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ORIGINAL PAPER

Education and household decision-making in Spanish mining communities, 1877–1924

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Abstract
In this paper, I use a unique micro-database of 254,000 individuals distributed in 12 Spanish mining municipalities to explore the households' decision-making processes regarding their children's education. This database covers individuals living in municipalities in Asturias, Cantabria, the Basque Country, Huelva, Almería, and Murcia from 1877 to 1924. Focusing on around 42,000 children between eight and 18 years old, the findings show that living standards were a key component of human capital formation. Children in working-class families had considerably lower literacy levels than the offspring of upper- and middle-class families. Moreover, the analysis shows that there was a significantly greater gender gap among mining families working in open-pit mines than among other working-class families or those of underground miners. This difference lowered the wages of open-pit mining families which translated into a higher burden for daughters, hampering their human capital formation.

Keywords Households · Microdata · Education · Mining industry · Spain · 19th century

JEL Classification N33 · N53 · D13

1 Introduction

In economic theory, education has been positively linked to higher economic growth (Romer 1990; Barro, 1991 and 2001; Mankiw et al. 1992; Benhabib and Spiegel 1994; and Vandenbussche et al. 2006). This positive relationship has been theoretically confirmed from a historical perspective by Mokyr (2005) and Galor (2011). Moreover, studying European countries during the nineteenth and early twentieth centuries, such as England, France, Prussia, Italy, Sweden, or Spain, economic historians have found that education fostered innovation and economic growth, and it

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was crucial for the implementation of new technologies (Meisenzahl and Mokyr 2011; Squicciarini and Voigtländer 2015; de Pleijt et al. 2020; O'Rourke and Williamson 1995; Cinnirella and Streb 2017; Becker et al. 2011; Ciccarelli and Fachin 2017; Nuvolari and Vasta 2017; Thomson 2005; and Martínez-Galarraga and Prat 2016).

Turning to a micro-perspective, the literature that explores economics within households and at the individual level has shown that education is positively linked to socioeconomic status and income levels (Becker 1993; de Janvry and Sadoulet 2001; and Turčínková and Stávková, 2012). In this regard, the literature studying Western European households and individual data in the nineteenth and early twentieth centuries finds a positive relationship between education and socioeconomic status (Long 2006; Clark and Gray 2014; Saaritsa and Kaihovaara 2016; and Beltrán Tapia and de Miguel Salanova 2021).

Despite this historical evidence of the positive effects of education on economic growth, socioeconomic status or income levels, the factors that were behind the formation of education and human capital accumulation during the nineteenth and early twentieth centuries are still in debate.[1] In this regard, despite the macro factors that affected the expansion of education during the nineteenth and early twentieth centuries, such as promotion by the Central Governments or the negative effects of inequality, human capital formation was subject to the decisions made with regard to education in the households. Therefore, they constitute a key element for understanding education formation during this period. In this process, the household's socioeconomic status played a major role, as, for instance, it determined the household's reliance on child labour, and, therefore, the parents' views on schooling (Basu and Van 1998; Basu 1999; and Bar and Basu 2009).[2] For instance, authors studying historical case studies find that for working-class families, schooling might be a luxury good, as they cannot afford the cost of losing their offspring's income (Cunningham 2000; Borras Llop, 2005; Burnette 2012; Humphries 2013; Larsson and Westberg 2020).[3]

During the nineteenth and early twentieth centuries, households whose members worked in the mines were among the working-class families with the lowest standards of living and thus relied heavily on child labour (John 1984, pp. 26–32; Heywood 1988, p. 140–144; Kirby 2003, pp. 76–78; Humphries 2011, p. 221).[4] As Mitch (1992, pp. 88–89) points out for England, this reliance on child labour within mining families, and the absence of literacy requirements to work in the sector, made that levels of school attendance among miners' children were relatively low. Similarly, Humphries (2011, pp. 340–343), looking at individual data in England finds that children whose father was a miner were relatively less educated, measured in years of school, than

[1] Among other factors during the 19th and early twentieth centuries, for the role of inequality see for instance, Cinnirella and Hornung (2016), Beltrán Tapia and Martinez-Galarraga (2018), or Westberg (2018), for the influence of Religion see Becker and Woessman (2009), or for what was the impact of governments and policies see Cvcek and Zajicek (2019) or Cappelli amd Vasta (2020).

[2] Factors such as the number of siblings also affected children's education, as the probability of being literate was lower in families with high fertility (Fernihough 2017; and Klemp and Weisdorf 2019).

[3] Fan (2011) argued that the luxury axiom only holds when a household faces a subsistence contraint in consumption due to having a low income. See Burki et al. (1999) and Mukherjee and Das (2008) for an analysis of the relationship between child labour and schooling.

[4] See also Colls (1976).

children with fathers working in agriculture or factories. However, despite these general and largely valuable characterisations of mining families by historians, only Humphries (2011) has carried out an individual and micro-level analysis in order to obtain a precise account of the education decision-making processes within these families.

Therefore, this paper tries to fill this gap in the literature by exploring how living standards—being in a mining family—affected children's education. Using mining towns and mining families, it seeks to further the understanding of how different dynamics influenced education in a crucial period of human capital accumulation. The low living standards of mining families meant that households struggled to distribute their scarce resources to educate their children. Moreover, cultural factors and the male-dominance of skilled jobs (steel mills, transportation, or trade) or a clearer relationship between being educated and more skilled and obtaining rewarded occupations in the case of men, meant that job prospects for educated women may have been limited. Therefore, this could have affected a family's preference to educate boys or girls when faced with scarce resources.

In order to do this, I analyse 41,982 girls and boys between eight and 18 years old, from a dataset of 254,000 individuals living in 12 Spanish mining towns between 1877 and 1924, compiled from the local population censuses. This data source contains highly detailed individual-level information on literacy, age, occupation, address, the municipality where the person was born, and the person's years of residence in that municipality. As the Spanish educational law made mandatory for children to attend school when they were between six and nine years old, analysing children between eight and 18 years old enables me to study the decisions about their offspring's education that families had already made. The 12 mining towns are geographically represented in Fig. 1 and they were in Asturias (Mieres), Cantabria (Castro-Urdiales), Biscay (Abanto, Galdames, Santurce, Lanestosa, and Carranza), Gipuzkoa (Irún), Murcia (Cartagena and Mazarrón), Almería (Vera), and Huelva (Nerva). This dataset covers an interesting period in Spain's education history, as educational levels (e.g. literacy or provision of schools) started to improve during this period from a significantly low level in comparison with other European countries (Vicent 2003; and Beltrán Tapia et al. 2021). Moreover, the territorial coverage provides a precise picture of the mining sector which significantly increased its production and exports form the late nineteenth century (Pérez de Perceval Verde & López-Morell 2006).

Following the geographical distribution seen in Fig. 1 and the educational conclusion extracted from Nuñez (1992) and Beltrán Tapia et al. (2021), in order to gain a better understanding of this process, I divide the sample into north and south due to the significant differences in the education provision and literacy rates between these regions. Likewise, I divide the miners themselves into two groups depending on the types of mines that were operating in their towns—i.e. open pit or underground—in order to assess the precise effects of each mining extraction method as different skill requirements and child labour were demanded in open pit and underground mines.

Consequently, I study an important process of decision-making regarding children's education that has not been previously researched in such detail or with such a broad scope by Spanish industrial or educational historiography, contributing to the literature in two ways. First, this study is based on a highly detailed dataset, which, by applying the micro-analysis used by the literature studying home economics and family decision

processes for contemporary cases, could enrich our understanding of the historical process of human capital accumulation and its individual determinants.

Second, this paper contributes to the literature, not only by showing how living standards affected children's education, but it also highlights the role of gender in this process. The detail provides a fine-grain view of how scarce resources in working-class families had a clear gender bias, as in these households, girls' education was neglected. Therefore, although it only analyses Spanish mining towns, this paper contributes to our understanding of the demand side of education, and which factors (in this case, the mining sector) affected human capital accumulation.

The results show that living standards were a key determinant of human capital formation. Children whose fathers were farmers, day labourers or miners had significantly lower literacy levels than children in upper- and middle-class families. Low wages, and therefore low living standards could force working-class families to rely on child labour, which would lead to school absenteeism, early dropouts, and the interruption of human capital formation in those children.

Moreover, the results reveal a significant gender bias in education, which is potentially linked to the clearer relationship between being educated and accessing better jobs among men than among women. This was especially important in northern working-class families. As these households faced scarce resources, they had to decide who could go to school, their sons or their daughters, choosing the former and neglecting the educational process of the latter. In this regard, it is especially interesting that northern working-class boys had higher literacy rates than their fathers, showing the importance given and the efforts made by these families to educate their sons. Among all the socioeconomic groups, the largest gender gaps prevailed in northern and southern open-pit mining families. This indicates that the lower skill level requirements in these mines, and therefore the lower wages in comparison to other occupations, may have forced open-pit mining families to divert their scarce resources to enable their sons to attend school as they had a similar literacy level to other working-class boys, neglecting girls' education. However, the result also could imply that these open-pit mining families relied more heavily on women in formal or informal labour, increasing the work or household burden on daughters, and hampering their human capital formation.

The structure of the paper is as follows. Section 2 gives the historical background, describing the mining sector and education of the municipalities selected. Section 3 explains the data, and variables used for the analysis, together with the methodology. Section 4 presents the econometric results. Section 5 concludes.

2 Historical context

2.1 General context

Although the education law of 1857 made mandatory mass schooling for children between six and nine years old, literacy remained low through the century, especially for women. For instance, in 1887 three quarters of the Spanish adult women

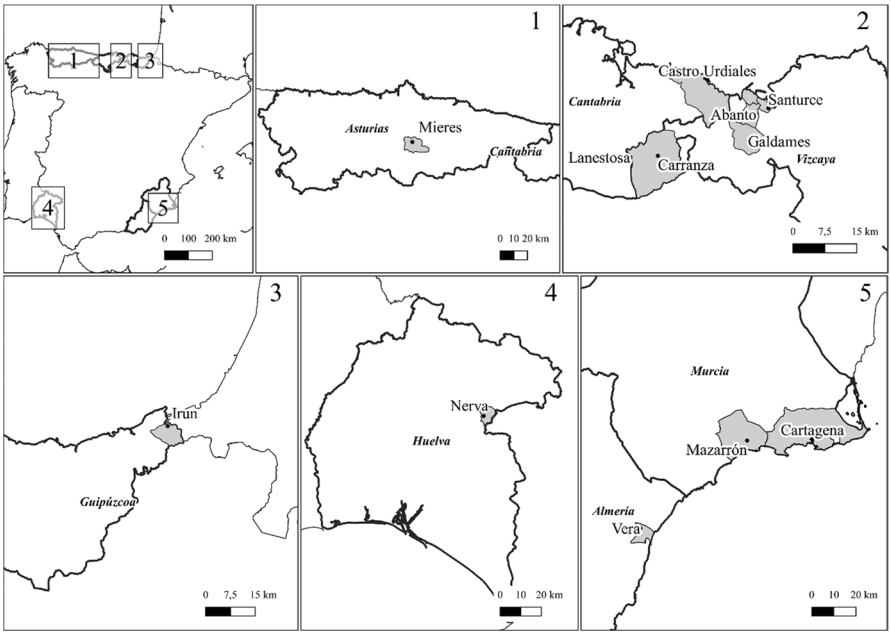


Fig. 1 Location of the studied mining towns. *Note*: The shaded areas are the area of the municipality and the names in italics are the Spanish Provinces

and half of the Spanish adult men did not know how to read and write (Beltrán Tapia et al. 2021, p. 609).[5] In contrast, other European countries such as France, England or the Netherlands left behind these illiteracy rates in the early nineteenth century (Vicent 2003). Although provision of education might be behind this backwardness in education, parents decided whether to comply with the law and send their children to school or not.

Thus, the families' characteristics were a key component on the process of human capital accumulation. One of the main determinants of whether children attended school was the parents' attitudes towards education, and whether they believed that being educated would improve their children's job market options. Indifference towards education was common among day labourers, as they had no economic incentives to be literate (Nuñez 2005). However, in regions like Old Castile, families engaged in smallholding agriculture were incentivised to educate their sons, as being literate could enhance their sons' job prospects in other regions (Nuñez 1992).

The families' economic resources also determined their children's education. Although schooling was mandatory for children aged six to nine, children may have been prevented from attending school if their family needed their help in the household, making truancy rampant in some regions (Pérez-Fuentes Hernández 2004;

[5] The literacy rates were 52.1% and 24.9% for men and women above 10 years, respectively.

and Borras Llop 2013).[6] For instance, in rural municipalities, school attendance fell during months of intensive agricultural activity, whereas it increased during the winter months (Borras Llop 2005). This need for the income or help provided by children was especially acute in poor and working-class households with low living standards.

Compared to other groups of workers in Spain, miners had relatively low wages and poor living conditions (Escudero Gutiérrez and Pérez Castroviejo 2010; and Pérez de Perceval Verde et al. 2016).[7] As miners' wages were often not enough to support their families, children were frequently needed to bring in extra income, which prevented them from attending school. In this sense, mines offer an important source of job opportunities for children, especially boys. This was reflected in the large presence of child labour in the mines, which accounted for around 15% of total employment between 1877 and 1920 (Pérez de Perceval Verde et al. 2013). Moreover, in underground mines, child labour was demanded by mining companies due to the experience that they gained, enabling them to become more productive adult miners. For instance, in 1909 the government supervisor of the labour inspection department argued that the banning of underground mining child labour was a mistake as it would prevent working at an early age, and therefore reduce the professional pool of miners.[8] Thus, the need for an extra income from child labour in mining families and the child labour opportunities in the sector was coupled with the skill requirements for working as a miner from the mining companies, especially in underground mines. These two factors meant that child labour was an important component of the mining sector, interfering with the schooling process. Although relying on help from children was also common in the agrarian sector, working in the mines did not face the seasonal rhythm characteristic of agricultural work and continued throughout the year, including in the winter months.

The evolution of the demand for education among families in mining towns can be seen in the minutes of the Local Committees of Primary Education (*Junta local de Primera Enseñanza*).[9] Perez-Fuentes Hernández (2004) showed that during the last third of the nineteenth century in San Salvador del Valle (Biscay), the surge in mining employment led to an increase in school absenteeism. Similarly, in the adjacent mining municipality of Abanto, the local committee pointed to the same

[6] In 1873, the first child labour law was implemented in Spain (Gaceta de Madrid, no. 209, p. 1193 (1873)). However, this regulation was not really implemented, as the answers to the questionnaire carried out by the state between 1889 and 1893 demonstrate (Información oral y escrita practicada por la Comisión de Reformas Sociales en las Provincias de La Coruña, Jaén, Navarra, Oviedo, Palencia y Vizcaya. Publicada 1893 (1985)).

[7] Although the mining sector flourished during the late nineteenth century, it was not until the late 1910s and early 1920s that wages and working conditions started to improve.

[8] This argument was similar to the reasoning that the director of the State-owned mines of Almaden claimed in 1838 for the use of children at the mines. Both cases in Borras Llop (1995, pp. 640–641).

[9] These local committees oversaw the correct implementation and development of primary education in the municipality (Ferrer y Rivero 1915, pp. 858–859).

problem in 1880.[10] In both towns, teachers complained that in the mining boroughs, one-third of the students attended school irregularly, usually because the children had to help their fathers either in the mine or in the household. In 1882, the committee in Abanto proposed that five-year-old children should be admitted to school, given that many children were dropping out before reaching the legal age of nine because they were needed in the household. Moreover, as low attendance was rampant, the committee asked the governor of the Biscay province to establish a fine for parents who did not send their children to school. However, the rural-agrarian boroughs of both municipalities had the same irregular attendance and absenteeism problems. In these towns, children often attended school irregularly because they had to provide care for their younger siblings (Pérez-Fuentes Hernández 2004, pp. 122–124).

2.2 Local historical context

2.2.1 The mining sector

The 12 mining municipalities analysed in this study had a variety of backgrounds, which enrich the dynamics and results obtained. Table 1 shows the importance of the mining sector in each town of the sample according to the information provided in the Mining Cadastre of 1889. This data source was the only official report that gathered mining information at the municipality level during the nineteenth and early twentieth centuries. Therefore, although it is a time-fixed snapshot of the sector, it could give some insight into the importance of mines in the towns analysed here.

Besides the geographical classification seen in Fig. 1 (north and south), Table 1 also splits the sample according to the type of mining activity carried out; underground and open-pit mining. This classification uses the detailed data from the Mining Cadastre of 1890 explained in Palacios-Mateo (2022, pp. 64–65), which provides information of miners in underground and open-pit mines. This classification allows having a better understanding on how work conditions, industrial linkages or job prospects affected the decision-making processes in the mining families. For instance, the early engagement of children in the underground tasks of the mines was required so as to produce more skilled and productive adult miners. However, open-pit methods relied on a few skilled workers (drillers and blasters or *barrenadores* in Spanish) who blasted large portions of the pit, which were then broken into smaller pieces and processed by unskilled and almost inexperienced workers (González Portilla et al. 2007).

Table 1 shows that the size of the mining sector in the towns analysed varied considerably. Looking at column (1), the share that miners had of the total population ranged from a very small proportion in Carranza, Lanestosa or Vera to the high percentage of miners in Abanto y Ciervana or Nerva. However, this percentage could mislead the conclusion, as children and women working in the mines are included in

[10] Archivo Foral de Vizcaya, Archivos Municipales, Abanto y Ciervana, 0594/002.

Table 1 The mining industry in the 12 municipalities in 1889

Municipality	Percentage of miners over total population	Percentage of male miners over male population	Child labour[a] (% of children miners over total miners)	Female labour (% of female miners over total miners)
	(1)	(2)	(3)	(4)
Underground north				
Mieres (asturias)	22.1	32.9	21.6	4.8
Carranza (biscay)	0.9	1.3	6.1	18.2
Lanestosa (biscay)	0.5	1.1	0	0
Irún (gipuzkoa)	5.4	8.7	17.5	1.8
Open-pit north				
Castro urdiales (cantabria)	9.6	18.6	6.2	1.1
Abanto y ciervana (biscay)	50.1	80.4	1.8	1.1
Galdames (biscay)	27.4	47.1	2.7	0.6
Santurce (biscay)	2.7	4.7	1.4	1.4
Underground south				
Cartagena (murcia)	2.9	3.8	31.1	0.04
Mazarrón (murcia)	4.2	7.1	14.9	0
Vera (almería)	1.4	1.8	37.5	0
Open-pit south				
Nerva (huelva)	54.5	85	11.4	0.3

Source: Own elaboration from population censuses of 1887 and mining cadastre of 1889

[a]The mining cadastre did not distinguish between boys and girls when mining child labour was reported, and therefore, the different child labour engagement according to gender cannot be framed when using this data source

the calculation, and these two groups had different engagement patterns in the towns of the sample. Thus, column (2) represents only adult male miners as a percentage of the male population, showing a more precise picture of the mining sector in the municipalities. Based on these figures and the extraction methods, three different groups within the 12 municipalities were determined.

First, Abanto y Ciervana, Galdames, Castro Urdiales in the North and Nerva in the South were towns where the main activity was open-pit mining. This importance meant that within these mining municipalities job prospects were significantly limited to this sector. Nevertheless, skilled jobs in neighbouring industrial towns, especially in the North, could act as a stimulus to education in order to improve job prospects.[11] In Table 7 in the appendix, the different wages in mining and post-extraction jobs are displayed for the early twentieth century, showing that occupations at steel mills were more rewarding job opportunities than being an open pit miner. However, in Nerva, although there were some skilled job opportunities, in the Rio Tinto Company, the only owner of the copper open-pit mines since 1873, the higher rank jobs of the Company were filled mainly by foreigners.[12]

Moreover, the increasing demand for the mineral extracted in these mining towns (iron and copper) during the second half of the nineteenth century led to an increasing demand for miners. The establishment of the Rio Tinto Company in 1873 and the arrival of English mining companies in Biscay gave rise to the intensive mining of these pits from the 1880s. The low level of skill and experience required to work as open-pit miners triggered a massive migration to Abanto y Ciervana, Galdames, Castro Urdiales and Nerva.[13] For instance, the population of Abanto y Ciervana grew by 216.5% from 1877 to 1887. The extraction method in open-pit mines was also reflected in the low level of child labour in these towns, especially in the North as children were more engaged in minor household tasks than in the mines (Pérez-Fuentes Hernández 2004). However, in Nerva, years of copper calcination made the region unsuitable for agriculture. Furthermore, the distance to industrial centres meant that the only jobs were to be found in the mining sector, which potentially explains the higher incidence of child labour (Chastagnaret 2017). The low level of skill required in these open-pit mines, together with the massive migration flows could have directly affected miners' wages, and thus household budgets and the need for formal or informal child labour within the family, which ultimately would have affected the children's education.

[11] Abanto y Ciervana, Galdames and Castro Urdiales were at less than 25 kms to provincial capital of Biscay (Bilbao), and the industrial towns of Baracaldo and Sestao. However, the job opportunities in Nerva in close towns were less clear as neighbouring municipalities were mainly agrarian, and the provincial capital was at almost 100 kms.

[12] For instance, out of nine engineers employed by the company, six were from England, France, or Germany.

[13] Palacios-Mateo (2022, pp. 195–196).

The second group comprises Mieres and Irún in the North, and Cartagena and Mazarrón in the South, where the mining sector, although significant, was not as prevalent as in the first group. In these underground mining towns, other occupations, such as farmers, fishermen, seamen and trade-related occupations, were also important, especially in Cartagena and Mazarrón. For instance, in Mieres, a local steelwork employed 1,500 workers in 1906, in comparison with 2,000 miners described in the same government report.[14] This meant that job opportunities in other sectors within these municipalities could alleviate a downward pressure on miners' wages, occurring in the first group due to an overcrowded job market.

Moreover, as previously mentioned, these underground mines had different skill requirements to open-pit mines. There was a demand for experienced underground miners, which necessitated an early engagement of children, mainly boys, in the mines. This was reflected in the high share of child labour of total miners in column (3), representing almost a quarter of the total workforce in the mines. These extraction methods also had consequences on the migration flows to these towns. For instance, and contrary to the massive migration flows in the previous group, in these towns, only the experienced underground miner migrants from the depleted mines of Almeria were able to work in the underground mines in Mazarrón and Cartagena (Martínez Soto et al. 2008). Consequently, although other job opportunities outside of the mining sector could act as an education stimulus in mining families, and the higher wages in underground mining seen in Table 7 could enhance education expenditure, the early engagement of children in the mines due to the experience requirements could directly affect children's education. This could be especially critical in the male human capital formation in the south as women in this region were barely engaged in mining activities (column (4)).

Finally, the shares that Carranza, Lanestosa, and Santurce in the North, and Vera in the South accounted for show that in these towns the mining sector played a minor role in their job markets. In this case, other sectors such as agriculture (Lanestosa, Carranza and Vera) or sea-related jobs and commerce (Santurce) employed most of the adult male population. Similarly to the previous group, in this case, job opportunities in other sectors with higher wages and a clearer skill premium reward could enhance children's educational investment. Moreover, due to the minor impact of the mining sector in these towns, child labour would not have had such a clear and overall effect on education as in the previous group.

2.2.2 Education

Table 2 displays the literacy levels, public schools per 10,000 inhabitants in the 12 mining towns and in their provinces in 1900 and the number of private primary schools, so as to shed some light on the educational achievements in these municipalities in comparison with other none-mining areas. First, in general, the northern towns in the sample were above the national average and the southern municipalities were below, as found by Nuñez (1992). Nevertheless, there were some exceptions,

[14] *Instituto de Reformas Sociales. Informe acerca de la Fábrica y de los obreros de Mieres, 1907.*

such as female literacy in Mieres, Cartagena, and Nerva, or the provision of schools in Irun, Abanto y Ciervana and Santurce. These geographical differences indicate the potential different treatment of human capital formation, in terms of both supply and demand, between northern and southern Spanish towns. Moreover, private schools (either funded by religious congregations, private donors, or companies) were absent from most of the mining towns, or their presence was negligible at best. For instance, in Cartagena, the ten private primary schools only added one school per 10,000 inhabitants to the public provision of 6.7.

At the provincial level, in Biscay, except in Lanestosa and Santurce, the mining towns in the sample had significantly lower literacy rates than the provincial average. Although in male education the gap is less clear, female literacy in Abanto y Ciervana and Galdames, where the mining sector was more important, was considerably below Biscay's average. Following Nuñez (1992), the massive migration from Old Castile Provinces, where the perception of female education was more negative than in Biscay, seems to have played an important role in education in the mining towns of Biscay. Moreover, as Perez-Fuentes Hernández (2004) points out, education provision for girls and boys may have affected human capital formation as the local councils of mining towns may not have been able to ensure the growth in the provision of schools at the same rate as that of the population. For instance, the number of public schools was considerably lower in mining towns than in rural Biscay municipalities (Lanestosa and Carranza). Thus, besides the potential effect of the mines on family decisions, the figures in Table 2 also indicate an effect of mines in Biscay through education provision.

For Castro Urdiales and Mieres, the results are similar. Both towns had lower literacy rates than the provincial average, especially among men in Castro Urdiales. In the case of Mieres, underground mining and its child labour requirements and a higher engagement of women in mining could be behind the slightly lower literacy rates, as education provision was similar to the average for Asturias. For Castro Urdiales, the argument would be similar to the effect of migration and population on education provision seen in the Biscay mining towns. Castro Urdiales increased its population by 86.2% in 1900 from the levels before the mining boom (1877), whereas the population in the province only grew by 17.3% for the same period. Thus, the significant lower provision of schools in Castro Urdiales might have prevented boys' attendance in comparison with other Cantabrian towns.

The results for Irún could shed some light on the rest of the values for the northern towns. As this Basque town was located near the border with France, it was an important hub for trade and other service sector occupations. Therefore, although its provision of education was similar to the provincial's average (around 12 schools per 10,000 inhabitants), literacy rates, both for men and women, were considerably above the average for Gipuzkoa. This reflects the importance of migration skill bias. As skilled workers were demanded for trade, railroad, or public and private clerical jobs, literate and skilled migrants settled in Irún, increasing the average literacy level of the local population. The opposite effect could be seen in Carranza (Biscay). As mainly agrarian jobs were offered in this northern town, the high level of school provision (30.7 schools in comparison with the 12.7 on average in Biscay) was not reflected in higher literacy rates as the literate population may have left to make

Table 2 Education in 1900

Province	Town	Literacy		Public schools per 10,000 inhabitants	Number of private schools
		Male	Female		
	Abanto y ciervana	52.3	33.2	12.4	0
	Galdames	56.6	29.7	15.1	0
	Lanestosa	68.9	54.4	27.8	0
	Carranza	54.4	36.4	30.7	0
	Santurce	59.7	38.1	11.6	1
Biscay		*57.2*	*41.9*	*12.7*	
	Castro Urdiales	56.8	42.8	12.7	2
Cantabria		*64.1*	*46.6*	*19.4*	
	Mieres	51.3	24.1	17.7	0
Asturias		*54.2*	*26.7*	*17.3*	
	Irún	56.7	52.7	12.1	0
Gipuzkoa		*46.5*	*40.5*	*12.0*	
	Cartagena	42.1	29.5	6.7	10
	Mazarrón	25.2	10.5	3.4	1
Murcia		*27.0*	*16.8*	*6.3*	
	Vera	22.0	12.3	4.1	0
Almería		*24.7*	*13.7*	*8.6*	
	Nerva	36.1	23.0	8.9	0
Huelva		*38.1*	*26.5*	*9.3*	
SPAIN		*42.2*	*25.1*	*12.7*	

Literacy only includes those who knew how to read and write. Source: Own elaboration from Population Census of 1900 and School Census of 1903, and *Anuario del Comercio, de la Industria, de la magistrature y de la Administración* 1900

The average of the Province is in italics

use of their education to get better jobs. Similarly, unskilled/illiterate migrants might have arrived en masse at Abanto y Ciervana and Galdames to work in the mines, lowering the male literacy rate.

In the South, Cartagena was one of the seats of the regional government (*Partido judicial*) and justice, and an important trade port, as well as one of the main military harbours and arsenals on the Spanish Mediterranean coast. Consequently, and similarly to what has been argued for Irun, the literacy rates of both men and women were significantly above Murcia's average, and close to the Spanish average, despite the significantly low provision of schools. In contrast, Mazarrón, Vera and Nerva had similar literacy rates to their provincial averages, although slightly lower. This may have been due to the lower provision of schools, which in Mazarron and Vera was half that of the provincial average. Although this could explain the difference between the literacy rate of these towns and the provincial average, the importance of child labour, seen in Table 1, in these mining towns might also have played an important role in preventing school attendance.

In conclusion, Tables 1 and 2 not only show how mining dynamics could affect education, but also the importance of the town's characteristics to the configuration of education provision and human capital formation. On the one hand, child labour in underground mines or unskilled miners in open-pit mines could directly affect school attendance or the skilled and literacy composition of the population. On the other hand, higher wages in underground mines could divert some family's resources into children's education, contrary to open-pit families. Similarly, jobs in post-extraction industries presented significantly higher salaries, which could incentive families in mining towns with these industries to educate their sons, to give them the opportunity to access these more skilled jobs. However, a more thorough analysis of salaries would be needed in order to understand the potential incentives and mechanisms behind the education decision-making and wages.

3 Data, variables and methodology

3.1 Data

In order to disentangle the effects of mining families' socioeconomic status and the mining industry on the demand for education in these households, this study uses individual-level data from the five population census records at the municipality level for the period between 1877 and 1924.[15] During this period, the information for the nationwide population censuses was first gathered at the town level. Local authorities had to conduct standard municipality-level censuses, the results of which were merged at the provincial level with those of the other municipalities, forming the population census. Although the data from these general and nationwide censuses can be used for a variety of analyses, they do not include information at the individual level. Therefore, the town-level censuses provide the microdata needed to perform a richer analysis.

Additionally, there is an important limitation on the access of this information. These individual-level population censuses are usually kept at local archives, thus having a geographical limitation to their access. Furthermore, small towns do not usually preserve these documents, making it impossible to access them. Additionally, highly populated towns, such as Mieres (Asturias) or Cartagena (Murcia), analysed in this paper, only have some of the censuses, as some of them were destroyed during the 20th-century. Consequently, the amount of individual data and the archival conservation of the censuses, impose several limitations to the towns and years selected for the analysis.

Nevertheless, the 12 mining towns from which I was able to gather the data represented a significant share of the Spanish mining sector. Taking the data gathered in 1889 in the Mining Cadastre, these 12 municipalities represented 38.6% of the total tonnage extracted in that year, and 18.7% of the miners. For instance, during the period under study, more than 80% of the iron ore production in Spain was in

[15] See Fig. 3 in the appendix for an example of these municipality population censuses.

Cantabria and Biscay (Escudero Gutierrez 2006). Moreover, using the data from the Mining Cadastre, the mining towns of Biscay and Cantabria analysed in this paper represented 58.9% of the total iron tonnes extracted that year and 46.5% of the miners. The representativeness of Mieres was lower, as it was the only coal town in the sample, accounting for 21.4% of the production of coal and miners extracting this mineral according to the data recorded in the Mining Cadastre. Nevertheless, it had a significant share of the total coal produced in that year taking into account that was only one town.

With respect to the southern mining towns, one-third of the lead miners in Spain in 1886 were employed in Murcia; a figure that did not change until the 1920s (Pérez de Perceval Verde and Sánchez Picón 2001). In 1887, according to the number of miners reported in the municipality censuses and the Mining Statistics of that year, 15.8% of lead miners in Spain were concentrated in the two towns of Mazarrón and Vera. In 1920, Mazarrón and Cartagena accounted for 38% of the Spanish lead miners.[16] Furthermore, between 1887 and 1920, around 90% of Spanish copper miners were employed in the province of Huelva. However, in this case, it is not possible to calculate the share of copper production or miners of Nerva in the Mining Cadastre of 1889, as the mines were in the neighbouring municipality of Minas de Riotinto. Thus, the Mining Statistics of 1900 and 1924 have been used which reveal that 42.3% of copper miners in Spain lived in Nerva in 1900, increasing to 55.6% in 1924.[17]

Therefore, these local censuses provide highly valuable and scarce individual data. This source contains information on every person who was in the municipality when the census was performed, including each person's birthplace, years of residence in the municipality, age, gender, marital status, literacy, and occupation. Moreover, this information was collected for all members of the household. Consequently, this information allows for a detailed analysis at the individual level, including information on the head of the household and other family members.

For the 12 mining towns analysed in this paper, the total number of individuals for whom information was gathered was 253,891.[18] However, in order to analyse the decision-making processes of families about their children's education, only information on individuals recorded as daughters or sons between eight and 18 years old has been selected, reducing the sample to 41,818 girls and boys. By looking at this group, I am able to analyse the decisions their parents made, as schooling was mandatory for children between six and nine years old. Therefore, children who were eight years old, and were thus in their last year of mandatory primary education, as well as children who were older should have been literate. For the upper threshold, Fig. 4 in the appendix has been followed, as the share of offspring older than

[16] Data from the population censuses and the Mining Statistics of 1887–1888 and 1920, p. 84 and pp. 16–17, respectively.

[17] Data from the population censuses and the Mining Statistics of 1900 and 1924, p. 24 and pp. 22–23, respectively.

[18] Table 8 in the appendix shows the distribution by municipality and year.

18 years within the household drops in comparison with younger groups. Moreover, taking eight as the lower threshold restricts the upper limit as some municipalities in this sample have censuses with a gap of 10 years, and taking individuals older than 18 years could lead to measuring the same girl or boy twice.[19]

Following the mining and educational context explained in the previous section and given the potential cultural and geographical differences between northern and southern towns, I divide the sample into two subsamples. Nerva (Huelva), Vera (Almería), Cartagena, and Mazarrón (Murcia) are in the southern subsample, being 26,806 children, while the rest of the municipalities are in the northern subsample, comprising 15,012 boys and girls. Similarly, as mentioned before, underground and open-pit miners have been differentiated, in order to better understand how the different living standards, skill requirements, job prospects or child labour affected the decision-making process in the mining families.

3.2 Variables

The highly detailed information that the population censuses provide can be used to create a wide range of variables. These variables can be classified as individual, family, and migration dimensions. Furthermore, the father's occupation, as will be explained below, is the main independent variable, as it is used to identify the mining families and the socioeconomic status of the children's families.

The first group of variables refers to the individual information that is recorded in the census. The main variable of analysis is the literacy level of each of the 41,818 children between eight and 18 years old, and it takes a value of one for those who know how to read and write. Those girls and boys who were only able to read were not included as literate because they did not complete their educational formation, meaning that household dynamics might have interfered with their human capital accumulation as opposed to fully literate children. Nevertheless, the percentage of those who were only able to read is negligible in the subsample analysed here (3.4%). Additionally, almost half of them (48.7%) had between eight and 10 years old, suggesting that when half-literacy (only knowing how to read) was reported, they were probably in the middle of the educational process. Moreover, in some of the 12 municipalities, despite there were two columns to report the individual's information about education (as could be seen in Fig. 3 in the appendix), only the "know how to write" column was filled. Therefore, I had to use only those able to read and write, because those that only know how to read were not reported in all the municipalities. Thus, this makes literacy variable (only those able to read and write), the most reliable indicator of the human capital formation using this data source.

Moreover, among the individual information gathered from the censuses, and following the results obtained by Zapata et al. (2011), being a female or a male is used to divide the analysis into girls and boys in order to examine the gender differences in education. Furthermore, following Beltrán Tapia and de Miguel Salanova (2021),

[19] Using 14 or 16 as thresholds give identical results.

age and age squared complete the individual information that is used as the basis for controls in the model.

The family variables are obtained using the information on other members of the household, as the census clearly identified the different families that were living in each municipality. Hence, following Hammel and Laslett (1974), I have created a dummy variable that takes a value of one if the household was simple, and a value of zero if it was extended or multiple. A simple family consisted only of parents living with their children, whereas an extended or multiple family could include other relatives, such as grandparents, aunts, and cousins. This variable is intended to measure the extent to which relatives were present in the household to help with finances, housework, or child-rearing, thus alleviating the family's reliance on their children's help in the household. Nevertheless, this variable also controls for the potential burden that some relatives, such as grandparents, could have represented for the household and its consequences on the family's finances, and therefore the children's education.

Moreover, following Emerson and Portela Souza (2008), and Klemp et al. (2013), a dummy variable has been created that indicates whether a child was the first-born, or was at least the eldest child reported in the household.[20] Therefore, this variable controls for a potential education decision bias towards the eldest child that was either positive because s/he would be the heir of his/her parents' properties, or negative because first-born children are required to help in the household, neglecting their schooling.

Likewise, the last variable gathered is the number of younger siblings, following the results obtained by the literature on the relationship between fertility, the number of siblings and children's education (Bengtsson and Dribe 2006; van Bavel and Kok 2010; de la Croix and Perrin 2018; or Cinnirella 2019). This variable is intended to control for the potential demand for the child to help care for his/her younger sisters and brothers. It also accounts for the potential competition for resources within the household that could have affected school attendance. Moreover, as it measures only younger siblings it seeks to avoid potential absent older sisters and brothers that had left, as this circumstance was less likely at younger ages (see the age distribution in Fig. 4 in the appendix).

The last group of variables included is related to the migration information that was recorded in the population census. The first migration variable that I have created is the region where a migrant mother was born, according to the regional classification by Rosés and Sánchez-Alonso (2004).[21] I use the mother's region of origin instead of the father's region of origin because the correlation coefficient of the former with the father's occupation is significantly lower.[22] Following Haddad (2017)

[20] See also Lindskog (2013), Ejrnæ and Pörtner (2004), De Haan et al. (2014).

[21] A map of the regions is shown in Fig. 5 in the appendix.

[22] Following Beltrán Tapia and de Miguel Salanova (2017), the father's origin is not used as there could be a skill or literacy migration bias and therefore a correlation with the main variable of interest; father's occupation. Nevertheless, the father's origin has been used with the same result being obtained as that for the variable father's occupation (results upon request).

and Maertens and Verhofstadt (2013), this variable controls for the potential influence of being a migrant and the cultural and educational background of the mother. For instance, mothers who migrated from Old Castile, where female literacy rates were relatively high, might have had a positive attitude regarding their children's education, especially for their daughters.

Finally, the last migration variable included is a dummy variable that takes a value of one if the children analysed migrated while between five and 10 years old, (i.e. during the mandatory schooling period), plus one year in the bottom and the upper threshold. This variable is intended to identify those girls and boys that started their schooling process in other municipalities, probably non-mining towns. Thus, this migration variable is used to exclude this group of children from the sample in order to assess only those that could have directly been affected by mining dynamics in their schooling process.[23]

3.2.1 Father's occupation

In order to measure the effect of the family's socioeconomic status on their decision-making process regarding their children's education, I include father's occupation following the HISCLASS classification scheme from van Leeuwen and Maas (2011), and the works of Santiago-Caballero (2020), and Beltrán Tapia and de Miguel Salanova (2021).[24] However, I firstly use the HISCO scheme adapted to Catalonia and Spain by Camps et al. (2001) in order to classify the different occupations in the sample. Then following Beltrán Tapia and de Miguel Salanova (2021), I classify these occupations into seven different occupation groups (eight using the subclassification for miners) using the HISCLASS scheme as presented in Table 11 in the appendix.

In the first group, the landed elite (landowner, rentiers and nobility) has been included, which has been categorised as group 13 in HISCLASS, as this scheme does not account for this group in the other 12 occupation groups. In the fifth group, fishermen and other occupations related have been excluded as in the censuses there was not a clear distinction between fishermen (HISCLASS group 8) and seaman (HISCLASS group 11). Similarly, in some censuses, the differences between day labourers, farmworkers, and factory workers are not clear. The job of *jornalero* (day labourer), which was reported by 22.3% of the individuals who indicated a job, could be defined as being a day labourer in a factory, a farm, or a mine. In order to overcome this problem I merge HISCLASS groups 11 and 12, and fishermen from HISCLASS group 8, in order to address this lack of clarity, as it takes into account

[23] Other migration variables, such as migration distance or a dummy variable controlling for whether the parents were migrants, are used with no variation in the father's occupation coefficients. Moreover, these other migration variables are not statistically significant and are highly correlated with the mother's origin.

[24] Following Beltrán Tapia and de Miguel Salanova (2021), I do not use the parents' literacy because of the high correlation between this variable and the father's occupation.

the similar living standards of day labourers, regardless of whether they were working in a factory or agriculture. However, as there are no employees of major factories in the sample, this group is mainly made up of farm day labourers.[25]

In order to determine the effect of having a miner father, the creation of the "miners" group is supplemented with geographical information. Individuals who reported being a miner are automatically included in this group. However, in the Biscay towns of the sample, the censuses did not record the presence of any miners. In these municipalities, miners identified themselves as *jornaleros* (day labourers). Nevertheless, as González Portilla et al. (2007) find for Biscay, the landownership system that prevailed led to an absence of *jornaleros* in the agricultural sector, and therefore the majority of them recorded in the Biscay censuses during this period were workers in mines, factories and other labour-intensive sectors. For instance, in 14 Biscay non-mining towns not included in this analysis, only 1.4% of the working population were *jornaleros*, whereas in the mining Biscay towns analysed in this paper, 29.2% of the total working population was reported as *jornaleros*. Therefore, to properly categorise these miners, I geographically located mines and identified the mining boroughs within the 12 municipalities as such if there was a mine located within one kilometre of the centroid of that borough, and I then classified the *jornaleros* living in these mining districts as miners.[26] As mentioned before, once this classification of miners has been done, this group is divided into those who were in underground or in open-pit mining municipalities, as different skill requirements, massive migration to open-pit mines, or child labour could have different dynamics in underground and open-pit mining towns.

Table 3 displays the percentage of the male adult population (older than 14 years) working as miners in each town and census year in the sample.[27] The results are similar to Table 1, with a significant increase in Cartagena and Mazarrón in Table 3, as in the Mining Cadastre of 1889, the number of miners seems to be underreported. Moreover, the result for Abanto y Ciervana in 1877 might indicate that, although the mining boom started in the 1880s with the arrival of foreign mining companies, the sector had already been dominant in previous decades.

Table 3, Tables 9 and 10 in the appendix show the engagement of adult women and boys (younger than 14 years) in the mining sector, respectively, counted as a percentage of total women and boys, and of total miners.[28] These tables could complement the data gathered and reported by the Government in the Mining Cadastre presented in Table 1, as the self-reported jobs in the censuses may reveal information that was concealed in the Cadastre.

[25] When controlling for the boroughs of Rebollada (Mieres), Puerto de Mazarron (Mazarron), and Santa Lucia (Cartagena), where there were industrial mills, the results do not change.

[26] Although this methodology could overestimate the number of individuals who belong to the miners category, using only the self-reported miners does not significantly change the coefficients in the model for the rest of groups in the north subsample (results upon request). I use the maps from *Minutas MTN50 (1915–1960),* selecting all the districts that had a mine within 1 km of their centroids. The maps used are *Minutas MTN50 (1915–1960), hojas 0052, 0053, 0036, 0037, 0060, 0061, 0041, 0065, 0938, 0939, 0953, 0954, 0955, 0956, 0975, 0976, 0977, 0978, 1014 y 1015.*

[27] The age of 14 is used as a limit to classify adult males because in the Mining Statistics of the early twentieth century, this age was taken as the lower threshold when presenting the data of miners.

[28] Girls are not displayed as their participation in the mining sector was negligible.

In the northern mines, the most interesting results can be observed in Mieres, Irun, Castro Urdiales, Abanto y Ciervana, and Galdames, as in the rest of the towns the mining sector was of lesser importance. In general, women were more involved in mining jobs than boys, which contradicts the results of Table 1. For instance, in Irun in 1910, or in Abanto y Ciervana in 1877, women represented around 20% of the total miners, as opposed to their irrelevance (less than 2%) reported in the Mining Cadastre in 1889. Thus, female mining labour might be more relevant than the official statistics reported, especially in the open-pit mines of the north. Moreover, the evolution observed in these mines from 1877 to 1910 could show an interesting dynamic. In Castro Urdiales and Abanto y Ciervana, there was a downward evolution of child and female labour, which occurred in parallel with the increase in production and exports beginning in the 1880s. Prior to this booming period, the results seem to indicate a family engagement in this pre-1880s period, whereby mothers and children complemented the fathers' work in the mines. However, as international competition arrived during the 1880s, mining companies may have started to look at productivity rates and focus their hiring on adult males.

In the southern municipalities, the female mining labour force seems to have experienced an increase in the early twentieth century, as the employment of women grew in Mazarrón and Nerva and was significantly high in Cartagena in comparison with the values presented in Table 1 for 1889. However, child labour may be underreported in the censuses, as the share of boys working as miners over total miners, was considerably below the percentage in 1889 for Cartagena, Nerva and Vera. This could indicate that parents may have concealed that fact that their children were working in order to avoid potential fines, as labour regulations banned child labour below the age of 14 from the early twentieth century. Nevertheless, it could also indicate a substitution effect of female labour as they did similar tasks to children at the mines (Pérez de Perceval Verde et al. 2020). This could explain the increasing presence of women in southern mines and the shrinking number of children, potentially fostered by the implementation of labour regulations during the 1910s and 1920s (Borras Llop 2013).

Finally, the detailed information from the municipality censuses enables us to test whether migration was related to the importance of the mining sector in each municipality. Figure 4 in the appendix displays the coefficient plot between the percentage of adult male miners, as depicted in Table 3, and the share of the population who was not born in the municipality. As we can observe, there was a clear positive relationship between these measures, confirming the importance of migration flows, especially those of open-pit miners. Thus, unexpected population growth and the cultural background of newcomers could have affected human capital formation. For instance, the pre-migration flow provision of schools might not have been sufficient for the new population. A massive arrival of unskilled migrants could have overwhelmed the job markets, decreasing wages and consequently the living standards in working-class families, or migrants might have had other perceptions of the utility of education.

Table 3 Percentage of adult men (older than 14) engaged in mining jobs

Municipality	1877	1887	1900	1910	1920
Underground north					
Mieres (alsturias)				28.8	
Carranza (biscay)				2	
Lanestosa (biscay)	3.4	7.4	7.1		
Irún (gipuzkoa)				7.6	
Open-pit north					
Castro urdiales (Cantabria)		19.3		21.3	
Abanto y ciervana (biscay)	45.7	74.9		73.5	
Galdames (biscay)			58.7		
Santurce (biscay)		1.1			
Underground south					
Cartagena (murcia)					13.2
Mazarrón (murcia)		34.0			28.0
Vera (almería)		2.3		1.4	
Open-pit south					
Nerva (huelva)			89.3		70.2*

Source: Own elaboration from population censuses. * The census year is 1924

3.2.2 Parents' occupations and literacy levels

The differences and gaps in the census years observed in the sample do not allow a direct interpretation and comparison of the data to be made. Therefore, Table 4 displays the probability of being literate according to the parents' occupation, including only those parents from families who had at least one offspring between eight and 18 years old. A logit regression with municipality and year fixed effects is used in order to overcome the sample gap problem and therefore allowing the interpretation of the data.[29]

Despite the geographical differences in education seen in Sect. 2, the results for upper-class and working mothers do not clearly point in this direction. For instance, the higher literacy level among southern working mothers could be related to a lower engagement of women in formal jobs in the south, only 69 of 5,648 mothers, as opposed to 278 in the northern subsample. Therefore, the few jobs reported by southern mothers could be more related to formal and skilled jobs, such as teachers or midwives, whereas, in the north, farming was the most common occupation reported by women. Consequently, the results for mothers in Table 4 should be taken with caution, and due to this job-reported problem, mother's occupation cannot be

[29] Figure 7 in the appendix shows the margins with 95% coefficient intervals.

used to measure the family's socioeconomic status, as the lack and bias of the mother's job would distort the conclusions.[30]

For fathers' occupations, the geographical gap is clearer. Except for farmers (group 5) and underground miners (group 7.2), all northern fathers were more literate than their southern counterparts. Moreover, in the north, there were clearly two groups regarding literacy. The first comprised the first four occupational groups with a literacy level of around 90%. Meanwhile, the working-class families, farmers, unskilled labourers and miners had a literacy level of a little under 60%. This educational class gap might not only indicate the lower living standards of working-class families, and therefore their restrictions to accessing the schooling system, but also the value and utility of education in the different jobs, on-the-job training or people forgetting how to read and write if these abilities were not used in their job.

However, southern fathers did not exhibit such a clear pattern as those of the north. The first four groups were clearly divided into the elite (first two groups) with literacy rates of around 85%, and the medium- and lower-skilled workers (groups 3 and 4), with a literacy level of around 70%. In the working-class group, farmers and underground miners seemed to have an equivalent educational performance to their northern counterparts (around 50% of them were literate). However, unskilled, and open-pit miners had a significantly lower literacy level than the other two working-class groups, not seen in the north. This may indicate that southern day labourers (group 6), and southern open-pit miners had lower wages, and thus, lower living standards preventing them from investing in education, or education was less demanded and used in these two occupational groups. Nevertheless, particularly significant is the low literacy rate of southern pit miners in Nerva, which could have been related to the monopolistic power of the Rio Tinto Company in the job market of the mining basin, together with the low demand for skilled or educated workers in open-pit mines.

3.2.3 Descriptive statistics

Table 12 in the appendix only displays the descriptive statistics for children between eight and 18 years old divided into the main two variables (literacy and father's occupation) and the controls. However, as previously mentioned, the gaps in the census years across the municipalities analysed here do not allow conclusions to be extracted without a previous treatment, which has been performed in Sect. 3.2.2. Nevertheless, it is worth noting that more than half of the sample was literate (51.2%), girls had a lower representation (49.2%), or most of the families analysed were formed only by the parents and their offspring. Moreover, 62% of the mothers in the sample were born in the town of analysis, similar to the percentage of fathers (57.7%). The main regions of the mother's origin were those in which the municipalities analysed were located, namely Andalusia, the North and Mediterranean

[30] While this problem of the under-representation of female jobs has been already tackled by the literature, with the data source used here, the problem cannot be resolved with the data source used here. See, for instance, Humphries and Sarasúa (2012).

Table 4 Parents' occupations and literacy levels

	Literacy margins (%)	
	North	South
Mother's occupation		
1.Upper-class	71.4	65.6
2.Wage labour	31.7	42.1
3.Home labour	38.3	30.9
Father's occupation		
1.Higher managers, professionals, and elite	93.7	85.4
2. Lower managers, professionals, clericals, and sales personnel	97.1	86.3
3. Foremen and medium-skilled workers	85	69.2
4. Lower-skilled workers	91	68.5
5. Farmers and lower-skilled farm workers	57.9	54.6
6. Unskilled	58	41.8
7. Miners		
7.1 Open pit	56.6	28.7
7.2 Underground	55.8	50.6

areas. This shows, as Silvestre (2005) points out, that during this period migration was short distance.

3.3 Methodology

Using the data set described in the previous section, the results presented here try to disentangle how being in a mining household shaped the children's education. As I mentioned before, the sample is analysed separately by girls and boys to examine the effect from a gender perspective. Likewise, the sample is further divided into northern and southern girls and boys to investigate the regional differences.[31]

Therefore, I use a Logit model, using literacy by gender as the dependent variable

$$Lit_i = \alpha + \beta_1 IFM_i + \beta_2 father' sjob_i + \beta_3 X + \varepsilon \quad (1)$$

where Lit_i is the binary variable literacy for individual i. On the right side, IFM_i includes the variables that control for the individual (age and age squared), family (simple family, eldest offspring, and the number of siblings), and migration variable (mother's region). Furthermore, $father' sjob_i$ is the main variable of interest, and it includes the father's occupation categories. Moreover, the X variable refers to the municipality and the year effects that are included to account for time and town fixed effects. Finally, the error term is clustered by municipality.

[31] Pooling northern and southern families in the same regressions gives similar results when a region interaction is used to examine the differences between the north and the south (results upon request).

4 Results

Table 5 reports the Logit regression models, including the occupation, individual and migration variables.[32] All of the fathers' occupations, except those of the second group for boys, had lower probabilities than the first occupational group (Higher managers, professionals, and elite). The effect of father's occupation is similar across the two regions. The highest negative coefficients correspond to those girls and boys whose fathers were open pit miners, followed by unskilled workers, underground miners, and farmers. Although boys and girls with fathers working as lower managers, clerks, foremen, medium- and lower-skilled workers (groups 2, 3 and 4) also had a lower probability of being literate than the first occupational group, the negative coefficients are around half of the values of groups 5 and 6 and miners. In light of the results displayed in Table 4, these coefficients highlight the differences in living standards and the perception and utility of education between upper- and middle-class families, and working-class households.

Moreover, the control variables show interesting results. Although many families may have included unproductive and dependant relatives that could have put a burden on the family's finance, in northern families it seems that living in these types of households fostered children's education. In the south, this positive effect was only apparent in the human capital formation of boys. This may indicate that despite a potential relief of household tasks for boys due to the presence of relatives, southern girls still had to help at home. Regarding the effect of the eldest offspring, the results are not conclusive. This may be due to the measurement problem of the variable commented above, as the real eldest and first-born offspring could have left, and this may not be recorded in the census. Moreover, the number of younger siblings only negatively affected girls, showing that the burden of taking care of them was mainly on young women, especially in the south. Finally, the mother's region of birth shows that only the positive cultural background of the North and the Ebro Valley (with the highest female literacy rates in Spain during the period under study), had a positive effect on girls' education. This result highlights the important effect that cultural background had on children's human capital formation, especially for girls, as literate mothers may have known the advantages of receiving a formal education and fostered their daughters' schooling.

In order to have a clearer perspective of the effect of father's occupation on children's education, Fig. 2 displays the probabilities of being literate according to the father's occupation using the regression in columns (1) to (4) in Table 5. This figure confirms the regional disparities, as there was a clear difference in the probabilities of being literate between the north and the south. For instance, those children in southern first group families, had the same probability of being literate, around 75%, as a northern girl with a father working in a medium- or lower-skilled job (third and

[32] Table 13 in the appendix reproduces Table 5, only displaying the results for occupations, and showing in each odd column the Logit regression without the individual and migration control. As we can observe, the coefficients for occupations do not significantly change when controls are included (even columns). As mentioned before, the omission of year and municipality fixed effects would not enable us to obtain a correct conclusion due to the gaps in the sample. Therefore, the Logit regressions without these fixed effects are not included.

fourth categories in the left panel). This geographical gap could be attributed to the significantly lower level of school provision in the southern towns of the sample seen in Table 2. The lack of schools affected all groups equally, although the upper-class could easily access private schools. Consequently, even if families wanted to educate their children, the absence of schools, especially acute in the South as described in Sect. 2, would prevent them from doing so. This was reflected in lower literacy rates in comparison with those of the better education-endowed north.

Moreover, there was a clear gender bias in northern working-class families (unskilled, and miners), which in the south was only present in open pit mining families. This gender gap can also be observed in Table 6, which represents the probabilities of fathers being literate according to the results presented in Table 4, and the probabilities of children being literate using the regressions of Table 5. In this case, the results for northern unskilled workers and miners show that boys' literacy (around 70%) was significantly higher than their fathers' (around 57%). However, for the northern girls of these families, the literacy rates were the same (60.3% for unskilled workers and 61.4% for underground miners). Similarly, in open pit northern families, the literacy level for girls was significantly lower than their fathers' literacy, with a gap of 10 percentage points. Likewise, the probability of girls in southern open-pit mining families being literate was 11 percentage points below their father's literacy (28.7%), while boys' education was statistically equal.

This double gender gap in education, regarding both girls' literacy in comparison to boys' and also with respect to their fathers' education, indicates that in northern working-class and southern open-pit mining families, efforts were focused on educating the boys. As these families probably had scarce resources due to their lower wages in comparison with other households, they may have decided to divert their investment towards the gender (boys) that could have higher returns in the job market with education.

Despite the overall lower literacy rate of children in comparison with their fathers' levels presented in Table 6, other households did not seem have a clear gender preference. This result is particularly relevant when comparing medium- and lower-skilled workers with unskilled workers and miners. In a scenario of a lack of schools, medium-lower-skilled, unskilled workers and miners would have faced the same restricted supply problem, as the upper-class (occupational groups 1 and 2) would most like have had access to private schools.[33] Thus, if the gender gap was a problem of a lack of schools for girls, the gap would have been common to other middle- and working-class families. Consequently, the gender gap was visible in children's education, and the potential effects that it could have in general human capital accumulation (e.g. less amount women with higher education), and in the local or regional economy could be attributed mainly to living standards and their effect on household decision-making.

4.1 Mining families and children's education

Focusing on mining families, Fig. 2 shows some interesting dynamics that could shed some light on how human capital formation was influenced by household decisions. In northern and southern mining families, open pit and underground miners

[33] Moreover, as seen in Table 2, the provision of private schools in the towns analysed was negligible.

Table 5 Logit model, literacy of children 8 to 18 years old

VARIABLES	North		South	
	Girls	Boys	Girls	Boys
	(1)	(2)	(3)	(4)
Father's occupation (Ref. 1st category)				
2. Lower managers, professionals, clericals, and sales personnel	−0.782***	−0.061	−0.633***	−0.310
	(0.268)	(0.277)	(0.213)	(0.216)
3. Foremen and medium-skilled workers	−1.665***	−1.121***	−1.460***	−1.113***
	(0.277)	(0.332)	(0.277)	(0.328)
4. Lower-skilled workers				
	−1.588***	−0.915***	−1.676***	−1.339***
	(0.359)	(0.223)	(0.298)	(0.288)
5. Farmers and lower-skilled farm workers	−2.337***	−1.746***	−2.296***	−2.070***
	(0.236)	(0.257)	(0.219)	(0.324)
6. Unskilled	−2.519***	−1.808***	−2.564***	−2.151***
	(0.227)	(0.355)	(0.174)	(0.247)
7.1 Open pit miners	−3.200***	−1.969***	−3.502***	−2.295***
	(0.238)	(0.245)	(0.230)	(0.283)
7.2 Underground miners	−2.465***	−1.757***	−2.493***	−2.137***
	(0.196)	(0.327)	(0.336)	(0.344)
Controls				
Age	1.349***	1.304***	0.641***	0.598***
	(0.086)	(0.092)	(0.072)	(0.090)
Age squared	−0.046***	−0.044***	−0.020***	−0.017***
	(0.003)	(0.002)	(0.003)	(0.003)
Simple family (dummy)	−0.479***	−0.293***	−0.027	−0.233**
	(0.151)	(0.085)	(0.149)	(0.111)
Eldest offspring (dummy)	0.018	−0.141***	0.044	−0.006
	(0.066)	(0.049)	(0.052)	(0.075)
Number of younger siblings	−0.064*	0.016	−0.101***	−0.031
	(0.033)	(0.020)	(0.030)	(0.023)
Mother's region birth (Ref. No migrant)				
Abroad	0.569	−0.299	−0.197	0.241
	(0.529)	(0.302)	(0.427)	(0.314)
Andalusia	−0.005	0.373	−0.052	−0.259***
	(0.685)	(0.451)	(0.139)	(0.088)
Mediterraneo	0.741	0.857	0.165**	0.182*
	(0.460)	(1.311)	(0.071)	(0.104)
New castile	0.274	1.040*	−0.357**	−0.323

Table 5 (continued)

VARIABLES	North		South	
	Girls	Boys	Girls	Boys
	(1)	(2)	(3)	(4)
	(0.260)	(0.544)	(0.181)	(0.243)
North	0.060	0.024	1.780***	−0.038
	(0.109)	(0.124)	(0.640)	(1.004)
Old castile	0.125	0.047	−0.132	−0.099
	(0.163)	(0.080)	(0.166)	(0.258)
Ebro valley	0.684***	0.204	2.111***	0.195
	(0.254)	(0.192)	(0.532)	(0.666)
Town FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	7,294	7,718	13,287	13,519
Pseudo R2	0.191	0.159	0.262	0.228

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

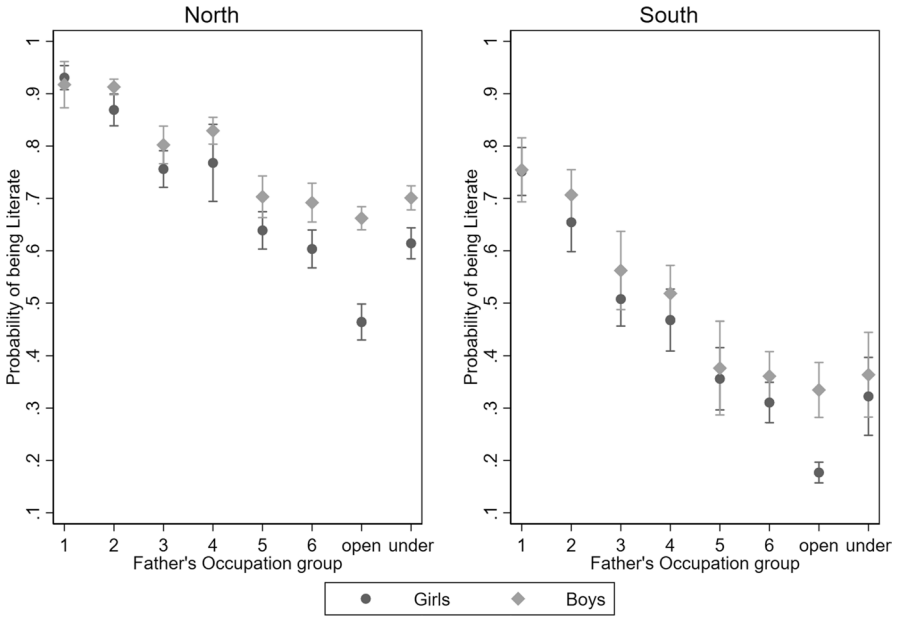


Fig. 2 Children's Education and Father's Occupation
Note: The predicted probabilities are from the estimation of Eq. (1) in Table 5, columns (1) and (2) for northern girls and boys, respectively, and (3) and (4) for southern girls and boys. Adjusted predictions with 95% CI. Categories: 1. Higher managers, professionals, and elite; 2. Lower managers, professionals, clericals, and sales personnel; 3. Foremen and medium-skilled workers; 4. Lower-skilled workers; 5. Farmers and lower-skilled farm workers; 6. Unskilled; open and under, miners according to the different mining extraction systems

Table 6 Fathers' and children's literacy margins

	Panel A: North			*Panel B: South*		
	Father's lit	Girls' lit	Boys' lit	Father's lit	Girls' lit	Boys' lit
	(1)	(2)	(3)	(4)	(5)	(6)
Father's occupation						
1	*93.7*	93.1	91.7	*85.4*	75.1 $^{+}$	75.5 $^{+}$
2	*97.1*	86.9 $^{+}$	91.3 $^{+}$	*86.3*	65.4 $^{+}$	70.7 $^{+}$
3	*85*	75.6 $^{+}$	80.2 $^{+}$	*69.2*	50.8 $^{+}$	56.2 $^{+}$
4	*91*	76.8 $^{+}$	82.9 $^{+}$	*68.5*	46.8 $^{+}$	51.8 $^{+}$
5	*57.9*	63.9 $^{++}$	70.3 $^{++}$	*54.6*	35.6 $^{+}$	37.6 $^{+}$
6	*58*	60.3	69.2 $^{++}$	*41.8*	31.1 $^{+}$	36.1 $^{+}$
7.1. Open	*56.6*	46.4 $^{+}$	66.2 $^{++}$	*28.7*	17.7 $^{+}$	33.5
7.2. Under	*55.8*	61.4	70.1 $^{++}$	*50.6*	32.2 $^{+}$	36.4 $^{+}$

Source: Own elaboration from Population Censuses. Father's literacy from the margins in Table 4 and children's literacy from margins in Table 5 + those margins that are significantly lower than father's literacy at 5%; ++ those margins that are significantly higher than father's literacy at 5%

behaved similarly. Children in underground mining households had similar literacy rates and gender gaps to children whose fathers worked as farmers or were unskilled. For instance, in the south, the literacy rate of boys from farmers' families was 31.1% and 32.2% for girls in underground mining families, or in the north, the gender gap was 8.9 percentage points among unskilled families, and 8.7 among underground mining households.

This similarity could indicate that, despite the high percentage of children working in underground mines, in other sectors, such as in agriculture, child labour was also widespread and a problem for schooling. Moreover, the higher wages in this type of mine, shown in Table 7, did not seem to be related to a higher investment in children's education in comparison to other working-class families, which indicates that a further and deeper analysis of wages at an individual level is required. Finally, the education stimulus of post-extraction industries in Mieres, or in other sectors such as commerce or white-collar jobs in Irun or Cartagena that demanded higher-skilled workers affected all families in the town, or neighbouring towns, and not exclusively the mining families. Consequently, children, especially boys, in mining families did not have higher literacy rates than other working-class offspring, as this positive stimulus would be widespread across households.

Thus, the results for underground miners show that they faced similar restrictions and were taking almost identical educational decisions as other similar households. Even though underground miners were relatively more skilled than day labourers or farmers, as their jobs needed longer periods of adaptation, the wages or living standards seemed to be similar in these three types of families.

For open-pit miners, both in the north and the south, the results show a significantly different behaviour to that of underground miners and other working-class families. The most striking results are the low literacy rates of girls in northern and southern open-pit mining families and the subsequent gender gap, 19.8 percentage

points in the north, and 15.8 in the south. Low wages, due to an overcrowded job market or the monopoly rule of a mining company (Rio Tinto Company in Nerva), would lead families to increase the number of family members in either the formal or informal job market. In this regard, child labour constituted a solution for obtaining extra income. However, the differences between the results of the two types of mining families can only be explained if this labour was female and considerably higher than in underground mines. Moreover, Tables 1 and 10 show that underground mines employed more children than open-pit mines.

Mothers working in formal or informal jobs may provide a better explanation for the disparities between open pit mining families and other working-class families. The low open-pit miners' wages forced these households to insert family members in the job market, mothers or young women could be one of the best options to bring an extra income. Massive male migration to these open-pit mines, as seen in Sect. 2, increased the demand for lodging, washing, and other formal and informal jobs culturally attributed to women. Consequently, mothers could engage in these occupations, which would translate into an increasing burden of household chores for daughters due to the absence of the mother, which, in turn, translated into a lower level of schooling. Similarly, if young women were the ones working in those jobs, this would have a direct impact on their human capital formation.

In conclusion, although child labour has been identified as one of the main reasons for low literacy rates, the results presented here seem to point in another, although similar, direction. Although child labour was probably an important impediment to human capital accumulation during the period under study, it was a reflection of the scarce economic resources of some families. Households facing financial restrictions due to low wages had to decide which members of the family should work to bring in an extra and needed income. This decision directly affected the human capital formation within the family if children were put to work, or indirectly if mothers had to start working outside the home, increasing the burden of household tasks for offspring, especially the daughters.

5 Conclusion

The highly detailed and micro-level dataset analysed in this study enables us to gain a better understanding of the important process of human capital formation from a historical perspective. In the nineteenth and early twentieth centuries, this process was particularly important as the literature has demonstrated that education fostered innovation and technology implementation, and therefore industrialisation and economic growth (see, for instance, Pleijt et al. 2020, or Cinnirella and Streb 2017). Thus, using Spanish mining towns as a case study, the unskilled level of miners' jobs, the low living standards in this occupation or the role of child labour in the mines are factors that reveal the dynamics that affected human capital formation within the household.

The results show the significant gender bias in the education decision-making of working-class households from a historical perspective. Low wages, which forced

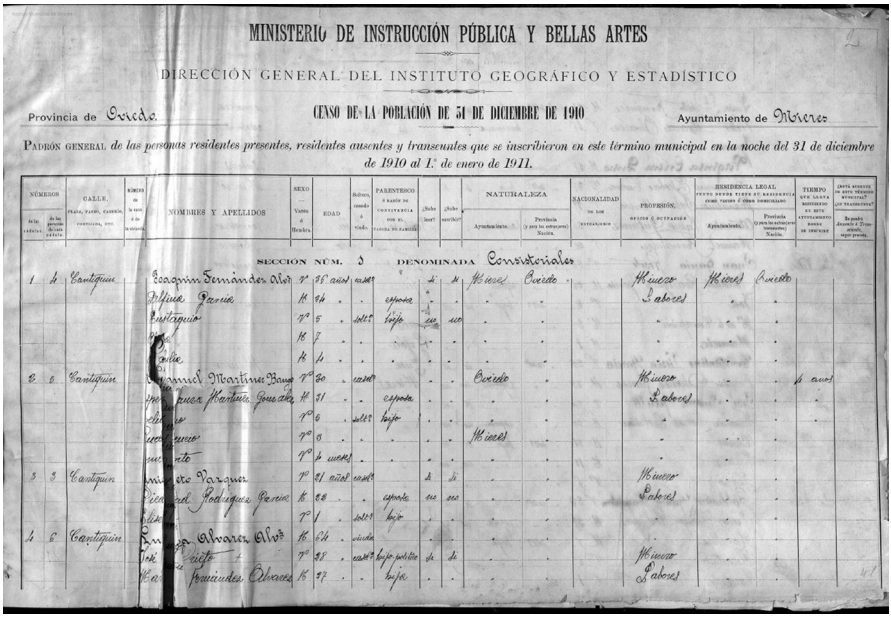
these families to rely on mothers, relatives or offspring to bring in an extra income, led to the neglect of daughters' education. Although this gender bias prevailed in the families of northern day labourers and underground miners it was especially relevant in the families of northern and southern open-pit miners. These mining families had lower living standards than other working-class families, forcing them to prioritise their sons' education and engage their daughters in formal or informal jobs or household tasks, hampering their education.

In conclusion, this paper enhances our understanding of how different occupations and socioeconomic status, living standards or child labour influenced schooling and education. In line with Beltrán Tapia and Martinez-Galarraga (2018), or Franck and Galor (2021), if finds that the dynamics in working-class families due to their low living standards meant that day labourers, industrial unskilled workers, or miners could not fully and equally educate their offspring, delaying the human capital accumulation process. However, this study also highlights the gender side of human capital formation from a historical perspective. When families faced scarce resources, the first to be affected were girls, as different factors such as culture or job prospects of educated women led to early dropouts or no schooling at all of daughters.

Appendix

Appendix A. Datasource

See Figure 3


MINISTERIO DE INSTRUCCIÓN PÚBLICA Y BELLAS ARTES

DIRECCIÓN GENERAL DEL INSTITUTO GEOGRÁFICO Y ESTADÍSTICO

Provincia de Oviedo. CENSO DE LA POBLACIÓN DE 31 DE DICIEMBRE DE 1910 Ayuntamiento de Mieres

PADRÓN GENERAL de las personas residentes presentes, residentes ausentes y transeuntes que se inscribieron en este término municipal en la noche del 31 de diciembre de 1910 al 1.º de enero de 1911.

SECCION NÚM. 3 DENOMINADA Consideriales

Fig. 3 Page 1 of the Mieres Population Census of 1910 (Archivo Municipal de Mieres)

Appendix B. Dataset and Descriptive Statistics

See Tables 7, 8, 9, 10, 11 and 12, Figures 4, 5, 6, 7.

Table 7 Salaries in the mining towns during the early 1900s

Province	Job	Pesetas$_{1913}$ per day [a]
Asturias	Rolling/refining	6.4
	Underground miner	5.1
Biscay	Open-pit miner	3.1
	Steel-mill worker	3.5–6.1 (max. 8.6)
Murcia	Open-pit miner	3.3
	Underground miner	4
Huelva	Open-pit miner	2.8–4
	Bessemer operators	3.5–4

Source: Asturias, Instituto de Reformas Sociales. Informe acerca de la Fábrica y de los obreros de Mieres, 1907. For Biscay, Instituto de Reformas Sociales. Informe referente a las Minas de Vizcaya, 1904. For Murcia Información sobre el trabajo en las minas a proposito de las peticiones que las Sociedad obreras elevaron al Gobierno el año 1909. For Huelva, Memoria redactada por la comisión nombrada por el instituro para estudiar las condiciones del trabajo en las Minas de Riotinto, 1913 and Arenas Posadas 1999.

[a] Wages deflated using 1913 as base year in Maluquer de Motes (2013, p.99).

Table 8 Distribution of data by year and municipality

Municipality	1877	1887	1900	1910	1920
Underground north					
Mieres (asturias)				28,082	
Carranza (biscay)				4,876	
Lanestosa (biscay)	692	675	879		
Irun (gipuzkoa)				11,994	
Open-pit north					
Castro urdiales (cantabria)		9,490		12,115	
Abanto y ciervana (biscay)	2,025	7,079		10,117	
Galdames (biscay)			3,308		
Santurce (biscay)		2,689			
Underground South					
Cartagena (murcia)					82,027
Mazarrón (murcia)		16,180			18,297
Vera (almería)		8,915		8,586	
Open-pit South					
Nerva (huelva)			11,896		13,969*
Total	2,717	45,028	16,083	75,770	114,293

Source: Own elaboration from population censuses. * The census year is 1924

Table 9 Percentage of adult women engaged in mining jobs/over total miners

Municipality	1877	1887	1900	1910	1920
Underground north					
Mieres (asturias)			1/3.3		
Carranza (biscay)			0.3/14.7		
Lanestosa (biscay)	0.8/20	3.5/39.1	0.6/10		
Irún (gipuzkoa)				1.4/17.6	
Open-pit north					
Castro urdiales (cantabria)		2.7/12.6		0.9/4.1	
Abanto y ciervana (biscay)	20/23.1	9.5/6.3		3.4/2.6	
Galdames (biscay)		3.2/2.3			
Santurce (biscay)	0.6/33.3				
Underground south					
Cartagena (murcia)				0.8/5.9	
Mazarrón (murcia)	0.3/0.8			0.4/1.2	
Vera (almería)	0.03/1.5		0/0		
Open-pit south					
Nerva (huelva)		0.8/0.7		1.9/2.6*	

Source: Own elaboration from population censuses. * The census year is 1924

Table 10 Percentage of boys (younger than 14) engaged in mining jobs/over total miners

Municipality	1877	1887	1900	1910	1920
Underground north					
Mieres (asturias)			1.5/3.5		
Carranza (biscay)			0.1/2.9		
Lanestosa (biscay)	0/0	0/0	0/0		
Irún (gipuzkoa)				0.3/1.7	
Open-pit north					
Castro urdiales (cantabria)		1.6/4.1		0.8/2.3	
Abanto y ciervana (biscay)	9.7/6.3	8.3/3.5		6.4/3.5	
Galdames (biscay)		6.8/3.6			
Santurce (biscay)	0/0				
Underground south					
Cartagena (murcia)				2/6.6	
Mazarrón (murcia)	9.2/14			9.5/14.5	
Vera (almería)	0.2/4.5		0/0		
Open-pit south					
Nerva (huelva)		11.2/5.3		4.4/2.7*	

Source: Own elaboration from population censuses. * The census year is 1924

Table 11 HISCLASS and Occupation groups

Occupation Groups	HISCLASS group
1.Higher managers, professionals, and elite	1. Higher managers
	2. Higher professionals
	13. Landowners, rentiers, and nobility (new group, see main text p. 20)
2.Lower managers, professionals, clericals, and sales personnel	3. Lower managers
	4. Lower professionals, clerical, and sales personnel
	5. Lower clerical and sales personnel
3.Foremen and medium-skilled workers	6. Foremen
	7. Medium-skilled workers
4. Lower-skilled workers	9. Lower-skilled workers
5. Farmers and lower-skilled farm workers	8. Farmers (fisherman excluded, see main text p. 20)
	10. Lower-skilled farm workers
6. Unskilled	11. Unskilled workers
	12. Unskilled farm workers
	8. Fisherman (see main text p. 20)
7. Miners	Miners
7.1. Open pit miners	*Miners in Abanto, Galdames and Santurce (Biscay), and Nerva (Huelva)*
7.2. Underground miners	*Miners in Mieres (Asturias), Carranza and Lanestosa (Biscay), Irún (Gipuzkoa), Mazarrón and Cartagena (Murcia) and Vera (Almería)*

Table 12 Summary statistics. Children between eight and 18 years old

	Obs.	Mean	Std. Dev.	min	max
Literacy	41,982	.512	.5	0	1
Father's occupation					
1.Higher managers, professionals, and elite	41,982	.049	.215	0	1
2. Lower managers, professionals, clericals, and sales personnel	41,982	.102	.303	0	1
3. Foremen and medium-skilled workers	41,982	.077	.266	0	1
4. Lower-skilled workers	41,982	.071	.257	0	1
5. Farmers and lower-skilled farm workers	41,982	.159	.365	0	1
6. Unskilled	41,982	.33	.47	0	1
7. Miners					
7.1 Open pit	41,982	.119	.324	0	1
7.2 Underground	41,982	.124	.33	0	1
Control variables					
Female	41,982	.492	.5	0	1
Age	41,982	12.637	3.155	8	18
Age squared	41,982	169.651	81.621	64	324
Simple family	41,982	.9	.3	0	1
Eldest offspring	41,982	.313	.464	0	1
Number young siblings	41,982	2.086	1.638	0	10
Mother's region					
No migrant	41,982	.62	.485	0	1
Abroad	41,982	.005	.073	0	1
Andalusia	41,982	.101	.301	0	1
Mediterraneo	41,982	.099	.298	0	1
New castile	41,982	.023	.151	0	1
North	41,982	.099	.299	0	1
Old castile	41,982	.037	.19	0	1
Ebro valley	41,982	.015	.123	0	1

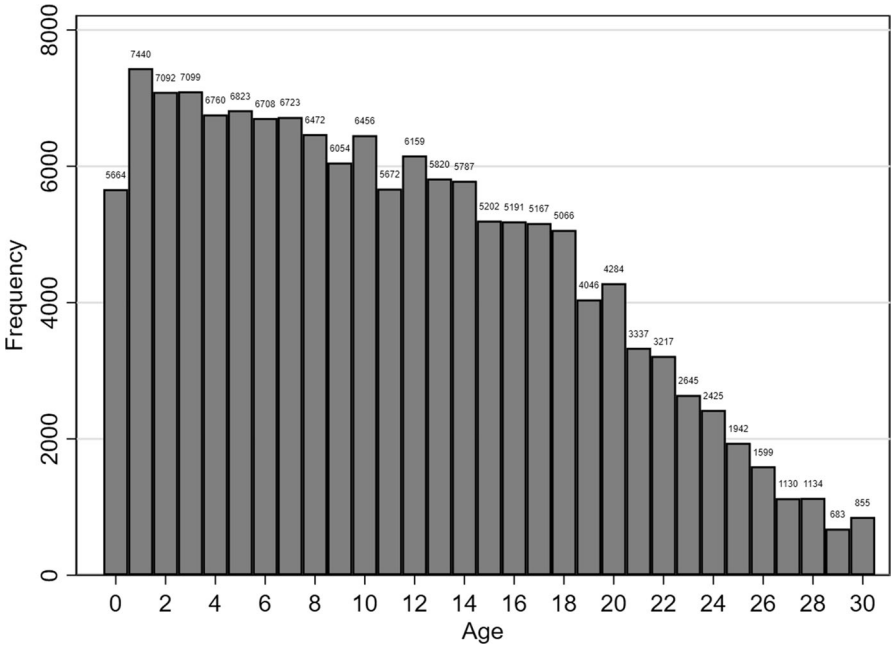


Fig. 4 Age distribution of Sons and Daughters in the Sample

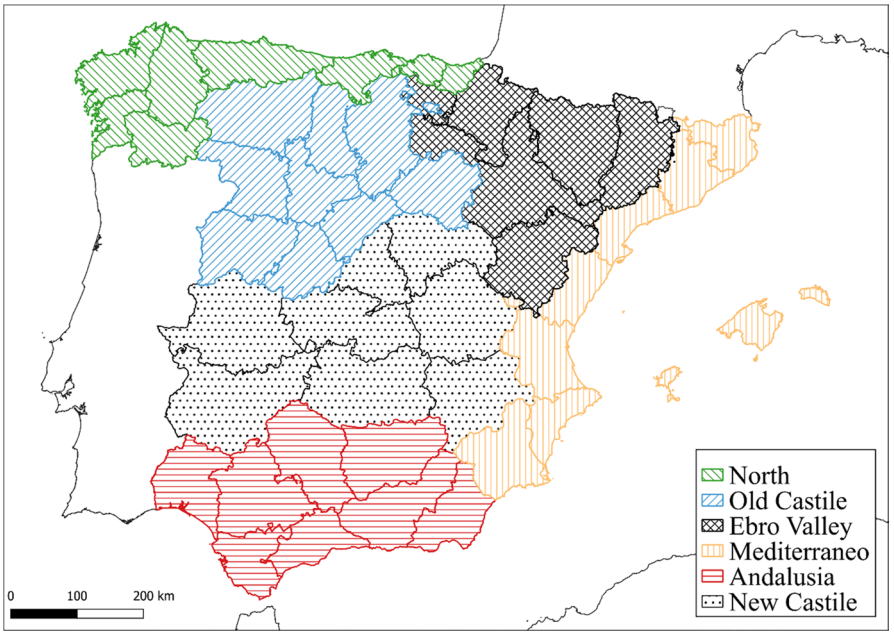


Fig. 5 Spanish regions classified according with Rosés and Sánchez-Alonso (2004)

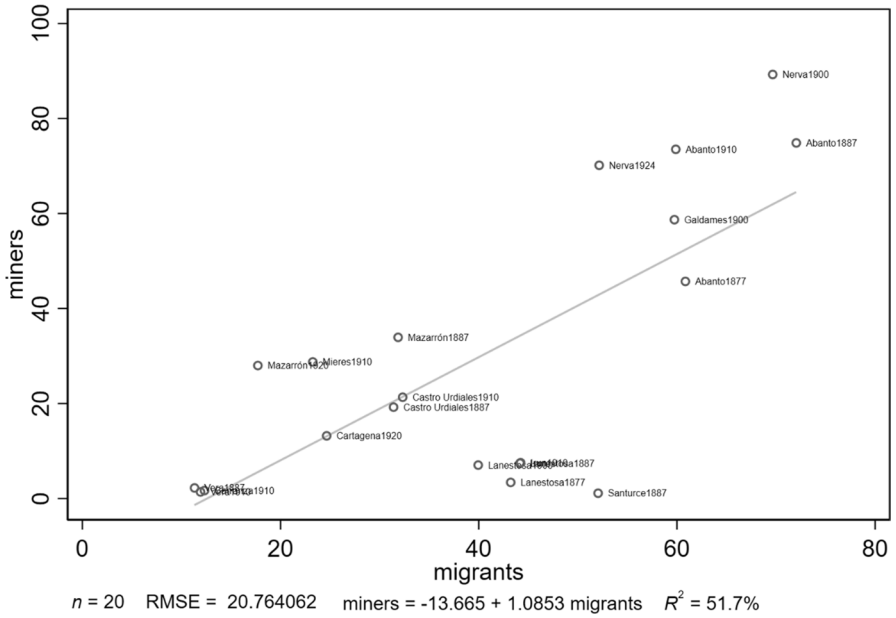


Fig. 6 Share of population born in other towns and Percentage of Miners

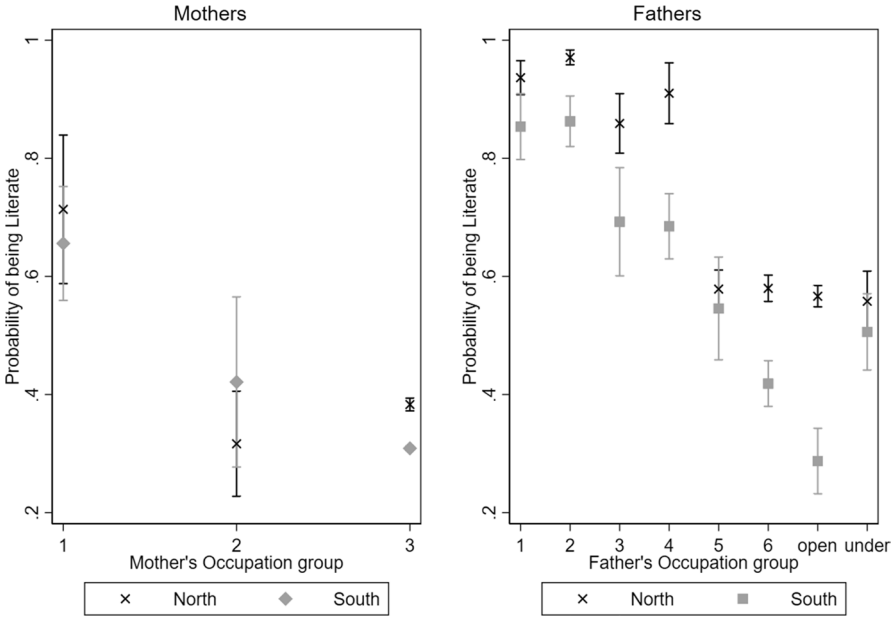


Fig. 7 Parents' Education and Occupational groups

Appendix C. Regression

See Table 13

Table 13 Logit model, literacy of Children 8 to 16 years old.

	Panel A: north				Panel B: south			
	Girls		Boys		Girls		Boys	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Father's occupation (Ref. 1st category)								
2. Lower managers, professionals, clericals, and sales personnel	−0.675***	−0.782***	−0.191	−0.061	−0.688***	−0.633***	−0.416*	−0.310
	(0.225)	(0.268)	(0.311)	(0.277)	(0.215)	(0.213)	(0.222)	(0.216)
3. Foremen and medium-skilled workers	−1.634***	−1.665***	−1.235***	−1.121***	−1.467***	−1.460***	−1.158***	−1.113***
	(0.256)	(0.277)	(0.382)	(0.332)	(0.255)	(0.277)	(0.312)	(0.328)
4. Lower-skilled workers								
	−1.451***	−1.588***	−1.028***	−0.915***	−1.702***	−1.676***	−1.398***	−1.339***
	(0.361)	(0.359)	(0.273)	(0.223)	(0.286)	(0.298)	(0.297)	(0.288)
5. Farmers and lower-skilled farm workers	−2.100***	−2.337***	−1.726***	−1.746***	−2.153***	−2.296***	−2.046***	−2.070***
	(0.175)	(0.236)	(0.317)	(0.257)	(0.216)	(0.219)	(0.318)	(0.324)
6. Unskilled	−2.370***	−2.519***	−1.915***	−1.808***	−2.497***	−2.564***	−2.163***	−2.151***
	(0.197)	(0.227)	(0.400)	(0.355)	(0.172)	(0.174)	(0.244)	(0.247)
7.1. Open pit miners	−2.880***	−3.200***	−2.008***	−1.969***	−3.502***	−3.502***	−2.237***	−2.295***
	(0.263)	(0.238)	(0.358)	(0.245)	(0.224)	(0.230)	(0.266)	(0.283)
7.2. Underground miners	−2.380***	−2.465***	−1.853***	−1.757***	−2.426***	−2.493***	−2.208***	−2.137***
	(0.171)	(0.196)	(0.351)	(0.327)	(0.323)	(0.336)	(0.333)	(0.344)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Town FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,742	7,294	8,146	7,718	14,057	13,287	14,224	13,519
Pseudo R2	0.122	0.191	0.0848	0.159	0.230	0.262	0.196	0.228

Robust standard errors in parentheses. *** p <0.01, ** p <0.05, * p <0.1

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Census sources

Abanto: *Censo de Población de 31 de diciembre de 1877, 1887* and *1910*. Archivo Foral de Bizkaia. http://apps.bizkaia.net/ARIT

Castro Urdiales: *Censo de Población de 31 de diciembre de 1887* and *1910*. Archivo municipal de Castro Urdiales.

Carranza: *Censo de Población de 31 de diciembre de 1910*. Archivo Foral de Bizkaia. http://apps.bizkaia.net/ARIT

Cartagena: *Padrón municipal de 1921*. Archivo municipal de Cartagena and Familysearch.org. https://archivomunicipal.cartagena.es/portalArchivo/controladorconopac?usr=null

Galdames: *Padrón de población de 1900*. Archivo Foral de Bizkaia. http://apps.bizkaia.net/ARIT

Irún: *Censo de Población de 31 de diciembre de 1910*. Archivo municipal de Irún. https://www.irun.org/archivo/fondo_historico.asp

Lanestosa: *Censo de Población de 31 de diciembre de 1877, 1887* and *1900*. Archivo Foral de Bizkaia. http://apps.bizkaia.net/ARIT

Mazarron: *Censo de Población de 31 de diciembre de 1887* and *1920*. Archivo municipal de Mazarron.

Mieres: *Censo de Población de 31 de diciembre de 1910*. Archivo municipal de Mieres. https://archivo.ayto-mieres.es/portalArchivo/seleccionopac?action=inicio&OP=OP999&usr=consulta&PT=PT000001

Nerva: *Padrón de habitantes de 1901* and *Padrón municipal de los vecinos domiciliados y transeúntes el día 1 de Diciembre de 1924*. Archivo municipal de Nerva.

Santurce: *Censo de Población de 31 de diciembre de 1887*. Archivo Foral de Bizkaia. http://apps.bizkaia.net/ARIT

Vera: *Padrón municipal de 1887* and *1910*. Archivo municipal de Vera. http://archivo.vera.es/archivo/archivo.php?dir=2.%20FONDOS%20DIGITALIZADOS%20DEL%20ARCHIVO%20MUNICIPAL%20DE%20VERA/

References

Arenas Posadas C (2016) Empresa, mercados, mina y mineros: Río Tinto, 1873-1936 Empresa, mercados, mina y mineros, pp. 1-292.

Bar T, Basu K (2009) Children, education, labor, and land: in the long run and short run. J Eur Econ Assoc 7(2/3):487–497

Barro RJ (1991) Economic Growth in a Cross Section of Countries. Quat J Econ 106(2):407–443
Barro RJ (2001) Human capital and growth. Am Econ Rev 91(2):12–17
Basu K (1999) Child labor: cause, consequence, and cure, with remarks on international lbaor standards. J Econ Lit 37(3):1083–1119
Basu K, Van PH (1998) The economics of child labor. Am Econ Rev 88(3):412–427
Becker GS (1993) Human capital, a theoretical and empirical analysis with special reference to education. The University of Chicago Press, Chicago, USA
Becker SO, Woessman L (2009) Was weber wrong? a human capital theory of protestant economic history. Quat J Econ 124(2):531–596
Becker SO, Hornung E, Woessmann L (2011) Education and catch-up in the industrial revolution. Am Econ J Macroecon 3:92–126
Beltrán Tapia FJ, de Miguel Salanova S (2017) Migrants' self-selection in the early stages of modern economic growth, Spain (1880–1930). Econ Hist Rev 70(1):101–121
Beltrán Tapia FJ, de Miguel Salanova S (2021) Class, literacy and social mobility: Madrid, 1880–1905. Hist Fam 26(1):149–172
Beltrán Tapia FJ, Martinez-Galarraga J (2018) Inequality and education in pre-industrial economies: Evidence from Spain. Explor Econ Hist No 69:81–101
Beltrán Tapia FJ, Díez-Minguela A, Martínez-Galarraga J, Tirado-Fabregat DA (2021) The uneven transition towards universal literacy in Spain, 1860–1930. Hist Educa 50(5):605–627
Bengtsson T, Dribe M (2006) Deliberate control in a natural fertility population: southern sweden, 1766–1864. Demography 43(4):727–746
Benhabib J, Spiegel MM (1994) The role of human capital in economic development: evidence from aggregate cross-country data. J Monet Econ 34:143–173
Borrás Llop JM (1995) Actitudes patronales ante la regularización del trabajo infantil, en el tránsito del siglo XIX al XX Salarios de subsistencia y economías domésticas. Hispania 55(190):629–644
Borras Llop JM (2005) Schooling and child farm labour in Spain, circa 1880–1930. Contin Chang 20(3):385–406
Borras Llop JM (2013) El trabajo infantil en España (1700–1950). Icaria Editorial S.A, Barcelona Spain
Burki AA, Fasih T, Din M-U (1999) Households' non-leisure time allocation for children and determinants of child labour in Punjab Pakistan. Pakistan Dev Rev 37(4):899–914
Burnette J (2012) Child day-labourers in agriculture: evidence from farm accounts, 1740–1850. Econ Hist Rev 65(3):1077–1099
Camps E, Borderias C, Ferrer L, López P, Llonch M, García A, Villar C (2001) Informe "historical international standard classificacion of occupations cataluña, siglos XIX-XX". Barcelona, Spain
Cappelli G, Vasta M (2020) Can school centralization foster human capital accumulation? a quasi-experiment from earlytwentieth-century Italy. Econ Hist Rev 73(1):159–184
Chastagnaret G (2017) Humos y sangre Protestas en la cuenca de las piritas y masacre en Riotinto (1877–1890) Alicante. Universitat d'Alacant, Servicio de Publicaciones, Spain
Ciccarelli C, Fachin S (2017) Regional growth with spatial dependence: a case study on early Italian industrialization. Pap Reg Sci 96(4):675–695
Cinnirella F (2019) Marital fertility and investment in children's education. In: Diebolt C, Rijpma A, Carmichael S, Dilli S, Störmer C (eds) Cliometrics of the family. Springer Nature Switzerland AG, Cham, Switzerland, pp 33–54
Cinnirella F, Hornung E (2016) Landownership concentration and the expansion of education. J Dev Econ 121:135–152
Cinnirella F, Streb J (2017) The role of human capital and innovation in economic development: evidence from post-Malthusian Prussia. J Econ Growth 22(2):193–227
Clark G, Gray R (2014) Geography is not destiny: geography, institutions and literacy in England, 1837–63. Oxf Econ Pap 66:1042–1069
Colls R (1976) "Oh happy english children!": coal, class and education in the North-East. Past & Present 73:75–99
Cunningham H (2000) The decline of child labour: labour markets and family economies in Europe and North America Since 1830. Econ Hist Rev New Ser 53(3):409–428
Cvcek T, Zajicek M (2019) The making of a liberal education: political economy of the Austrian school reform, 1865–1880. Explor Econ Hisotry 73:1–17
De Haan M, Plug E, Rosero J (2014) Birth order and human capital evidence from ecuador. J Human Resour 49(2):359–392

de Janvry A, Sadoulet E (2001) Income strategies among rural households in Mexico: the role of off-farm activities. World Dev 29(3):467–480
de la Croix D, Perrin F (2018) How far can economic incentives explain the French fertility and education transition? Eur Econ Rev 108:221–245
de Motes JM (2013) La inflación en España Un índice de precios de consumo, 1830–2012. Banco de España, Eurosistema, Madrid Spain
de Perceval Verde MAP & López-Morell MÁ (2006) Una visión general del sector minero en la historia contemporánea española. In: Minería y desarrollo económico en España, Síntesis, (pp. 17-32)
de Perceval Verde MAP, Soto APM, & Picón, AS (2013) El trabajo de los menores en la minería española, 1840-1940. In: El trabajo infantil en España,(1750-1950) (pp. 153-192).
de Perceval P, Verde MÁ, Martínez-Carrión JM, Martínez-Soto ÁP (2016) Biological welfare and inequality during the mining boom: rio tinto, 1832–1935. Revista De Historia Industrial 64:149–181
De Pleijt A, Nuvolari A, Weisdorf J (2020) Human capital formation during the first industrial revolution: evidence from the use of steam engines. J Eur Econ Assoc 18(2):829–889
Ejrnæ M, Pörtner CS (2004) Birth order and the intrahousehold allocation of time and education. Rev Econ Stat 86(4):1008–1019
Emerson PM, Portela Souza A (2008) Birth order, child labor, and school attendance in Brazil. World Dev 36(9):1647–1664
Escudero A, Pérez Castroviejo P (2010) The living standard of miners in Biscay (1876–1936): Wages, the Human Development Index and Height. J Iberian Latin Am Econ Hist 28(3):503–534
Fan S (2011) The luxury axiom, the wealth paradox, and child labor. J Econ Dev 36(3):25–45
Fernihough A (2017) Human capital and the quantity–quality trade-off during the demographic transition. J Econ Growth 22(1):35–65
Ferrer y Rivero P (1915) Tratado de la Legislación de Primera Enseñanza vigente en España. 2ª Época-Edición 1ª Madrid, Spain Librería de los Sucesores de Hernando
Franck R, Galor O (2021) Flowers of evil? Industrialization and long run development. J Monet Econ 117:108–128
Galor O (2011) Unified growth theory. Princeton University Press, Princeton, New Jersey
González Portilla M, García Abad R, Lizarraga Urrutikoetxea J (2007) Las "Ciudades Mineras" de la Ría de Bilbao durante el boom minero: inmigración, capital humano y mestizaje. Servicio Editorial de la Universidad del País Vasco, Bilbao, Spain
Gutiérrez AE (2006). Expansión y decadencia de la minería del hierro española. In: Minería y desarrollo económico en España (pp. 153-177). Síntesis.
Haddad GK (2017) Parents' decision on child labour and school attendance: evidence from Iranian households. J Educ Work 30(6):612–631
Hammel EA, Laslett P (1974) Comparing household structure over time and between cultures. Comp Stud Soc Hist 16(1):73–109
Heywood C (1988) Childhood in nineteenth-Century France: work, health and education among the "classes populaires." Cambridge University Press. https://doi.org/10.1017/CBO9780511523359
Humphries J (2011) Childhood and child labour in the British industrial revolution. Cambridge University Press, New York, USA
Humphries J (2013) Childhood and child labour in the British industrial revolution. Econ Hist Rev 66(2):395–418
Humphries J, Sarasúa C (2012) Off the record: reconstructing women's labor force participation in the European past. Fem Econ 18(4):39–67
John AV (1984) By the sweat of their brow. women workers at victorian coal mines. Routledge & Kegan Paul plc, London, UK
Kirby P (2003) Child labour in Britain, 1750–1870. Palgrave MacMillan, Houndmills, UK
Klemp M, Weisdorf J (2019) Fecundity, fertility and the formation of human capital. Econ J 129(618):925–960
Klemp M, Minns C, Wallis P, Weisdorf J (2013) Picking winners? The effect of birth order and migration on parental human capitalinvestments in pre-modern England. Eur Rev Econ Hist 17(2):210–232
Larsson G, Westberg J (2020) Child Labour, parental neglect, school boards, and teacher quality: school inspector reports on the supply and demand of schooling in mid-nineteenth-century Sweden. Hist Stud Educ/revue D'histoire De L'éduc 32(1):69–88
Lindskog A (2013) The effect of older siblings' literacy on school entry and primary school progress in the ethiopian highlands. Econ Educ Rev 34:45–68
Long J (2006) The socioeconomic return to primary schooling in victorian England. J Econ Hist 66(4):1026–1053

Maertens M, Verhofstadt E (2013) Horticultural exports, female wage employment and primary schoolenrolment: theory and evidence from Senegal. Food Policy 43:118–131
Mankiw G, Romer D, Weil DN (1992) A contribution to the empirics of economic growth. Q J Econ 107(2):407–437
Martínez Soto AP, de Perceval P, Verde MA, Sánchez Picón A (2008) Itinerarios migratorios y mercados de trabajo en la minería meridional del XIX. Bol Geol Min 119(3):399–418
Martínez-Galarraga J, Prat M (2016) Wages, prices, and technology in early Catalan industrialization. Econ Hist Rev 69(2):548–574
Meisenzahl RR, Mokyr J (2011) The rate an direction of invention in the british industrial revolution: incentives and institutions. In: Lerner J, Stern S (eds) The rate and direction of inventive activity revisited. University of Chicago Press, Chicago, USA, pp 443–479
Mokyr J (2005) The intellectual origins of modern economic growth. J Econ Hist 2(65):285–351
Mukherjee D, Das S (2008) Role of parental education in schooling and child labour decision: urban india in the last decade. Soc Indic Res 89:305–322
Nuñez CE (1992) La Fuente de la riqueza. Educación y desarrollo económico en la España Contemporanea, Madrid, S.A.
Nuñez CE (2005) A modern human capital stock. Spain in the 19th and 20th centuries, En M Jerneck, M Mörner, G Tortella & S Åkerman, Different Paths to Modernity, A Nordic and Spanish Perspective, Lund, Sweden Nordic Academic Press 122–142
Nuvolari A, Vasta M (2017) The geography of innovation in Italy, 1861–1913: evidence from patent data. Eur Rev Econ Hist 21(3):326–356
O'Rourke KH, & Williamson JG (1995) Open economy forces and late 19th century scandinavian catch-up. nber working paper no. w5112.
Palacios-Mateo A (2022) Education, industrialisation and the mining sector: Spain 1860–1924. Norway Norwegian University of Science and Technology, Trondheim
Pérez de Perceval, MA, & Sánchez Picón, A (2001) El plomo en la minería española del siglo XIX. Evolución del sector y panorama empresarial, Madrid Fundación Empresa Pública.
Pérez-Fuentes Hernández P (2004) "Ganadores de Pan" y "Amas de Casa". Otra mirada sobre la industrialización vasca. Bilbao, Spain Universidad del País Vasco, Servicio Editorial.
Romer PM (1990) Endogenous technological change. J Polit Econ 98(5 Part 2):S71–S102
Rosés JR, Sánchez-Alonso B (2004) Regional wage convergence in Spain 1850–1930. Explor Econ Hist 41:404–425
Saaritsa S, Kaihovaara A (2016) Good for girls or bad for boys? schooling, social inequality and intrahousehold allocation in early twentieth century Finland. Cliometrica 10:55–98
Santiago-Caballero C (2020) Intergenerational occupational mobility in 19th-century Spain (Valencia), 1841–1870. J Iberian and Latin Am Econ Hist 30(2):219–264
Silvestre J (2005) Internal migrations in Spain, 1877–1930. Eur Rev Econ Hist 9:233–265
Squicciarini MP, Voigtländer N (2015) Human capital and industrialization: evidence from the age of enlightenment. Quat J Econ 130(4):1825–1883
Thomson J (2005) Explaining the 'take-off' of the catalan cotton industry. Econ Hist Rev 58(4):701–735
Turčínková J, Stávková J (2012) Does the attained level of education affect the income situation of households? Procedia Soc Behav Sci 55(5):1036–1042
Van Bavel J, Kok J (2010) A mixed effects model of birth spacing for pre-transition populations: evidence of deliberate fertility control from nineteenth century Netherlands. Hist Fam 15(2):125–138
van Leeuwen MH, Maas I (2011) HISCLASS. a historical inernational social class scheme. Leuven University Press, Leuven, Belgium
Vandenbussche J, Aghion P, Meghir C (2006) Growth, distance to frontier and composition of human capital. J Econ Growth 11:97–127
Vicent D (2003) The progress of literacy. Victorian Studies 45(3):405–431
Westberg J (2018) A conflicted political will to levy local taxes: inequality and local school politics in Sweden, 1840–1900. Nordic J Stud Educ Policy 4(1):3–12
Zapata D, Contreras D, Kruger D (2011) Child labor and schooling in Bolivia: Who's falling behind? the roles of domestic work, gender, and ethnicity. World Dev 39(4):588–599