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 is novel 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. To explore the causal mechanisms at work in more depth, 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."[1] 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.[2] 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,[3] early,[4] or late[5] 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 both a methodological/measurement and substantive perspectives by arguing, and empirically testing, the positive relationship between income taxation and state-consolidation overtime. The argument outlines how income taxation had positive spillover effects over state institutions, increasing levels of state consolidation over time. The evidence documents how the presence of tax assessors and collectors throughout the territory increased norms of enforcement of state regulations more generally, fostering overall state-capacities over time. Additionally, 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 to earthquakes systematically decreased (that is, *state capacities increased*) after the income tax law was implemented. Importantly, these changes over time are not correlated with economic growth nor industrialization levels. The empirical section also provides a qualitative case study, several robustness checks, and different tests of alternative explanations.

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 inter-sectoral asset diversification was weak.

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 over time via spillover effects (Figure 1). Consequently, the paper not only builds on the fiscal sociology literature,[6] but on the sectoral politics approach too.[7] 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.[8] 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 famously attributed to Tilly (1992),[9] and extended to the Latin American case by Thies (2005) and Thies, Chyzh, and Nieman (2016), and Kurtz (2006).[10]

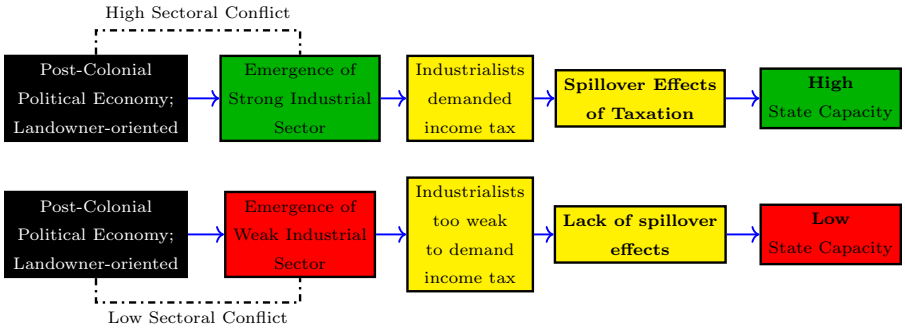

Figure 1: Causal Mechanism.

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.[11] Moreover, 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."[12] In fact, the little public infrastructure that existed mostly benefited the agricultural sector.[13] By extension, the landowning class controlled most of the politics too.[14] For instance, 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."[15]

However, when the structural transformation took place,[16] this process 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 translated into lower levels of inter-sectoral inequality, generating political, economic, and military threats to the landed elites.[17] For instance, before the civil war, *salitreras* (nitrate towns) in northern Chile were so prominent that they were considered "a state within the state."[18] 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.

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,[19] so they systematically resisted taxation. However, as capital could be reinvested in nontaxable sectors,[20] 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."[21] 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."[22] 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,"[23] essentially contributing to an equilibrium of quasi-voluntary compliance.[24]

II. Positive Externalities of Income Taxation on State Centralization

The tax was not only important because of the new revenue it collected. Musgrave (1992, 99) argues that since taxation (especially on incomes) requires such a high degree of state penetration, public finances offer also a theory of state-building. Indirect taxes are easier to levy, and, hence, this kind of revenue is generally considered "unearned income"[25] or "easy-to-collect source of revenues."[26] Given the relatively lower costs states have to incur to collect them, indirect taxes have a very low impact on state-building.[27] For example, 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." In fact, when early Latin American states depended heavily on trade taxes, the state apparatus tended to be less developed.[28] 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.[29]

As fiscal sociologists argue, the implementation of the income tax fostered state-consolidation via spillovers,[30] or *technical complementarities*, which are situations in which "an increase in the output of [a] commodity [...] lowers the marginal costs of producing [other] commodity."[31] In other words, implementing the tax, lowered the marginal costs of adding an additional layer of state*ness* on the territory.

The mechanism through which the positive spillover effects of taxation on state-building occur, were situations where the stock of knowledge generated in a state organization, spread to other state institutions. In particular, the stock of know-how accumulated in the revenue service, spread to other state institutions related to counting individuals,[32] improving levels of public spending and

security, contract enforcement, and levels of enforcement of both building codes and zoning laws.

The intuition is that, via learning-by-doing, there were improvements in fiscal efficiency that lowered the marginal costs of improving the existent stock of bureaucratic knowledge in other state institutions. For instance, bureaucrats in Chile that were sent to collect and administer taxes, eventually learned to solve land disputes and dispense justice, among other state tasks. 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—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.[33] 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,[34] 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,[35] and that the dependence on custom taxes decreased from 70.2% to 41.1% during those same years.[36]

III. From Earthquake Death Tolls to State Capacities

More than being blessed, the literature is in fact cursed due to an over-abundance of poor indicators of state consolidation.[37] In fact, its abundance "points to the poor state of empirical measures of the quality of states."[38]

One notable example is protection of the rule of law, which is commonly used as proxy for state capacities.[39] 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.[40] 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,"[41] thereby introducing systematic measurement error.[42] 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."[43] Not only tax shares reflect policy preferences too,[44] but also, as Fukuyama (2013, 353) explains it, there "is a difference between extractive *potential* and *actual* extraction rates."[45] For instance, since American institutions were deliberately designed to limit the exercise of state power, the U.S. taxes very little.[46] However, it is not reasonable to say that the U.S. has 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."[47]

Finally, others have proxied state-capacity with economic growth, which is also problematic.[48] 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 sources of variation 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)."[49] 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,"[50] 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,[51] such as infrastructure, roads,[52] electrification (measured as light intensity per pixel),[53] and railroads.[54] However, many of these measurements are debatable. For instance, Soifer (2012, 593) explains that "railroads were often constructed by private actors."[55] The same problem applies to other types of infrastructure. There are others more appropriate strategies, such as the opening of postal offices,[56] the administration of national censuses,[57] and vaccination.[58] While these measurements do capture historical variations of state capacities, 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. 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 capacities over time. Unlike censuses—*unfortunately*— earthquakes happen in Chile very often. While "[e]arthquakes alone claim thousands of lives a year,"[59] they are not well studied in the discipline.[60] Building on Mann (1984, 113), the proposed measurement intends to capture the state's *infrastructural* power.[61] "Natural hazards can be seen as a function of a specific natural process and human [...] activity."[62] Given that earthquakes happen at random and are exogenous to the affected locality,[63] the only part that is left unexplained is the systematic human component, which is what the measurement captures. Earthquakes are orthogonal to levels of state capacity and economic development.[64] Thus, 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.[65] I focus on earthquakes and not on other natural disasters, such as "extreme temperature events, floods, landslides, and windstorms,"[66] 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.[67] State capacity consist 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. Since "[e]arthquake-resistant construction depends on responsible governance,"[68] state capacity act as a scope condition undermining (facilitating) the implementation of these norms. For example, Bilham (2013, 169) explains that "although engineering codes may *exist*[,] mechanisms to *implement* these codes are largely unavailable"[69] 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,[70] 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.[71] However, the measurement has a number of drawbacks. Obviously, the country needs to have earthquakes, possibly limiting the number of potential cases. However, most earthquakes occur at the various borders of the Pacific, Latin American, African, Arabic, Indian and Eurasian plates,[72] allowing a number of potential

cross-country comparisons.[73] Thus, like other measurements available, this is a context-specific strategy. 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.

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.[74] Another potential concern is that the ability of counting the death-toll might be a function of state capacities itself.[75] 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,[76] this strategy unfortunately adds more than one layer of complexity. All in all, this measurement offers a rough approximation of levels of state capacities over time.

IV. Empirical Section

I. Spillover Effects of Income Taxation on State Capacity

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.[77] The dataset "contains information on destructive earthquakes from 2150 B.C. to the present," and records the number of deaths,[78] the magnitude, date, latitude, and longitude of every quake, among other variables. Using archival census data from 1907 to 2012,[79] 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.[80] Using archival census data as well, the main economic activity of the affected municipality was coded,[81] in addition to whether the municipality was urban or rural.[82] The death tolls and magnitudes proportionated by the NOAA dataset were contrasted case by case with historical press archival information.[83] Magnitudes, in particular, were also compared with the International Seismological Centre.

Figure OA1 plots the over time earthquakes and magnitudes, while Figure 2 plots the geographical distribution and magnitudes of the quakes, as well as the dominant productive sector.[84] Both figures suggest that Chile is a good case to study infrastructural state-capacity using the earthquake framework, since it 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 an agricultural region. Relatedly, both regions vary according to their climate. 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.[85] 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.[86] All things considered, earthquakes have affected the territory from coast to mountain,[87] and both north and south, solving potential concerns about geographical sectoral self-selection.

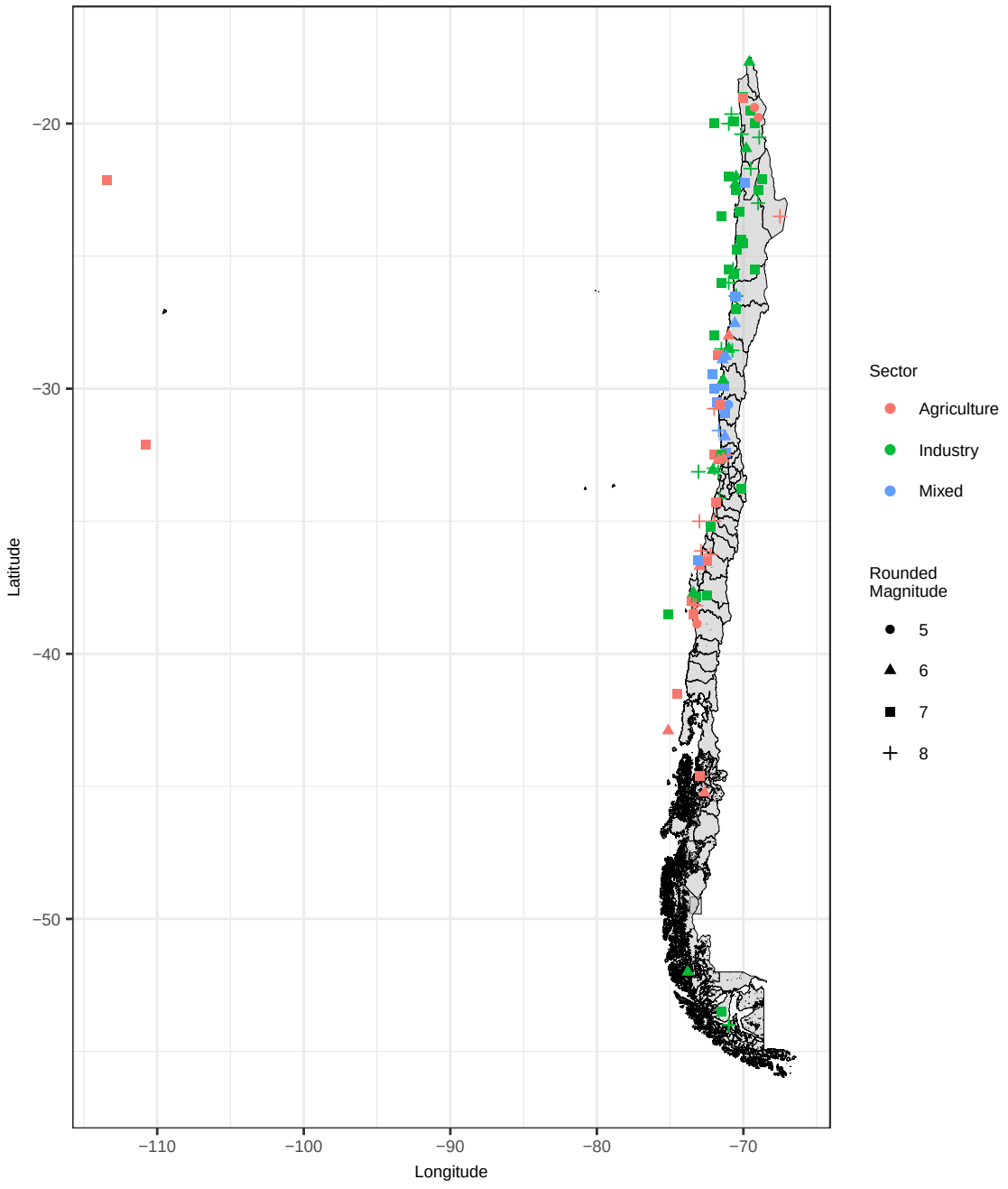

Figure 2: Data Used in the Analyses: Geographical Distribution of Earthquakes in Chile, 1903-2015.

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. Figure OA1 shows the overtime variation.*

The unit of analysis is the earthquake.[88] As an event, each earthquake has associated to it a death toll, a location, a magnitude, a local population, and an urban/rural setting. Specifically, following the statistical convention, a Bayesian Poisson regression was employed to test the effect of implementing the income tax law on death-tolls over time.[89] The main quantity of interest is a binary variable (i.e. *Income Tax*) that denotes whether the income tax is implemented or not. The model considers year fixed-effects to account for time-varying confounding factors and for unmeasured sources of variation. More formally,[90] Equation 1 was fitted:

$$\begin{aligned} \text{Deaths} \ &\sim \text{Poisson}(\lambda_i) \\ log(\lambda_i) &= \mu + \beta_1 \text{Income Tax}_i + \beta_2 \text{Magnitude}_i^2 + \beta_3 \text{Latitude}_i + \beta_4 \text{Longitude}_i + \\ &\quad \beta_5 \text{Population}_i + \beta_6 \text{Urban}_i + \beta_7 \text{Year}_t \end{aligned} \tag{1}$$

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.[91] Fixed-effects should be able to account for these and other unmeasured yearly factors. In addition, local population also serves as a rough proxy for local economic development,[92] which might impact negatively casualties. 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.[93]

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 Table OA1 find support for this claim. Particularly, implementing the income tax *decreases* the death-toll by an estimated over time average of 2. Figure 3 shows that death-tolls (state capacities) systematically *decrease* (increase) over time once the income tax law is implemented. Before the income tax law was implemented, death-tolls were relatively stable, averaging approximately -1 casualties per earthquake. However, once the income tax law was implemented, the death-toll decreased to -2. Moreover, the figure shows that the trajectory of casualties goes from -1 in 1903 to -2 in 2007. The fixed-effects estimation makes these results robust to considerations of geography

and economic development.

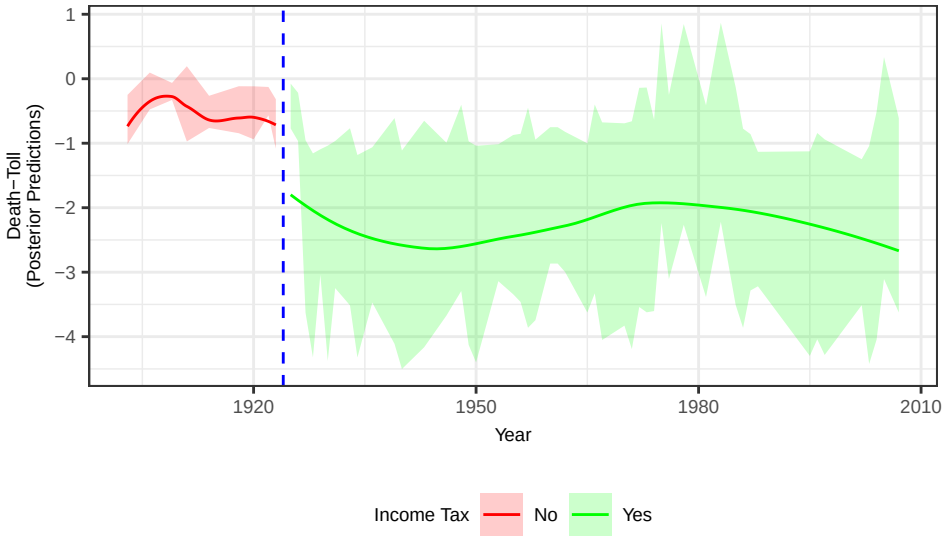

Figure 3: Income Taxation and State Capacity in Chile: An Overtime Approach.
Note: *Using the estimations from Table OA1 (Equation 1), the figure shows predicted death-tolls before and after the implementation of the income tax in 1924. In average, the death-toll decreases from -1 to -2. The figure suggests that implementing the income tax law had positive effects on state-capacity overtime. The figure also shows credible intervals at the 95% level.*

II. Industrial Expansion and the Origins of the Income Tax

In an effort to generalize the argument about the sectoral origins of the income tax law, data on eight other Latin American countries were collected (Ecuador, Nicaragua, Venezuela, Peru, Colombia, Guatemala, Argentina and Mexico). The degree in which industrial elites challenged incumbent landowners (e.g. sectoral contestation) was measured by using industrial and agricultural sectoral growth rates as presented in the MOxLAD data.[94] The dataset spans from 1900 to (potentially) 2010.[95] According to Astorga, Berges, and Fitzgerald (2005, 790), these data provide extended comparable sectoral value-added series in constant purchasing power parity prices.[96] Leveraging some more additional archival data, Table OA2 shows the year when the income tax law was passed in these countries. Finally, Figure 4 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 *timing* of implementing the income tax law

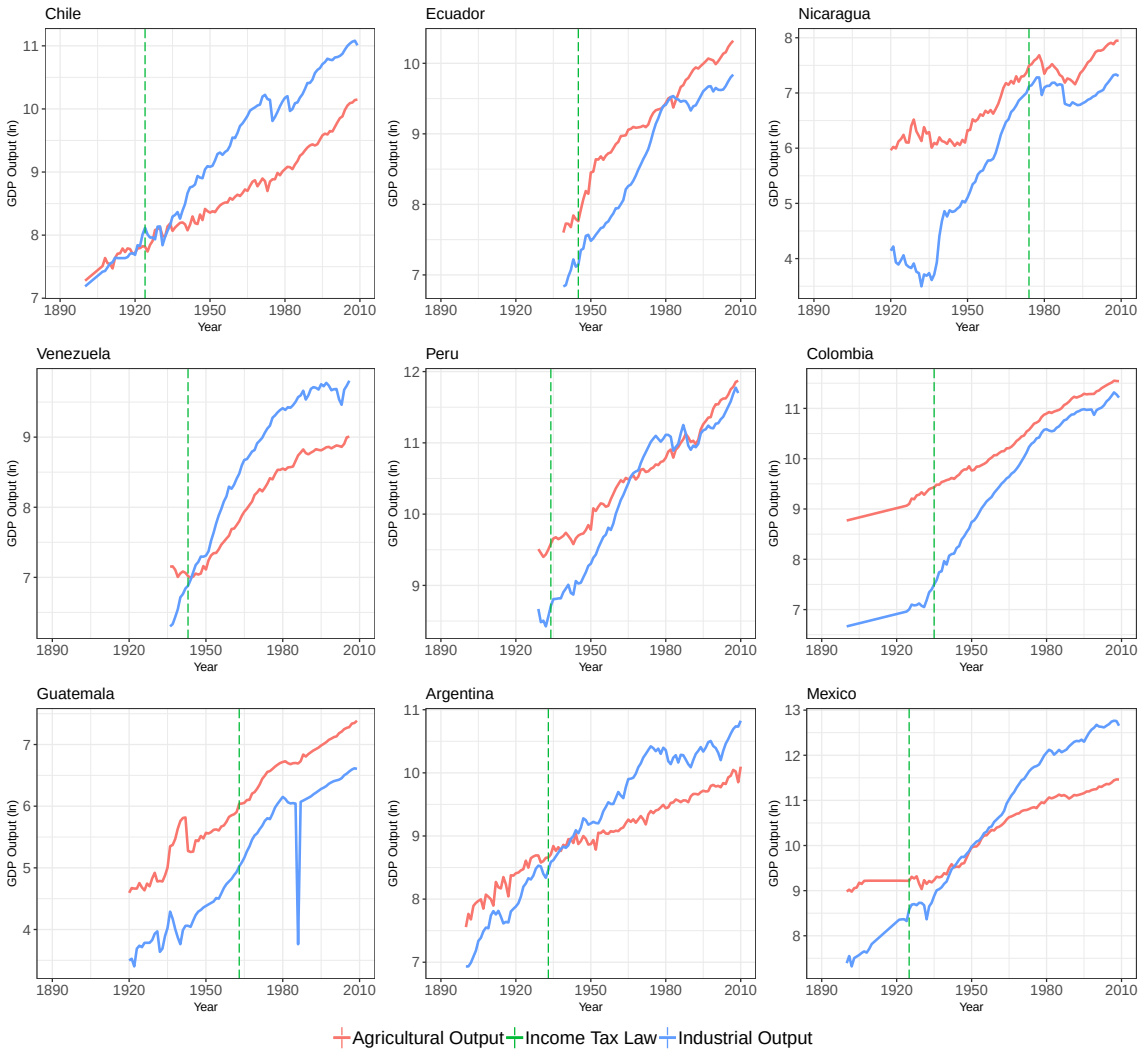

Figure 4: Industrial and Agricultural Outputs, and The Passage of the Income Tax Law.
Note: *Figure shows historical sectoral outputs, and year of the passage of the income tax law. Following convention, the figure shows logged values.*
Source: *MOxLAD, and other sources compiled by the author (see Table OA2).*

in nine Latin American polities, and particularly, about the individual contribution of both the agricultural and industrial sectors. Table OA3 shows 3 models.[97] 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, as a function of industrial and agricultural outputs. Since the idea is to capture the *sectoral contribution* of the implementation of the income tax law, these

variables were not combined. Following Box-Steffensmeier and Jones (2004, 49), the next equation was fitted for all countries i and years t:

$$h_i(t) = exp(\beta_1 \text{Industrial Growth}_{i,t} + \beta_2 \text{Agricultural Growth}_{i,t} + \beta_3 \text{Total Population}_{i,t}) h_0(t) \quad (2)$$

Countries drop out of the sample when they adopt the income tax. Model 2 shows the estimated coefficients of a generalized estimating equation (GEE). Following Zorn (2006, 331), the next equation was fitted:

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

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.[98] From a substantive standpoint, GEE models provide an estimated marginal mean, or the *weighted average* of all cluster-specific effects (or conditional means). Model 3 is a conditional logit. More formally, the next equation was fitted:

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

where α are the country fixed effects for all countries i. Since population has been associated with the probability elites expand the franchise,[99] and consequently the tax base, country-year population was included as a control variable.

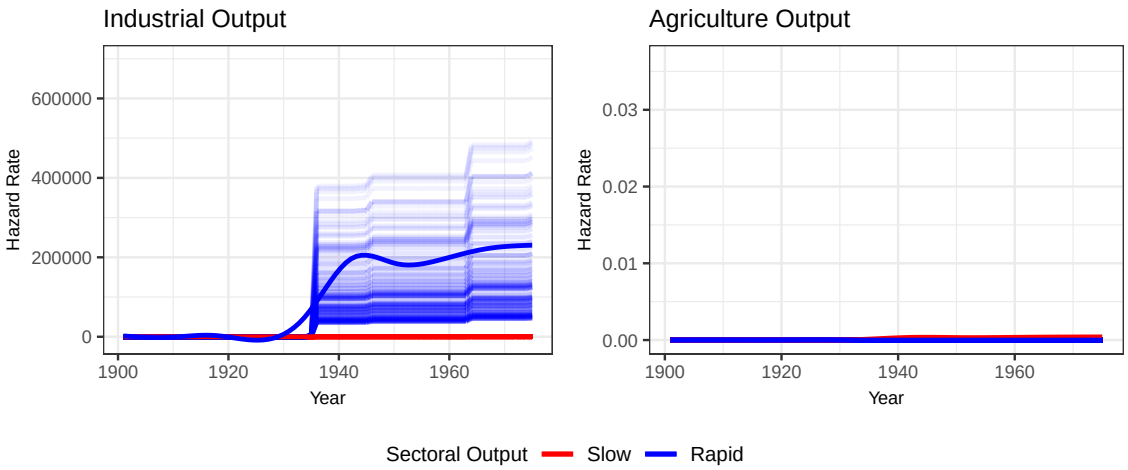

Figure 5: Hazard Rate of Implementing the Income Tax Law.
Note: *Using estimations of Model 1 in Table OA3 (Equation 2), figure shows 10,000 simulations with different sectoral growth speeds. "Slow" is the minimum value, while "rapid" is the maximum value for each sectoral output. The figure also shows the 95% confidence intervals.*

Figure 5 shows that it is not *overall* 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. 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.

III. Alternative Explanations

Undoubtedly, some municipalities should be wealthier than others, and presumably, better able to *privately* investment in earthquake proofing.[100] Inhabitants of such municipalities could be able to afford better construction materials and more advanced construction techniques, lowering death-tolls. If this possibility is not ruled out, then lower death-tolls have less to do with the capacity of the state

to enforce building codes than with private wealth. To examine this possibility, a "rolling" version of Equation 1 was performed. Figure 6 plots 103 models which resulted from iteratively excluding one observation at a time. Since earthquakes happen at any level of economic development, this strategy is especially appealing. By subtracting (with replacement) iteratively one observation at a time, these analyses account for possible concerns about influential municipalities (especially wealthy ones) downpressing the death-count. The figure shows that the substantive results are not being driven by the capacity of the rich (or incapacity of the poor) municipalities. There is a steady pattern of decline in death-tolls, regardless of which observations are included/excluded.

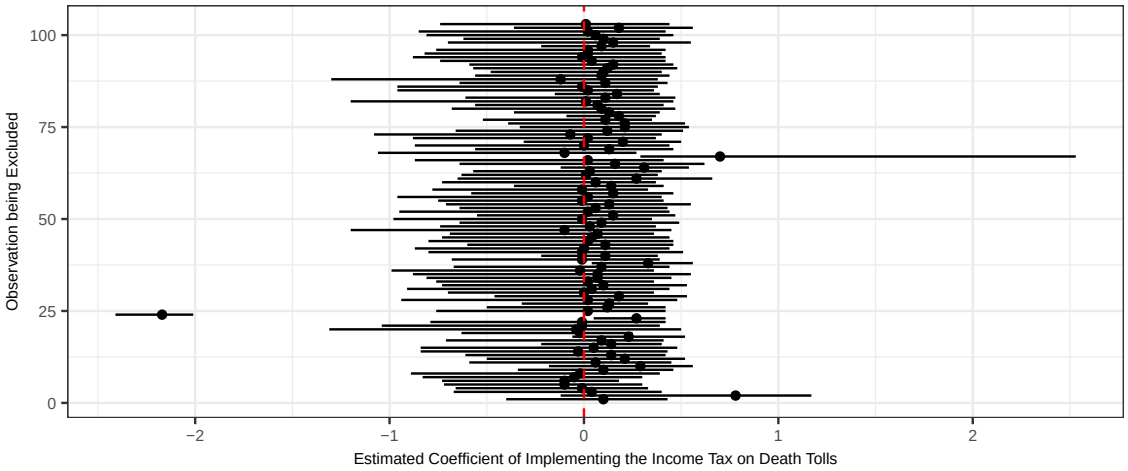

Figure 6: Rolling Bayesian Poisson Regression.
Note: *Figure shows the estimates of implementing the income tax on death-tolls of 103 models which correspond to fully estimating Equation 1, but excluding one observation at a time. 95% credible intervals were included. The figure suggest that the negative results of income taxation and death-tolls are not driven by wealthy municipalities, but to the capacity of the state of enforcing building codes.*

A second potential issue might be whether certain sectors self-select into less earthquake-prone geographical locations. For instance, it might be argued that agricultural areas, being mostly rural, might have lower constructions, while industrial areas, being more urban, might have both highly populated municipalities and higher constructions (edifices), potentially showing higher default death-tolls. To rule-out this possibility, a hierarchical variant of Equation 1 was estimated. Using the same set of control variables, Equation 5 considers whether earthquake magnitudes affect the death-toll of agricultural, industrial or mixed municipalities in different ways. More formally,

Equation 5 was fitted:

$$\begin{aligned} \text{Deaths} \ &\sim \text{Poisson}(\lambda_i) \\ log(\lambda_i) &= \mu + \beta_{1_j}\text{Magnitude}_i^2 + \beta_2\text{Latitude}_i + \beta_3\text{Longitude}_i + \\ &\quad \beta_4\text{Population}_i + \beta_5\text{Urban}_i + \beta_6\text{Year}_t \end{aligned} \tag{5}$$

where,

$i_{1,\dots I}$ and I = 103 observations,

$j_{1,\dots J}$ and J = 3 sectors,

$t_{1,\dots T}$ and T = 64 years.

Table 1 suggests that death-tolls are orthogonal to the economic sector. Belonging to an agricultural or industrial sector contributes with 0.08 or 0.03 additional deaths, respectively.

	Mean	SD	Lower	Upper	Pr.
Magnitude [Agr]	0.08	0.00	0.08	0.09	1.00
Magnitude [Ind]	0.03	0.00	0.02	0.04	1.00
Magnitude [Mixed]	0.11	0.01	0.10	0.13	1.00
Latitude	-0.00	0.00	-0.01	-0.00	0.99
Longitude	0.01	0.00	0.01	0.01	1.00
Population	0.00	0.00	0.00	0.01	1.00
Urban	-0.67	0.03	-0.71	-0.62	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.
Year fixed effects were omitted in the table.
A total of 1 chains were run. Detailed diagnostic plots available here.

Table 1: Simulated Posterior Predictions (Hierarchical Poisson Regression, Equation 5).

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,[101] there was a blurry class division between the industrial and agricultural sectors.[102] 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."[103] In fact, this practice shows how the credit system was oriented to give unfair advantage to the landed elites.[104] Similarly, Zeitlin (1984, 174) finds "the combined ownership of capital and landed property was a distinctive quality of *certain* [elites] actors,"[105] 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."[106]

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.[107] 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.[108] 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."[109] 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.[110] Surplus of labor naturally leads to a reallocation of redundant workers into the industrial sector, which is the crux of economic development.[111] Nurkse (1953), in fact, argues that development means to employ the surplus labor.[112]

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).*

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,[113] and that (2) 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 the implementing the tax reversed the way in which one sector "Granger-caused" the other.[114] 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 6, 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 OA5), and as per the lag length structure, it also passes standard normality and stability tests (Table OA4). More formally, the next equation was fitted:

$$\begin{aligned} \triangle M_{t_m} &= \alpha_m + \beta_m \triangle M_{t-l} + \beta_m \triangle A_{t-l} + \epsilon_{t_m} \\ \triangle A_{t_a} &= \alpha_a + \beta_a \triangle M_{t-l} + \beta_a \triangle A_{t-l} + \epsilon_{t_a} \end{aligned} \tag{6}$$

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.

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

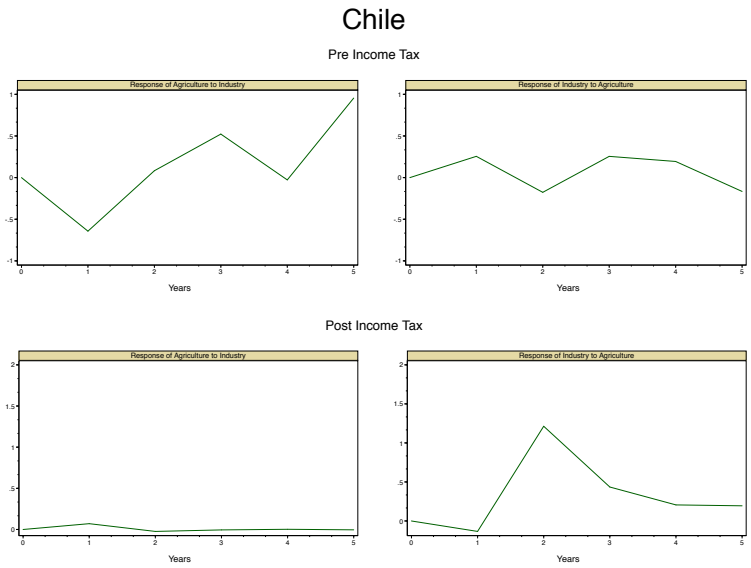

Figure 7: VAR Impulse Response Functions: Sectoral Responses to Each Other's Growths. **Note***: Granger-causality tests in Table 2 show the instantaneous causality between industrial and agricultural expansion, and vice versa. Impulse response functions, however, show via forecasting methods the inter-sectoral 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.*

the transference of inputs from one sector to another, and given that the agricultural sector is determined to lag behind the industrial sector,[115] 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 ends in the industries.[116]

V. Final Comments

The paper sketched an argument about how higher levels of sectoral contestation increased state-capacities over time. 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 over time. 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.[117] 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,[118] 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"[119] of the modern nation-state [...] Taxation enmeshes us in the web of generalized reciprocity that constitutes modern society."[120]

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VI. Online Appendix

$$i_{1,\dots I} \text{ and I} = 103$$

$$t_{1,\dots T} \text{ and T} = 64;$$

and,

$$\beta_{k,\dots K} \sim \mathcal{U}\backslash\backslash\{(-1000, 1000) \text{ where K} = 8$$

$$\tau_{p,\dots P} \sim \mathcal{G}(0.5, 0.001) \text{ where P} = 64.$$

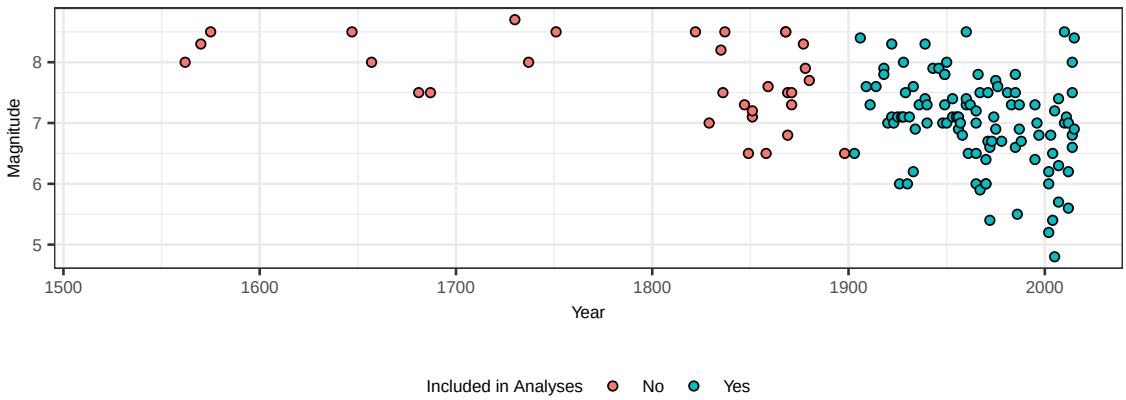

Figure OA1: Earthquakes in Chile: 1500-2010.
Note: *Figure shows earthquakes available in the NOAA dataset (N=186). Due to data availability at the local level (local population, for example), however, it was only possible to include in the analyses the earthquakes that took place begining in 1903. Figure 2 shows the geographical location of the actual observations used in the analyses (N=103).*

	Mean	SD	Lower	Upper	Pr.
Income Tax	-2.26	0.79	-3.35	-0.90	1.00
Magnitude	0.10	0.01	0.08	0.12	1.00
Latitude	-0.02	0.01	-0.04	0.00	0.94
Longitude	0.02	0.01	0.01	0.03	1.00
Population	0.01	0.00	0.01	0.01	1.00
Urban	-0.49	0.15	-0.68	-0.14	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.

Year fixed effects were omitted in the table.

A total of 1 chains were run. Detailed diagnostic plots available here.

Table OA1: Income Tax Adoption Model: Simulated Posterior Predictions (Poisson Regression, Equation 1).

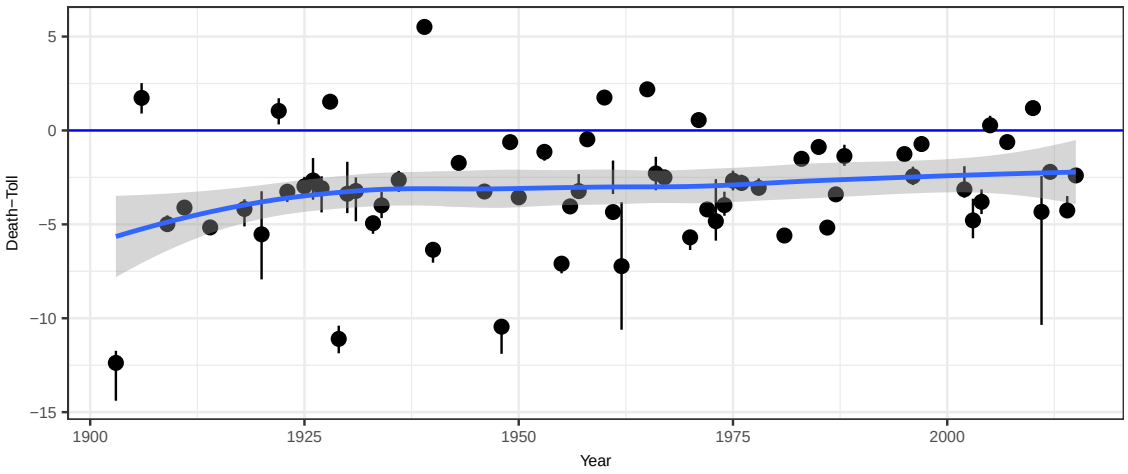

Figure OA2: Year Fixed Effects.
Note: *Figure shows the estimated posteriors of the year fixed effects (as per Table OA1). Formally, it shows all β_6's from Equation 5. Substantively, the figure suggests that, overall, there are no influential years driving the results.*

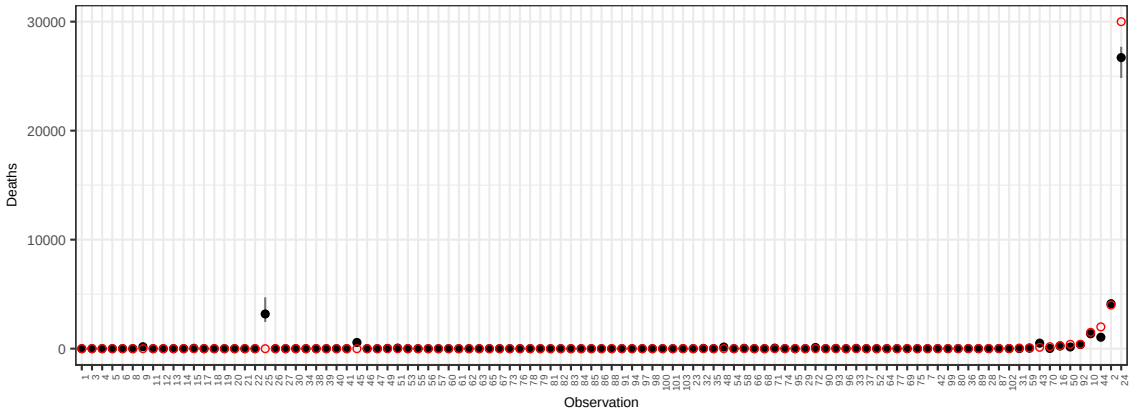

Figure OA3: Assessing Model Fit.

Note: *The figure assesses the goodness of fit of Equation 5 (Table OA1). 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.*

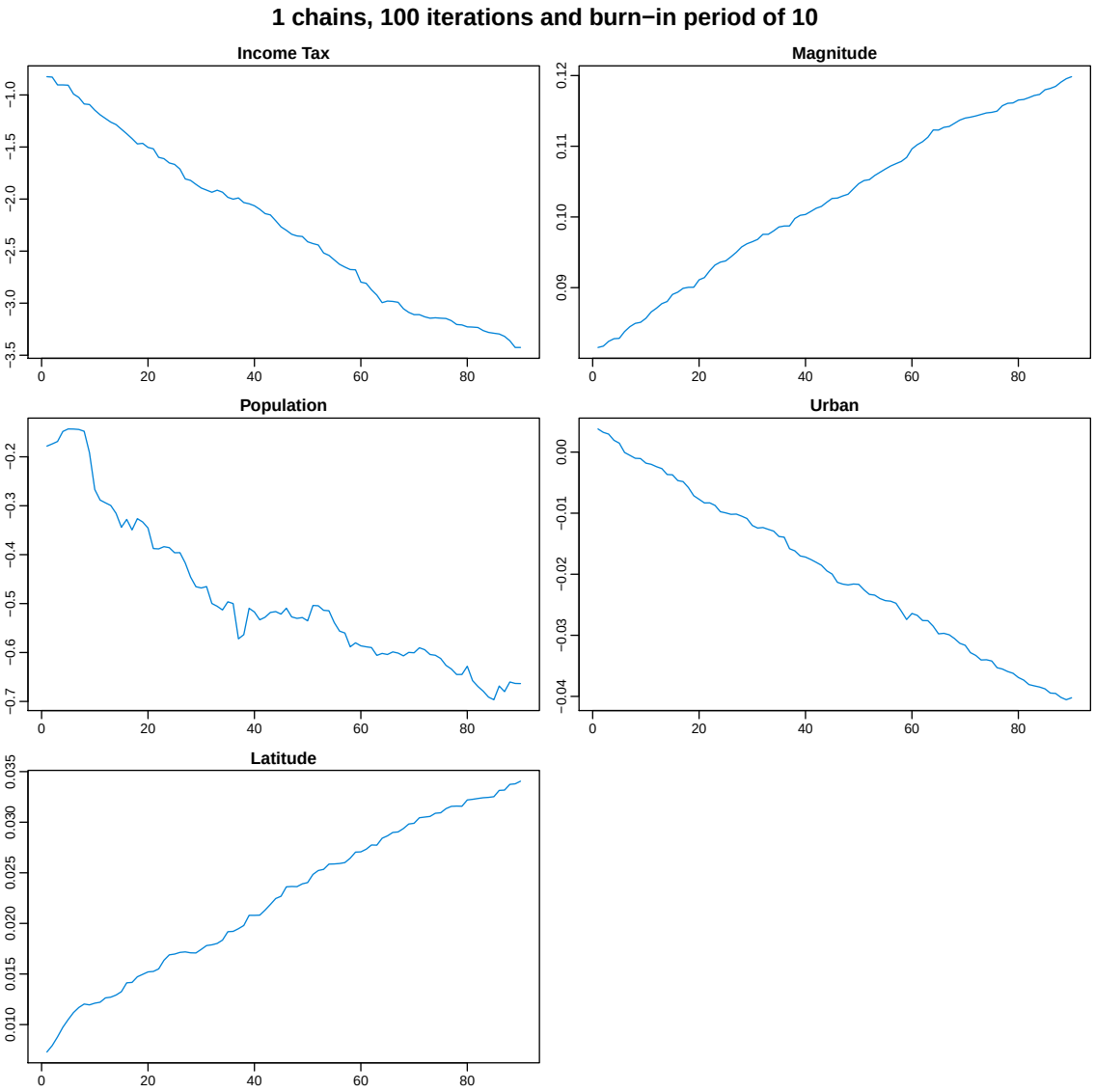

Figure OA4: *Trace Plots: Income Tax Adoption Model*

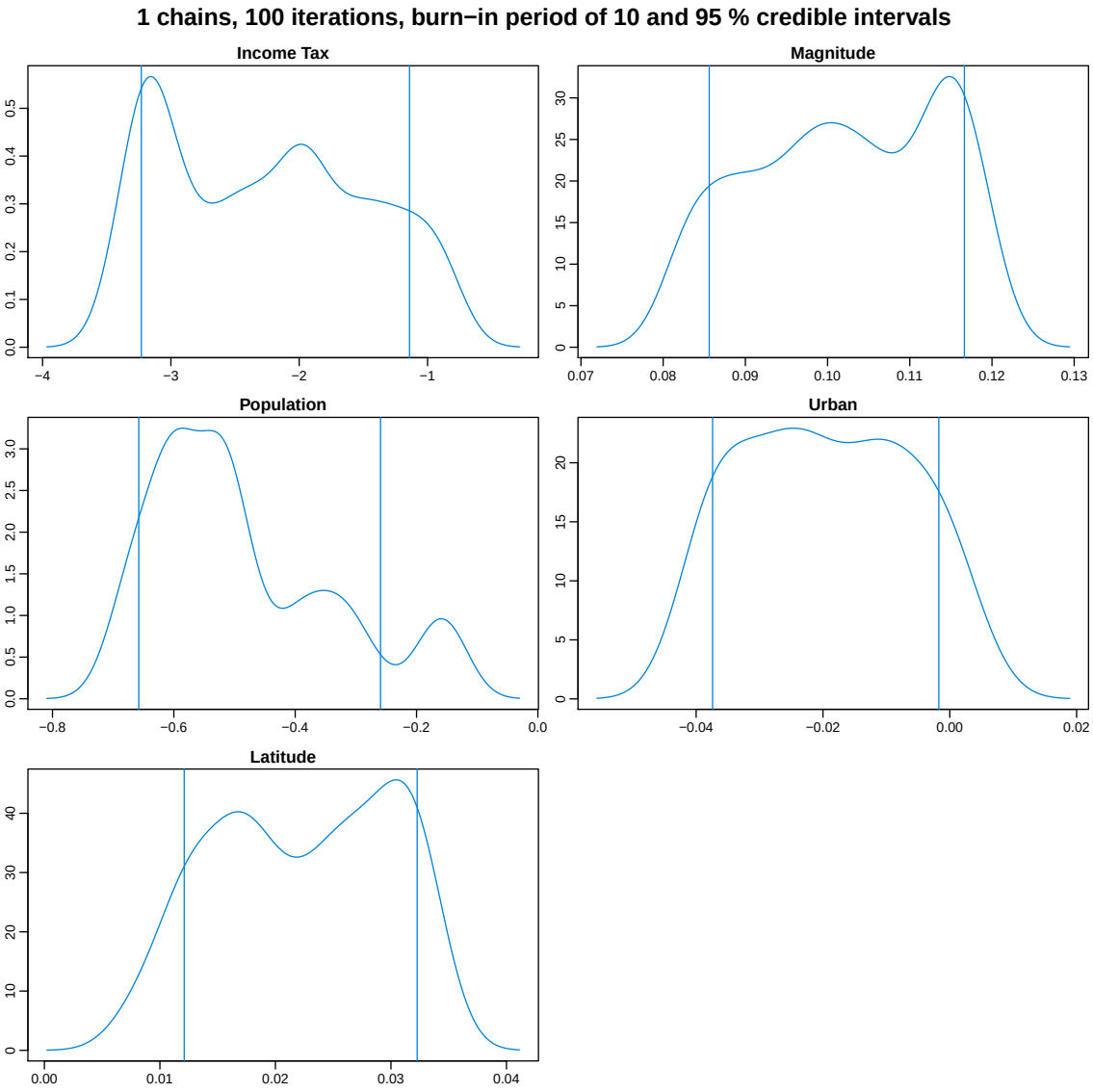

Figure OA5: *Density Plots: Income Tax Adoption Model*

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 OA2: Sample, Data Availability, and Year the Income Tax Law was Implemented.

	(1) Cox (1 lag)	(2) Logit GEE	(3) Conditional Logit (FE)
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 OA3: Sectoral Origins of Income Taxation: Income Tax Law and Industrial Development.

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

Table OA4: 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 OA5: Unit Root Tests for Agricultural and Industrial Growth.