

ON THE ACCURACY OF CHILEAN FOREIGN TRADE STATISTICS
DURING THE NITRATE BOOM: 1870-1935

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The objective of this paper is to test the accuracy of Chilean official trade statistics for the 1870 - 1935 period. These were the years when the country experienced the nitrate boom that permitted the country to experience rapid economic growth and import socio-economic transformation.

From an economic history point of view, interest in trade statistics derives from the fact that they constitute a good basis for estimating other macroeconomic aggregates, and by themselves, they provide valuable information on the economy's performance. Works on Chilean economic history have relied on unadjusted official statistics; therefore, their conclusions need reassessment (see, for example Cortes, Butelman and Videla, 1981)

This paper has five sections. Section 1 describes typical problems encountered in foreign trade statistics. Section 2 develops accuracy tests based on origin and destination of trade flows and tests based on prices. Section 3 is a critical review of official Chilean statistics. Section 4 implements the tests developed in section 2 for the Chilean case. Section 5 summarizes the main conclusions of the paper.

1. Common Problems with Foreign Trade Statistics

The statistical agency in charge of generating the value of trade flows in any country needs to know the physical quantities traded, and the price at which commodities are traded. Trade restrictions in the form of (a) export and import taxes, (b) export and import licenses, (c) export and import quantity restrictions, and (d) export and import market imperfections lead to smuggling as well as false reporting by merchants to either the customs agency and/or the statistical agency. In the case of exports, the higher the difference between the destination price and the domestic price, the higher smuggling and false reporting of prices. In the case of imports the higher the difference between the domestic price and the price of origin, the higher smuggling and false reporting of prices.

Customs authorities try to solve these issues in several ways that end up generating incorrect measurements of the trade flows. Smuggling is legally penalized, but the smugglers compare expected penalties to expected profits, and if the equation shows profits, smuggling continues. In the case of exports, goods leave from unauthorized ports and it becomes practically impossible to estimate the quantity being smuggled. In the case of imports, goods enter the country through unauthorized ports and they rapidly disappear making it equally difficult to estimate the quantity being smuggled.

In order to solve faulty price reporting, customs authorities may decide to establish tables of export and import prices. These "customs prices" become the basis on which taxes are levied and the physical flows are valued. There is no reason to expect that "customs prices" correspond to domestic or international market prices; moreover, they may have reflected those values at one point in time, but if they are not regularly updated, they do not reflect the market value of the trade flows. In addition, given that these "customs prices" are the basis for trade taxes, they are subject to intense lobbying by exporters and domestic producers making it almost impossible for them to reflect the actual market value of the flows. Finally, the establishment of "customs prices" does not eliminate the problem of smuggling.

Market imperfections in the form of monopolistic or oligopolistic market structure can also produce faulty evaluation of trade flows. A good example is OPEC where members agree to production quotas, cheating in the volume of oil exports has been reported more than once.

In addition to trade restrictions, there are problems arising from the unit of account used to value trade flows. The perfect unit of account would be a unit that allows intertemporal comparisons without the problems derived from changes in purchasing power of the unit chosen. It is possible to construct such a unit, for example British pounds, French francs, or US dollars with purchasing power of 1913; the problem with these units lies on the price index used to transform current values into values of 1913.

An alternative to the use of an arbitrary price index lies on expressing all goods in terms of their relative price with respect to one commodity, for example, gold. Although not a perfect solution, this procedure is easy to implement during the years covered by this paper.

During the Gold Standard years -1870 to 1914-, the countries that carried most of the world trade had currencies convertible in gold, easily converted into one another. However, important countries were not in the gold standard: China, India and Mexico, for example, were under a silver standard, while many Latin American countries had paper money. However, if exchange rate markets are free and competitive, and there is free capital mobility, the problem of different standards is easily solved due to the availability of exchange rate quotations for almost all currency during the period.

However, when the exchange rate market is not free, and there are restrictions to capital mobility and restrictions to specie exports, the situation becomes more complex. During WWI, Britain, France and Germany abandoned convertibility and established severe restrictions on specie exports, thus exchange rates need to be carefully adjusted to reflect the true gold content their currencies. A more difficult problem arose after 1929, when several countries adopted multiple exchange rate regimes; under these conditions it becomes extremely complicated to correctly value trade flows. Finally, the default on external debts during the 1930's led countries to establish bilateral compensation agreements that makes it almost impossible to value trade flows.

2. Accuracy Tests

Given that Chile levied taxes on exports and imports, it is not possible to *a priori* ascertain the accuracy its trade flows. In order to establish the accuracy of trade statistics, it is possible to implement two types of tests on Chilean official statistics. The first test is based on the origin and destination of trade flows, and the second on the prices of the trade flows.

2.1 Tests Based on the Origin and Destination of Trade Flows

These tests result from the fact that exports from one country constitute imports in another country or countries. Thus, foreign trade statistics offer the possibility of double-checking the registration of each shipment. Therefore, is possible to construct an "accuracy index" by comparing trade flow records for pairs of countries. Formally,

$$(1) \quad XAI_{i,j} = [X_{i,j}/(M_{j,i}*\pi_{j,i})] * 100$$

$$(2) \quad MAI_{i,j} = [M_{i,j}/(X_{j,i}*\pi_{j,i})]*100$$

Where $XAI_{i,j}$ is the accuracy index for exports of country i with respect to country j , $X_{i,j}$ are total exports registered by country i destined to country j , and $M_{j,i}$ are total imports registered by country j as coming from country i . $MAI_{i,j}$ is the accuracy index for imports of country i from country j , $M_{i,j}$ are total imports registered by country i as coming from country j , and $X_{j,i}$ are total exports registered by country j destined to country i . Trade flows have to be expressed in the same currency, $\pi_{j,i}$ represents the units of country j currency per unit of country i currency.

Zuckermann (1921), Morgenstern (1950), Federico and Tena (1991), Tena (1992), van Bergeijk (1995), Makhoul and Otterstrom (1998), Kuntz (2002), among others, have shown that this double counting procedure is far from perfect: the accuracy indexes are not equal to 100. There are two obvious reasons for the lack of "perfect accuracy:" (i) geographical allocation of trade flows is not always correct, and (ii) prices at origin are different from prices at destination due to freight, insurance, cost of ports, and market imperfections. In this section concentrates on trade allocation problems. Statistical agencies have followed different methods to geographically allocate trade flows: (i) allocation in terms of port of origin and port of destination instead of actual source or actual final destination of the goods, and (ii) allocation of exports and imports according to the country of

registration of the vessel. Britain, for example, used both procedures. The Annual Statement of 1910, p vi, states that "The countries whence goods are consigned are not in all cases the countries of actual origin, since the goods produced in one country may be purchase by a firm in another country and thence dispatched, after a longer or shorter interval to the United Kingdom. In such case the second country would be the country of consignment, to which the goods would be recorded." The Annual Statement of 1897, p. ix, states "Switzerland, Bolivia, the South African Republic, and the Orange Free State, having no seaboard, do not figure in the returns at all. It has been found impracticable to distinguish Merchandise imported from these States, and such Merchandise is therefore credited to the country containing the port of shipment," and more important in this case, "Goods from Chile and Peru are largely transshipped at Colon on the isthmus of Panama. In all these cases the goods are, so far as possible, credited to the country of original shipment instead of the Republic of Colombia." Regarding exports, the same publication states in p ix: "Exports are, as a rule, credited in the tables to the country of ultimate destination as declared by the exporter in their entries. Exports, however, to Switzerland, Bolivia, the South African Republic and the Orange Free State, which possess no seaboard, are credited to the country which the port of discharge is situated, some assigned the trade flows to the country of registration of the vessel."

These are two more allocation issues: (i) border changes are not immediately recognized by statistical agencies, e.g.: Britain, France, Germany, and the United States did not recognize the border changes between Chile, Bolivia and Peru that took place in 1880 until 1889. (ii) the definition of the trade flows is not always consistent, in the Chilean case sales of domestic goods to foreign vessels was not consider an export until 1929.

Given these problems, Federico and Tena (1991) have concluded that bilateral accuracy indexes can at best measure whether trade flows have been properly allocated geographically. In order to solve some of the problems discussed above they propose an aggregate index of accuracy. This index takes into account most of the trade partners of a particular country, the comparison is then among total trade flows and thus it will tend to eliminate some of the distortions resulting from inaccurate geographical allocation. The proposed index is

$$(3) \quad AXAI_i = \left[\frac{\sum_{j=1}^n X_{i,j}}{\sum_{j=1}^n M_{j,i} * \pi_{j,i}} \right] * 100$$

$$(4) \quad AMAI_i = \left[\frac{\sum_{j=1}^n M_{i,j}}{\sum_{j=1}^n X_{j,i} * \pi_{j,i}} \right] * 100$$

$AXAI_i$ stands for the aggregate exports accuracy index for country i ; $\sum_{j=1}^n X_{i,j}$ is the sum of total exports from country i to its n trade partners, and $\sum_{j=1}^n M_{j,i}$ is the sum of total imports by the n trade partners of country i from country i . $AMAI_i$ stands for the aggregate imports accuracy index fo country i ; $\sum_{j=1}^n M_{i,j}$ is the sum of total imports by country i from its n trade partners, and $\sum_{j=1}^n X_{j,i}$ is the sum of total exports from the n trade partners of country i to country i .

Even when trade flows are properly allocated from a geographical point of view, the numerator and denominator of expressions (1) to (4) will differ due to the "freight factor," i.e., the difference between FOB and CIF prices. In principle, the CIF/FOB difference could be estimated for most commodities; however, the large number of combinations of goods and destinations make these calculations insurmountable. Tena (1992), based on calculations of the "freight factor" for eight countries that constituted 50 per cent of world trade, suggests that for "perfect accuracy" the aggregate accuracy index lies in the 90 to 100 range for exports, and the 100 to 110 range for imports. For "good accuracy," the aggregate accuracy index lies in the 80 to 100 range for exports, and in the 100 to 120 range for imports.

2.2 Tests Based on the Pricing of Trade Flows

This section develops a test to check the pricing methods followed by customs/statistical agencies. Although the tests are symmetric, the first is to be applied to exports, and the second to import.

3.2.1 Test for Export Prices

Normally exports are valued at FOB prices. From an accounting point the FOB price of a given good in a given country plus the "freight cost" is equal to the CIF price in another country. Loosely following Persson (2002), the price difference for a given good, say barley, in London and in Chile must be equal to the sum of the transportation costs, TR, insurance, I, port costs in both countries, PC_{London} and PC_{Chile} , possible quality differences, QUAX, and a residual, RES:

$$(5) \quad P^{\text{British Barley}}_{\text{London}} - P^{\text{Chilean Barley}}_{\text{Chile}} = TR + I + PC_{\text{Chile}} + PC_{\text{London}} + QUAX + RES$$

The residual could be the consequence of market imperfections, and faulty arbitrage due to slow information flows, for example. Quality differences could be measured in terms of price difference of British and Chilean barley in the same market:

$$(6) \quad QUAX = P^{\text{British Barley}}_{\text{London}} - P^{\text{Chilean Barley}}_{\text{London}}$$

Substituting (6) into (5) we obtain the following equality:

$$(7) \quad P^{\text{Chilean Barley}}_{\text{London}} - (TR + I + PC_{\text{London}}) = P^{\text{Chilean Barley}}_{\text{Chile}} + (PC_{\text{Chile}} + RES)$$

Equation (7) shows two ways for calculating the FOB price of barley in Chile: the left hand side starts from the British price and the right hand side from the Chilean side. Let's call the left hand side FOB price London, $P^{\text{FOB}}_{\text{London}}$, and the right hand side FOB price Chile, $P^{\text{FOB}}_{\text{Chile}}$.

In order to test whether the price used by the customs/statistical agency was correct, the following test can be performed:

$$(8) \quad \begin{array}{ll} \text{(i)} & P^{\text{Barley}}_{\text{Chilean Statistics}} / P^{\text{FOB}}_{\text{Chile}} = 1 \\ \text{(ii)} & P^{\text{Barley}}_{\text{Chilean Statistics}} / P^{\text{FOB}}_{\text{London}} = 1 \\ \text{(iii)} & P^{\text{FOB}}_{\text{London}} / P^{\text{FOB}}_{\text{Chile}} = 1 \end{array}$$

Measurement errors plus the fact that the actual value of RES is not zero -the expected value of RES is zero- imply that conditions (i) to (iii) are not always fulfilled. However, if these ratios follow stationary processes whose means reverts to one, it is likely that the statistical agency consistently valued exports at FOB prices. Moreover, it is possible to establish limits on the variation of these ratios: for example, variations greater than \pm one standard deviation from the mean require price corrections.¹

2.2.2 Test for Import Prices

Normally, imports are valued at CIF prices. From an accounting point of view, the difference between price at destination and price at origin is also the "freight cost":

$$(9) \quad P^{\text{Chilean Cloth}}_{\text{Chile}} - P^{\text{British Cloth}}_{\text{London}} = TR + I + PC_{\text{London}} + PC_{\text{Chile}} + QUAM + CTR + RES$$

¹ In this example, the price of barley in Chile is inclusive of export taxes.

QUAM states possible quality differences between cloth produced in Chile and cloth produced in London; CTR reflects the cost of trade restrictions, and it could be thought of as the implicit import tariff.² As in the case of exports,

$$(10) \quad \text{QUAM} = P^{\text{Chilean Cloth}}_{\text{Chile}} - P^{\text{British Cloth}}_{\text{Chile}}$$

Substituting (10) into (9), we obtain the following equality:

$$(11) \quad P^{\text{British Cloth}}_{\text{Chile}} - (\text{PC}_{\text{Chile}} + \text{CTR} + \text{RES}) = P^{\text{British Cloth}}_{\text{London}} + (\text{TR} + \text{I} + \text{PC}_{\text{London}})$$

Equation (11) represents two ways of estimating the CIF price of cloth in Chile: the left hand side starts from Chile and the right hand side from London. Let's call the left hand side CIF price Chile, $P^{\text{CIF}}_{\text{Chile}}$, and the right hand side CIF price London, $P^{\text{CIF}}_{\text{London}}$.

In order to test whether the price used by the customs/statistical agency was correct, the following tests can be performed:

$$(12) \quad \begin{array}{ll} \text{(i)} & P^{\text{Cloth}}_{\text{Chilean Statistics}} / P^{\text{CIF}}_{\text{Chile}} = 1 \\ \text{(ii)} & P^{\text{Cloth}}_{\text{Chilean Statistics}} / P^{\text{CIF}}_{\text{London}} = 1 \\ \text{(iii)} & P^{\text{CIF}}_{\text{London}} / P^{\text{CIF}}_{\text{Chile}} = 1 \end{array}$$

Measurement errors plus the fact that the actual value of RES is not zero -the expected value of RES is zero - imply that conditions (i) to (iii) are not always fulfilled. However, if these ratios follow stationary processes whose means reverts to one, it is likely that the statistical agency consistently valued imports at CIF prices. Moreover, it is possible to establish limits on the variation of these ratios: for example, variations greater than \pm one standard deviation from the mean require price corrections.

2.2.3 Difficulties in Implementing Price Tests

Perhaps one of the most serious shortcomings of these tests arises from the distance between origin and destination: the longer this distance, in general, the higher transportation and insurance costs. Therefore, Chilean exports of low value goods -mainly agricultural- may have not gone to Europe or the United States, but to some closer destination. An incorrect allocation of export flows will give the wrong destination price. Secondly, when destination is not a big international market -London, New York, Hamburg- it is practically impossible to obtain prices at destination. Thirdly, freight information for routes different from the main world hubs is very difficult to obtain.

In the case of imports, aside from the problem the proper identification of the origin, the price in Chile of foreign goods is not available for most imported goods. Moreover, imports are not concentrated in a few relatively homogeneous products, but they constitute a myriad of commodities.

3. Chilean Foreign Trade Statistics: A Critical Review

In 1844, the Chilean government began to publish regular foreign trade statistics. The publication was called *Estadística Comercial de la República de Chile* and it run from 1844 until 1915. Starting in 1916 foreign trade statistics were included in the *Anuario Estadístico de la República de Chile* under the same format as *Estadística Comercial*. The data comes from the returns of the customs agency.

² An implicit import tariff could be an explicit import tariff, the cost of licences, the cost of prior deposits and their summation.

Chilean customs returns are a reliable source for trade statistics, at least with respect to quantities. This fact is the result of an early institutional development that made graft and corruption severely prosecuted and punished. The press, which was very liberal, did not comment on widespread smuggling scandals. In addition, Chile's particular geographical configuration makes smuggling of large quantities of goods difficult.

From 1870 to 1878, Chilean economic activity took place in the center of the country, which had an approximate length of 1500 kilometers and approximate average width of only 190 kilometers. To the east of the country the formidable Andean mountains, reaching an average height of 6000 meters, constitute a natural barrier with Argentina; there were very few mountain passes, all of them at high altitudes. To the west, the coastal range reaches 3000 meters, and it abruptly drops in to the Pacific Ocean. There are very few natural ports on this turbulent coast. Valparaíso, Concepción, and Talcahuano were the only ports capable of handling large volumes of grain and general cargoes. In both ports there were well-established customs offices.

After the War of the Pacific, 1879 - 1883, Chile added 850 kilometers in length to the north, with about the same width as before. These new territories constitute a driest desert in the world –Atacama desert- and they are rich in minerals, in particular, nitrate, and copper. To the east the Andes, higher than in the central part of the country, become a barrier with Bolivia. To the west, the coastal range drops in a cliff of 1000 meters in to the Pacific Ocean, leaving an extremely narrow seaboard of less than 1 kilometer. There are three main ports connecting the desert with the sea: Pisagua, Iquique and Antofagasta. From 1880 to 1928, the main export of the country was nitrate, and the most important source of revenue for the government was the export tax on nitrate; well established and manned customs offices functioned in these ports and even in smaller ones.

After 1880 Chile began the occupation of the western Patagonia adding another 2000 kilometers in length to the south of Puerto Montt, with approximately the same width as the original settlement. This region was only accessible by sea, and its main production was wool and frozen lamb meat.

In terms of the unit of account, Chile had a bimetallic standard from 1817 to 1878, a paper currency regime from 1878 to 1924, the gold standard from 1925 to 1931, and a multiple exchange rate regime from 1931 to 1935. Under the original bimetallic standard, the gold par value of the Chilean peso was 45d or \$ 5.00 per British pound. Due to the overvaluation of silver by the Chilean Mint, the exchange was above 45d. The decline of the price of silver that began in 1875 moved the country to a *de facto* silver standard, and the exchange rate depreciated with respect to gold-based currencies. The abandonment of specie convertibility in 1878 resulted in further exchange rate depreciation. From 1895 to 1898, there was a short-lived gold standard; the parity was set at 18d per peso or \$ 13.33 per British pound. After the abandonment of the gold standard until 1925, the Chilean peso continued to depreciate. In 1925 the gold standard was adopted for a second time, the exchange rate was set at 6d per peso or \$ 40 pesos per British pound. In 1931, the standard was abandoned and a multiple exchange rate regime was implemented. As we will see below, the Chilean statistical office dealt with these exchange regime changes in different ways during the period.

The following sections describe the accounting methods for exports and imports, the results of the accuracy tests performed, and they provide alternative series for aggregate exports and imports for the 1870 - 1935 period.

3.1 Exports

During the nitrate boom, nitrate, and copper were the main exports followed by iodine, a sub product in the elaboration of nitrate, and silver. Agricultural exports had been important prior to 1879, in particular, wheat, flour of wheat, and barley, but they lost importance as the period unfolded. Wool,

produced in the extreme south of the country, became an important export commodity by the 1890's. The share of agricultural exports in total exports declined significantly during the Nitrate Boom.

If smuggling was not a serious problem, there are three aspects that impinge upon testing the accuracy of exports: destination of exports, unit of account, and prices.

3.1.1 Destination of Exports

From 1870 to 1903 *Estadística Comercial* computed the destination of exports in terms of the destination of the vessel. This procedure does not take into account the problem of transshipment: ships going to London, for example, might have carried cargoes whose final destination was France, Germany or Mediterranean ports. The publication acknowledges that it is practically impossible to deal with countries without coasts like Switzerland. In some instances, the allocated destination was the country of registration of the vessel, although this procedure was not accepted by the customs by-laws.

For the years 1902 and 1903 *Estadística Comercial* published both, the destination of the vessel and final destination of the shipment. The share of exports to Britain was greatly reduced when using the second accounting method. Starting 1904 the destination of exports seems to be computed in terms of the final destination of the shipment.

From 1914 to 1921 and from 1929 to 1935 a large percentage of nitrate exports were *a la orden*, meaning without destination at the time of the shipment.

3.1.2 Unit of Account for Exports

From 1844 until 1884, *Estadística Comercial* valued exports in current pesos. As mentioned above, from 1844 to 1875 the Chilean peso had a stable exchange rate against the British pound, thus the unit of account represents a currency with a stable gold content. The authorities established in 1879 that import and export taxes had to be paid in pesos of 38d or \$ 6.32 per British pound. Exports began to be expressed in this unit of account in 1885. In order to obtain the conversion from current pesos into pesos of 38d the statistical office used the monthly average exchange rate. Therefore, the value of exports is expressed in a fictional unit of constant gold content.

From 1898 to 1925 the statistical office published the export series in pesos of 18d. By the end of 1898 the actual exchange rate was 12.75d per peso, therefore, this unit of account was a new fictional unit that expressed exports in gold terms until 1914. As in the previous period the monthly average exchange rate was used to transform current pesos in to pesos of 18d.

There was not change in the procedure to value exports during WWI. However, Britain was on gold during the war until 1922, and the British pound depreciated in gold terms. The implication for Chilean statistics was that from 1916 to 1922 the unit of account, peso of 18d, had a lower gold content than before 1914. Once the pound was back to convertibility, the gold content was reestablished.

Chile adopted the gold standard in 1925, and from 1926 onwards the statistical office published export series in pesos of 6d or \$ 40 pesos per British pound. Once Britain abandoned the gold standard, Chile defined its currency in terms of the gold equivalent of 6 d prior to the September 1931, i.e., 0.1830595 grams of fine gold. In 1932, Chile abandoned the gold standard, and adopted a system of multiple exchange rates: there was an official rate and an export rate for all exports except copper, nitrate, and iodine that went with the official rate. The statistical office continued to express trade flows at the rate of 0.1830595 grams of fine gold and call it gold pesos of 6d. The transformation of current pesos into this fictional rate was done at the official exchange rate set by the Chilean Central Bank.

Table 2 summarizes the unit of accounts for exports used by the statistical office from 1870 to 1935.

Table 2. Units of Account for Exports Used by Chilean Statistical Office

Period	Unit of Account
1870 - 1884	Current Chilean Pesos
1885 - 1897	Pesos of 38d
1898 - 1925	Pesos of 18d
1926 - 1935	Gold Pesos of 6d

3.2.3 Export Prices

From 1870 to 1928 the statistical office used the price in Chile for valuing exports. The office used the monthly average exchange rate to transform these prices into the going unit of account from 1885 to 1928. These prices did not include the cost of portage, but they included the transport cost from the interior of the country to the dispatching port.

Starting in 1929 the statistical office began to value exports in FOB terms. In order to do so they took the going international prices for export goods in London or New York and deducted from them the CIF component to reach the FOB price in Chile. These prices, expressed in foreign currencies, were transformed in the unit of account using the exchange rate between the British pound and the Chilean peso, when Britain left the gold standard the currency used was the US dollar, and after the US left the standard the currency used was the French franc.

From 1870 until 1895 the export of silver bars were priced in nominal terms, i.e., in terms of fine silver content of a silver Chilean peso coin of \$ 1.00. This content was 22.5 grams; therefore, the price of silver used by the statistical office was \$ 0.044 per gram, regardless of the unit of account. In 1895-1897, the price was \$ 0.05 per gram. Starting in 1899 the white metal began to be valued at market prices.

Nitrate became a special case in the 1930's. The nitrate market collapsed in 1929/30 and the Chilean government took over the operation of most of the industry through the *Corporación de Salitre de Chile* that later became *Corporación de Ventas de Salitre de Chile*. These institutions fixed the price at which they sold nitrate in London and New York. But sales by this corporations did not represent the whole industry and the price quoted does not represent the price in London or New York. The statistical office hesitated between the market price and the "official" price and published data with using one or the other without giving any explanation.

3.2 Imports

Like in any country, imports constitute a myriad of all types of goods. The formidable expansion of the railroad network -it expanded from 1600 kilometers in 1870 to 8600 kilometers in 1925- required large imports of railroad material for its construction and operation. The expansion of the nitrate industry required coal, crude oil, and jute sacs, and the general expansion of the economy raised the demand for an increasing quantity of intermediate and consumption goods.

Arms and military supplies during the War of the Pacific and afterwards were not included in the official statistics. We have not found on the imports statistics the cost of two dreadnoughts bought by the Chilean navy from Britain in the 1890's.

Imports of commercial ships were also not included in the statistics. (Estadística Comercial, 1880)

As in the case of exports, assuming that smuggling was not serious problem, there are three aspects that impinge upon testing the accuracy imports: origin of imports, unit of account, and prices.

3.2.1 Origin of Imports

From 1870 until 1903, *Estadística Comercial* allocated imports to the country of the port of origin of the vessel. As in the case of exports, this procedure does not considering transshipment, and thus the share of Britain in total imports is greatly exaggerated.

In 1902 and 1903 *Estadística Comercial* shows the origin of imports in terms of origin of the vessel and actual origin of the goods. Starting in 1904 imports are allocated according to the country of origin of the goods, if it were known, otherwise the port of origin of the vessel is used as origin.

3.2.2 Unit of Account

From 1870 until 1879, *Estadística Comercial* valued imports at current prices. The depreciation of the Chilean peso from 1876 to 1879 implies that in those three years imports do not represent the same amount of gold per peso than in the previous five.

From 1880 to 1897 imports are expressed in pesos of 38d. From 1898 to 1925 the unit of account for imports was pesos of 18d, with the same provisos already discussed for exports. And from 1926 to 1935 they were valued in pesos of 6d with gold content of 0.1830595 grams, with the same provisos already discussed for exports.

Table 3 summarizes the unit of accounts for imports used by the statistical office from 1870 to 1935.

Table 3. Units of Account for Imports Used by Chilean Statistical Office

Period	Unit of Account
1870 - 1879	Current Chilean Pesos
1880 - 1897	Pesos of 38d
1898 - 1925	Pesos of 18d
1926 - 1935	Gold Pesos of 6d

3.2.3 Import Prices

The Chilean customs office followed the Continental practice of establishing official import prices. In the French version, probably the model for Chile, the *Commission de valeurs en doune* set import prices according to French market conditions; the *Commission* regularly updated these prices. In the Chilean case a commission formed by two high level customs officials, merchants from Valparaiso, and starting in 1884 a representative of Sofofa, Chilean Industrialist Association, established the *tarifa de avalúos* or import prices. Taxes on imports were based on these import prices. The Chilean customs office did not regularly update import prices regularly, therefore, often import prices did not represent the going market prices. In addition, the assimilation of actual goods to the *Tarifa de Avalúos* was not exact because the items in the *Tarifa* were far less than the diversity of imported goods.

Table 4 shows the years when a new *Tarifa de Avalúos* was compiled and the year when it began to be implemented.

Table 4. *Tarifa de Avalúos*

Year	
1863	Implemented in 1863 valid until 1873
1872	Implemented in 1873 valid until 1875 reformed in 1876 and valid until 1879
1879	Implemented in 1880, reformed in 1884 and valid until 1887
1887	Implemented in 1888 valid until 1897
1894/95	Implemented in 1898 valid until 1903
1903	Implemented in 1904 valid until 1907
1907	Implemented in 1908 valid until 1916

It is interesting to transcribe a couple of comments on the measurement problems generated by the *Tarifa de Avalúos*. The editor of the *Estadística Comercial* (p ix, 1877) in 1877 states that "The actual value of goods dispatched for domestic consumption is greater than the value calculated according to the *tarifa de avalúos*, the excess could be estimated in twenty-five percent." The editor went on to say that this underestimation had been going on for one decade. The *Memoria de la Superintendencia de Aduanas* from 1899, p 35, states, "The decret from November 25, 1898 declared that the actual *Tarifa de Avalúos* will be implemented in 1899. It seems that the *Tarifa* will not be reformed this year -1899- and that it will continue to be applied without any modification in 1900. This process is very inconvenient because it maintains a *Tarifa* that is excessively erroneous. [...] Today's *Tarifa* is the same as the one from 1887, except that the values are expressed in pesos of 18d instead of the imaginary currency of 38d."

In 1916 the system was radically changed. Imports would be valued according to the invoice, which needed to be validated by the Chilean consul in the place of origin; at the same time, all import taxes became specific, i.e., based on the quantity imported rather than on the price. This new system effectively priced imports at their FOB price at origin.

In 1929 a new change took place when imports had to be priced at CIF prices Chile. In order to do this the customs office required the original invoice validated by the Chilean consul in the place of origin and added to this number freight, insurance and commission costs.

4. Accuracy Tests

We have conducted accuracy tests based on the destination of exports and origin of imports as well as tests based on export and import prices. In order to perform these tests we adopted a uniform unit of account: Gold Pesos with a gold content of 0.5491785 grams of fine gold, this unit corresponds to the "peso of 18d." Therefore, all series are in gold terms; note that this does not mean constant purchasing power because the price of gold varied during the period.

The transformation of the unit of account used by the Chilean statistical office into Gold Pesos was performed using the exchange rate for the period 1870 to 1884 in the case of exports and 1870 to 1879 in the case of imports. One peso of 38d is equivalent to 2.11 pesos of 18d, and one peso of 18d is equivalent to 3 pesos of 6d.

In order to obtain Gold Pesos at the times when the British pound was not on gold, we used the Swiss franc as the pivotal exchange rate to find the value of the Gold Peso. This procedure is simple because the Swiss franc was freely convertible into gold from 1913 to 1935, and it was not devalued during the 1920's.³ Table 4 shows the exchange rate between the pesos of 18d and gold pesos from 1914 to 1935.

³ Switzerland abandoned the gold standard in September, 1936.

Table 4. Exchange Rate between Pesos of 18d and Gold Pesos

Year	Pesos of 18d per Gold Peso	Swiss Franc per British Pound
1914	1.0000	25.2650
1915	1.0000	25.3878
1916	1.0126	24.9075
1917	1.1074	22.7750
1918	1.2072	20.8925
1919	1.0815	23.3200
1920	1.1632	21.6825
1921	1.1370	22.1825
1922	1.0867	23.2075
1923	1.0000	25.3100
1924 - 1928	1.0000	24.9710 ⁽¹⁾
1929	1.0000	25.1900
1930	1.0056	25.0800
1931	1.0080	23.3500
1932	1.3981	18.0400
1933	1.4723	17.1300
1934	1.6209	15.5600
1935	1.6724	15.0800

⁽¹⁾ Average quotation for the period.

Source for the Swiss franc exchange rate: *Statistisches Jahrbuch der Schweiz*

4.1 Implementation of Tests Based on the Origin and Destination of Trade Flows

This section describes the implementation of accuracy tests based on the destination of exports and origin of imports. The tests used are the AXAI and the AMAI. The sample of trade partners to implement these tests includes Chile's major trade partners and the country's three neighboring countries, Peru, Bolivia, and Argentina. Unfortunately, complete statistics are not available for all the countries for the whole period, although Chilean export statistics are available for all the countries in the sample for the whole period. Table 5 shows the years for which trade partners identify Chile as separate country or for which there are national trade statistics.

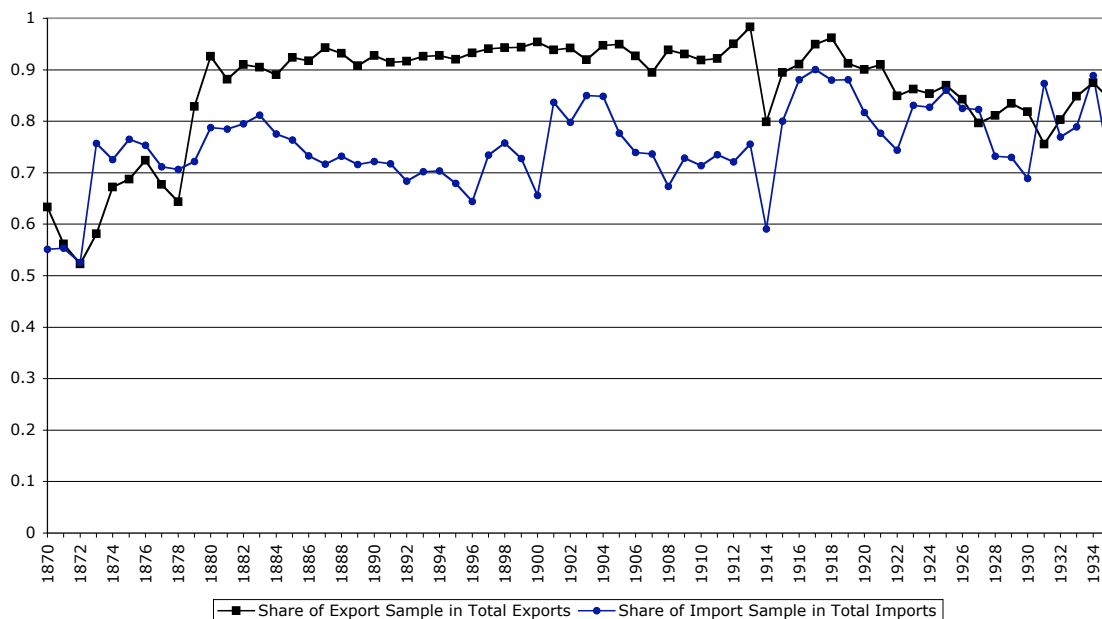
Table 5. Trade Partners Availability of Statistics

Country	Exports	Imports
Argentina	1870 - 1935	1870 - 1935
Belgium	1875 - 1913, 1920 - 1921, 1923 - 1935	1875 - 1913, 1920 - 1921, 1923 - 1935
Bolivia	1912 - 1933, 1935	1912 - 1933, 1935
Brazil	1902 - 1935	1902 - 1935
France	1873 - 1935	1873 - 1935
Germany	1880 - 1913, 1923 - 1935	1880 - 1913, 1923 - 1935
Italy	1894 - 1935	1898 - 1935
Netherlands	1912 - 1935	1912 - 1935
Peru	1897 - 1935	1897 - 1935
Spain	1911 - 1935	1911 - 1935

United Kingdom	1871 - 1935	1870 - 1935
United States	1870 - 1935	1870 - 1935

Figure 1 shows the sample's share in the official exports and imports statistics. For the first decade the sample's share is below eighty per cent for both aggregates. From 1880 until WWI the share of the exports sample is above ninety percent, and the share of the imports sample is in between seventy and eighty percent. After WWI the sample's share of exports stays below ninety percent and that for imports above eighty percent.

Figure 1: SHARE OF SAMPLE IN TOTAL EXPORTS AND IMPORTS



4.1.1 Aggregate Accuracy Index for Exports

Figure 2 depicts the Aggregate Accuracy Index for Exports. For the first five years, 1870 - 1875, the index stays below the perfect accuracy range. One explanation for this behavior is the fact that foreign partners wrongly recorded nitrate imports as Chilean exports; however, at that time only Peru and Bolivia produced and exported nitrate, it was not possible for Chile to export nitrate because the country did not produce it. Table 6 shows nitrate imports allocated to Chile by British statistics. Perhaps this error stems from the fact that the nitrate price was set at the Valparaiso stock exchange.

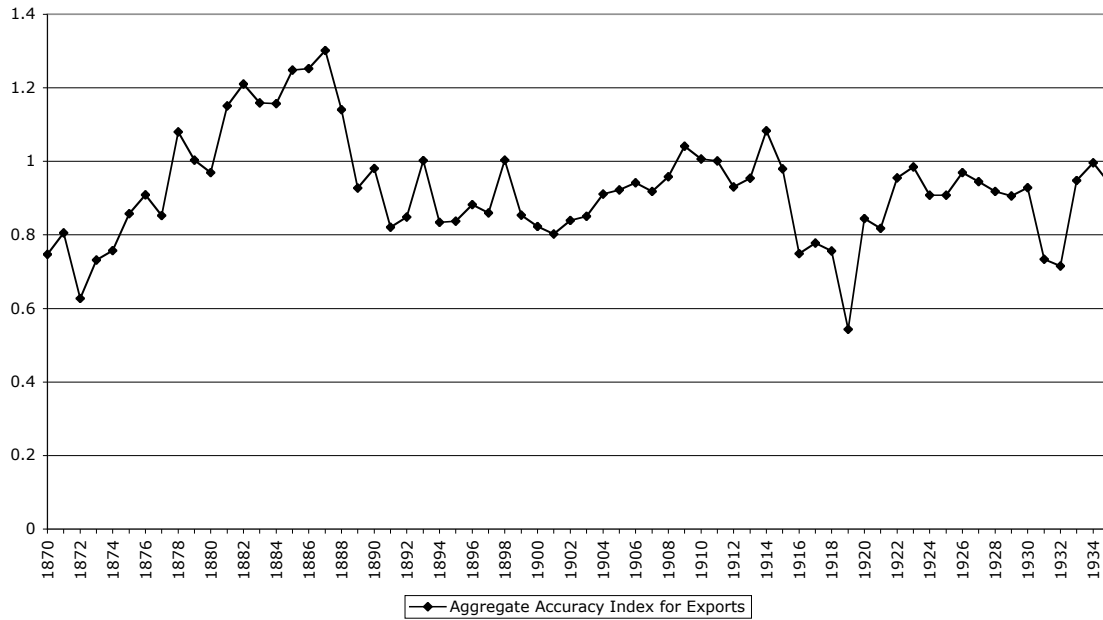
Table 6. Britain Nitrate Imports Recorded as Chilean Exports: 1870 - 1878

Year	Quantity (metric tons)	Value (Gold Pesos)
1870	1926	426,999.89
1871	646	122,942.59
1872	2843	565,871.83
1873	4331	762,116.09
1874	1502	241,832.86
1875	1177	170,490.70
1876	2199	302,057.80

1877	1546	251,763.71
1878	0	0

From 1878 to 1888 the index is well above 1, thus indicating that Chilean statistics are larger than imports from Chile recorded by trade partners. In this case the problem might be the opposite, i.e., trade partners considered nitrate imports as coming from Peru and Bolivia. After correcting for this error, the index, as shown in Figure 2, continues to be above 1.

Figure 2: AGGREGATE ACCURACY INDEX FOR EXPORTS



Starting 1889 and until 1913, the index lies within the "good accuracy" value. Trade partners seemed to have allocated nitrate imports to Chile. It should be mentioned that incomplete figures for the Netherlands seem to indicate that this country changed the allocation procedure only by 1902.

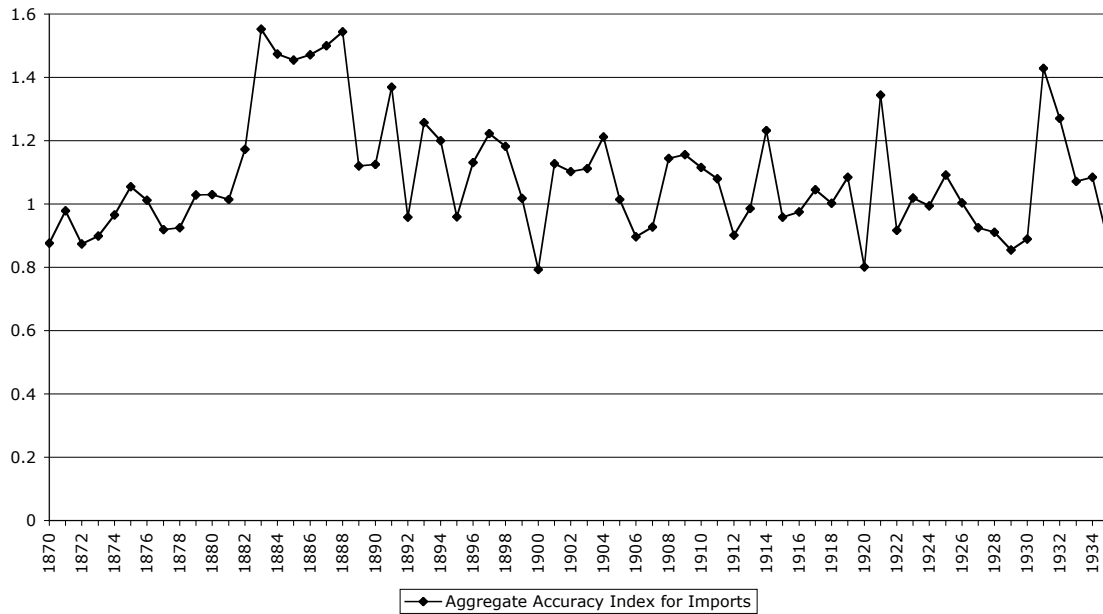
During WWI the index goes above 1 for 1914 and below 0.8 from 1916 to 1918. In other words, trade partners recorded Chilean imports at a greater value than Chilean recorded exports. One possible explanation stems from the difference between Chilean valuation of nitrate exports and trade partners valuation of nitrate imports. The cost of freight and insurance rose considerably during those years.

From 1920 to 1930 the index stays within the "perfect accuracy" range. It dips in 1931 and 1932 probably due to valuation issues resulting from the abandonment of the gold standard by Chile, Britain, and the United States, Chile's main trade partners then.

4.1.2 Aggregate Accuracy Index for Imports

Figure 3 depicts the Aggregate Accuracy Index. For only twenty-five of the years included, the index lies in within the "good accuracy" range of 1 - 1.2. The other observations are either above or below the range without a very clear tendency.

Figure 3: AGGREGATE ACCURACY INDEX FOR IMPORTS



From 1870 to 1881 recorded Chilean imports are below the value of exports from trade partners to Chile. We already mentioned the editor of *Estadística Comercial* stating that the value of imports according the *Tarifa de Avalúos* was perhaps seventy-five per cent of its market value. In addition during the War of the Pacific, imports of arms and war materials were not included in the Chilean statistics. Table 7 shows the value of arms exported from Britain to Chile during the 1870's until the end of the War of the Pacific in 1883.

Table 7. British Exports of Arms to Chile: 1871 - 1885

Year	British Export of Arms to Chile (Gold Pesos)	Percentage of Official Chilean Imports %
1871	609,207.66	0.90
1872	793,521.57	0.89
1873	572,190.25	0.61
1874	575,496.09	0.60
1875	615,486.09	0.66
1876	566,165.09	0.71
1877	476,454.19	0.70
1878	196,697.48	0.35
1879	689,640.88	1.65
1880	803,012.53	1.28
1881	1,215,696.00	1.46
1882	413,230.00	0.38
1883	279,556.76	0.24
1884	244,778.79	0.22
1885	124,702.15	0.15

These figures are not large enough to increase the AMAI for the years 1879 to 1883; however, it is likely that Britain was not the only supplier of armament to Chile during the war, we suspect that Germany could have been another important supplier.

From 1884 to 1888 AMAI is well above "good accuracy." One possible explanation is the same given for exports: trade partners did not consider the border changes due to the War of the Pacific. In the case of imports, the production of nitrate requires coal, and although Chile produced coal, it was not sufficient to run the nitrate industry. Coal could come from Britain, Belgium, France, and Germany, countries that wrongly allocated their nitrate imports to Peru and Bolivia until 1889.

For 1917 to 1928 "perfect accuracy" for the AMAI should be around 1 because, as mentioned earlier, imports began to be valued at FOB prices. The index hovers around 1 for except for 1920 and 1921, indicating a relatively good accuracy.

Starting in 1929 imports began to be valued at CIF prices computed by the statistical office, the index indicates problems in the implementation of this methodology all the way until 1935.

4.1.3 Conclusions on the Aggregate Accuracy Indices

Once we accept that the quantities reported by Chilean statistics are correctly recorded, the problems indicated by the accuracy index have three sources: (1) faulty recording by trade partners that do not disappear with aggregation, and (2) valuation problems, in particular in the case of imports, and (3) lack of inclusion of war material in the import series.

Problem (1) has nothing to do with Chile, and problem (3) cannot be solved until we have access to the accounting of the Ministry of Defense, a tall order in Chile, even today. In the next section we analyze valuation problems.

4.2 Implementation of Tests Based on the Pricing of Trade Flows

In this section we implement the tests described by equations (8) and (12). The first subsection deals with export prices and the second with import prices. Once again, we remind the reader that in this paper all prices are expressed in Gold Pesos of 0.5491785 grams of fine gold. Gold Pesos are equal to "pesos of 18d" for all the period, except 1916 - 1922 and 1931 - 1935, when the British pound was not on gold.

In order to estimate FOB and CIF prices we need the "freight factor," i.e., cost of freight, insurance, commissions, and cost of portage. In this paper the estimation of the "freight factor" are based on the nitrate market.

The basic figures for freight come from Mohammed and Williamson (2003) who constructed freight indices based on E.A.V. Angier (1920) *Fifty Year Freights*. Angier gave only maximum and minimum freight rates, Mohammed and Williamson constructed their indices averaging these two figures. Chilean statistics provide monthly freight rates for nitrate from 1892 until 1918. The yearly averages calculated from Chilean data differ from Mohammed and Williamson averages; in fact, their averages are mostly out of the two standard deviation range around the average. Given the way in which Angier presented the data, it is not possible to solve this problem. In spite of this problem, we used the Mohammed and Williamson indices to expand the Chilean original data for the whole period.

The insurance rate used for 1870 to 1913 is based on the rate charged in the nitrate trade: 1.789 percent based on the Chilean price. This rate was reported by *Memoria del Delegado Fiscal de Salitreras* for 1892; Michels and Semper (1903) reported the same rate for 1902. Persson (2002) reports a similar rate for the 1870's. Table 8 summarizes the rates used for the whole period.

Table 8. Maritime Insurance Rates

Year	Insurance Rate Based on Chilean Price %
1870 - 1913	1.785
1914 - 1915	1.785
1916	15.000
1917 - 1918	20.000
1919 - 1920	8.000
1921 - 1935	5.000

In addition to freight and insurance, there were other transaction costs: commissions and other charges that amounted to 15.018 percent of the Chilean price. We used this figure for the whole period.

Finally, there are portage costs. In 1892 these costs amounted to \$ 3.27 per metric ton of nitrate in the United Kingdom.⁴ For grains, Persson (2002) estimated the British portage cost in \$ 0.71 per metric ton in 1872. We generated series for portage costs in Britain using the evolution of nominal wages, as reported by Mitchell (1962). These two indices are in nominal terms, but corrected to express Gold Pesos for the whole period.

In 1892, the portage cost in Iquique, Chile was \$ 1.76 per metric ton of nitrate; different sources indicate that Valparaiso was more expensive. We generated series of portage costs in Chile using the evolution of nominal wages. We estimated an index of nominal wages based on the index for real wages and the general price index calculated by Braun et al. (2000).

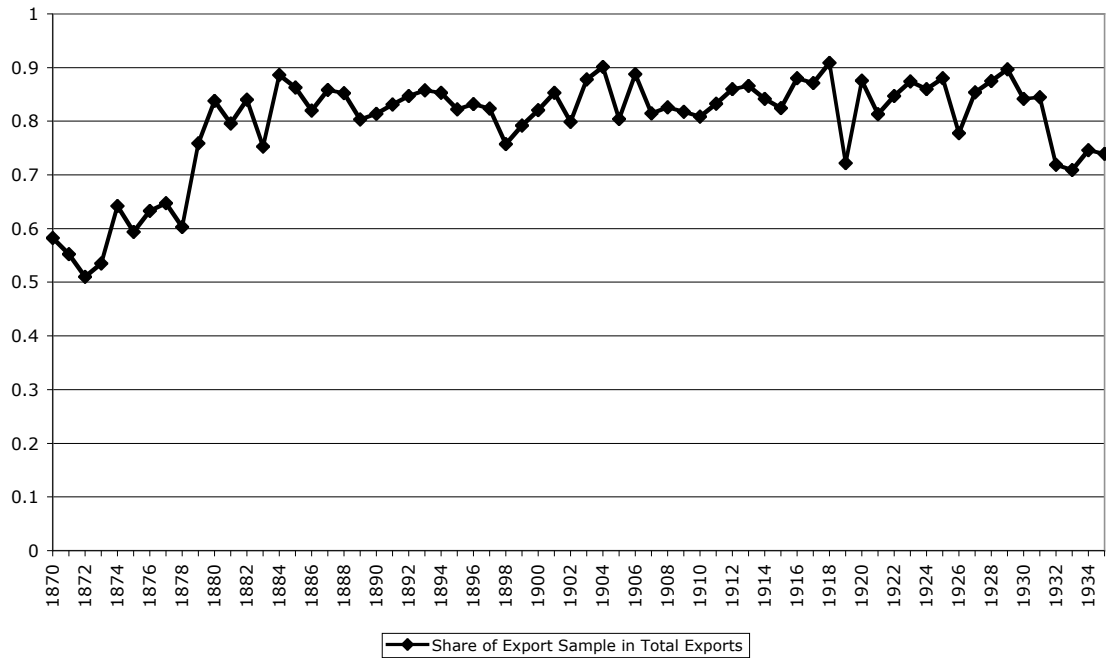
In addition to these calculations, the tests require to know the price of Chilean exports in Britain and the price of British exports in Chile. We will discuss the assumptions on these two problems as we deal with specific commodities below.

4.2.1 Price Tests for Exports

In order to perform these tests, we chose a sample of export goods that represent the bulk of Chilean exports during the period. The sample includes four mining goods -copper, nitrate, iodine, and silver bars- and four agricultural products -barley, wheat, wheat flour, and wool. Copper, iodine, silver, and wool are high value products; therefore, their "freight factor" is a rather small percentage of their CIF price. Nitrate, wheat, wheat flour, and barley are bulk commodities, where the "freight factor" represent an important part of the CIF price. Figure 4 depicts the share of this sample in total officially valued exports.

⁴ These are Gold Pesos, they correspond to 4s 11d or £ 0.2453

Figure 4: Share of Export Sample in Total Exports



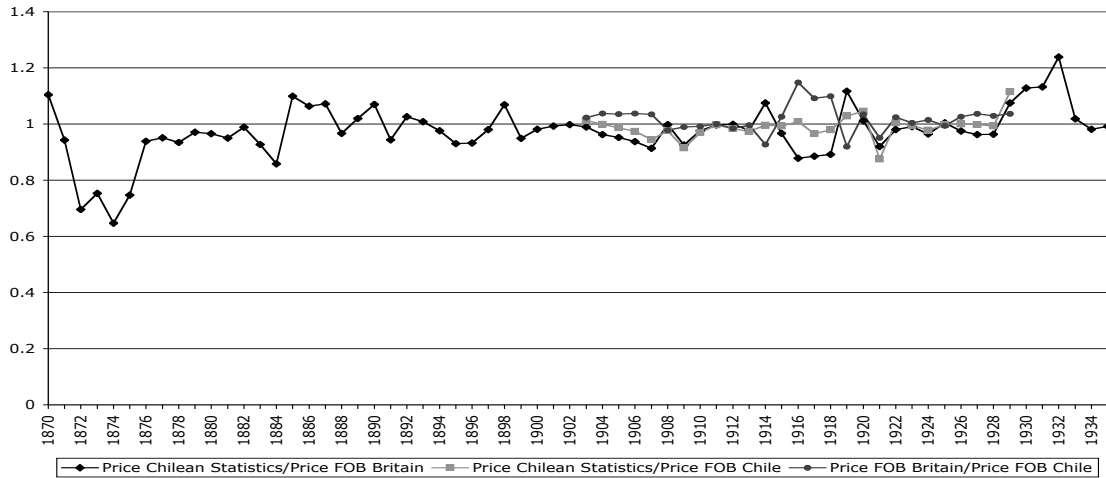
From 1870 to 1880, Chilean exports were mostly copper minerals and bars, and agricultural products. Some of these agricultural exports went to the nitrate producing areas that were part of Peru and Bolivia until 1880. After 1880, agricultural exports decline in part for this reason, but also due to the lost of comparative advantage in the production of grains.

Already by the early 1880 nitrate became the most important export of the country. From 1884 until 1931, this sample represents in between eighty to ninety percent of total exports. This fact is not extraordinary, given that copper and nitrate were by far the most important exports during the period.

4.2.1.1 Copper Bars

It is not possible to perform tests based on total copper exports because there is not information of the mineral content of copper minerals and of copper mate; therefore, we have taken copper bars as representative of this commodity. Sauerbeck included the price of "Chili Bars" in his price index; these were copper bars imported from Chile with a mineral content above ninety per cent. British prices are available for the whole period. The price in Chile these bars is only available from 1903 to 1929.

Figure 6: COPPER PRICE TEST



The freight rate was calculated using the Mohammed and Williamson's freight index for coal from the United Kingdom to West Latin America. Since this index runs only until 1913, it was continued until 1935 using the index for coal to East Latin America. In order to obtain nominal values, we used figures provided by Chilean statistics for the years 1903, 1904, 1912, and 1913. Figure 5 depicts the results of the test.

The average ratio of the price fob measured from Britain to the price implicit in Chilean statistics is 0.97 and the standard deviation is 0.09. Chilean official statistics undervalued copper from 1872 to 1875 and overvalued it from 1930 to 1932.

4.2.1.2 Nitrate

The importance of the nitrate industry for the Chilean economy of 1880 to 1930 is manifold. It was the main export commodity, reaching ninety percent of total exports by the end of the 1800's. It generated demand for the domestic industrial and agricultural sectors. And the export tax on nitrate generated approximately fifty percent of the ordinary fiscal revenues. Already in 1880 the authorities established the *Delegación Fiscal de Salitreras* to supervise the industry. Later on, the government actively participated in international advertising campaigns to promote the use of nitrate. The statistical information accumulated by the *Delegación* is extensive and interesting.

The nitrate boom began in 1880 and it reached its heyday during WWI. Nitrate is used not only as a fertilizer, but also to produce explosives. After WWI, production cost of ammonium sulfate declined sharply and this competitor began to make serious inroads in the nitrate share of the fertilizer market. The final blow happened in 1929/30, the Great Depression reduced the price of nitrate to one third of its regular value. The industry collapsed generating serious social problems as the workers from the industry moved to the center of the country. The government reorganized the industry by reducing production and closing many plants; in the end, only two plants remained open.

In addition to the implicit price of nitrate used by the statistical office, there are two series for the price of nitrate: the Chilean price of nitrate published in the section on Mining of the *Anuario Estadístico*. This price is FAS, i.e., free along side the ship; however, it seems to refer to the price on

the dock. In addition, the same publication reproduced the price in Britain taken from the *London Gazette*, this price is practically the same as the one published by Sauerbeck.⁵

For the year 1892 *Memoria del Delegado Fiscal de Salitreras* published an itemized composition of the cost of sending nitrate to Europe, which is shown by Table 9.

Table 9. Costs of Exporting Nitrate to Europe, 1892

Cost Items	Gold Pesos per metric ton
Price FAS	\$ 85.50
Freight	\$ 13.50
Insurance	\$ 1.53
Portage Costs in Europe	\$ 3.27
Commission and Other Financial Costs	\$ 12.84

The same composition is quoted by Semper and Michels (1908).

Figure 7 depicts the result of the accuracy price test for the nitrate.

Figure 7: PRICE TEST FOR NITRATE

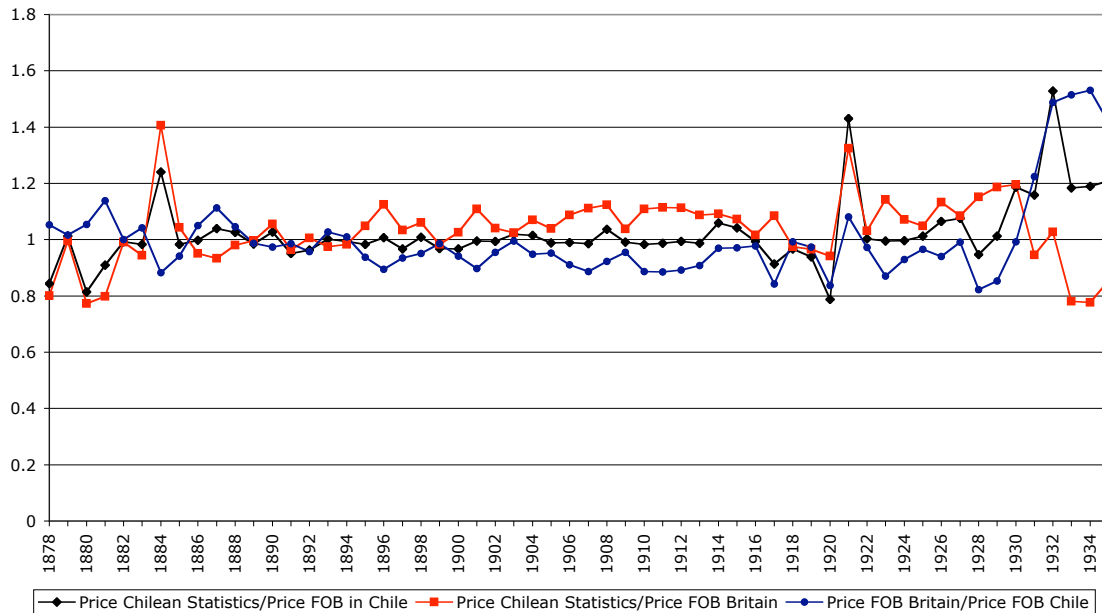


Table 10 shows the average and standard deviation for the three ratios in Figure 7.

Table 10. Price Test for Nitrate. Price Ratios Average and Standard Deviation

Ratio	Average	Standard Deviation
Price Chilean Statistics/Price FOB Chile	1.026	0.1198

⁵ Sauerbeck's nitrate price was taken from the *London Gazette*.

Price Chilean Statistics/Price FOB UK	1.037	0.1152
Price FOB UK/Price FOB Chile	1.000	0.1556

The only years that show problems are 1880, 1881, 1884, 1920, 1921, and 1930 - 1935. The problems in 1880 and 1881 probably are a consequence of the development of the War of the Pacific that could have disrupted the markets. We do not have a hypothesis for 1884. 1920 and 1921 resulted from the selling of the nitrate stocks accumulated by the Allied countries after WWI. In addition, the 1930 - 1935 period the price in the official statistics is marred due to the government take over of the industry.

4.2.1.3 Iodine

The iodine market was monopolized and the price used by the statistical office seems to have been the one Gibbs and Co. settled with Chilean producers.

4.2.1.4 Silver Bars

As mentioned earlier, the statistical office valued silver bars in nominal terms from 1870 to 1898. The Mining section of *Anuario Estadístico* reported the price of silver in Chile from 1896 to 1928. Regarding the cost of transporting silver/gold to Europe we found two quotes: (1) Ramón Santelices (1900, p CXXXII) estimated the "freight cost" of silver in two percent of the British price of silver, which corresponds to approximately 2.11 percent of the Chilean price in 1900, and (2) Guillermo Subercaseaux (1922, p 165) who estimated the cost of shipping gold from London to Chile in 1918 at five percent of the price of gold, of course that trade was not possible because Britain had suspended gold payments and the exportation of specie.

We estimated a regression between the price of silver in Chile and the price of silver in Britain for the 1896 - 1928. The result was that the Chilean price of silver was equal to 94.6 percent of the price in Britain. We check this result for the 1850 - 1876 period, when Chile was under a bimetallic standard, and the percentage seems appropriate.

The corrected price of silver has three components: (1) 1870 - 1900 the corrected price is equal to 94.6 percent of the British price, (2) 1901 - 1929 the corrected price is equal to the Chilean price of silver, and (3) 1930 - 1935 the corrected price is equal to the implicit price in Chilean statistics.

In addition to the price of silver, the valuation of silver bars should take into account their grade. Unfortunately, it is not possible to know whether the quantities reported by *Estadística Comercial* and *Comercio Exterior. Anuario Estadístico* corresponds to fine silver. We have not done any further adjustment due to this issue, which is equivalent of assuming that the reported quantities represent fine silver.

4.2.1.5 Agricultural Exports

The share of agricultural commodities in total exports declined sharply from 1870 to 1935. Figure 8 shows the share of barley, wheat flour, wheat, and wool in total exports. As mentioned above this was a consequence of the incorporation of nitrate production areas into Chile, that were previously Peruvian and Bolivian provinces, but also due to a loss of comparative advantage.

Figure 8: SHARE OF AGRICULTURAL COMMODITIES IN TOTAL EXPORTS

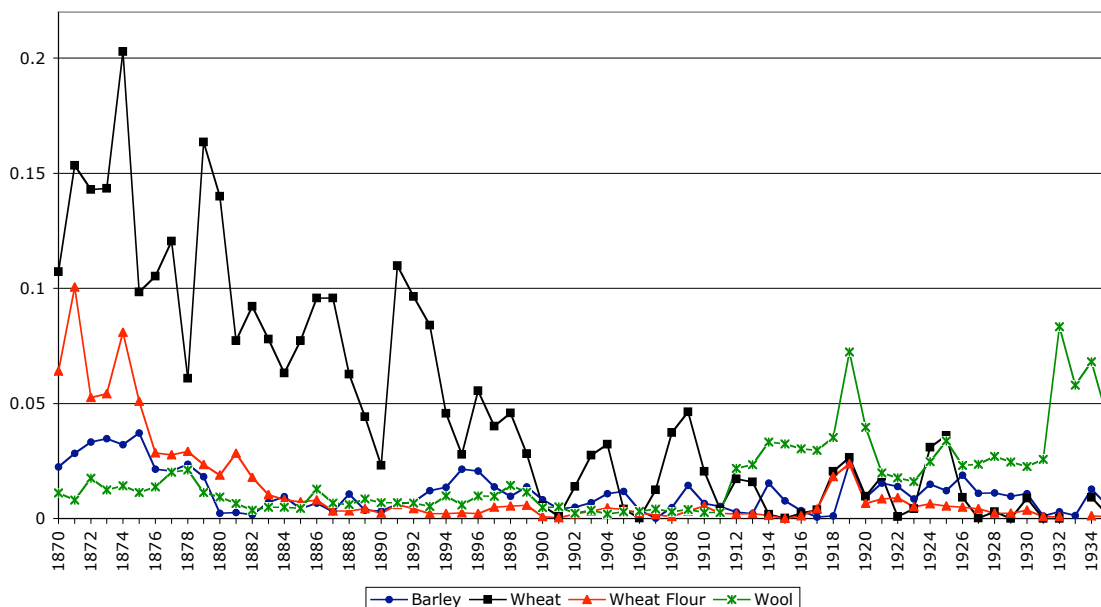


Table 10 shows agricultural commodities exports to Peru from 1871 to 1895.

Table 10. Exports of Agricultural Commodities to Peru, 1871 - 1895

Year	Peru		
	Barley (metric tons)	Wheat (metric tons)	Wheat Flour (metric tons)
1871	23932	27588	8462
1875	29666	29691	5824
1880	109	5802	1889
1886	610	22861	1389
1895	534	28874	1472

The implementation of the price accuracy tests requires the price of these commodities in Chile and the British price of the Chilean commodities. In addition we need freight and insurance rates, and portage costs in Chile and Britain.

Latorre (1958) reported Chilean prices of barley, wheat, and wool from 1870 to 1925. Bauer (1975) reported the price of wheat flour from 1870 to 1925. The section on Domestic Commerce of *Anuario Estadístico* as well as *Sinópsis Geográfica y Estadística de la República de Chile* published data on prices of agricultural commodities from 1897 to 1925 and from 1928 to 1935. The 1926 -1927 gap was filled using data reported by Matus (2009).

There is no data on the price of Chilean agricultural commodities in Britain. However, the destination of Chilean agricultural exports was not Europe, but other South American countries. Therefore, it is reasonable to use the generic price of grains published by the *London Gazette*, and reproduced by Sauerbeck, as an indicator of the price that Chilean producers would have had to compete with.

For several years, Angier (1920) reported the nitrate freight rate from Chile to the Continent as equivalent to the freight of grains for the same voyage. The maritime insurance rates reported by Persson (2002) for grains are similar to those reported for nitrate. Persson (2002) also reported the portage costs in Britain. We assume that the portage costs in Chile are the same for these agricultural commodities than for nitrate.

In the case of wool, the comparison assumes that Chilean wool is equivalent to Sauerbeck's "Merino, Adelaide, Average Grease." In order to obtain the freight rate we used the index calculated by Tena and ??? (2012) for the Buenos Aires - Britain rate, but transformed it into nominal terms using freight rate quoted in *Estadística Chilena* for 1935.

Figures 9 to 12 depicts the price accuracy tests for these four commodities.

Figure 9: PRICE TEST FOR BARLEY

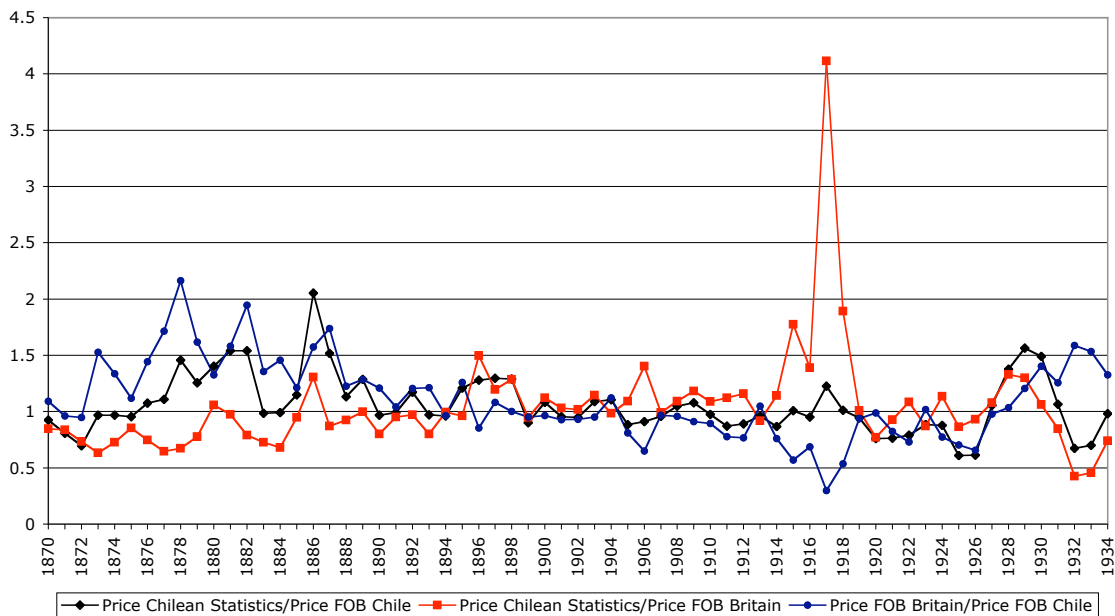


Figure 10: PRICE TEST FOR WHEAT

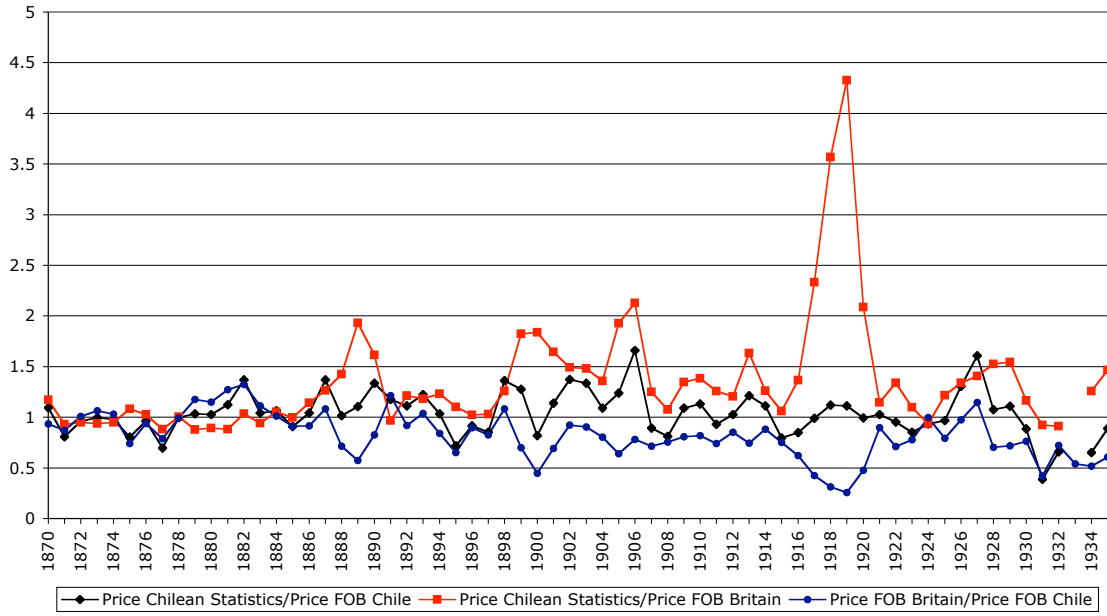


Figure 11: PRICE TEST FOR WHEAT FLOUR

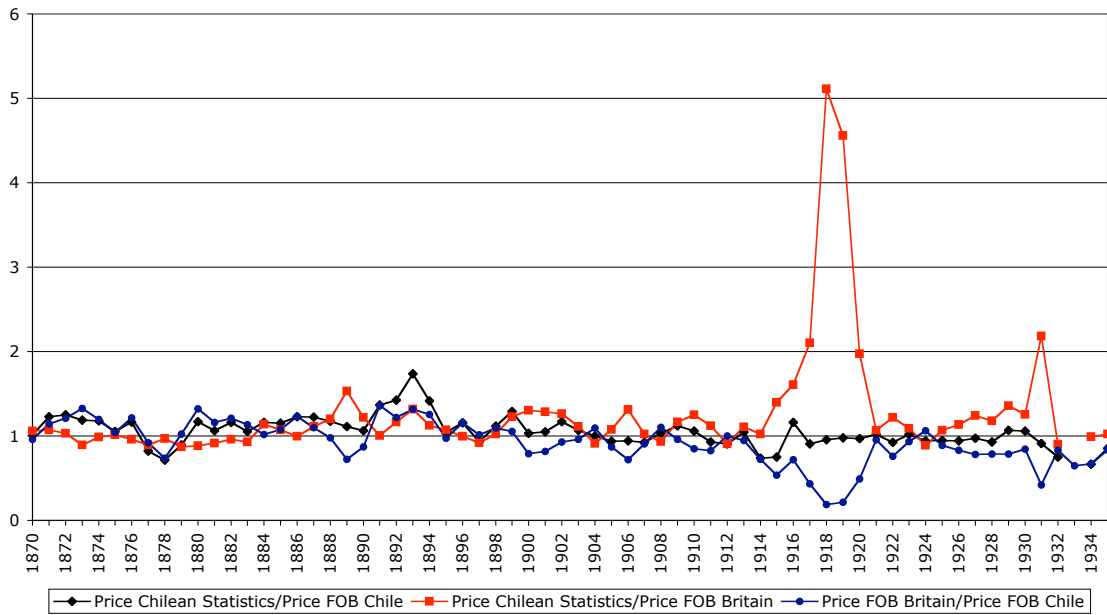


Figure 12: PRICE TEST FOR WOOL

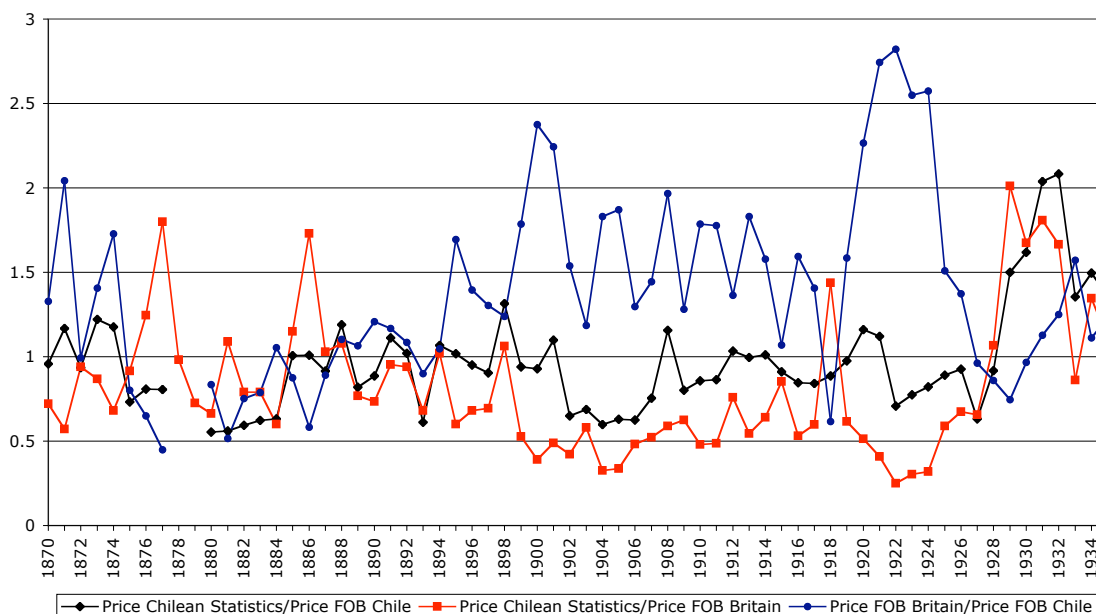


Table 11 depicts the average and standard deviation for the three ratios and the four commodities.

Table 11. Price Test for Agricultural Commodities. Average and Standard Deviation for Price Ratios

Ratio	Barley		Wheat		Wheat Flour		Wool	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Price Chilean Statistics/Price FOB Chile	1.05	0.2621	1.03	0.2208	1.04	0.1802	0.97	0.3103
Price Chilean Statistics/Price FOB Britain	1.04	0.4648	1.36	0.5755	1.26	0.6951	0.82	0.4011
Price FOB Britain/Price FOB Chile	1.10	0.3488	0.82	0.2231	0.93	0.2515	1.37	0.5511

Observing Figures 9 to 12 it seems clear that WWI and its aftermath as well as 1930 to 1935 are years where it is difficult to estimate FOB prices for agricultural commodities. Looking into specific products, we can conclude that Chilean statistics overvalued barley from 1870 to 1890, overvalued wheat, and undervalued wool. The ratio of the Price FOB Britain to Price FOB Chile for wheat indicates that from 1886 until 1920, the Chilean FOB price became larger than the British one, indicating a competitiveness problem.

4.2.2 Price Tests for Imports

Performing price tests for imports is far more difficult than for exports. The number of import commodities is much larger than the number of export commodities. International prices are not readily available and freight rates are practically impossible to obtain. Our criteria to construct an import sample were constrained by the availability of information. Two sources proved quite useful: French import prices calculated by the *Commission des valeurs en douane* and the declared import and export values in British trade statistics. With respect to domestic prices in Chile, we used those published by Matus (2009); there are several problems with these prices, the most important being that it is not clearly known the currency unit in which the original prices were published. In addition, most of the series start only in 1897.

Regarding freight rates, the only accessible one is an index for coal rate from Britain to the West Coast of Latin America, published by Mohammed and Williamson (2003). Oribe Stemmer (1989) states that the freight rate for coal to the West Coast was \$ 13.91 per metric ton in 1906.⁶

In summary, we were able to perform the test price as described by equation (18) only for coal. For other commodities we estimated the Chilean border price and compare it with the Chilean statistics price and the British and French available prices. And for a much larger sample, we just estimated the ratio of the Chilean statistics price to the British and/or French available price.

4.2.2.1 Coal

Chile has never been an energy self-sufficient country. The production of nitrate was relatively energy intensive and the railroads that carry the finished product to the ports run on coal. In addition to this important source of demand, there was the demand from the economic center of the country. There was domestic production of coal, but it had a low calorific power. Coal was one of the most important import commodities of the country.

In order to implement the price test we proceeded from the British side, adding the portage cost that we have used for grains and the freight rate to the British declared export price. The Chilean price of coal does not distinguished between domestic coal -of low quality- and imported coal. In spite of this problem, we estimated a border price taking the tariff away from the quoted Chilean price. The sources for the Chilean price of coal are Matus (2009) who states that the price is that of Lota, one of the Chilean mines; this data runs from 1880 to 1897. From 1901 to 1935 the price is the one quoted in the section on Mining of the *Anuario Estadístico*. The useful data on coal is only from 1870 to 1929, by 1915 crude oil substituted coal in the Chilean energy market.

Figure 13 shows the three ratios that we have looked before. The ratio of the Chilean statistical price to the British CIF price seems to indicate that the statistics greatly undervalued the price of coal from 1871 to 1891. From 1891 to 1909 the ratio moves around 1 and starting in 1910 it goes down, in part reflecting the effect of WWI and valuation problems in Chile.

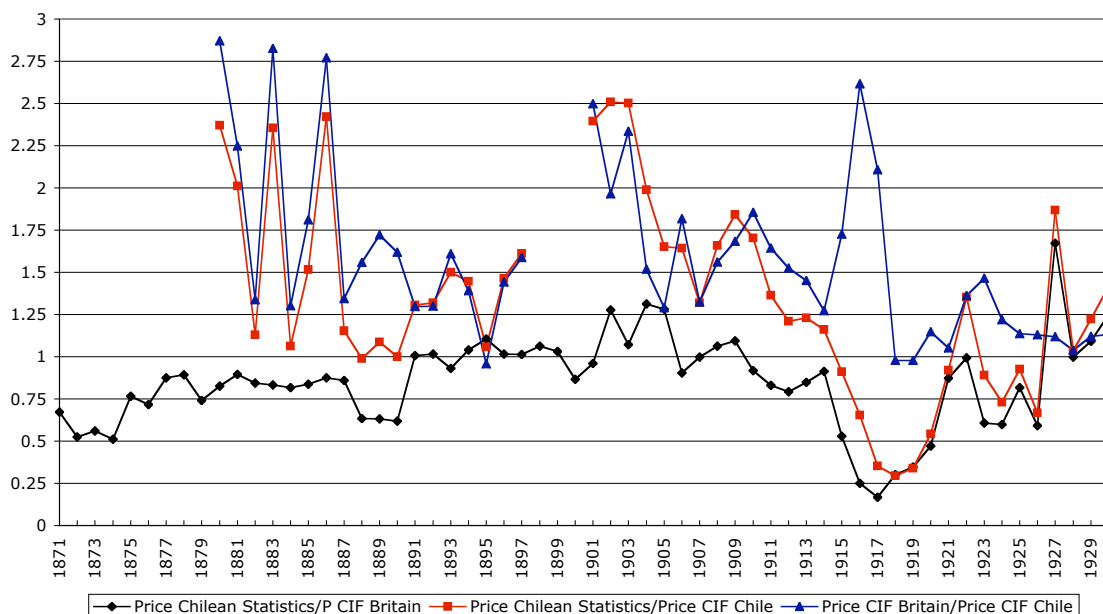
Unfortunately, the other two ratios -Chilean statistics price to Chilean CIF price, and British CIF price to Chilean CIF price jump all over the place without proving any useful information, except the suspicion that the domestic price is wrongly calculated and that Chilean statistics do not use the right price to value coal imports.

4.2.2.2 Six Commodities: Bags, Cement, Coffee, Rice, Unprocessed Sugar, and Tea

For these six commodities we estimated the Chilean border price or CIF price starting from the domestic price. The source of the domestic price is Matus (2009). In order to obtain the border or CIF price we deducted the import tax from the domestic price. Tables 12 to 17 depict the Chilean statistics implicit price, the Chilean border price, the British import or export price, and the French import price.

⁶ This rate is consistent with the one quoted by Marthe Barbance (1969).

Figure 13: PRICE TEST FOR COAL



In the six cases one can see the working of the *Tarifa de Avalúos* from 1903 to 1915. In terms of the Chilean border there seems to be an undervaluation of imports in the case of bags, sugar, and tea. Moreover, there is a tendency to undervaluation from 1915 until the end of the sample. Bags and coffee are undervalued in terms of British prices, while cement, rice, and tea are overvalued.

**Table 12. Price of Bags
(Gold Pesos per Kilo)**

Year	Chilean Statistics Price	Chilean Border Price	British Export Price
1897	0.3421	0.3403	0.5491
1898	0.2140	0.3177	0.5197
1899	0.2005	0.4549	0.5174
1900	0.2029	0.5314	0.5653
1901	0.2000	0.5010	0.5675
1902	0.2115	0.4762	0.6091
1903	0.2500	0.5185	0.6115
1904	0.2500	0.5102	0.5295
1905	0.2500	0.4851	0.6259
1906	0.2552	0.4425	0.6262
1907	0.2565	0.5078	0.7827
1908	0.2992	0.4917	0.4465
1909	0.3030	0.4353	0.6002
1910	0.3015	0.4356	0.6312
1911	0.3044	0.4282	0.7117
1912	0.3022	0.5040	0.6426
1913	0.3045	0.5913	0.8360
1914	0.3018	0.5392	0.9550
1915	0.2999	0.5839	1.0258
1916	0.2679	0.7805	0.8252
1917	0.4073	1.1235	0.7971
1918	0.4852	1.0481	1.2313
1919	0.5963	1.0610	1.9050
1920	0.9390	1.0109	1.8658
1921	0.8229	0.6875	1.2109
1922	0.7771	0.9132	1.4592
1923	0.5093	0.8363	1.2295
1924	0.4862	0.4219	1.0566
1925	0.5956	0.3617	1.2590
1926	0.6407	1.1201	1.2587
1927	0.5858	1.2511	1.0552
1928	0.5348	1.0492	0.9589
1929	0.5747	1.1165	0.9754
1930	1.0172	1.0537	0.8627
1931	0.4985	0.9028	0.5657
1932	0.3832	0.6677	0.4969
1933	0.2295	0.8472	0.4232
1934	0.2018	0.7058	0.3176
1935	0.1995	0.5493	0.3527

Table 13. Price of Cement
(Gold Pesos per Kilo)

Year	Chilean Statistics Price	Chilean Border Price	British Export Price
1897	0.0423	0.0285	0.0217
1898	0.0400	0.0318	0.0245
1899	0.0400	0.0436	0.0257
1900	0.0400	0.0345	0.0245
1901	0.0401	0.0343	0.0251
1902	0.0400	0.0365	0.0226
1903	0.0400	0.0335	0.0222
1904	0.0400	0.0308	0.0215
1905	0.0400	0.0312	0.0207
1906	0.0400	0.0380	0.0198
1907	0.0400	0.0415	0.0218
1908	0.0400	0.0401	0.0210
1909	0.0400	0.0400	0.0194
1910	0.0400	0.0347	0.0189
1911	0.0400	0.0314	0.0197
1912	0.0400	0.0293	0.0207
1913	0.0400	0.0317	0.0223
1914	0.0400	0.0343	0.0224
1915	0.0400	0.0404	0.0257
1916	0.0382	0.0466	0.0315
1917	0.0355	0.0751	0.0371
1918	0.0441	0.0770	0.0400
1919	0.0699	0.0978	0.0646
1920	0.0636	0.1015	0.0680
1921	0.0708	0.1108	0.0661
1922	0.0507	0.0689	0.0392
1923	0.0397	0.0631	0.0354
1924	0.0402	0.0540	0.0324
1925	0.0363	0.0509	0.0334
1926	0.0309	0.0499	0.0349
1927	0.0313	0.0540	0.0351
1928	0.0345	0.0521	0.0328
1929	0.0339	0.0501	0.0302
1930	0.0274	0.0497	0.0287
1931	0.0272	0.0459	0.0255
1932	0.0320		0.0175
1933	0.0448		0.0147
1934	0.0481		0.0118
1935	0.0147		0.0114

Table 14. Price of Coffee
(Gold Pesos per Kilo)

Year	Chilean Statistics Price	Chilean Border Price	British Import Price	French Import Price
1897	0.8452	0.9096	1.2440	0.7167
1898	1.6000	0.6446	1.0210	0.7087
1899	1.5999	0.5497	0.8871	0.5774
1900	1.5996	0.6243	0.8792	0.5879
1901	1.6000	0.6113	0.9107	0.5669
1902	0.6000	0.5255	0.7454	0.5428
1903	0.6000	0.5043	0.7191	0.5302
1904	0.6000	0.5684	0.8267	0.5375
1905	0.6000	0.6378	0.7270	0.5481
1906	0.6000	0.5076	0.6929	0.5459
1907	0.6000	0.4429	0.6063	0.5354
1908	0.6000	0.4138	0.7296	0.5323
1909	0.6000	0.4338	0.6640	0.5500
1910	0.6000	0.5120	0.6456	0.6086
1911	0.6000	0.6712	0.8294	0.7936
1912	0.6000	0.7619	0.9816	1.0335
1913	0.6000	0.8921	0.9055	0.9540
1914	0.6000	0.7614	0.8976	0.9181
1915	0.6000	0.7120	0.8845	0.9587
1916	0.5627	0.6693	0.7517	0.9058
1917	0.5852	0.7302	0.8295	1.1742
1918	0.5294	0.6051	0.9697	1.5493
1919	1.0231	1.3134	1.3638	1.7856
1920	1.0633	1.2180	1.3628	1.3596
1921	0.6560	0.6648	0.9995	0.9292
1922	0.6584	0.9203	0.9805	0.8126
1923	0.7078	1.0574	1.2700	0.8190
1924	0.8215	1.3566	1.5313	1.1804
1925	1.1280	1.6530	1.8628	1.3417
1926	1.1039	0.9590	1.8414	1.2928
1927	0.9215	1.4331	1.8484	1.0435
1928	1.0041	1.2343	1.8123	1.1571
1929	1.0022	1.2059	1.7692	1.0426
1930	0.6383	0.8703	3.9556	0.6701
1931	0.5016	0.6392	1.3052	0.5361
1932	0.5900	0.6574	0.8936	0.5842
1933	0.3933	0.5547	0.7837	0.4790
1934	0.3068	0.4677	0.7496	0.4258
1935	0.2551	0.3607	0.6005	0.3425

Table 15. Price of Rice
(Gold Pesos per Kilo)

Year	Price	Chilean Statistics	Price	Chilean Border	British Import Price	French Import Price
1897		0.1918		0.1599	0.1072	0.1370
1898		0.1408		0.1448	0.1157	0.1312
1899		0.1400		0.1611	0.1143	0.1155
1900		0.1420		0.1187	0.1339	0.1207
1901		0.1401		0.1299	0.1283	0.1207
1902		0.1400		0.1172	0.1120	0.1212
1903		0.1400		0.1517	0.1144	0.1107
1904		0.1400		0.1588	0.1028	0.1181
1905		0.1400		0.1386	0.1085	0.1238
1906		0.1400		0.1178	0.1139	0.1260
1907		0.1400		0.1189	0.1270	0.1312
1908		0.1400		0.1208	0.1201	0.1528
1909		0.1400		0.1252	0.1159	0.1491
1910		0.1400		0.1212	0.1127	0.1376
1911		0.1400		0.1010	0.1216	0.1455
1912		0.1400		0.1390	0.1483	0.1537
1913		0.1400		0.1299	0.1366	0.1457
1914		0.1400		0.2124	0.1258	0.1526
1915		0.1400		0.1543	0.1372	0.1714
1916		0.2095		0.1280	0.1897	0.2182
1917		0.3306		0.2543	0.2468	0.7449
1918		0.3705		0.3118	0.2451	0.7023
1919		0.5803		0.4705	0.3307	0.9761
1920		0.6461		0.5764	0.4259	0.4441
1921		0.3489		0.3712	0.2075	0.5439
1922		0.2894		0.3220	0.2005	0.2709
1923		0.2938		0.2931	0.1963	0.1592
1924		0.3314		0.2831	0.1869	0.1870
1925		0.3859		0.2641	0.2208	0.1811
1926		0.2894		0.2751	0.2279	0.1594
1927		0.2625		0.3289	0.2135	0.1809
1928		0.2508		0.3163	0.1931	0.1582
1929		0.2711		0.3037	0.1974	0.1621
1930		0.2437		0.2762	0.1743	0.1595
1931		0.2013		0.2299	0.1275	0.1153
1932		0.1814		0.1978	0.1068	0.0995
1933		0.1106		0.1773	0.0737	0.0814
1934		0.0840		0.1532	0.0627	0.0858
1935		0.0943		0.1374	0.0660	0.0966

Table 16. Price of Unprocessed Sugar
(Gold Pesos per Kilo)

Year	Chilean Statistics Price	Chilean Border Price	French Import Price
1897	0.2954	0.3696	0.1370
1898	0.1200	0.3765	0.1627
1899	0.1200	0.3677	0.1575
1900	0.1200	0.3823	0.1522
1901	0.1200	0.3538	0.1207
1902	0.1000	0.3814	0.1001
1903	0.1000	0.4174	0.1207
1904	0.1000	0.3992	0.1370
1905	0.1000	0.3694	0.1528
1906	0.1000	0.3300	0.1155
1907	0.1000	0.2766	0.1207
1908	0.1000	0.2990	0.1423
1909	0.1000	0.2621	0.1481
1910	0.1000	0.2930	0.1958
1911	0.1000	0.2692	0.2010
1912	0.1000	0.2750	0.2173
1913	0.1000	0.2535	0.1537
1914	0.1000	0.2788	0.1964
1915	0.1000	0.3392	0.3652
1916	0.1068	0.4780	0.3896
1917	0.1941	0.5467	0.3943
1918	0.2131	0.5291	0.4214
1919	0.2241	0.6958	0.7539
1920	0.3056	1.0190	0.6579
1921	0.3054	0.4991	0.2946
1922	0.1563	0.4122	0.2032
1923	0.1700	0.5036	0.3715
1924	0.2298	0.4542	0.2828
1925	0.1940	0.3357	0.1837
1926	0.1615	0.3025	0.1612
1927	0.1375	0.2486	0.1475
1928	0.1355	0.2286	0.1582
1929	0.1203	0.2017	0.1546
1930	0.0932	0.1761	0.1145
1931	0.0815	0.2141	0.0833
1932	0.0588	0.1272	0.0503
1933	0.0504	0.1566	0.0589
1934	0.0384	0.1678	0.0536
1935	0.0341	0.1401	0.0526

Table 17. Price of Tea
(Gold Pesos per Kilo)

Year	Chilean Statistics Price	Chilean Border Price	British Import Price
1897	3.1495	1.1510	1.1464
1898	2.0000	1.1135	1.1182
1899	2.0251	1.1311	1.0803
1900	2.0000	1.2633	1.0460
1901	2.0000	1.1388	0.9394
1902	0.8000	1.0461	0.8818
1903	0.8000	1.0361	0.9443
1904	0.8000	2.2088	0.8867
1905	0.8000	2.0620	0.8867
1906	0.8000	1.8170	0.9088
1907	0.8000	1.8505	0.9958
1908	1.5000	2.1829	0.9749
1909	1.5000	2.1691	0.9994
1910	1.5000	2.0370	1.0080
1911	1.5000	2.9040	1.1023
1912	1.5000	2.9923	1.0680
1913	1.5000	3.0796	1.1231
1914	1.4715	3.0716	1.1317
1915	1.5000	2.7397	1.3485
1916	1.9643	2.9087	1.3716
1917	2.0077	5.1950	1.6291
1918	2.1462	4.7735	1.5148
1919	2.3391	4.6329	1.8108
1920	2.3784	4.7177	1.5889
1921	1.9169	2.5470	1.3735
1922	1.5608	2.4785	1.7288
1923	2.2709	2.7273	2.1546
1924	2.3893	2.8294	2.3291
1925	2.4189	2.7290	2.2474
1926	2.5088	3.1619	2.3057
1927	2.5236	3.5184	2.2761
1928	2.5380	2.8797	2.0624
1929	2.4145	2.5295	1.9744
1930	2.1245	2.4107	1.8411
1931	1.5747	1.9894	1.5055
1932	0.9521	1.2338	0.9418
1933	0.6451	0.9504	0.9852
1934	0.8209	1.3823	0.9974
1935	0.6794	1.0634	0.9555

4.2.2.3 Three Baskets of Commodities

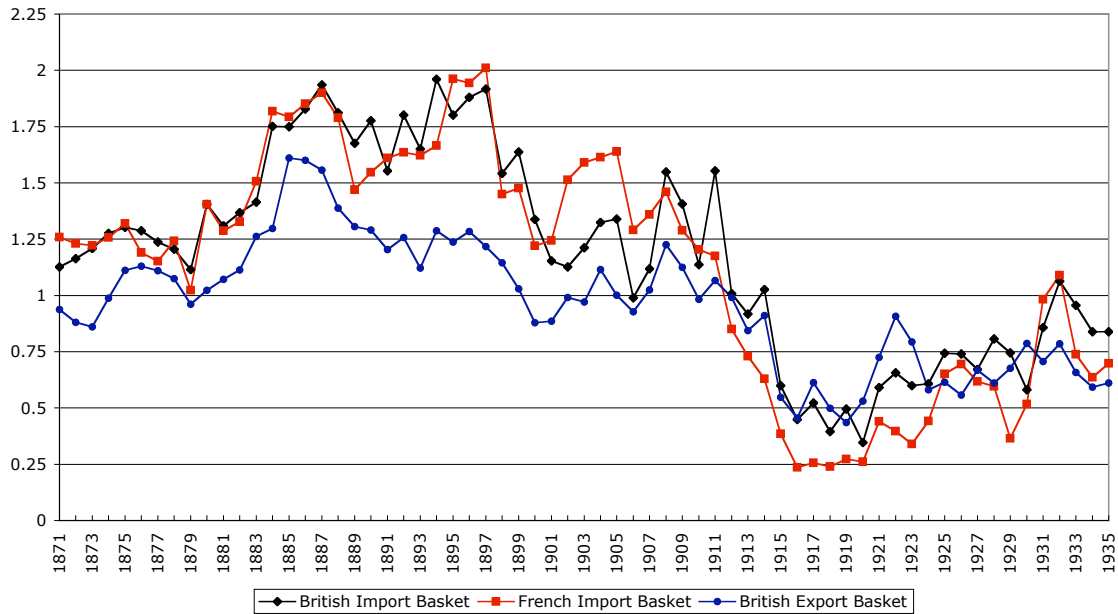
Finally, we compare the value of three baskets of commodities to the value of the same baskets according to the Chilean statistics. Table 18 gives the composition of the baskets.

Table 18. Composition of Baskets of Commodities

British Import Basket	British Export Basket	French Import Basket
Olive Oil	Bleached Cotton Pieces	Olive Oil
Linseed Oil	Unbleached Cotton Pieces	Linseed Oil
Raw Cotton	Coal	Raw Cotton
Rice	Coke	Rice
Refined Sugar	Cement	Unprocessed Sugar
Coffee	Iron Ingots	Refined Sugar
Kerosene Paste	Iron Plates	Coffee
Pulp Paste	Condensed Milk	Coal
Crude Oil	Rails	Coke
Lead Bars	Bags	Wheat Flour
Tea	Wheat Flour	Iron Ingots
	Wheat	Iron Plates
		Crude Oil
		Lead Bars
		Wheat

Figure 14 gives the ratio of the Chilean value of each basket to the respective basket.

Figure 14: CHILEAN IMPORTS VS. BRITISH AND FRENCH BASKETS



The import baskets show a similar behavior. From 1871 to 1880, the ratios are around 1.25, indicating a reasonable level of accuracy. But from 1881 to 1911 the ratios are much larger than 1.25, suggesting a serious overvaluation of imports. And from 1912 to 1935 the ratios go below 1.00 indicating a serious undervaluation. It should be remembered that from 1917 to 1928 the Chilean statistical office valued imports in FOB terms port of origin.

The British exports basket seems to behave better, however, one cannot forget that the British prices implicit in the value of this basket do not include the "freight factor," if this factor were included, the behavior of this ratio will differ significantly from the other two.

4.2. 2.4 Final Comments on Imports

Chilean official import statistics show serious valuation problems. The problem is not so much the use of *Tarifa de Avalúos*, but the fact that it was not modified according to market conditions. The valuation of imports according to invoice starting in 1917 did not solve the problem, but seems to have created a serious undervaluation problem. And for the years 1929 to 1935, when valuation at CIF prices should have taken place does not seem to have solve the undervaluation problem, however, the Great Depression poses important valuation difficulties due to the worldwide implementation of trade and exchange rate restriction.

The two British and the French basket do not represent more than thirty per cent of total imports, at official prices. Therefore, we are not yet in a situation to produce reliable estimates of the real value of imports.

5. Final Comments

Exports and imports fare differently regarding accuracy: exports are properly recorded, while imports show serious deficiencies.

Official export series can be corrected, particularly the year 1870 to 1880 and 1929 to 1935. The price tests run in this paper could be use to decide how to revalue those years. The valuation of nitrate from 1929 to 1935 will always be fraught, but nitrate's share in total exports declined sharply and, therefore, it becomes less of a problem. The undervaluation of copper exports from 1872 to 1875 can be easily corrected and the same is true for the overvaluation observed from 1930 to 1935. Although in the later case, the problems posed by the multiple exchange rate regime are not of a simple solution.

All tests report that the official import series is faulty valued. Assuming that import quantities are properly recorded, the only solution consists of recalculating the whole series using the appropriate prices. Unfortunately these prices are not forthcoming. Archival research into commercial publications and newspaper would provide information about prices in Chile for most intermediate goods and some consumption goods.

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