures." Others have found that literacy levels in Chile rose in 1907 from 40% to 66% in 1925 (Engerman, Sokoloff and Mariscal, in Engerman and Sokoloff (2011, Ch. 5)), the share of national revenue accounted for by income taxes after implementing the income tax in 1924, rose from 6% in 1920 to 23.7% in 1940 (Engerman, Sokoloff and Zolt, in Engerman and Sokoloff (2011, 178)). Humud (1969, p. 154) documents that the income tax was widely enforced, generating considerable resources for the Chilean treasury (Bowman and Wallerstein 1982, 451-452), and that the dependence on custom taxes decreased from 70.2% to 41.1% during those same years (Engerman, Sokoloff and Zolt, in Engerman and Sokoloff (2011, Ch. 6)).

III. From Earthquake Death-Tolls to State Capacities

Did the implementation of the income tax in Chile foster state development overtime? While this section *motivates* the measurement approach pursued in this paper, it leaves for future research—

6. My emphases.

presumably, in a "measurement paper"—further performance and sensitivity analyses regarding this measurement.

More than being blessed, the literature is in fact cursed due to an over-abundance of poor indicators of state consolidation (Soifer 2012, 589). In fact, its abundance "points to the poor state of empirical measures of the quality of states" (Fukuyama 2013, 347). Furthermore, most indices are conflated with analytical and conceptual problems (Ferreira 2017, 1292).

One notable example is "protection of the rule of law," which is commonly used as proxy for state capacity (Besley and Persson 2009, 1237). As Kurtz and Schrank (2007, 543) explain, this strategy is severely confounded "with policy preferences over the structure of private property rights." On the one hand, this is problematic since the sources of this data are usually elite interviews (Fukuyama 2013, 349). To "the extent that public bureaucracies *are* effective in imposing taxes or regulatory demands [...] they are likely to be judged 'burdensome' and 'growth-inhibiting' by many businesspersons" (Kurtz and Schrank 2007, 542), thereby introducing systematic measurement error (Kurtz and Schrank 2012, 618). On the other hand, the problem is conceptual. As Soifer (2008, 247) puts it, there is a widely spread "problem of misalignment between dimension and indicator." Kurtz and Schrank (2012, 619) recommend "explicitly avoid[ing] an emphasis on outputs that are at the center of political or policy debates, such as property rights." For example, the U.S.S.R. had a strong state, however it did *not* protect property rights.

Another iconic example of this misalignment problem is the use of fiscal extraction as a proxy of state capacity. Johnson and Koyama (2017, 3) explain that "[t]ax revenue per capita is a commonly used metric of fiscal capacity," which in turn "speaks" to levels of state-capacity. In fact, Thies (2015, 172) conceptualizes "fiscal capacity [...] in terms of tax revenue extracted from society." This error is very common in the literature, and other examples are Besley, Ilzetzki, and Persson (2013, 224) and Besley and Persson (2014). Not only tax shares reflect policy preferences too (Soifer 2013, 9), but also, as Fukuyama (2013, 353) explains it, there "is a difference between extractive *potential* and *actual* extraction rates."[7] For instance, since American institutions were deliberately designed to limit the exercise of state power, the U.S. taxes very little (Fukuyama 2004, 6). However, it is not reasonable to say that the U.S. is a "weak state." Moreover, in late imperial China, "high taxes on peasants [...] were the result of rulers' *lack* of power. Chinese rulers consistently attempted to limit officials' excessive extractions from the masses, but were unable to do so" (Kiser and Tong

7. My emphases.

1992, 301).[8]

Finally, others have proxied state-capacity with economic growth, which is also problematic (Fearon and Laitin 2003; Besley and Persson 2011). Interestingly, Mahoney (2010, 4, 6-7) pursues the same strategy. As Dargent, Feldmann, and Luna (2017) explain, state-capacity and economic growth are causally distinct mechanisms. For instance, boom-led economic growth has left net state capacity low in Peru.

This paper identifies an additional limitation. Beyond conceptual and analytical problems, most available measurements are unable to capture temporal variations of state capacity. Since most explanations of state-making have a strong historical component, the lack of an indicator able to *travel in time* represents a huge deficit in the literature. Just to name a few examples, Soifer (2012, 585) "builds a new measure of state capacity for [...] *contemporary* Latin America [combining] multiple dimensions (extraction, security, and the administration of basic services)."[9] Kurtz and Schrank (2012, 618-619) designed some list-experiments to study bureaucrat's opinions, Dargent, Feldmann, and Luna (2017) "analyses the evolution of state capacity in Peru during the *recent* commodity boom,"[10] while Luna and Toro (2014) and Luna and Soifer (2017) employ a survey-based design to measure *contemporary* subnational state capacities. While these measurements do overcome the conceptual and analytical problems mentioned above, they do not help us in studying state capacities in a historical setup.

Economic historians offer other alternatives. Some examples are levels of investments in public goods such as infrastructure (Enriquez, Sybblis, and Centeno 2017), roads (Mann 1984, 2008; Acemoglu 2005; Saylor 2012; Thies 2009; Besley and Persson 2010), electrification (measured as light intensity per pixel) (Huntington and Wibbels 2014), and railroads (Saylor (2012, 302),Coatsworth (1974)). Unfortunately, many of these measurements are debatable. For instance, Soifer (2012, 593) explains that "railroads were often constructed by private actors." The same problem applies to other types of infrastructure. There are others more appropriate strategies, such as the opening of postal offices (Acemoglu, Moscona, and Robinson 2016), the administration of national censuses (Lee and Zhang 2017; Soifer 2013; Centeno 2002; Hanson and Sigman 2013; Hanson 2015). Another variation of this technique is "age heaping" or vaccination (Soifer 2012). While these measurements do capture historical variations of state capacity, some other problems arise. Censuses, for example,

8. My emphasis.
9. My emphasis.
10. My emphasis.

provide a non-continuous temporal measurement of state capacities. For instance, censuses are applied in Chile every ten years. Having just a few snapshots of state-capacity should compromise any statistical analysis. In turn, vaccines are usually targeted at primary and high school students. In practice, vaccines are administered by the schools themselves, both public and private. Private schools might be more efficient in doing so, inflating the average level of state-capacity.

To solve some of these limitations, the paper proposes earthquake death-tolls as an alternative to measure state capacity overtime. In particular, the proposed measure is explained leveraging the Chilean case. Unlike censuses—*unfortunately*—earthquakes happen in Chile very often. While "[e]arthquakes alone claim thousands of lives a year" (Anbarci, Escaleras, and Register 2005, 1908), they are not well studied in political science (Brancati 2007, 719). Building on Mann (1984, 113), the proposed measurement intends to capture the state's *infrastructural* power. That is, "the capacity of the state [to] actually [...] penetrate civil society, and to implement logistically political decisions throughout the realm."

Natural hazards involve two kinds of processes, one natural, and another human (Raschky 2008, 627). In the case of earthquakes, the natural component happens at random, and as a consequence, they are exogenous to the affected locality. For instance, Brancati (2007, 728) explains that "earthquakes constitute a natural experiment," while Gignoux and Menéndez (2016, 27) also point out "that the occurrence of earthquakes can be viewed as random [allowing the analyses of] these events as a set of repeated social experiments." In fact, earthquakes are orthogonal to levels of state capacity and economic development (Kahn (2005, 271) and Brancati (2007)).

Since the natural process associated with the realization of earthquakes is random, the only unexplained part that is left is the systematic human component, which is what the measurement captures. Consequently, keeping earthquake magnitudes constant at their means, (population-weighted) death counts should be attributed to the (*in*)capacity of the states to invest in preparedness and earthquake-mitigation institutions.

I focus on earthquakes and not on other natural disasters, such as "extreme temperature events, floods, landslides, and windstorms" (Kahn 2005, 280), because earthquakes cannot be foreseen and, as such, they put to test the states' capacity for having their preventive institutions *already* in place and in good shape. In fact, Brancati (2007, 716) explains that "[e]arthquakes may provoke conflict more than any other type of natural disaster because they have rapid onsets [and] are not

predictable."[11] State capacity consists of sustained proactive efforts of enforcing institutions in the territory, and, hence, short-term reactive actions should not be considered state-*making*.

Under reasonable assumptions, the capacity of deploying inspectors to enforce quake-sensitive zoning and building codes should be a reflection of the overall levels of state capacity. In fact, Ambraseys and Bilham (2011, 153) explain that "[e]arthquake-resistant construction depends on responsible governance," while Raschky (2008, 628) argue that the effects of natural hazards depend on the region's "institutional vulnerability." Thus, state capacity acts as a scope condition undermining (facilitating) the implementation of construction norms. For example, Bilham (2013, 169) explains that "although engineering codes may *exist*[,] mechanisms to *implement* these codes are largely unavailable"[12] in low-capacity states. For example, Anbarci, Escaleras, and Register (2005, 1910) explain that "while Iran has building codes [...] comparable to those existing in the United States, they tend to be enforced only in the country's larger cities," not in the countryside.

Only high-capacity states overcome their own limitations, not only implementing but also enforcing quake-sensitive regulations. The Chilean government started its efforts to ameliorate the impact of earthquakes after the great quake of 1928 in Talca. A first effort happened in 1929, when *Ley* number 4563 was implemented. The law was among the first attempts to prohibit "construction, reconstruction or any other repairing or transformations [...] without a permit from the authorities." Importantly, the law required that all blueprints had to be signed off by an expert before the construction started. By 1930, *Decreto* number 4882 was adopted, but this time the rule made a number of technical prescriptions,[13] determining what kinds of construction materials ought to be used, among other requirements. Critically, while the central government had retained the control of the supervision of the code since the promulgation of the *ley*, the *decreto* explicitly created the role of the *inspector* to supervise, enforce, and monitor these measures at the local level. Furthermore, *artículo* 414 of the Chilean *Decreto* 4882 granted inspectors "free access to the building" at any time during the construction process. The proposed measurement captures whether these good intentions achieved lower death-tolls.

The proposed measurement has a number of advantages. Unlike non-experimental survey-based or purely policy-based measures, earthquake death-tolls are an *objective* measurement of earthquake preparedness, an activity that *any* state *must* perform. For instance, Carlin, Love, and Zechmeister

11. My emphasis.
12. My emphases.
13. See especially article 151.

(2014, 422) explain that "a basket of 'minimal' state functions [typically includes] primary education, public health, rule of law, public finance management, and *disaster relief*."[14]

However, the measurement has a number of drawbacks. Obviously, the country needs to have earthquakes, possibly limiting the number of potential cases. Yet, good indicators of state-capacity also suffer from the same problem (i.e. context-specificity). For instance, Soifer (2012, 593) and Slater (2008, 252) propose a measurement based on whether states are able to enforce voter registration "where voting is mandatory," or conduct "state registration of marginal populations," respectively, limiting the study of state-capacity to democratic countries only. This is not only a democracy-specific limitation, but also a temporal one.

One advantage that actually mitigates some of these drawbacks is that most earthquakes occur at the various borders of the Pacific, Latin American, African, Arabic, Indian and Eurasian plates, allowing a number of potential cross-country comparisons (Keefer, Neumayer, and Plümper 2011, 1534). In fact, from a population size perspective, this measurement is also a convenient one. A "quarter of the world's population inhabits [...] the northern edge of the Arabian and Indian Plates that are colliding with the southern margin of the Eurasian Plate" (Bilham and Gaur 2013, 618).

Moving forward, there are countries, like India or the United States, where earthquakes happen in certain regions only. Presumably, mitigation policies in these places would need to be targeted to specific areas, possibly undermining the assumption that these kinds of policies should penetrate the entire territory. For instance, Dunbar, Bilham, and Laituri (2003, 164) explains that the Indian state implements targeted policies (that might not necessarily correspond to the administrative areas) based on isoseismal maps that define different zones of seismic hazard.

Another potential concern is that the ability of counting the death-toll might be a function of state capacities itself.[15] However, in most cases, civic organizations, the Catholic Church, and, particularly, the press (national and local) have been the main entities who (willingly or not) have carried out the task of enumerating the deaths. Another potential issue is the measurement of the magnitudes. Before the instrumental period, magnitudes were obtained in an estimative way, and, while there are methods to approximate historically-felt magnitudes to instrumental-like intensities (Szeliga et al. 2010), this strategy unfortunately adds more than one layer of complexity. All in all, this measurement offers a rough approximation of levels of state capacities overtime.

14. My emphases.
15. I thank Paul Poast for this comment.

IV. Empirical Section

I. Data and Statistical Model

I constructed a novel hand-collected longitudinal dataset using the *Significant Earthquake Database* compiled by the National Centers for Environmental Information (NOAA) as a starting point (NGDC/WDS, National Geophysical Data Center / World Data Service 2015). The dataset "contains information on destructive earthquakes from 2150 B.C. to the present," such as magnitude, date, latitude, longitude, number of deaths, among other variables. Tsunami casualties were excluded. And since "most of the damage in major earthquakes occurs within 30 km of the epicenter" (Dunbar, Bilham, and Laituri 2003, 172), earthquakes that did not happen on land were not dropped. While the epicenter might have been a few miles away from the shore, the consequences certainly reached the land.

Using archival census data from 1907 to 2012,[16] the NOAA dataset was complemented with local population at the municipal level where the quake hit. Local population was used to weight the death toll.[17] Using archival census data as well, the main economic activity of the affected municipality was coded,[18] in addition to whether the municipality was urban or rural.[19] The death-tolls and magnitudes proportionated by the NOAA dataset were contrasted case by case with historical press archival information.[20] Magnitudes, in particular, were also compared with the International Seismological Centre.

16. Particularly, censuses of 1907, 1920, 1930, 1940, 1952, 1960, 1970, 1982, 1992, 2002 and 2012. Some of them were kept at the *Biblioteca Nacional* and others at the *National Statistic Institute* historical library.

17. Around 90% of the times it was possible to recover the actual local population. For the rest, the population of the most concentrated area nearby was recovered. Consequently, population is used as a control, not to directly weight the dependent variable.

18. This variable was constructed by coding press and official sources (mainly censuses) of the main economic sector at the local level. *Agriculture* (n=31), *Industry* (n=56), *Mixed* (n=16).

19. Urban=85, rural=18. If more than 50% of the population lived in an urban setting, I assigned a 1 to that municipality, 0 otherwise. Urban concentrations are most likely to have vertical constructions rather than one-story buildings, increasing the potential number of casualties. Consequently, it is important to control for this source of variation. I thank Daniel Kelemen for this suggestion.

20. *El Mercurio* and *La Nación* newspapers, both kept at the *Archivo Nacional* of the *Biblioteca Nacional de Chile*.

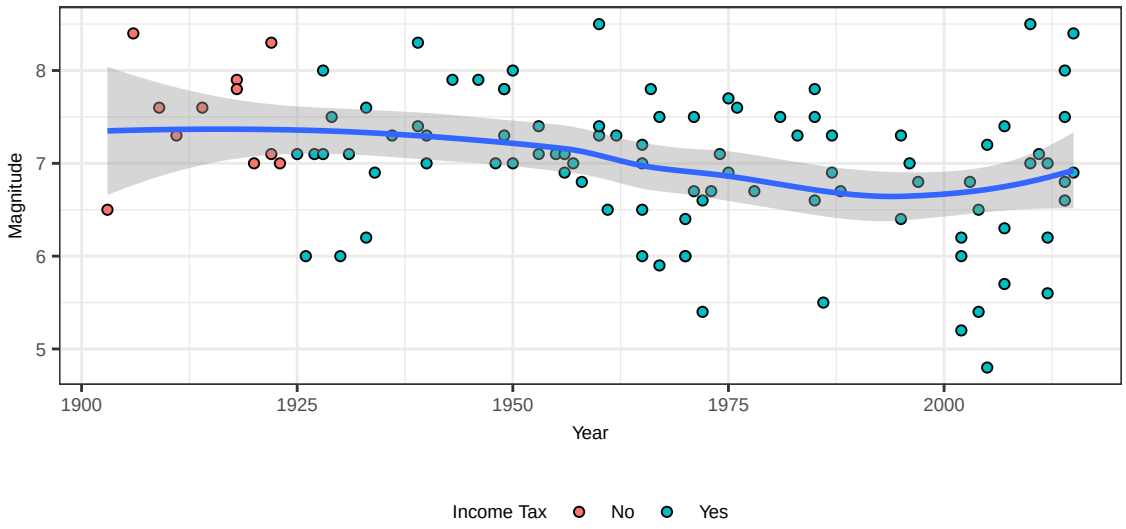

Figure 2: Earthquakes in Chile:1903-2015.
Note: *Figure shows earthquakes overtime (N=103). Additionally, the figure shows earthquakes before and after the implementation of the income tax in 1924. A smoothing function was added to show that there are not statistically significant different decreases/increases in magnitudes overtime.*

Figure 2 plots the overtime variation, while Figure 3 plots the geographical variation, as well as the dominant productive sector. Both figures suggest that Chile is a good case to study infrastructural state-capacity using the earthquake framework: Chile has considerable variance regarding quake magnitudes, locations and sectoral variation. The northern part of Chile has historically been an industrial region, while the southern part of Chile has traditionally been agricultural. Relatedly, both regions vary according to their climate (which correlates with agriculture). Furthermore, the distance from Santiago, which is located near latitude 33°, might impose some degree of difficulty for the central government to reach the farthest northern/southern parts of the territory (Foa and Nemirovskaya 2016, 418). There is also variance considering longitude. Closeness to the Andean mountains (around longitude 70°) determines the ruggedness of the terrain, presumably making it harder for the state to penetrate these areas. In fact, Brancati (2007, 729) explains that "[e]arthquakes often occur in mountainous areas." All things considered, earthquakes have affected the territory from coast to mountain, both north and south, and both agricultural and industrial areas, solving potential concerns about geographical sectoral self-selection. For instance, it would

have been a problem that a specific sector, say the industrialists, were located *only* in the northern part, which is the most earthquake-prone.

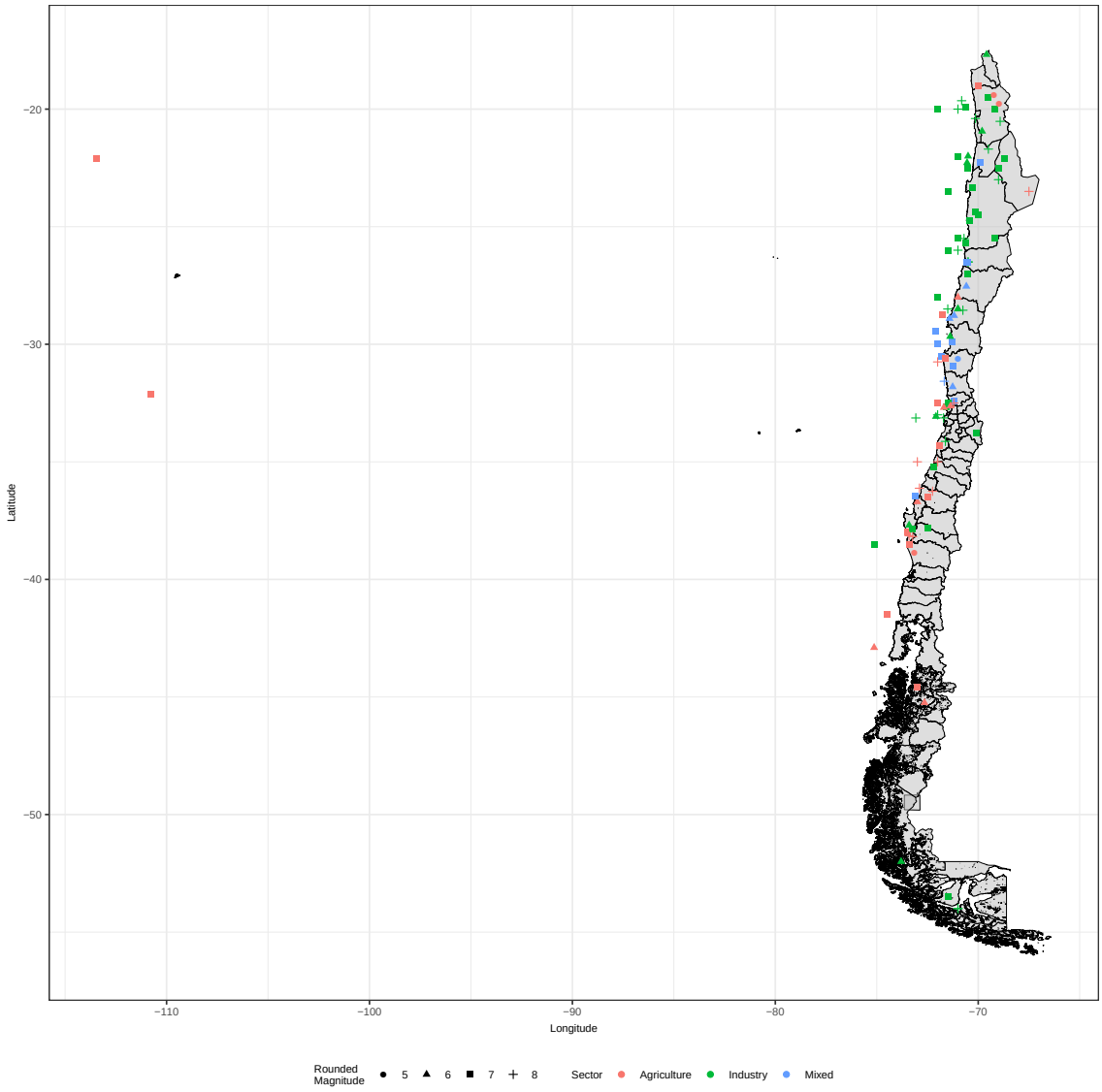

Figure 3: Data Used in the Analyses: Geographical Distribution of Earthquakes in Chile, 1903-2015.
Note*: Using a combination of archival information and external sources, the figure shows a total of 103 earthquakes. Each quake was colorized according to the predominant economic sector at the municipal level. In total, there were 31 earthquakes that took place in agricultural localities, 56 in industrial, and 16 in mixed municipalities.*

Following conventional wisdom, the unit of analysis is the earthquake (Kahn 2005, 273). As an event, each earthquake has associated to it a death toll, a location, a magnitude, a local population, and an urban/rural setting. And following statistical convention, a count model was used to test the effect of implementing the income tax law on earthquake death-tolls overtime (Anbarci, Escaleras, and Register (2005, 1907), Kahn (2005, 276), Brancati (2007, 729), Escaleras, Anbarci, and Register (2007)), in particular, a Bayesian Poisson regression was employed.

The main quantity of interest is an interaction term—β_3 in Equation 1—between earthquake magnitude, and a binary variable that denotes whether the income tax had been implemented at the time of the event. The idea is to inspect whether the base line propensity of the earthquake's magnitude of increasing the death-toll is modified when combined with the introduction of the income tax. The null hypothesis is that the income tax does not alter this baseline propensity. The alternative, however, is that introducing the income tax decreases (increases) the propensity.

Following standard convention, the model includes year fixed-effects to account for time-varying confounding factors, and for unmeasured sources of variation (Brancati 2007, 729). For instance, fiscal development is also a function of country-specific prior state-capacities. Additionally, technological changes (advances in construction, for example) should diminish death-tolls.[21] Fixed-effects should be able to account for these, and other unmeasured yearly factors.

In addition, local population was used to proxy for local economic development (Sokoloff and Engerman 2000). Since the idea is to account for the state's ability to enforce building codes and zoning laws, it is important to control for the capacity wealthier localities might have had to enforce those norms on their own—i.e. without the need of the state. Latitude was included to control for the proximity to the Andean mountains, aiming to control for a built-in tectonic earthquake predisposition. Longitude seeks to control for climate, and other unmeasured conditions that make agricultural development more difficult. In turn, both measurements serve as good proxies of terrain ruggedness, and the difficulties the state faces in reaching these areas.

Undoubtedly, there are many more factors that might increase death-tolls. Ambraseys and Bilham (2011, 154), for example, explain that the "number of fatalities depends on whether an earthquake happens at night or during the day, in the winter or in the summer, in a mountainous region or in a valley, after strong and protracted fore-shocks and with or without warning." While the model has some of these factors accounted for, complete hourly data is lacking. However,

21. I thank Hillel Soifer for this suggestion.

Lomnitz (1970, 1309) explains that "some of the larger Chilean earthquakes which have caused deaths" between the 1900's and the 1960's have been afternoon quakes. Other factors such as "the speed of tectonic movements [and] the degree to which the lower plate bends the upper plate" and the focal depth (Keefer, Neumayer, and Plümper 2011, 1534), could not be included due to the lack of complete data overtime.

All in all, the next equation was fitted:[22]

$$\begin{aligned} \text{Deaths} \ &\sim \text{Poisson}(\lambda_i) \\ log(\lambda_i) &= \mu + \beta_1 \text{Magnitude}_i + \beta_2 \text{Income Tax}_i + \\ &\quad \beta_3 \text{Magnitude}_i \times \text{Income Tax}_i + \\ &\quad \beta_4 \text{Population}_i + \beta_5 \text{Longitude}_i + \beta_6 \text{Latitude}_i + \\ &\quad \beta_{7,k} \text{Sector}_i + \beta_{8,t} \text{Year}_i \end{aligned} \tag{1}$$

where,

$$\begin{aligned} i_{1,\dots I} \text{ and I} &= 103 \text{ events;} \\ k_{1,\dots K} \text{ and T} &= 3 \text{ sectors;} \\ t_{1,\dots T} \text{ and T} &= 64 \text{ years.} \end{aligned}$$

II. Spillover Effects of Income Taxation on State Capacity

Fiscal sociologists, mostly focusing on the continental cases, have for a long time claimed that the capacity of taxing individuals' incomes fosters overall state-capacities. Unfortunately, there have not been attempts to study this relationship for the Latin American cases. The results presented in this paper, find support for this claim.

22. All parameters $\beta \sim \mathcal{N}(0, 0.0001)$, all precisions $\tau \sim \mathcal{G}(1, 1)$, while $\mu \sim \mathcal{N}(0, 0.0001)$.

	Mean	SD	Lower	Upper	Pr.
Income Tax	65.62	11.91	43.33	81.83	1.00
Magnitude	9.44	1.57	6.35	11.63	1.00
Income Tax * Magnitude	-9.05	1.60	-11.39	-5.96	1.00
Latitude	-0.00	0.01	-0.03	0.02	0.50
Longitude	0.10	0.02	0.06	0.14	1.00
Population	-0.02	0.00	-0.02	-0.01	1.00
Sector[Agriculture]	5.93	2.94	-0.73	11.84	0.94
Sector[Industry]	4.75	2.97	-1.95	10.59	0.92
Sector[Mixed]	7.22	2.87	0.82	12.85	1.00

Note: 100 iterations with a burn-in period of n = 10 iterations discarded.
95% credible intervals (upper/lower bounds). All R-Hat statistics below critical levels.
Standard convergence diagnostics suggest good mixing and convergence.
A total of 1 chains were run. Figure OA2 shows that the model fits well the data.

Table 1: Income Tax Adoption Model: Simulated Posterior Predictions (Poisson Regression, Equation 1).

Table 1 shows the estimated results. Methodologically speaking, however, the coefficient of the interaction term (i.e. β_3) remains uninterpretable in practice, making regression tables useless from a substantive standpoint (Brambor, Clark, and Golder 2006, 74). These problems get more complex when it comes to generalized models, as a number of challenges arise. In an important paper, Ai and Norton (2003) explain that the interaction effect could be nonzero, even when the coefficient says it is zero; the statistical significance of the interaction effect cannot be tested with a simple t-test on the coefficient of the interaction term; the interaction effect is conditional on the independent variables; and that the interaction effect may have different signs for different values of covariates. In addition to all these challenges, and given that cross-partial derivatives are not advisable either, simulation methods are required (Zelner 2009; King, Tomz, and Wittenberg 2000). This procedure samples via simulation from the point estimates, generating a new, and larger distribution. That is, taking the single estimated parameters (i.e. the regression coefficients), I constructed a distribution of estimated values for each coefficient. Relying on the central limit theorem, with enough sampling draws, the new simulated distribution is a transformation that approximates with a great degree of precision the (uninterpretable) coefficients. Subsequently, means and uncertainty measures can be constructed for each of these distributions.

Fortunately, the Bayesian framework has embedded these procedures into it, providing a systematic, and yet intuitive, methodology to solve these challenges. In particular, for every coefficient, I estimated 1 chains, with 100 iterations per chain. And considering the Monte Carlo Markov Chain

properties, I discarded the first 10 iterations of every chain. Following (Brambor, Clark, and Golder 2006), Figure 4 shows the conditional effect of earthquake magnitudes on implementing the income tax.[23]

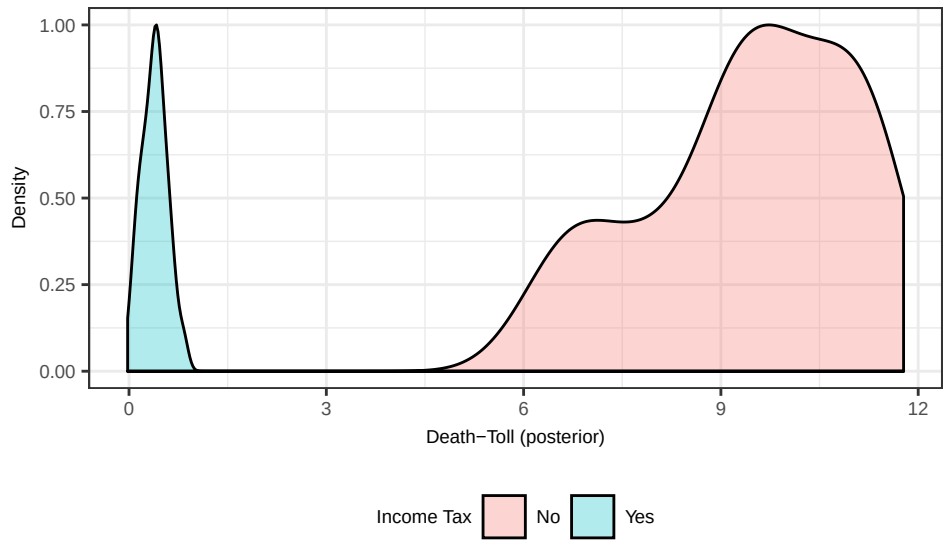

Figure 4: Conditional Effect of Earthquake Magnitudes on Implementing the Income Tax.
Note: *Using the estimations from Table 1 (Equation 1), and following the advice of Brambor, Clark, and Golder (2006), the figure shows the conditional effect of earthquake magnitudes on implementing the income tax in 1924 ($\beta_1 + \beta_3 \times$ Income Tax$_i$). Particularly, by implementing the income tax, the base line propensity of the earthquake's magnitude of increasing the death-toll,* decreases *from an estimated overtime average of 9 to an estimated overtime average of 0. Hence, the figure suggests that implementing the income tax law had positive effects on state-capacity overtime. Both distributions were computed via a MCMC routine, particularly iterating 1 chains with 100 iterations per chain. And considering the Monte Carlo Markov Chain properties, the first 10 observations of every chain were discarded.*

Substantively, Figure 4 shows that the death-toll systematically *decreases*—i.e. state capacity systematically *increases* overtime—*once the income tax law is implemented*. Particularly, by implementing the income tax, the baseline propensity of earthquake of increasing the death-toll, *decreases* from an estimated overtime average of 9 to an estimated overtime average of 0. Importantly, the fixed-effects approach makes these results robust to considerations of progressive national and local economic development. By absorbing yearly sources of variation, Equation 1 is capable of controlling for unobserved factors that might have an impact on the dependent variable (Figure OA1

23. Based on Equation 1, the simulated matrix was constructed following the routine described above, iterating over the next generalized equation: $\beta_1 + \beta_3 \times$ Income Tax$_i$.

shows the estimated year fixed-effects).

As argued before, a potential issue might be that sectors self-select into more/less earthquake-prone geographical locations. For instance, it might be argued that agricultural areas, being mostly rural, might have lower constructions, and less populated areas, with potentially less earthquake death-tolls. Industrialists, in turn, being a more urban-oriented sector, might have both highly populated municipalities, and higher constructions (edifices), potentially showing higher default death-tolls.

To rule-out this possibility, $\beta_{7,k}$—in Equation 1—has a hierarchical structure which allows having three different intercepts, one per every k sector. In other words, this parameter shows whether earthquake magnitudes affect earthquake death-tolls in agricultural, industrial or mixed municipalities, in different ways. Table 1 strongly suggests that industrial areas do not have higher earthquake death-tolls when compared to agricultural areas. The posterior predicted means for the former are 5 casualties, and for the latter, 6 deaths. Similarly, mixed municipalities have a predicted death-toll of 7.

Diagnostics here: traplot, etc.

III. Industrial Expansion and the Origins of the Income Tax

The theory, and the empirics, put heavy emphasis on the long-term effects of implementing the income tax. In particular, the implementation of the income tax in Chile is associated with an increase in state-capacity overtime. However, *where does the income tax come from?* The historical evidence presented above strongly suggests that there existed an inter-sectoral alliance. Chilean industrialists posed credible threats to agricultural landowners, materializing an inter-sectoral alliance between the two: industrial elites pursued the implementation of the income tax, in exchange of public goods delivered at the local level. *Can this finding be generalized to other countries?*

In this section, the paper presents an effort to generalize the argument about the sectoral origins of the implementation of the income tax law. Following the economic development typology suggested in Mahoney (2010, 5), nine polities were selected. Three "higher level" countries (Argentina, Chile, and Venezuela), three "intermediate level" countries (Mexico, Colombia, and Peru), and three "lower level" countries (Ecuador, Nicaragua, and Guatemala). For each polity, economic data were collected to observe the degree in which industrial elites challenged incumbent landowners.

Sectoral contestation was measured by using industrial and agricultural sectoral growth rates,

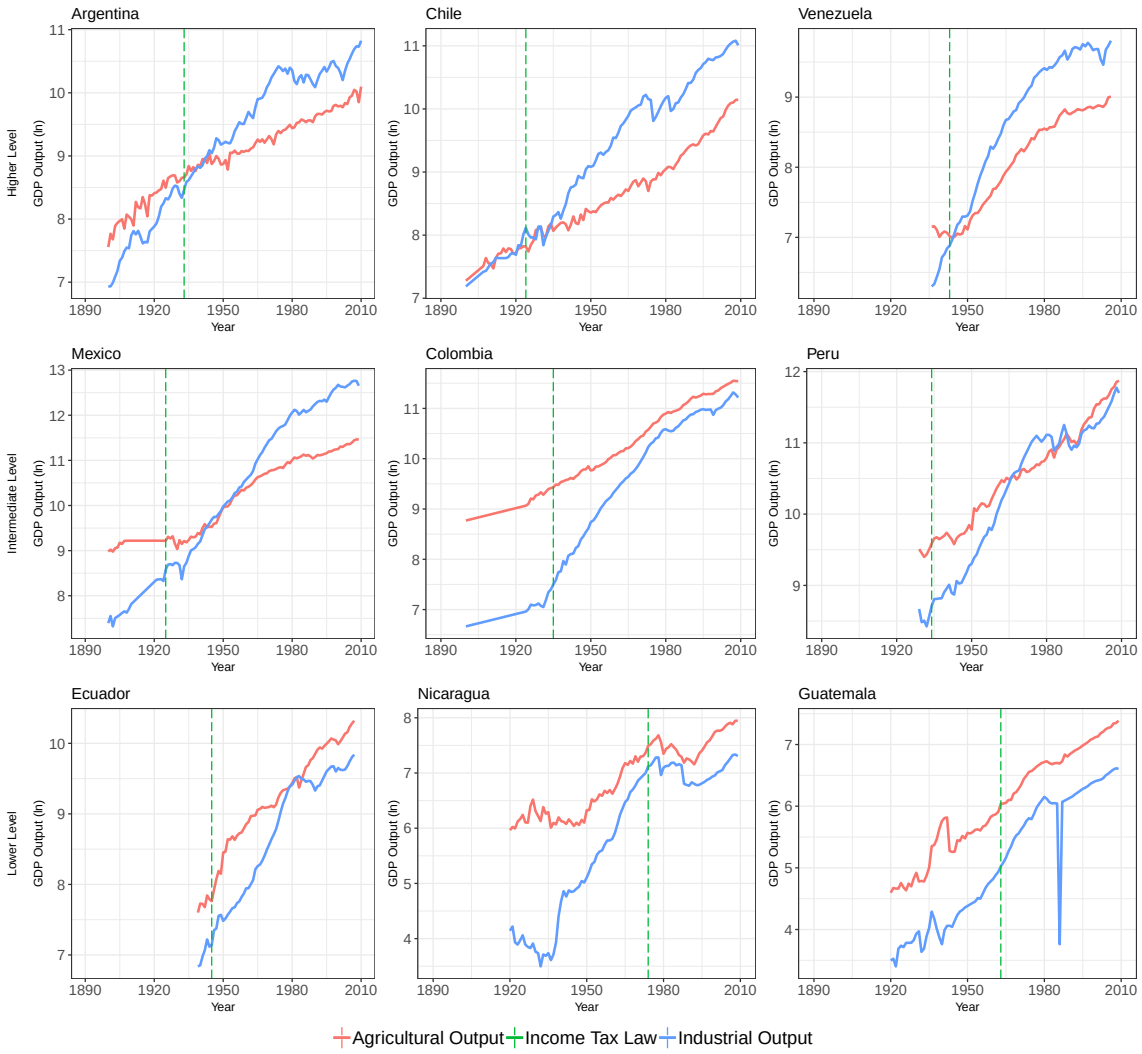

Figure 5: Industrial and Agricultural Outputs, and The Passage of the Income Tax Law.
Note: *Figure shows historical sectoral outputs, and year of the passage of the income tax law. Following convention, the figure shows logged values. Following the economic development typology suggested in Mahoney (2010, 5), nine polities were selected. Three "higher level" countries (Argentina, Chile, and Venezuela), three "intermediate level" countries (Mexico, Colombia, and Peru), and three "lower level" countries (Ecuador, Nicaragua, and Guatemala).*
Source: *MOxLAD, and other sources compiled by the author (see Table OA1).*

as presented in the MOxLAD data.[24] The dataset has been used before in the state-formation literature (Thies 2005), and outputs span from 1900 to (potentially) 2010.[25] According to Astorga, Berges, and Fitzgerald (2005, 790), these data provide extended comparable sectoral value-added

series in constant purchasing power parity prices. Leveraging some more additional archival data, Table OA1 shows the year when the income tax law was passed in these countries. Finally, Figure 5 conveys both agricultural and industrial outputs (independent variables), and the year when the income tax law was passed (dependent variable).

Econometrically, this section is concerned about the sectoral contribution to the *timing* of implementing the income tax law. In other words, we would like to know if the income tax law was implemented *because* of agricultural expansion, *or* industrial expansion. Table 2 shows 3 models.[26] Following Aidt and Jensen (2009), model 1 computes the lagged conditional hazard ratio of a country which has not yet adopted the income tax, adopts it in a given year. Since the idea is to capture the *sectoral contribution* to the implementation of the income tax law, these variables were not combined. Following Box-Steffensmeier and Jones (2004, 49), the next Cox model was fitted for all countries i and years t:

$$\begin{aligned} h_i(t) = exp(&\beta_1 \text{Industrial Growth}_{i,t-1} + \\ &\beta_2 \text{Agricultural Growth}_{i,t-1} + \\ &\beta_3 \text{Total Population}_{i,t-1} \\ &) h_0(t) \end{aligned} \tag{2}$$

Model 2 in Table 2 shows the estimated coefficients of a generalized estimating equation (GEE). Following Zorn (2006, 331), the next equation was fitted:

$$\begin{aligned} \pi_{i,t} = \Phi(&\beta_1 \log(\text{Industrial Growth}_{i,t}) + \\ &\beta_2 \log(\text{Agricultural Growth}_{i,t}) + \\ &\beta_3 \log(\text{Total Population}_{i,t}) \\ &) \end{aligned} \tag{3}$$

24. Both the *agriculture value-added* and *manufacturing value-added* variables were used.

25. Since countries are censored once they implement the income tax law, they leave the sample (potentially) before 2010.

26. The table was produced using the `texreg` package (Leifeld 2013). The Cox model was computed using the `survival R` package (Therneau 2015). The GEE logistic regression model was computed using the `geepack` package (Hojsgaard, Halekoh, and Yan 2016). The simulations were performed using the `simPH R` package (Gandrud 2015).

where π is the logit link function, and Φ is as scale parameter (i.e. the cumulative distribution function), for all i countries, and years t.

Generalized estimating equations were introduced by Liang and Zeger (1986) to fit clustered, repeated/correlated, and panel data (Zorn 2006, 322). This method is especially well suited to analyze binary data (Hanley et al. 2003), something particularly useful given the nature of the dependent variable. GEE methods require analysts to parameterize the working correlation matrix. While GEE models are robust to misspecification of the correlation structure (Hedeker and Gibbons 2006, 139), following Hardin and Hilbe (2013, 166), the "independence" working covariance structure was used, since observations were collected overtime. From a substantive standpoint, GEE models provide an estimated marginal mean, or the weighted average of all cluster-specific effects (or conditional means).

Finally, model 3 is a conditional logit, or "fixed-effects" panel logit model:

$$\begin{aligned}\pi_{i,t} = \Phi(\beta_0 + & \\ & \beta_1 \log(\text{Industrial Growth}_{i,t}) + \\ & \beta_2 \log(\text{Agricultural Growth}_{i,t}) + \\ & \beta_3 \log(\text{Total Population}_{i,t}) + \\ & \alpha_i)\end{aligned} \tag{4}$$

where α_i are the country fixed effects for all countries i.

Since population has been associated with the probability elites expand the franchise (Engerman and Sokoloff 2005, 892-893), and consequently the tax base, country-year population was included as a control variable in all three models.

Table 2 shows that industrial expansion is always positive and statistically significant, while agricultural expansion is always negative and statistically significant. Substantively, industrial expansion is systematically associated with an *earlier* implementation of the income tax, while agricultural expansion in fact *delays* the implementation of the income tax.

To have a more substantive grasp, and using simulation methods, Figure 6 shows the hazard rates of the Cox model (model 1 in Table 2, or). The simulation considers both the maximum and the minimum output rate in the entire dataset. THe figure shows that it is not *overall*

	(1) Cox	(2) Logit GEE	(3) Conditional Logit
Manufacture Output$_{t-1}$	4.923**		
	(1.851)		
Agricultural Output$_{t-1}$	−4.208*		
	(1.638)		
Total Population	0.000**		
	(0.000)		
Manufacture Output (ln)		1.924***	0.668***
		(0.514)	(0.143)
Agricultural Output (ln)		−1.596**	−0.941***
		(0.603)	(0.281)
Total Population (ln)		1.259	1.030**
		(1.052)	(0.391)
AIC	12.796		4505.538
R^2	0.059		0.341
Max. R^2	0.085		0.997
Num. events	9		610
Num. obs.	241	842	842
Missings	0		0
PH test	0.388		
Num. clust.		9	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{cdot}p < 0.1$. Robust standard errors in all models. Intercept omitted.

Table 2: Sectoral Origins of Income Taxation: Income Tax Law and Industrial Development.

growth that accelerates the implementation of the income tax, but *industrial* growth. In fact, agricultural expansion *delays* the implementation of the law, harming state development in the long run. Since industrialists preferred the income tax, these analyses suggest that industrial expansion is systematically associated with the implementation of the income tax, not only in Chile, but in other Latin American polities too. These results support the idea that income tax is directly related with industrial expansion rather than economic development, but also support the idea of the sectoral *conflict* behind its implementation. Since each sector had their own preferences toward income taxation, the emergence of the industrial sector facilitated state development by implementing the income tax, while agricultural expansion not only delayed the income tax, but also compromised state formation.

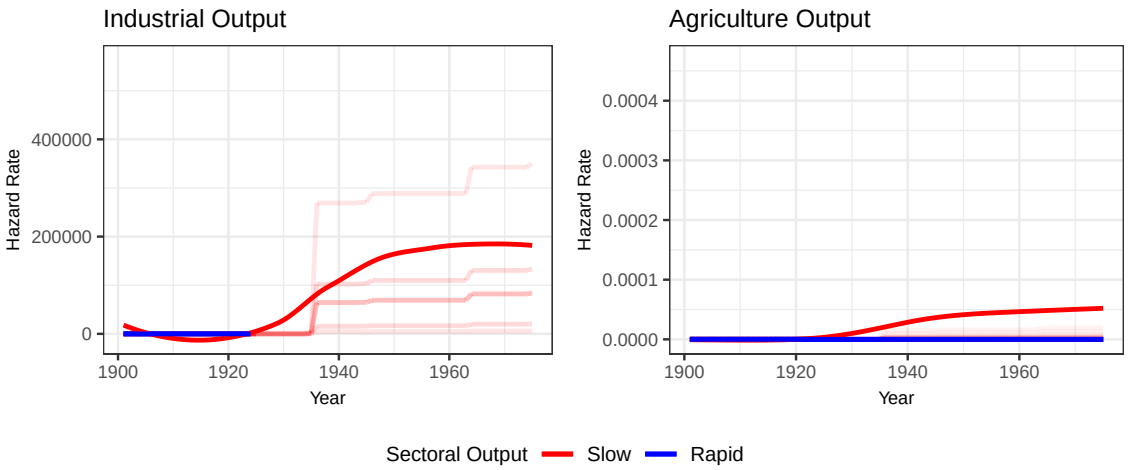

Figure 6: Hazard Rate of Implementing the Income Tax Law.
Note: *Using estimations of model 1 in Table 2, figure shows 20 simulations with different sectoral growth speeds. "Slow" is the minimum value, while "rapid" is the maximum value for each sectoral output. The figure also shows the 95% confidence intervals.*

IV. Alternative Explanations

referirse aqui a EQ1, donde ya inclui el componente sectoral.

Finally, it could be argued that the distinction between two separate and opposite sectors is inaccurate. Some historians claim that since landowners also invested in industry,[27] there was a blurry class division between the industrial and agricultural sectors.[28] Perhaps the most cited reference regarding this issue is Veliz (1963, 231-247). However, there are a number of stylized facts that strongly suggest that there was indeed a structural sectoral cleavage. For example, it was common that industrialists invested in real estate. Yet, in many instances they did so *just* to obtain credit. Kirsch (1977, 59) explains that "in a *rural society* land offered one of the best guarantees for loans [since] loans could not be secured by equipment, machinery, or inventory. Only real estate was acceptable collateral."[29] In fact, this practice shows how the credit system was oriented to give

27. Kirsch (1977, 57, 95), citing Bauer (2008), who explains that "[m]iners and merchants bought haciendas but landowners in turn invested in banks, insurance companies, commercial firms and the incipient industrial sector." Coatsworth and Williamson (2002, 23) argue that "[t]he only landowners that mattered in 19th century Latin American politics were those for whom land represented but one asset in a much broader portfolio."
28. Bauer (2008, 30, 44, 94, 108).
29. My emphases.

unfair advantage to the landed elites.[30] Similarly, Zeitlin (1984, 174) finds "the combined ownership of capital and landed property was a distinctive quality of *certain* [elites] actors,"[31] not *all* elites. There were also other instances where miners invested in banking. Yet, Segall (1953) argues that Chilean bankers, after the crisis of the mining sector around the 1870s, had acquired a number of mineral deposits given as collateral years before. And finally, but for the Argentinean case, Hora (2002, 609) explains that "the image of an entrepreneurial elite with assets *scattered throughout several spheres of investment* does not appear entirely correct."[32]

Additionally, there are structural reasons to believe that cross-sectoral investments were not efficient. The "dual sector" model argues that the economy is divided into agriculture and industry.[33] One finding of this paradigm is that the "natural" structural role of the agricultural sector is to provide labor and cheap foodstuff to the industrial sector.[34] For instance, Dixit (1973, 326) argues that the "agricultural sector *must* fulfill [...] its dual *role* of supplier of labour to industry and of food for the industrial labour force."[35] The rationale is that more efficient agricultural techniques make agricultural production less labor intensive, allowing landowners to free workers, which the industrial sector can rely on.[36] Surplus of labor naturally leads to a reallocation of redundant workers into the industrial sector, which is the crux of economic development.[37] Nurkse (1953), in fact, argues that development means to employ the surplus labor.[38]

The paper has argued about the effect of sectoral conflicts on state consolidation. Was there a sectoral conflict? Were there two separate elites? To empirically test the existence of a sectoral duality, particularly in the context of income taxation, the same MOxLAD sectoral data were used. Since the income tax (1) had positive spillover effects on overall state capacity and (2) its implementation was split across a sectoral base, we should see that (1) adopting the income tax fostered state institutions, causing long-term economic growth,[39] and that (2) its implementation altered the sectoral mechanics of growth accumulation. In empirical terms, we should see that by

30. Unda (2017, 9) explains that in Mexico, industrial elites complied with the income tax in exchange for having a credit system more adequate for them.
31. My emphasis.
32. My emphasis.
33. Jorgenson (1961, 311).
34. Ranis and Fei (1964, 114). Reyes (2015, 129) documents a real increment in industrial salaries around 1938.
35. My emphases.
36. Johnston (1951, 498).
37. Ranis and Fei (1964, 7) and Leibenstein (1957, 51).
38. Similarly, Matsuyama (1991, 621-622) points out that "[i]ndustrialization [*consists of*] a shift of resources from agriculture to manufacturing."
39. North (1990) and Besley and Persson (2011).

Pre/Post Income Tax	Period	Directionality	chi2	P-value
Pre	1905 - 1924	Agriculture → Industry	3.55	0.47
		Industry → Agriculture	12.13	0.02
Post	1925 - 2009	Agriculture → Industry	11.92	0.00
		Industry → Agriculture	5.37	0.07

Table 3: Granger Causality Wald Tests (Chilean Sectoral Growth).
Note*: The table shows which sector Granger-causes the other. The p-values change in a way that suggests that there was a reversal of institutions after implementing the income tax. Before the tax, industrial expansion Granger-caused agricultural production (a backwards equilibrium). However, after implementing the tax, agricultural expansion Granger-causes industrial development (modern growth).*

altering the post-colonial order, implementing the income tax *reversed* the flow of inputs, installing a mechanism of growth generation that went *from* the agricultural sector *to* the industrial sector. In econometric terms, we should see that the implementing the tax reversed the way in which one sector "Granger-caused" the other.[40] Table 3 tests for Granger-causality both prior to and after the implementation of the income tax law. The tests were computed after estimating Equation 5, which is a reduced form VAR in differences, both before and after implementing the tax. For both periods, the VAR equation passes standard unit root tests (see Table OA3), and as per the lag length structure, it also passes standard normality and stability tests (Table OA2). More formally, the next equation was fitted:

$$\begin{aligned} \triangle M_{t_m} =& \alpha_m + \beta_m \triangle M_{t-l} + \beta_m \triangle A_{t-l} + \epsilon_{t_m} \\ \triangle A_{t_a} =& \alpha_a + \beta_a \triangle M_{t-l} + \beta_a \triangle A_{t-l} + \epsilon_{t_a} \end{aligned} \tag{5}$$

The results strongly suggest that before the income tax law, industrial growth Granger-caused agricultural growth (backwards growth), but after the income tax law, the agricultural sector Granger-caused industrial development (modern growth), indicating that the implementation of the income tax was associated with the reversal of economically backwards institutions, fostering longer-run economic development.

40. Lutkepohl (2006, 42) explains that if some variable X forecasts variable Y (and not vise versa), X is said to "Granger-cause" Y. According to Granger (1980, 349), this concept of "causation" is based on the idea "that the future cannot cause the past."

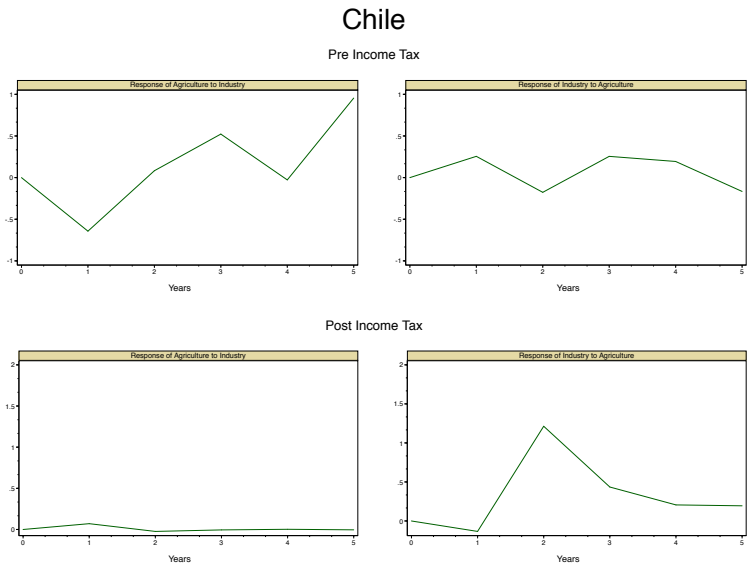

Figure 7: VAR Impulse Response Functions: Sectoral Responses to Each Other's Growths. **Note***: Granger-causality tests in Table 3 show the instantaneous causality between industrial and agricultural expansion, and vice versa. Impulse response functions, however, show via forecasting methods the inter-sectoral long-run equilibrium. In particular, the figure shows that the instantaneous Granger-causal relationships established in Table 3 (i.e. the reversal of institutions after implementing the income tax), persist in the long-run.*

It also needs to be examined whether these changes persisted in the long-term. Following Johansen (1988), the long-run sectoral relationship was estimated using a vector-autoregressive (VAR) approach. Figure 7 suggests that implementing the tax is associated with long-term economic growth. Particularly, the response of industry to agriculture after implementing the tax seems to persist for some time, not decaying at least after five periods.

Overall, these structural conditions should have prevented cross-sectoral investments. Given the transference of inputs from one sector to another, and given that the agricultural sector is determined to lag behind the industrial sector,[41] elites invested in both sectors should experiment important allocative inefficiencies and deadweight losses, putting heavy pressures to invest in one or the other, not both. Granger-causality tests also suggest that after the tax is implemented, the agricultural sector lagged behind the industrial sector, while the VAR equation suggests a long-term equilibrium between the two sectors, where growth (i.e. factor allocation) begins in the land and

41. The industrial sector uses capital and labor with increasing returns to scale, while agriculture uses land (which is fixed) as the main input (Jorgenson 1961, 311, Ranis and Fei 1964, 59, Jorgenson 1967, 291, Skott and Larudee 1998, 279-280, and Vollrath 2009, 290).

ends in the industries.[42]

V. Final Comments

The paper sketched an argument about how higher levels of sectoral contestation increased state-capacities overtime. Particularly, it explained how the emergence of industrial elites lowered levels of inter-sectoral inequality, pushing agricultural and industrial elites to reach agreements that materialized in investments in state-making institutions (the income tax), fostering higher levels of state-capacities overtime. The empirical analyses showed that death-tolls decrease (state capacities increase) after the income tax law is implemented, and that the emergence of the industrial sector, and not purely economic growth, accelerated the implementation of the income tax. Additional analyses also suggest that there was a structural sectoral cleavage rather than a blurred elite separation. While Kurtz (2009, 2013) and Soifer (2015) situate the relevant state-building critical juncture at the end of the colonial period, before the class compromises this paper identifies, the argument posited that the implementation of the income tax was an important building block in this process.

Enforcing quake-sensitive building codes embodies the most basic form of social contract that exists between the state and its subjects. Earthquake damage poses a major threat to commercial, official, and residential buildings, potentially triggering higher levels of looting and social unrest. And such, any kind of political leader should be interested in preventing looting and social unrest. Leaders not only care about their own survival but also about the legitimacy of *the state*. In the event of heavy social unrest, not only is the essential social Hobbesian-like contract broken but the expectations of social peace are also questioned.[43] The physical presence of the state literally *crumbles* when institutions of social coercion and discipline, such as state schools, prisons, and police stations, collapse. For example, when the magnitude 7.0 earthquake hit Hati in 2010, the *Prison Civile de Port-au-Prince* had a population of 4,500 inmates. During the quake, five inmates died. As a prison guard describes it, "everyone escaped. Everyone. Except the dead." This natural disaster

42. To clarify, "the agricultural sector declines relative to the overall economy but continues to expand absolutely" (Nerlove 1994, 14). In other words, it is the "the proportional contribution of agriculture to the growth" that decays (Kuznets 1961, 45), implying that in the long run the agricultural sector "must also grow" (Ranis and Fei 1961, 534), especially given the continuing dependence on a constant supply of food (Nicholls 1963, 2).

43. Carlin, Love, and Zechmeister (2014, 419) study how earthquakes damage interpersonal trust. They argue that "state capacity plays a decisive role in determining natural disasters' consequences for social capital."

exacerbated the already existent chaos, freeing "gang bosses, kidnappers, gunmen," among others,[44] reducing the legitimacy of the state to zero.

Finally, income taxation did even more than just triggering other state capacities. Via a process of assimilation, it also helped in constructing the figure of the citizen centered around the concept of the taxpayer. Regardless of an individual's race, religion, culture, or any other kind of status, the state classifies its subjects according to their incomes and obliges them to pay, punishing whoever refuses to do so. From a sociological standpoint, this "generality makes taxation a crucial element in the development of the "imagined community"[45] of the modern nation-state [...] Taxation enmeshes us in the web of generalized reciprocity that constitutes modern society."[46]

44. Reed (2011). See also Laursen (2010).
45. Anderson (2006).
46. Martin et al., in Martin, Mehrotra, and Prasad 2009, 3.

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VI. Online Appendix

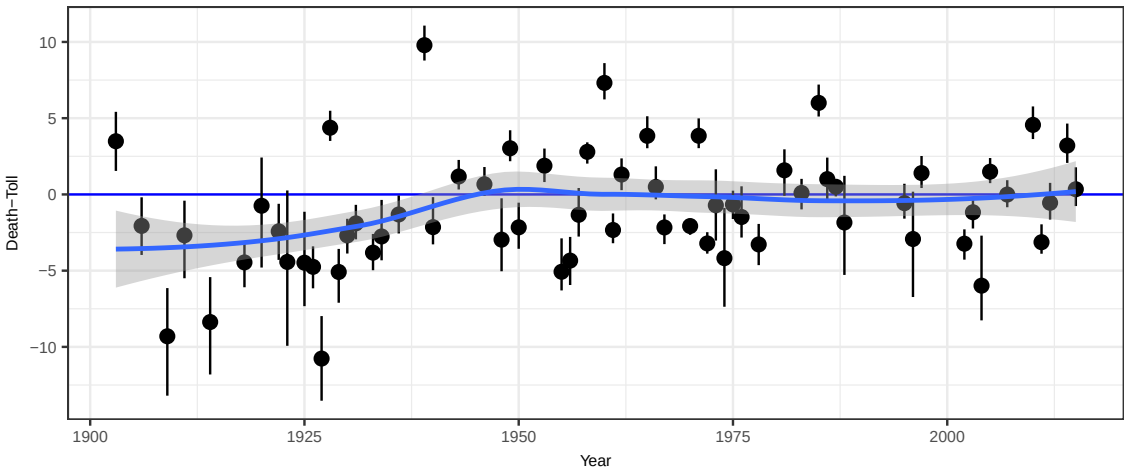

Figure OA1: Year Fixed-Effects.

Note: *Figure shows the estimated posteriors of the year fixed-effects (as per Table 1). Formally, it shows all β_8's from Equation 1. Substantively, the figure suggests that, overall, there are no influential years driving the results.*

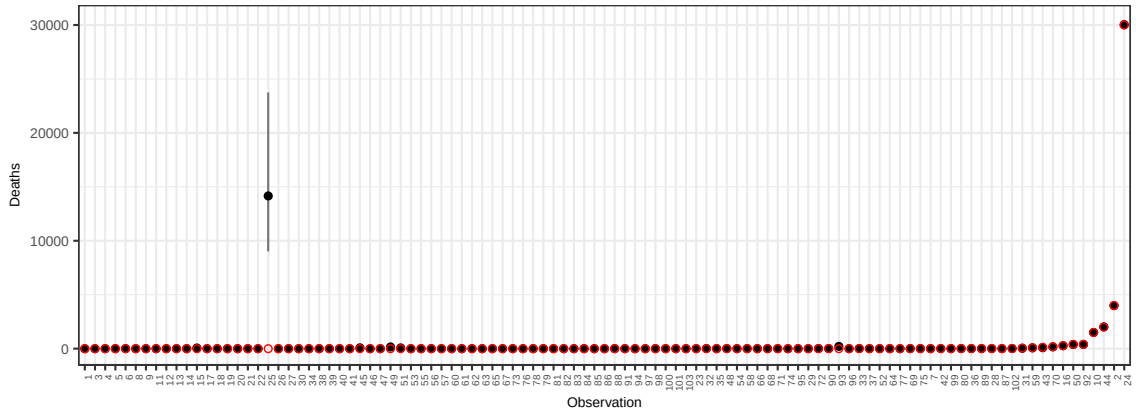

Figure OA2: Assessing Model Fit.

Note: *The figure assesses the goodness of fit of Equation 1 (Table 1). Since the model deals with the count of casualties associated with earthquakes (Y-axis), a "good" model should minimize the distance between the predicted count (black dots, with credible intervals), and the actual count (red dots). The figure shows that the model does a good job in predicting the actual death-toll.*

Country	Available Data	Year Income Tax	Law	Source
Chile	1900 - 2009	1924	*Ley* 3996	Mamalakis (1976, 20) and LeyChile.Cl (official)
Peru	1929 - 2009	1934	*Ley* 7904	Gobierno del Perú (1934) (official)
Venezuela	1936 - 2006	1943	*Ley* 20851	*Gaceta Oficial* (official) and Ventura and Armas (2013, 27)
Colombia	1900 - 2009	1935	*Ley* 78	Figueroa (2008, 9)
Argentina	1900 - 2010	1933	*Ley* 11682	Infoleg.Gob.Ar (official)
Mexico	1900 - 2009	1925	*Ley de Impuesto sobre la Renta*	Unda (2017, 8)
Ecuador	1939 - 2007	1945	-	Aguilera and Vera (2013, 135)
Nicaragua	1920 - 2009	1974	*Ley* 662	Legislacion.Asamblea.Gob.Ni (official)
Guatemala	1920 - 2009	1963	*Decreto* 1559	Instituto Centroamericano de Estudios Fiscales (2007, 165)

Table OA1: Sample, Data Availability, and Year the Income Tax Law was Implemented.

Country	Time Frame	Number of Lags	LM	Normally Tests			Stability Condition
				Jarque-Bera	*Skewness*	*Kurtosis*	
Chile	Pre	4	✓	✓	✓	✓	✓
	Post	2	✓	✓$^{-}$	✓$^{-}$	✓$^{-}$	✓

Table OA2: Lag Length and Post-Estimation Results.

Country	Time Frame	Sector	Augmented Dickey-Fuller	Phillips-Perron	KPSS	Conclusion
Chile	Pre	Agriculture	-1.185 (0.68)	-1.241 (0.66)	.107†	I(1)
		Industry	2.310 (0.99)	2.556 (0.99)	.113†	I(1)
	Post	Agriculture	4.557 (1.00)	5.40 (1.00)	.289	I(1)
		Industry	0.908 (0.99)	1.458 (0.99)	.249	I(1)
	All	Agriculture	5.521 (1.00)	6.722 (1.00)	.31	I(1)
		Industry	1.582 (0.99)	2.305 (0.99)	.314	I(1)

Table OA3: Unit Root Tests for Agricultural and Industrial Growth.