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 increases 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, I create 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. The paper shows that death tolls decrease (that is, state capacity increases) once the income tax law was implemented in 1924 using a Bayesian Poisson regression to test the effect of implementing the income tax law on death tolls between 1900 and 2010. To control for unmeasured sources of variation, the model also leverages a fixed-effects approach. To explore the causal mechanisms at work, I discuss the Chilean case since the 1920s.

Keywords— state-building; fiscal sociology; development; Latin America; time series and panel-data econometrics.

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Levi (1989, 1) famously explained "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 European cases, the study of public finance 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 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) or early (Kurtz 2013; Soifer 2015), 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*.

This paper contributes to the literature from a substantive perspective by explaining the positive relationship between income taxation and state consolidation over time. 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 over time. The mechanisms evidence how the presence of tax assessors and collectors throughout the territory increased norms of enforcement of state regulations more generally, fostering overall state capacity over time.

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 capacity. Exploiting this variation via a Bayesian Poisson model with year fixed-effects, I find that death tolls associated with earthquakes systematically decreased (that is, *state capacities increased*) after the income tax

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.

law was implemented in 1924. Importantly, these changes over time are not correlated with economic growth or industrialization levels. The empirical section also provides an in-depth qualitative case study.

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, we present evidence that suggests that the emergence of the industrial sector *accelerated* the implementation of the income tax. Also, using vector auto-regressive time-series models and Granger-causality tests, we also challenge 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.

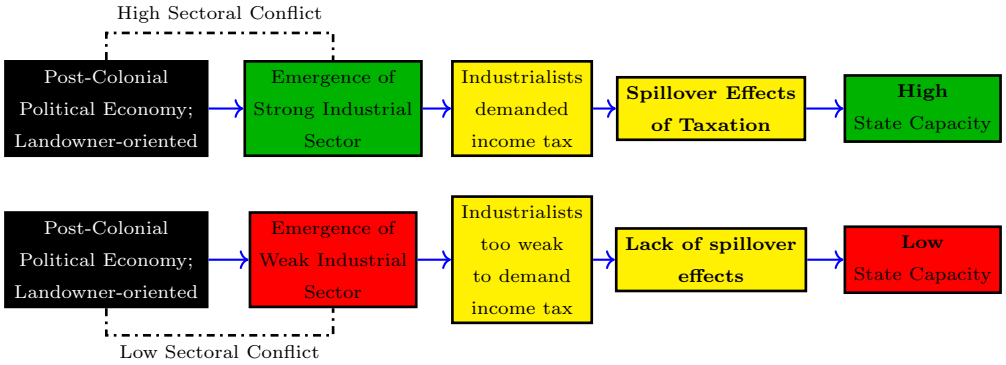

Figure 1: Causal Mechanism.

The paper argues, in more detail, 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 over time 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, "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."

As 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). And 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 that this paper identifies, the argument pursued in this paper explains that the implementation of the income tax was an important building block in this process.

I. Sectoral Conflicts, and Income Taxation

The landed Latin American elites were an hegemonic economic 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 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

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.

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 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 sets of practices posited 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.

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 income taxes 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

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 over time. 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, 1907, 1912, 1915, and 1919 (in Collier and Collier 2002, 109), suggesting an equilibrium where no elite was the leading elite.

(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 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 oftentimes 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 also offers 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, and the enforcement of public security, contracts, building codes, zoning laws, among others. The state-building literature has also considered these types of 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—at marginally lower costs—to perform other state tasks.

4. My emphases.

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 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) that was what fostered state consolidation over time. 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.

And 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, 208) 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 per capita (1) total expenditures, (2) education expenditures, and (3) health expenditures. Others have found that literacy levels in Chile rose from 40% in 1907 to 66% in 1925 (Engerman, Sokoloff and Mariscal, in Engerman and Sokoloff (2011, Ch. 5)), and 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)). In turn, Humud (1969, p. 154) documents that the income tax was *widely* enforced, generating considerable resources for the Chilean treasury (in 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)).

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

6. My emphases.

III. From Earthquake Death-Tolls to State Capacity

Did the implementation of the income tax in Chile foster state development over time? While this section *motivates* the measurement approach pursued in this paper, it leaves for future research—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) mostly because 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 a 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 these 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 do tax shares reflect policy preferences (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

7. My emphases.

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 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 bureaucrats' 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.

Still, economic historians offer other alternatives to proxy levels of state capacity over time. 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.

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

There are other 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, provide a non-continuous temporal measurement of state capacities. For instance, censuses are applied in Chile every ten years, so 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 over time. In particular, the proposed measure is explained leveraging the Chilean case. Unlike censuses—*unfortunately*—earthquakes happen in Chile 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 the 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) argues 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 implement and enforce 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

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

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 (2014, 422) explain that "a basket of 'minimal' state functions [typically includes] primary education, public health, [the] 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).

Additionally, there are countries like India or the United States where earthquakes happen only in certain regions. 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) explain 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 to count the death toll might be a function of state capacity 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

14. My emphases.

15. I thank [redacted] for this comment.

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.

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. Additionally, 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 measures at the municipal level where the quake hit. The local population was used to weight the death toll.[17] Adding archival census data, I coded the main economic activity of the affected municipality as to whether the municipality was urban or rural.[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]

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 time 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 weight the dependent variable directly.

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 [redacted] for this suggestion.

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

Magnitudes, in particular, were also compared with the International Seismological Centre.

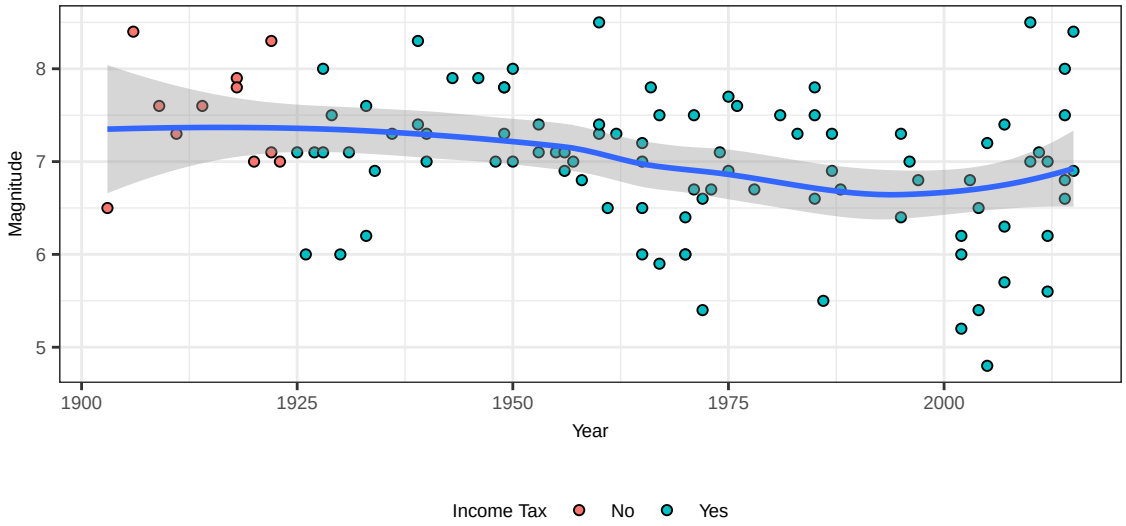

Figure 2: Earthquakes in Chile: 1903-2015.
Note: *Figure shows earthquakes over time (N=103). Additionally, the figure shows earthquakes before and after the implementation of the income tax in 1924. A smoothing function was added to show that there are not statistically significant different decreases/increases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

Figure 2 plots the overtime variation, while Figure 3 plots the geographical variation, and the dominant productive sector at the municipal level. 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. Both have been affected by earthquakes in a similar fashion. 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). However, the central part also has considerable earthquake activity. 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, close and far away from Santiago, and in 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 area.

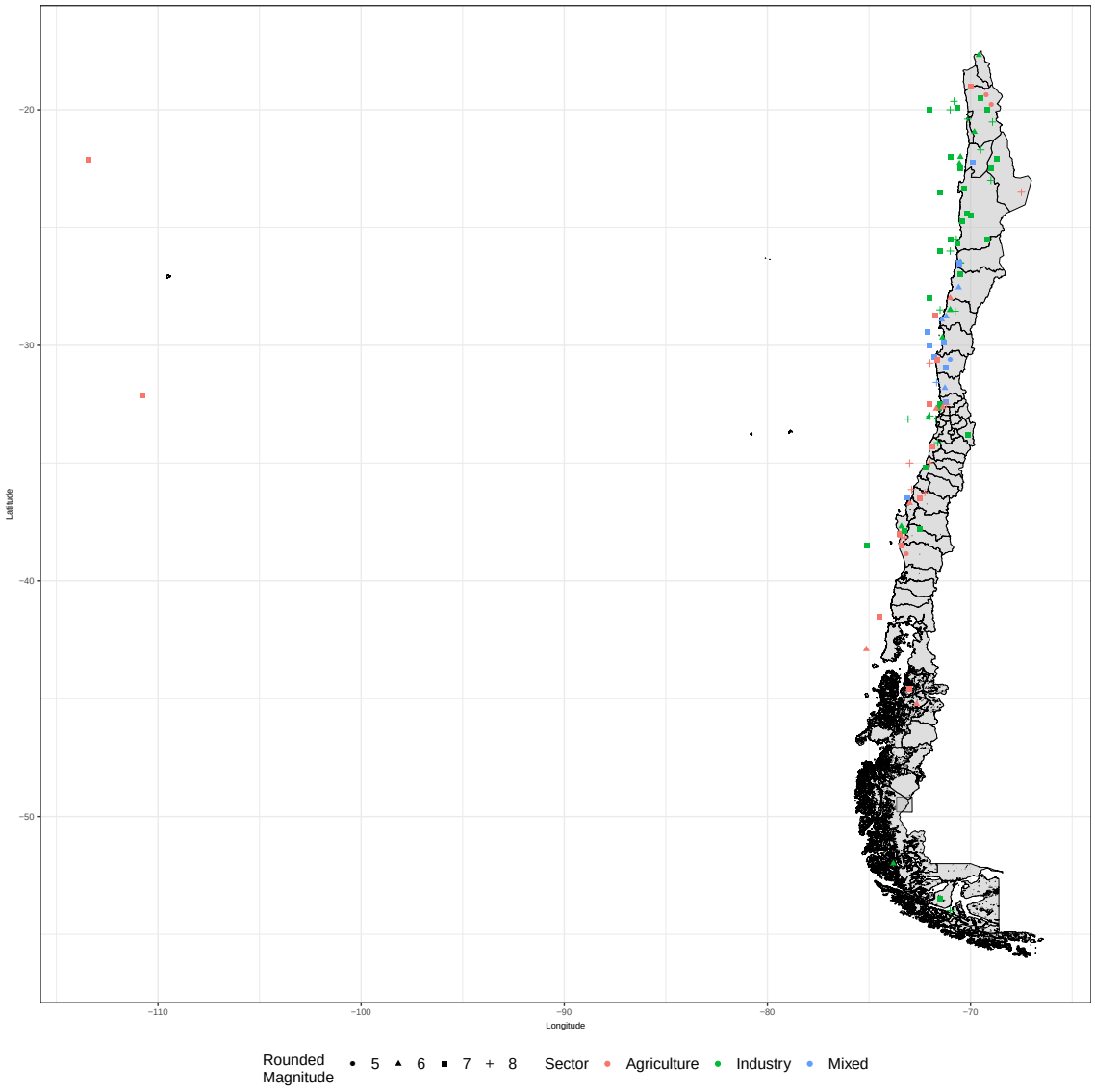

Figure 3: Data Used in the Analyses: Geographical Distribution of Earthquakes in Chile, 1903-2015.
Note: *The figure shows a total of 103 earthquakes. earthquakes using a combination of archival information and external sources. Each quake was colorized according to the predominant economic sector at 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 is associated with a death toll, a location, a magnitude, a local population,

and an urban/rural setting. Following statistical convention, a count model was used to test the effect of implementing the income tax law on earthquake death tolls over time (Anbarci, Escaleras, and Register (2005, 1907), Kahn (2005, 276), Brancati (2007, 729), Escaleras, Anbarci, and Register (2007)), specifically 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 baseline 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 yearly sources of variation (Brancati 2007, 729). For instance, fiscal development is also a function of country-specific prior state capacity, and 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, the 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, Lomnitz (1970, 1309) explains that "some of the larger Chilean earthquakes which have caused

21. I thank [redacted] for this suggestion.

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 over time.

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

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

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 capacity. Unfortunately, there are no 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 $\mu \sim \mathcal{N}(0, 0.0001)$. Traceplots—not shown but available upon request—indicate that the model has good mixing.

	Mean	SD	Lower	Upper	Pr.
Income Tax	60.56	39.55	-16.03	137.68	0.94
Magnitude	8.10	1.96	5.41	12.82	1.00
Income Tax * Magnitude	-7.50	1.97	-12.28	-4.79	1.00
Latitude	0.02	0.03	-0.02	0.07	0.77
Longitude	0.07	0.03	0.00	0.13	0.98
Population	-0.01	0.00	-0.02	-0.01	1.00
Sector[Agriculture]	-28.74	46.96	-123.74	62.35	0.73
Sector[Industry]	-29.77	46.95	-124.72	61.41	0.74
Sector[Mixed]	-26.95	46.95	-122.15	63.85	0.72

Note: 300,000 iterations with a burn-in period of n = 30,000 iterations discarded.
95% credible intervals (upper/lower bounds). All R-Hat statistics are below critical levels.
Standard convergence diagnostics suggest good mixing and convergence.
A total of five chains were run. Figure OA1 shows that the model fits well the data.

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

While Table 1 shows the estimated results, the coefficient of the interaction term (i.e. β_3) remains uninterpretable from a substantive standpoint (Brambor, Clark, and Golder 2006, 74). The problem becomes more complex when it comes to generalized models (such as Poisson 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 also not advisable, 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), a new distribution of estimated values for each coefficient is constructed. Relying on the central limit theorem, the new simulated distribution is a transformation that approximates with a great degree of precision the (uninterpretable) coefficients with enough sampling draws. Subsequently, means and uncertainty measures can be constructed for each of these distributions.

Fortunately, Bayesian methods have embedded a systematic and intuitive framework to solve these challenges. In particular, for every coefficient, I estimated five chains, with 300,000 iterations per chain. Considering the Monte Carlo Markov Chain properties, the first 30000 iterations of every chain were discarded. Following (Brambor, Clark, and Golder 2006), Figure 4 shows the conditional

effect of earthquake magnitudes on implementing the income tax.[23]

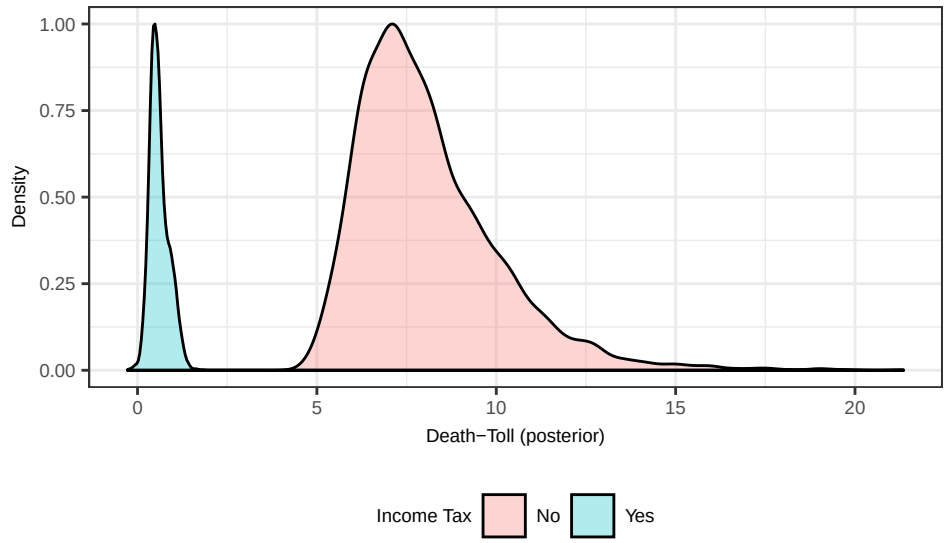

Figure 4: Conditional Effects of Earthquake Magnitudes on Implementing the Income Tax Over Time.
Note: *Using the estimations from Table 1 (Equation 1), and following the advice of Brambor, Clark, and Golder (2006), the figure shows the conditional effect of earthquake magnitudes on implementing the income tax in 1924 ($\beta_1 + \beta_3 \times$ Income Tax$_i$). Particularly, by implementing the income tax, the baseline propensity of the earthquake's magnitude of increasing the death toll* decreases *from an estimated overtime average of eight to an estimated overtime average of one. Hence, the figure suggests that implementing the income tax law had positive effects on state capacity over time. Both distributions were computed via a MCMC routine, particularly the iteration of five chains with 300,000 iterations per chain. Considering the Monte Carlo Markov Chain properties, the first 30,000 observations of every chain were discarded.*

Substantively, Figure 4 shows that the death toll systematically *decreases* over time—i.e. levels of state capacity systematically increase over time—*once the income tax law is implemented*. Particularly, by implementing the income tax, the baseline propensity of an earthquake increasing the death toll decreases from an estimated overtime average of *eight* to an estimated overtime average of *one*. 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 heterogeneous factors that might have an impact on the dependent variable (Figure OA2 shows the estimated year fixed-effects).

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$_i$.

III. Alternative Explanations

Sectors might self-select into more/less earthquake-prone areas. 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, potentially having lower earthquake death tolls. Industrialists, in turn, being a more urban-oriented sector, might have highly populated municipalities and higher constructions (edifices), potentially showing higher 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 death tolls are systematically higher in agricultural, industrial, or mixed municipalities. 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 -30 deaths and for the latter, -29 deaths. Similarly, mixed municipalities have a predicted death toll of -27.

Blurry distinction between the two sectors. Finally, it could be argued that the idea of sectoral conflict is overstated and that they were not conflicting sectors.

Some historians claim that there was just one economic and political elite, invested in both sectors. Since landowners also invested in industry (Kirsch (1977, 57, 95), Bauer (2008), Coatsworth and Williamson (2002, 23)), it could be argued that there was a blurry class division between the industrial and agricultural sectors (Bauer 2008, 30, 44, 94, 108). 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 cleavage between the two sectors. 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."[24] In fact, this practice shows how the credit system was oriented to give an unfair advantage to the landed elites. Unda (2017, 9), for instance, explains that in Mexico, industrial elites complied with the income tax in exchange for having a credit system more adequate for them. Similarly, Zeitlin (1984, 174) finds "the combined ownership of capital and landed property was a distinctive quality of *certain*

24. My emphases.

[elites] actors,"[25] not *all* their members. 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."[26]

There are also 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 (Jorgenson 1961, 311). 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 (Ranis and Fei (1964, 114), Reyes (2015, 129)). 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."[27] The rationale is that more efficient agricultural techniques make agricultural production less labor intensive, allowing landowners to free workers that the industrial sector can rely on (Johnston 1951, 498). A surplus of labor naturally leads to a reallocation of redundant workers into the industrial sector, which is the crux of economic development (Ranis and Fei (1964, 7), Leibenstein (1957, 51)). Nurkse (1953), in fact, argues that development means to employ the surplus labor. Similarly, Matsuyama (1991, 621-622) points out that "[i]ndustrialization [*consists of*] a shift of resources from agriculture to manufacturing."

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 2: 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).*

25. My emphasis.
26. My emphasis.
27. My emphases.

Were there two separate and conflicting 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 state capacity and (2) its implementation was split across a sectoral base, we should see that (a) adopting the income tax fostered state institutions, causing long-term economic growth (North 1990; Besley and Persson 2011) and that (b) its implementation altered the sectoral mechanics of growth accumulation.

In empirical terms, we should see that by 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 implementing the tax reversed the way in which one sector "Granger-caused" the other. 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."

Table 2 tests for Granger-causality both prior to and after the implementation of the income tax law. The tests were computed after estimating Equation 2, 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 OA2), and as per the lag length structure, it also passes standard normality and stability tests (Table OA1). More formally, the next equation was fitted:

$$\begin{aligned} \triangle M_{t_m} &= \alpha_m + \beta_m \triangle M_{t-l} + \beta_m \triangle A_{t-l} + \epsilon_{t_m} \\ \triangle A_{t_a} &= \alpha_a + \beta_a \triangle M_{t-l} + \beta_a \triangle A_{t-l} + \epsilon_{t_a} \end{aligned} \tag{2}$$

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 in Chile was associated with the reversal of economically backwards institutions, fostering longer-run economic development.

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 5 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

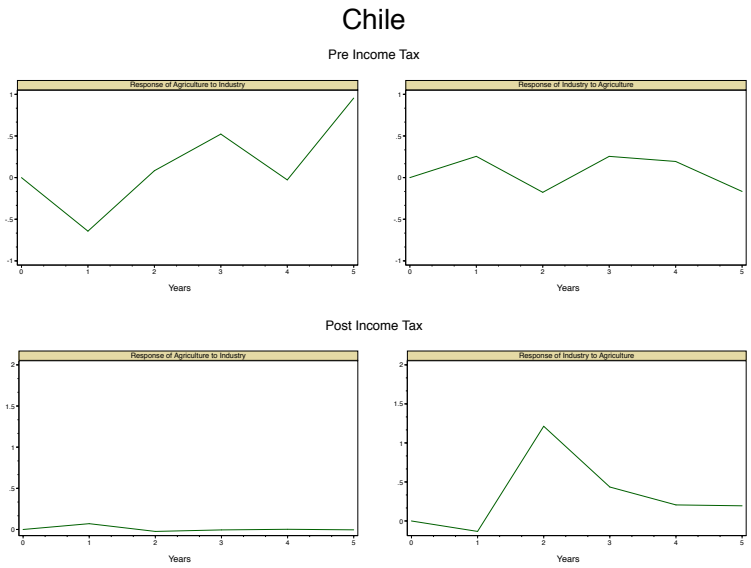

Figure 5: VAR Impulse Response Functions: Sectoral Responses to Each Other's Growths. **Note***: Granger-causality tests in Table 2 show the instantaneous causality between industrial and agricultural expansion and vice versa. Impulse response functions, however, show via forecasting methods the inter-sectoral long-run equilibrium. In particular, the figure shows that the instantaneous Granger-causal relationships established in Table 2 (i.e. the reversal of institutions after implementing the income tax) persist in the long run.*

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 (Jorgenson 1961, 311, Ranis and Fei 1964, 59, Jorgenson 1967, 291, Skott and Larudee 1998, 279-280, and Vollrath 2009, 290),[28] 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—that is, factor allocation—begins in the land and ends in the industries. However, and 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

28. The industrial sector uses capital and labor with increasing returns to scale, while agriculture uses land (which is fixed) as the main input.

(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).

IV. Industrial Expansion and the Origins of the Income Tax

The theory and empirics put a 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 over time. However, *where does the income tax law 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 for public goods delivered at the local level. *Can this finding be generalized to other countries?*

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

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.

In particular, the argument is that higher levels of sectoral contestation fostered the implementation of the income tax law. Given the initial structural advantage of the landed elites (Figure 1), "sectoral contestation" was measured by using industrial and agricultural sectoral growth rates, as presented in the MOxLAD data.[29] More "contested" polities were instances when the rate of sectoral expansion of one sector was "faster" relative to the other sector. The dataset has been used before in the state-formation literature (Thies 2005), and the two outputs span from 1900 to (potentially) 2010.[30] According to Astorga, Berges, and Fitzgerald (2005, 790), these data provide extended comparable sectoral value-added series in constant purchasing power parity prices. Table 3 shows the year when the income tax law was passed in these countries, leveraging some additional archival data. Finally, Figure 6 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 *or* industrial expansion. Table 4 shows three models.[31] Following Aidt and Jensen (2009), model 1 computes the lagged conditional hazard ratio of a country that 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:

$$\begin{aligned} h_i(t) = exp(&\beta_1 \text{Industrial Growth}_{i,t-1} + \\ &\beta_2 \text{Agricultural Growth}_{i,t-1} + \\ &\beta_3 \text{Total Population}_{i,t-1} \\ &) h_0(t) \end{aligned} \tag{3}$$

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

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

31. 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).

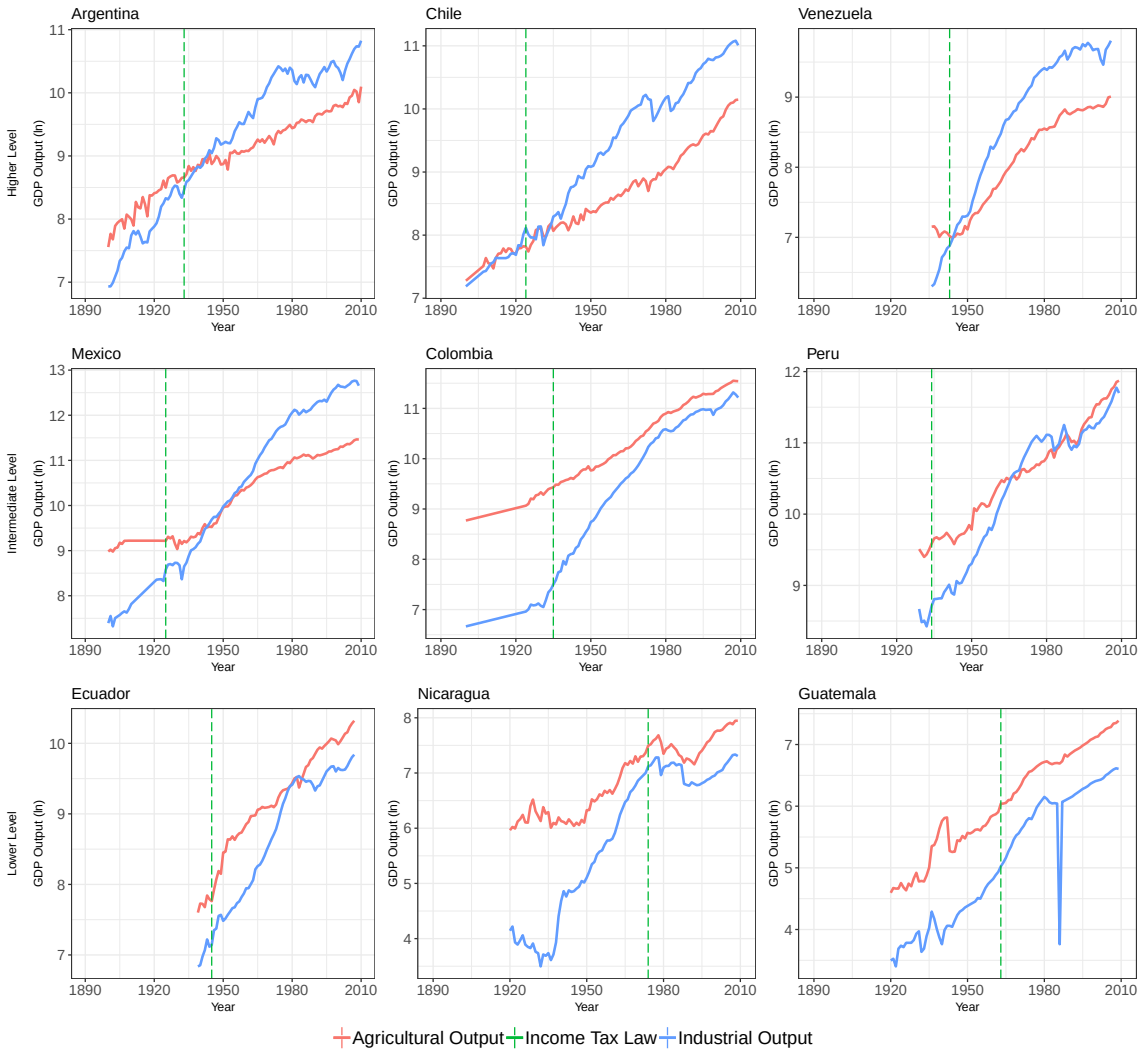

Figure 6: Industrial and Agricultural Outputs, and The Passage of the Income Tax Law.
Note: *Figure shows historical sectoral outputs and year of the passage of the income tax law. Following convention, the figure shows logged values. Following the economic development typology suggested in Mahoney (2010, 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 3).*

Model 2 in Table 4 shows the estimated coefficients of a generalized estimating equation (GEE). Following Zorn (2006, 331), the next equation was fitted:

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

where π is the logit link function, and Φ is a 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 over time. 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:

$$\begin{aligned}\pi_{i,t} = \Phi(&\beta_0 + \\ &\beta_1 \log(\text{Industrial Growth}_{i,t}) + \\ &\beta_2 \log(\text{Agricultural Growth}_{i,t}) + \\ &\beta_3 \log(\text{Total Population}_{i,t}) + \\ &\alpha_i)\end{aligned} \tag{5}$$

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

Since population has been associated with the probability that 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.

	(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 4: Sectoral Origins of Income Taxation: Income Tax Law and Industrial Development.

Table 4 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 at these results, Figure 7 shows the simulated overtime hazard rates of β_1 and β_2, both from Equation 3 (Cox model). The simulation shows the following counterfactual: what would have happened to a country, regarding the implementation of the income tax law, under two hypothetical conditions, had either the empirically slowest or the empirically fastest sectoral expansion. The figure clearly shows that it is not *overall* growth that accelerates the implementation of the income tax but *industrial* growth only. 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 also in other Latin American polities.

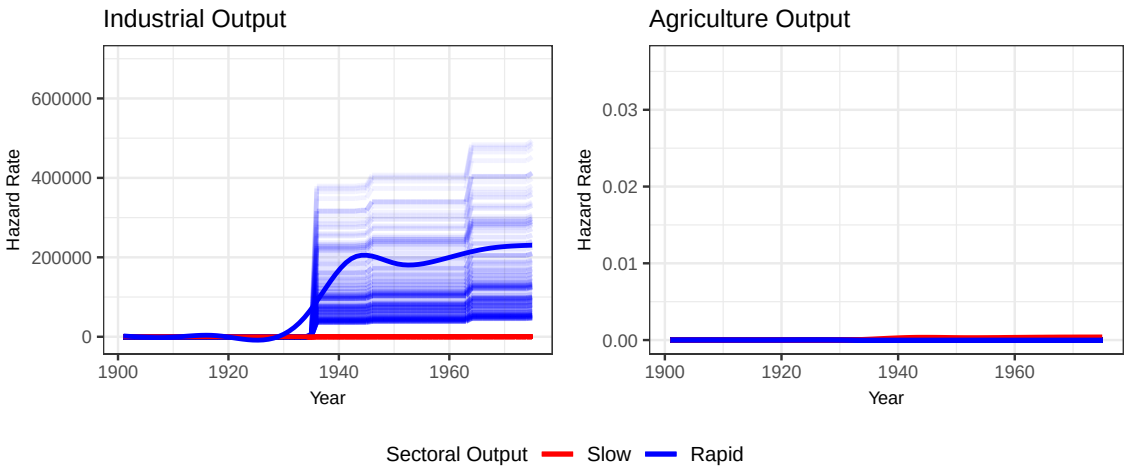

Figure 7: Hazard Rate of Implementing the Income Tax Law.
Note: *Using estimations of model 1 in Table 4, the figure shows 10,000 simulations with different sectoral growth speeds. "Slow" is the minimum value, while "rapid" is the maximum value for each sectoral output. The figure also shows the 95% confidence intervals.*

The overall results support the idea that income tax was directly related to industrial expansion rather than general economic development but also support the idea of the sectoral conflict behind its implementation. Since each sector had their 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.

V. Discussion

The paper sketched an argument about how higher levels of sectoral contestation increased state capacity over time. Particularly, it explained how the emergence of industrial elites posited credible threats to incumbent landowners, pushing agricultural and industrial elites to reach agreements that materialized in investments in state-making institutions (the income tax), which in turn fostered higher levels of state consolidation over time.

The empirical analyses showed that earthquake death tolls decrease (i.e. state capacity increases) after the income tax law is implemented and that the emergence of the industrial sector accelerated the implementation of the income tax. Additional analyses also suggest that there was a structural, sectoral cleavage rather than a blurred elite separation.

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. 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 (Carlin, Love, and Zechmeister 2014, 419). 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 exacerbated the already existent chaos, freeing "gang bosses, kidnappers, gunmen," among others (Reed 2011; Laursen 2010), reducing the legitimacy of the state to zero.

Finally, income taxation did even more than just trigger other state capacities. Via a process of assimilation, it also helped in constructing the figure of the citizen, centered on 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" (Anderson 2006), of the modern nation-state [...] Taxation enmeshes us in the web of generalized reciprocity that constitutes modern society" (Martin et al., in Martin, Mehrotra, and Prasad 2009, 3).

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VI. Online Appendix

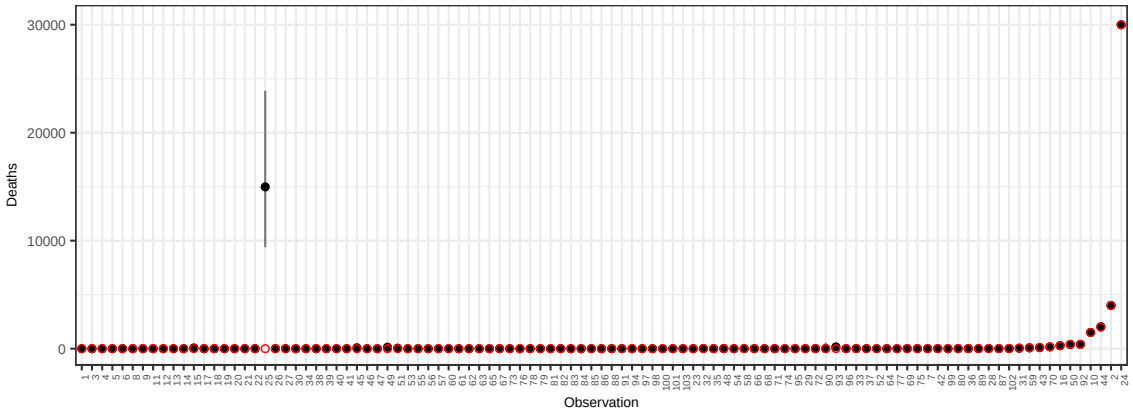

Figure OA1: Assessing Model Fit.

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.*

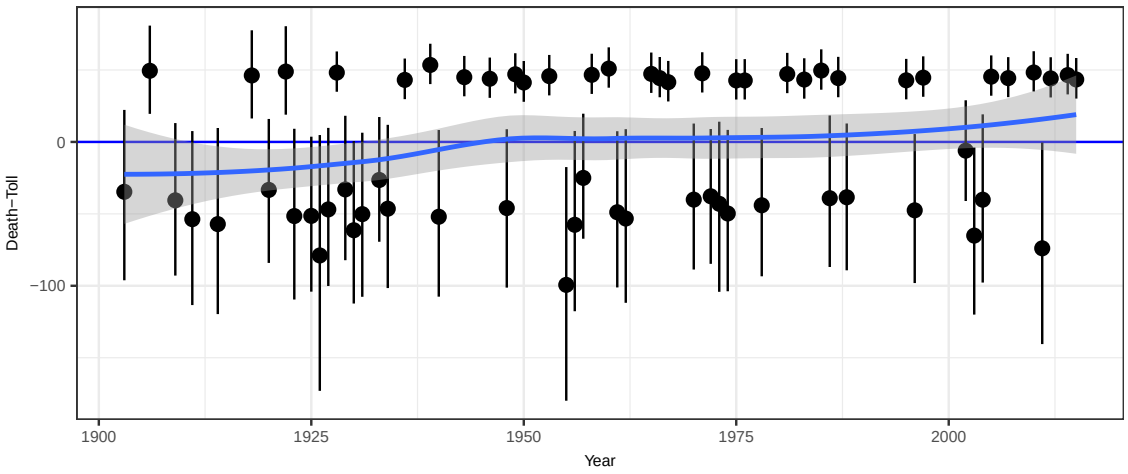

Figure OA2: Year Fixed-Effects.
Note: *Figure shows the estimated posteriors of the year fixed-effects (as per Table 1). Formally, it shows all β_8's from Equation 1. Substantively, the figure suggests that, overall, there are no influential years driving the results.*

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

Table OA1: 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 OA2: Unit Root Tests for Agricultural and Industrial Growth.