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EXPORT TARIFF, WELFARE AND PUBLIC FINANCE: NITRATES FROM 1880 TO 1930

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[**] The paper is part of a broader investigation aiming at the understanding of Chile's republican growth process.

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ABSTRACT

The traditional exception to the welfare reducing character of protectionism is based on the optimum tariff argument. If in addition the market power can be traced back to control of a necessary, cero substitution natural resource type input, then the corresponding trade tax and the shadow price of the resource are on common ground, eventually the former is also an instrument for charging the latter. In the political economy context such an export tax is also a device for nationalizing the income stream the scenario promises; but also, once this revenue takes over a significant fraction of fiscal income the country's Treasury may turn into a conservative force impeding tax innovations dictated by dwindling monopoly power. Specially so if government comes to display an agency type of behavior and the revenue reductions to be derived from the adaptation of the tariff to changing demand conditions concentrate in the present, meanwhile expected benefits of such an action extend into the future.

Based on a simple analytical framework and exploring the issue with a set of simulations, the optimality of the export tax on nitrates is evaluated for its complete lifespan extending over half a century. Its nil capacity for adapting to changing conditions is then interpreted in terms of the assumed incentive structure of governments, but recognizing the inherent difficulties in predicting future market power and therefore of tax design.

In the 1870th in face of the rapidly expanding international demand for nitrates, concentration in its southern province of a high proportion of world's total natural deposits and thirdly underdeveloped technology in artificially produced nitrate, Peruvian government puts into practice a set of policies aimed at capturing potential monopoly rents to be derived from this situation.

To meet the challenge Peruvian nitrate industry was nationalized financing future payment with specially designed certificates. Since geographic concentration of deposits did not coincided completely with its own jurisdictional area, it additionally bought establishments located in Bolivian provinces, also obtaining from its government an agreement restricting further licensing of nitrate land. These measures plus public

control over access to nitrate mining lands in its own region should have given Peru access to sizable profits, but it was too late.

The Pacific War started in 1879 when the Bolivian government intended to apply a special tax on the only nitrate producing establishment not under some kind of Peruvian regulation, a firm owned by Chileans. In the early 1880 and once authority over the nitrate region was completed the Chilean government faced the same opportunity, that is appropriation of rents stemming from controlled exploitation of the natural resource.[1]

The government had a clear advantage in its claim. It not only exercised military control over the whole territory containing natural deposits, but any initiative in this same direction by industry itself was debilitated by recent experience with nationalization. Last but no least, war effort exercised a severe demand on Chilean fiscal accounts, a hole nitrate rents could nicely fill and the burden of the enterprise would no longer fall only on its constituency.

Reflection on previous experience with nationalization might have been important when designing the specific policy instrument for capturing those rents. The Peruvian administration had run into management difficulties and faced financial problems when intending to pay the bill for nationalization. The first problem was partly overcome by returning administration of the extracting and refining establishments to former proprietors. Financial difficulties on the other hand can be traced back to lukewarm participation of the international banking industry in policy financing.

Those reflections plus retaliation possibilities of various types and other political issues related to the international power game, should have been present when Chile decided in 1880 to impose a tariff equivalent to 18.55 grams of gold per ton of nitrate exports, a tax to be repealed only after generating public revenue for half a century.[2] The adopted solution at once started to generate a generous flow of resources into governments purse.

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[1] Participation in world's total supply was above 90 per cent in 1880

[2] In July 1879 the Chilean government experimented with a 10 per cent tax on net profits (we are not sure if this policy was finally put into practice). The issue was debated in Parliament and basically three possible policies were discussed: (i)cero tax (here the argument was that Chile's reason for war had been its discomfort with the tax applied by Bolivia), (ii)tax on profits; (iii)a specific tax (proposed by Zorobabel Rodriguez, an economist who had been a student of Courcelle Seneuil, a French economist who spent some years in Chile in the 1860's)

The policy mix adopted by the Chilean government was based on three pillars. First, the previously mentioned export tariff. Second, the establishment of a privately owned industry that hopefully would supply the product at marginal cost. And third, a distinct deviation from general mining law, a policy following earlier Peruvian initiatives and whose objective was to establish fiscal control over all potential mining land which had not been already conceded, restricting further entrance into industry unless authorized[3].

In relation to the export tax different lines of economic thought intermingle. It is a tax on trade and therefore points directly towards the issue of protectionism and its rich literature. On the other hand, as Bickerdike (1906) already mentioned (cited by Scitowsky, 1987) this particular tax may act as a substitute for cartel building and eventually generate a beneficial impact on the welfare of the country applying it, provided the underlying market power actually exists.

Public revenue generated by such an export tax compares favorably with other excises raising the corresponding fiscal income; an increase in monopoly rents to be obtained from this source lowers the required domestic taxation and thru it eventual distortions. Therefore and for a budget of a given size, its welfare enhancing character implied by the international transfer is complemented by a fall in total cost of public funds, the latter including both, distortions and administrative collection costs.

In what follows we concentrate on the first issue: the optimality –non optimality– of the export tariff, that is its capacity for monopoly rent extraction and in particular on its constancy (in gold but not in general purchasing power as the reader may soon see) in face of a rapidly declining participation in nitrates supply (fertilizer)[4],

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In September 1879 the law established a specific export tax of 0,40 Chilean pesos (equivalent to 38d); finally, in October 1880 the law established the tax of $1,6 (equivalent to38 pence (d) per metric quintal with a gold content of 18.55 gr.). It could be paid either in these unit ("peso fuerte") or current paper money (government establishing the relation). Initially exports south of the paralell 24 were exempted from tax payment for a two year period starting in September 1879. But the latter only accounted for a very small fraction of total supply. See Alejandro Silva de la Fuente in Semana del Salitre Abril 1926, p.472

[3] General mining regulation consists in a more or less free access policy. Search and exclusive extraction rights are easily obtained paying a relatively low annual fee.

[4] "The challenge came from two chemical substitutes, by product nitrogen and synthetic nitrogen. By product nitrogen in its most common form, sulphate of ammonia, was derived from coal distillation in the manufacture of coke and artificial gas. Sulphate of ammonia had been produced commercially since 1858 and by 1914 it was a serious competitor in the world nitrogen market. The war encouraged further development and production of the second alternative, synthetic nitrogen. Germany initially relied on synthetics to compensate for the interdiction of Chilean supplies by the Allied blockade and then set up protective barriers for its domestic insdustry in the postwar years. Synthetics were produced by capturing nitrogen out of the air using one of three methods: the arc, cynamide or Haber-Bosch process. The Haber-Bosch process, which produced

[5]. The next section briefly discusses the export tariff in a general setting of protectionism and cost of public revenue. Section two brings a few stylized facts on Chilean nitrates. In three the methodology based on a comparison between optimum and effective tax rates is exposed and the respective simulations are presented. Four extends the analytical scenario considering the additional possibility of an private participation in monopoly profits. In final remarks we hypothesize on diverse long run implications of nitrate's tariff maintenance in the 1920's.

1. PROTECTIONISM AND THE COST OF PUBLIC REVENUE

In the face of the reputation protectionism now enjoys in the literature it is surprising that many countries depended heavily on trade taxes in their public finances. For example, in the 18th and 19th Century, U.S. Federal budget trade taxes constitute a very high fraction of total federal income (Wallis, 2000) and even around the middle of the 20th Century in many developing countries public income stemming from these taxes were still important (Goode, Lent and Ohja, 1966 and Lewis Jr., 1963).

As long as there are any benefits to be derived from trade the fundamental requirement for obtaining public revenue by means of trade taxes rests on the jurisdictional division of space. Revenue so obtained will depend on the size of the trade base, hence on GDP and the countries openness. One should keep in mind that from a strict revenue perspective the level of tariffs, as in most taxes, is restricted by Laffer type considerations. Therefore tariffs inspired in public revenue objectives should be in a "reasonable" range, prohibitive tariffs being useless.

However most of the discussion about import and export based tariffs centers on other topics, even if the fiscal revenue consequences are the most visible and easily quantifiable. A simple ordering of these issues distinguishes various lines of thought not all of which will be mentioned here. Following traditional tax theory, one insists on the costs generated by the respective "excess burden", since trade tariffs only tax a

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synthetic ammonia by combining nitrogen and hydrogen at high temperatures, rapidly became the single largest source of non Chilean nitrogen in the late 1920's and 1930's." O'Brien (1989), pp.122-159, 137

[5] See Peltzman (1977), Caves (1989), Schmalense (1989), and Sutton (1997). A recent revision can be found in Sapelli (2001) Concentration (participation) should not be understood mechanically and a priori as a proxy for monopoly power, [5] but it constitutes one of the elements shaping the demand elasticity faced by the monopolist –Chile's government- and should be taken into account.

proportion of total consumption. This line of thought tends to associate tariffs with protectionism and therefore negative effects on national wealth, even so its potentialities in distributional matters might be acknowledged. Trade based taxes generate net distortions when compared to more general excises, as for example a sales tax on the product and not only on its traded fraction (Corden, 1974). It is precisely the existence of alternatives what is behind economists distaste for protectionism[6].

A complementary line of thought emphasizes the possibility of an tariff producing real income for the nation levying it, proposing that terms of trade are endogenous to tariff design, and that this tax may constitute a policy instrument in the gamble for world rent distribution, Bickerdike, 1906 (cited by Scitowsky, 1987). Seen from another angle this view fits into the fashion of pigouvian taxation aiming at the capture of external effects.

Scitowsky underlines the similarity between this view of tariffs and, on the other hand, monopoly and monopsony theory. Tariffs with this character, "have been imposed almost exclusively on primary products and only in countries where those are grown by many small growers under competitive conditions" (pp. 588)[7].

The topic we explore in the following pages is a case study of the Chilean government nitrate tax management, covering the years 1880 to 1930. In 1880 as

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[6] An extension of this line of thought centering on excess burden and inefficient substitutions induced by tariffs, stretches this view towards a more general concept of cost of public funds. When raising one dollar of public revenues, distortions generate an excess burden, meaning that the cost to citizens is $(1 + \lambda)$ times the revenues raised. Even considering taxes of a more general character then tariffs, the magnitude of λ can be quite large. See, for example: Ballard, Charles, John Shoven and John Walley (1985).
Following this line of thought, one would argue, see for example Corden, op cit., that what needs to be minimized is the total cost of public funds, that is $(\lambda + \gamma)$, where γ measures resources used by the government to enforce tax laws, expressed in terms of tax revenues. Both λ and γ depend on the composition, but also on the level of government expenditures relative to GNP. At certain times, stages of development or convergence degrees, the γ from trade taxes might be lower then the enforcement cost coefficients for more general tributes, like those associated to general sales taxes or even general income taxes (Corden, 1974). For example, the control of borders, specially when there are few ports, might be easier and therefore the associated enforcement costs might perhaps be cheaper, then those associated with taxes levied on many individual tax payers distributed over a broad spatial spectrum of the domestic territory.
We recognize that our argument runs exclusively in terms of that part of λ which has to be paid by the government, ignoring costs incurred by private agents. Finally, a subtle issue, we also do not consider, is the change over time of these two components, that is λ and γ.
As a result, the overall burden of trade taxes might, in certain cases, be lower than that of taxes with a more general base. Therefore, a scenario where a heavy dependence of public revenue on trade based taxes might qualify as efficient, should be one where the total cost of public funds, that is $(\lambda + \gamma)$, is lower for these taxes then for alternatives sources.

[7] He further points out that industrial countries, exporters of manufactures, do not apply export duties *because monopoly positions are exploited directly by large producers*. This, he adds explains Britains 19th Century doctrine of free trade: monopoly and monopsony positions in world market were already efficiently exploited by large export producers and by large wholesale import merchants.

already mentioned thanks to the territorial conquest undertaken by the Republic, a large fraction of world production of nitrates concentrated in the Northern regions of the country. Domestic consumption of the product was relatively insignificant and producers, as we will argue, were competitive during most of the period.

Was the level of that tax optimum? Leaving aside the issue of enforcement costs, a tariff is optimal if it maximizes some measure of national welfare for the tariff levying country. Behind this view of the tax a variant of the market failure hypothesis can be found, one proposing that if many producers operate under competitive conditions it takes government intervention to exert national monopoly power; in other words it is assumed that industry cannot exploit it by itself (Pomery, 1987). Cartel building requires a collective decision among different producers, a cooperation which according to this view may not come about spontaneously since competition among independent producers generates an equilibrium where export price equals marginal cost. Prohibitive transaction costs would make the private solution unlikely, unstable or of short duration.

A variant of the above considers that government intervention through an export or import tax is a way of nationalizing profits to be derived from a potential, *socially efficient*, cartel. In this view, government makes use of its powers to *inhibit* private cartel formation and extracts the monopoly (or monopsony) rent in its benefit. In particular in the case of poor and labor intensive countries, it may also be necessary to consider that even if private cartel formation is not prohibitive, there is no guarantee that its outcome would engross national welfare since such an organization could easily turn out being of foreign ownership. In this perspective the monopoly tariff and complemented by measures favoring competitive industry, could be seen as an alternative to either outright nationalization of industry or to a sort of discriminatory corporate tax capable of capturing those rents.

2. CHILEAN NITRATES: STYLIZED FACTS

The extraction of the natural resource is a surface mining and in those years labor intensive activity. After arriving at the establishment and once refined the natural

nitrate (Chile nitrate)[8] is transported to port. When loading the product on ship the export tax is charged; price data (price free aside ship) includes all the above stages of production including the latter.

Freight to foreign market plus commercial and financial services by importers constitute the final stages. These costs plus the above FAS price define the London Price. The analysis of monopoly power and tax optimality will center on the demand – the demand faced by Chile's government-implied by the above FAS price. [9]

In relation to the stylized facts of industry's development between 1880 and 1930 *two phases*, approximately divided by World War I, will be distinguished (see tables and graphs of the Appendix). In the first production *increased relatively steadily*, while thereafter it more or less *stagnated but with profound periodical ups and downs* (Graph NºA1). The total employment pattern in the industry followed that of production relatively closely (Graph NºA2). Prices, showing a like behavior, nevertheless begun to *fluctuate* a few years before the War (Graph NºA3), affecting export values in the same sense (Graph NºA4). [10] In a similar fashion, standard deviations of production, price, and value of production, were relatively low until World War I, or a few years before depending on the variable, but since then and until 1930, very large deviations took place (Graph NºA5). Moreover, the number of Chilean Nitrate production plants, the inverse of a proxy for industry concentration, suggests that around 1914 a break in industry's development style took place (Graph NºA6). Finally, Chile's share in World production *declined during the whole 1880-1930 period*, from over 90 per cent at the beginning to 20 per cent at the end of the 1920s (Graph NºA7)[11], but again it is during the war years where a clear discrete fall can be seen, from about 50 per cent in 1914 to 32 per cent in 1920. In 1927 the share again decreases sharply, this time by about a third.

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[8] Pure content changed from 42 to 20 per cent between 1890 and 1910. O'Brien (1989), p.132

[9] Also included in section four is a minor reflection on the eventual monopoly power in the last stage, but it does not go beyond description of long run tendencies.

[10] "with at least three fourths of output used as fertilizer, the importance of the level of farm income for the nitrate industry can hardly be exaggerated. When prices of farm products rose, the desire to obtain maximum yields created a strong demand for nitrates; but in the periods of decline, a cutback in fertilizer purchases ... The nitrate industry was particularly sensitive to ... sugar beet cultivation in Western Europe ... " Brown, J.R. (1963), p.231, based on Lamer (1957)

[11] World production is here identified with total nitrate production (azoe).

Competition faced by Chilean nitrates stiffens through time. The London price ratio of Chilean nitrate over sulphate of ammonia, the early competitor, shows a sharp decline in the early 1880's but from there on and up to World War I no definitive up or downward tendency may be identified. But starting with the war and over the 1920's large fluctuations characterize this ratio.

Sulphate of ammonia, and specially since the 1910's is far from being the only competitor (O'Brien 1989, footnote above), and therefore its price may not register all the competitive pressure. In Table 1 the average yearly change in world production of all types of azoe is divided into quantities supplied by Chile and the rest of producers, that is sulphate of ammonia and other synthetic goods.

Table 1
AZOE: Average Yearly Production Change, Chile and the Rest 1880-1930
(Selected periods, tons.)

	Chile	Rest	By Product	Synthetic
1880-1900	7.500	4.749		
1901-1903	16.667	0	4.733	
1904-1913	20.000	27.300	18.830	9.443
1914-1922	-61.111	18.778	1.311	33.200
1923-1926	59.000	98.075	18.325	92.225
1927-1929	34.133	229.333	33.100	206.300
1930-1939	-28.310	131.400	2.788*	120.525*

Sources: Ministerio de Hacienda Sección Salitre Antecedentes sobre la Industria Salitrera (1925); Bertrand: La crisis del salitre (1910); Bertrand: Estudio sobre la Industria y comercio... (1915); Ministerio de Hacienda: La industria del salitre en Chile (1934); DGE Mineria 1945; O'Brien (1989), p.138.
*Average 1930-1937.

Already by 1904 competitors begin to expand production more rapidly than Chile and this in an increasing trend. The evolution of this measure coincides with early warnings of market observers (Bertrand 1910, for example) pointing towards the growing competition faced by Chile, that is a relative decrease in its market power.

Table 2 on the other hand brings a general outlook on the dimensions reached by export tax revenues stemming from nitrates for selected years .

Table 2
Fiscal Revenue and Trade Tax 1879-1935 (%)

	Fiscal revenue as Percentage of GDP	Nitrate Export Tax as Percentage of Fiscal Revenue	Rest of Export and Import Taxes as Percentage of Fiscal Revenue (*)
1879	4,1	4,0	51,2
1880	6,4	24,5	35,9
1900	9,7	55,9	31,9
1913	10,1	51,1	37,1
1920	6,9	49,3	21,1
1925	13,1	25,7	21,1
1930	15,4	14,9	31,3
1935	17,2	3,7	30,0

(*) Nitrate tax is not included.
Source: Jofré, Lüders and Wagner (2000)

3. CHILE´S NITRATE MONOPOLY POWER AND THE EXPORT TAX: FIRST PERHAPS TOO LITTLE AND LATER TOO MUCH?

In this section we first describe the analytical framework to measure Chile´s nitrate monopoly power over time and then applying it to evaluate the character of the export tax on nitrates.

3.1. Conceptual framework

Government is seen as the cartel manager, the agency in charge of capturing potential monopoly profit. Domestic consumption is insignificant and the main instrument at its disposal for capturing this flow is a tax per unit of exported nitrate. The tribute is enforced at cero marginal cost and there are no possibilities for product transfers from the domestic to the international market which could avoid its payment .

In this view nitrate is generated by a relatively large number of independent and competitive producers, synthesizing into an industry wide marginal cost function. From the perspective of the producer-exporter the tax simply represents an additional necessary payment for reaching consumers in the rest of the world. From governments point of view the optimum export tax is equal to the profit maximizing difference between the monopoly price to be paid by foreign consumers and industry's marginal cost. Our exercise centers on the determination of the optimum wedge, then comparing

it with the effective margin, that is tax really charged. Later on, section four, the scenario opens up and the possibility of a second stage monopolist and private participation in monopoly profits are evaluated.

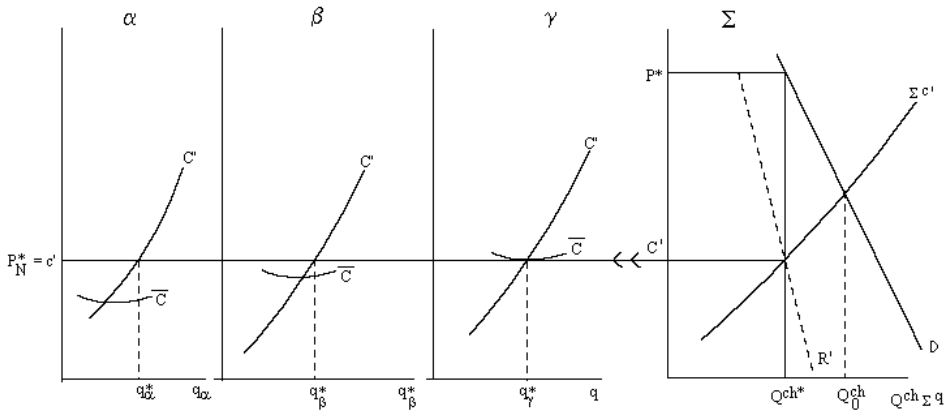
The underlying political economy model is crude, mainly assuming that government is only interested in maximizing fiscal revenue from this source. It does not deny that optimum tariff will enhance disposable income, transferring to the country some fraction of what otherwise could have taken the form of foreign consumer surplus.

In graph 1, right side, industry's marginal cost, $\Sigma c'$, and marginal revenue, R', are obtained from nitrate demand faced by Chile, D^{Ch}. The export quantity identified when equalizing both concepts illuminates the fiscal revenue maximizing mark-up, T*, as the difference between marginal cost and the corresponding price for consumers. On the other hand $\Sigma c'$ represents the sum over individual firms (establishments) marginal cost, c'. Net price, equal to monopoly profit maximizing price, P* minus T* is then the guide to output determination, that is price faced at producer establishment level.

Heterogeneity in industry is illustrated in the graph by the presence of three type of producers: α, β and γ. Under this tax scheme and meanwhile α and β are registering positive profits, establishment γ is the marginal producer. These intra marginal profits, not to be confused with monopoly revenue which here is captured exclusively by government, may stand for quite a range of situations, non market pricing of inputs comes here easily to mind; for example, nitrate content of minerals or aspects related to establishments location, as distance from ports and access to water supply (a critical factor in the desert).

Another way for expressing the same idea would have average cost equal to net price for all establishments, case where all resources would be priced at the corresponding shadow wage price. Finally the eventual difference among short and long run average cost due to the existence of fixed factors in the former period will play an important role, but its presentation is delayed until final discussion.

Graph 1
Optimum export tax with a competitive industry



Over time the demand may increase and schedule D^{Ch} displaces eastwards. Expansion of existing firms and or new entrances may push Σc' in the same direction, increasing production, exports and public revenue, perhaps without mayor changes in the relevant marginal cost of industry.

A situation of "oversupply", employing the expression in relation to a long run equilibrium supply, might be illustrated by a positive displacement of Σc' without an equivalent increase in demand, D^{Ch}. For industry this means that net price is somehow below a net expected price (not explicitly identified), and therefore profits of establishments are slim or even negative. As already mentioned the nitrate industry seems to have faced this type of situation in different occasions; sometimes it tried to administer them through producer combinations (see section 4).

Tax being by far the main policy instrument it is not the only one at governments disposal, and it also decides the quantity of mining fields to be licensed. But the incidence of this instrument is again conditioned by independent private decisions. The demand for additional mining field licenses may reflect the intention to expand output immediately, but it may also be only an option visualizing possible future product expansions in a context where not only the demand faced by industry might be unstable but also licensing behavior followed by government might be discretionary. Therefore in our analysis this option will be ignored; we may add that revenue derived from this source has been negligible, at least when compared to tax income.

From 1880 onwards the specific tax measured in gold units, T (without supra script, the effective tax) was applied, therefore the question to be evaluated period after period collapses into the comparison of T* with T. Turning again to Graph 1, if the tax T exceeds T*, or falls short of it , in both cases fiscal revenue stemming directly from nitrates should not be at its theoretical maximum. For example, if T<T*, the difference means that fiscal revenue would have been higher with a smaller export level, - the profit maximizing Q^{Ch}*- and a tax equal to T*. Since T is fixed a priori by law and is not a consequence of a maximization process conditioned by the yearly outlook, the possibility of a difference between actual and optimum tax is a very real issue.

The challenge facing Congress (public authority) when choosing the export tax level was no minor task. It is our hypothesis that the objective function[12] of these authorities can be understood as maximization of public revenue stemming from nitrates, but one needs to add that for political and economic reasons the yearly redefinition of the tax should be prohibitive.[13] The tax horizon is really not part of the discussion: for all practical purposes once fixed it cannot be changed, unless of course something really dramatic happens. In this scenario the experimental method of tax fixing, that is finding maximum profits through a process of successive approximations was a non available policy instrument.

Two aspects should be kept in mind. The first as already mentioned is that the tax is fixed a priori by law and is not the consequence of a yearly maximization process conditioned by the respective outlook. The second one centers on the particular conditions posed by Graph 1 where a lineal demand curve implies a constantly changing elasticity and therefore marginal revenue. Optimum mark-up T* is unique and could be easily established provided the required information were available, the demand curve itself. But this is not the case in our simulations and as will be seen in the next section

[12] A discussion of tax approval in a public choice setting is here avoided. From a strictly rational point of view there should not have been much opposition: the tax was supposed to be paid by the rest of the world, it was also an opportunity to lower domestic taxes, the excise on tobacco being the main example. Of course some representatives related to existent producers and railroad interests, either Chilean or foreign, exercised some opposition.

[13] In a counterfactual scenario authorities would have enough commercial and analytical capacity and could have found the optimum export tax for each year. But in practice they were not given the discretionary power for doing it. Of course it is also possible that these optimizing capacities of the public bureaucracy was recognized as inexistent, be it for technical and informational reasons or be it because of eventual agency problem conflicts, and that precisely for this reason the tax was fixed by law and not changed. Implicit in this discussion favoring a stable tax is the issue of the possible incidence of unexpected tax changes on industry's investment. These institutional dimension of the nitrate export tax are not examined in the present paper.

our procedure is of a more speculative character, and only a set of plausible elasticities are constructed. This procedure conditions the interpretation of our results (section 3.3).

3.2. Estimation and Data

(i) Optimum Tax

The traditional profit maximizing condition, marginal revenue equals marginal cost,

$$P\,(1+(1/\eta)) = c'$$

defines optimum price , P*, as

$$P^* = c'\,[1/(1+(1/\eta))]$$

Therefore, the optimum tax (T*) is simply the difference between P* and cost, and the tax efficiency indicator to be used is T/T*, effective over optimum export tax.

Two inputs are required for the determination of T*: cost and elasticity. The former, given the above competitive equilibrium scenario, is simply understood being equal to P-T, that is price minus tax, both effectively observed. The determination of the second one is explained below.

(ii) Demand Elasticity

The demand elasticity faced by Chile is obtained thru an traditional excess demand formulation:

$$\eta_{ch} = (Q_t/Q_{ch})*\eta_{wd} - (Q_r/Q_{ch})*\xi_r$$

where

Q_t. = World (total) production (consumption)

Q_{ch} = Chile's exports (we ignore the insignificant difference between production and exports)

Q_r = competitor's production

This demand elasticity faced by government , η_{ch}, combines market participation ratios (Table A1) with a set of a priori values for the world demand elasticity for nitrates (η_{wd}) and for the supply elasticity of competitors(ξ_r).

Simulations are supposed to generate an elasticity for each particular year, therefore and specially in the case of ξ_r they constitute short run or year specific values. In the longer run, that is when taking into account the reaction to price changes over more extended periods, ξ_r eventually may turn out being quite elastic, accounting for expansions and innovations by actual and potential competitors, a possibility to be taken into account when it comes to the evaluation of yearly results obtained.

The fourteen a priori selected elasticity combinations for generating η_{ch} are the following:

Table 3
World Demand Elasticity for Nitrates and Competitors Supply Elasticity: A priori estimates

η_{wd}	ξ_r	η_{wd}	ξ_r
-0,5	3	-0,2	1
-1	1	-0,2	0,7
-0,7	1	0	1
-1	0	-1	3
-0,5	1	-1	2
-0,7	0,2	-1,5	1
-0,5	0,5	-2	1

Due to its unreasonable marginal cost implication any elasticity equal to one or less in absolute value, that is inelastic, is eliminated . The rest is synthesized into four series, each registering an elasticity for every year:[14]

[14] Direct econometric estimations of Chilean demand elasticity did not generate acceptable results. But a reasonable estimate for World demand elasticity could be obtained from the 1880-World War I period. The estimated equation is the following (all variables in logs):

Dependent Variable	*Constant*	*London Price*	*GDP (selected countries)*	R^2*(%)*
World Production	-18.55	-1.15	2.77	92.7
	(-4.59)	(-3.14)	(15.5)	

Table 3 above was re-estimated with the same inputs for competitors supply elasticity and participation rates but now taking the econometric estimation for World demand elasticity, that is –1.15. In relation to the Chilean elasticities estimates (1) and (4) above, and with the exception of elasticity (1) where this new procedure generates significantly higher values, the three others show little difference with simulations in the first four columns of Table A.2. They are somewhat lower up to the first half of the period and definitively a little after World War I (range from –20 per cent up to +15 per cent, depending on the elasticity).

(1) The least elastic

(2) The average once maximum and minimum values have been eliminated

(3) Average of (2) and (4)

(4) The most elastic estimate

These four series for the constructed demand elasticity faced by Chile and their respective Lerner coefficients can be found in Table A2.

(iii) Data

Tax (T) is the effective nitrate export tax as reported by fiscal revenue accounts. It coincides more or less perfectly with the tax as specified by the code once expressed in the same unit (1995 US dollars). Price (P) is the quoted price aside ship in Chilean port, also in 1995 dollars[15]. The quantity measure (Q) refers to exports (tons.). There are periods where production and exports do not coincide, stocks in Chile accounting for the difference.[16] Finally, cost follows Graph 1 and is taken to be the difference between the above price and tax; it is identified as C2.

(iv) Optimum values

As already mentioned, P* is constructed with two inputs: cost and the respective Lerner mark-up coefficient (L). Hence $P^* = C2 \times L$, and therefore optimum tax is $T^* = P^* - C2$.

The evaluation of tax optimality starts comparing the effective and optimal tax ratios T/T^*. This is the first and in our opinion the most important result. Analysis then extends in the direction of revenue implications of tax differences. Effective revenue is compared with potential monopoly profits, T^*Q^*. Rent maximizing quantity, Q^*, is calculated through the expression $Q^* = Q + dQ$. The latter element is taken to be:

$$dQ = \eta_{ch} (Q/P)\, dP$$

where

[15] Not all nitrate is actually sold in Chile and British companies tended to be more vertically integrated. We assume that the quoted price is also the relevant shadow price for the latter exports.

$dP = (P^* - P)$

When P* turns out to be above P, then the optimum quantity Q* should be less than Q, the actual export. Since Q and P are necessarily positive, the negative sign of the demand elasticity determines the required negative dQ.

When comparing the effective and the optimum revenue it is necessary to keep in mind that, as mentioned in 3.1, calculations are based on constructed elasticities. In particular when calculating Q*, the elasticity implicit in both, Q and Q* is forced to be the same, opening up the possibility of an effective revenue near to or even larger than the theoretical optimum (once lack of precision of discrete calculations is acknowledged). No exogenous test for the constructed elasticity is applied and therefore a constant elasticity in the range Q-Q* cannot be ruled out a fortiori, neither confirmed.

In other words, a constant demand elasticity implies constant marginal revenue, and when assuming scale independent unit costs as we do, it gives rise to a range of profit maximizing export levels. Therefore the particular elasticity assumption opens up the possibility for similarity, eventually identity, among effective and optimum public revenue from nitrates, even if $T^* \neq T$.

3.3. Results

The ratio of real to optimal nitrate export tax for each of the above constructed demand elasticity faced by Chile is shown in the initial four columns of Table A3. The following set of four columns in the same Table depicts the ratios of real to optimum exports, Q/Q*.

The ratio of T/T* for the least elastic value (1) is characterized by enormous differences, implying that the real tax should have been ten, twenty or even more times higher, implying an absurd corollary: Q*, the optimum export volume turns out negative in most years. Our interpretation is that the assumed elasticity is too small and not useful for evaluating the optimality issue.

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[16] Sales to consumers, mainly agriculture, and Chilean exports are not necessarily equal on a year by year basis. Data on stocks of Chilean nitrate in Europe is only available for a few more recent years. Due to this limitation our calculations are based on exports and not strictly on consumption.

Calculations based on elasticity four, the most elastic are the only ones generating positive Q/Q* ratios for the whole period. Elasticity two and also three generate positive Q/Q* ratios, except for early years. The tax was established in 1880, and assuming some rationality and reasonable information by the tax fixers, it is precisely in those years where an acceptable fit should be expected. [17] Therefore at least for those years only ratios based on elasticity four answers our main question; for later years the T/T* ratios based on elasticity 2 and 3 cannot be eliminated from discussion.

The last four columns of Table A3 take the two measures together and compare actual and optimum fiscal revenue. The first aspect to be noticed when centering attention only on the most elastic case (4), underlines that even if deviations between actual and optimum quantities are significant, real and optimum revenue tend to be similar. When taking this figures without further consideration the optimum monopoly quantity in practice turns out being a broad range of quantities and not a unique point. In others words and referring again to Graph 1, marginal revenue and cost are more or less equal for a range of quantities. But as discussed in the last section, the result needs careful interpretation because of its implicit conditioning by basic methodological procedures, in particular the constant elasticity assumption when calculating Q* (and constant cost).

In Table A4 the first four columns show the same ratios of effective to optimum revenue, but now imposing the additional condition that the coefficient stays within the range: 0<coefficient<1,09 The lower limit simply eliminates all negative values, because of their implicit negative optimum export quantity. The upper limit on the other hand is more discretionary, leaving aside cases in which effective revenue is 10 per cent and more higher than estimated under maximizing conditions. The argument behind this restriction is empirical based on the notion that an excessive ratio of effective over optimal revenue puts the simulated values under critical light. But, what is excessive? Even if discretionary we postulate that an estimation error of less than 10 per cent is tolerable. Of course a purist's approach may want to reduce it to a still lower limit, eliminating all cases above unity.

[17] The tax was approved by parliament but in our understanding its level was heavily influenced by the proposition of the executive. Before that the issue was studied by a special committee.

The last set of four columns in Table A4 reproduces only indicators of the first group surviving the test, therefore all T/T* ratios not complying with the above condition disappear.

When accepting the revenue consequences as established by ratio TQ/T*Q* and also the above criterion of positive coefficients below the ten per cent difference, then a value of T/T* above unity literally implies that effective tax could have been reduced without paying a revenue slice. But even if the conclusion is conditional to the acceptance of this criteria, the important aspect to notice is the rising trend which remains for the T/T* at least for the cases of elasticities 3 and 4. This upward trend in later years will be interpreted as a policy opportunity for tax reduction without loss of public revenue (but more on this , later in section 6). Additionally, a lowering of the tax within a reasonable range might also have helped industry's competitive position.

4. PRIVATE PARTICIPATION IN MONOPOLY RENTS. DID IT EXIST?

In section 3 the assumed competitive environment translates into an industry supply where cost is identified by the observed price minus real tax and the government receives the monopoly rent. This scenario will now be modified so that additional possibilities may be evaluated. On the one hand a broader participation scheme in the above monopoly rent will be allowed for, and on the other the `possibility of a second stage monopoly is introduced.

4.1. Private participation in the one stage monopoly context?

Nitrate historians inform about different privately induced cartel agreements ("combinaciones") each lasting for a short period of years. Agreements are said to have been either ineffective in obtaining reductions of production or if registering some success, did not work for long. Taken strictly these reports do not imply permanent private participation in those monopoly rents, but the possibility is explored in what follows.

The evaluation of this broader participation schemes in monopoly rents was facilitated by cost data found when searching for nitrate facts, a data series stretching

from 1880 up to 1925.[18] In this way price may be decomposed into: tax, cost and a residual and once the latter is interpreted as profit a first step for a broader participation scheme emerges.

Of course we cannot establish a priori for what profits (residual) so obtained would exactly stand for, but the general hypothesis guiding analysis is that all or part of it may be classified as an industry participation in the Chilean monopoly power.[19] In what follows different interpretations of this cost data are used for discussing the idea explored in section three. In total eight different concepts for this eventual private participation are defined for simulation purposes.[20]

For each of these eight cost definitions the corresponding monopoly price is calculated based on the same set of Lerner coefficients already mentioned (Table A2). The respective monopoly mark-up, M*, that is P* minus the specific cost definition, then

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[18] Ministry of Finance as reported by the publication " Semana del salitre celebrada en Santiago de Chile Abril de 1926", Santiago, La Ilustración, p. 900. It is an ad hoc serie and our pressumption is that it does not come from industry studies and is only a series prepared for 1926 meeting.
For an overall impression on the factors sustaining the long period tendency, cost per ton was regressed on a scale indicator, average production per establishment (oficina), plus a tendency or time element. Both coefficients are significant (R^2=66 per cent). The time series elasticity so obtained for the 1894-1924 period is –0,696; therefore, a 10 per cent scale increase lowed cost per ton around 7 per cent. The tendency coefficient is also negative an equal to –0,0176.
Historians of the nitrate in Chile underline two mayor technological changes, presumably with a significant impact: the adoption of the Shanks refining system around 1880 and the innovations –mechanization- introduced by the Guggenheims since the late twenties. The above data presumably excludes both.

[19] There are two basic sources for cost data. One is a survey prepared by Fernandez(1978) which we take from Reyes (1994). The second one was elaborated by the Ministry of Finance (1925) for the 1880-1924 period. In general, with the exception of 1907, a year characterized by heavy strikes, differences between sources are not exceptional, the second being an average slightly higher. This latter was preferred given its broader extension.

[20] Experiments take into account nine different definitions for the monopoly component of profits (G).

(1) G=0, the case reported in section 3. Here cost is simply price less tax.
(2) Based on the same cost concept of (1) but taking tendency values; deviations of actual and tendency values are considered to be private monopoly rents.
(3) Based on cost figures of Ministry of Finance; decomposes G so obtained into a tendency component GT and a residual. GT is interpreted to be cost, some sort of capital cost and the residual GN is industry participation in monopoly profits (the latter is negative in some years).
(4) The same as (3) but here GN is part of cost and GT is assumed to correspond to monopoly profit participation by industry.
(5) Cost is the sum of the tendency values of cost as identified by the Ministry of Finance and the corresponding profits. Here the industry participation in monopoly profit is Price minus Tax minus the above cost.
(6) Directly takes the Ministry of Finances figures to be total cost and all profits so obtained are considered as industry's participation in monopoly rent.
(7) The same as (6) except that now cost is the tendency value of Ministry of Finance data.
(8) Cost is Ministry of Finance figures plus a fraction of the residual estimated as a risk compensation element based on standard deviation of nitrate's price.
(9) The same as (8) but here the risk compensation factor included as cost bases on the standard deviation of quantity exported.

distributes into tax and private monopoly profit participation (GP). Therefore M* = (TP + GP)*.

Notice that this scenario does not generate a measure for the revenue maximizing tax as in section 3; it only determines the optimum mark-up M* but not its distribution into tax and private profit. Additionally, government is also restricted by the specifications of the tax law of the early 1880's, having no capacity for yearly negotiations, therefore TP = T and GP absorbs fluctuations in M* (in a few cases GP turns out being negative).

It should also be noticed that the exercise simply assumes some sort of private participation in monopoly rents and then explores its consequences, but it does not provide an explicit justification for the existence of this participation.[21]

4.1.1. Results

As in section 3 and using the same set of elasticities the effective monopoly returns are calculated; are visualizing them as the effective tax plus the corresponding industry participation magnitude in relation to optimum monopoly mark-up, that is (T+G)Q/(T+G)*Q*. Additionally we identify (T+G)/(T+G)*, that is the actual to optimum mark-up, for those ratios within a range running from 0 up to 1.09.

Only from 1915 onwards and for all cost definitions is this ratio accepted by the above test in the case of simulations based on the least elastic demand ($\eta 1$), what brings us to dismiss indicators developed under this elasticity assumption.

On the other hand for the most elastic demand ($\eta 4$) assumption it is possible to observe mark-up ratios since 1880, but more than half disappear after 1907. The difficulty with the surviving indicators stretching over most of the fifty year period, is that their usually high values, above unity suggest that already in the 1880's and 1890's total mark-up tended to be excessive in a systematic fashion, a situation difficult to believe for the early years.

Mark-up ratios computed with intermediate elasticity values ($\eta 2$ and $\eta 3$) and similar to the most elastic case ($\eta 4$), show half of the indicators disappearing between

[21] There are different candidates for explaining private participation; cartel agreements already mentioned being one; maybe government licensing of new fields could be another one. The railroad Company is said to have exercised market power (due to the government concession scheme) specially in the first decades. But this should not show up in the above GP since all of our cost definitions already account for this freight.

the years 1908 and 1912 and from then onwards. The rest, those covering a more substantial part of the total period register more observations in the $\eta 3$ case than in the $\eta 2$ case. Both elasticities generate indicators nearer to an interpretation where in the initial years mark-up is somewhat below optimum, but turning definitively excessive in the 1920; but some already point towards an excessive margin in the 1890's.

It seems clear to us that this ratios might be criticized for proposing irrational behavior by private participants: an excessive margin and considering the tax as given would reflect an non optimizing adjustment. Abstaining from this limitation, these results do not argue themselves in favor or against the hypothesis of a broader participation scheme. Rather they show that if the analytical scenario allows for private participation, then the general impression obtained in section 3 is still valid: may be too little was charged in the early years, but it definitively became too large later on, a consistent finding for all surviving indicators for the 1920's.

4.2. Second Stage Monopoly?

Price distributes into cost, profit and tax in highly varying proportions; for example, tax shares calculated over the FAS price go from a maximum of 47 per cent to a minimum of 12 per cent (see Appendix, Table A1) following no precise time trend. But since consumption localizes mainly in Europe and USA the above price, used in all previous calculations, only represents the cost of one bundle of inputs of the product finally consumed , the difference being sea freight, trade and financial services.[22]

Public debate with respect to nitrate policy considered this particular aspect to be a weak feature in government control over nitrate business. The particular question for our present purpose is the extent to which this margin, that is London-FAS price[23],

[22] Nitrate establishments localized in northern provinces were owned by proprietors of different nationalities including Chilean ones (proportions varied much through the period, in part only of a spurious reflection of the introduction of corporate taxes in Great Britain). Loosely speaking we may say that British owned establishments exported directly, but the rest really were selling the product in Chile.

[23] Both London and FAS prices are yearly averages. At least in London's case, it corresponds to a yearly average, with clearly different maximum and minimum observations. We ignore how the averages were computed.

obeys exclusively to cost or if it also contains some element of market power.

When regressing the above margin against time, a secular annual decrease of 1,5 per cent is obtained. And when subdividing the margin into the freight component and a residual, they show an annual decrease of 1,9 per cent and 1,3 per cent, respectively.[24] The decrease in freights over this period of 36 years should not constitute a surprise, after all important technological changes and innovations characterize transport per sea in those years.

We do not see an easy and a priori cost based explanation for the decreasing tendency shown by the residual (London Price – FAS Price – Freight). A possibility is that trade and financial costs, inputs which presumably account for this residual, are more or less constant over time and therefore the possibility of a decreasing monopoly power in hands of wholesale importers of the product should be taken into account. This possibility will not be further explored.

5. WELFARE IMPLICATIONS: A CLOSER LOOK

For three or three and a half decades the export tariff on nitrates generated income transfers from the rest of the world and in Chile's favor, the statement being conditioned by the underlying counterfactual. Initially - section three- it is represented by the competitive outcome, the discussion centering directly on the optimality of the tariff. Later on -section four- the possibility of some participation by foreign factors is explored, something our analysis neither proves or disproves; therefore this constitutes an aspect to be taken into account when discussing the plausibility of the above counterfactual. Its exact dimension might require further discussion, but it is our impression that the main conclusion about the existence of significant transfers from the rest of the world firmly holds.

[24] The three regressions used data for the 1882-1915 period and the results are presented in the next table (t-statistic between brackets):

Dependent Variable	*Constant*	*Trend*	R^2 *(%)*
Log Margin	5,20	-0,0154	33,99
	(65,7)	(-4,05)	
Log Freight	4,61	-0,0186	27,72
	(41,51)	(-3,5)	
Log Residual	4,45	-0,130	19,18
	(44,84)	(-2,75)	

Jumping directly from transfers to welfare implications smacks of partial or incomplete analysis and for avoiding it at least two potential issues should be discussed. Retaliation by trade partners is one aspect; the second assumes that welfare associates with goods consumed and given no unique relation running from foreign transfers to the level and composition of output, decisions pertaining public sectors expenditure may play a central role. The present section discusses both briefly.

i) Retaliation by importers

Trade partner reactions to interventions in the free market for goods and resources constitute a possible danger to any tariff measure, and retaliation may express itself in many different ways: tariffs, quotas, an unsolicited visit of the fleet, etc.

The possibility of retaliation to nitrate's export tax seems absent from Chilean public policy discussions. But this is only an impression and not a conclusion flowing from rigorous historical analysis, something the authors feel not prepared to realize; recognizing this in what follows the above statement is taken only as a working hypothesis.[25] It is only in the late twenties and specially with the Great Depression that regulatory reactions of trade partners start to inhibit nitrate exports, but and as our discussion suggests in those years Chile already was nearer to a price taker than fixer position and therefore its capacity for obtaining transfers thru trade taxes is quite limited, probably inexistent

The overall transfer from trade partners provoked by the export tax includes, (i) effective tax receipts by the Chilean government plus (ii) the respective Harberger triangle,[26] once free competitive world trade is taken as the pertinent counterfactual. Total excise so defined when compared to a rough estimate of total agricultural GDP of

[25] For example, a revision of the correspondence of the UK Foreign Office and its Chilean representatives, and also internal letters of large British trade houses may possibly change this view.

[26] The standard expression for the excessive charge, for example Stiglitz (1988, Ch.18) when assuming elastic marginal cost conditions, is given by $0.5*\tau^2*P*Q*\eta$, where τ stands for the equivalent ad valorem tax calculated over net supply price (P), Q is quantity, and η is demand elasticity. We estimated the magnitude of the excessive charge for the year 1900; P is equivalent to Chilean marginal cost (FAS price minus tax, T) and Q to Chilean exports divided by market participation, therefore a proxy for world volume. For price and tax we take the corresponding averages for the 1895-1905 period. Our procedure assumes that all foreign production generates excessive charge from the point of view of world consumers. The total excise so obtained, that is excessive charge plus revenue so defined –chilean tax receipts plus the foreign production effect- gives a total of 477million 1995 US dollars. When comparing to a rough estimate of the main importing countries agricultural sector GDP this total excise is equal to one fifth of I%.

main importers (our sample includes only UK, USA, Germany, Spain and France), gives a cost equal to one fifth of one percent.[27]

There may also have been other issues explaining the apparent absence of retaliation, about their relevance we can only speculate. One of them derives from the heavy presence of foreign ownership in nitrate manufacture. Since any retaliation could quite possibly have had a negative incidence on these interests, industry's property structure may have protected Chile's monopoly power, at least in the short run. Secondly international creditors were involved in industry itself, but also maintained obligations issued by the Chilean government. Assuming that retaliation in response to the export tax might have generated difficulties for debt servicing capacity, the inter relations so obtained could have been a sort of stabilizing element in the scenario.

ii) Optimal export tariff and Chilean welfare.

Once nitrate fields came under Chilean jurisdiction and government starts extracting those rents, public revenue expands rapidly; in this context one obvious question refers to its translation into effective welfare. Judging the situation on a simple normative scenario where citizens preferences are to be taken into account, and where the demand behavior of the different goods consumed is assumed to be normal, such an income shock would divide among state and citizens. With two composite goods entering citizens utility function –let us say one private one public- the revenue expansion distributes into both goods (Bradford and Oates 1971).

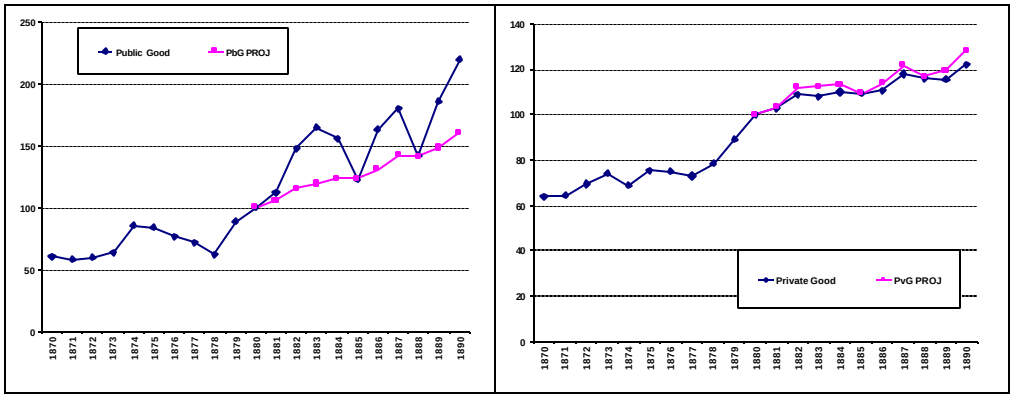
An empirical impression can be obtained when Chilean fiscal expenditure is taken as representing the public good, and GDP minus fiscal expenditure as the private one. Table 5 proportions income elasticities for these goods and for two periods, before the nitrate episode and for three decades from 1880 onwards. According to these results nitrate revenues open up new or formerly hidden dimensions of the Chilean public choice process.

[27] As explained in the previous footnote total excise represents a negligible fraction of production. What is more surprising is the implicit cost of public funds; when taking the role of a world wide planer, each dollar of Chilean revenue so obtained costs the world 37 cents.
But of course, Chilean government was not accountable for this cost; without retaliation it was irrelevant for its constituency.

Table 5
Private and Public Good: Income Elasticities
(Pre and post 1880) [28]

	Private Good	Public Good
1840-1880	1.04	0.78
1880-1910	0.85	2.24

The following Graph on the other hand , registers actual figures from 1870 up to 1890 and from 1880 onwards incorporates projections based on first periods elasticities[29]. Income expansion obtained from nitrates translates mostly into public sectors expansion, resembling a distribution governed by the flypaper effect as it is known in the literature referring to transfers from central to local governments ("money sticks where it falls on").[30]



The above exercise contrasts the empirical with an assumed or historical income elasticity and therefore the observed difference neither proves or disproves the validity of the respective assumption. Its main objective is to call attention onto an

[28] Elasticities are obtained in a single variable relationship between the respective good and GDP, using first differences. The data source is Braun and others (2000). Specially in the first period the private good as computed is a very important component of GDP, hence the estimate of public good elasticity.

[29] The above empirical finding is opposed to some historical literature claiming that governments lost the golden opportunity for the country not using these resources directly for fostering development; the least to be said is that fiscal expenditure expansions are far from negligible. But it might be that the criticism rests on expenditure decisions within the budget not referring to the income distribution decision between public and private goods, a question we leave here.

[30] For a recent survey applied to local public finance, where the local distribution of central government transfers are examined, see Hines and Thaler (1995)

unexplored issue, that is a discussion of the nitrate episode with reference to a broad public choice scenario in both periods, one where options and restrictions are properly identified in the choice setting. For example, the understanding of nitrate's incidence on the public budget and finally on welfare should benefit from its discussion on a general scenario where public expenditure in specific items are allowed a more active role. Defense or eventually infrastructure might after all be somehow linked to territorial expansion, much more at least then an elasticity comparison permits; in other words the underlying technology, that is the production function of nitrates incorporation into Chilean jurisdiction is eventually a more complex issue, a restriction not to be ignored. But extensions like this we cannot examine further.

6. FINAL REMARKS

For half a century nitrate exports provided Chile's government with a generous income stream; from 1880 and up to 1930, discounted at the 10% rate, the stock value of the public revenue flow derived from this base is equivalent to 65.7% of 1880's GDP.[31] The evolution of this flow of export tax receipts is far from uniform, being highly irregular from World War I onwards, and with the exception of a few years much below pre-war levels.

a) Tax incidence

The policy instrument thru which the potential revenue flow materializes, the specific export tax measured in gold units, stayed constant over the whole period in spite of the dwindling Chilean market power. Our main objective has been the evaluation of the optimality of this tariff design, that is the extent to which it coincided with the monopoly profit maximizing mark-up thru time, and in this sense clear signals of a fundamental change can be observed around World War I, sooner or later depending on the specific simulation; in particular in the 1920's the coefficient of the effective export tariff in relation to optimum mark up is significantly higher then its pre war level. Nevertheless the capacity of the export tax for raising state revenue is still

[31] The discounted flow refers to export tariff receipts. Import tariffs charged on the corresponding imports are not included.

important; for example, in the boom years 1927-29 public income stemming from nitrate still added up to 77 per cent of the historical maximum reached in 1911-13.

As mentioned the high level reached in those years by the effective to monopoly maximizing mark-up can be seen as a normative indicator favoring tax change. But now it is time for discussing the consequence on public revenue of an eventual tax reduction.

Referring to this question various aspects should be taken into consideration. To begin with optimum tariff simulations are specifically determined for each year, but on the other hand, the same elasticity is employed when calculating the ratio of effective to optimum revenue, in particular for obtaining the revenue maximizing quantity, Q*. In this sense the similarity between both revenues, specially in the case of simulations 3 and 4, is a consequence of this procedure but not necessarily does it constitute a reasonable prediction of effective revenue in face of an tariff reduction. Constant elasticity demand curves not being guaranteed a priori, such a prediction would require an independent indicator for eventual elasticity changes. This we do not provide and therefore our estimates for optimum revenue do not answer such a question, an aspect to be taken into account in the following discussion.

In a long run perspective and to the extent that world price is still influenced by the Chilean tax, [32] one concludes that a lower tax would have been followed by a smaller price. As long as this is valid, in other words as long as the country keeps some market power and additionally expansions of production by third parties are characterized by an non zero supply elasticity, then Chile's long run participation in total output will be endogenous to its previous export tax level, a higher present tax implying a lower future share. Taking these considerations together the tax change comes under a more favorable light: when lowering its level in year t, its impact on fiscal receipts of the same year cannot be predicted by our calculations but a shrinking revenue is quite possible. On the other hand and for future periods such a change might generate a larger share in total world output and eventually even more fiscal income. This simple reasoning does not provide any clue to possible lags and timing, and the overall evaluation of an

[32] A simple regression of FAS price with effective nitrate export tax for 1881 up to 1910 generates a positive coefficient for the tax.

eventual tax change should have required additional information, one being the long run supply elasticity for foreign production.

As already said our estimations suggest a rapidly falling monopoly power from World War I onwards, but and given the inherent limitation in our methodology specially with respect to the foreign supply elasticity, the possibility of little or non market power left in 1920 cannot be ignored.[33] This brings us to the third dimension of such a tax change, that is the effective market situation in those years. A correct identification is not provided and only a hypothetical scenario is briefly discussed. Hereunder suppose that the 1920's already offered a sort of competitive price facing scenario to Chilean nitrates, what then is the incidence of the export tax?

Fixed, that is nitrate specific assets behind establishment's production functions make this tax possible in the short period. Nevertheless in a steady state equilibrium rents to be derived from those assets take the form of necessary income for long run survival. In such a context, therefore, the export tax effectively charged in the 1920's should have inhibited Chilean production and exports would disappear completely in the long run.

Steady state is only an assumption for describing a case of extreme tax incidence, the real 1920's surely offered deviations from this hypothetical scenario, and eventually exogenous technological innovation or changes in factor prices and of intermediate goods changes may have been helpful to industry.

Industry spokesman emphasized the excessive character of the tax, specially in the 1920's; in itself and as Adam Smith taught us, such expressions not necessarily constitute unbiased opinion. But there is more and early reflections of a government observer of the nitrate market, already in the first decade of 1900 confirm the presence of stiffer foreign competition (Bertrand as quoted by Reyes 1994, pp.15-21). In the second half of the 1920's it is government itself who seems to recognize a problem

[33] The econometric estimation of World demand elasticity (see footnote 15) already points to ward somewhat higher elasticity estimates than those underlying our calculations for the 1920's.

when starting to return a fraction of revenue to industry.[34] It also began to prepare a new tax code and finally in 1930 the specific tax was repealed in favor of a tax on capital; also a mayor reorganization imposed a centralized sales agency.

The hypothetical tax cut in year t, say in the 1920's, would probably have meant more or less similar production but less fiscal income in the same year; its long run incidence on both variables remaining an open question. Such reasoning must surely have been part of government reflections when it came to tax innovation. Henceforth policy change must have been taken as a rather risky adventure, where quite visible and negative immediate consequences could not have been turned around by eventually positive long run effects, and this before introducing any consideration with respect to governments rather reduced time horizons.

In the 1920's, may be somewhat earlier, the different governments seem to have found themselves in an ever increasing dilemma: (i) lower the export tax and face quite possibly a simultaneous revenue decrease, but thru it also obtain an increment of the probability of larger- compared to business as usual- future incomes from this source; (ii) on the other hand, stick to the existing tax and at least obtain the "sure" thing now (a way of saying since exports in that decade were highly variable). "Larger" future income to be derived from a tax cut is expected and its presently perceived magnitude, once taking into account the declining evolution of market participation experienced by the country, could have been rather slim. Adding to this the agency problem which is said to characterize governments in general when it comes to discount future income , it is not surprising that the tax was maintained.

(b) The Great Depression: a defining moment for nitrate exports?

The incidence of the Great Depression of the 1930 is put under a new light by our findings. By many accounts, see for example Cepal (1949), the depression is really a

[34] Devolution by the "Caja de Fomento Salitrero" accounted for the following percentages of revenues stemming from nitrates export tax (our data on revenues reported in this paper are therefore gross revenues): 1927, 2 percent; 1928, 21 per cent; 1929, 26 per cent. Source: Rep. de Chile Ministerio de Hacienda, Of. Presupuesto, Folleto No. 27 Noviembre 1930, " Compañia de Salitre de Chile", p.8. Devolution based on law 4.144, July 27th 1927, whose aim was to save the specific export tax established in 1880, probably under the assumption that the crisis industry was living was not permanent. Devolution itself had more of year by year discretionary character and is therefore more similar to sudden unexpected capital gains than to industry income to be included in project evaluation. The above reflection is included in the introduction to the law project creating the "Compañia Salitrera Nacional de Chile" in 1930, when also the specific export tax is repealed and a centralized sales agency is created.

defining moment in Chile's development, limiting its access to world markets and pushing the country towards inward-looking policies. The depression is seen and correctly we think, as a worldwide and completely exogenous phenomena imposing itself on this small and export oriented country. But and this is the point we want to emphasize the statement should not be turned around and simply understood as the unique cause behind export contraction. The fall in exports we argue was additionally conditioned by the domestic nitrate policy applied earlier. Our findings not only underline the convenience of a broader scenario for the discussion of the depression, they also suggests a qualitative answer: domestic public decisions or better absence of decisions were quite relevant in nitrate's collapse.[35] The outbreak of the depression probably helped in fixing the exact time point of the phenomena, but its more or less definitive character has much deeper roots.

(c) Reflections on tax stability

For about three decades from 1880 onwards did the application of the export tax generate quite satisfactory results, capturing rents and providing fiscal revenue. If the tax was the best suited policy instrument available for exploiting the opportunity offered by world demand and control of supply conditions is debatable. One may think of alternatives offering more capacity of adaptation to changing market conditions, but tax asessment and enforcement costs in general should not be forgotten when developing such an exercise. Anyway even if the conclusion of such a search would bring us to consider the nitrate tax as the best available instrument, it seems quite evident that this inference should no longer be valid after World War I.

Remember now that the tax was established in gold pesos, and that once metal's price began to change the effective tax followed it closely. Comparing the effective tax charged with a counterfactual one fixed in real dollars at the initial 1880 level, we find the first departing markedly from the second, as it can be seen in the Graph A8. Until World War I, even if non negligible fluctuations are present, the tax stays above the 75 per cent level (of 1880). A sharp decline follows and only in the second half of 1920's it climbs back to 55 per cent of its initial level.

[35] One interesting future exercise would compare public policy towards nitrates and towards copper in the 1920's, the latter an export good rapidly recovering after 1930 and at least initially taxed by a quite different and more flexible code. But this is a subject for another study

In other words, once monopoly power shows clear signs of rapid declination, the tax adjusts accordingly. This can be seen as a lucky circumstance for tax survival, but also as an additional variable to be taken into account when trying to understand why government should have hesitated with tax changes. In this sense the upward trend of the effective tax in the 20's might have been an additional factor stimulating redesign of the tax code.

Was there an alternative tax available? Strictly speaking this question may be impossible to answer here, but a look at the tax treatment received by copper, the sharply rising export activity of the 1920's may throw some light on it. Reynolds (1965) states "it is clear that taxation before 1925 was well below 5 per cent of the value of sales" (p.226). Income tax in large scale copper production was not collected until 1922. In 1925 and due to advice of the Kemmerer Mission, a 6 per cent levy on profits was added.[36]

But again the overall impression to be obtained from copper's tax experience is that government cannot have found in it a very solid argument for tax change in nitrates. As so many times in Chilean development policy, change required the presence of a really sharp depression, but it came too late.

[36] It is understood that Social Security taxes and regulations, heavily enforced in the copper sector, produced some temporal increase in the wage bill of large copper mining (op. cit., p.228). The latter could be considered as a short run tax-expenditure program with redistributive effects favoring labor in the sector.

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APPENDIX

Table A1
Chilean Nitrates 1880-1930: Basic Data (US$ 1995 per ton and shares)

	FAS Price	London Price	Tax	Cost	Freight	World Azoe Production: Chile (%)	World Azoe Production: Others (%)
1880	547,35	775,93	172,14	146,17	101,98	87,86	12,14
1881	446,37	697,06	127,80	247,13	129,11	89,18	10,82
1882	405,85	601,07	125,86	294,42	99,23	89,41	10,59
1883	371,67	554,08	134,73	287,77	101,57	88,62	11,38
1884	388,45	518,48	153,38	230,78	79,63	85,45	14,55
1885	460,97	604,37	159,95	184,91	86,96	78,30	21,70
1886	414,88	591,06	125,44	215,17	76,89	75,50	24,50
1887	363,07	563,00	136,22	213,40	82,43	79,89	20,11
1888	389,61	575,85	153,43	182,33	87,14	78,30	21,70
1889	392,73	570,37	161,98	200,91	93,07	77,90	22,10
1890	338,76	497,14	158,40	212,01	109,74	76,66	23,34
1891	374,63	536,62	133,28	214,58	106,56	72,66	27,34
1892	432,50	579,32	173,54	198,24	67,45	68,90	31,10
1893	423,94	610,41	166,64	163,88	80,73	71,03	28,97
1894	477,76	679,73	188,25	191,07	94,15	72,31	27,69
1895	423,50	582,98	179,89	256,51	86,23	73,33	26,67
1896	459,59	589,82	198,21	196,50	75,20	70,04	29,96
1897	427,25	572,31	173,70	240,12	77,56	67,49	32,51
1898	367,14	534,87	161,44	201,39	99,53	71,38	28,62
1899	357,47	523,94	169,51	196,52	90,49	71,16	28,84
1900	356,00	516,65	160,65	219,28	101,98	70,50	29,50
1901	433,57	557,70	166,45	196,35	74,90	67,53	32,47
1902	421,26	544,83	146,23	208,36	52,30	68,62	31,38
1903	417,35	548,59	149,25	257,59	44,68	70,38	29,62
1904	462,06	590,20	149,90	218,46	49,30	68,24	31,76
1905	482,86	616,26	151,29	233,24	57,11	67,68	32,32
1906	522,84	623,68	145,93	282,86	45,69	65,42	34,58
1907	506,24	585,05	135,72	330,48	37,17	62,60	37,40
1908	458,14	560,33	141,15	173,92	40,20	61,04	38,96
1909	385,67	497,70	131,14	176,86	45,73	59,61	40,39
1910	372,95	457,27	127,97	157,19	44,31	60,31	39,69
1911	431,68	524,26	137,79	172,34	49,78	57,88	42,12
1912	440,73	549,34	128,89	159,93	65,88	55,54	44,46
1913	428,87	543,98	123,91	187,23	64,22	54,32	45,68
1914	390,98	526,17	133,98	161,60	49,56	51,58	48,42
1915	379,94	616,31	127,15	170,90	166,52	33,73	66,27
1916	342,60	704,51	103,33	153,04	250,56	41,31	58,69
1917	407,96	321,80	83,20	136,31	224,01	38,38	61,62
1918	353,41	288,56	43,65	85,97	218,04	34,86	65,14
1919	285,65	219,79	55,57	123,97	164,76	30,58	69,42
1920	405,26	252,07	55,70	100,90	*43,50*	31,51	68,49
1921	423,77	478,72	76,24	130,96	*43,31*	32,31	67,69
1922	361,99	417,19	73,45	161,49	*43,12*	24,04	75,96
1923	353,47	655,70	81,46	154,96	*42,93*	32,20	67,80
1924	362,03	501,54	81,19	158,71	*42,74*	35,56	64,44
1925	332,17	347,38	86,05	*129,77*	*42,55*	33,93	66,07
1926	339,57	345,62	93,23	*122,59*	*42,36*	25,67	74,33
1927	310,74	337,91	102,24	*113,57*	*42,17*	19,52	80,48
1928	303,19	298,84	93,18	*122,64*	*41,98*	27,51	72,49
1929	286,13	298,04	95,04	*120,78*	*41,80*	24,17	75,83
1930	265,89	349,45	98,55	*117,26*	*41,61*	18,37	81,63

Estimates in cursive

Table A2
Demand Elasticities and Lerner Coefficients Simulation, 1880-1930

	Elasticity 1	Elasticity 2	Elasticity 3	Elasticity 4	Lerner Coefficient 1	Lerner Coefficient 2	Lerner Coefficient 3	Lerner Coefficient 4
1880	-1,14	-1,52	-1,97	-2,41	8,23	2,91	2,03	1,71
1881	-1,12	-1,47	-1,92	-2,36	9,24	3,11	2,09	1,73
1882	-1,12	-1,47	-1,91	-2,36	9,45	3,15	2,10	1,74
1883	-1,13	-1,49	-1,94	-2,39	8,79	3,02	2,06	1,72
1884	-1,10	-1,53	-2,02	-2,51	11,41	2,90	1,98	1,66
1885	-1,17	-1,74	-2,29	-2,83	6,85	2,35	1,78	1,55
1886	-1,25	-1,87	-2,42	-2,97	4,98	2,16	1,70	1,51
1887	-1,13	-1,67	-2,21	-2,76	8,82	2,49	1,82	1,57
1888	-1,17	-1,74	-2,29	-2,83	6,85	2,35	1,78	1,55
1889	-1,18	-1,76	-2,30	-2,85	6,49	2,32	1,77	1,54
1890	-1,22	-1,81	-2,36	-2,91	5,59	2,23	1,73	1,52
1891	-1,04	-1,80	-2,47	-3,13	26,92	2,25	1,68	1,47
1892	-1,11	-1,98	-2,67	-3,35	10,42	2,02	1,60	1,42
1893	-1,07	-1,88	-2,55	-3,22	15,93	2,14	1,64	1,45
1894	-1,04	-1,82	-2,48	-3,15	23,41	2,22	1,67	1,47
1895	-1,03	-1,77	-2,43	-3,09	37,62	2,29	1,70	1,48
1896	-1,09	-1,93	-2,61	-3,28	12,76	2,08	1,62	1,44
1897	-1,13	-2,06	-2,75	-3,45	8,49	1,95	1,57	1,41
1898	-1,06	-1,86	-2,53	-3,20	17,44	2,16	1,65	1,45
1899	-1,06	-1,87	-2,54	-3,22	16,43	2,15	1,65	1,45
1900	-1,08	-1,90	-2,58	-3,26	14,06	2,11	1,63	1,44
1901	-1,13	-2,05	-2,75	-3,44	8,54	1,95	1,57	1,41
1902	-1,11	-2,00	-2,68	-3,37	9,97	2,00	1,59	1,42
1903	-1,08	-1,91	-2,59	-3,26	13,70	2,10	1,63	1,44
1904	-1,12	-2,02	-2,71	-3,40	9,41	1,98	1,59	1,42
1905	-1,13	-2,05	-2,74	-3,43	8,70	1,96	1,57	1,41
1906	-1,03	-2,06	-2,82	-3,59	35,87	1,94	1,55	1,39
1907	-1,10	-2,21	-3,00	-3,79	11,26	1,83	1,50	1,36
1908	-1,14	-2,30	-3,11	-3,91	8,23	1,77	1,47	1,34
1909	-1,01	-2,27	-3,15	-4,03	76,54	1,79	1,46	1,33
1910	-1,16	-2,35	-3,16	-3,97	7,33	1,74	1,46	1,34
1911	-1,07	-2,38	-3,28	-4,18	14,64	1,73	1,44	1,31
1912	-1,16	-2,53	-3,47	-4,40	7,22	1,65	1,41	1,29
1913	-1,21	-2,61	-3,57	-4,52	5,78	1,62	1,39	1,28
1914	-1,04	-2,68	-3,75	-4,82	23,28	1,59	1,36	1,26
1915	-1,96	-4,45	-6,66	-8,86	2,04	1,29	1,18	1,13
1916	-1,42	-3,44	-5,06	-6,68	3,38	1,41	1,25	1,18
1917	-1,61	-3,79	-5,60	-7,42	2,65	1,36	1,22	1,16
1918	-1,87	-4,27	-6,37	-8,47	2,15	1,31	1,19	1,13
1919	-2,24	-5,02	-7,55	-10,08	1,80	1,25	1,15	1,11
1920	-2,16	-4,84	-7,27	-9,69	1,86	1,26	1,16	1,12
1921	-2,09	-4,69	-7,04	-9,38	1,92	1,27	1,17	1,12
1922	-3,04	-6,67	-10,16	-13,64	1,49	1,18	1,11	1,08
1923	-2,09	-4,71	-7,07	-9,42	1,91	1,27	1,16	1,12
1924	-1,81	-4,17	-6,21	-8,25	2,23	1,32	1,19	1,14
1925	-1,95	-4,42	-6,60	-8,79	2,06	1,29	1,18	1,13
1926	-2,81	-6,18	-9,38	-12,58	1,55	1,19	1,12	1,09
1927	-3,91	-8,46	-12,98	-17,49	1,34	1,13	1,08	1,06
1928	-2,57	-5,70	-8,62	-11,54	1,64	1,21	1,13	1,09
1929	-3,02	-6,63	-10,09	-13,55	1,49	1,18	1,11	1,08
1930	-4,20	-9,06	-13,92	-18,78	1,31	1,12	1,08	1,06

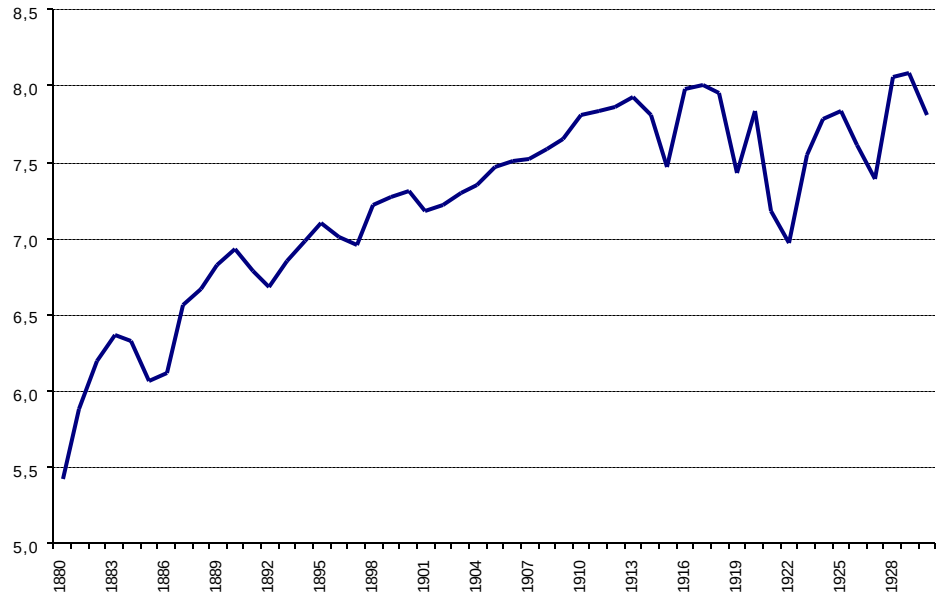
Table A3
Tax Exports and Revenue: ratios of real to optimal, 1880-1930

	Elast 1 T/T*	*Elast 2* T/T*	*Elast 3* T/T*	*Elast 4* T/T*	*Elast 1* Q/Q*	*Elast 2* Q/Q*	*Elast 3* Q/Q*	*Elast 4* Q/Q*	*Elast 1* TQ/T*Q*	*Elast 2* TQ/T*Q*	*Elast 3* TQ/T*Q*	*Elast 4* TQ/T*Q*
1880	0,06	0,24	0,44	0,65	-0,23	-1,93	19,85	1,70	-0,01	-0,46	8,82	1,10
1881	0,05	0,19	0,37	0,55	-0,19	-1,25	-6,28	2,27	-0,01	-0,24	-2,31	1,24
1882	0,05	0,21	0,41	0,61	-0,19	-1,39	-18,35	1,88	-0,01	-0,29	-7,51	1,15
1883	0,07	0,28	0,53	0,79	-0,24	-2,59	4,06	1,30	-0,02	-0,73	2,17	1,03
1884	0,06	0,34	0,66	0,99	-0,18	-6,51	2,00	1,01	-0,01	-2,23	1,33	1,00
1885	0,09	0,39	0,68	0,97	-0,33	15,00	1,84	1,03	-0,03	5,89	1,26	1,00
1886	0,11	0,37	0,62	0,86	-0,48	16,70	2,29	1,18	-0,05	6,26	1,41	1,01
1887	0,08	0,40	0,73	1,05	-0,24	14,02	1,63	0,95	-0,02	5,65	1,19	1,00
1888	0,11	0,48	0,83	1,19	-0,37	3,87	1,28	0,85	-0,04	1,86	1,07	1,01
1889	0,13	0,53	0,92	1,30	-0,43	2,78	1,12	0,79	-0,06	1,47	1,03	1,02
1890	0,19	0,71	1,20	1,68	-0,71	1,52	0,82	0,64	-0,14	1,08	0,98	1,08
1891	0,02	0,44	0,81	1,18	-0,06	5,13	1,36	0,86	0,00	2,28	1,10	1,01
1892	0,07	0,66	1,12	1,58	-0,21	1,70	0,88	0,67	-0,01	1,12	0,98	1,06
1893	0,04	0,57	1,00	1,44	-0,12	2,27	0,99	0,72	-0,01	1,29	1,00	1,04
1894	0,03	0,53	0,96	1,40	-0,08	2,70	1,05	0,74	0,00	1,44	1,01	1,03
1895	0,02	0,57	1,06	1,54	-0,05	2,31	0,93	0,68	0,00	1,32	0,99	1,06
1896	0,06	0,70	1,22	1,73	-0,17	1,54	0,80	0,63	-0,01	1,08	0,97	1,08
1897	0,09	0,72	1,20	1,68	-0,28	1,47	0,81	0,64	-0,03	1,06	0,97	1,07
1898	0,05	0,68	1,20	1,73	-0,12	1,64	0,81	0,63	-0,01	1,11	0,97	1,08
1899	0,06	0,79	1,39	2,00	-0,14	1,32	0,70	0,57	-0,01	1,04	0,97	1,13
1900	0,06	0,74	1,30	1,85	-0,16	1,42	0,75	0,60	-0,01	1,06	0,97	1,11
1901	0,08	0,66	1,09	1,52	-0,26	1,70	0,90	0,69	-0,02	1,12	0,98	1,05
1902	0,06	0,53	0,90	1,26	-0,20	2,59	1,16	0,80	-0,01	1,37	1,04	1,02
1903	0,04	0,51	0,88	1,26	-0,13	2,99	1,18	0,81	-0,01	1,51	1,04	1,02
1904	0,06	0,49	0,82	1,15	-0,20	3,18	1,32	0,87	-0,01	1,55	1,08	1,01
1905	0,06	0,48	0,79	1,11	-0,22	3,35	1,39	0,90	-0,01	1,60	1,10	1,00
1906	0,01	0,41	0,71	1,00	-0,04	5,79	1,72	1,00	0,00	2,37	1,21	1,00
1907	0,04	0,44	0,73	1,02	-0,14	3,89	1,59	0,98	-0,01	1,73	1,16	1,00
1908	0,06	0,58	0,94	1,30	-0,23	2,05	1,08	0,78	-0,01	1,19	1,02	1,02
1909	0,01	0,65	1,11	1,56	-0,02	1,69	0,88	0,67	0,00	1,10	0,98	1,05
1910	0,08	0,70	1,13	1,55	-0,29	1,51	0,87	0,67	-0,02	1,06	0,98	1,05
1911	0,03	0,64	1,07	1,49	-0,12	1,72	0,92	0,69	0,00	1,11	0,98	1,04
1912	0,07	0,63	1,02	1,41	-0,27	1,76	0,98	0,73	-0,02	1,11	1,00	1,03
1913	0,08	0,66	1,04	1,43	-0,36	1,66	0,95	0,72	-0,03	1,09	0,99	1,03
1914	0,02	0,88	1,43	1,99	-0,07	1,15	0,67	0,55	0,00	1,01	0,96	1,09
1915	0,49	1,74	2,84	3,95	3,30	0,61	0,34	0,31	1,60	1,06	0,97	1,23
1916	0,18	1,06	1,75	2,45	-1,07	0,95	0,54	0,46	-0,20	1,00	0,94	1,12
1917	0,16	0,71	1,18	1,65	-1,28	1,45	0,81	0,63	-0,20	1,03	0,96	1,03
1918	0,12	0,46	0,76	1,05	-1,53	2,61	1,50	0,95	-0,19	1,20	1,14	1,00
1919	0,30	0,97	1,58	2,19	-59,65	1,03	0,58	0,48	-17,91	1,00	0,92	1,06
1920	0,18	0,61	1,00	1,39	-3,20	1,73	1,00	0,73	-0,59	1,06	1,00	1,01
1921	0,24	0,81	1,32	1,84	-4,99	1,25	0,71	0,57	-1,19	1,01	0,94	1,04
1922	0,52	1,44	2,33	3,22	2,32	0,71	0,39	0,34	1,21	1,02	0,90	1,11
1923	0,33	1,11	1,82	2,52	95,89	0,90	0,51	0,43	31,44	1,00	0,92	1,09
1924	0,23	0,92	1,51	2,10	-3,09	1,09	0,62	0,51	-0,72	1,00	0,93	1,07
1925	0,33	1,20	1,96	2,72	-52,84	0,84	0,47	0,41	-17,50	1,01	0,93	1,12
1926	0,68	1,96	3,17	4,38	1,55	0,55	0,30	0,27	1,06	1,07	0,94	1,20
1927	1,43	3,66	5,87	8,09	0,72	0,33	0,17	0,17	1,03	1,21	1,02	1,34
1928	0,70	2,08	3,38	4,68	1,52	0,52	0,29	0,26	1,06	1,09	0,97	1,23
1929	1,01	2,80	4,52	6,24	0,99	0,41	0,22	0,21	1,00	1,16	1,00	1,31
1930	1,88	4,75	7,61	10,47	0,58	0,27	0,14	0,14	1,09	1,30	1,08	1,44

Table A4
Tax Exports and Revenue: ratios of real to optimal, 1880-1930
Only if 0< TQ/T*Q* <1,09

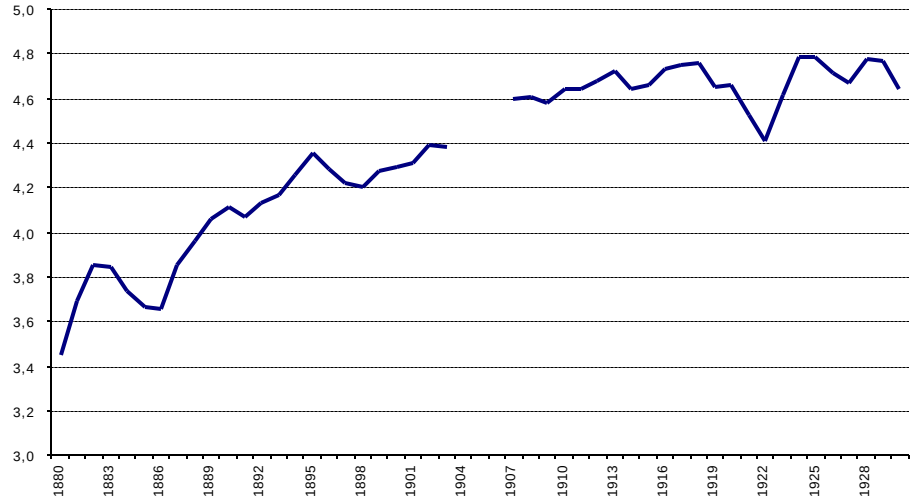
	Elast 1 TQ/T*Q*	*Elast 2* TQ/T*Q*	*Elast 3* TQ/T*Q*	*Elast 4* TQ/T*Q*	*Elast 1* T/T*	*Elast 2* T/T*	*Elast 3* T/T*	*Elast 4* T/T*
1880								
1881								
1882								
1883				1,03				0,79
1884				1,00				0,99
1885				1,00				0,97
1886				1,01				0,86
1887				1,00				1,05
1888			1,07	1,01			0,83	1,19
1889			1,03	1,02			0,92	1,30
1890		1,08	0,98	1,08		0,71	1,20	1,68
1891				1,01				1,18
1892			0,98	1,06			1,12	1,58
1893			1,00	1,04			1,00	1,44
1894			1,01	1,03			0,96	1,40
1895			0,99	1,06			1,06	1,54
1896		1,08	0,97	1,08		0,70	1,22	1,73
1897		1,06	0,97	1,07		0,72	1,20	1,68
1898			0,97	1,08			1,20	1,73
1899		1,04	0,97			0,79	1,39	
1900		1,06	0,97			0,74	1,30	
1901			0,98	1,05			1,09	1,52
1902			1,04	1,02			0,90	1,26
1903			1,04	1,02			0,88	1,26
1904			1,08	1,01			0,82	1,15
1905				1,00				1,11
1906				1,00				1,00
1907				1,00				1,02
1908			1,02	1,02			0,94	1,30
1909			0,98	1,05			1,11	1,56
1910		1,06	0,98	1,05		0,70	1,13	1,55
1911			0,98	1,04			1,07	1,49
1912			1,00	1,03			1,02	1,41
1913		1,09	0,99	1,03		0,66	1,04	1,43
1914		1,01	0,96			0,88	1,43	
1915		1,06	0,97			1,74	2,84	
1916		1,00	0,94			1,06	1,75	
1917		1,03	0,96	1,03		0,71	1,18	1,65
1918				1,00				1,05
1919		1,00	0,92	1,06		0,97	1,58	2,19
1920		1,06	1,00	1,01		0,61	1,00	1,39
1921		1,01	0,94	1,04		0,81	1,32	1,84
1922		1,02	0,90			1,44	2,33	
1923		1,00	0,92			1,11	1,82	
1924		1,00	0,93	1,07		0,92	1,51	2,10
1925		1,01	0,93			1,20	1,96	
1926	1,06	1,07	0,94		0,68	1,96	3,17	
1927	1,03		1,02		1,43		5,87	
1928	1,06		0,97		0,70		3,38	
1929	1,00		1,00		1,01		4,52	
1930	1,09		1,08		1,88		7,61	

Graph A1
Nitrate Production (log)



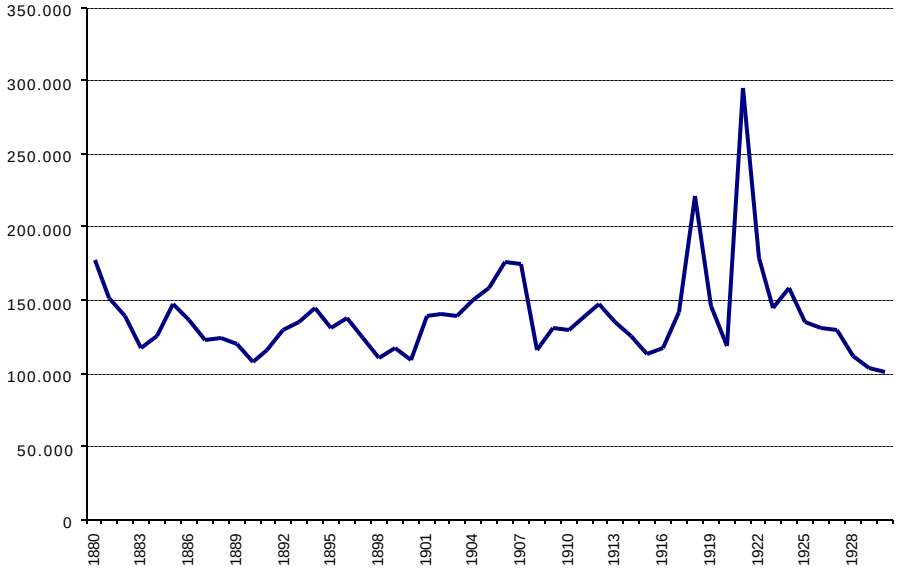
Source: Braun et.al. (2000)

Graph A2
Employees (log)



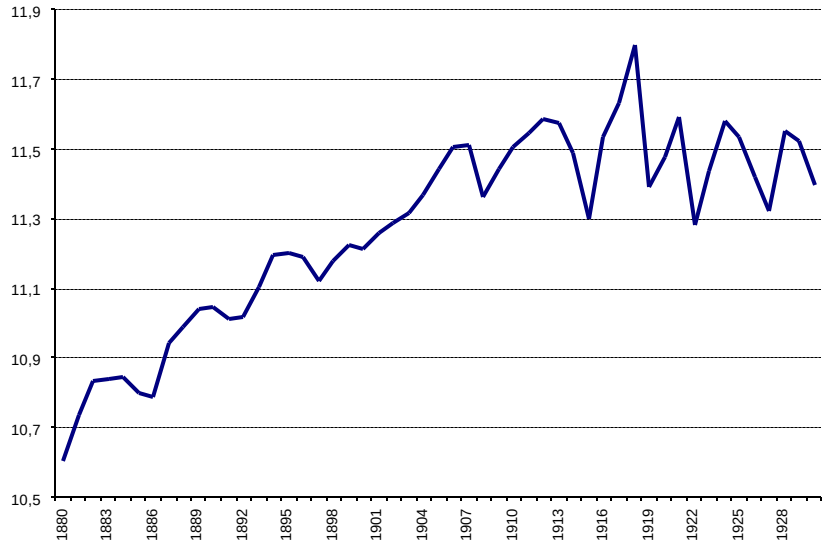
Source: Cariola y Sunkel (1982)

Graph A3
Price of Nitrate ($1995 per ton)



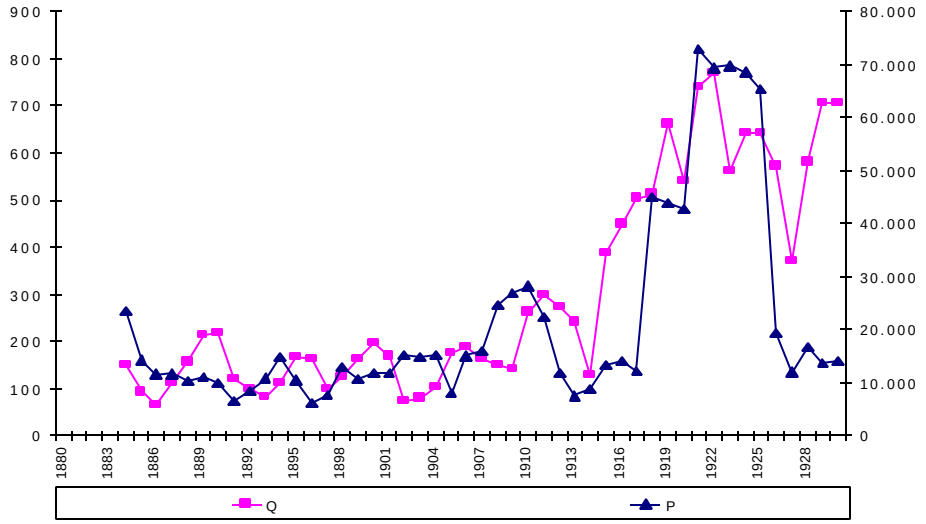
Source: Braun et.al. (2000).

Graph A4
Value of Nitrate Production (log)



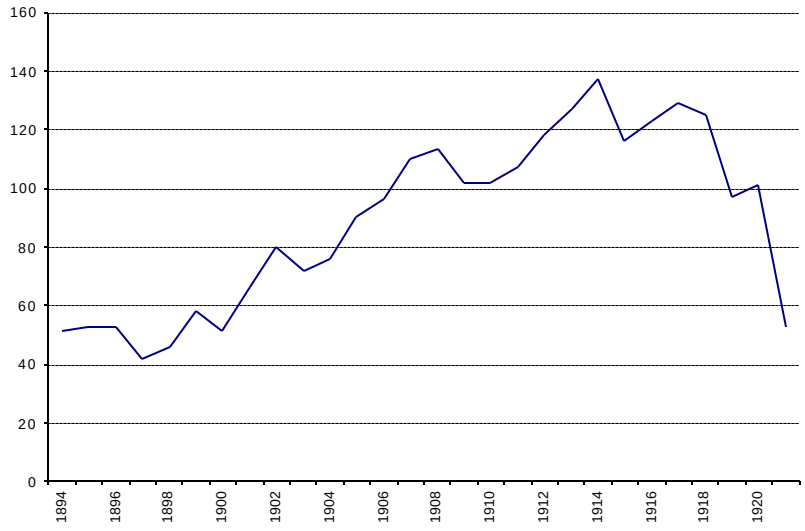
Source: Derived from price and production statistics. Braun et.al. (2000).

Graph A5
Nitrate Production and Price : Standard deviation, 1880-1930
5 years moving average



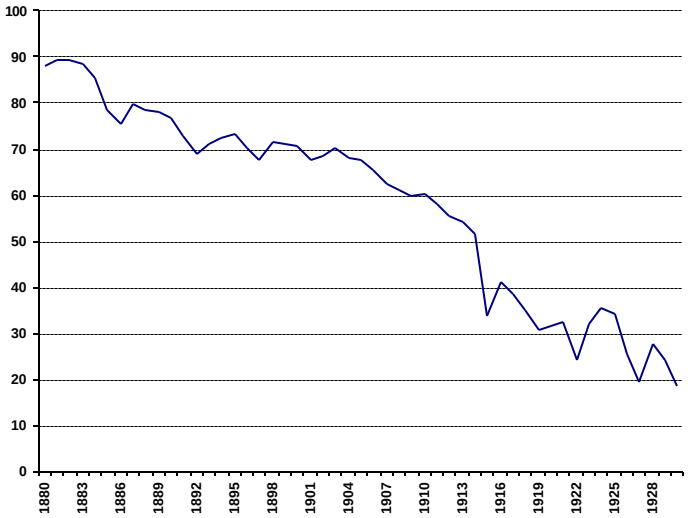
Source: Calculed from Data Appendix

Graph A6
Number of Oficinas



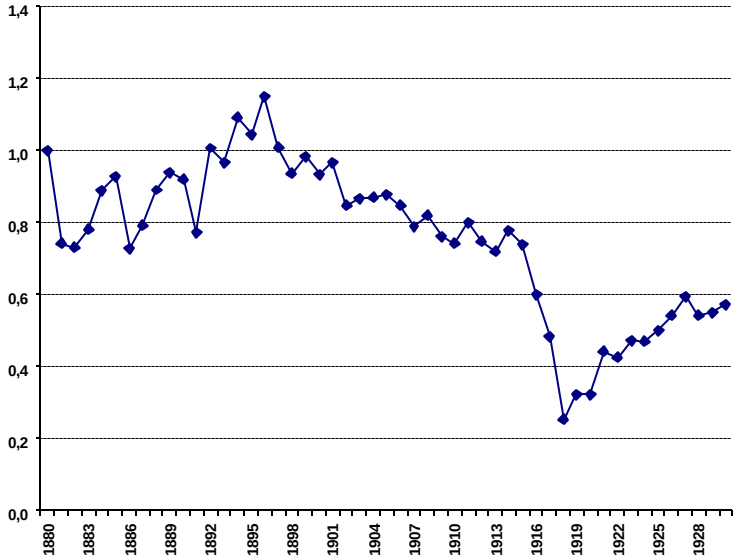
Source: Cariola y Sunkel (1982).

Graph A7
Chilean production of Azoe as percentage of World production, 1880-1930



Source: Chile. Ministerio de Hacienda: Antecedentes sobre la industria salitrera. Santiago, Universo, 1925
Chile. Ministerio de Hacienda: La Industria del Salitre de Chile. Santiago, La Nación, 1934

Graph A8
Effective Export Tax 1880-1930
(measured in units of 1880 tax level)



Source: Table A1