



## Does the location of salmon farms contribute to the reduction of poverty in remote coastal areas? An impact assessment using a Chilean case study



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### ABSTRACT

We test if the establishment of salmon farms in remote coastal areas had a significant impact on poverty reduction in the period 1992–2002 in Los Lagos Region, Chile. We employ impact assessment techniques using as control group people residing in geographic areas where no salmon farms were established during the period studied. Poverty incidence is estimated using small-area models at the household level that combines socio-economic surveys with census data. Our results show that poverty decreased considerably more in localities where salmon farms were installed than in localities without salmon farms. We identify the distances between localities and salmon farms where this impact was significant. Our findings contribute to the debate on the socioeconomic effects of aquaculture for capital-intensive, international market-oriented industries.

### 1. Introduction

Where, and under what circumstances, does aquaculture improve the living conditions of households? According to Beveridge *et al.* (2010), this question remains without a conclusive answer, even in literature that seeks to understand the impact of aquaculture activity on the welfare of associated communities. International evidence is mainly based on case studies, due to the different forms that this activity has adopted in the industries and places in which it has developed (see Béné *et al.* (2016) for an evaluation of this evidence). It is possible to find studies that show positive impacts (Belton *et al.*, 2012; Toufique and Belton, 2014) or no impact at all (Nguyen *et al.*, 2016).

There is a hypothesis in the literature which asserts that high technological and capital intensive aquaculture, which demands high skilled and specialized workers, might not have a large impact on rural poverty (Belton *et al.*, 2012; Irz *et al.*, 2007; Stevenson and Irz, 2009). The reason being that this type of aquaculture does not require low-skilled rural labor, and, therefore, would have little effect on the living conditions of the rural population. This could be the case of salmon farming, which is export oriented (Barton, 1998) and which carries out a significant part of its production process, the fattening of fish, in remote, coastal, rural areas (Barton, 1997).

Salmon farming in Chile is an interesting case to test this hypothesis that an intensive aquaculture industry does not benefit the rural poor. Chilean salmon aquaculture grew rapidly during the eighties and

nineties to become the second largest exporter of salmon in the world (Bjørndal, 2002). In 1981, it produced 305 tons of salmon in total (Barton, 1998), while in 2002 it increased to 500,000 tons (Sernapesca, 2016). Moreover, the geographical concentration of its facilities in remote, coastal areas (Iizuka and Zanlungo, 2016, pp. 109–135) is instrumental to discovering the potential impact of this activity on the living conditions of the rural population living close to the farms. The magnitude of this spatially concentrated growth process makes it appropriate for identifying the impact that the development of the industry could have had on the living conditions of the rural population over a delimited span of time. Given these background facts, it seems reasonable to think that the development of this activity might have improved the living conditions and reduced the poverty rates of the populations living in the areas where this activity took place (Hosono *et al.*, 2016, p. 79).

This research relies on the characteristics of the salmon growth process and the geographic concentration of activities to identify its potential effects on household incomes and poverty. We use impact assessment methodologies and the differences in differences (DID) approach to compare the temporal evolution of the poverty rate in remote coastal areas affected by salmon farms (the treated) with areas not impacted by the location of salmon farms (the controls). The sample period of 1992–2002 is chosen because of data availability, as will be discussed later. However, the period seems appropriate for the tested hypothesis since it covers the period of the most rapid growth in

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Chilean salmon aquaculture. We chose to perform this evaluation in Los Lagos region since this is the region where salmon farming was most highly concentrated during the period being considered.

Our article continues in the following section with some background information, including a brief description of the salmon farming sector and the definition and evolution of poverty in Chile. In Section 3, we discuss methodological aspects of the study that include a review of the literature on the relationship between aquaculture and poverty, how to obtain geographically disaggregated estimates of poverty from small sample surveys, and the strategy used to assess the impact of salmon farming on poverty in remote coastal areas. In Section 4, we present the results, and, in Section 5, we summarize the conclusions.

## 2. Background: Salmon farming and poverty in Los Lagos region

The development of salmon production in Chile was the result of a partnership between the public sector and the Japan International Cooperation Agency in the 1970s (Fløysand et al., 2010). By 1994, Chile had become the second largest producer of salmon worldwide and was consolidated as an exporting industry. This success has been attributed to the excellent hydro-biological conditions for rearing, the international market advantage coming from its location in the Southern hemisphere with seasons opposite to the Northern hemisphere, and the low cost of labor and fish feed (Barton, 1997, 1998).

Salmon farming was initially concentrated in Los Lagos region in southern Chile (see Fig. 1). Indeed, in the period of 1992–2002, 85% of rainbow trout, 80% of Pacific salmon and almost 100% of Atlantic salmon (the main species farmed) were produced in this region (Claude et al., 2000). The Chilean salmon industry is heavily concentrated in certain areas, with farms of great magnitude and high salmon density. Asche et al. (2013) show that Chile also follows the tendency towards fewer but larger companies. In fact, 80% of the harvest of Atlantic salmon is concentrated in ten companies. These figures are in line with the concentration of industry worldwide; for example, Norway, Scotland, and Canada concentrate 80% of their production in 25, 5, and 5 companies, respectively (Asche et al., 2013).

Different authors agree on the great impact that the industry has made in terms of labor absorption and job creation (Barrett et al., 2002; Fløysand et al., 2010). In 1994, the salmon industry directly employed 8000 workers in Los Lagos region, plus around 3000–4000 workers in related industries, e.g., fish meal, net making and maintenance, land and sea transport of inputs and products, net pen lighting, infrastructure for fattening farms, cleaning and hygiene of net pens, etc. (Barton, 1997). In 2002, it was estimated that direct employment amounted to 38,400 workers (Iizuka et al., 2016, pp. 75–107). This means that 2% of the total labor force in 1992, and 7% in 2002, was employed in salmon aquaculture in Los Lagos region. However, most of these jobs were generated in urban areas. Barrett et al. (2002) pointed out that people perceived a rise in their purchasing power as a consequence of the salmon industry development, an aspect that might have influenced poverty reduction in the remote coastal areas.

In contrast, Fløysand et al. (2010) reported that people who live in these areas have a negative perception of the distribution of benefits generated by the salmon aquaculture sector. A source for this negative perception could be the impact that the industry has had on other activities and stakeholders, given the externalities and conflicts over the use of marine space. Externalities could come from pollution generated from feeding and salmon feces, which could reduce benthic biodiversity in areas with salmonid farms (Soto and Norambuena, 2004), and from the escape of salmon into the natural environment which, through the interaction with native fish, could produce significant damage on the ecosystem (Naylor et al., 2005). Regarding competition for marine space, the main conflict is with the installation of salmon farms in the fishing grounds of artisanal fishermen. In the case of mussel aquaculture producers, they compete with salmon producers over the use of marine space for farm installation. At the same time, there is some

evidence of potential environmental interactions on the productive level between the mussel and salmon producers (Whitmarsh et al., 2006).

Several authors have indicated that the salmon industry is characterized by low wage levels, poor or non-existent safety and health regulations, resistance to unionization, and low responsibility and respect for the community, the environment and the workers (Barrett et al., 2002; Barton, 1998; Ganga et al., 2010). In addition, during the period under review, a technological change that automated several of the productive processes was introduced, reducing labor intensity and generating a demand for more qualified labor (Barrett et al., 2002). These latter elements might have limited the impact of the industry on poverty reduction. However, no other work has addressed the impact of salmon farming on poverty in an empirically rigorous way.

When considering what potential impact the salmon industry might have on the living conditions of the remote coastal population, the greatest effects should come from the installation of salmon farms for fattening purposes in remote areas. Thus, the link to aquaculture activity in this case should come through the employment of remote coastal labor (this point is discussed in Section 3.1). In this context, it is important to draw attention to the fact that Los Lagos region, and its minor administrative divisions, is one of the more isolated areas in Chile (Ministerio de Interior, 1999). Its fragmented geography probably gives rise to high costs of mobilization between different localities in terms of money and time. Therefore, farm location must take into consideration the difficulties of hiring workers living far from the salmon farms, both in terms of monetary costs and commuting time. In this sense, the potential effect of salmon farming on coastal household incomes should be geographically limited to the vicinity near where salmon farms are installed.

The official poverty estimates in Chile use the income method. This method employs income as an indicator of the ability of households or household members to meet their basic needs. The method identifies poor households by comparing their monthly per capita income with the value of a basket of basic goods and services (“basic basket”), which represents the poverty line or the minimum income established to meet the basic needs of one person. If the average income of the household is below the poverty line, the household is considered poor. The poverty line is lower in rural than in urban areas, considering that in rural areas, households can harvest or cultivate their own food (Ministerio de Desarrollo Social, n.d.a). In 1992, a person living in a rural area was considered poor if his monthly income was less than \$17,362 Chilean pesos per month (about \$1.53 US/day); by 2002, this figure rose to \$29,473 (about \$1.57 US/day), all in nominal terms.

Table 1 shows rural, urban, and total poverty rates at the national level and for Los Lagos region in 1992 and 2003. Poverty incidence (PI) in the rural areas at the national level was reduced 11.9 percentage points during this period, while in Los Lagos region, the poverty rate fell only 5.3 percentage points. This contrasts with the trend of the poverty rate in the urban areas of Los Lagos region, which decreased by 20.6 percentage. This divergence in the evolution of the rural and urban poverty rate is not observed at the national level.

Several authors (Ganga et al., 2010; Ramírez and Ruben, 2015) point to the salmon industry as being responsible for the reduction in poverty rates in the Los Lagos region. However, Table 1 shows that this trend is also observed at the national level, where the influence of the salmon industry should be of lesser importance. Hence, there may be other inter-regional factors at stake, not necessarily related to the salmon industry, which could be behind the reduction of poverty in Los Lagos region in this period. On the other hand, there have been significant intraregional migratory flows from rural to urban areas, linked to new employment opportunities (Amtmann et al. (2001)). Therefore, the process of poverty reduction does not necessarily occur at the same rate in the urban and rural areas. This is evident in the rural and urban poverty rates in Los Lagos region, as depicted in Table 1. Moreover, the impact that the salmon industry had on social conditions may be

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