From Boom to Bust: The Structural Transformation of Chile's Industrial Sector After the Nitrate Collapse

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Extended Research Abstract

Motivation and Research Question

Natural resource booms and busts have long played a significant role in shaping economic development, particularly in countries with high levels of extractive dependence. While the literature on the so-called "resource curse" has traditionally emphasised the distortions created by resource abundance—such as Dutch Disease, rent-seeking, and institutional weakening—the short and long-run developmental consequences of the collapse of extractive sectors remain underexplored. Yet such episodes may be deeply transformative, especially when they are sudden and irreversible (Sachs and Warner, 1995; Alexeev and Conrad, 2011; van der Ploeg, 2011).

This paper uses a unique historical episode as a natural experiment to explore broader questions about structural transformation and regional inequality in resource-dependent economies. It focuses on one of the largest and most consequential natural resource busts: the collapse of Chile's Nitrate Cycle in the early twentieth century. Once a globally strategic commodity, nitrate extraction accounted for over half of Chile's fiscal revenues and more than three-quarters of its exports at their peak (Miller, 2021). However, the commercialisation of German synthetic nitrate in 1928, followed by the collapse of global demand in 1931, brought this dominance to an abrupt end, reshaping both national and regional dynamics (Monteón, 1982). Concretely, it aims to analyse how sudden and irreversible collapses of extractive sectors reshape regional industrial dynamics in resource-dependent economies, using the collapse of Chile's nitrate sector as a case study. Focusing on the period from the 1900s to the 1950s, it examines how the disappearance of a dominant export sector altered patterns of subnational industrial transformation.

Rather than presuming uniform effects, this study tries to understand whether regions hosting the administrative and commercial functions of the nitrate economy followed different industrial trajectories from the nitrate-mining areas. This spatial distinction between extraction sites and administrative hubs, while still evident in many resource-based economies today, has received limited attention in the literature despite its potential relevance. Production regions are typically characterised by highly specialised labour markets dominated by blue-collar mining employment, which may constrain post-bust reallocation of workers to other sectors of the economy. Administrative centres, by contrast, concentrate managerial, commercial, and technical activities, where skills and organisational capital may be more easily redeployed. These differences, mediated through market and financial mechanisms, are likely to shape how each type of region adapts after a bust, with implications for agglomeration effects, specialisation traps, and the persistence of spatial inequality (Michaels, 2011; Allcott and Keniston, 2018; Katovich et al., 2026).

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Historical context

Chile's nitrate boom was enabled by territorial change and sustained by strong external demand. After the War of the Pacific (1879–1883), Chile annexed Antofagasta and Tarapacá, securing the Atacama Desert's *caliche* deposits and inaugurating the "Saltpetre Era" (1880–1931). Nitrate's value derived from its dual use as a fertiliser and as a key input for explosives, with wartime demand strengthening Chile's position. At its peak, this critical mineral accounted for more than three-quarters of export value and generated over half of fiscal revenues (Miller, 2021).

Nitrate rents reshaped state finance and public investment, but the gains were unevenly distributed (Cariola and Sunkel, 1982; Hurtado, 1966). Extraction and blue-collar employment were concentrated in the *Norte Grande* (Tarapacá and Antofagasta), whereas firm headquarters, finance, and commercial coordination clustered in the *Núcleo Central* (Santiago and Valparaíso), where access to public goods and state capacity was relatively greater. This separation implied that the North generated labour income, while the Centre captured a disproportionate share of fiscal and commercial returns. The industry combined foreign influence with growing Chilean participation after 1910 and recurrent cartelization to manage output and prices (Miller, 2021; Wagner, 2005).

The bust was abrupt and effectively irreversible. Germany's development of a perfect synthetic substitute culminated in its unexpected commercialisation in 1928, weakening Chile's market power, and the Great Depression precipitated a definitive collapse in 1931. Prices fell by more than 90% and over 200 nitrate works closed (Miller, 2021). Because the shock was externally induced and permanent, and because production and coordination were geographically separated, the episode provides a rare setting.

Contribution to the literature

This paper contributes to two distinct strands of literature. First, it speaks to the Chilean nitrate-bust historiography, where existing work is largely national in scope, qualitative, and offers divergent interpretations of the boom-bust legacy. This literature ranges from uneven development and weak manufacturing (Cariola and Sunkel, 1982), to entrenched external dependence (Pinto, 1959), to infrastructure and agricultural positive spillovers (Hurtado, 1966). Even recent contributions remain mixed, variously stressing avoidance of classic Dutch Disease (Miller, 2021), declining industrial competitiveness (Badia-Miró and Díaz-Bahamonde, 2017), or the role of nitrate rents in public investment and capacity building (Ducoing and Peres-Cajías, 2021). The paper addresses the likely source of this lack of consensus—national aggregation—by providing the first systematic subnational evidence, enabled by a newly constructed panel dataset and the use of modern causal inference tools.

Secondly, it also contributes to the broader natural-resources literature, which has long debated whether resource abundance undermines development through channels such as Dutch Disease and institutional weakening (Corden and Neary, 1982; Auty, 1997; Sachs and Warner, 1995), and whether outcomes depend on institutions' quality (Brunnschweiler, 2008; van der Ploeg, 2011). While subnational evidence on resource booms is mixed (Michaels, 2011; Allcott and Keniston, 2018), the long-run effects of negative commodity shocks under extreme specialisation—especially outside oil and outside advanced economies (Jacobsen and Parker, 2016; Katovich et al., 2026)—are underexplored. By leveraging the nitrate collapse as a historical natural experiment in a developing country, this paper is one of the first to analyse, from an empirical point of view, what we know about how busts reshape industrialisation and spatial inequality across regions in a developing country.

Data and Methodology

A Novel Panel Dataset

A major contribution of this study is the construction of a novel, high-resolution panel dataset that enables a systematic analysis of regional economic trajectories during and after Chile's nitrate collapse. Drawing from Chilean Statistical Yearbooks and Population Censuses produced between 1883 and 1960, the dataset offers unprecedented geographic and sectoral coverage for the first half of the Chilean twentieth century.

The dataset can be divided into two complementary components: (i) a provincial panel centred on the industrial sector, and (ii) a port-level panel on trade flows derived from customs records. The first component comprises annual information for up to 24 provinces over 43 years (1909–1951), encompassing mainly variables related to the industrial sector (e.g., industrial activity, wages, employment, capital formation, fiscal indicators, and infrastructure), with the remainder related to other economic sectors (e.g., the copper mining sector or agriculture, among others). In parallel, I constructed a second dataset on trade flows. Because customs records are organised by port of entry and exit rather than by administrative unit, this dataset is defined at the port–year level. Over the full sample, I identify 129 distinct ports observed at least once between 1914 and 1951. To integrate these data into the departmental framework that will be used in the analysis, each port was mapped to its corresponding department. Where the underlying sources did not explicitly state departmental affiliation, I relied on historical cartography to geolocate ports and assign them consistently across time. The resulting series provides measures of international imports and exports disaggregated by sector, as well as domestic imports and exports, by volume and Free On Board (FOB) prices.

This effort required an extensive and technically demanding digitisation process. In total, I worked with 62 documents, each containing roughly 2,000–3,000 typed pages, which amounted to between 124,000 and 186,000 pages overall. These volumes were divided into smaller files organised by variable, their image quality enhanced, and then processed with Optical Character Recognition (OCR) to extract numerical tables. Yet OCR alone was insufficient: about 36% of the pages with useful information lacked the quality needed for efficient automatic digitisation and had to be transcribed manually. On top of that, all digitised content, whether OCR-based or manual, underwent human verification to ensure accuracy. This workflow ultimately yielded a harmonised panel dataset of more than 110,000 observations for the industrial component (43 years $\times$ 24 provinces $\times$ 110 variables). Using the same digitisation workflow, I also compiled the trade component, which adds more than 40,000 observations. Taken together, these two components make the resulting dataset one of the richest quantitative sources currently available on Chile's historical economy, spanning both industrial development and trade flows.

Empirical Strategy

To assess the impact of the nitrate sector's collapse on Chilean industrial development, this study employs a two-step empirical strategy based on the Synthetic Control (SC) method, complemented by the Synthetic Difference-in-Differences (SDiD) estimator.

In this context, the collapse of the nitrate sector is modelled as a discrete intervention in 1931, when natural nitrate international exports effectively ceased. A second specification also considers 1928, the year when the German synthetic nitrate entered world markets, as an "anticipatory" shock.

The empirical design also evaluates two distinct treatment groups, each with its own donor pool. The first is the nitrate extraction zone (*Norte Grande*), composed of the provinces of Tarapacá and Antofagasta. Its synthetic control is built from a pool of 20 provinces excluding those in the

Núcleo Central. The second treatment group is the *Núcleo Central* (Valparaíso and Santiago), the core of the administrative and financial coordination, with a donor pool excluding the *Norte Grande*. These design choices yield, therefore, to four treatment configurations:

- D_1 = Tarapacá, Antofagasta, $T_0 = 1931$,
- D_2 = Tarapacá, Antofagasta, $T_0 = 1928$,
- D_3 = Valparaíso, Santiago, $T_0 = 1931$,
- D_4 = Valparaíso, Santiago, $T_0 = 1928$.

This setup allows for estimating both the direct effects of the collapse on the extraction region and the indirect consequences for the administrative-financial hub, while also distinguishing between the anticipatory and definitive phases of the shock.

Descriptive evidence

Using the novel panel, the data document three main stylised facts that are masked by national aggregates. First, the nitrate bust lead a large and abrupt external contraction: exports collapsed in 1931, and imports fell sharply as foreign-exchange capacity tightened, consistent with severe import compression. Second, exposure to this shock is spatially uneven. The Norte Grande was the principal export region before the bust and retains low but persistent export activity thereafter, whereas the Núcleo Central concentrated most of the nation's imports and ran a systematically negative trade balance. Third, industrial adjustment is heterogeneous across regions as well. After the bust, the administrative–commercial core displays a sustained upward shift in industrial scale, while the nitrate-mining provinces exhibit comparatively muted industrial dynamism. These patterns provide the empirical backdrop for the comparative-case estimators that follow and discipline the interpretation of the causal estimates.

To summarise the potential multidimensional patterns of an industrialisation process in a consistent, data-driven way, I track three complementary measures intended to capture distinct dimensions of structural change: an Industrialisation Index (overall scale), a Production Efficiency Index (industrial sophistication), and a concentration-based diversification measure (Herfindahl-Hirschman Index, HHI, or H-H index). These indices are not intended to serve as the only dependent variables in the main causal analysis. Instead, they provide a broad characterisation of how the collapse of the nitrate sector affected different dimensions of industrialisation across regions.

Main Findings

The results reveal a sharp and persistent asymmetry in post-collapse industrial adjustment.

In the Núcleo Central, the nitrate collapse is followed by large, statistically significant increases in both industrial scale and industrial efficiency. Depending on treatment timing and estimator, the Industrial Scale Index rises by roughly 1 to 2 log points relative to the synthetic control (about 2.7 to 7.4 times higher), consistent with an industrial boom. The Efficiency Index also increases by approximately 0.8 to 1.5 log points (roughly 2.3 to 4.5 times). Disaggregated outcomes show broad-based gains: production, wages, and the value of industrial assets rise strongly (on the order of 1–2 log points), and firm density and the number of establishments increase, indicating both scaling of existing plants and entry of new firms. Crucially, diversification effects are weak. The HHI declines modestly under some specifications, but the evidence is not robust once SDiD is used. This pattern is consistent with industrial deepening rather than extensive diversification: the central provinces expand within existing industrial branches

Table 1: Estimated treatment effects (full sample, 1909–1951)

	1931 (Standard)		1928 (Anticipation)	
	SC	SDiD	SC	SDiD
ATT	(1)	(2)	(3)	(4)
Norte Grande				
Industrial Scale Index	-0.187	-0.140	-0.510	-0.293
	(0.301)	(0.430)	(0.349)	(0.342)
Industrial Efficiency Index	-0.188	-0.155	-0.152	-0.119
	(0.301)	(0.285)	(0.322)	(0.700)
H-H Index	0.068***	0.071***	0.058***	0.062***
	(0.014)	(0.013)	(0.013)	(0.012)
Núcleo Central				
Industrial Scale Index	1.940***	0.985**	1.996***	1.053**
	(0.330)	(0.339)	(0.342)	(0.341)
Industrial Efficiency Index	1.434***	0.835***	1.515***	0.936***
	(0.322)	(0.283)	(0.323)	(0.283)
H-H Index	-0.029*	-0.016	-0.027*	-0.014
	(0.014)	(0.012)	(0.014)	(0.014)
Observations	946	946	946	946

Note: Entries report estimated average treatment effects (ATT) obtained using Synthetic Control (SC, columns 1 and 3) and Synthetic Difference-in-Differences (SDiD, columns 2 and 4). Indices of industrialisation and efficiency are derived from PCA and standardised (mean zero, unit variance). The H-H Index refers to the HHI or Herfindahl-Hirschman Index. The "Standard" specification dates the nitrate collapse to 1931, while the "Anticipation" specification accounts for the earlier commercialisation of German synthetic nitrate in 1928. Fixed effects are normalised to zero to avoid multicollinearity, following Arkhangelsky et al. (2021), and placebo inference is implemented. Standard errors are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

(including chemicals, textiles, and metallurgical activities) rather than developing an entirely new sectoral base.

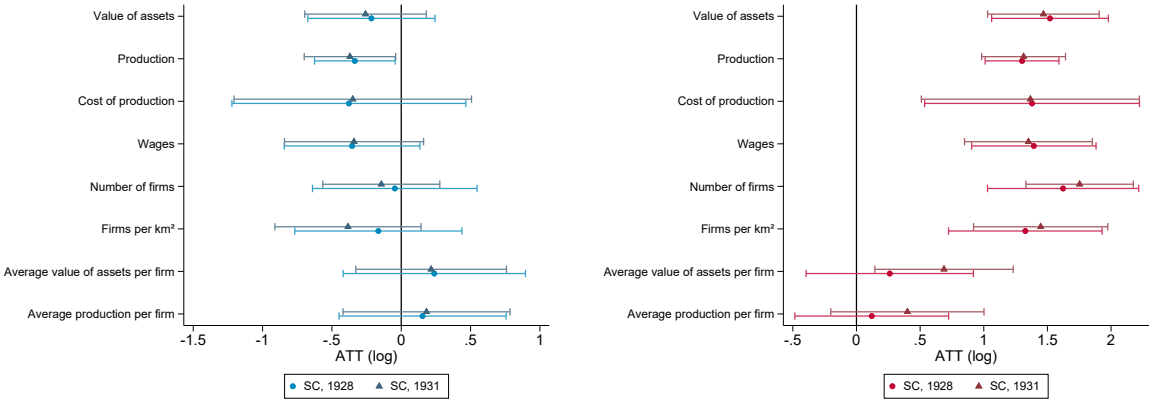
The nitrate-producing Norte Grande, by contrast, shows no compensatory industrial expansion. Across baseline specifications, the Industrial Scale and Efficiency indices are negative but statistically insignificant across all specifications. Disaggregated measures show small-to-moderate contractions in production, wages, costs, and firm density (around 0 to –0.5 log points), consistent with stagnation and contraction rather than transformation. The strongest and most consistent effect in the Norte Grande is increased industrial concentration. The HHI rises by around 0.06–0.07 log points (approximately a 7% increase in concentration relative to the synthetic control), indicating that the industrial base became even more specialised after the collapse. Sector-level evidence suggests that the only subsectors showing any relative expansion are edibles and papermaking—activities that are comparatively labour-intensive, low-capital, and closely tied to primary production. These findings are robust across a range of specifications and sensitivity checks.

Mechanisms

Why did the collapse produce an industrial improvement in the centre but stagnation in the extraction zone? I interpret the evidence through a reallocation framework that emphasises differences in factor mobility and sectoral opportunity sets.

In the Núcleo Central, nitrate-linked resources were embodied in mobile forms: ownership, commercial networks, managerial and technical labour, and financial capital. When the nitrate sector's long-run viability collapsed, these inputs could be redirected towards manufacturing and services concentrated in Santiago and Valparaíso, fostering industrial deepening. The observed

Figure 1: SC estimates of industrial outcomes



(a) Norte Grande (b) Núcleo Central

Note: Everything is expressed in natural logarithms. Monetary values were previously expressed in constant 1916 Chilean pesos, obtained by rebasing the implicit GDP deflator from Díaz et al. (2016).

expansion in more capital-intensive industries, such as chemicals and textiles, is consistent with a channel running through investment decisions and the redeployment of organisational capital.

In the Norte Grande, by contrast, the nitrate economy operated as an enclave. Production capital was highly specific to extraction, and the workforce was predominantly blue-collar. These characteristics limited the ability to transition into technically demanding manufacturing. The absence of large-scale depopulation suggests that the region did not adjust primarily through mass out migration. Instead, preliminary complementary evidence points to adjustment within extractive and low-skilled activities. Copper production increases, consistent with labour and capital shifting towards a geographically proximate extractive alternative that required similar skills. In addition, low capital industrial subsectors (mainly edibles and papermaking) expand modestly, but by amounts too small to absorb a large displaced workforce.

Finally, descriptive trade evidence suggests that the post collapse environment involved severe import compression. This raises the possibility that part of the industrial expansion in the centre reflected import substitution driven by necessity rather than by export-oriented growth. This mechanism, while not the primary focus of the causal design, helps contextualise why the Núcleo Central's industrial scale and efficiency could rise despite the severe external contraction.

Conclusion

The findings have three broader implications. First, they demonstrate that commodity busts can be transformative moments in long-run development, not merely negative shocks. However, their legacy may depend on the geography of the value chain organisation, whether factors of production are mobile or place and sector-specific, and on the availability of other extractive opportunities (like copper in this case). Second, they provide a concrete mechanism for persistent spatial inequality. By triggering industrial deepening in the administrative–commercial hub while leaving the extraction enclave stagnant, the nitrate collapse entrenched a dual regional trajectory that might help to explain why Chile's north–centre disparities remained visible long after nitrate's disappearance. Third, they qualify canonical models that assume smooth reallocation of labour and capital across sectors and space. The Chilean case shows that in enclave economies with limited industrial capabilities, the collapse of a dominant sector can lock regions into specialisation traps and uneven structural transformation.

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