Chile's regional export specialization and its effects on wage distribution

Emma Scandolo — 449906

Supervisor: Prof. Anna Baiardi

Second reader: Prof. Aksel Erbahar

Erasmus School of Economics — Erasmus University Rotterdam

July 2019

Bachelor Thesis for the International Economics Major

International Bachelor Economics and Business Economics

Abstract

This paper analyses the effect of increased international trade on returns to education in different working sectors and regions of Chile. A Difference-in-Difference model is used for three different regions of export specialization, where each export-intensive sector is compared with a synthetic control group of non-tradable sectors before and after the Free Trade Agreements that Chile signed with the EU and US. We find that returns to unskilled labor in the agriculture sector benefit compared with returns to mid-skilled labor in the sector. Mid-skilled labor, which is used intensively in the beverages industry sector, seems to have gained compared to unskilled labor but the effect is not highly significant. In the aquaculture sector, returns to unskilled labor have significantly decreased.

1 Introduction

Avocado, salmon, nuts, and red wine abound on European and American tables, but average consumers might not be aware that Chile is one of the main exporters to the EU and US of these products (Naamani, 2007). In our globalized world it has become hard to keep trace of where the things we feed ourselves with come from. While country trademarks created in the last century, such as fashion and design "Made in Italy" are still recognized today, the highly diversified range of products that are being traded in our century makes it harder for emerging markets to achieve such an accreditation.

Even less obvious are to EU and US consumers the consequences that eating more or less avocados have on the wage distribution in the exporting country.

This paper aims at analyzing the effects that the two Free Trade Agreements (FTA), to which Chile has committed with the European Union in 2003 and with the United States in 2004, had on education-driven wage inequality in Chile. Although trade liberalization in Chile started well before (see section 2.1), both FTAs marked important turning points for the exporting sectors.

Chilean economic production has always evolved around the exploitation of its natural resources. Nowadays, Chile vests the role of global leader in the production and exportation of copper. However, copper is a not dutiable good in the EU market, and thus any changes in its export volume to the EU cannot be linked to decreased tariffs after the Free Trade Agreement.

Second to the mining industry, the production of wine, salmon and other agricultural goods has also been at the core of Chilean export activities. The latter sectors are very likely to be directly affected by the FTAs as both EU and US tariffs on such products in absence of a FTA are generally very high (Nowak-Lehmann, Herzer, & Vollmer, 2007).

Within each sector, we will investigate the effect of the FTA on wage inequalities due to returns to education. This effect is of extreme importance firstly because, despite the country's impressive economic achievements such as being the first South American country to join the OECD, the education system still under performs compared to other OECD countries. Secondly, Chile still ranks as one of the most unequal countries despite its drastic reduction in poverty rates.

Therefore, assessing whether the FTA with the EU has contributed to wage inequalities with respect to education is of great importance for Chilean future trade liberalization process.

Although economic models predict a clear link between international trade and inequality (see section 3.1), previous studies seem to find that the link is context specific. In India, the 1991 international trade reforms that reduced trade barriers from 80% to 30% have enhanced the decline in inequality that had mildly started in the 1980s. However, poorer households living in rural areas experienced lower decline in inequality after the reforms, as increased import competition reduced demand for labor, putting downward pressure, intensified also by lower mobility, on agricultural and industry wages (Topalova, 2010).

On the other hand, the poorest households in Vietnam benefited from the 2001 international trade agreement with the US, as those provinces that experienced positive export shocks increased demand and wages for unskilled workers, thus decreasing inequality. (McCaig, 2011) But the example of Vietnam is also presenting a very important trade-off that some sectors and regions in Chile might be facing as well: does less inequality come at the expense of education levels remaining low?

Several studies developed an ex-ante assessment of the general equilibrium effects that the FTAs had on the Chilean economy as a whole (Chumacero, Schmidt-Hebbel, & Fuentes, 2004; Nowak-Lehmann et al., 2007; Barton & Murray, 2009), however much less importance has been given to the ex-post evaluation.

This research is conducted following the belief that ex-post evaluation of international trade policies is just as important to improve their effectiveness as it for labor market policies (Jean, Mulder, & Ramos, 2014). Jean et al. have, in fact, conducted an ex-post evaluation of the Chile-EU FTA, finding that the agreement mainly benefited unskilled labor, and that the sectors that have gained the most include fisheries, wine and fruits. What makes the focus of this paper particularly unique is that it combines the need for ex-post evaluation of international trade policies with the importance of a regional approach in order to accommodate for the regional specialization in production that is present in Chile (Rehner, Baeza, & Barton, 2014).

2 Chile: a geographic and economic overview

2.1 The Importance of a Regional Approach

Due to Chile's unique geographic position, expanding approximately for 4300km along the Pacific Coastline, territorial characteristics and natural resources greatly vary from region to region, ranging from arid land in the north to glaciers in the south and with fertile valleys in the middle (Newbold, 2003). The abundance of natural resources has historically shaped Chilean trading patterns, and different regional factor endowments call for analysis to be conducted on the regional level rather than only on the national level. Chile nowadays consists of fifteen regions, as shown in Figure 7 (Appendix A).

In the North, the region of Antofagasta started dominating the export market in the 1990s and nowadays makes of Chile the biggest copper exporting economy. Gaining a more and more significant share in the global copper market, workers' training grew as well, increasing the region's intensity of skilled-labor. By 1998, the region of Antofagasta finds itself with the highest job-training index in Chile. Mining companies not only invested in on-the-job training, they were also involved in schooling programs, thus increasing the overall education level in the region (Newbold, 2003).

In the central regions, the climate and landscape allows for agricultural and wine production to take place.

Agriculture takes place in Central-Southern regions, with the majority of farms being concentrated between region VI and IX. In this case, increased exports due to lower tariffs were found to have increased the demand and wages for unskilled-labor, which is abundant in the agricultural sector (Jean et al., 2014).

Wine production is distributed along a number of clusters. Wine valleys are present in all regions from Region V (Valparaiso) to Region VIII (Maule), including the the Region Metropolitana of Santiago (Region XIII), but this paper will focus on the three of them in particular. Region VII (Maule) is taken into consideration because it is the single largest wine producing region, accounting for roughly 50% of total national production. Interestingly, however, Region VI (O'Higgins) accounts for the highest number of exporting wineries in the country. Lastly, the Maipo Valley in the Region Metropolitana is worthy of analyzing as it is the region with the highest number of "top wines bottles" production (Farinelli, 2012).

The educational classification of the wine sector is not as straight forward as in the agricultural sector. Workers in the wine industry can be positioned on very different places along the skill-intensity spectrum as wine production involves various divisions of labor. Firstly, unskilled-labor is required for basic viticultural practices; secondly, relatively more skilled-labor is required for the usage of capital goods such as machinery and equipment and for the assessment of intermediate inputs and lastly, skilled-labor is required for sensory analysis and marketing (Farinelli, 2012).

The last sector of interest for this paper that has greatly benefited from trade liberalization is aquaculture. Although traditional capture fisheries have developed around some port cities in the northern regions, the fjord-like geography of southern regions, namely Los Lagos, Aysen and Magellanes (region X, XI and XII), has captured the highest concentration of Chilean aquaculture exports thanks to the development of the salmon fishing industry.

Also within the fishing industry the intensity of labor varies depending on the different tiers of the activity. The executive functions which require skilled-labor are located in the Metropolitan Region and thus do not affect the education level of the region. Regional and site managers, however, are based in the region and require a university or professional experience. Seasonal harvesting labor however is at the other end of the skill-distribution and the minimum salaries have remained extremely low also in recent years (Barton & Murray, 2009).

2.2 A Long Trade Liberalization Process

In order to understand the international trade position Chile finds itself in nowadays, it is important to shed light on two major economic eras that the country has undergone.

The first step towards an open economy was taken under Pinochet's military dictatorship in the 1970s, when the country started adapting "laissez-faire" principles that had been advocated by neo-liberal American economists (de Piñeres & Ferrantino, 1997).

The second step was taken in the 1990s, a period in which Chile embarked on a number of Preferential and Free Trade Agreements. After signing agreements with fellow Latin American developing economies, the FTAs signed with the EU and the US marked the start of a commitment that would further enhance Chilean economic development (Nowak-Lehmann et al., 2007).

3 Theoretical Background

3.1 The Heckscher-Ohlin model

The Heckscher-Ohlin model of international trade assumes a two-country, two-factors and two-goods setting. In this setting, the two countries are represented by a developing country and a developed one. The developing country is relatively more abundant in unskilled-labor and thus has a comparative advantage in the production of the good which is unskilled-labor intensive. Viceversa, the developed country is relatively more abundant in skilled-labor and thus has a comparative advantage in the production of the other good.

To analyze the effects of international trade, we start by assuming that each country is in autarky, a situation in which each country produces both goods and attempts to be self-sufficient. As international trade between the two countries takes place, the model predicts that each country will start exporting the good whose production factor it is abundant in and importing the other one.

International trade thus results in increased demand for skilled labor in the developed country at the expense of increased demand for unskilled labor in the developing country.

In the developing country, the model predicts a decrease in that fraction of wage inequality which is due to returns to education.

3.2 Chile: a developing or developed country?

As explained in section 2.1, the skill-intensity of Chilean labor varies from region to region, from sector to sector. Therefore, the Heckscher-Ohlin model should be applied regionally.

In the regions where the agriculture sector dominates, decreased EU and US tariffs are supposed to increase the demand and thus the wages for unskilled labor, which in turn should reflect in a decrease of returns to education.

In the regions where the production of wine and other beverages take place, the effect of enhanced exports to the EU and the US is harder to predict due to the diversity of the skill-intensity of labor within the industry. Because the dataset used to conduct this analysis does not differentiate between the viniculture side and the marketing side of the wine industry, we make a prediction based on what our dataset allows. We calculate the amount of workers per each education level and we define the type of labor used intensively in this sector by looking at the education level with the highest amount of workers. This is done in Section 4.2.3, where we find that the beverage industry sector is medium-skilled labor intensive. We therefore adjust our prediction and we hypothesize that the returns to education of medium-skilled workers should increase compared to those of low-skilled workers.

Aquiculture, mainly represented by salmon production, also involves skilled and unskilled labor. Based on previous studies (O'RYAN, De Miguel, Miller, & Pereira, 2011) and given that a differentiation between fishermen and site managers is allowed by the dataset, the cultivation of salmon is considered to be unskilled-labor intensive. After the FTAs, the returns to education in the aquaculture sector are predicted to decrease.

Table 1 presents a summary of the predictions made by applying the Heckscher-Ohlin theory regionally.

Table 1: Predictions of the returns to education for low-skilled labor compared to medium-skilled labor per sector

	Agriculture Sector	Beverages Industry	Aquaculture Sector
Returns to low-skilled labor	Increase	Decrease	Increase

4 Data

4.1 Variables description

We obtained data from eleven waves of a dataset created by the Chilean ministry of development. The so-called Caracterizacion Socioeconomica Nacional (CASEN) is a household and individual survey containing extensive micro data information.

The CASEN surveys used in this paper date from 1994 to the latest one in 2017 [1]. Compared to the other source of household micro data sets often used for empirical purposes, the "Greater Santiago household survey", our data set is a far better match for the regional approach of this paper, as it includes data on all regions rather than just on the Metropolitan Region of Santiago. For each wave, we want to estimate the returns to education for different working sectors in different regions.

Unfortunately, the coding of variable names differs from wave to wave (e.g. variable indicating employment sector is called called "o8" in one year but "rama" in another year), which prevents us from merging all data sets and requires editing to be done for each wave individually. We therefore proceed to create new variable names in each wave in order to have consistent variable names before merging the data sets and conducing the analysis.

To start, we create a dummy variable for each of the three different types of exporting regions our study is focusing on: the fishing regions, the agriculture regions and the beverages regions (Figure 7).

The second step involves associating each individual to its corresponding working sector, and to do so we use the 4-digit [2] codes of economic activity: "Clasificación Internacional Industrial Uniforme" (CIIU). In this step we encounter another difficulty as new revisions of CIIU codes are released over the years. Using the data manual provided for each wave, we are able to identify the codes for each sector in each different year, and we create dummy variables for the sectors of interest. A more detailed explanation of CIIU codes specifications is given in table 11 (Appendix B).

Lastly, the returns to education are proxied by the calculation of the skill-premium based on a Mincer regression (Beyer, Rojas, & Vergara, 1999). The variables needed for this regression include wage, experience, an indicator of full-time or part-time employment and education level.

From all wage indicators provided in the data set, we select the one described as "salary obtained from main occupation" rather than "total salary" or "monetary remuneration" to represent our

[1] New releases were made in years: 1996, 1998, 2000, 2003, 2006, 2009, 2011, 2013, 2015 and 2017

[2] This code only consisted of 3 digits until 1996

wage variable as we are interested in sectoral wages. To obtain a better scale of the regression, we make use of the logarithmic value of this variable.

We created a variable called experience which, as commonly assumed, is calculated as follows:

$$Experience = Age - YearsOfSchooling - 6^{3} \quad (1)$$

We also use the squared value of experience, in order to capture the decline, over time, of "on-the-job" training investments.

Data regarding hours worked also varied from wave to wave, as sometimes they were calculated on a weekly basis and other times on a monthly basis. A previous study on part-time labor in Chile (Leiva, 2000) explains that part-time work was not recognized by Chilean legislation in the 1990s, but in order to conduct research on individuals that worked less than full time they used a threshold of 35 hours per week. Similarly, we create a dummy variable called "full time" which takes value 1 for individuals that work more than 35 hours in a week and 0 otherwise.

Lastly, the most important variable needed to complete the skill premium regression is an education variable that differentiates between the skill-level of individuals.

We differentiate between four different levels of education. The lowest level is made of workers who never went to school; following, individuals who studied between 1 and 11 years fall into the basic education level; individuals who completed high-school represent the mid-educated level and, lastly, the highest level of education is made of individuals who obtained a university degree.

4.1.1 Calculation of the skill-premium

The skill premium is a valid measure to account for returns to education as it captures the positive wage difference that workers perceive due to a higher level of education.

This indicator aims at isolating that part of wage differences that is due solely to educational difference. To accomplish this, one must regress individual wages, taken in logarithmic terms as explained in section 4.1, on the categorical variable indicating education levels. Control variables that are plausibly correlated to the attainment of a certain educational level and that might influence individual wages are included in the regression to avoid a biased estimation of the education level coefficient.

Such variables have been identified in the Mincer regression:

$$ln(Wage) = \alpha + \beta_1 BasicEduc + \beta_2 MidEduc + \beta_3 HighEduc + \gamma_1 Exp + \gamma_2 Exp^2 + \delta FullTime + \epsilon \quad (2)$$

[3] Six is the commonly assumed age at which individuals start attending mandatory education

Where "Exp" refers to the variable that accounts for experience gained on the job, and "FullTime" is the dummy variable accounting for working hours. "BasicEduc" takes values 1 if the maximum level of education of a person is basic education, and 0 otherwise; the same goes for "MidEduc" and "HighEduc". Each β coefficient represents the contribution of the given level of education to earnings. The skill-premium is then calculated by taking the difference between the coefficients of the different levels of education. Based on descriptive statistics, section 4.2.3 explains which education levels are taken into account for the calculation of the skill-premium for each different sector.

4.2 Descriptive Statistics

4.2.1 Regional Employment distribution

In order to understand whether our data sample was representative of the whole population, we compare employment indicators gathered from previous literature in Section 2.1 to employment indicators from our dataset. If the regions that we predicted to be most agriculture intensive appear to have the highest number of workers employed in the agriculture sector from our dataset, and the same for the other two sectors of interest, our dataset is more likely to be representative of the whole population.

Table 2 presents the number of workers, per region, employed in each sector of interest as resulting from our dataset. Our dataset presents two levels of employment sector classification; the one-digit classification and the more specific four-digit classification. As the one-digit classification does not provide a distinction between the agriculture, forestry and hunting sectors, we make use of the more specific four-digit classification code. For this reason, the total number of employment sectors among which we selected our sectors of interest amounts to 280 sectors.

Column (2) shows that our sample is well representative of the agricultural sector employment per region. As previously discussed and as represented in Figure 7, O'Higgins Maule and Bio Bio are the three regions with the highest number of workers employed in the agricultural sector. Similarly, from column (3) we observe that also in our sample the regions mostly devoted to beverages production are O'higgins, Maule and the Metropolitan region. Lastly, column (4) presents the number of workers employed in the aquaculture sector. On the one hand, as expected, Los Lagos and Aysen are the regions with the highest number of people employed in the aquaculture industry; on the other hand, the third region we considered important for salmon production is not represented as such in our dataset. In fact, we can observe that the distribution is more uniform across the country;

this is because in the northern regions other (non-salmon) aquaculture activities take place. But since in this paper we are concerned with the exportation of the salmon industry, we have included the Magallanes region in our three most salmon-intensive regions.

Table 2: Regional sectoral employment

Region	(1) Total	(2) Agriculture sector	(3) Beverages industry	(4) Aquaculture sector
Tarapaca (I)	80,986	5,845	63	1,079
Antofagasta (II)	84,437	1,181	76	1,312
Atacama (III)	79,692	3,877	63	1,165
Coquimbo (IV)	109,189	9,983	200	1,174
Valparaiso (V)	242,615	17,787	335	1,023
O'Higgins (VI)	154,359	22,786	743	222
Maule (VII)	173,473	27,164	672	573
Bio Bio (VIII)	334,855	20,631	336	2,056
La Araucania (IX)	183,487	17,132	122	357
Los Lagos (X)	171,360	12,508	75	6,753
Aysen (XI)	43,768	1,907	17	1,507
Magallanes (XII)	39,887	1,552	35	884
Metropolitana (XIII)	480,354	14,537	1,008	68
Los Rios (XIV)	52,943	1,867	23	432
Arica y Parinacota (XV)	28,732	1,237	41	155

All in all, we are confident that our dataset presents a fairly good representation of the regional sectoral employment levels.

4.2.2 Experience and Full-time employment

Experience, as explained in equation 1, accounts for the years that workers spend on the job. As can be seen from table 12 (Appendix B), workers employed in the agriculture sectors report the highest value for average years spent on the job. This is because they are, on average, both older and have completed less years of school compared to workers in the beverages and aquaculture industries.

Overall, in all sectors the amount of people working full-time is far higher than those working part-time; but the difference between the beverages industry and the aquaculture sector is evident. Table 13 in Appendix B shows that one in four workers works less than 35 hours per week in the aquaculture sector, while 96% works more than 35 hours per week in the beverages industry.

4.2.3 Education

As expected, we observe in table 3 that the agriculture sector is low-skilled labor abundant. More precisely, 75.8% have a basic education and 17% have a high school diploma. To calculate the skill-premium, we take the difference between those two groups, also because otherwise the number of observations to calculate the skill-premium would decrease drastically.

The same technique is used for the aquaculture sector, where 73.1% of workers report to have elementary school education and 22.9% report having achieved a high school diploma (see table 3). We find that the beverages industry sector makes intensive use of medium-skilled workers, which amount to 47.2% of total workers. Basic education level is the second most represented education level in the sector, but the difference is very small. The skill premium is calculated by taking the difference in returns between those two sectors.

Table 3: Workers per education level in each sector

	(1)	(2)	(3)
	Agriculture	Beverages Ind.	Aquaculture
Education Level	Freq (%)	Freq (%)	Freq (%)
No Education	4,171 (5.9)	47 (1.9)	120 (1.8)
Basic	53,497 (75.8)	1,098 (45.3)	4,937 (73.1)
High School	12,034 (17)	1,143 (47.2)	1,543 (22.9)
University	879 (1.2)	135 (5.6)	153 (2.3)

4.2.4 Skill-Premium

Table 4 shows the values for the skill-premium variable over time in each sector of interest. For instance, in 1994, workers with a high school diploma working in the agriculture sector received a wage 63.3% higher than workers who had a basic level of education. This specific return to education decreased to 17.5% by 2017. Our analysis will try to identify whether this decrease in skill-premium was common to other non-traded sectors in those regions or whether it was due to increased agriculture exports demanding more unskilled-labor. We observe that the difference in returns to education between workers with a high school diploma and those with basic education also decreased overtime in the beverage industry. On average, before the FTAs, medium-skilled workers recorded wages 46.4% higher than unskilled workers; this wage gap decreased to 35.1% on average afterwards. At a first glance, this seems to be contrasting our expectations as medium skilled workers were predicted to gain compared to low-skilled workers; however, before drawing any conclusions we must check whether this trend was experienced by other non-traded sectors or whether it affected only the beverage industry workers.

In the aquaculture industry, the results again seem to contradict our predictions, as high-school workers experienced wages 27.5% higher than low-skilled workers before the FTAs and 30.4% higher after the FTAs.

Table 4: Summary table for Skill-Premia

YEAR	Agriculture sector	Beverages sector	Aquaculture sector
1994	0.633	0.579	0.247
1996	0.480	0.189	0.307
1998	0.426	0.444	0.285
2000	0.513	0.526	0.187
2003	0.351	0.582	0.349
2006	0.356	0.295	0.247
2009	0.259	0.372	0.179
2011	0.278	0.413	0.409
2013	0.249	0.421	0.419
2015	0.201	0.303	0.403
2017	0.175	0.303	0.165
Mean	0.356	0.429	0.291
Mean before treatment	0.464	0.464	0.275
Mean after treatment	0.253	0.351	0.304

5 Methodology

To assess the validity of the predictions made in section 3, we use a Synthetic Difference-in-Difference model. To minimize the risk that the treatment effect is due to other factors other than the factor of interest, a standard Difference-In-Difference (DID) model compares the treated unit with a control group or counterfactual. This approach estimates the treatment effect by taking the difference between the change in the treated unit and the change in the control unit in the periods before and after the intervention. Assuming that the difference between the treated and control unit is constant in the pre-treatment periods, and that the intervention is the only event that affects the two units differently, any change in the difference between the two units in the post-intervention periods is interpreted as the treatment effect (Bouttell, Craig, Lewsey, Robinson, & Popham, 2018).

It is sometimes difficult, however, to find a control group which is a valid representation of what would have happened to the treated unit had there been no intervention. To fight this problem, we make use of a synthetic control group, which is artificially created to maximize the likeliness of treated and control groups in the periods prior to the intervention (Doudchenko & Imbens, 2016). We use an algorithm which calculates which weights to allocate to each control unit, such to minimize the squared differences between the control and treatment group (Abadie, Diamond, & Hainmueller, 2010). This model is applied regionally for each sector of interest. The treatment group is represented by the workers in the region-intensive sector (the agriculture sector, the beverages sector or the aquaculture sector); the intervention is, for all regions, the increased demand for regional exports as a result of the FTAs; lastly, the synthetic control group is made up of a weighted average of non-tradable service sectors[4].

The regression framework we use is of the following form:

$$SkillPremium_{it} = \alpha + \rho G_i + \gamma_t Year + \beta T_{it} + \epsilon_{it} \tag{3}$$

Where SkillPremium is the skill-premium for one of the treatment groups (the agriculture sector, the beverage industry sector or the aquaculture sector) or the synthetic control group for each time period t; G is a dummy for being in the treatment group; Year is a vector of time-dummies for each time period that takes value 1 if an observation happens after the intervention (first observation after the intervention is in year 2006); T is an interaction effect of the time dummy and the group

[4] Those sectors being: public services, education services, medical services, social services, entertainment services, recreation services, sanitary services, laundry services, domestic services, commercial services and personal services

dummy ($T_{it} = G_i \times \text{Year}$)[5]; and ϵ is the error term.

The coefficient we are interested in is β, as it calculates the average treatment effect on the treated, which is the post-intervention change in the difference between the skill premium of the treatment group and the one of the synthetic control group. This treatment effect, however, can only be interpreted under a set of assumptions.

One of the most important assumptions of our model, as previously mentioned, is that the difference between the skill-premium of the treatment and synthetic control group is constant throughout the pre-treatment period. This assumption, known as the "Parallel Trends" assumption, is important to test as it is an indication of whether the synthetic control group we build is indeed a valid counterfactual.

Another assumption our model is sensitive to is that, apart from the FTAs, all other events affected the treatment and control groups in the same way. Although this assumption is hard to test for, by taking a regional approach we have selected a small number of regions which heavily rely on the sectors we analyze, therefore minimizing the number of possible other factors that could have affected our treatment and control groups differently.

The last assumption we discuss is that the synthetic control group must not be affected by international trade. Although service sectors are usually not affected by international trade, in our case this assumption is important to test because the regions we consider are heavily relying on the performance of their respective exporting sector, and therefore other sectors could be indirectly affected by trade as well.

Robustness tests

To test the "Parallel Trends" assumption, we include a lead of the treatment indicator into equation (3):

$$SkillPremium_{it} = \alpha + \rho G_i + \gamma_t Year + \beta T_{it} + \beta_1 T_{i,t+1} + \epsilon_{it} \tag{4}$$

In this specification of the model we are interested in the coefficient β_1, because it serves as a proof that the trends of the treatment and control group did not differ before the treatment has taken place. If β_1 were to be significant, this would violate the assumption of the model as it would imply that even before the treatment took place the trends were diverging.

A second placebo test is run to test whether the control groups used to build the synthetic control group were indeed non-tradable sectors unaffected by the increased international trade after the

[5] T will be equal to 1 iff both factors of the product are also 1, that is, if a given observation is in the treatment group and from the post-treatment period

FTAs. Like testing for parallel trends, the aim of such tests is to estimate causal effects that are known to be insignificant based on a-priori knowledge.

Using the same synthetic DID method as before, we test whether the service sectors with the highest weight in each synthetic control group were significantly affected by the intervention compared with service sectors that were not included in the synthetic control group. We expect the service sectors to have different trends, but we do not expect their trends to diverge significantly after the FTAs.

The following sections present a more detailed overview of the analyses conducted in each different group of regions.

5.1 Agriculture

The analysis for the returns to education in the agricultural sector is conducted in the three regions with the most intensive agricultural production, namely region VI, VII, VIII.

As previously discussed, the education level required in the agriculture sector is low, for this reason the skill premium is calculated by taking the difference between the returns to high school education and returns to elementary education.

The treatment group for these regions is composed by the workers in the agriculture sector. We compute the skill-premium of this sector for each observed year between 1994 and 2017 in order to compare it with that of the control group. The control group is composed by four different service sectors, weighted as reported in table 5.

As reported in table 5, the Hobby and Domestic services are the two control groups with the highest weight in the synthetic control group. In order to make sure that the change in the skill-premium of the agriculture sector is due to the FTAs affecting the sector itself rather than affecting the synthetic control group, we test whether one of the service sectors with the highest weight was significantly different, after the FTAs, from other service sectors not included in the synthetic control group.

If the effect is significant, the robustness of our results is threatened as our model is based on the assumption that the control group is not affected by international trade. The testing setting is again Difference-in-Difference with a synthetic control group with the "Hobby" service sector as the treated unit. We then also test for the parallel trends assumption in order to be able to interpret the coefficient of our placebo test.

Table 5: Weighting outcome for the synthetic control group of the agriculture sector

Sector	Weight
Public Services	0.061
Education Services	0.061
Medical Services	0.065
Social Services	0.054
Entertainment Services	0.056
Hobby Services	0.214
Sanitary Services	0.044
Laundry Services	0.061
Domestic Services	0.243
Other Services	0.068
Personal Services	0.072

Excluding service sectors with weight zero

5.2 Beverages Industry

The central regions, in which beverages industries are located, are considered for this section.
As discussed in section 2.1, the education level in the wine sector, which is the main beverage produced in the Chilean beverage industry, ranges from university level education to elementary; but in our dataset the most represented levels of education were the elementary and high school ones. To investigate the effect of increased exports in the sector we therefore took the different between the skill-premium coefficients for high school and elementary education.
The treatment group for those regions is composed by the workers in the beverage industry sector, while the synthetic control group is made up by four different service sectors with respective weights as reported in table 6.

Table 6: Weighting outcome for the synthetic control group of the beverages sector

Sector	Weight
Sanitary Services	0.484
Laundry Services	0.259
Other Services	0.257

Excluding service sectors with weight zero

For this sector, we make a placebo test to make sure that the skill-premium of Sanitary Services has not been subject to changes after the FTAs. Once again, we use a Difference-in-Difference model with a synthetic control group and thus we have to test for parallel trends before interpreting the result of our placebo test.

5.3 Aquaculture

The three southernmost regions of Chile are of interest for this sector.
As discussed in section 2.1, also the skill-intensity of labor in the aquaculture industry varies.
Judging from our dataset (see section 4.2.3), we look at different returns to education between mid-skilled workers and low-skilled ones.
The treatment group for those regions is composed by the workers in the aquaculture sector, while the synthetic control group is made up by two service sectors with respective weights as reported in table 7.

Table 7: Weighting outcome for the synthetic control group of the aquaculture sector

Sector	Weight
Public services	0.143
Medical Services	0.033
Domestic Services	0.824

Excluding service sectors with weight zero

Similarly to the other sectors, the placebo test for this sector tests whether the Domestic Services sector has experienced a change in the skill-premium after the FTAs when compared to the other service sectors not included in the synthetic control group.

6 Results

In this section, we present and interpret the coefficients of the Difference-in-Difference analysis per each sector, we also test for the main assumption of the model and present the results of placebo tests.

6.1 Agriculture

The results for this sector are reported in table 8. The first column presents the coefficients obtained from equation (3). The coefficient of the interaction term shows a decrease, significant at the 10% level, in the skill-premium for the agriculture workers after the increased international trade resulting from the FTAs. More precisely, lower tariffs on agriculture goods decreased the agriculture sector skill-premium by 7.78%. This means that, compared to a situation where international trade had not increased, agriculture workers experience a 7.78% lower wage increase when their education level increases from basic education to obtaining a high-school diploma.

In the second column of table 8 we control for the lead variable to test for parallel trends and assess whether our results are can be interpreted as causal. We observe that the coefficient of the lead variable is insignificant, meaning that we cannot find proof for a violation of the parallel trends assumption. It is also useful to look at the graphical representation of our Diff-in-Diff analysis in order to check for parallel trends and to observe visually the treatment effect. Figure 1 in Appendix A shows the significant decrease in the skill-premium of the agriculture sector compared to its synthetic control group. We can also observe that before the treatment period the trends run relatively parallely.

Table 8: Results table for agriculture sector

	(1)	(2)	(3)	(4)
VARIABLES	Diff-in-Diff	Parallel Trends	Diff-in-Diff Placebo Test	Parallel Trends Placebo Test
Treatment	-0.0778*	-0.0370	-0.186	-0.00533
	(0.0388)	(0.0328)	(0.139)	(0.0970)
Lead		-0.0323		-0.257
		(0.0318)		(0.141)
Constant	0.571***	0.567***	1.005***	0.973***
	(0.0421)	(0.0421)	(0.122)	(0.105)
Observations	22	20	22	20
R-squared	0.927	0.938	0.844	0.858

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The third and fourth columns of table 8 repeat the same analysis as the first two columns for the placebo test. As explained in section 5.1, we test the validity of our synthetic control group, because we want to make sure that the control groups that most resemble our treatment group were not affected by the FTAs. To do this, we ran the same model with "hobby" services as a treatment group. From the insignificance of the coefficient of the treatment effect in column (3) supported by the insignificance of the lead variable in column (4), we can conclude that the Hobby service sector is not affected by international trade. This can also be seen from the graphic representation of the model in Figure 2 (Appendix A).

Overall, we have reasons to believe that the effect of FTAs on the skill-premium of the agriculture sector is causal and we can therefore conclude that our results for the agriculture sector are in line with our predictions as returns to education are lower in the unskilled-labor abundant sector whose exports increased.

6.2 Beverages Industry

Table 9 presents the results for workers in the beverage industry, while a graphic representation is presented in figure 3 in Appendix A.

The first column of the table reports the estimations for the difference in difference model specified in equation 3. The sign of the treatment effect coefficient is in line with our expectation. However, the coefficient is only significant at 10.5%, which is just below the 10% threshold. As the significance thresholds are set very subjectively at random values (a coefficient with a p-value of 10.1% is not less informative than a coefficient with a p-value of 9.9%) we can still infer some information from this specification. There seems to be some evidence supporting an increase in the returns to education after the FTAs also from Figure 3 in A, where we can observe that, except for two time periods, the trend of the treatment group increased compared with that of the control group, however, overall the evidence is inconclusive.

We are confident about the interpretation of the results as from both the graphical representation of the analysis and the insignificance of the lead coefficient in column (2) we cannot falsify the parallel trends assumption.

Columns (3) and (4) present the results for the placebo test, and a graphical representation is provided in Figure 4 (Appendix A). Since both the treatment effect and the lead coefficients are insignificant, we are confident that the synthetic control group is built with sectors that are not affected by changes in international trade.

Overall, although the significance of our results is up for subjective interpretation, we do observe a slight increase in the skill-premium. More specifically, compared to workers in service sectors, beverage industry workers experience a 8.92% higher increase in their wage if their education level increases from basic education to having obtained a high-school diploma.

Table 9: Results table for beverages sector

VARIABLES	(1) Diff-in-Diff	(2) Parallel Trends	(3) Diff-in-Diff Placebo Test	(4) Parallel Trends Placebo Test
Treatment	0.0892	0.0612	-0.0849	-0.118
	(0.0494)	(0.0512)	(0.0894)	(0.0772)
Lead		0.00646		0.0481
		(0.0218)		(0.0923)
Constant	0.589***	0.590***	0.757***	0.763***
	(0.00767)	(0.0109)	(0.103)	(0.122)
Observations	22	20	22	20
R-squared	0.895	0.897	0.839	0.823

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6.3 Aquaculture

From table 10, a positive and significant interaction effect suggests that the skill-premium for workers in the aquaculture sector has increased after the FTAs. More precisely, the coefficient indicates that, compared with workers from the control group, workers in the fishing sector experience a 16% higher increase in their wage when increasing their education level from elementary to middle school. This result seems to oppose to our initial expectations as returns to education in the fishing sector were expected to decrease.

Taking a look at the graphical representation of the analysis, in Figure 5, we observe that the aquaculture sector experienced a drastic increase in the skill-premium around 2009, which then dropped again around 2015.

In the following section we will explore other possible events in the fishing industry that could have contributed to such a change.

From the insignificant coefficient of the lead variable in column (2) and from the graphical representation of the analysis (figure 5), we cannot falsify the parallel trends assumption. Also the results of the placebo test give us reasons to believe that the our model is correct.

Table 10: Results table for aquaculture sector

	(1)	(2)	(3)	(4)
VARIABLES	Diff-in-Diff	Parallel Trends	Diff-in-Diff	Parallel Trends
		Placebo Test	Placebo Test	
Treatment	0.160***	0.190***	-0.00871	0.0410
	(0.0292)	(0.0277)	(0.115)	(0.0584)
Lead		-0.0230		0.0636
		(0.0197)		(0.0413)
Constant	0.276***	0.273***	0.750***	0.758***
	(0.0175)	(0.0229)	(0.0479)	(0.0443)
Observations	22	20	22	20
R-squared	0.923	0.927	0.457	0.788

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7 Discussion & Conclusion

The aim of this research was to determine whether wage inequality perceived by workers due to different levels of education has been affected by increased demand for Chilean production from the EU and US. The Heckhscher-Ohlin model has been used in order to formulate the predictions of the effect; and to accommodate for Chilean regional endowments of resources, the analysis has been conducted on a regional level. Three groups of regions were formed in order to assess the impact of the FTAs on the production of three main categories of goods whose exports have benefited from decreased tariffs.

We conclude that, for the production of agricultural products, wage inequality between workers with a high school diploma and those with basic education has decreased, in line with the predictions of the economic model. This is an important consequence which should be taken into account when evaluating the benefits that Chile has achieved from international trade. On the one hand, international trade has made unskilled agriculture workers better off, thus decreasing the level of inequality in a country where inequality levels are still skyrocketing; on the other hand, international trade failed to incentivize people employed in agriculture to be more educated, in a country where the education sector underperforms compared with countries with similar economic development conditions.

Wage inequality due to education in the beverage industry has increased in line with our predictions, although the results are not highly significant. A possible explanation for the low level of significance lies in the fact that one of the main regions involved in the production of wine and other beverages is the Region Metropolitana. Being this the region where the capital of the country is located, overall returns to education might have increased due to higher chances of being exposed to better education levels compared with other regions, thus making it harder for a specific sector to stand out.

For the fishing industry, we found that workers experienced a significant increase in their returns to education, compared with non-traded sectors. This effect is in contrast with our expectations, and we think the reason for it is that the Chilean salmon industry, which is by far the most profitable fishing industry in Chile, has experienced a sanitary crisis starting in the late 90s which escalated and reached its peak in 2007. In order to solve this sanitary crisis, better knowledge of the local biological environment was required (Iizuka & Zanlungo, 2016). In fact, from Figure 5, we observe that the fishing sector experienced a drastic increase to the returns to education experience around 2009, probably in response to the sanitary crisis demands.

This is an example of how international trade can increase the sanitary standards required in an industry, therefore stimulating people to achieve higher education levels.

For further research, we suggest to conduct the analysis over a larger time-span or to consider an institution that releases datasets yearly rather than every two or three years. Moreover, we suggest to consider a dataset that clearly differentiates between the different jobs (marketing and viticulture) within the wine and beverages sector.

References

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of california's tobacco control program. *Journal of the American statistical Association*, *105*(490), 493–505.

Barton, J. R., & Murray, W. E. (2009). Grounding geographies of economic globalisation: globalised spaces in chile's non-traditional export sector, 1980–2005. *Tijdschrift voor economische en sociale geografie*, *100*(1), 81–100.

Beyer, H., Rojas, P., & Vergara, R. (1999). Trade liberalization and wage inequality. *Journal of Development Economics*, *59*(1), 103–123.

Bouttell, J., Craig, P., Lewsey, J., Robinson, M., & Popham, F. (2018). Synthetic control methodology as a tool for evaluating population-level health interventions. *Journal of Epidemiology & Community Health*, *72*(8), 673–678. doi: 10.1136/jech-2017-210106

Chumacero, R. A., Schmidt-Hebbel, K., & Fuentes, R. (2004). Chile¿ s free trade agreements: How big is the deal? *Documentos de Trabajo (Banco Central de Chile)*(264), 1–33.

de Piñeres, S. A. G., & Ferrantino, M. (1997). Export diversification and structural dynamics in the growth process: The case of chile. *Journal of development Economics*, *52*(2), 375–391.

Doudchenko, N., & Imbens, G. W. (2016). *Balancing, regression, difference-in-differences and synthetic control methods: A synthesis* (Tech. Rep.). National Bureau of Economic Research.

Farinelli, F. (2012). *Natural resources, innovation and export growth: the wine industry in chile and argentina*. Maastricht University.

Iizuka, M., & Zanlungo, J. P. (2016). Environmental collapse and institutional restructuring: the sanitary crisis in the chilean salmon industry. In *Chile's salmon industry* (pp. 109–135). Springer.

Jean, S., Mulder, N., & Ramos, M. P. (2014). A general equilibrium, ex-post evaluation of the eu–chile free trade agreement. *Economic Modelling*, *41*, 33–45.

Leiva, S. (2000). *Part-time work in chile: is it precarious employment?: reflections from a gender perspective*. ECLAC.

McCaig, B. (2011). Exporting out of poverty: Provincial poverty in vietnam and us market access. *Journal of International Economics*, *85*(1), 102–113.

Naamani, G. (2007). Developments in the avocado world. *California Avocado Society*, *2007*, 71–76.

Newbold, J. (2003). Social consequences of mining and present day solutions—region ii in chile highlighted. *Sustainable Development*, *11*(2), 84–90.

Nowak-Lehmann, F., Herzer, D., & Vollmer, S. (2007). The free trade agreement between chile and the eu: Its potential impact on chile's export industry. *Applied Econometrics and International Development*, *7*(1).

O'RYAN, R., De Miguel, C. J., Miller, S., & Pereira, M. (2011). The socioeconomic and environmental effects of free trade agreements: a dynamic cge analysis for chile. *Environment and Development Economics*, *16*(3), 305–327.

Rehner, J., Baeza, S. A., & Barton, J. R. (2014). Chile's resource-based export boom and its outcomes: Regional specialization, export stability and economic growth. *Geoforum*, *56*, 35–45.

Topalova, P. (2010). Factor immobility and regional impacts of trade liberalization: Evidence on poverty from india. *American Economic Journal: Applied Economics*, *2*(4), 1–41.

Appendices

A Figures

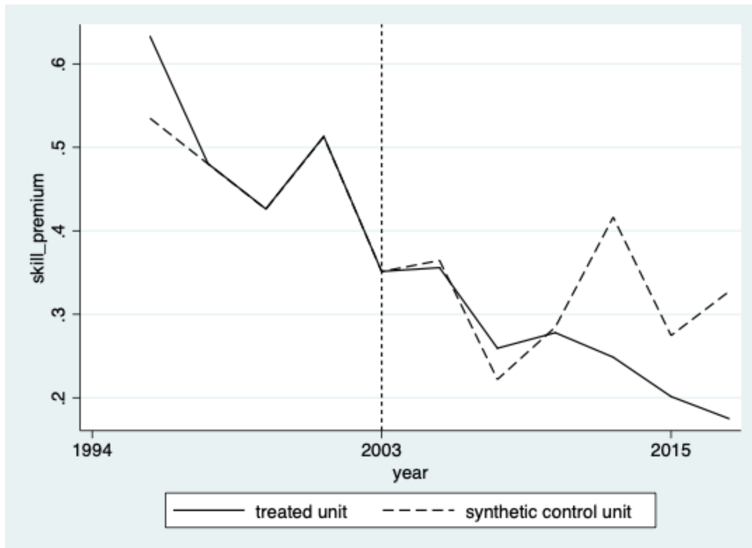

Figure 1: Evolution of skill-premia in the agriculture sector and its control group

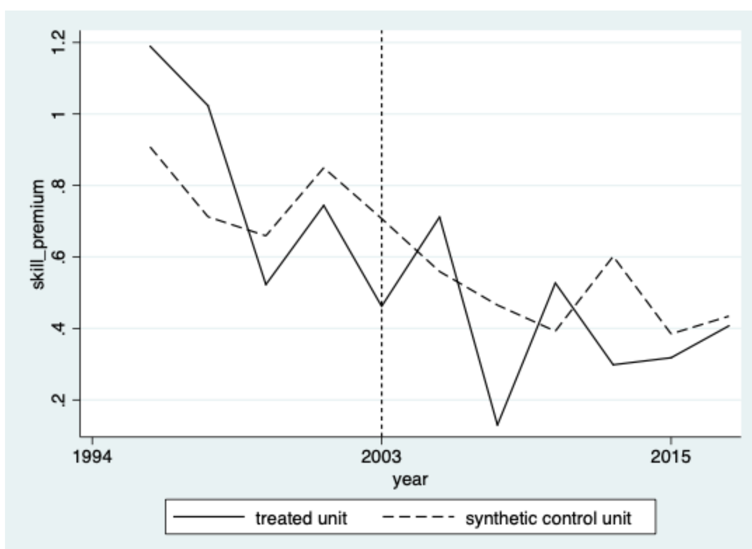

Figure 2: Placebo test analysis for the agriculture sector

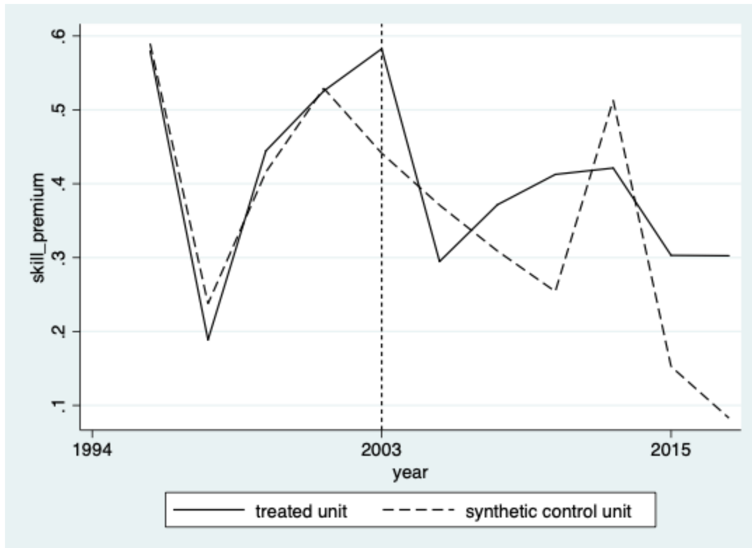

Figure 3: Evolution of skill-premia in the beverage industry and its control group

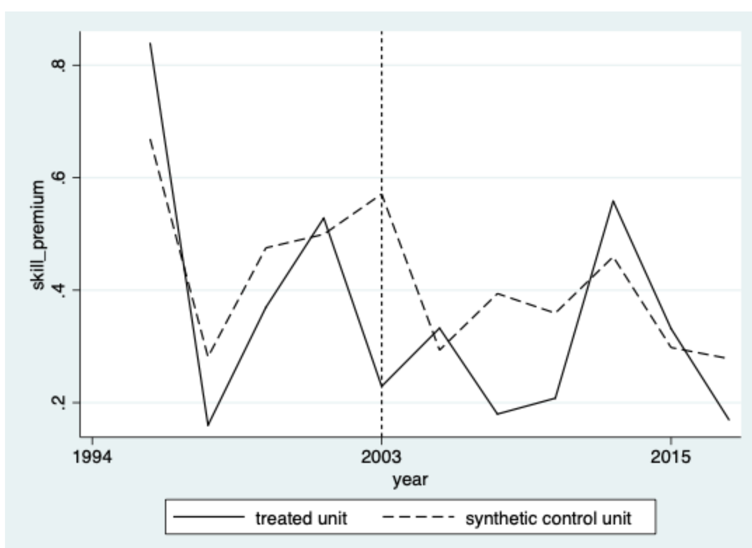

Figure 4: Placebo test analysis for beverages industry

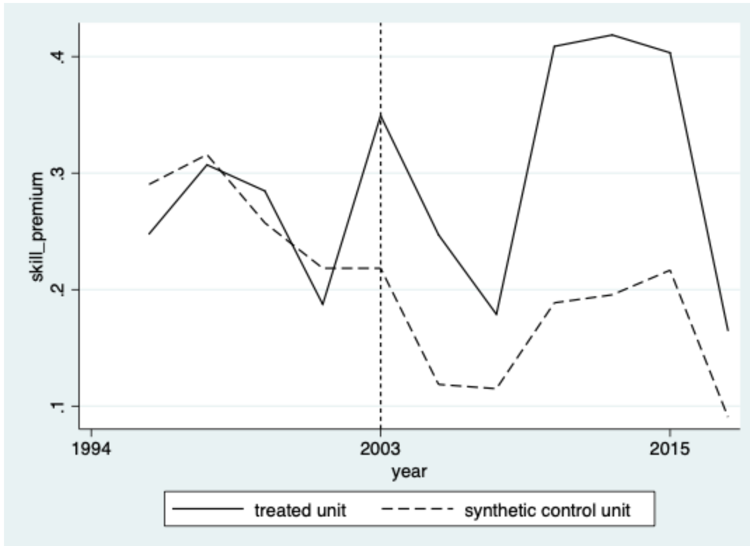

Figure 5: Evolution of skill-premia in the aquaculture sector and its control group

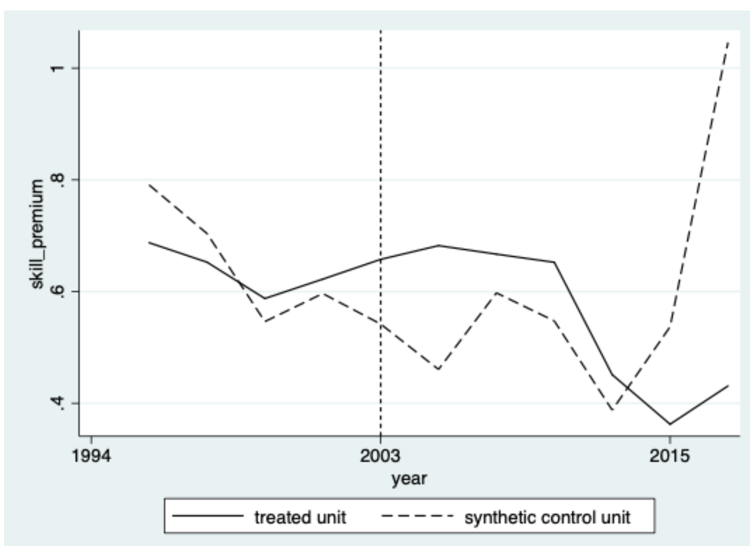

Figure 6: Placebo test analysis for aquaculture sector

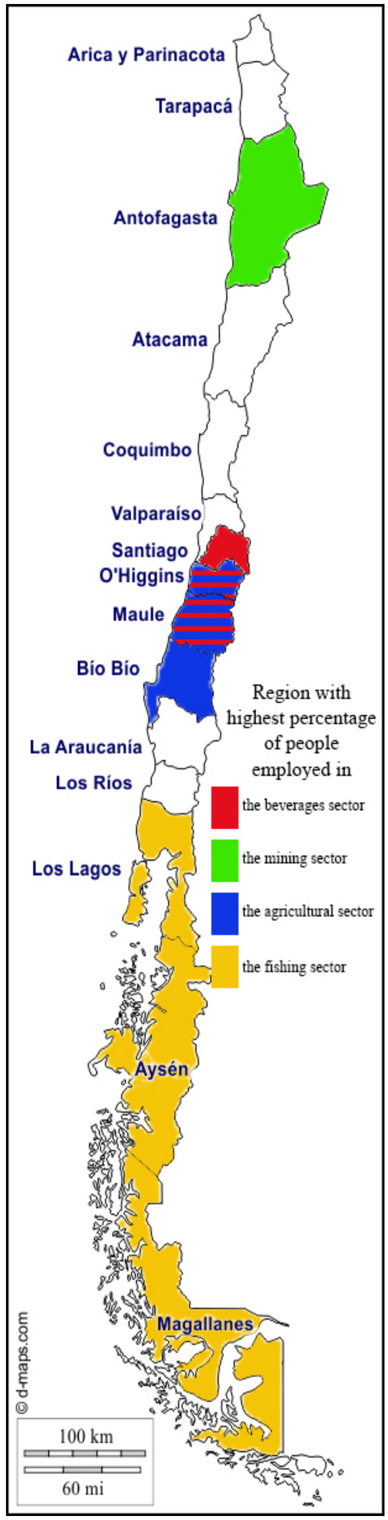

Figure 7: Chilean regions

B Tables

Table 11: CIIU codes evolution per sector of interest

Sector	1994-1996	1998-2009	2011-2017
Agriculture	111	1110	0111-0113
Aquaculture	130	1301-1302	0500
Beverages Ind.	313	3131-3134	1551-1554
Public Services	910	9100	7511-7514; 7521-7523; 7530
Sanitary Services	920	9200	9000
Education Services	931	9310	8010; 8021-8022; 8030; 8090
Medical Services	932	9320	8511-8512; 8519-8520
Social Services	933	9330	8531-8532
Other Social Services	939	9391; 9399	9191-9192; 9199
Entertainment Services	934	9411-9415	9211-9214; 9219-9220
Recreation Services	935	9490	9241;9249
Laundry Services	952	9520	9301
Domestic Services	953	9530	9500
Personal Services	959	9591; 9592	9301

Table 12: Mean values for experience and its components in each sector

	(1)	(2)	(3)
	Agriculture	Beverages Ind.	Aquaculture
VARIABLE	Mean	Mean	Mean
Experience	28	21	22
Age	41	37	36
School Yrs.	7	10	8

Table 13: Full-time and part-time workers per sector

	(1)	(2)	(3)
	Agriculture	Beverages Ind.	Aquaculture
	Frequency	Frequency	Frequency
	(Percent)	(Percent)	(Percent)
Part-time	7,945	93	1,705
	(11.26)	(3.838)	(25.25)
Full-time	62,636	2,330	5,040
	(88.74)	(96.16)	(74.75)