Chilean manufacturing performance in a comparative perspective[1]

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1. Introduction[2]

There exists a vast literature on the import substitution period in Latin American economies and a wide range of explanations about its performance. The role of the manufacturing sector as the main driver of the economies and especially how the State intervened, has been part of controversial debates. However, less it is known about the quantitative performance of manufacturing measured by labour productivity levels in an international context.

In terms of its empirical contribution this is the first work which presents estimates of labour productivity between a Latin American country and the United States during the interwar period based on the industry-of-origin approach. With these estimates, I aim to provide new insights about the labour productivity gap in manufacturing between a Latin American economy -Chile- and a developed country- the United States-, and if there are variations across industries.

Despite the differences in economic structure between both countries, it is appropriate to compare with the United States since it was the leader economy during much of the twentieth century. Previous works offer empirical evidence to support this fact: the average level of labour productivity was in favour of the American economy over other advanced economies, such as the United Kingdom and Germany (Broadberry, 1997; de Jong and Woltjer, 2011; Veenstra, 2014). The international comparison provides another insight to understand the performance of manufacturing, which complements the analysis of its own evolution offered in 3.2. The main focus of this approach relies on the comparison by industries between Chile and the world frontier in order to identify trajectories of catching up over the period.

Even with data limitations especially for Chile, now we have the first estimate. As expected, productivity performance at industry levels reveals substantial gaps between Chile and the United States. The results display that Chilean labour productivity level remained 17 percent of the level in the United States in 1939. Far from being homogeneous, the results show cross-section variation by industries. In the benchmark year the range goes from 10 percent in non-metallic minerals to 33.84 percent in tobacco. Moreover, labour productivity

[1] This paper is presented at the 6th Uruguayan Economic History Congress, 2015.
[2] Please do not quote, this paper is part of one chapter of my PhD dissertation.

comparisons between both countries during a longer time period (1939-67) are substantially different across industries.

This paper is structured as follows. The next section describes the industrialization process in Chile. Section 3 presents a literature review, summarizes the data and methodology. Then, I show the main results (section 4) and conclude (section 5).

2. Industrialization process in Chile

2.1. A historical overview

By the end of World War I, and more intensely after the Great Depression in 1929, Latin American countries were unable to have sustainable economic growth based on primary goods exports. The world had changed; the international trade had decreased as well as external investment. Furthermore, other political and economic ideas opposed to liberal policies had expanded such as Keynesianism and its theory of state intervention. Due to this international situation and the current account deficits, Latin American governments encouraged industrialization for the domestic market using inward-looking economic policies especially after the 1940s (Hofman, 1998). Besides this context, a vast literature provides evidence of significant industrial activity before 1930 in Argentina, Uruguay, Chile, Mexico, and Brazil, which contributes to explain the growth of this sector after the crisis of 1929 (Bulmer-Thomas et al, 1997; Bértola and Ocampo, 2010).

Regarding Chile, the industrial activity appeared in the middle of the nineteenth century and strengthened in the 1880s due to the nitrate boom after the War of the Pacific[3]. The economic prosperity driven by mining, transportation, and agriculture, together with demographic changes, increased the domestic possibilities of developing the manufacturing sector. Besides, higher national income and the expansion of an urban middle class generated a demand for a wide range of manufactured goods. Among the most important industries were concrete, sugar, flour-milling, brewery, textiles, paper, and wine. Protection tariffs, state production and export subsidies were instruments implemented by the state to protect the infant industries. Kirsch (1977) argues that the tariff system of 1897, despite being moderate, may be considered a milestone in the protectionism scheme. On the other hand, these domestic industries depended on foreign machinery, technology, and technicians. Europeans and Americans invested directly in manufacturing in Chile, and immigrants from these regions helped to cover the needs of employing qualified labour force.

During the first stage of globalization, world trade was the main engine of growth and Chile recorded growth rates well above the average of Latin American countries (Bértola and Ocampo, 2010)[4]. However, the collapse of the nitrate after 1930, precipitated by the appearance of cheap synthetic nitrate, showed the fragility of an economy highly dependent on primary exports. Previous works claim that the Chilean economy was the most affected in the world during the crisis of 1929. While the index of world trade between 1929 and 1932 fell

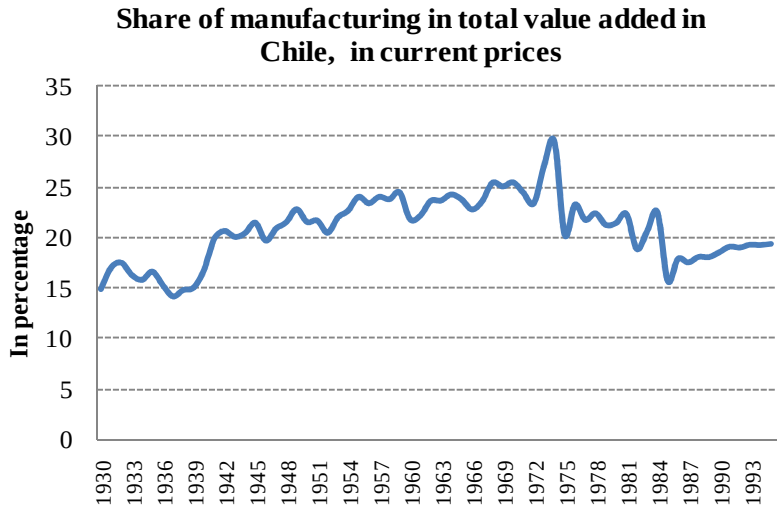
[3]Palma (1984) also supports the idea that the industrial sector was developed before the 1930s. His evidence shows that between 1914 and 1929 the domestic production increased whereas the imports were reduced. Besides, the industrial policies oriented the demand towards the local production.

[4] Chile, together with Argentina and Uruguay, was part of the group of high-income countries in the region.

from 100 to 75, in Chile this trade index dropped from 100 to 24 in exports and to 25 in imports (Palma, 1984). Besides this international context, after the 1930s the new stage of industrialization in Chile was encouraged by three domestic factors: economic groups interested in the manufacturing sector, the development of an ideology favourable to the active role of the state, and the balance among political forces (Muñoz, 1986).

As a consequence of industrialization, economic growth was driven by the manufacturing sector. Figure 1 reports the share of manufacturing in total value added from 1930 to 1995 in Chile. Two periods can be distinguished clearly. Between the years 1930-74 the manufacturing sector, despite cyclical movements, increased its share in total GDP.

Figure 1



Source: Haindl, E. (2007) "Chile y su desarrollo económico en el siglo XX".

The second period from 1974 onwards shows the decline of the manufacturing sector in the total economy. This long-run trend is quite similar to other small economies in Latin America, such as Uruguay.

The industrialization model was first a process stimulated exogenously by import substitution, and later it became in an endogenous process sustained by domestic demand and productivity. The higher demand of consumer goods increased domestic production, leading to new investments and an expansion of the supply side. Moreover, the substitution of imports by domestic production relieved the pressures on the current account deficits.

Muñoz (1971) distinguishes two different periods of industrial growth in Chile: before and after 1940. In the first period, industrial firms were led primarily by the private sector, produced non-durable goods and absorbed workers from other economic sectors. The urbanization involved the displacement of the workforce from rural workshops to the manufacturing establishments in the cities and increased the domestic consumer market (Mamalakis, 1965). Geographically, specific zones in Santiago, Valparaiso, and Concepción were transformed into dynamic centers of manufacturing (Mamalakis, 1976; Badía-Miró, 2008).

After 1940, high rates of productivity growth in total manufacturing were obtained due to greater capital intensity and a reduction of labour input. During this second period, chemicals, paper, non-metallic minerals, and textiles played a key role in the industrialization process. Especially in chemicals and paper, high investment and technical progress increased productivity rates. The paper industry is one of the oldest industries in Chile, and its production capacity grew due to mechanical and chemical pulp production. Besides, the comparative advantages of the paper and cement industry[5] explained their performance in domestic and foreign markets in these years.

Under the government of President Pedro Aguirre Cerda (1938-44), member of the Radical Party, different mechanisms to protect manufacturing were developed. The most common instruments were tariff discrimination, import licenses, quotas, prohibitions, exchange controls, and multiple exchange rates (Pinto, 1959). However, this protectionism was not homogeneous. Food, tobacco and textile were the most protected industries with a net effective protection of 100 percent. On the other hand, the rates of net effective protection in non-metallic minerals, furniture, and basic metals were between 50 and 100 percent, and chemicals and durable goods enjoyed low levels of protectionism (Muñoz, 1971; Mamalakis, 1976).

In 1939, the government created the Production Development Corporation (in Spanish: *Corporación de Fomento de la Producción de Chile,* henceforth CORFO). CORFO aimed at creating a strategy to promote economic growth and development in Chile, and it was financed by a tax on the copper industry. This organization encouraged private and public investment, stimulated technological research, and supported new industries in strategic fields, namely electricity, oil, and steel (Lagos, 1966). Thus, CORFO intended to achieve a more diversified manufacturing structure and a faster industrial growth with less external dependence.

Regarding investment, between 1940-54 CORFO controlled more than 30 percent of total investment in machinery and equipment and 18 percent of total gross domestic investment (Mamalakis, 1965). However, from a macroeconomic perspective total investment was significantly low in Chile and one of the bottleneck of the economic development. While in the 1960s the rate of gross domestic fixed investment as a percentage of GDP was 17 percent in the Latin American countries, this ratio was 9 percent in Chile (ECLAC, 1959).

A consistent policy of industrialization was followed until 1952, year in which the Radical Party was defeated. As a result of the policies implemented by the government of General Carlos Ibáñez, the economy grew but without being dynamic (Mamalakis, 1965). In the 1950s, this pattern of industrial development faced several difficulties. The literature suggests that domestic factors had a negative effect on manufacturing performance: excessive protectionism based on tariffs, weak private investment, the lack of qualified workers, inconsistency of industrial policies, inefficiency and complexity of the public administration without clear purposes (Pinto, 1959, CORFO, 1967; Lagos, 1966). However, other authors provide different explanations. Ffrench-Davis, Muñoz, Benavente, and Crespi (2003) explained that the major

[5] In 1906 Chile had the largest cement producer enterprise (*Companía Cemento El Melón*) in Latin America and the fifth largest in the world (Kirsh, 1977).

problem was not caused by the inefficiencies of protectionism, but by social inequalities, the high inflation and the orthodox plans to control it. In addition, Thorp (1998) claimed that the industrialization in Chile failed mainly because of political problems.

Due to high public spending, inflation worsened in the 1950s. The current account deficits, increased by the end of the Korean War, led to the highest inflation in the economic history of the country (an annual inflation rate of 84 percent in 1955). Due to this fact, the government hired the American consulting firm Klein-Saks to design and implement an anti-inflationary program. The main conclusions of the Klein-Saks mission were that Chile should reduce its fiscal deficit, eliminate the system of multiple exchange rates, the subsidies, the price controls and the automatic adjustment of salaries in the public and private sector. The government followed Klein-Saks stabilization policies and managed to control inflation in 1960[6]; however, industrial production declined and the unemployment rate increased due to the recessive impact of such policies. One year later, broad political and social opposition induced government to cancel these liberal reforms (Frank, 1972).

Between 1960 and 1964, under the liberal government of Alessandri, economic development in Chile was led by high and sustainable industrial growth. Nevertheless, during the tenure of the Christian Democrats (1965-70), with Frei as president, industrial growth remained sluggish. The economic policies aimed to liberalize markets and encouraged the private sector in the sixties; despite that, partial progress was made in the nationalization of copper, removal of large estates, and in industrialization policies to stimulate telecommunications and petrochemical industry. Meanwhile, political and ideological conflicts arose, weakening the institutional environment, and during his government Frei was accused of being too reformist for the right and too conservative for the left.

In 1968, CORFO claimed that due to its small domestic market Chile should increase manufacturing exports, reduce protectionism and monopolies, and liberalize the economy. Contrary to these ideas, in 1970 the Popular Unity Party (in Spanish: *Unidad Popular*) won the elections with its candidate Salvador Allende, and it reestablished and deepened the reforms based on state intervention, agrarian reform, nationalization and industrialization in a highly polarized political context (Ffrench-Davis et al 2003). As figure 1 depicts, the share of manufacturing in total value added reached its highest point during this period (27 percent in 1972).

However, the pattern of development oriented to the domestic market and led by the manufacturing sector ended in 1973. The democracy was disrupted by a military dictatorship and Chile followed the neo-liberal recipes suggested by the international financial institutions, such as privatization of state enterprises, trade liberalization, and exchange rate deregulation. This economic policy worsened the industrial growth, and on the other side, favoured the exporters of natural resources such as mining and agrarian products. Only from the late eighties did the new model implemented achieved to boost economic growth again (French Davis et al, 2003).

[6] The inflation rate dropped from 30 percent in 1959 to 7 percent in 1960 (Central Bank of Chile).

2.2. The structure of the manufacturing sector: output, employment, labour productivity and wages

In terms of contribution to the country's total value added from manufacturing sector, the figure 1 has shown that this sector played a key role in the economy between 1930 and 1974. In this subsection I describe with more detail this economic sector considering variables such as output, employment, productivity and wages disaggregated by industries. Finally, a data panel analysis aims to provide more insight into the industrialization process in Chile.

Table 1 shows the share of manufacturing in employment and total value added in different years between 1939 and 1967. While in 1939 food and beverages was the most important industry in terms of employment and value added, its shares jumped from 24.86 percent in employment and 28.75 percent in output in 1939 to 18.02 and 20.49 percent in 1967, respectively. By contrast, the share in total value added of modern industries such as basic metals, machinery, and transport equipment grew from 8.42 percent in 1939 to 30.95 percent in 1967. Moreover, these heavy industries employed 11.53 percent of total labour force in 1939, and 26.53 percent in 1967. This remarkable change is explained to a great extent by the role of CORFO during the industrialization process, as it was mentioned in 2.1.

Concerning chemicals, although it contributed significantly within total value added in 1939 and 1967, in table 1 it does not exhibit a dynamic pattern through this period. In the case of textiles, it remained a high share of total employment; however, it saw a reduction in its share of total value added since the 1950s. Apparel is another highly labour intensive industry which employed approximately 10 percent of total labour force during the period, and mainly female workers[7]. By the contrary, tobacco industry contributed more in terms of value added than in terms of employment; this fact is consistent with a capital intensive industry. On the other hand, wood and furniture, paper and printing, and non-metallic minerals achieved to play a considerable role during the period 1939-47, and lost their share in total manufacturing in the following years.

In general terms, the structure of the manufacturing sector seems to be more diversified in 1967 compared with 1939; however, it remains still dominant by the traditional industries. The economic implications of diversifying and developing more modern sectors will be presented in a future work where I will examine the process of structural change through the reallocation of labour among sectors.

[7] In the apparel industry approximately 75 percent of workers were female.

Table 1

Share of manufacturing in employment and total value added in current prices (%), Chile, selected years

	1939		1947		1957		1967	
	Labour	Value added	Labour	Value added	Labour	Value added	Labour	Value added
Food and beverages	24.86	28.75	20.29	23.52	19.41	22.63	18.02	20.49
Tobacco	1.49	2.62	0.72	5.57	0.45	5.38	0.41	3.40
Textiles	17.08	17.21	19.30	18.81	18.47	13.25	18.01	13.03
Leather and rubber	3.90	4.63	4.58	3.12	2.42	2.50	2.85	3.06
Apparel	11.52	6.10	10.81	6.54	15.89	7.79	9.27	5.09
Chemical products	5.10	11.69	6.59	11.72	4.86	7.83	5.33	7.79
Petroleum refining	0.00	0.00	0.00	0.00	0.43	3.18	0.45	0.73
Basic metals, machinery and transport equipment	11.53	8.42	15.04	11.72	18.07	20.65	26.53	30.95
Wood products and furniture	7.81	5.95	8.66	5.01	7.86	4.77	6.29	2.70
Paper and printing	7.77	8.39	5.05	6.19	4.50	5.57	4.58	6.24
Non-metallic minerals	8.56	5.17	8.76	7.39	5.98	5.23	5.07	3.93
Miscellaneous	0.40	1.08	0.19	0.40	1.66	1.22	3.18	2.58
Total manufacturing	100	100	100	100	100	100	100	100

Source: author's estimates based on *Dirección General de Estadística*, Chile.

Table 2 presents labour productivity and wage per labour both in constant prices of 1953 for several years. Labour productivity is measured as value added per total labour (employees and workers). From the official statistics I construct series of total wages, labour and value added in current prices by industries and total manufacturing. The series of value added are deflated by sector specific price indexes from 1939 to 1957 and since 1958 adjusted with official output indexes (see Appendix B). Wages are deflated using the consumer price index provided by the National Institute of Statistics[8].

As table 2 depicts wages per labour by industries are close to the level of total manufacturing. However, in tobacco, paper and printing, and chemical industries, workers obtained higher remunerations, whereas the lowest wages were paid to workers in apparel and wood and furniture industries. Despite this low dispersion, but increased during the period (see table 2. last row), in comparative terms wage differentials in Chile were larger than those calculated in highly industrialized countries. Related to this latter, explanations are based mainly on a more heterogeneous labour market in Chile. To illustrate this point, Gregory (1966) claims that Chilean industries are likely to have more unskilled labour force than in the United States and that contributes to their lower relative position in the wage structure. Furthermore, due to a higher technological gap between modern and traditional sectors, wage differentials are usually larger in less developed societies.

[8] See ttp://www.ine.cl/canales/chile_estadistico/estadisticas_precios/ipc/series_antecedentes_historicos/index.php.

On the other hand, labour productivity by industries shows a higher dispersion than remunerations, and after 1947 the coefficient of variation of labour productivity had a sharp increase. Several factors can explain this heterogeneity, such as differences in capital intensity, economies of scale, monopoly power, and institutional variables.

While workers in tobacco and chemical industries were more productive than workers in total manufacturing, in apparel and wood and furniture[9] labour productivity reached the lowest levels. In the case of metals, although it has increased its share in total value added, its productivity level remained below total manufacturing. This latter may be due to insufficient number of modern and highly capital intensive firms (Muñoz, 1971).

Table 2

Wage per labour and value added per labour by industries, in thousand chilean pesos of 1953, Chile, several years

	1939		1947		1957		1967	
	Wage per labour	Value added per labour	Wage per labour	Value added per labour	Wage per labour	Value added per labour	Wage per labour	Value added per labour
Food	69.66	181.01	69.16	202.45	73.22	264.15	139.64	344.40
Beverages	67.56	238.09	84.64	340.48	79.05	511.14	155.64	654.20
Tobacco	80.28	456.27	132.14	1,952.05	168.67	1,947.23	310.15	4,113.05
Textiles	59.33	125.76	79.11	167.20	65.42	182.93	133.88	252.24
Apparel	48.41	121.81	60.88	143.86	38.68	116.42	90.60	221.60
Wood and furniture	54.19	219.97	50.50	157.75	52.37	103.99	87.78	165.22
Paper and printing	104.98	113.73	101.78	189.87	108.85	193.85	221.36	277.42
Leather and rubber	56.56	125.38	65.82	127.56	66.17	143.32	141.40	234.14
Chemicals	79.71	323.14	88.02	429.13	100.16	379.28	183.15	309.25
Petroleum					128.78	613.77	311.91	1,776.77
Non metallic minerals	66.86	90.91	72.26	169.84	83.14	199.30	149.58	310.97
Metals	74.89	119.90	88.92	176.75	87.03	238.58	170.84	278.16
Total	68.72	144.73	90.23	194.50	86.90	239.12	150.79	324.54
Standard deviation	15.71	111.96	22.27	533.04	35.37	509.90	73.28	1,148.35
Mean	69.31	192.36	81.20	368.81	87.63	407.83	174.66	744.78
Coefficient of variation	0.23	0.58	0.27	1.45	0.40	1.25	0.42	1.54

Source: author's estimates based on *Dirección General de Estadística*, Chile.

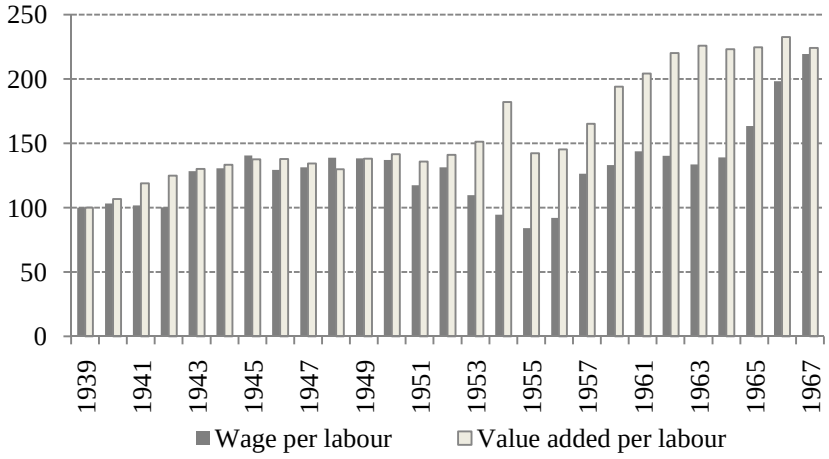
Furthermore, an overview of the evolution of productivity and wages helps to examine more in depth the industrial relations and overall manufacturing performance in the long run. Figure 2 shows that labour productivity and real wages in total manufacturing evolved similarly between 1939 and 1952, and from 1951-67 labour productivity exceeded real wages. This result is aligned with other authors who evidenced absence of positive income redistribution in favour of workers in the manufacturing sector in Chile, as it happened in other industrialized countries (Muñoz, 1971). Estimates of both indicators for Brazil and Uruguay sepa-

[9]There is an exception in 1939. In this year labour productivity in wood and furniture is 52 percent higher than the total manufacturing.

rately, also demonstrate that labour productivity performed better than real wages in total manufacturing in a similar period (Colistete, 2007; Arnábal, Bertino and Fleitas, 2011).

Figure 2

Indexes of labour productivity and wages per labour, total manufacturing, Chile. 1939=100



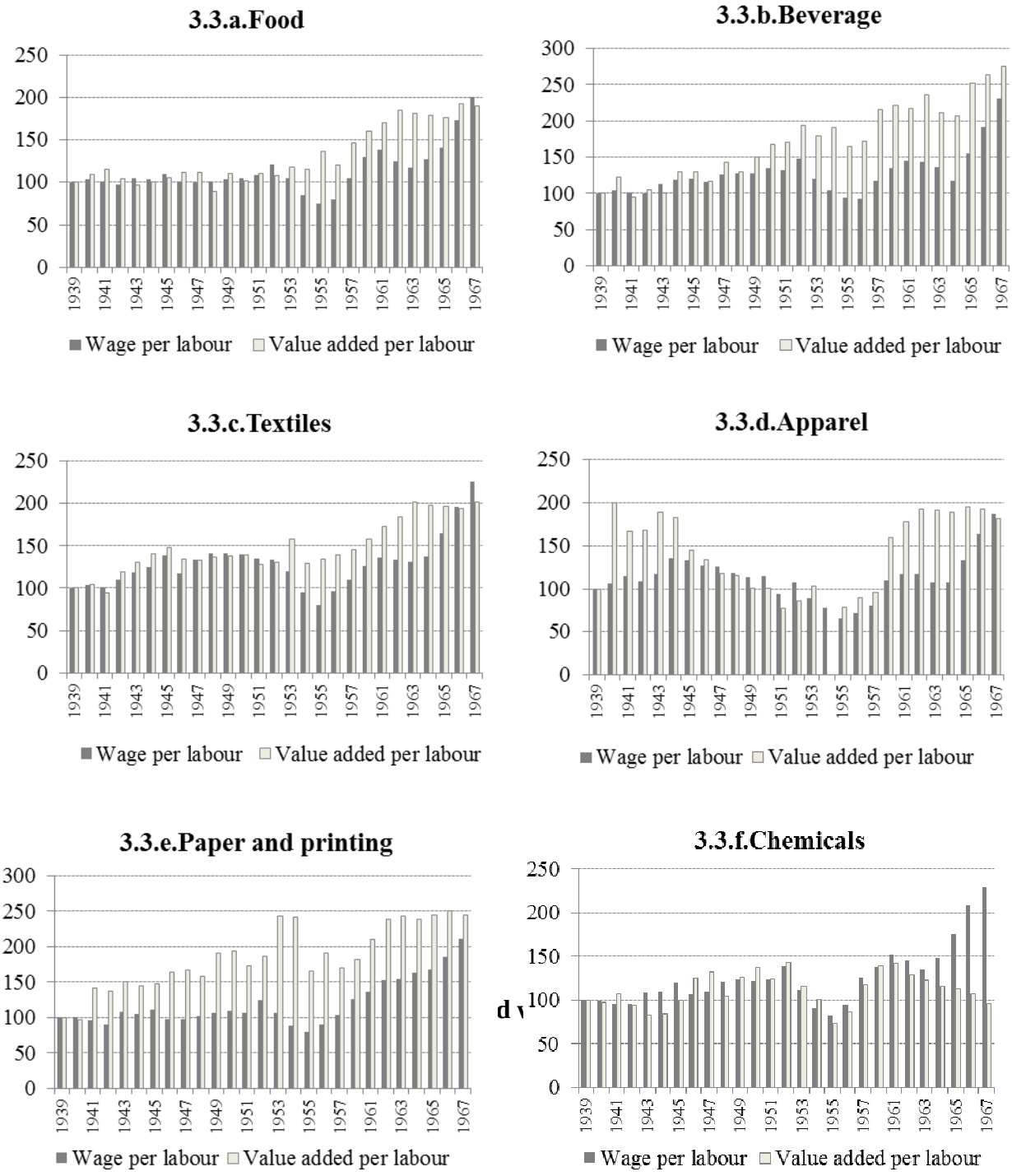
Source: author's estimates based on *Dirección General de Estadística*, Chile.

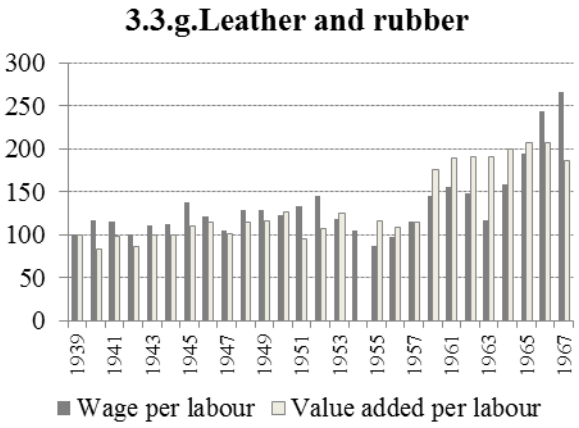
The different trajectories by industries are illustrated in the following figures. In paper and printing, non-metallic minerals, and tobacco productivity rose faster than wages per labour for the whole period. For the first two industries, as pointed out by Muñoz (1971) a higher export propensity led to take advantage of economies of scale, hence it stimulated their endowment of capital per worker and as a result of this an increase in labour productivity. In the case of tobacco industries, productivity depended positively on its high capital intensity and monopolistic structure.

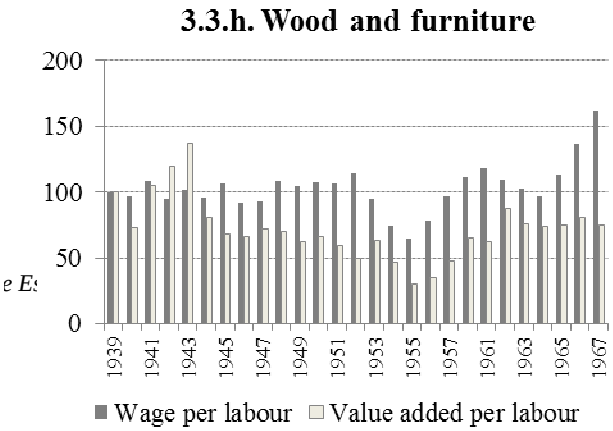
On the other hand, in food, beverages, textiles, and metals productivity evolved similarly to wages until the 1950s, and since then workers' productivity increased more rapidly than their remunerations. Productivity growth in textiles could be attributed to a late implementation of technical progress (Muñoz, 1971).

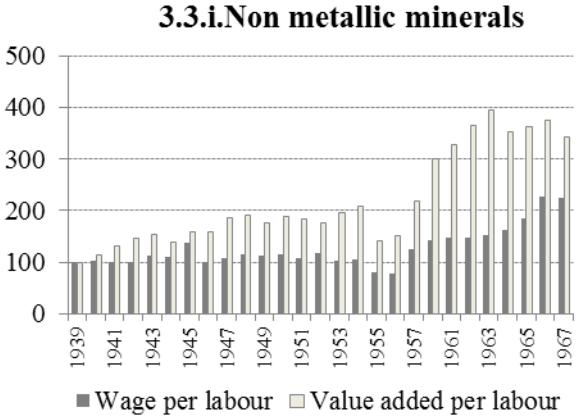
In figures 3.f and 3.h wages per labour exceeded productivity growth. While in chemicals, this took place since the 1960s, in wood and furniture this fact was noted during almost the whole period. Finally, in leather and rubber productivity and wages grew at a similar rate while in apparel productivity growth was superior to remuneration especially in the 1960s.

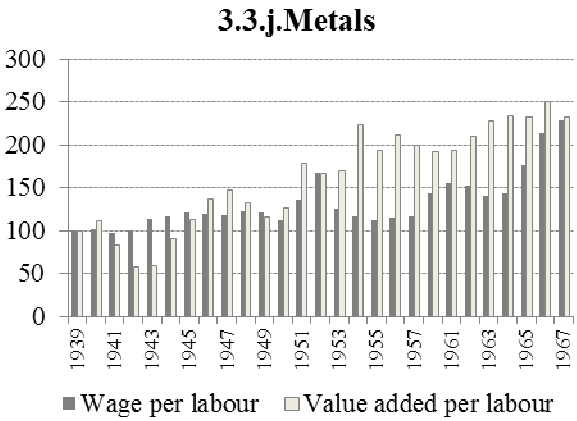
Figure 3. Indexes of labour productivity and wages per labour, by industries, Chile. 1939=100

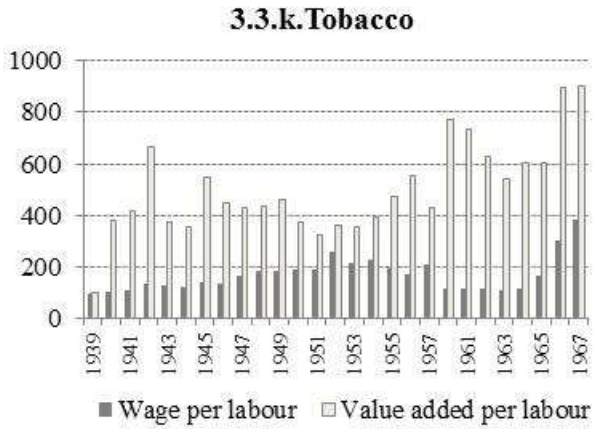












Source: author's estimates based on *Dirección General de Estadística*, Chile.

3. Methodology

3.1. Literature review

One of the aims of this chapter is to estimate labour productivity by industries for Chile compared to the United States based on the benchmark year 1939. Comparisons between two countries require to find a suitable conversion factor to express value of product and value added of both countries in a common monetary unit. The most direct way is using the exchange rate. Exchange rates are affected by capital movements, monetary policies, and other fluctuations. Therefore, they represent a suitable conversion rate for tradable goods and services, but not for non-tradable sectors (van Ark and Maddison, 1988; van Ark, 1993).

The second alternative consists of using purchasing power parities (henceforth PPPs) to establish the conversion rate. PPPs can be estimated using two alternatives. The first method, known as Expenditure PPPs, estimates price relatives by the same product groups of final expenditure (goods and services) in national currencies in different countries. Researchers have applied this methodology in the United Nations International Comparison Project (ICP), which has also been adopted by EUROSTAT and the OECD. Expenditure PPPs are based on retail consumption prices of goods produced by the country and imported goods but exclude goods produced for export and price ratios of intermediate sectors (Mulder, Montout and Peres Lopes, 2002), and are affected by trade and transport margins. Such points make this method less accurate to compare value added at industry level. Conversely, the so-called industry-of-origin method provides a more sophisticated conversion rate to compare specific economic sectors. One major advantage of this method is that the data required is obtained from a single primary source; in general, in manufacturing the sources are censuses of production or industrial surveys.

The pioneering works of this industry-of-origin method were by Laszlo Rostas (1948) and Paige and Bombach (1959). Rostas (1948) compared productivity between the United Kingdom and the United States for 31 industries using physical gross output per worker based on the UK Census of Production for 1935 and the US Census of Manufactures for 1937. Their estimates reveal that the American productivity was about 2.2 times higher than in Britain, and this advantage was especially higher in paper and printing, engineering, iron and steel, and clay and stone.

Paige and Bombach (1959) also compared both countries for 1950, but they used data on net output. By dividing the value of sales by the quantities for each product in both countries, Paige and Bombach obtained sector-specific purchasing power parities to convert value added in the same currencies by industries (Broadberry, 1997).

From the 1970s onwards, under the leadership of Professor Angus Maddison at Groningen University in the Netherlands, the Programme for International Comparison of Output and Productivity (ICOP) has developed bilateral comparisons for manufacturing using the industry-of-origin approach (van Ark and Maddison, 1988). Van Ark (1993) compiled productivity comparisons for eleven countries for the period after World War II: France, Germany, Japan, Netherlands, Japan, the United Kingdom, the United States, India, South Korea, Brazil and Mexico.

More recent studies estimate purchasing power parities to compare different countries in the twentieth century: Broadberry (1997), de Jong and Soete (1997), Fremdling, de Jong and Timmer (2007), Prado (2008), de Jong and Woltjer (2011), Frankema, Smits and Woltjer (2013), Woltjer (2013), Veenstra (2014), and Bos (2015). In the following paragraphs I summarize the main points of these papers.

Broadberry (1997) estimates British manufacturing performance between 1850 and 1990 in a comparative perspective. His estimates before 1945 are based on physical output per worker, whereas after 1945 Broadberry compares productivity levels following Paige and Bombach. The estimates after 1945 covered 77 industries in the comparison between the United States and the United Kingdom, and 32 industries between Germany and the United Kingdom. One of his results displays that during 1909/07 and 1967/68 British manufacturing performed better than Germany and the United States in lighter industries, especially food, beverages, tobacco, and textiles. On the contrary, Germany and the United States were more productive than United Kingdom in heavy industry. However, since the 1970s British heavy industry improved its performance compared with their two counterparts.

On the other hand, de Jong and Soete (1997) calculate productivity levels in manufacturing between the Netherlands and Belgium for the years 1937, 1960 and 1987. For the benchmark year 1937, the paper estimates labour productivity levels using physical quantities of output for 25 products and industries. Labour productivity in Belgium is higher compared to the Netherlands in chemicals, primary metals, brewing and cotton yarn. Conversely, in food, tobacco, paper and shipbuilding the Netherlands remains more productive than its neighbour.

Fremdling, de Jong and Timmer (2007) compare manufacturing productivity levels between the United Kingdom and Germany for the benchmark 1935/1936 applying the double deflation procedure[10].The United Kingdom shows an advantage over Germany in textile, leather, clothing, food, beverages and tobacco, and wood products. On the contrary, labour productivity levels between the UK and Germany are lower in industries such as iron and steel, engineering, shipbuilding, chemicals, paper, and manufacturing as a whole.

For Sweden, Prado (2008) estimates physical comparisons between this country and the United Kingdom and the United States, in three benchmark years (circa 1907/09, 1924/25, and 1937/35). His results show that Sweden could catch up with both countries during the period, although the gaps were considerably different. While in 1935 the British supremacy was estimated in 17 percent, the American level was 85 percent higher than Sweden for this year. Additionally, the Nordic economy presented poorer results in stone, clay, glass, chemicals, and engineering.

For a British/American comparison, de Jong and Woltjer (2011) calculate the manufacturing productivity gap based on the benchmark year 1935 using single and double deflation, and also adjusting for hours worked. They conclude that US/UK manufacturing productivity levels in terms of hours worked and double deflated PPPs increased from around

[10] According to OECD Glossary of Statistical terms: Double deflation is a method whereby gross value added is measured at constant prices by subtracting intermediate consumption at constant prices from output at constant prices; this method is feasible only for constant price estimates which are additive, such as those calculated using a Laspeyres' formula (either fixed-base or for estimates expressed in the previous year's prices).

200 to 300 between 1900 and 1957. Chemicals, paper and engineering industries were the main industries which explained this American successful performance. Later, Woltjer (2013) provides estimates for the United States and the United Kingdom around 1910 at sectoral levels (agriculture, mining and 11 manufacturing industries). His results using double deflated PPPs show that the United States was more productive in industries of durable goods, such as metal industries, engineering and wood. Conversely, the United Kingdom showed more advantage in food, beverages and tobacco, textile, apparel and leather, chemicals, petroleum and rubber.

A broader study on the Netherlands, France, the United Kingdom and the United States (Frankema, Smits and Woltjer, 2013) estimates levels of labour productivity for agriculture, mining and five manufacturing industries circa 1910.One of the main findings is that in manufacturing as a whole, labour productivity in the United Kingdom remained 55 percent below the American level, in France about 60percentand in the Netherlands about 70percent.

In 2014 Veenstra compares manufacturing productivity levels in Germany with the United States and the United Kingdom for the benchmarks years 1909 and for 1935-36. The matching procedure between Germany and the US covers 74 items in 1909 and 125 in 1935. German and American productivity levels did not converge in the interwar period, explained by the success of the US rather than German poor performance. Moreover, his work applies industry-of-origin benchmarks between five European countries (the United Kingdom, Germany, France, the Netherlands and Sweden) relative to the United States around 1910. The results shows that German labour productivity level remained at 50 percent of the United States level, whereas British was at 41 percent, French 38 at percent, Dutch at 32 percent and Swedish at 36 percent.

Finally, Bos (2015) employs a unit value comparison between West Germany and the United Kingdom for three benchmark years (1935, 1951, and 1968). For 1935, the matching procedure covers 229 items, while in 1951 it covers 186 items representing 26 percent of British industry and 33 percent of German industry. West-Germany labour productivity is higher than the British level for the three benchmark years, especially in 1951 (Germany was 83 percent ahead of the UK). The German lead is more evident in heavy industry and chemicals.

This literature review reveals that no peripheral country has been compared before using purchasing power parities for the manufacturing sector and in a disaggregated level during the interwar period. Therefore, the results presented above are a significant reference to compare with this current research.

3.2. Data

Following the industry-of-origin method average value of produced items are calculated to establish a relative price of a product in the two countries in the comparison. These are obtained by taking the ratio of values and quantities of items as reported in the production statistics.

The source of information for Chile has certain shortcomings that must be considered. The available data about quantities and output value by products could be collected only from sta-

tistical yearbooks, published by the General Administration of Statistic (in Spanish: *Dirección General de Estadística)*[11]. For this benchmark I use the Yearbook of 1939. Firms with less than 5 employees are not considered in the statistics. Moreover, the description provided in the Yearbook is not comprehensive enough to measure the bias introduced by this collecting procedure. However, one could infer from references in the subsequent (and more rigorous) censuses[12] that small and informal enterprises were not included. Assuming that small units are less productive than medium or large, hence the bias would be towards overestimating productivity levels for total manufacturing. In the absence of a more complete coverage these results cannot be simply generalized.

The Yearbook 1939 provides the following data disaggregated by industries and regions[13]: wages and salaries, employees and workers, horse-power (electrical and non-electrical), output, value added, number of establishments, and capital investment.

Data about physical quantities and output value could be obtained for some selected industries: textile, apparel, footwear and leather, and chemicals. Because of output value constraints, wholesale prices were employed in two cases in order to fill this gap (cigars for tobacco industry and paper for paper and printing industry)[14].

The data for the United States is obtained from the Census of Manufacturing 1939.Data was collected only from establishments reporting products to the value of 5,000 dollars or more. It includes at industry level: number of establishments, employees and workers, wages and salaries, hours worked, value added, and output. Physical quantities and output by products are detailed in the reports by industries of the Census of Manufactures 1939, and the product supplement of the Census of Manufactures 1947.

The benchmark year 1939 is extrapolated until 1967 using the series of value added at constant prices and labour for Chile and the United States explained carefully in the Annex B.

3.3. The industry-of-origin approach

In order to estimate sector-specific purchasing power parities, so-called unit value ratios (uvrs), comparable products are identified in the two countries. There can be numerous problems in establishing the correspondence between products, such as the differences in unit of measurement, product quality differences, and products in one country that are not produced in the other. The matching procedure starts at the most detailed level as possible, and only then aggregated to a higher level[15].

I calculate for the two countries (Chile and United States), for each product matched, the unit value (p_i), obtained by dividing the output value (v_i) by the respective quantity for this product (q_i) (see equation 1). Therefore, the unit value represents the average producer price of each product i in the countries. The unit value ratios (uvr_{io}) reflect the product specific

[11] The manufacturing censuses do not provide information about output value and quantities by products.
[12]Census of Manufacturing 1967.
[13]The Province of Ñuble was excluded because of the devastating earthquake on 24 January,1939. However, its contribution to national value added has been insignificant in previous years (see appendix B).
[14]Information about physical quantities and wholesale prices are obtained from the Yearbook of 1939.
[15]The assumptions behind the products matched are quite strong: products with comparable qualities, similar market structures, and prices would only reflect different currency values.

relative prices expressed in terms of country n´s currency (Chilean pesos) per unit of the base country o´s currency (US dollars) (see equation 2).

(1) $p_i = \frac{v_i}{q_i}$, calculated separately for Chile and United States

(2) $uvr_{io} = \frac{p_{in}}{p_{io}}$

The aggregation procedure to obtain the aggregated uvrs at industry level, is calculated weighting the uvr_i of the matched products in the same industry group according to their share in the total matched output ($^{v_i}/_{\sum v_i}$). First, using American output weights (the base country o) (see equation 3) and then Chilean output weights (the numerator country n) (see equation 4): Laspeyres (L^{agg}) and Paasche (P^{agg}), respectively (Woltjer, 2013; Veenstra, 2014).

(3) $L^{agg} = \frac{\sum v_{io} * uvr_{io}}{\sum v_{io}}$

(4) $P^{agg} = \frac{\sum v_{in}}{\sum v_{in}/uvr_{io}}$

The final uvr used is a Fisher index, which is a geometric average of the Paasche and Laspeyres indexes. The Fisher uvr satisfies the country reversal test (i.e. changing the denominator and numerator does not alter the results) and the factor reversal test (i.e. a Fisher price index times a Fisher quantity index gives a Fisher value index) (van Ark, 1993). The Fisher uvr is used to calculate productivity binary comparisons on a disaggregated basis.

(5) $F = \sqrt{L^{agg} * P^{agg}}$

Finally, I use the single indicator method. Although double deflation is more adequate than single deflation since it takes into account relative prices for intermediate inputs, it is not possible to find physical quantities and prices for inputs and construct inputs PPPs. The single deflation is based on the following assumptions: 1) at product level, the value share of intermediate inputs in each unit of output is the same for all products within that industry and across countries, 2) UVRs for inputs equal the corresponding UVR for gross output (van Ark, 1993).

4. Chile/US comparisons of labour productivity

4.1. Benchmark results

A number of 46 products are matched between Chile and the United States for the benchmark year 1939 covering the following industries: tobacco, textiles, leather and rubber, chemical products, and paper and printing. The inability to match more products stems from insufficient Chilean data and the remarkable disparities in the economic structures of both countries.

The coverage ratio of the industries is calculated by dividing the value of matched products by the value of total products recorded in the official statistics (the manufacturing census in the United States and the statistical yearbook in Chile). As table 3 illustrates the average coverage ratio represents 16 percent of total manufacturing in Chile and 4 percent in the United States (see last row and column VIII), much lower than the coverage ratio obtained in the binary comparisons mentioned in 3.1.

These low coverage ratios and the inability to match products linked to heavy industries may introduce a bias in the estimates. It is likely that the results obtained underestimate the advantages of the United States over Chile.

Table 3

Number of UVRs, value of matched and total products, coverage ratio, Chile and US, 1939

Branches	Number of UVRs	Value of matched products		Value of total products		Coverage ratio (% of matched)		
		Chile (thousand pesos)	USA (thousand dollars)	Chile (thousand pesos)	USA (thousand dollars)	Chile	USA	Geometric average
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Tobacco	1	3,362	159,903	149,485	1,322,189	2	12	5
Textiles	8	347,064	1,683,101	530,322	3,930,678	65	43	53
Leather and rubber	3	176,838	659	372,518	2,291,843	47	0	1
Chemical products	31	82,596	313,933	357,451	3,606,948	23	9	14
Paper and printing	3	59,491	263,218	271,684	4,598,033	22	6	11
Total of above	46	669,352	2,420,814	1,681,459	15,749,690	40	15	25
Total manufacturing		669,352	2,420,814	4,167,787	56,695,751	16	4	8

Source: author's estimates based on *Dirección General de Estadísticas*, Chile; Census Bureau, US

Leaving aside the levels of coverage ratio, I assume that each industry and total manufacturing is well represented by the total matched. Therefore, the Fisher UVR for total manufacturing is 32.73 Chilean pesos per dollar, which is slightly higher than the exchange rate[16] (32.02). The relative price level is calculated by dividing the Fisher UVR by the

[16]The exchange rate is obtained from Braun, J., Bran, M., Briones, I., Díaz, J., Lüders, R., & Wagner, G., (2000) "Economía Chilena 1810-1995: Estadísticas históricas", Documento de Trabajo No. 187, Instituto de Economía – Pontificia Universidad Católica, Santiago de Chile.

exchange rate. In the manufacturing sector as a whole, the relative price level is 102.22 (see table 4). This figure indicates that Chilean manufacturing products are less price-competitive than the American products. This is shown when relative price levels are above 100.

Table 4

Unit value ratios for the benchmark year 1939, total manufacturing national currency to numéraire currency

Binary comparison	Laspeyres UVR	Paasche UVR	Fisher UVR	Exchange rate	Relative price level
Chile/US	39.89	26.86	32.73	32.02	102.22

Source: author's estimates based on *Dirección General de Estadística*, Chile; Census Bureau, US

Table 5 depicts that Chile is more price-competitive than the United States in tobacco, leather and rubber, and paper and printing. Conversely, the United States is more price-competitive in chemical products, textiles, and manufacturing as a whole. For chemicals, Laspeyres and Paasche UVR are significantly different. Remember, however, that the weights in Laspeyres and Paasche are derived from output value in the United States and Chile respectively, therefore the deviation between them reflects the different economic structures in both countries.

Table 5

Unit value ratios for industries, Chile and the United States, 1939

	Laspeyres UVR	**Paasche UVR**	**Fisher UVR**	**Fisher UVR as % of Exchange rate**
Tobacco	19.63	19.63	19.63	61
Textiles	41.27	34.11	37.52	117
Leather and rubber	25.46	26.28	25.87	81
Chemical products	61.23	18.44	33.60	105
Paper and printing	17.91	17.67	17.79	56
Total manufacturing	39.89	26.86	32.73	102

Source: author's estimates based on *Dirección General de Estadística*, Chile; Census Bureau, US

Table 6 illustrates the comparative levels for the benchmark between Chile and the United States of value added per employee using Fisher UVR. In the remaining industries, when sectoral PPPs could not be estimated, I employ the Fisher UVR for total manufacturing. Productivity levels can be calculated as value added per employee and value added per hour worked. Because of working hour data constraints in Chile, I only present value added per employee. Implicitly, it assumes in both countries the same average length of the working week, and the number of holidays.

Relative levels of value added per employee are calculated as the ratio of value added per employee in Chile (expressed in dollars using Fisher UVR) over value added per employee in the United States (expressed in dollars).

The ratio of value added per employee (using Fisher UVR) measures the gap between both countries. Chilean labour productivity in 1939 was 17 percent of the American level, and despite variations across sectors, the productivity ratio always remains favourable to the United States, by no means surpassing 35 percent (see table 6). As expected, these results are rather poor compared with the productivity ratio estimated between European countries and the United States for a similar period. By industries, Chile reduces its labour productivity gap in relation to the United States in textiles, wood and furniture, and tobacco.

Since the Fisher UVR for total manufacturing closely resembles the exchange rate[17], the ratios of value added per employee in Chile compared to the United States using the exchange rate and the UVR do not differ: 17.06 and 16.69, respectively. However, these ratios vary noticeably in the matched industries, with the exception of chemicals. In tobacco, leather and rubber, and paper and printing labour productivity ratios using the Fisher UVR present higher levels than using the exchange rate (see columns VIII and IX in table 6).

Table 6

Value added, person engaged, and comparative productivity levels by industries, Chile and the United States, 1939

	Value added in current currency		Value added Chile using UVR Fisher	All employees		Value added per employee (US$) using UVRs		Labour productivity (US=100) using UVR	Labour productivity (US=100) using exchange rate
	Chile (thousand pesos)	USA (thousand dollars)	Chile (thousand dollars)	Chile	USA	Chile	USA		
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
Food and beverages	451,412	3,555,987	13,792	25,272	916,221	546	3,881	14.06	14.37
Tobacco	41,212	350,152	2,099	1,628	91,870	1,290	3,811	33.84	20.74
Textiles	270,217	1,821,752	7,202	17,085	1,137,175	422	1,602	26.31	30.83
Apparel	29,960	1,381,338	915	3,834	788,517	239	1,752	13.63	13.93
Leather and rubber	138,493	989,757	5,353	11,396	486,029	470	2,036	23.07	18.64
Chemicals products	183,501	1,822,301	5,462	5,789	330,228	943	5,518	17.10	17.94
Petroleum	-	695,614	-		126,245		5,510		
Paper and printing	131,712	2,636,359	7,404	8,830	740,151	839	3,562	23.54	13.08
Wood and furniture	93,490	1,144,814	2,856	7,812	652,259	366	1,755	20.83	21.29
Non metallic minerals	81,123	911,359	2,479	8,485	314,977	292	2,893	10.10	10.32
Metals	132,288	8,361,332	4,042	11,738	2,823,307	344	2,962	11.63	11.88
Miscellaneous	16,885	933,607	516	545	356,328	947	2,620	36.13	36.93
Total manufacturing	1,570,291	24,604,372	47,977	102,414	8,763,307	468	2,808	16.69	17.06

Note: metals comprises basic metals, machinery, and transport equipment.
Source: author's estimates based on Dirección de Estadística y Censos, Chile; Census Bureau, US.

[17]Several previous works have also found an UVR for total manufacturing similar to the exchange rate (de Jong, 2003; Prado, 2008; Frankema et al 2009; Veenstra, 2014; Bos, 2015).

Another binary comparison is the net result of relative productivity and relative remuneration, expressed by the concept of unit labor cost. The relative productivity is measured as the labour productivity in Chile related to the United States, and the relative remuneration is measured as the wage per employee in Chile relative to the United States. Therefore, unit labour cost (ULC) measures the average cost of labour per unit of output and is calculated as the ratio of relative remuneration to relative productivity.

Understanding the ULC as a reflection of cost competitiveness, Chile is more cost-competitive than the United States in total manufacturing (ULC is almost 20 percent below the American), and also at a disaggregated level, with the exception of food and beverages, non-metallic minerals, and metals (see table 7).In such industries, relative wages per employee do not differ from the total manufacturing; however, their labour productivity ratios performed below average. In tobacco industry, which is a highly concentrated sector (Lagos, 1966), relative wages per employee reaches the highest rate (23.36 per cent), aligned with a relatively high productivity rate (33.84 per cent).

Table 7

Relative levels of unit labour cost in Chile (USA=100), 1939

	Unit labour costs	Wage per employee	Labour productivity
Food and beverages	102.47	14.41	14.06
Tobacco	69.04	23.36	33.84
Textiles	62.09	16.34	26.31
Apparel	96.04	13.09	13.63
Leather and rubber	55.36	12.77	23.07
Chemicals products	82.75	14.15	17.10
Paper and printing	73.98	17.42	23.54
Wood and furniture	68.15	14.20	20.83
Non metallic minerals	132.96	13.42	10.10
Metals	104.64	12.17	11.63
Miscellaneous	54.81	19.80	36.13
Total manufacturing	**81.42**	**13.59**	**16.69**

Note: metals comprises basic metals, machinery, and transport equipment.

Source: author's estimates based *on Dirección General de Estadística*, Chile; Census Bureau, US

4.2. Explaining the differences in labour productivity levels

In this subsection, I analyze possible variables which help to explain labour productivity gap between Chile and the United States at a disaggregated level for 1939. The data is obtained by the statistics mentioned in 3.2.

Following Broadberry (1997) and de Jong (2003), a selected group of relative factors might contribute to explaining relative labour productivity between countries across sectors. The variables are capital intensity, human capital, market size and plant size, and are expressed in Chilean terms as a proportion of its US counterpart.

Given the lack of comparable data on industrial capital, capital intensity is calculated as the ratio of installed horsepower by worker in both countries[18]. As expected, Table 8 shows that the American industries had higher capital intensity than their Chilean counterparts, and it was rather significant in chemicals, non-metallic minerals, metals, wood and furniture, and leather and rubber[19].

Table 8

Comparison between Chile and the US: output value per unit of labour, capital intensity, human capital, market size, and plant size. US=100. Year 1939

	Output value per unit of labour	Capital intensity	Human capital	Market size	Plant size
Food and beverage	18.65	52.11	14.40	14.57	63.90
Tobacco	32.50	66.14	23.35	16.31	n.a.
Textiles	23.93	39.93	16.34	10.19	53.48
Apparel	17.59	n.a.	13.09	2.42	19.78
Wood and furniture	19.07	29.02	14.19	6.47	54.64
Paper and printing	27.84	92.93	17.41	9.41	76.70
Leather and rubber	26.80	26.02	12.77	17.80	n.a.
Chemicals	16.82	18.00	14.14	8.35	19.16
Non metallic minerals	12.58	24.89	13.42	9.60	96.01
Metals	10.18	34.18	12.16	1.20	88.13
Miscellaneous	25.37	37.71	19.80	1.10	34.71
Total	19.22	42.12	13.58	6.36	79.59

Note: metals comprises basic metals, machinery, and transport equipment.
Source: author's estimates based on *Dirección General de Estadística*, Chile; Census Bureau, US

On the other hand, human capital is another important factor related to productivity performance. An appropriate indicator of human capital should weight wages by years of schooling levels; however, data on schooling is not available and human capital is proxied by wage per worker. The strong assumption behind this is that earning per worker is equal to his

[18] Veenstra (2014), and Frankema and Visker (2011) also employ installed horse power per hours worked or per employees, in their analysis of the productivity gap.
[19] After checked, the result extremely favourable to Chile in apparel industry is not convincing; thus it is not presented in the table 8.

marginal productivity. The results report that Chilean average wages across industries were lower than corresponding American wages, especially in metals, non-metallic minerals, chemicals, and leather and rubber industries (see table 8).

In addition, market size is estimated as the comparative total gross output of the industries divided by total population, and then compared between the two countries[20]. As de Jong (2003: 93) pointed out: *"A large market size may influence the level of productivity of industries because it enables them to benefit from economies of scale and allows companies or plants within a particular industry to specialize"*. Concerning this variable, the figures in table 3.8 report that the market available to Chilean companies is insignificant compared to the American market.

The last variable is the average plant size. This is calculated as the number of employees per establishment. According to Chandler (cited by de Jong, 2003: 97), higher plant size impacts positively on labour productivity. Nevertheless, this statement is controversial; Broadberry and Crafts reject it. Table 3.8 illustrates that plant size in Chile is smaller than in the United States.

Using descriptive statistics, the correlation coefficients show a positive relationship between Chile/US labour productivity and human capital, market size, and capital intensity. However, the magnitudes are different. Human capital presents an extremely strong linear relationship; whereas market size and capital intensity are less strongly related. On the other hand, plant size and labour productivity are not correlated (see table 9).

Table 9

Coefficients of correlation between comparative Chile/US labour productivity and explanatory variables	
Capital intensity	0.57
Human capital	0.77
Market size	0.51
Plant size	-0.28
Number of observations=11	

Source: author's estimates based on *Dirección General de Estadística*, Chile; Census Bureau, US.

4.3. Series of labour productivity levels between 1939 and 1967

I start with the labour productivity comparison for the benchmark year 1939, and after extrapolating the series of value added and labour I cover the period 1939 to 1967.

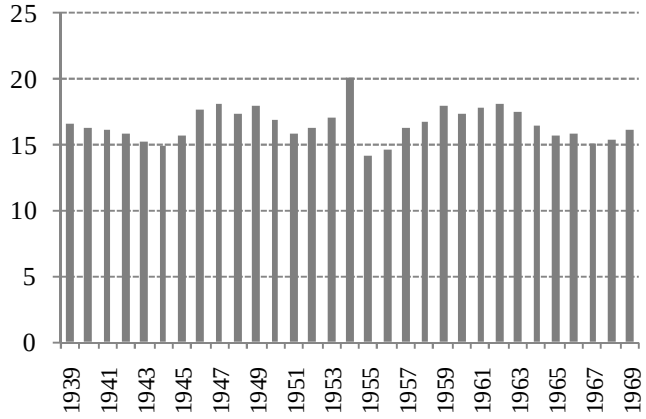
In this subsection I present the results of labour productivity levels between Chile and the United States by industries. In the total manufacturing, Chilean productivity related to the United States presented a volatile evolution, reaching its highest point in 1953 (20 percent of

[20] A more sophisticated estimate should include industrial imports and exports; however, this data is not available.

the American level). In 1954 the gap increases sharply and then it started to reduce slightly until 1962. From 1963 onwards productivity in Chile diverges from the American levels steadily. In sum, according to the data collected it is evident that Chile could not reduce its gap with the United States, and its short improvements were followed by periods of failure. Market size, standardization, the relative cheaper price of energy, were factors which contribute to explaining the performance of the United States during this period.

Figure 4

Labour productivity Chile/US, total manufacturing. US=100



Source: author's estimates based on *Dirección General de Estadística*, Chile; Census Bureau, US

The figures in 5 show the different performances by industries. Value added per labour in food and beverages in both countries increased during the period, although in Chile it grew much faster than in the United States (see figure 3.5.a). In both countries factors such as greater scale of operation and intensity of mechanization explained their productivity performance. In the case of food industry in Chile, since the 1960s the fishmeal and fishoil industries were supported by the state and it led to increase their production growth.

Concerning tobacco industry, Chile had an advantage over the United States between 1940 and 1949 due to its high capital intensity production, its monopolistic structure, and the more reduced share of cigar production compared with the American industry. However, since the 1950s greater standardization in the United States led to improvements in labour productivity in this sector and a better position compared to Chile.

During 1939 and 1950 labour productivity level in the Chilean textile industry remained 75 percent of the American level, which one of the best results achieved by industries. After that, specialization, integration and a more concentration of employment in the United States explained its much faster progress compared with Chile. Apparel industry lost its ground in Chile compared with the United States between 1940-1955 (with the exception of 1954) and from 1956 it recovered slowly.

In the case of leather and rubber, the gap remained 80 percent of the American level, and the performance of this latter was key to understand the comparison. Footwear in the United States, which is included in leather and rubber, improved its productivity due to larger size of the average firm, specialization, and more intensified preparation of work, among other reasons.

During 1939-1943 wood and furniture's productivity in Chile compared with the Unites States improved, but since then the gap started to increase, despite the fact that the American performance was disappointing until the 1960s.

On the other side, Chilean's paper and printing industry closed the gap with the American counterpart during 1939-1954. The performance of this industry in Chile could be explained by its high capital intensity, high plant size, abundant and high quality raw materials, and its export propensity. Despite American industry improved during the period, Chile could catch up with the US and reached one of the shortest gap in 1953-54.

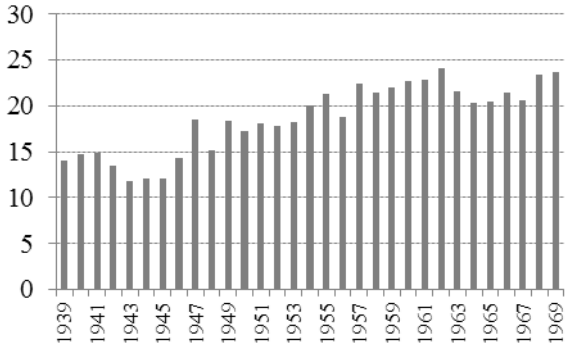
In the case of non-metallic minerals, there was also a process relatively successful for Chile. Although value added per labour increased in the United States because of improvements in quality and technical progress[21], the Chilean industry could improve along the period.

In the heavy industries (chemicals and metals) the catching-up process with the United States was even more difficult because in both industries the American economy performed better during the period. The highest level of mechanization was one of the explanations of the American performance in metal industry. In Chile, since the 1950s chemicals widened the gap with the US, whereas metals improved but remaining below the level of 15 percent. Low market size and low human capital in metal industry in Chile contribute to determine its low productivity level in comparative terms.

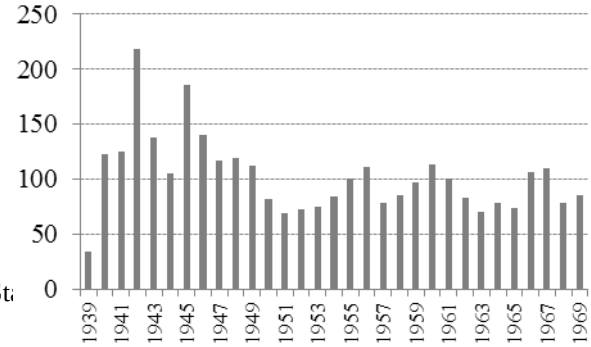
To sum up, the comparative labour productivity (see figures 5) suggest that there was a substantial difference between Chilean and American manufacturers. Despite some exceptions, Chilean producers did not take advantages of technology or scale in the industries. Paper industry, non-metallic minerals, and food and beverages could be considered the industries which performed better during the period compared with the United States. Moreover, these industries are primarily intensive in natural resources.

Figures 5. Labour productivity Chile/US by industries. US=100

3.5.a. Food and beverages

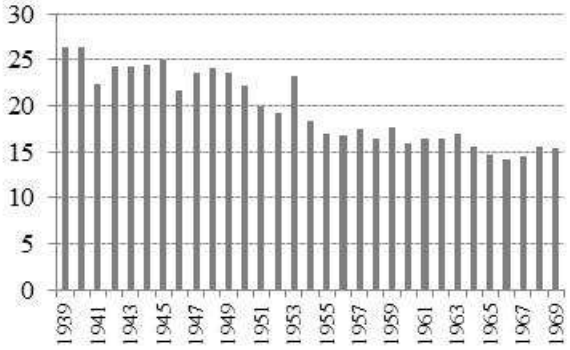


3.5.b. Tobacco

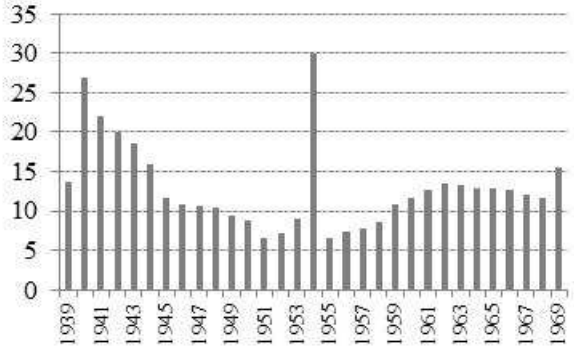


Figures 5. Labour productivity Chile/US by industries. US=100

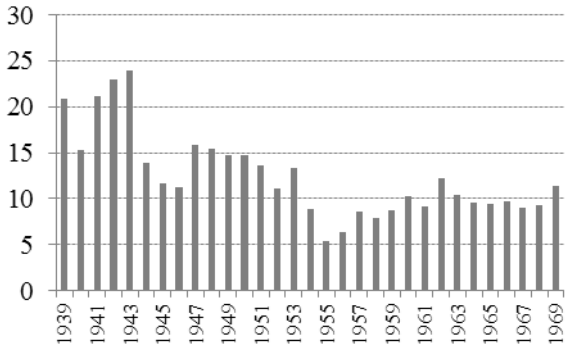
3.5.c. Textiles



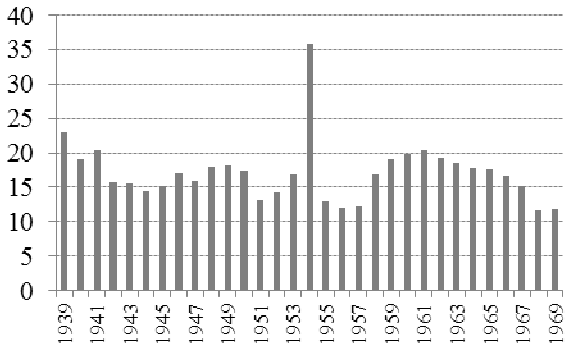
3.5.d. Apparel



3.5.e. Wood and furniture

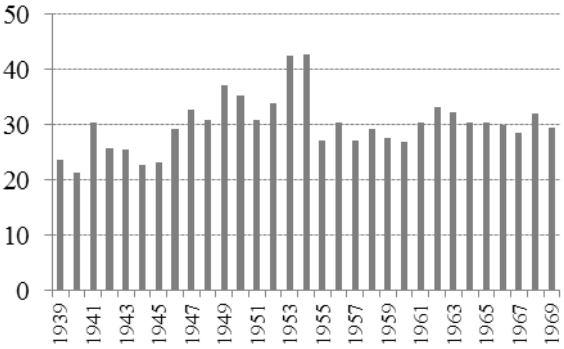


3.5.f. Leather and rubber

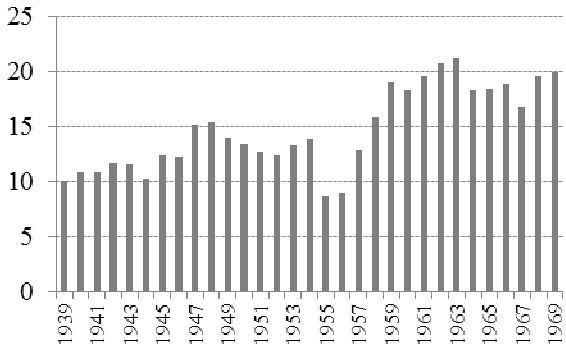


Est

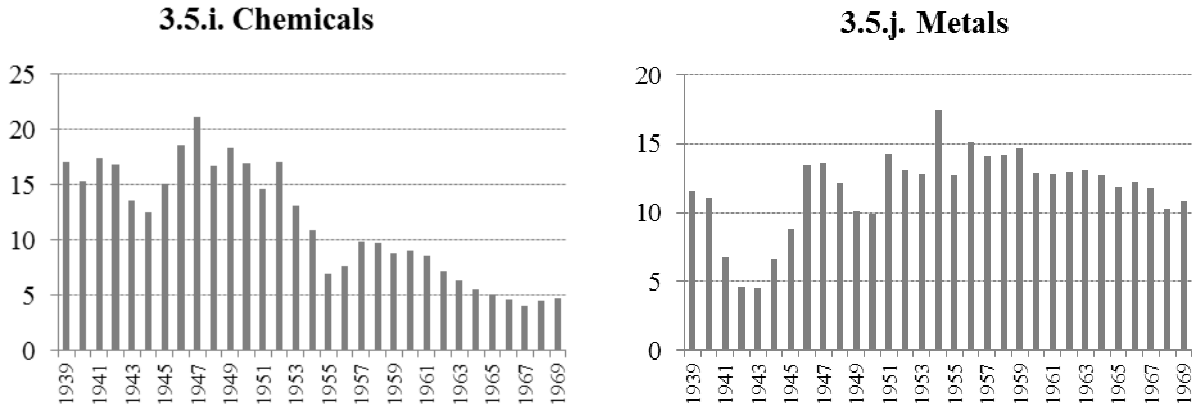
3.5.g. Paper and printing



3.5.h. Non metallic minerals



Figures 5. Labour productivity Chile/US by industries. US=100



Source: author's estimates based on *Dirección General de Estadística*, Chile; Census Bureau, US

5. Conclusion

I apply the industry-of-origin approach to obtain currency conversion factors or so-called "unit value ratios" in order to compare the manufacturing performance of Chile to the United States. These factors are obtained as the ratio of values and quantities of items reported in production statistics, and they are matched across the two countries.

In terms of its empirical contribution this is the first work which presents estimates of labour productivity between a Latin American country and the United States during the interwar period based on the industry-of-origin approach. With these estimates, I aim to provide new insights about the labour productivity gap in manufacturing between a Latin American economy-Chile- and a developed country-the United States-, and if remains cross industries variations.

In the matching procedure I had to deal with difficulties, mainly due to insufficient data in Chilean statistics. The coverage ratio of the industries matched represents 16 percent of total manufacturing in Chile and slightly 4 percent in the United States. However, it is high unlikely to improve this coverage ratio after having explored official statistics in Chile comprehensively. Furthermore, the low coverage ratios, the inability of matching products linked to heavy industries, and the source employed in Chile, may introduce a bias which underestimates the advantages of the United States over Chile.

Assuming that the matching is representative of the whole sector, for the benchmark year 1939 the Chilean labour productivity level was 17 percent of the American level, and despite variations across sectors, the productivity ratio always remains favourable to the United States by no means surpassing 35 percent. As expected, these results are rather poor compared with the productivity ratio estimated between European countries and the United States for a similar period. In addition, in the comparison by industries, in textiles, wood and furniture,

and tobacco, relative labour productivity ratios improve slightly between Chile and the United States.

In terms of unit labour costs, Chile is more cost-competitive than the United States in total manufacturing and at a disaggregated level, with the exception of food and beverages, non-metallic minerals, and metals. In these industries, relative wages per employee do not differ from the total manufacturing; however, their labour productivity ratios performed below the average.

Annex A. Data

Table 1. Product items, unit of measure, quantities produced, output value, unit value in local currency, quantities valued at other currency, and unit value ratios. Chile and US, 1939

		Chile			
Product item	Unit of measure	Quantity	Value of product shipment	Unit value in local currency	Quantity valued at other currency
Cigars	number	5,595,258	3,362,316	0.60	171,288
Wool yarn	kgs	480,541	17,516,524	36.45	1,184,284
Cotton fabrics	mtrs	24,680,445	116,333,398	4.71	2,315,732
Hosiery (incl socks)	dozen pairs	1,091,890	60,360,167	55.28	2,916,300
Underwear	dozen	362,996	33,676,547	92.77	836,014
Outerwear	dozen	41,343	7,896,026	190.99	528,050
Textile fabrics	kgs	96,830	4,400,658	45.45	150,185
Silk fabric	mtrs	4,767,212	73,611,458	15.44	1,060,907
Jute products	kgs	5,112,403	33,269,295	6.51	1,184,281
Footwear for men	pairs	1,195,380	70,168,806	58.70	2,501,820
Footwear for women	pairs	1,822,046	76,799,239	42.15	3,269,644
Footwear for kids	pairs	1,334,675	29,870,027	22.38	956,358
Writing paper	kgs	13,250,788	36,614,019	2.76	2,063,156
Wrapping paper	kgs	11,762,149	18,231,331	1.55	1,009,943
Cardboard	kgs	3,248,795	4,645,777	1.43	294,433
Hydrochloric acid	kgs	481,455	400,882	0.83	24,755
Nitric acid	kgs	126,984	318,306	2.51	2,411
Sulphuric acid	kgs	3,470,088	3,171,774	0.91	16,978
Tartaric acid	kgs	44,464	838,813	18.86	25,975
Acetic acid	kgs	81	2,252	27.80	8
Boric acid	kgs	25,000	90,000	3.60	2,370
Sodium sulfide	kgs	1,021,978	1,987,706	1.94	53,204
Phosphate	kgs	17,959,632	8,953,952	0.50	1,617,349
Iron sulfate	kgs	50,000	40,000	0.80	628
Zinc sulfate	kgs	2,000	6,000	3.00	108
Aluminium sulfate	kgs	392,525	382,119	0.97	7,976
magnesium sulfate	kgs	684,053	610,320	0.89	20,216
Sodium sulfate	kgs	870,250	294,284	0.34	10,703
Barium sulfate	kgs	767,000	285,811	0.37	44,389
sodium sulfite anhydrous	kgs	17,823	58,889	3.30	1,103
Liquid and powder sodium	kgs	288,536	441,054	1.53	96,535
sodium silicate	kgs	56,791	78,530	1.38	2,222
Potassium iodide	kgs	2,000	140,000	70.00	5,179
Silver nitrate	kgs	520	192,440	370.08	4,866
zinc oxide	kgs	55,248	230,942	4.18	5,823
Ammonia	kgs	139,428	421,421	3.02	11,460
glycerin	kgs	153,215	1,632,747	10.66	26,812
methyl alcohol	litres	44,503	734,299	16.50	3,209
calcium carbonate	tons	18,576	1,056,183	56.86	433,602
Copper carbonate	kgs	35,000	350,000	10.00	12,271
Carbonate of magnesia	kgs	565	5,650	10.00	64
Sal sode	kgs	2,173,000	1,738,400	0.80	54,784
crystallized soda	kgs	115,541	93,469	0.81	1,282
calcium carbide	kgs	2,209,550	5,827,781	2.64	111,994
Industrial gelatin	kgs	9,165	153,255	16.72	7,320
Soap	kgs	11,326,200	52,058,833	4.60	1,874,569

Continue Table 1. Product items, unit of measure, quantities produced, value of product shipment, unit value in local currency, quantities valued at other currency, and unit value ratios. Chile and the United States, 1939

Product item	Unit of measure	United States				UVR
		Quantity	Value of product shipment	Unit value in local currency	Quantity valued at other currency	
Cigars	number	5,223,368,000	159,903,002	0.03	3,138,838,960	19.63
Wool yarn	kgs	35,014,552	86,292,714	2.46	1,276,339,053	14.79
Cotton fabrics	mtrs	7,699,931,893	722,473,948	0.09	36,294,290,542	50.24
Hosiery (incl socks)	dozen pairs	152,342,091	406,886,510	2.67	8,421,538,849	20.70
Underwear	dozen	10,509,742	24,204,936	2.30	975,029,533	40.28
Outerwear	dozen	7,680,819	98,102,528	12.77	1,466,945,953	14.95
Textile fabrics	kgs	36176547.5	56110516	1.55	1,644,124,891	29.30
Silk fabric	mtrs	1,226,486,468	272,945,238	0.22	18,938,418,755	69.39
Jute products	kgs	69,435,250	16,084,583	0.23	451,854,402	28.09
Footwear for men	pairs	122,078	255,498	2.09	7,165,979	28.05
Footwear for women	pairs	214,778	385,417	1.79	9,052,893	23.49
Footwear for kids	pairs	24,632	17,650	0.72	551,264	31.23
Writing paper	kgs	539,324,957	83,973,218	0.16	1,490,240,012	17.75
Wrapping paper	kgs	2,031,180,283	174,404,823	0.09	3,148,329,438	18.05
Cardboard	kgs	53,409,594	4,840,432	0.09	76,375,720	15.78
Hydrochloric acid	kgs	76,800,000	3,948,831	0.05	63,947,280	16.19
Nitric acid	kgs	167,740,000	3,184,912	0.02	420,467,527	132.02
Sulphuric acid	kgs	7,711,487,000	37,730,541	0.00	7,048,551,497	186.81
Tartaric acid	kgs	4,451,910	2,600,682	0.58	83,985,242	32.29
Acetic acid	kgs	22,084,631	2,298,442	0.10	614,007,271	267.14
Boric acid	kgs	15,737,861	1,491,651	0.09	56,656,298	37.98
Sodium sulfide	kgs	31,481,000	1,638,895	0.05	61,229,276	37.36
Phosphate	kgs	223,253,000	20,104,982	0.09	111,304,989	5.54
Iron sulfate	kgs	35,214,000	442,573	0.01	28,171,200	63.65
Zinc sulfate	kgs	13,189,358	710,952	0.05	39,568,073	55.66
Aluminium sulfate	kgs	416,108,000	8,455,376	0.02	405,076,805	47.91
magnesium sulfate	kgs	47,689,000	1,409,398	0.03	42,548,677	30.19
Sodium sulfate	kgs	337,243,000	4,147,614	0.01	114,042,194	27.50
Barium sulfate	kgs	5,571,344	322,435	0.06	2,076,077	6.44
sodium sulfite anhydrous	kgs	11,213,000	693,773	0.06	37,048,889	53.40
Liquid and powder sodium	kgs	6,682,360	2,235,713	0.33	10,214,607	4.57
sodium silicate	kgs	46,012,000	1,799,982	0.04	63,624,912	35.35
Potassium iodide	kgs	415,003	1,074,653	2.59	29,050,242	27.03
Silver nitrate	kgs	670,560	6,274,506	9.36	248,158,656	39.55
zinc oxide	kgs	136,937,375	14,431,992	0.11	572,411,513	39.66
Ammonia	kgs	103,064,827	8,470,900	0.08	311,513,343	36.77
glycerin	kgs	13,275,046	2,323,087	0.17	141,466,513	60.90
methyl alcohol	litres	129,259,204	9,319,752	0.07	2,132,775,410	228.84
calcium carbonate	tons	70,504	1,645,707	23.34	4,008,674	2.44
Copper carbonate	kgs	274,469	96,229	0.35	2,744,692	28.52
Carbonate of magnesia	kgs	5,679,000	646,981	0.11	56,790,000	87.78
Sal sode	kgs	29,971,000	755,609	0.03	23,976,800	31.73
crystallized soda	kgs	2,960,722,000	32,862,016	0.01	2,395,130,080	72.88
calcium carbide	kgs	167,592,000	8,494,613	0.05	442,030,944	52.04
Industrial gelatin	kgs	13,219,598	10,557,903	0.80	221,055,047	20.94
Soap	kgs	747,776,195	123,762,430	0.17	3,437,018,247	27.77

Annex B. Explanatory Note

Explanatory Note: Output, Value added and Labour by industries

1. Output, value added and employment in Chile

1.1. Output and value added in current prices 1938-1967

Sources:

Between 1938-1956: Statistic industrial yearbooks of the *Dirección de Estadística y Censos Chile.* This data does not come from censuses or surveys, the way of collecting the data is not explicit in the yearbooks. According to the explanations in Muñoz (1971) this data is limited to the industrial modern sector, thus workshops are not included (with less than five employees).

Between 1951-1956: value added is not explicit in the yearbook. It is estimated by output minus inputs (national and imported) and fuel and electric energy consumed in the production process. Data come from industrial yearbooks.

In 1957: Census of Manufactures of the *Dirección de Estadística y Censos Chile.* Unfortunately, data from statistic yearbook is not available for 1957, therefore I use this data directly (without adjustment).

1958-1959: no data available.

1960-1969: data obtained from the publication: *Manufacturing industries, Dirección de Estadística y Censos Chile.*

1960-67: Industrial survey includes establishments with 10 employees or more. Survey conducted by the *Statistics National Institute, Chile.*

1968-69: Industrial survey includes establishments with 50 employees or more. Survey conducted by the *Statistics National Institute, Chile.*

Explanatory notes:

Since 1951 apparel and footwear are joined. In order to follow apparel and footwear separately I use weights to divide into both industries. These weights are obtained from an average between the share of apparel and footwear in the sum of both for the years 1950 (industrial yearbook), 1957 (census data) and 1967 (census data).

In 1939: an earthquake devastated the province of Ñuble and for this reason it is not included in the yearbook. As this province represented slightly 0.5% of total output in the manufacturing sector in 1939, I assume that its exclusion does not change the final results.

In order to obtain a long time series metal industry aggregates several industries, such as basic metals, metal products, and machinery.

Every figure has been checked and digitized as they appear in the yearbooks and censuses, however, it may persist some inconsistencies which are not corrected. The most remarkable cases are: 1) in 1954 apparel and footwear value added increases in more than 400 percent and then it falls 50 percent; 2) tobacco value added in 1939 is extremely low due to a high increase in inputs. This increase is not permanent and consistent with the production series. In case 1) the decision is to exclude these figures.

Currency:

- 1938-1959: Chilean pesos.
- 1960-1975: Chilean escudos. It replaced the peso at a rate of 1 escudo = 1000 pesos.
- 1976-2015: Chilean pesos. The current peso was introduced on 1975 by decree 1,123, replacing the escudoat a rate of 1 peso for 1,000 escudos.

1.2. Output and value added in constant prices 1938-1979

1938-1957:

I use the following Price indexes to deflate output and value added. Source: Crecimiento industrial de Chile 1914-1965 Oscar Muñoz page 176-177.

Food: 1938-1950 section cost of food from the cost of living index. 1951-1961 index of wholesale prices of food goods, *Dirección de Estadísticas y Censos.*

Beverages: index of retail prices of beer, *Dirección de Estadísticas y Censos.*

Tobacco: index of retail prices of cigarettes, *Dirección de Estadísticas y Censos.*

Textiles: index of wholesale prices of textiles, *Dirección de Estadísticas y Censos.*

Apparel: section cost of food from the cost of living index, *Dirección de Estadísticas y Censos.*

Footwear: index of retail price of footwear, *Dirección de Estadísticas y Censos.*

Wood products: index weighted by the indexes of wholesale prices of lingue and raulí woods, *Dirección de Estadísticas y Censos.* The weights are the share of each good in the total output value in 1950 with quantities produced.

Paper: index of wholesale prices of printing paper, *Dirección de Estadísticas y Censos.*

Rubber: index of wholesale prices of tire 600*16, *Dirección de Estadísticas y Censos.*

Chemicals: 1938-1950 index weighted by the indexes of wholesale prices of soap and candles. 1950-1961 index weighted by the indexes of wholesale prices of gum, matches, soap, candles, and sulfuric acid. The weights are the share of each good in the total output value in 1950 with quantities produced. *Dirección de Estadísticas y Censos.*

Petroleum: index of wholesale prices of petroleum in Santiago city. *Dirección de Estadísticas y Censos.*

Minerals nonmetallic: 1938-1950 index of wholesale prices of concrete. 1950-1961 index of wholesale prices, building materials. *Dirección de Estadísticas y Censos.*

Metal products: index of wholesale prices of flat irons. *Dirección de Estadísticas y Censos.*

Total manufacturing: index of industrial wholesale prices. *Servicio Nacional de Estadística y Censos.*

Explanatory notes:

Between 1938-1949: textiles and rubber use the same price deflator than total manufacturing.

Price deflator of leather and rubber: it is used the deflator index of rubber.

1957-1979:

Series of constant prices are adjusted by the variation of Output Index base 1953=100 and Output Index base 1968=100.

Between 1957-1959 Output index by industries 1953=100obtained from *Estadísticachilena 1960 (1963),Servicio Nacional de Estadística y Censos.*

Between 1960-1968 Output index by industries 1953=100 from *Indicadores económicos y sociales de Chile 1960-2000, Banco Central de Chile*.

Between 1968-1979 Output index by industries 1968=100 from *Indicadores económicos y sociales de Chile 1960-2000, Banco Central de Chile*.

Explanatory notes:

Paper and printing, leather and rubber, and metals are aggregated, and the weights come from yearbook 1953 and census of manufacturing 1967.

1.3. Employment 1938-1969

Between 1938-1956: Statistic industrial yearbooks of the *Dirección de Estadística y Censos Chile.* This data does not come from censuses or surveys, the way of collecting the data is not explicit in the yearbooks.

In 1957: Census of Manufactures of the *Dirección de Estadística y Censos Chile.* Unfortunately, data from statistic yearbook is not available for 1957, therefore I use this data directly (without adjustment).

1958-1959: no data available. It was estimated taking the years 1960 and 1957 and using linear growth rate.

1960-1969: data obtained from the publication: *Manufacturing industries, Dirección de Estadística y Censos Chile.*

1960-67:Industrial survey includes establishments with 10 employees or more. Survey conducted by the *Statistics National Institute, Chile.*

1968-69: Industrial survey includes establishments with 50 employees or more. Survey conducted by the *Statistics National Institute, Chile.*

Explanatory notes:

Since 1951 apparel and footwear are joined. In order to follow apparel and footwear separately I use weights to divide into both industries. These weights are obtained from an average between the share of apparel and footwear in the sum of both for the years 1950 (industrial yearbook), 1957 (census data) and 1967 (census data).

2. Output, value added and employment in the United States

2.1. Value added in current prices 1947-1999

Between 1947-1999: Historical statistics of the United States. Millennial edition. Volume 4. Economic Sectors.

2.2. Value added in constant prices 1939-2001

Between 1947-2001 I begin with the value added in current prices year 1947 (census data). I adjust by using indexes of industrial production by industry group 1947-2001, obtained from Historical statistics of the United States.

Between 1939-1947: estimates from 1947 backwards are covered by variations using Bakker, Crafts, Woltjer (2015), "A Vision of the Growth Process in a Technologically Progressive Economy: the United States, 1899-1941".

2.3. Employment 1929-1995

Between 1929-1946: estimates from 1947 backwards are covered by variations using Bakker, Crafts, Woltjer (2015), "A Vision of the Growth Process in a Technologically Progressive Economy: the United States, 1899-1941".

Between 1947-1995: Historical statistics of the United States. Millennial edition. Volume 4. Economic Sectors.

1948: It was estimated using the variation of the manufacturing output indexes between 1947-1948 by industries.

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