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Commodity Price Boom and Copper mines in Chile: The assessment of local spillover effects on the labor market.

by

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Chile has been benefited from a commodity boom in the copper industry during the first decade of the 21st century. Does a mineral boom increase local labour opportunities? Can women get benefit from a resource boom? Can the mineral boom have indirect effects in non-mining sectors? The present paper attempts to explore and measure the impact of an exogenous increase in copper global prices between 2003 and 2011, on Chilean labor market, with a particular focus on gender disparities. To do that, I exploit the temporal and spatial variation of the raise in copper production, that differ between Chilean communes. For the discussion of the results, I employed the framework of local labor demand shocks on tradable sectors and its multipliers effect explained by Moretti (2011). The results obtained by Linear Probability Models show a reduction on the overall probability of working for women living in communes with at least one active copper mine after the boom in copper. By exploring the impact of the copper boom on the probability of working in different occupations, it is suggested that the local multipliers effect from the resource boom are weak in women labor markets.

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Introduction

Previous literature shows that commodity price shocks affect several outcomes: employment, displacement, and resettlement of population, infrastructure and social amenities, environment, and health (Imakando, S. (2016)). Labor markets in countries that economically depend on natural resource react to an exogenous boom in global mineral prices by increasing production, exports, wages and the employment demand by mining companies and other industries related with extractive activities such as the construction of infrastructures or transport networks.

Within the studies about whether natural resource abundance in countries is a curse or a blessing, the most recent literature is focused on the local impacts of the natural resources booms in labor markets. Researchers attempt to assess if local shocks that increase oil, gas or mining production benefit suppliers regions by increasing local employment rates and wages, or if instead, they crowd out other sectors of the economy such as manufacturing, by increasing factor prices. This is a relevant topic for policymakers and urban economist since it will explain the creation of agglomeration economies that can also generate indirect local spillover effects in other sectors, affecting the regional prosperity and workers welfare (Pellares A. (2015)). Unluckily, measuring the effects of a commodity shock to a local labor market can be ambiguous as companies' decisions are endogenous and hence counterfactuals are hard to assess.

Furthermore, Moretti (2010) by the estimation of long-term employment multiplier at the local level argues that apart from this recognizable direct effect, when a local economy creates a new job by appealing a new business, supplementary jobs might also be generated, principally through higher demand for local goods and services. Development and countercyclical policies from local governments rely on the magnitude of these local multipliers effects determining the spending of taxpayer money on incentives to attract new businesses to their jurisdictions.

An exogenous shock in the mining labor demand could produce an increase in labor cost, hurting local producers of tradable goods. This is associated with an economic phenomenon found in previous literature and commonly evidenced in the resource-abundant countries called ‘Dutch Disease’ (Harding, T., & Venables, A. J. (2016)). It engages a rise in the real exchange caused by the boom in natural resources in the country, making cheaper for locals to import tradable goods than buy them from domestic producers. Furthermore, the increase in local jobs and higher wages originated by the boom in resource production lead to a rise in the city budget constraint and a consequently higher local demand for no tradable goods. These two mechanisms shift the economy away from the traded sector (agriculture and manufacturing) towards the non-traded sector (construction and services).

An increase on the demand of labor in the tradable sector can also have a positive effect in other tradable industries, but the direction is unclear, since the multipliers for tradables depend on local changes in labor costs, since tradable goods have prices set nationally or internationally. For all of this, there is the intuition that local multipliers for the rest of the tradable sector might be lower than the one for the non-tradable sector, or even negative. However, this negative effect may be partly compensated by industrial agglomeration. If these externalities exist, the transport cost of good, people and ideas is reduced (Marshall (1920)) and there is an increase in the demand for intermediate inputs if supply chains are localized.

The present paper attempt to analyze the geographically spillover effects on Chilean labor markets, generated by an increase in the copper global prices between 2003 and 2011. To do that, I exploit the exogenous temporal and spatial variation of the raise in global copper prices and the differences patterns in the mine expansion along Chile. For the discussion of the results, I employed the framework of local labor demand shocks on tradable sectors and its multipliers effect explained by Moretti (2011). The results obtained by Linear probability models show a reduction on the probability of working for women living in communes with at least one active copper mine after the boom in copper. By exploring the composition of the overall probability on women workforce, it is suggested that the local multipliers effect from the resource boom are weak in women labor markets.

1.1 How can a Resource boom affect women labor force participation?

In this section, I am going to explain how a resource boom can affect female labor demand and supply. First of all, a relevant aspect to interpret divergences in local multipliers in the tradable and non-tradable sector is to notice that there are economic activities more linked to certain demographic groups than to other ones. In many developing countries, women used to work in manufacture industries and agriculture, and they are excluded from the extractive industries, construction or retail sectors (Ross (2008)). Gary Becker (1957) explains that taste for discrimination of women from the non-tradable sector is due to prejudices from the employers of women or other minority group's capacity or the fear of the reduction of workers productivity when mixing genders in the team job. According to him, this taste against population from disadvantaged groups can be interpreted as the individual preferences between goods and services, giving no explanation about these prejudices.

Moreover, the different role of men and women in the household or the social imposition of the maternity such as the "main goal of women" discourages the investment on women education and then the presence of women in high skill jobs. Hence, due to occupational segregation and patriarchal structures in the labor force, women have been more employed in tradable sectors and unskilled jobs such as agriculture and manufacture, prevailing lower returns from education.

Therefore, if labor markets are gender segregated, the effects of "Dutch disease" that damage the employment rates on tradable sectors, might affect in a different way women and men workforces. According to these arguments, the spillover effects from the resource boom might be going to reduce in a bigger proportion the women labor demand than the one for men, since they are more employed in the tradable sectors. Hence, a mineral boom can have deep social consequences: higher fertility rates, less education for girls, and less women bargaining power in political spheres.

Furthermore, female labor supply can be also reduced by household income effects. The increase in male wages and government transfers, caused by the expansion of the non-traded sector that employs more men than women and by the effect of booming mineral exports on government revenues, increase women unearned income. This leads to a reduction on women's reservation wage and a consequent drop in women's labor supply. Hence, these arguments show how women workforce can be reduced by the resource boom via labor demand and supply.

1.2 Natural resource abundant economies; a curse or a blessing?

This paper contributes to the debate about whether a natural resource boom is a curse or a blessing for the welfare of a country. Sachs and Warner (1995) were the first on give empirical credibility to the concept of "Natural Resource Curse". By using a sample of 23 African countries and employing cross-sectional estimations, they show that economies with high natural resource export rates such a share of GDP in 1971 are more likely to have slow economic growth between 1971 to 1989. They blame on the economic condition called Dutch Diseases, characterized by an increase in the exchange rate of the country and a consequent crowd out in the manufacturing sector. Furthermore, in previous literature this natural resource curse has been linked as well with bad institutions measured by corruption rates (Hannan and Moshin (2015)), governments' inefficiency and lack of democracy (Barro (2000)), high risk of armed conflicts (Ross (2006)), and lower status of women due to the non inclusivity of extractive industries (Ross (2008)).

The empirical evidence presented in these above mentioned researches that support the "Natural Resource Curse" hypothesis is obtained by cross sectional analysis, leaving a door open to the non consistency of the results due to the heterogeneous effects between countries or the lack of observations in the sample. Hence, in order to be closer to obtain causal results, in this paper the spill-over effects from the copper boom are going to be assessed by within country variation and using individual data from Chile.

1.3 Labor markets and natural resources booms: Previous reasearchs.

In previous literature there are many authors that tried to assess the effects of a resource boom by exploiting within-country variation. Aragon and Rud (2013) exploit the expansion of the Yanacocha gold mine in the city of Cajamarca, Peru, which local procurement policy gave priority to local and encouraged suppliers to hire local workers. They used household surveys for the period 1997 to 2006, and their identification strategy exploits the expansion of the mine's demand for local inputs and distance to Cajamarca City, the mine's supplying market. In concrete, they employed a difference-in-differences strategy, using the households located close to Cajamarca City such a treated group. Their results show that the mine expansion has a positive impact on nominal and real income and a paralleled increase in household consumption and poverty reduction.

Regarding the researches that links women status with resource boom, there are mixed results about whether industrial mining increases or decreases female employment. In general, they coincide with the common knowledge that an expansion on extractive industries hurts women labor force, due to its non female inclusivity and gender occupational segregation. For example, Ross (2008), by employing a cross country regressions of female labor force participation on oil wealth, arguments that the responsible of the strong patriarchal structures and the low status of women in Middle East is oil and gas exporting oriented economies in these countries, and non due to the Islamic culture in the region. As it is expressed in Section 1.1, Ross (2008) explained the reduction of female labor force by the drop on women labor demand and supply. The demand is affected by the Dutch Disease's effects of shifting the economy away from the manufacturing and agricultural sector that employ more women, and the supply by the household income effect entailing the higher male wages and government transfer caused by the resource boom.

On the other hand, Kotsadam and Tolonel (2015) give empirical evidence of a localized structural change where a mine opening offers new employment opportunities for women in Sub-Saharan Africa. By using a Difference in Difference strategy, comparing areas near to mines with areas farther away, they show a decrease in agricultural employment and an increase in service sector employment, and an overall drop in labor force participation. In the case of men, they discover a structural shift focused on increasing work in skilled manual jobs and decreasing self-employment in farming. Hence, according to these authors, mine expansion can pull workers from low value added sectors to higher value added sectors, such as services and skilled manual labor.

The present paper could be complementary to the one of Pellandra A. (2015). For the case of Chile, the author assesses the short term effect of the large increase in commodity prices between 2003 and 2011 combined with the increase on mining mine sector, on regional employment, wages, poverty, and inequality in a local level. Their empirical evidence give the intuition that unskilled workers in regions abundant on natural resources obtained a large profit and that their gains contributed to the reduction in the skilled wage gap experienced by the country in the period under analysis. These results shed light on the reduction of persistent high-income inequality in Chile.

2 Copper industry; the case of Chile

Copper is one of the most consumed industrial metals, after iron and aluminum, due to its characteristics of high ductility, malleability, thermal and electrical conductivity, and its resistance to corrosion. It is employed for electrical uses, like power transmission and generation, building wiring, telecommunication or to construct infrastructure, transport or electronic products (USG, 2018).

Chile is by far the largest copper ore exporter in the world (29.2% of total world copper ore exports), followed by Peru (20.1%), Australia (7%) and Indonesia (6.6%)[1]. In this section it is remarked the historical importance of the mining sector in Chile, becoming the backbone of the country's economy. Due to this dependence of natural resource, particularly copper in terms of output and exports, the Chilean economy is characterized by its regional inequalities. Antofagasta, Tarapaca, and Atacama are the three regions with highest copper reserves and also with the highest GDP per capita (OECD (2018)). Auracania is the poorest Chilean region, with a GDP per capita lower than Egypt, while the one for the richest region, Antofagasta, is higher than Switzerland.

In order to evaluate the contribution of the copper sector in the first decade of 21st century, it is assessed the increase in global copper prices from 2003 to 2011 such as main driver of the boom in copper export value. Finally, it is explained why the fact of the price boom is an appropriate temporal framework to assess the impact of a resource boom.

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[1] Data obtained from World Top Export, Ore Copper (2018) http://www.worldstopexports.com/copper-ore-exports-by-country/

2.1 Importance of mining sector in Chile

Chile has an important comparative advantage in the mining sector, specifically in copper mining. This country is the number one producer of copper, iodine, molybdenum, and rhenium. Since 1982, the country is leading the world copper production and in 2015 accounts for 30% of global mine output.

The importance of minerals in Chile for the global market dates back to the beginning of the 20^{th} century, because of the discovery of synthetic nitrates. Between 1890 and 1924, nitrates exports supposed in average an approximate of the 25% of the GDP and the taxes obtained from this commodity exports represented half of the National budget revenues in this period, establishing Chile as one of the most economically powerful countries in Latin America in 1910. However, the high economic dependence to nitrates exports and hence to international markets, contributed to the economic instability of the country, leading to an economical crisis. Gradually, the country started to incentivized FDI in full copper scale projects, determined by the increase in the global demand due to the rise of electrical industry, the spread of construction sector and technological innovation in the United States, making companies from this country to buy almost all Chilean copper mines until 1970.

Due to the negative experience with nitrates exports dependence, the government was concern about the high control of North American firms over copper and the possibility of the mineral uprooting from the Chilean economy (Ministerio de Mineria, Gobierno de Chile (2019)). Hence, Salvador Allende's government expropriated all of the foreign copper companies performing in the country and nationalized Chilean copper. This resolution was supported by the Pinochet government that followed the military coup in 1973. The National Copper Corporation of Chile (Codelco), was a state-owned company created in 1976, operating in the mines before owned by the nationalized foreign firms. It was not until the return of the democracy in 1990s, when the government started to incentive again local large scale investments from foreign companies in new copper mines.

Consequently of this complicated history, nowadays copper production in Chile is rule by fifteen large companies, operating 27 major mines mainly in the Antofagasta, Tarapaca and Atacama regions. In Table A2, there is a summary of the main Chile's copper operations, indicating the name of the main copper mines, the region and commune that the mine belongs to, the owner company and the operator country. Codelco managed seven mines and produced 1.7Mt of mined copper; accounting for almost 30% of total mined copper production in Chile in 2017 and is now the biggest copper production company in the world. The Escondida Mine is the second most important copper producer company, producing 1.15 Mt of mined copper and accounting for the 20% of total mined copper production in Chile (USGS, 2018). The rest of the country's copper output comes from 19 other mines

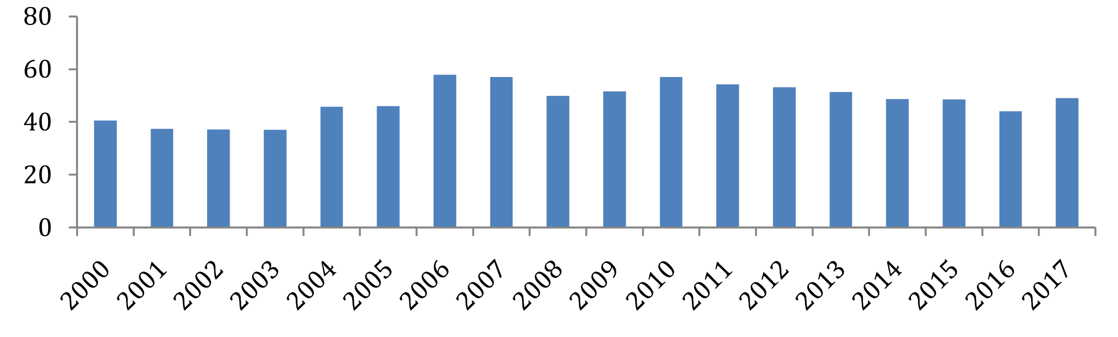
The potential nature advantage of the presence in copper in the country, suppose copper mining as the most significant economic activity in Chile. In the last two decades, copper mining represented for a 10% of Chile's GDP, an important percentage also if we compared with mining industry as a whole that represents 10.9% of GDP, and accounting for one in every three dollars entering the country (International copper association (2017)). Furthermore, as we can see in Figure 2, Copper represents around 50% of Chilean total goods exports in the last decade.

2.2 Global copper price boom

The mining sector experimented fluctuations in their economical contribution. From 1994 to 2003, mine sector represented 6% of Chilean fiscal revenues; a share that tripled between 2004 and 2014, representing an annual average of 20%, and from 2015 the contribution come back to the levels before accounted before 2004 (Comisión Nacional de productividad (2018)). Figure 2 shows an impressive increase of copper export value in Chile in the period under study, between 2003 and 2011, accounting for an average growth rate of the 23.06%. This increase in copper production and value was mainly due to the companies' reaction to the "super cycle" of copper prices, which led them to give more importance to the quantity produced over other criteria such as efficiency. As we can see in Figure 3, there is a sharp increase in global copper prices from $1779 in 2003 to $8823 in 2011.

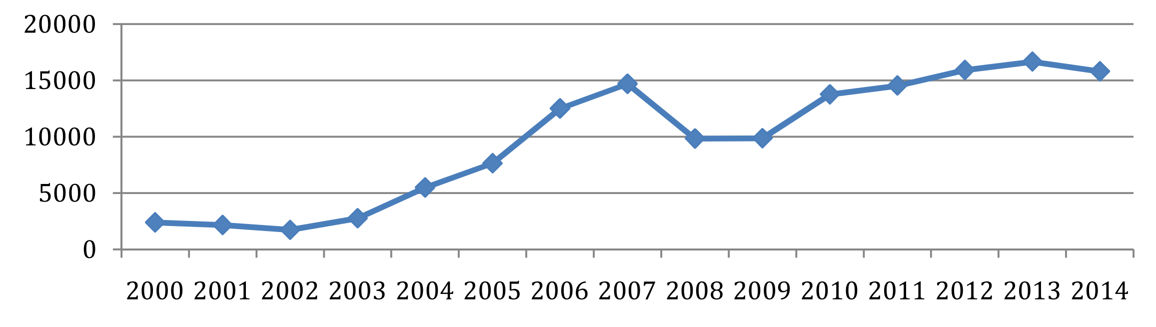
Price of copper is mainly determined by the ability of copper suppliers to extract and transport the mineral, as the demand for goods and services that require copper. Pellandra A. (2015) takes the global copper prices boom such an exogenous shock for Chile, converting copper in a price taker in the global copper market. Hence, Chile is a good scenario to assess the impact of a mineral boom in labor markets, since the spillover and multipliers effects from the copper production on labor markets are going to be stronger in years of high copper global prices, and it is interesting to compare the impact of living in a area affected by a copper mine and non affected on labor markets during the pre and post shock years.

Figure 1 Chilean exports of copper 2000-15, as percent of total exports



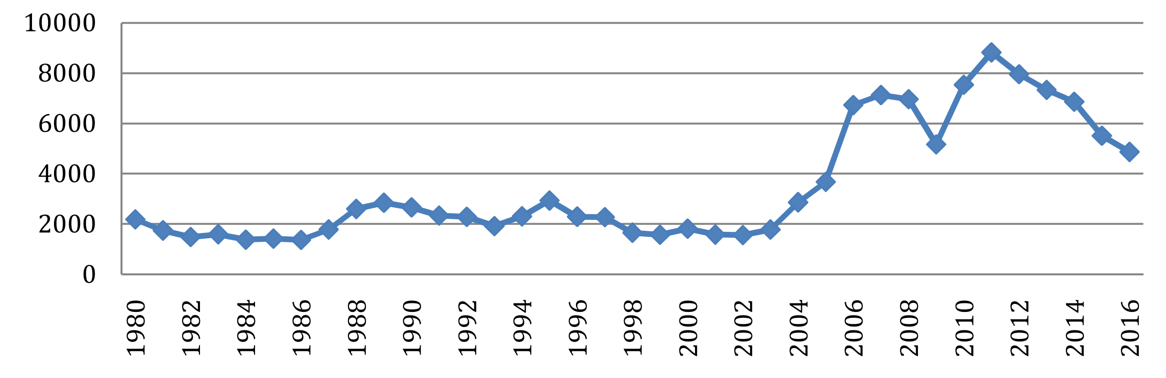
Sources: The observatory of economic complexity

Figure 2 Chilean Copper ore exports (Millions US $)



Source: Comtrade Database

Figure 3 Global copper prices (US$ per Metric Ton)



Source: Federal Reserve Economic Data

3 Data

In order to investigate the spillover effects of a copper boom on labor markets in Chile, I employed individuals in 2003 and 2011 rounds of the Chilean Government's Encuesta de Caracterización Socioeconómica Nacional (CASEN). It is a cyclical cross-section household survey on specific social and economic aspects of the inhabitants in Chile, including information about wages and employment classified by 4-digit ISIC sector (International Standard Industrial classification) and micro-region both at the individual and household level.

Chile's local administration is composed by 15 regions, 54 provinces and 346 communes in 2011[2]. Communes are the lowest regional administrative level in the country. Only 19 of these communes have had at least one active copper mine in 2003 and 2011. Data about mine activity, operator companies, production and coordinates is taken from SNL mining intelligence platform and USGS (U.S Geological Survey), and it is presented in Table A2.

Taking the assumption that households living near a copper mine are going to be more affected by a copper boom, the individuals residing in communes with at least one active copper mine are going to be part of the "interest or treated group" to analyze the impact of the resource boom in labor markets. Then, the control group it is going to be formed by the population living in communes with no active copper mines in them. Henceforth, in order to simplify the treated group is going to be called "copper communes", and it is created by

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[2] The communes' boundaries shift between 2003 and 2011, fact that makes almost impossible to merge two databases, as I will explain more detailed in section 4.

linking the individual data from CASEN surveys, to the mine activity information from SNL and USGS platforms.

3.1 Descriptive Statics

The sample distribution it is shown in Table 1. The surveyed individuals are restricted to those in the working age (between 15 and 65 years old) and they are differentiated by living in copper and non copper communes and by gender. As we can see, the share of the total working age population living in copper communes is 6.4% and 12.8% in 2003 and 2011. This suggests a migratory transition from non-copper communes to copper communes during the global copper price boom due to the mine expansion.

In tables A3 and A4, we can see the mean and standard deviation of labor force participation[3] and sector distribution by gender and copper and non-copper communes in 2003 and 2011. In average terms, in 2003 there were more women working in copper communes than in non copper communes. However, in 2011 the female labor participation in non-copper communes is 0.8% higher than in copper communes. On the other hand, it is the other way around for men; male labor participation in copper communes is 1.8% higher than in non-copper communes. This gives the intuition of a relative reduction of the women labor force participation in copper communes in 2011 compared with 2003.

By observing these tables we can have an intuition of the structural change and the possible spillover effects from the mine expansion between 2003 and 2011 in Chile. First, there is an impressive drop in the percent of women living near a copper mine that works in agriculture from 4.7% to 1.2 %. However, the analogue variation for those women residing in non-copper

[3] Labor force participation is defined as the section of working population in the age group of 15-65 surveyed in the CASEN individual survey that respond to be currently employed or seeking employment.

communes has been a slight decrease from 5.2% to a 4%. There is a parallel change for male population; the percent of men living in copper communes working in agriculture drastically fell from 17% to 4.3% and from 27.5% to 14.7% for those living in non copper communes. Although it seems that there is a natural shift of the labor markets away from the primary sector, these results suggest that the boom of copper industries crowed out agricultural employment.

Regarding the mine sector, there is evidenced of occupational segregation biased to men in both years, although there is an increase in the percent of women living in copper communes on working in mines increase from 0.5% to 1.8%. Nevertheless, in 2011 the 19% of men residing in copper communes were working in mines, an impressive increase since in 2003 it was the 11.7% of them. The percentage for male living far from copper mines is irrelevant, accounting for a 2.9% of them in 2011. This fact supports the assumption that the direct and indirect effects from the resource boom should be stronger in areas near mines.

Looking the calculations for the manufacture sector, there is not drastically changes between the two years and different place of residence. In average for the two years, only the 1.85% and 2.75% of women living in copper and non copper communes respectively are employed in the manufacture sector.

The main occupation of women in both years is Commerce and hostelry. There is an increase in the percentage of women that lives in copper communes on working in commerce sector from 10.4% to 17.4%.

To sum up, the intuition of Table A6 and A7 suggests a crowd out of agriculture for both genders probably due to mine expansion, and a shift of women to commerce and hostelry or to the low skill service sector. There is also evidence that there is higher labor demand of mine workers in areas next to the copper mines and after the global copper price shock.

Now we are going to observe the summary statics for the main demographic variables in the CASEN household surveys in 2003 and 2011, shown in Table A1. The mean and the standard errors are given by restricted samples for people living in copper and non copper communes. The mean values for the demographic variables such as percent of women, age, years of education, percent of married people, are similar between copper and non copper communes for both years. The income per capita is higher in 2011 than in 2003, but the income gap between copper and non copper communes is bigger after the copper boom. This is consistent with the first order effects of a labor demand shock in the tradable sector described by Moretti (2011), which are the increase on the city budget constraint because of the higher local employment rate and the increase in wages. Moreover, the percent of people living under poverty and extreme poverty have been reduced by a half in copper communes, much more than in the average of non copper communes that have been reduced by a quarter. According to Aragón, F and Rud, J. P. (2013), this raise in income per capita is paralleled by an increase in household consumption and poverty reduction, associated with the mine expansion.

Table 1 Sample distribution: Number of individuals in the working age, living in copper and non copper communes, in 2003 and 2011

		Copper Communes	**Non Copper Communes**	**Total**
2003	**Women**	5,411	79,516	84,927
	Men	5,370	78,033	83,403
2011	**Women**	9,023	61,998	71,021
	Men	8,376	56,425	64,801

Source: CASEN (2003, 2011)

4 Empirical Strategy

In this section we are going to know more about the empirical strategy followed to assess the hypothesis arising in this paper. First:

H1: An increase in global copper prices and the consequent boom in copper exports generates local spill-over effects on labor markets of the tradable and non tradable sector in areas around mines.

If the Hypothesis 1 cannot be rejected , there is strong linkage and local multipliers effects. As it has been said before, the individuals living near a copper mine are going to be more exposed for the resource boom, due to the minor transport cost. Moreover, the impact on labor markets is going to be higher in years with high mineral prices due to the increase in wages, income per capita and consumption. Hence, in order to tests the hypothesisis presented in this paper I am going to use the natural experiment provided by the increase in global copper prices from 2003 to 2011, and the differences in regional mine expansion in Chile, to identify the impact of the boom in copper exports in labor markets in a local level.

Apart of assess the impact of the resource shock on the probability of participate in the labor force in Chile, I am going to explore the sector composition of the overall effect on employment and the possibility of heterogeneous effects between sectors.

Furthermore, I am going to assess the local spill-overs effects on female labor market, to see if the results are consistent as the one found by Kotsadam, A., and Tolonen, A. (2016) for the Sub- Saharan countries; a mining boom crowd out the agricultural employment and increases the probability of working in the service sector for women.

H2: An increase in global copper prices and the consequent boom in copper exports generates a shift of the women labor market away from the tradable sector to the service sector

Since Chile is a price taker in the international copper market, the price shock provides an appropriate framework to study the spill-over and multipliers effects from resource extraction on labor markets.

4.1 The Approach

In order to test the hypothesis proposed, I am going to exploit the exogenous temporal and spatial variation of the raise in global copper prices and the differences in the mine expansion in Chile. The distance of the individual residence from a copper mine is going to determine the treated group, which is formed by population living in a commune with at least one active copper mine. These communes are presented in Table A2, and are linked with the corresponding active copper mine, production and name of the owner company.

The idea behind the empirical strategy is a difference in difference model. However, since the communes in Chile shift between 2003 and 2011, the results of merging both databases would be biased. The boundaries in the treatment group, formed by communes with at least one active mine in both years, stay constant, however the rest of communes shift during the price shock period. Hence, the strategy employed is to compare the coefficient of the treatment variable in two Linear Probability Models for each pre and post price shock year. The principal equations of LPM for 2003 and 2011 employed are 1 and 2:

(1) $T = 2003,\ Y_{ic} = \alpha_0 + \alpha_1 CopperComune_i + \mu_1 \sum X_{ic} + e_{ic}$

(2) $T = 2011,\ Y_{ic} = \beta_0 + \beta_1 CopperComune_i + \mu_1 \sum X_{ic} + u_{ic}$

The outcome variable (overall probability of participate in the labor force or by sector of employment) for an individual *i* living in a commune *c* is regressed on a dummy variable equal one if the individual surveyed reside in a copper commune ($CopperComune_i$) and a vector of individual control variable: marital status, age and years of schooling, which summary statics are presented in Table A1. To assess for the gender inequality in the impact of the resource boom on the labor market I run the regression for women and men at working age.

It is important to notice that it is possible to have heterogeneous effect between copper communes, since each linked copper mine have different production rates. With the purpose of account for statistical problems such as endogeneity from the heterogeneous effect on the probability of participate in the labor force, I control for these fixed effects by including a dummy for the total of the communes in each year. This allows me as well to assess if there is divergences between copper communes and if the results agreed with the ones in models (1) and (2) given by the aggregate variable that accounts for all the population living in copper communes.

Table 2 LPM for probability of Labor participation for men and women in 2003 and 2011

2011	(1) Men	(2) Women	**2003**	(1) Men	(2) Women
Age	0.00705***	0.00734***	**Age**	0.00505***	0.00674***
	(0.000132)	(0.000137)		(0.000116)	(0.000130)
Year School	0.0128***	0.0346***	**Year School**	0.00697***	0.0365***
	(0.000434)	(0.000494)		(0.000345)	(0.000428)
Married	0.278***	-0.0804***	**Married**	0.262***	-0.114***
	(0.00376)	(0.00379)		(0.00314)	(0.00344)
Copper Communes	0.0213***	-0.0224***	**Copper Communes**	0.00661	0.000590
	(0.00471)	(0.00535)		(0.00531)	(0.00654)
Constant	0.165***	-0.179***	**Constant**	0.387***	-0.132***
	(0.00719)	(0.00848)		(0.00567)	(0.00728)
Mean	781%	38.7%		71.1%	42.4%
Observations	64,801	71,021	**Observations**	83,160	84,687
R-squared	0.216	0.080	**R-squared**	0.181	0.091

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 Results and discussion

The OLS estimations from equations 1 and 2 are presented in Table 2. The empirical evidence presented for the year 2003, suggests that there is not significant effect on the probability of working for population living in a copper commune before the shock in copper prices. This means that there are not significant pre-trends. However, this changes for the year 2011. Men living in a commune with at least one active mine have 2.13% more probability of participate in the labor force than men living in other communes. On the other hand, women living in copper communes have 2.24% less probability of participate in the labor force than women living in the rest of the communes. How can be explaining the divergences in the probability of working between men and women? We will focus on that in the section 5.1.

To see if these results are robust to the inclusion of region fixed effects and assess the differences between labor markets in the copper communes I include dummies for each of the 346 communes to the same model as the one showed in Table 1. Due to space reason, only the coefficients of the 19 dummy variables of living in a copper commune are presented in the Table A5, and the ones for the control variables and the rest of the communes are omitted.

For the year 2003 there is only significant pre-trend for men that live in Taltal. This commune has a long mine trajectory that starts in 1850 with the opening of the copper mine "El Cobre". Mine sector employ lot of men population so this probably affects to the positive pre-trend in this commune. In the case of women, there is only significant negative pre trends on the probability of working for four communes: Mejillón, Andacollo, Chañara and Vallenar. It could be because these communes have a mine oriented trajectory, and it can negatively affect women labor force by the rents effects or the occupational segregation of the labor markets, also before the copper boom.

Although there is some differences in the impact on the probability of working between living in the different copper communes, the results of the inclusion of communes fixed effects seems to be in the same line as the one showed by the aggregate variable of copper communes in Table 2. This means that for the big majority of the communes there is no significant pre trend on the probability of working for both sexes, and after the boom in copper prices there is more probability of working for men living in copper communes than in the other communes, and the opposite effect for women.

5.1 Exploring the sectoral composition of the overall effect on employment

The sector composition of the overall impact of living in a copper commune on the probability of working is presented in Tables A6 and A7. As we can see, the impact of living in a commune with at least one active copper mine on the probability of working for women change for several sectors after the boom on copper global prices. For example, the probability for women who live in copper communes of working in the agriculture sector in 2011 is 2.3% less than women living in the rest of communes, although in 2003 these women had 0.5% more probability of work in agriculture. This suggests that the shock on copper industry has negative multipliers effects for the agriculture sector. It could be due to the increase in labor costs generated by the initial labor demand shock that hurts local producers of tradable good. The effect could be canceled out by the agglomeration externalities, but even though supply chains are localized, there is not positive effect for the probability of working in agriculture.

There is no evidence of multipliers effects on the services sector for women. Only in the Finance sector there is a positive change between 2003 and 2011; women living in copper communes in 2011 have 0.7% more probability of working in this sector than women in other communes, and in 2003 this impact was negative. In the case of the Commerce sector there is also an increase in 2011 on the probability of working on that occupation with respect women living in the non copper sector. However, there is no evidence of strong multipliers effect for the women labor market. Moreover, it seems like the crowd out effect on agriculture is bigger than the positive effect on finance and commerce, and then the overall probability of working of women living in copper communes is negative after the boom in prices. Nevertheless, we cannot imply causal effects, since there are significant pre-trend in 2003 for most of the sectors.

For male population sample, the results are showed in Table A7.The sectors boosted by the copper boom are related by the direct effect from the increase of mine production: mining employment, construction and transport sector. It seems as well that there is a structural change away from the Commerce and Restaurant sectors, but as it has been mentioned for the results on female population, it cannot be ensure causal effects due to the significant pre trends in the 2003. Only for the finance sector there is not significant pre trend, suggesting a shift of male population living in copper communes to this sector in 2011.

6 Conclusions

The aim of this thesis is to assess the impact of the increase in global copper prices occurred during the last decade on local employment in the Chile. Within the theoretical framework of local multipliers effects from a boom in the tradable sector given by Moretti (2010), I test the hypothesis of whether the boom in copper exports generates local spill-over effects on labor markets of the non tradable sector in areas around the mines.

Given the occupational segregation between genders of the labor market, the multipliers effects from a resource boom are going to be different for men and women workforce. Hence, with the purpose of innovate with the literature of the impact of a resource boom on gender inequality in the local level, I test the hypothesis that an increase in global copper prices generates a shift of the women labor market away from the tradable sector to the service sector, following the multipliers literature from Moretti (2010).

For the assessment of this hypothesis I employed data from the Chilean Government's Encuesta de Caracterización Socioeconómica Nacional (CASEN) for 2003 and 2011. Then, I exploit the exogenous temporal and spatial variation of the raise in global copper prices and the differences in the mine sector expansion in Chile. The distance of the individuals residence from a copper mine is going to determine the treated group, which is formed by population living in a commune with at least one active copper mine. The idea behind the empirical strategy is a difference in difference model, but since it is not possible to merge the two databases employed, I compare the coefficient of the treatment variable in two Linear Probability Models for each pre and post price shock year.

According to the results presented for the year 2003, there is not significant effect on the probability of working for population living in a copper commune before the shock in copper prices. This means that there are not significant pre-trends. However, this changes for the year 2011. Men living in a commune with at least one active mine have 2.13% more probability of participate in the labor force than men living in other communes. On the other hand, women living in copper communes have 2.24% less probability of participate in the labor force than women living in the rest of the communes.

According to Moretti (2010) the increase on the mining labor demand increase the city budget constraint due to the higher local labor rates and wages, resulting on multipliers effects for the non-tradable sector such as hospitality industry, transport, finance, communal or education sector. However, there is not consistent evidence of that in this case for women. Only the intuition of an increase on the probability of women living in copper communes on working in Commerce and Finance sectors, but the results are not consistent due to the existence of significant impacts on the pre trends. In the case of male population living in copper communes, the sectors boosted by the copper boom are related by the direct effect from the increase of mine production: mining employment, construction and transport sector.

Skilled jobs have higher multipliers. Since the mine sector is not characterized such a high skill job, It could be a reason why the multipliers effects from the increase in the labor demand of mine workers are not strong. Hence, according to the results presented in this paper, there is no evidence of positive spill-over effects on Chilean women labor markets, rejecting the intuition of a structural shift from the to the service sector.

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Appendix A

Table A1. Summary statistics of the main variables from the household survey

Variables	**Communes with a copper mine or not**	**2003**	**2011**
Percent women	Copper	50.1% (0.5)	51.85% (0.51)
	Non copper	50.47% (0.5)	52.35 (0.52)
Age	Copper	35.84 (4.06)	36.46 (4.15)
	Non copper	36.41 (5.0)	37.6 (5.05)
Years of education	Copper	9.76 (3.7)	11.28 (3.44)
	Non copper	9.21 (4.0)	10.59 (3.84)
Percent of Married	Copper	56.15% (0.49)	50.38% (0.49)
	Non copper	56.05% (0.56)	51.4% (0.5)
Income per capita	Copper	184.27 (6.5)	388.96 (7.0)
	Non copper	183.98 (7.0)	352,60 (7.1)
Percent poor	Copper	13.13 (0.8)	7.12 (0.38)
	Non copper	15.65 (0.7)	11.23 (0.6)
Percent extreme poor	Copper	4.68 (0.4)	1.91 (0.4)
	Non copper	5.74 (0.5)	2.73 (0.45)

Notes: Calculations base son CASEN household surveys. Standard error in parentheses. The mean and its standard error are calculated using sample weights. Income per capita is measured in US$ per month. Poverty indicator employed is FGT(0).

Table A2 Mine Activity in Chile

Name of the mine	Region	Commune	Company	Operator Country	Reserves & Resources: Ore Tonnage
Collahuasi	Tarapacá	Pica	Glencore	Switzerland	10.380.000.000
Quebrada Blanca	Tarapacá	Pica	Teck	Canada	6.143.500.000
Cerro Colorado	Tarapacá	Pozo Almonte	BHP Billiton	Australia	2.186.000.000
Zaldivar	Antofagasta	Antofagasta	Barrick Gold	Canada	818.628.000
Escondida	Antofagasta	Antofagasta	BHP Billiton	Australia	29.271.000.000
Mantos Blancos	Antofagasta	Mejillones	Anglo American Chile	UK	299.583.000
Michilla	Antofagasta	Mejillones	Antofagasta Minerals	Chile	60.300.000
Esperanza Sur	Antofagasta	Sierra Gorda	Antofagasta Minerals	Chile	NA
Spence	Antofagasta	Sierra Gorda	BHP Billiton	Australia	2.512.400.000
Gabriela Mistral	Antofagasta	Sierra Gorda	Codelco	Chile	917.000.000
Chuquicamata	Antofagasta	Calama	Codelco	Chile	14.652.000.000
Radomiro Tomic	Antofagasta	Calama	Codelco	Chile	7.372.000.000
El Abra	Antofagasta	Calama	Freeport-MacMoran	USA	2.967.000.000
Ministro Hales	Antofagasta	Calama	Codelco	Chile	NA
Franke	Antofagasta	Taltal	KGHM Polska	Poland	29.924.000
Aura	Atacama	Copiapio	Anfield Energy Inc.	USA	NA
Mateo	Atacama	Vallenar	Red Metal Resources Ltd.	Canada	68.000
Mantoverde	Atacama	Chañaral	Anglo American Chile	UK	646.100.000
Salvador	Atacama	Diego de Almagro	Codelco	Chile	3.564.000.000
Candelaria	Atacama	Tierra Amarilla	Freeport-MacMoran	USA	1.005.193.000
Los Pelambres	Coquimbo	Salamanca	Antofagasta Mineral	Chile	6.024.100.000
Carmen de Andacollo	Coquimbo	Andacollo	Teck	Canada	590.400.000
El Durazno	Coquimbo	Los Vilos	Minera Los Vilos S.A.	Chile	NA
Los Bronces	Valparaiso	Los Andes	Anglo American Chile	UK	5.708.100.000
El Soldado	Valparaiso	Nogales	Anglo American Chile	UK	201.800.000
El Teniente	Libertador	Machalí	Codelco	Chile	14.923.000.000
Minera Valle Central	Libertador	Requínoa	Amerigo Resources Ltd.	Canada	1.223.704.000

Source: SNL mining intelligence platform (SP Global Market Intelligence)

Table A3 Labor force and sector distribution by gender and copper and non copper communes in 2003

		Women	Men
Labor participation	Copper Communes	.397 (.201)	.789 (.311)
	Non copper Communes	.385 (.221)	.779 (.200)
Agriculture	Copper Communes	.047 (.211)	.170 (.376)
	Non copper Communes	.052 (.223)	.275 (.446)
Mines and quarries exploitations	Copper Communes	.005 (.074)	.117 (.322)
	Non copper Communes	.000 (.020)	.011 (.106)
Manufacture industries	Copper Communes	.020 (.141)	.0642 (.245)
	Non copper Communes	.030 (.171)	.083 (.277)
Electricity, gas and water	Copper Communes	.000 (.023)	.0067 (.081)
	Non copper Communes	.001 (.033)	.005 (.070)
Construction	Copper Communes	.003 (.062)	.100 (.301)
	Non copper	.002	.0846

	Communes	(.053)	(.278)
Commerce and Hostelry	Copper Communes	.104 (.306)	.078 (.268)
	Non copper Communes	.081 (.272)	.082 (.224)
Transport and communication	Copper Communes	.012 (.112)	.076 (.265)
	Non copper Communes	.009 (.098)	.053 (.154)
Finance	Copper Communes	.012 (.108)	.025 (.157)
	Non copper Communes	.014 (.119)	.024 (.295)

Notes: The occupational sectors here presented are the most representative of the Chilean labor market. However, the communal services and volunteering sector is also important in the country mostly for women, but the calculations are not here accounted because sometimes are not pay jobs.
Calculations based on CASEN surveys.

TableA4 Labor force and sector distribution by gender and copper and non copper communes in 2011

		Women	Men
Labor participation	Copper Communes	.417 (.493)	.727 (.445)
	Non copper Communes	.425 (.494)	.708 (.454)
Agriculture, hunting, forestry and fishing	Copper Communes	.0123 (.110)	.043 (.203)
	Non copper Communes	.040 (.197)	.147
Mines and quarries exploitations	Copper Communes	.018 (.133)	.190
	Non copper Communes	.002 (.045)	.029 (.055)
Manufacture industries	Copper Communes	.017 (.132)	.057 (.130)
	Non copper Communes	.025 (.157)	.076 (.162)
Electricity, gaz and water	Copper Communes	.001 (.043)	.006 (.046)
	Non copper Communes	.001 (.037)	.007 (.047)
Construction	Copper Communes	.007 (.088)	.085 (.090
	Non copper	.004	.101

	Communes	(.065)	(.077)
Commerce and Hostelery	Copper Communes	.174 (.460)	.147 (.501)
	Non copper Communes	.155 (.429)	.159 (.451)
Transport and comunication	Copper Communes	.012 (.111)	.085 (.199)
	Non copper Communes	.012 (.110)	.067 (.120)
Finance	Copper Communes	.006 (.080)	.003 (.099)
	Non copper Communes	.006 (.080)	.005 (.095)

Notes: The occupational sectors here presented are the most representative of the Chilean labor market. However, the communal services and volunteering sector is also important in the country mostly for women, but the calculations are not here accounted because sometimes are not pay jobs.
Calculations based on CASEN surveys.

Table A5 Impact of living in each communes on the probability of working. OLS estimations

2003	(1) Men	(2) Women	2011	(1) Men	(2) Women
Pica	-0.0464	0.0372	Pica	-0.0628	-0.0168
	(0.0330)	(0.0394)		(0.0505)	(0.0615)
Pozo Almonte	0.0473	-0.0170	Pozo Almonte	-0.0162	-0.0219
	(0.0303)	(0.0377)		(0.0328)	(0.0403)
Calama	0.00372	-0.0455	Calama	0.0539***	-0.0442***
	(0.0269)	(0.0328)		(0.0146)	(0.0164)
Antofagasta	0.00478	-0.0294	Antofagasta	0.0246**	-0.0665***
	(0.0266)	(0.0327)		(0.0107)	(0.0122)
Mejillón	-0.000598	-0.0779**	Mejillón	0.0140*	-0.0568
	(0.0295)	(0.0363)		(0.007)	(0.0454)
Sierra Gorda	0.0307	0.0194	Sierra Gorda	0.142*	0.138
	(0.0310)	(0.0395)		(0.0835)	(0.0947)
Taltal	0.0773**	-0.0288	Taltal	0.0974***	-0.0589
	(0.0318)	(0.0399)		(0.0361)	(0.0458)
Chañara	0.00908	-0.0661*	Chañara	-0.0110	-0.0386
	(0.0302)	(0.0373)		(0.0315)	(0.0354)
Diego de Almagro	-0.0327	-0.124***	Diego de Almagro	0.0318	-0.0710**
	(0.0305)	(0.0390)		(0.0255)	(0.0300)
Copiapio	-0.00284	-0.00311	Copiapio	0.0448***	-0.0179
	(0.0282)	(0.0348)		(0.0132)	(0.0151)
Tierra Amarilla	0.0482	-0.0399	Tierra Amarilla	0.110***	-0.0783**
	(0.0302)	(0.0378)		(0.0302)	(0.0365)
Vallenar	0.0131	-0.0865**	Vallenar	-0.00887	-0.0945***
	(0.0284)	(0.0342)		(0.0183)	(0.0205)
Andacollo	-0.00198	-0.140***	Andacollo	0.0568	-0.0566
	(0.0314)	(0.0383)		(0.0412)	(0.0513)
Ovalle	-0.0299	-0.0559	Ovalle	0.00335*	-0.0684***
	(0.0296)	(0.0355)		(0.020)	(0.0251)
Salamanca	0.0331	-0.190	Salamanca	-0.0528	-0.159***
	(0.0312)	(0.3387)		(0.0397)	(0.0519)
Los Vilos	-0.0111	-0.0594	Los Vilos	0.138***	0.00373
	(0.0309)	(0.0363)		(0.0339)	(0.0364)
Los Andes	-0.0572	-0.00198	Los Andes	-0.0115	-0.0674**
	(0.0305)	(0.0365)		(0.0259)	(0.0291)
Nogales	-0.000772	-0.0549	Nogales	-0.0288	-0.128***
	(0.0310)	(0.0394)		(0.0402)	(0.0445)
Machalí	-0.00493	-0.0447	Machalí	-0.0130	0.0679
	(0.0304)	(0.0374)		(0.0402)	(0.0464)
Requino	0.0210	0.0190	Requino	0.0590*	0.0585
	(0.0291)	(0.0358)		(0.0306)	(0.0418)
Observations	83,16	84,687	Observations	64,801	71,021
R-squared	0.193	0.114	R-squared	0.230	0.095

Notes: due to the reduced space, coefficients of demographic variables and the dummies for the non-copper communes are not presented in the table.

Table A6 Probability of working by sector for women living in copper communes in 2003 and 2011

Women 2003	1 Agriculture	2 Manufacture	3 Commerce	4 Restaurants and Hotels	5 Transport	6 Finance	7 Communal Services	8 Education
Copper Communes	0.005***	-0.010***	0.010***	0.012***	0.00225	-0.004**	-0.011**	-0.003*
	(0.001)	(0.002)	(0.003)	(0.00194)	(0.00139)	(0.002)	(0.005)	(0.002)
Mean	8.6%	2.97%	6,31%	1.95%	0.99%	1.44%	14.81%	1.86%
Observations	84,687	84,687	84,687	84,687	84,687	84,687	84,687	84,687
R-squared	0.002	0.004	0.008	0.001	0.0050	0.020	0.071	0.087

Women 2011	1 Agriculture	2 Manufacture	3 Commerce	4 Restaurants and Hotels	Transport	5 Finance	6 Communal Services	7 Education
Copper Communes	-0.023***	-0.00810***	0.022***	0.008***	-.00065	0.007***	-0.0101***	-0.00981***
	(0.00202)	(0.00175)	(0.00379)	(0.00184)	(.00125)	(0.00190)	(0.00320)	(0.00254)
Mean	3.72 %	2.46%	13.04%	15.77%	1.24%	0.65%	8.9%	5.7%
Observations	71,021	71,021	71,021	71,021	71,021	71,021	71,021	71,021
R-squared	0.009	0.003	0.002	0.001	0.002	0.017	0.015	0.069

Notes: The demographic control variables are included in the models. In these tables there is also showed the mean of the dependent variable in percentage terms. Only the population at working age is taken in the sample. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A7 Probability of working by sector for men living in copper communes in 2003 and 2011

	1	2	3	4	5	6	7	8	9	10
Men 2003	Agric	Manuf	Mine	Construct	Transport	Restaurant	Commerce	Finance	Communal Services	Education
Copper Communes	-0.018***	-0.023***	0.105***	0.006***	0.010***	0.000	-0.009**	-0.003	-0.026***	-0.004***
	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.001)	(0.004)	(0.002)	(0.004)	(0.001)
Mean	5.16%	8.27%	1.83%	8.57%	5.45%	1.12%	8.18%	2.44%	9.54%	0.98%
Obs	83,16	83,16	83,16	83,16	83,16	83,16	83,16	83,16	83,16	83,16
R-squared	0.019	0.012	0.044	0.009	0.018	0.002	0.011	0.027	0.058	0.047

	1	2	3	4	5	6	7	8	9	10
Men 2011	Agric	Manuf	Mine	Construct	Transport	Restaurant	Commerce	Finance	Communal Services	Education
Copper Communes	-0.077***	-0.012***	0.158***	0.012***	0.017***	-0.003**	-0.012***	0.008***	-0.020***	-0.007***
	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)
Mean	11.66%	7.4%	5.04%	9.92%	7.01%	1.5%	15.8%	0.56%	5.4%	2.3%
Observations	64,801	64,801	64,801	64,801	64,801	64,801	64,801	64,801	64,801	64,801
R-squared	0.074	0.008	0.073	0.014	0.015	0.001	0.005	0.025	0.017	0.040

Notes: The demographic control variables are included in the models. In these tables there is also showed the mean of the dependent variable in percentage terms. Only the population at working age is taken in the sample.
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1