The formation of Human capital in pre-modern Latin America

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Contents

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Symbols and abbreviations

ABCC Index that yields an estimate of the share of individuals who report unrounded age

GDP Gross domestic product

OLS Ordinal list Squares Estimation

Archives

AGN Archivo general de la Nación Montevideo, Uruguay

AGN BA Archivo general de la Nación Buenos Aires, Argentina

AGN J Archivo General de la Nación/ Archivo judicial. Montevideo, Uruguay

AGN PE Archivo General de la Nación de Perú

1. INTRODUCTION

"A country would hardly be said to be richer, except by metaphor, however, precious a possession it might have in the genius, the virtues, or the accomplishments of its inhabitants"

John Stuart Mill 1848

1.1. JUSTIFICATION AND AIM OF THE THESIS

The purpose of this thesis is to contribute to the knowledge of the different development and inequality in Latin America in the long run, with a particular focus on the southern region and the colonial period before the first economic globalization (in 1860). The argument of the thesis is in concordance with the debate about the colonial origins of the Latin American divergence given by the institutional scholars (Acemoglu, Johnson and Robinson 2001, 2002, 2012; Bruhn and Gallego 2012). This debate addresses that the institutions generated in the colonial period were one of the main reasons for the current economic backwardness. In general terms, this discussion focuses on the economic growth and the inequality in comparison with the developed countries. It conceives as 'colonial legacy' the 'bad' and exploitative institutions generated in this period. This thesis focuses on the formation of Human Capital as one of the reasons for the current divergence. In this sense, another contribution of this thesis is the generation of a new micro-database with information on Human capital and different social and geographical variables of the pre-modern period of southern Latin America. The construction of this database was one of the initial efforts of the thesis since it was unpublished. Most of the registers –mainly the census and population registers– are primary sources from the National Archives of Montevideo, Buenos Aires, and La Paz. From these sources, I constructed an extensive database by region in which it is possible to identify the mathematical capabilities (numeracy) of the population. In some cases, it was possible to compare the numeracy with the occupational categories. The analysis focuses on the *Rio de la Plata* region; however, other countries are also included, especially in Chapters Three and Four. The objective is to contribute to wider debates

through a regionalization of the analysis taking into account the particularities of each area. This thesis attempts to answer some questions concerning Human capital formation in this period and region: Was the formation of Human capital relevant in a pre-modern society? What are the determinants of the formation of Human Capital in a pre-modern period? Are there any differences in Human capital formation among the Latin American regions? Are the natural resources linked to Human capital formation? Was the creation of Human capital relevant for wealth?

1.2. HUMAN CAPITAL AND ITS IMPLICATIONS IN ECONOMIC PERFORMANCE

The origin of the theorizing of Human capital goes back to the emergence of classical economics in 1776, and after that developed as an economic theory (Fitzsimons, 1999). After the manifestation of that concept as a theory, Schultz (1961) recognized Human capital as a central factor for national economic growth in the modern economy. With the emergence and development of Human Capital as an academic field, some researchers attempted to clarify how human capital could contribute to the socio-political development and freedom (Alexander, 1996; Grubb & Lazerson, 2004; Sen, 1999). The most prominent economists to address issues of Human Capital were Adam Smith, John Stuart Mill, and Alfred Marshall. Irving Fisher expressed the pivotal arguments connecting early economic thought to contemporary human capital methodologies (Sweetland, 1996).

One of the most analyzed perspectives of Human Capital is the relation of the labor force to production. Romer (1990) refers to Human capital as a fundamental source for economic productivity. Rosen (1999) states Human Capital is an investment that people make in themselves to increase their productivity. More recently, Frank and Bemanke (2007) defined Human capital as ‘an amalgam of factors such as education, experience, training, intelligence, energy, work habits, trustworthiness, and initiative that affect the value of a worker's marginal

product.' Considering the production-oriented perspective, Human capital is the stock of skills and knowledge embodied in the ability to perform labor so as to produce economic value (Sheffin, 2003). Furthermore, some researchers defined Human capital as 'the knowledge, skills, competencies and attributes in individuals that facilitate the creation of personal, social and economic well-being' within the social perspective (Rodriguez & Loomis, 2007).

The term 'Human capital' is semantically the combination of 'human' and 'capital.' From an economic perspective, capital refers to 'production factors used to create goods or services that are not themselves significantly consumed in the production process' (Boldizzoni, 2008). The Human would be the subject to take charge of all economic activities such as production, consumption, and transaction. On the establishment of these concepts, Human capital means one of the production elements that can generate added-value through its input (Kwon, 2009).

The ways to invest in Human Capital can be classified into two types. The first is to use humans as a labor force. In the classical economic perspective, this means that economic added-value generates the input of the workforce with other production factors such as financial capital, land, machinery, and labor hours. Until the economic growth of the 1950s, most economists had supported the importance of such a quantitative workforce to create products (Kwon, 2009). The second focuses on the assumption that the investment of physical capital may show the same effectiveness as Human capital in education and training (Little, 2003). Considering that the assumption accepts as a premise that Human capital broadly includes the meaning of 'human as creator' who frames knowledge, skills, competency, and experience originated by continuously connecting between 'self' and 'environment.'

In the 1950s, some economists highlighted that the investment of Human capital was the primary element to raise individuals' wages compared to the quantitative input of other components such as land, financial capital, and labor force (Salamon, 1991). Throughout the investment of Human Capital, an individual's acquired knowledge and skills can easily transfer to certain goods and services (Romer, 1990). Considering that accumulation of knowledge and

expertise is an important role for Human capital, there is a widespread belief that learning is the core factor to increase Human capital. In other words, learning is a significant piece in obtaining much knowledge and skills through many ways of acquisition including the relationship between an individual and society (Sleezer, Conti & Nolan, 2003).

Such accumulation of Human capital through learning activities significantly influences many sectors. Many researchers argue that accumulation of Human capital through education and training investment mostly affects the growth of the individual's wages and the whole national economy (Denison, 1962; Schultz, 1961).

According to Lucas (1988), a microeconomic model shows that education investment for workers significantly affects their productivity in the workplace. Related to the previous idea, some scholars stress the importance of education and training in the Human Capital field (Griliches & Regev, 1995; Rosen, 1999).

From the microeconomic point of view, the foundations of Human capital theory were laid by Theodore Schultz (1961) and Gary Becker (1976). They developed a theoretical framework of individual decisions on Human capital investments (Schultz 1961), and of parental decisions on the investments in the education of children (Becker et al., 1960).

Over the last three decades, many scholars have been devoted to the generation of indicators of Human capital and their impact on well-being. This literature addresses the relation between Human capital and economic growth. With the emergence of the endogenous growth theory, scholars agree that Human capital is a crucial fact that explains why some countries are rich and others poor (Cinirella & Streb, 2013). In the 1980s some scholars tended to include Human Capital as part of the aggregate production function of the neoclassical growth model of Solow (1956). The aim of these scholars was to consider technology as endogenous, treating it as an exogenous variable in neoclassical economic growth theory (Romer, 1986; Lucas, 1988; Rebelo, 1991).

Around the 2000s the growth model of the unified growth theory proposed by Galor and Weil (2000) stressed that Human capital is a complement of technology since it is a necessary instrument for innovation. This idea focuses primarily in underdeveloped countries for the adoption of foreign technology (Galor & Weil, 2000; Galor, 2005, 2010). Given the importance of human capital for economic growth, many scholars created Human capital indicators to compare the origins of the economic disparities, in which Human capital seems to have been one of the reasons. Unfortunately, it is not possible to find direct measurements of human capital for pre-modern periods; hence scholars made an effort to approximate it according to different indicators. For example, Baten and Van Zanden (2008) argued that Human capital measured by book production as a proxy for literacy skills can explain differences in economic growth before industrialization. However, there is no agreement among scholars on whether Human capital was a driving factor for economic growth before the industrial revolution.

In the origins of inequality in Latin America, Human capital was closely related to the formation of institutions. For example, the work of Lipset (1960) claims that Human capital improves the quality of institutions. In the first place, it is required to generate institutions committed to the protection of human rights. Furthermore, educated people tend to resolve their problems by discussion and elections instead of violence (Swanson & King, 1991). The link between Human capital and institutions was empirically tested by Glaeser et al. (2004), Alvarez et al. (2000), and Barro (1999). The relation between institutions and Human capital formation is one of the most preferred explanations of the origins of economic and social disparities in the world. Over the past three decades, the economic history literature has claimed that the 'good institutions' are drivers of economic growth and 'bad institutions' are one of the main reasons of economic backwardness (North et al., 1999; Acemoglu, Johnson & Robinson, 2001, 2002, 2012; Bruhn & Gallego, 2012).

However, the creation of Human capital indicators remains one of the main deficiencies of the pre-modern period since there is a lack of primary sources. In the next section, I will describe

the characteristics of the measurement of Human capital, mainly for pre-modern periods, which is the subject of this thesis.

1.3. APPROXIMATION TO HUMAN CAPITAL MEASUREMENTS

Human capital implies investment in more than education; it includes the health and nutrition of people (Shultz, 1981). However, the formal education is considered the primary indicator in empirical studies. One of the reasons is that education improves health and nutrition and is more quantifiable (Mincer, 1974). Apart from formal education, informal education, such as apprenticeships, on the job training, and education at home, plays a significant role in Human capital formation (Shultz, 1981; Mincer, 1974). However, the most extended measurements of Human capital are based on formal education. Some examples are the years of schooling (Barro & Lee, 1996), enrolment rates (Barro, 1991; Mankiw, Romer & Weil, 1992), literacy (Romer, 1991), and educational attainment (Barro & Lee, 1993). Unfortunately, most of these indicators cannot be used in pre-modern periods since the data is not available. For this reason, scholars have constructed indirect measurements to approximate Human capital. One of the most widely used is literacy -approximated by the signature on marriage registers and other legal documents- and, more recently, numeracy (approximated by the ability to count). Both techniques have potential biases since they are not direct measurements; but, without these methods, it would not be possible to have Human capital indicators in the pre-industrial era.

1.4. NUMERACY AND THE AGE HEAPING TECHNIQUE

According to Cohen (1982), the word 'numeracy' is a relatively recent addition to the English language. The 1976 supplement to the *Oxford English Dictionary* has defined it as 'ability with or knowledge with numbers' and locates its origins in a 1959 report on English education that contrasted illiterate scientists with innumerate humanists. The word was intended to be the analog of 'literacy.' Nascent quantification -as a necessity to measure and count- appeared in Western culture in a variety of contexts and situations in the 16th and 17th centuries. On one level, its appearance correlates with important changes in the political, economic, and religious life of these turbulent times and to well-known historical processes, such as the growth of centralized government and the expansion of overseas trade. On a deeper level, quantification is a peculiar mental activity that satisfies a need for precision and finitude. Was not coincidental that it appeared in a period of numerous crises (Cohen, 1982). In this thesis, numeracy is interpreted as the ability to count, keep records of these numbers, and make rational calculations (Emigh, 2002).

Numeracy started to be a central factor in the early 19th century with the emergence of market capitalism. The ability to calculate gradually becomes an important skill in commerce and finances. According to A´Hearn, Crayen, and Baten (2009), the most basic skills in numeracy diffused earlier than literacy. The progress of numeracy before the era of formal schooling indicates that the spread of market activity promoted the development of quantitative reasoning among ordinary citizens. However, the most important driving factor of numeracy has been claimed to be formal education (A´Hearn, Crayen & Baten, 2009).

Traditional literature has used mainly literacy skills in the measurement of Human capital formation; however, recent research has incorporated numeracy through the 'age heaping' technique. (Baten & Mumme, 2010; (Manzel, Baten & Stolz, 2011; Hippe & Baten, 2012; Juif

& Baten, 2013). In this thesis, I use age heaping as an approximation of mathematical abilities and Human capital formation.

The age heaping technique allows to calculate the proportion of a given population able to provide to census takers, or the parish priest, their exact age, rather than providing a rounded age. This indicator of basic numeracy is a pre-condition for developing more advanced skills, including literacy. The age heaping approach captures a basic form of Human capital that is useful in this analysis, since age is relatively easy to find in pre-statistical data records. This technique applies both to historical populations and to the poor countries of today, in which a considerable share of the population was or is unable to calculate their age and hence report a rounded age ending in a multiple of five. Age heaping is calculated as the ratio between the preferred rounded ages and the others. The quality of age reporting can be measured by means of age heaping indices to detect the degree of preference for or avoidance of certain ages. Among standard indices (Bachi' 1951; Myers, 1976; Whipple & Zelnik, 1961),[1] the Whipple index is the most widely applied.[2] The original Whipple index is obtained by summing the number of people in the age range 23–62 inclusive, and calculating the ratio of reported ages ending in zero or five to one-fifth of the total sample. The index assumes a linear distribution of ages in each range of five years, i.e., a continuous and linear decrease in the number of persons of each age within the age range considered. Low ages (0–23 years) and high ages (72 years and above), for which the linearity assumption is not plausible, are excluded from the calculation (Spoorenberg & Dutreuilh, 2007).

$$(1) \qquad Wh = \left(\frac{\left(Age25 + Age30 + Age35 + ...Age60\right)}{1/5 \times Age23 + Age24 + Age25 + ... + Age62} \right) \times 100$$

[1] The methods to calculate these indices are in Shyrock and Siegel (1976: 115–119).

[2] A'Hearn, Baten, and Crayen (2009) argue that this is the only index that fulfils the desired properties of scale independence (a linear response to the degree of heaping) and that it offers a reliable ranking of samples among which the degree of heaping varies.

To interpret this more easily, A'Hearn, Baten, and Crayen (2009) suggested another index: the ABCC index.[3] It is a simple linear transformation of the Whipple index and yields an estimate of the share of individuals who correctly report their age:

$$(2)\ ABCC = \left(1 - \frac{(Wh - 100)}{400}\right) \times 100 \text{ if } Wh \geq 100; \text{ else } ABCC = 100$$

The index takes a value between zero and one. A value of zero means total age heaping, while a value of one means no heaping at all.

The share of persons able to report an exact age has been shown to be highly correlated with other measures of Human capital, such as literacy and schooling (Mokyr, 1983; A'Hearn et al., 2009; Crayen & Baten, 2010). A'Hearn, Baten, and Crayen (2009) found a close correlation in less developed countries between illiteracy and age heaping.

The age heaping technique has the advantage of being an outcome measure of education and for this reason does not suffer from the limitation of input measures such as, for example, enrolment ratios or years of schooling. This kind of measure does not take into account the fact that the quality of education varies substantially among the different regions. Another advantage of the age heaping methodology is that age is more available than other Human capital proxies, such as signature ability or school attendance. Furthermore, age is available for earlier periods than the school enrolments. The most common source used to capture age heaping are census lists, but also parish registers, such as marriage and death records, have recently been taken into account for the age heaping technique. In this thesis, I use mainly census and population records and, in one Chapter, marriage registers.

[3] The name results from the initials of the authors' last names plus Greg Clark's, who suggested this in a comment on their paper. Whipple indices below 100 are normally caused by random variation of birth rates in 20th century rich countries. They do not carry important information, hence are normally set to 100 in the ABCC index.

1.5. BRIEF DESCRIPTION OF THE PRE-MODERN PERIOD IN LATIN AMERICA

This thesis focuses on the study of the pre-modern and colonial societies of Latin America. Is centered in the time before the agro-exportation boom and the first globalization of the economy. The majority of the data set is of the period between 1760 and 1860. However, one Chapter (3) covers an earlier period (1630-1750). It is part of a long research trajectory that studies the economy, society, and institutions of the Río de la Plata Region between 1760 and 1860, started with my M.A. thesis entitled *Montevideo y la campaña Sur. Estructura social y demográfica. 1769-1858*. The entire period goes from the beginnings of the Spanish settlements in the territory (*Río de la Plata*) to the years after independence and the beginning of modernization. It is pertinent to study this period because it covers the process of institutional formation, which is claimed to be one of the causes of the current economic backwardness of Latin America. Furthermore, the colonial period is at the heart of the economic history debate, in the explanation of the inequality and economic divergence of Latin America in comparison to the developed countries.

From data collection, it is a pre-statistical period, hence, was no specific intention to collect the data (census and population registers) for statistical purposes, but rather for electoral and tax purposes. Furthermore, on many occasions the data are not continuous in time or some information is not included in all the registers (such as occupation or age).

1.6 OUTLINE

This is an accumulative thesis of four papers which are ordered as Chapters. The thesis contains six Chapters of which Chapter Two is already published, and Chapters Three and Four and Five are intended for publication. All the Chapters of this thesis focus on Human capital formation in Latin America in the pre-modern period. The first three papers (Chapters Two, Three, and Four) are devoted to explaining the determinants of Human capital formation in different regions of Latin America, while Chapter Five includes an analysis of human capital formation linked to inequality and wealth.

Chapter Two reviews the human capital formation in *Río de la Plata* region between 1744 and 1860. One of the central questions is whether the ability to count affects Human capital formation in this period. The Chapter is based on primary sources -census and population registers- from Buenos Aires, Montevideo, and surrounding areas from 1744 to 1860. The age heaping technique allowed confirmation that these societies were not extremely unequal regarding numeracy and occupational categories; furthermore, the bulk of the population were employed in low and medium positions in the labor market. The classification into occupational categories by economic sectors allowed to corroborate that the economic structure of these societies was already established in the colonial period and remained so until the modernization.

Chapter Three analyzed the Human capital conditions in three of the leading economies of the Peruvian Viceroyalty: Potosí, La Paz, and Oruro. The aim of this Chapter was to identify if the forced system of labor, called *mita*, affected early Human capital formation. In general terms, the analysis refers to the extremely adverse conditions of the workers in the mining economies. The results showed that the region in the locality of the silver mines was the most affected regarding Human Capital formation. Furthermore, the characteristics of the labor markets under consideration seem to have played a key role in the qualification of Human capital, since those regions with better work conditions were also the highest qualified regarding numeracy.

Chapter Four continues with the debate of human capital formation linked to different kinds of economies in Latin America. In this case, I used an extensive database of marriage registers from nine Latin American countries. The aim was to compare the Human capital performance in different regions of Latin America considering the primary natural resources, the geographical location, the weather, and some institutional and historical characteristics. The Chapter continues with the debate of the institutional causes of Latin American 'economic backwardness' but emphases on human capital formation instead of economic growth. The strongest contribution of this Chapter is the generation of a regional database of many Latin American countries, with local information about Human capital and other relevant variables for the analysis. Among the main findings of the Chapter, is that the formation of Human capital varies widely within countries in Latin America, and the roots of early Human capital were given before the beginning of the 1750s. However, the formation of Human Capital started to be determinant of the current economic growth already in the 1850s.

Chapter Five introduces the debate of wealth inequality in one of the biggest ports of the *Río de la Plata* Viceroyalty: Montevideo. In this case, I analyzed the Gini coefficients of the real income, the number of slaves, and the properties (such as real estate and cattle), between 1760 and 1855. The purpose was to introduce the debate on the origins of inequality in Latin America in a period in which studies are scarce. One of the main findings of the Chapter is that there is a low and middle concentration in the distribution of wealth and income. One of the central questions of this Chapter was motivated by the recent analysis of Piketty (2014) which compares the distribution of wealth of the pre-industrial societies with current inequality. The argument emphasizes that inequality was based on heritage (and the stock of capital). Hence, wealth was not achieved by work or education, but by inheritance or marriage. Regarding this analysis, the findings of Chapter Five of this thesis are that the segment of the population with a low level of wealth was visibly less numerate than the part with a medium wealth level. However, the differences in numeracy between the wealthiest and the medium are not visible

over time. Apparently, primary education was necessary to achieve some level of wealth; however, the social status given by the position in the labor market seems to have a substantial impact on wealth and the early Human capital formation. The life course of the person also had a positive influence on the achievement of wealth.

Finally, Chapter Six concludes this thesis.

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2.HUMAN CAPITAL IN SOUTH LATIN AMERICA: THE RÍO DE LA PLATA REGION BETWEEN 1744 AND 1860

ABSTRACT:

Has the ability to quantify any influence in the formation of Human Capital? The aim of this Chapter is to discuss certain characteristics of the labor market in Latin America, specifically in the *Rio de la Plata* region. The study employed a large data set of census and population registers from Montevideo, Buenos Aires and the surrounding areas from 1744 to1858. Through the age-heaping technique and Armstrong's (1972) occupational taxonomy, I confirm that these societies were relatively equal, holding medium and low positions in the labor market. Furthermore, the classification of the occupational categories in economic sectors confirms that the economic structure of these societies was established in the early colonial period. This Chapter contributes to the study of the educational inequality and the labor force capabilities from colonial times until the agricultural export boom.

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2.1. INTRODUCTION

The economic disadvantage of Latin America lies at the heart of the economic history debate. Part of the literature argues that the economic gap began to emerge in the colonial period. Institutions, natural resources, and geography are among the preferred explanations for this. Concepts such as "colonial heritage" or "path dependence" prevail in the discussion (North et al. 1999, Acemoglu et al. 2001, Acemoglu et. al 2002, Acemoglu and Robinson 2012, Bruhn and Gallego 2012). To examine this issue empirically, a large proportion of the research is devoted to the construction of economic and social indicators with the objective of comparing the performance of Latin America with that of developed countries. In this sense, the development of comparative economic history attempts to explain the lag in Latin American terms of trends (Coatsworth, 1998, Prados de la Escosura 2004, Prados de la Escosura 2005, Dobado 2009, Bértola and Ocampo 2010, Williamson 2010).

The construction of indicators for a pre-statistical period has many difficulties linked to the scarcity, heterogeneity and lack of precision of the sources. In this Chapter, I will approximate to one indicator of Human capital formation (numeracy) to analyze the performance of the labor market in the Río de la Plata region from the colonial period until the agricultural exportation boom.

The formation of Human capital (or lack of it) is one of the main explanations for Latin American disadvantage. Economic growth theories have emphasized the role of Human Capital in nation formation as an essential factor for growth. One of the first drivers of the idea was Mokyr (1983), who analyzed the Human capital characteristics of Irish emigrants in 1840. According to this author, skill, experience, and professional training in trades and crafts were the primary forms of Human Capital (Mokyr 1983).

Growth theory has studied the role of Human Capital in the transition from a Malthusian regime to the modern era of economic growth, finding a positive relationship between population

growth, technical change and living standards (Galor and Weil 2000). Given that the accumulation of Human capital is a crucial factor in long-term economic growth theory, efforts have been made to strengthen the available empirical evidence. O'Rourke and Williamson (1997) were pioneers in this respect, and they concluded that globalization has a significant influence on related development. These authors consider that since schooling data disappeared in the period before, proxies of literacy should be used, such as the ability to sign marriage certificates and legal documents or numeracy (O'Rourke and Williamson 1997).

Numeracy is considered by Crayen and Baten (2008) to be a good indicator of Human capital as the ability to count is probably more important for economic growth than the capacity to sign (Crayen and Baten 2008). Numeracy is linked to technological capabilities and is necessary for trade development in modern economies. Weber, Sombart and Schumpeter regard numeracy as the basis of modern capitalism (Crayen and Baten 2008).

The Western world experienced significant changes in the second half of the 18th century linked to the economic environment and general Human life. Mortality was progressively reduced, life expectancy increased and a significant part of the population became educated (Cervellati and Sunde 2005). In the *Río de la Plata* region the economic conditions changed dramatically towards 1860: there was an expansion in the economy, a great increase in the population and multiplication in inter-oceanic trade. This fact was related to the first economic globalization and an agricultural export boom in these regions. Furthermore, there was considerable diversification in occupational categories with the beginning of urbanization. The aim of the emphasis on the *Rio de la Plata* region is to analyze the economic development of the new settlement economies of Latin America taken into account the different patterns of development and economic growth of this region. Uruguay and Argentina were part of the Rio de la Plata Viceroyalty which was the last and shorter of the Spanish crown. This later colonization is claimed in the literature to be one of the main reasons of the different economic performance of this region. Although the *Rio de la Plata* Viceroyalty was extended over the

Rio de la Plata basin to the current territories of Argentina, Bolivia, Paraguay and Uruguay, the capital was Buenos Aires, and the most active economic centers were the ports of Montevideo and Buenos Aires, especially after the first economic globalization in 1860. In this sense, the contribution of the study of the *Rio de la Plata* region in the pre-modern period contributes to the understanding of the different patterns of economic performance among the Latin American countries, and especially in these new settlement economies. Some of the central questions of this research are: Which were the characteristics of the occupational distribution in the *Rio de la Plata* region? Were the occupations "equally" distributed? Was the Human capital formation linked to the position in the labor market?

Following this introduction, in the remainder of the Chapter, I analyze the Human Capital characteristics of the lower *Río de la Plata* region for the period1744–1858. In section 2, I describe certain features of the background in Latin America and review the main literature. In section 3, I present the data and methodology, describing the data set and analysis of the sources regarding the age-heaping technique and Armstrong's (1972) occupational taxonomy. In sections 4, 5 and 6, I present the main results: section 4 addresses qualification and skill levels; Section 5 illustrates numeracy trends; section 6 concerns the determinants of numeracy. Finally, in section 7, I make final remarks and draw conclusions. All tables and figures are provided in the Appendices.

2.2 BRIEF HISTORY AND MAIN LITERATURE

2.2.1 HUMAN CAPITAL FORMATION IN LATIN AMERICA

As Bértola and Ocampo (2010) have pointed out, education and Human capital are different concepts. *Education* is part of the Human capital development and the acquisition of individual capabilities; *Human capital* is part of the production function and determines the

competitiveness of an economy. In the first case, an educated population is necessary to amplify the capabilities of a society as a whole. The second instance concerns an instrument to generate sustainable economies (Bértola and Ocampo 2010). In this Chapter, I analyze Human capital as part of the performance of the economy by data linked to the labor market; however, I also make reference to education in the broad sense.

Most of the research related to the formation of human capital is devoted to the study of labor markets. Traditional research on Human Capital, labor markets and social structure in Latin America emphases on the idea of an extremely hierarchical society, in which the main ways to climb the social pyramid were through marriage, inheritance and crown concessions. The colonial society model has often been assumed to be corporate or organic, differing from individualistic and competitive societies(Bethell 1990, Hoberman and Socolow 1992).

Bethell (1990) argues that Spanish Colonial America was a society organized in client relationships. Family ties and patronage were mixed with commercial links. The family was a vertical institution joined by three or four generations through marriage or *padrinazgo*. This kind of household could unify different social classes (Hoberman and Socolow, 1992). As a result, the mechanisms for entry into the labor market in these societies were distinct from those for capitalist societies. Salary relations were not as well defined as in capitalism. Family work, many forms of indentured labor and slavery were the primary sources of the workforce.

Part of the literature agrees that the poor level of education in Latin America is the leading cause of the low-skilled nature of Human Capital. According to Rama and Tedesco (1979), the cultural and educational system of Latin America gave symbolic legitimacy to the differentiations contained in the social structure. The high and middle sectors, mainly rural and racially white, controlled the main information channels. Meanwhile, the rest of the population, living under different ethnic and linguistic conditions, was outside the channels in which knowledge was spread (Rama and Tedesco, 1979). Furthermore, some researchers argue that

the form of education brought to America by the Europeans was hardly more than ornamental culture; literacy was unimportant and African slaves were not educated at all (Gomes, 1993).

Recent research has focused on Human capital in the long term in Latin America. Taking into account the large databases of Latin America and developed countries, studies have found that inequality in education was higher in Latin America before the 20thcentury. 20thcentury globalization seems to have had positive effects by reducing educational inequality (Baten and Mumme, 2010). Regarding numeracy, they argue that Latin America was on a path of convergence with Western Europe during the early 18thcentury and there was stagnation of numeracy levels in the 19thcentury. Furthermore, they found that the differences between the countries are increased in this period (Manzel, Baten and Stolz. 2011).

One point of agreement in the literature is the existence of a "colonial legacy" in Latin America, which might have had an influence on later development patterns. The qualification of the human resources is given as one of the fundamental causes of the late development. Among others, the literature has focused on differences in institutions and property rights. Better institutions provide secure property rights, and less distorted policies invest more in physical and human capital to achieve better levels of income (North and Thomas 1973, Jones 1981, North 1981). Although path dependence is a factor common to all Latin American countries, part of the literature distinguishes between countries. All Latin American countries began with a relative abundance of land and resources, however, after the initial depopulation, there was a variation linked to their factor endowments. This fact contributed to substantial differences between them in the distribution of land, wealth and political power, in part caused by their natural resources; the Spanish colonies, such as Mexico or Peru, have been characterized since their early histories by extreme inequality. In these cases, the large native populations and the abundant mineral resources encouraged the elite to promote extractive institutions. The result of this was a high concentration of land and extreme inequality (Engerman and Sokoloff 1994).

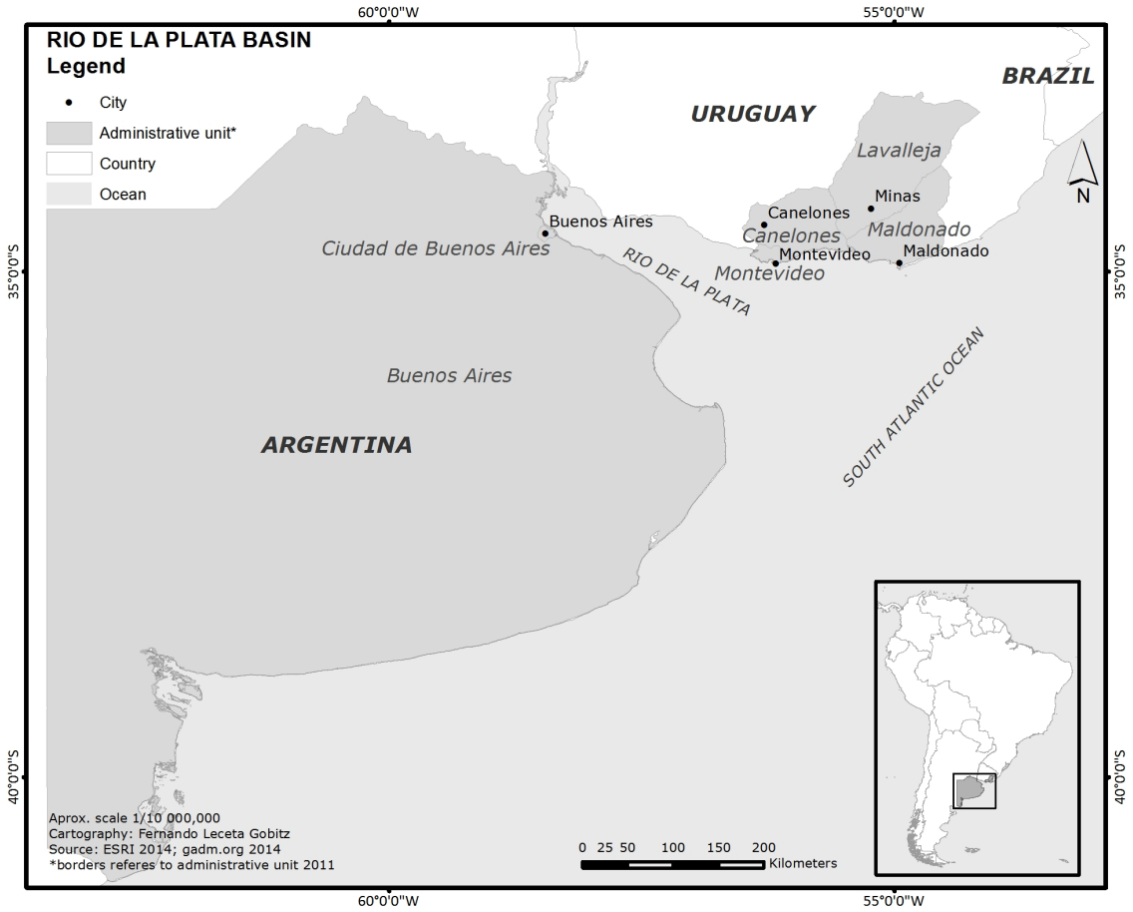
2.2.3 RÍO DE LA PLATA

The formation of Human Capital in *Río de la Plata* has been studied mainly from certain characteristics of the labor market and linked to labor and social inequality. Traditional historiography has described the structural features of society and class integration from a static point of view. This description focuses on the occupational categories inserted into social strata and relations of dependence of the labor market. In most cases, there is an emphasis on the unequal distribution (generally of land) and the material relationships generated by the production system (Reyes Abadie et al. 1966), the inequality from the social classes (Sala de Touron et al. 1967, Sala de Touron 1991) and the characteristics of social production relationships (Sala de Touron and Alonso Eloy 1991). More recent research has focused on income distribution (Bértola 2005, Bértola and Ocampo 2010, Gelman and Santilli 2010), the composition of the labor market (Cuesta 2006) and agrarian production (Garavaglia and Meléndez 1985, Moraes 2012).

The region of the *Litoral Platense* was part of a vast economic region of South America organized in about the 16th Century around the silver production of the Peruvian Viceroyalty. Although in the colonial period the *Litoral Platense* had a relatively marginal position in this macro-economic region, at the end of the 18thcentury the expansion of the economy and population brought this area to the fore. This fact was a fundamental aspect of political processes in the period1810-1830 until the agricultural exportation boom in the last quarter of the 19th century (Moraes 2012).

Regarding the geography of the region, Río de la Plata is the territory in which there is a confluence of the rivers of the Río de la Plata estuary, which then flows into the Atlantic Ocean. According to Moraes (2012), it is possible to identify two sub-regions of the Litoral Platense: in the north, there was a missionary region organized in the 16thcentury around the Jesuit missions of Paraguay; in the south, there was an Atlantic region structured around the ports of Montevideo and Buenos Aires.

FIGURE 2.1 RIO DE LA PLATA BASIN. CURRENT GEOGRAPHICAL DIVISIONS



The colonization of the Río de la Plata region was late in comparison with the rest of Latin America. The land was relatively empty and the civilizations that inhabited this territory were nomadic (except the Jesuit missions in North Uruguay, South Brazil, Paraguay and North Corrientes, Argentina). After colonization, unlike the rest of Latin America, in Montevideo and Buenos Aires, the settlements were primarily represented by white people (the conquerors).

Real de Azúa (1984) pointed out that the colonial establishment of the region was late and weak. He argued that the frontier condition of Uruguayan society has not been emphasized sufficiently by historians. The frontier is an undefined territory in which significant horizontal mobility is usually clandestine or semi-clandestine due to the weakness of institutions, and there are unstable and often contradictory property rights; in the case of Uruguay, all of this exerted a considerable influence on the traditional course of the country. Linked to these factors, this

was an area in which raids and forays took place, perpetrated by the Portuguese, Indian tribes, porters, pirates, etc. Furthermore, the lateness of the land distribution also meant that the settlement system was not at all precise (Real de Azúa 1984).

This late-coming, white European population made a difference in a number of ways in comparison with the histories of other countries in Latin America.[4] In the first place, the confrontation between the conqueror and the native-settler was worst in those cases in which the civilizations were relatively developed. In those cases, the inequalities in terms of Human capital and inequality were more pronounced. The kinds of natural resources present and the institutions generated to exploit them are the key reasons why the Río de la Plata region differed from the rest of Latin America in terms of equality (Engerman and Sokoloff 1994, Bruhn and Gallego, 2012).

2.3. METHODS

2.3.1. DATA

The colonization of the Río de la Plata region was late in comparison with the rest of Latin America. The land was relatively empty and the civilizations that inhabited this territory were nomadic (except the Jesuit missions in North Uruguay, South Brazil, Paraguay and North Corrientes, Argentina). After colonization, unlike the rest of Latin America, in Montevideo and Buenos Aires, the settlements were primarily represented by white people (the conquerors).

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[4] "White" and "European" primarily represents the populations of Montevideo and Buenos Aires. In other parts of the territory the settlement was different.

a considerable influence on the traditional course of the country. Linked to these factors, this was an area in which raids and forays took place, perpetrated by the Portuguese, Indian tribes, porters, pirates, etc. Furthermore, the lateness of the land distribution also meant that the settlement system was not at all precise (Real de Azúa 1984).

Benchmark E focuses on data from Montevideo and many towns and villages nearby in 1836. This census was conducted for electoral reasons (Pollero 2001).Taking into account the city and the rest of the villages and farms, the total number of records for1836 is17,114; that is 74% of the estimated population of the province.[5]

Benchmark F focuses on data from Buenos Aires in 1855, Minas in 1855 and Montevideo in 1858. Minas is a town close to Montevideo devoted mainly to livestock. For this benchmark, I have a sample of the population.[6] This census was conducted as training for the first National Census in 1860 and was probably linked to electoral reasons (Pollero 2001). The population estimate for Montevideo city in 1860 is 22,812 compared with the data in this study which give a figure of 12,393, representing 54% of the estimated population in 1860.The census of Buenos Aires in1855 was ordered in 1853, at the time when Buenos Aires was formally made an official province.[7] The provincial government created by decree the Department of Statistics, designed to develop these kinds of records. Census records have always been useful for governments, especially in periods of civil war regarding the potential participants in the conflict. In addition, census have historically provided governments with the most accurate picture of the population they ruled. The census in 1854 was the first attempt to complete the picture of the population in Buenos Aires and the surrounding countryside (*campaña de Buenos Aires*). Since the record

[5] 1836 was the first census after independence, which is why instead of "jurisdiction" I refer to "provinces".

[6] In the Minas census, one in three homes was selected in the urban areas and one in four in the rural areas. In the case of Montevideo, one in ten homes was selected in the old city and one in three in the new city, always taking into account the total number of homes in both cases. A more detailed explanation is provided in Pollero (2001) "Familia y fecundidad en el Uruguay. La inmigración en la conformación de la familia uruguaya. 1850-1908" Tesis de maestría en estudios migratorios. Facultad de Humanidades y Ciencias de la Educación. Montevideo.

[7] The first National census in Argentina was in 1869.

was highly criticized, in 1855 the head of the Department of Statistics (Juan de Bernabé) ordered a new population census (Massé 2009).The data collected for this Chapter are only a fraction of those collected for public buildings, such as different churches, public jails, hospitals and some migrant communities. Although it is not a census of the whole of Buenos Aires, the regions are well represented: every neighborhood and census tract appears in this sample. The number of records is 2,219, 2.4% of the estimated population. Although it is small compared with an entire census, these data are added to the last benchmark in order to have registers from Buenos Aires for this period.

2.3.2 ABCC INDEX

Quantification depends on numeracy, that is, the ability to count, keep records of counts and make rational calculations. The rise in numeracy can be considered a social process which includes two components. The first, its spread, is the way in which more people become numerate and acquire mathematical capabilities at any given level; hence, more people can perform any given numerical task. The second, its development, is the way in which individuals become numerate at higher levels and are able to engage in more complicated mathematical calculations and representations. Numeracy is also an outcome of the interaction between states and societies over time: as one side becomes more numerate, the other side reciprocates. A higher level of knowledge on the part of one party requires a higher level on the part of the other. For example, tax assessments and population statistics require the existence of numerical categories and the ability to record quantities within these. Once the official information is available, individuals make use of it in everyday life, thus spurring the need for more thorough information gathering (Emigh 2002).

Numeracy is also a significant indicator of the Human capital formation. To approximate this indicator, I applied age-heaping methodology.[8] The idea underlying this is that in pre-modern times, when census takers, army recruitment officers, or prison officials asked an individual his or her exact age, only a certain number of the people were able to answer. Depending on the level of numerical education, many people tended to round their age up or down, for example to 40, when in fact, they were 39 or 41 (Manzel et al. 2008). The approximation in age manifests itself in the "heaping" phenomenon. Individuals tended to choose an "attractive" number such as those ending in 5 or0 (A'Hearn et al. 2009).

The quality of age reporting can be measured by means of age-heaping indices to detect the degree of preference for or avoidance of certain ages. Among standard indices (Bachi1951, Myers 1976, Zelnik 1961)[9]the Whipple index is that most widely applied.[10] The original Whipple index is obtained by summing the number of people in the age range 23–62 (inclusive) and calculating the ratio of reported ages ending in 0 or 5 to one-fifth of the total sample. As pointed out above (c.f. 3.1), the index assumes a linear distribution of ages in each range of five years, i.e. a continuous and linear decrease in the number of persons of each age within the age range considered. Low ages (0–23 years) and high ages (72 years and above), for which the linearity assumption is not plausible, are excluded from the calculation (Spoorenberg and Dutreuilh 2007). Thus:

$$(1) \qquad Wh = \left(\frac{\left(Age25 + Age30 + Age35 + \ldots Age60\right)}{1/5 \times Age23 + Age24 + Age25 + \ldots + Age62} \right) \times 100$$

[8] For more detailed surveys on the age-heaping methodology, see A'Hearn et al. (2009).
[9] The methods used to calculate these indices are in Shyrock and Siegel (1976: 115–119).
[10]A'Hearn et al. (2009) argue that this is the only index that fulfills the desired properties of scale independence (a linear response to the degree of heaping) and that it offers a reliable ranking of samples among which the degree of heaping varies.

For easier interpretation, A'Hearn et al. (2009) suggested another index: the ABCC index.[11]This is a simple linear transformation of the Whipple index and yields an estimate of the share of individuals who correctly report their age:

$$(2)\quad ABCC = \left(1 - \frac{(Wh - 100)}{400}\right) \times 100 \text{ if } Wh \geq 100 \text{; else } ABCC = 100$$

The index takes the values between 0 and 1. A value of 0 means total age-heaping whereas a value of 1 means no heaping at all. To visualize the evolution of the ABCC index by birth decades, I calculated the birth decade of each age group, taking into account the median age of the age group. For example, in the age group 23–32, I calculate the birth decade of those who are 27 years old. The figures of the ABCC index using Armstrong (1972)'s taxonomy are presented by birth decade and by half-birth decade and not by the year of the census.

An advantage of the age-heaping methodology is that age is more available than other Human capital proxies, such as the ability to write a signature or school attendance. In general, all population records have the age as one of the main information. As Reis (2008) points out, age-heaping is a very basic measure of human capital. It is especially useful in the study of Human capital development in Latin America during the 17th and 18th centuries, when more advanced Human capital indicators were quite scarce and also in terms of offering insights into a broad spectrum of a given population rather than a limited one, i.e. that of the socioeconomic elite (Reis 2008).

Through the age-heaping technique, I approximate the Human capital formation of the individuals classified in different occupations. Age-heaping provides an approximation of the Human capital formation of the labor market.

[11] The name results from the initials of the authors' last names plus Greg Clark's, who suggested this in a comment on their paper. Whipple indices below 100 are normally caused by random variation of birth rates in the 20th century rich countries. They do not carry important information; hence they are normally set to 100 in the ABCC index.

2.3.3 ARMSTRONG'S (1972) OCCUPATIONAL TAXONOMY

Armstrong's (1972) occupational taxonomy was primarily based on two factors: industrial groups (to trace the economic contours of society) and social ranking; in this Chapter, I analyze social ranking linked to Human capital. The taxonomy of social ranking was initially created to analyze a social the class scale in England at the beginning of the Industrial Revolution. The society which existed in Western Europe before the Industrial Revolution was hierarchical. Pre-industrial society is viewed as a kind of pyramid, with the monarchy at the apex, then the peerage, the gentry, farmers, laborers and finally paupers (Armstrong 1972). The ranking was based on the occupations declared in the population records as this was the data available in early registers. The taxonomy consists of five groups ranked from unskilled to professional. The following table presents the principal occupations according to these patterns.

TABLE 2.1. ARMSTRONG'S OCCUPATIONAL TAXONOMY

1. Unskilled	Manual workers who usually do heavy unskilled work. Pawns (rural areas), labourers (urban areas).
2. Semi-skilled	Workers who have acquired some level of skill through formal training or experience, e.g. tradesmen's assistants, painters, etc.
3. Skilled	All qualified trades-people, usually after an apprenticeship or other formal training, and also "modern" tasks, such as drivers. Farmers, big owners –*estancieros* –(rural areas), small traders (urban areas);offices (carpenters, shoemakers).
4. Non-manual intermediate or semi-professional	Lower-level "white collar" (non-manual) workers, such as clerks, technicians, nurses, etc.; skilled workers in managerial positions or technicians. Council and crown employees, large-scale traders and merchants.
5. Professionals	Those who possess upper secondary, college or university qualifications, or substantial training and superior status.

Source: Armstrong (1972)

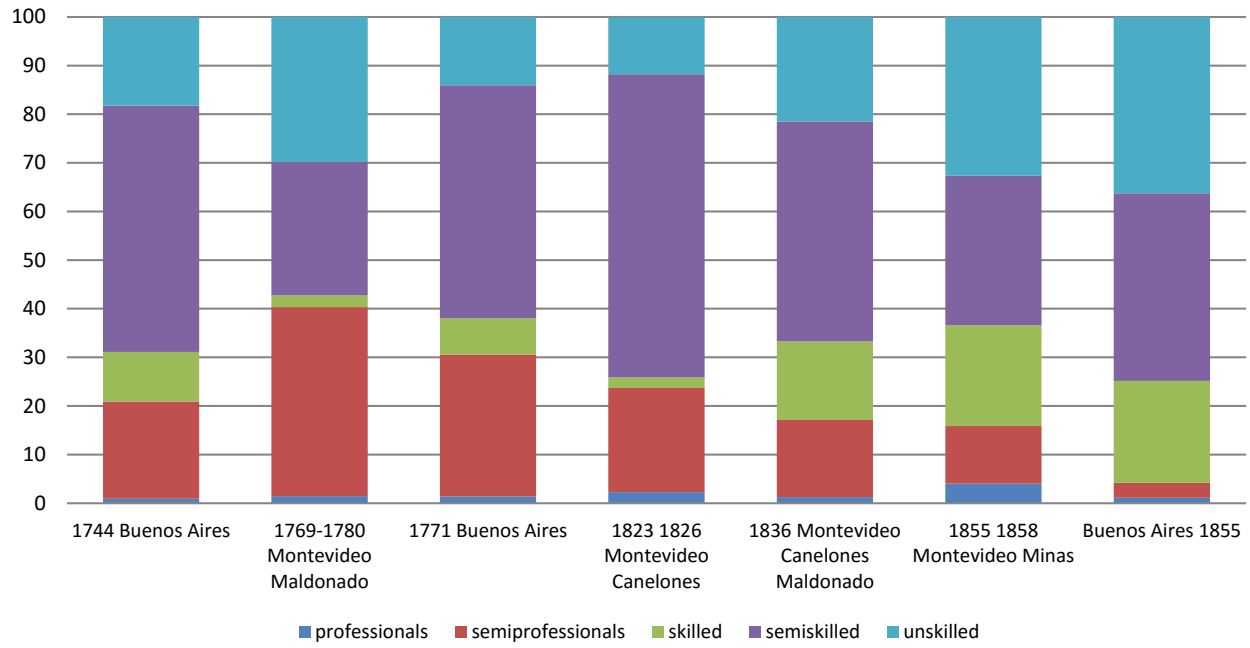
Through this taxonomy, it is possible to analyze the skills of the labor force. By combining the two methodologies (age-heaping and the taxonomy), it is feasible to analyze the level of numeracy (mathematical skills) within the skills groups.

To reinforce the analysis, I include some regression models. The objective of applying these models is not to analyze all the determinants of Human capital, but rather to approximate the significance of the variables and the relations among them.

2.4 LABOR FORCE QUALIFICATIONS IN THE RÍO DE LA PLATA REGION

Figure 2.2 displays the distribution of the skills in the labor market for the whole period. In general terms, the figure suggests the same pattern: a strong presence of semi-skilled and semi-professional laborers (workers linked to the public administration and church, and small farmers), a very low proportion of professionals (doctors, lawyers) and the rest comprising the unskilled (laborers, pawns, seasonal workers).The manual jobs represented by the artisans, tailors and shoemakers are underrepresented in this sample. The differences in each period represent the characteristics of the census and not the real evolution of skills. However, the figure suggests several aspects that have already been discussed in the literature.

FIGURE 2.2. SHARE OF EACH OCCUPATIONAL GROUP AS A % OF TOTAL INDIVIDUALS IN THE SAMPLE LOWER RIO DE LA PLATA. 1744-1858 (%)



Sources: Buenos Aires 1744 Censo Militar. Documentos para la Historia Argentina. Montevideo 1769 Apolant, Ob. Cit, Buenos Aires 1771 Ravignani 1955. Maldonado 1780 AGN BA IX 20-4-3, Montevideo 1823 AGN 464, Canelones 1826 AGN 279, Censo de Montevideo 1836 AGN 146, Extramuros de Montevideo AGN 148, Extramuros de Montevideo AGN 465, Partido de Manga 1836 AGN 148, Padrón de Santa Lucía 1836 AGN 279, Padrón de las Piedras AGN 279, Padrón de Pando 1836 AGN 279, Padrón de Maldonado 1836 AGN 283, Padrón de Minas 1855 AGN 287, Padrón de Minas 1855 (urbano) AGN 287, Padrón de Montevideo 1858 AGN-AGA 267. Buenos Aires 1855.
* In this figure the slaves are not counted into the skill level for two reasons: in the first place the task of the slave is not declared, the slave is registered only as "slave"; in the second place there is a sub registration of the slaves in all the registers.

In the first place, it is a society, in which most of the people had basic skills, representing relatively equal medium-low qualifications. Since this is a society in expansion, it is expected to have occupations linked to the public organization. There was a rise in the "unskilled" category in the last two censuses, reaching almost 40%. That does not mean a structural change in the composition of skills, but it gives an idea of the increments in migration as pointed to by the literature (e.g. Reyes Abadie and Bruschera, Melogno1985; Sala de Touron and Alonso 1991; Sala de Touron and de la Torre and Rodríguez 1967).

In the second place, the small proportion of professionals shows the difficulty in achieving higher levels of education. Activities linked to professionals are mostly those connected to the

law (lawyer, notary), health (doctors) and education (school teachers), but they comprise scarcely 2% of the occupations. These activities are concentrated mostly in urban areas.

In the third place, there is a considerable difference in the registers in which a greater proportion of the urban population is counted (Montevideo and Maldonado 1769, Montevideo and Minas 1855/1858 and Buenos Aires 1855). In those registers, there is an overrepresentation of unskilled workers. Those workers are predominantly registered as "laborers" or just "workers." It is likely that this part of the labor force had no qualifications and was concentrated in the villages or cities where the economic opportunities would be higher.

In sum, the occupational structure according to Armstrong's (1972) taxonomy confirms that this society was not extremely differentiated regarding qualifications, but that the skill levels were low. In general terms, most of the work force had some ability which allowed these communities to develop small activities linked to trades in leather, wood, cattle and agriculture. Unskilled workers rarely exceeded 30% in the first censuses and reached the 40% in the last periods. Taking into account the imprecision of the declaration of occupation by the omission of some skills or the record as just "labourer", the small proportion of the "unskilled" category contributes to reinforcing an image of the labour market in which qualification was at the medium level, with a high proportion of semi-skilled workers and "white collar" workers.

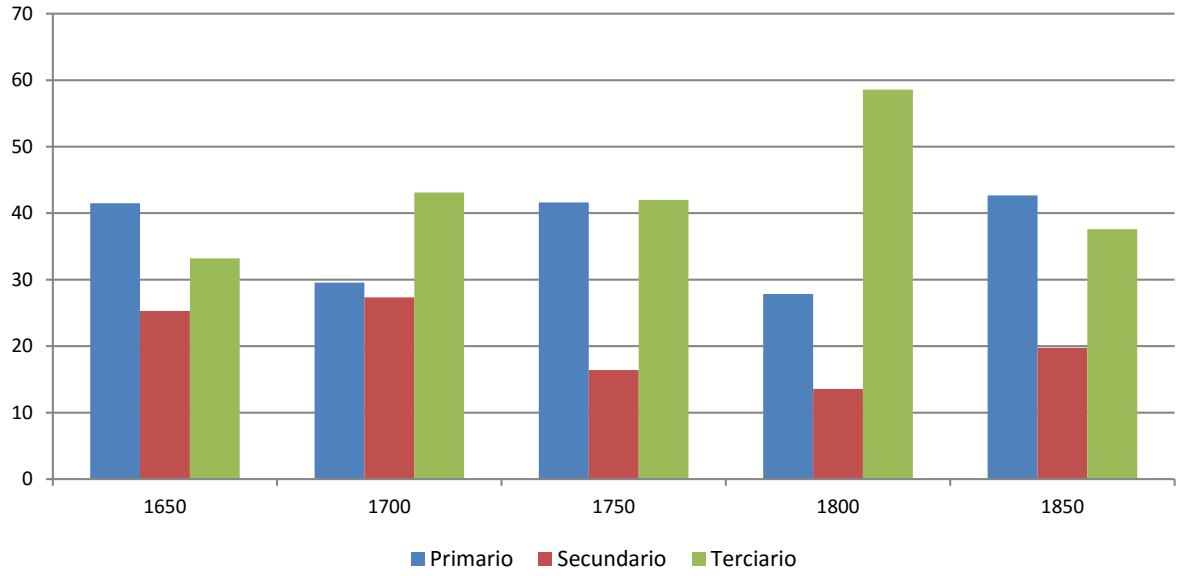
This society was abundant in natural resources and promoted full employment and the development of diverse activities. Was clearly an open and frontier society. Far from being segmented into a bulk of unskilled laborers and a few qualified people, this labor market was rather homogeneous, mainly in the low and medium levels of qualification. From the previous discussion, it can be assumed that the educational and social borders are not entirely defined.

As a complementary measure, I classified occupations into economic sectors based on Cuesta (2006b). The analysis of economic structure is an important complement to qualification ranking and gives a complete idea of the composition of the labor market. Figure 2.3 displays

the information concerning the proportion of the population in each economic sector by birth decade.

The primary sector is essentially composed of agrarian activities (farmers and livestock, amongst others); the secondary sector is linked to manufactured goods (shoemakers, textiles and occupations linked to leather); the tertiary sector is linked to services, administration and education, amongst others.[12]

FIGURE 2.3 ECONOMIC SECTORS BY BIRTH DECADE. 1650-1850



Sources: Buenos Aires 1744 Censo Militar. Documentos para la Historia Argentina. Montevideo 1769 Apolant, Ob. Cit, Buenos Aires 1771 Ravignani 1955. Maldonado 1780 AGN BA IX 20-4-3, Montevideo 1823 AGN 464, Canelones 1826 AGN 279, Censo de Montevideo 1836 AGN 146, Extramuros de Montevideo AGN 148, Extramuros de Montevideo AGN 465, Partido de Manga 1836 AGN 148, Padrón de Santa Lucía 1836 AGN 279, Padrón de las Piedras AGN 279, Padrón de Pando 1836 AGN 279, Padrón de Maldonado 1836 AGN 283, Padrón de Minas 1855 AGN 287, Padrón de Minas 1855 (urbano) AGN 287, Padrón de Montevideo 1858 AGN-AGA 267. Buenos Aires 1855.
*This figure is presented in half-decades according to the year of birth.

In general terms, in all the periods, there is a prevalence of the primary and tertiary sectors. As pointed out above, this figure does not display the evolution of the economic structure for the

[12] A detailed explanation of this taxonomy is provided in Cuesta (2006b), "Evolución de la población y estructura social de Buenos Aires 1700-1810", Papeles de Población, vol. 12 N°49, Universidad Autónoma de México.

whole period, but rather indicates the importance of these two sectors in all the censuses. Although this figure does not approximate changes in the economic sectors over time, it is possible to expect that the economic structure of this society remained consistent within particular periods of time. As Cuesta (2006b) points out for the case of Buenos Aires, the composition of the economic sectors in any given period does not result in significant changes in the census analyzed. The primary and tertiary sectors have the leadership in all the periods analyzed. Hence, it could be argued that the basis for the occupational structure was already established in colonial times.

2.5 NUMERACY TRENDS

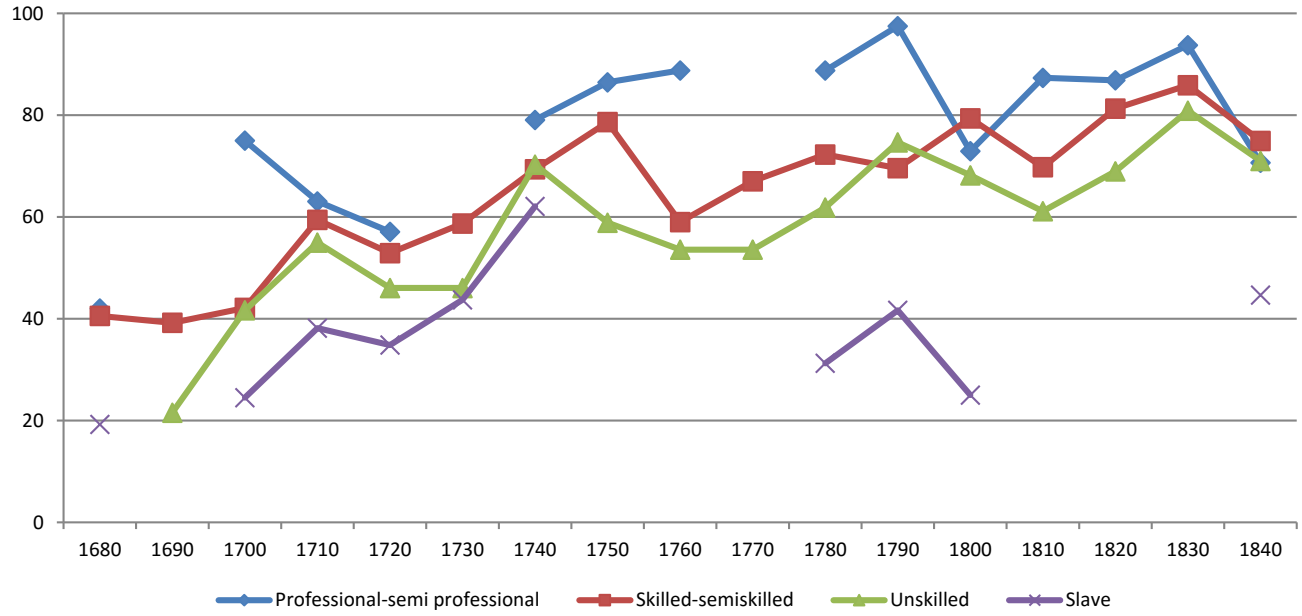
In this section, I combine the age-heaping technique with Armstrong's (1972) occupational taxonomy to analyze the formation of Human capital at each level of qualification. I compare the ABCC index with the workers' skill level. Depending on the amount of data available, I constructed groups within taxonomy to visualize the different levels of qualification.

First, I analyze the data concerning the ABCC index and Armstrong's (1972) taxonomy by birth decade; second, I focus the discussion on the evolution of the ABCC index in time; finally, I run some regression models to estimate possible determinants of the Human capital formation. In the first part, I aim to highlight the relation between the ABCC index and the labor force qualification; the point here is to analyze the formation of Human capital at each skill level. In the second part, I analyze the evolution of the index over time; one of the aims here is to visualize whether the mathematical capabilities changed over time. Finally, with the logistic regression model, the goal is to analyze potential determinants of numeracy.

The results of the numeracy trends are displayed in Figures 2.4 to 2.6. Figure 2.4 presents the numeracy trends by skill. The categories "professional/semi-professional" and "skilled/semi-skilled" are in one category to improve the pattern. Although "slaves" are not part of the

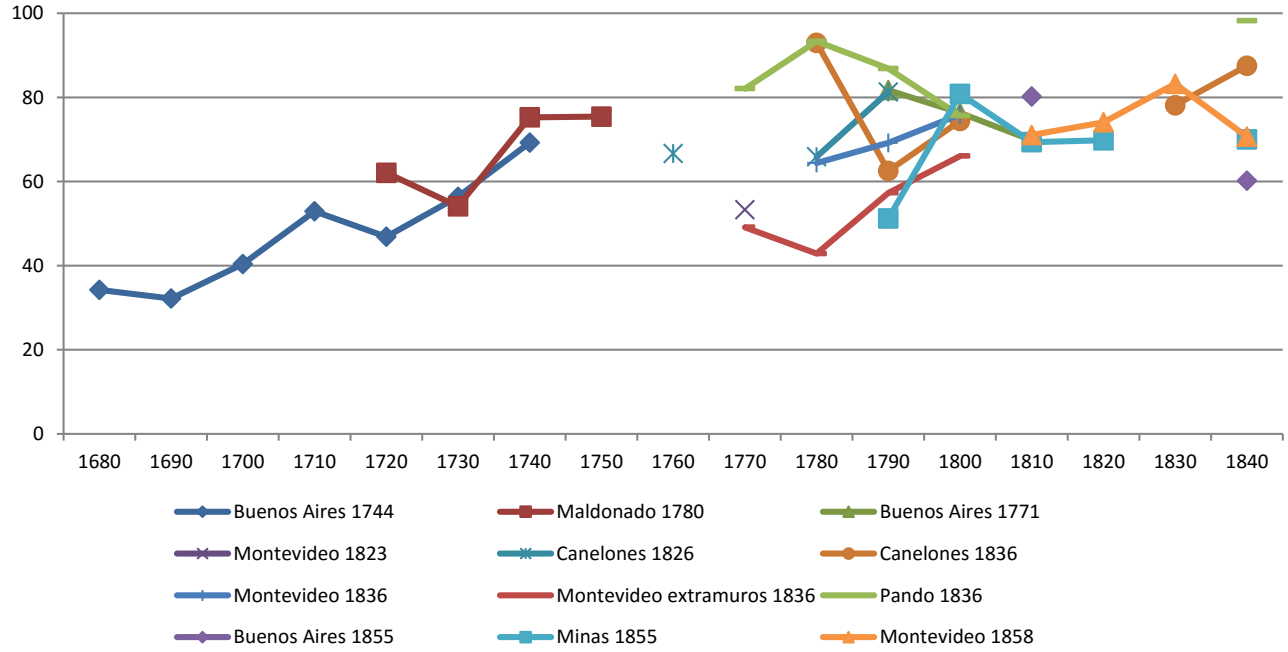
Armstrong ranking, I incorporated this separate category to compare the ABCC levels. The main difficulty with the slaves is that they were registered only as "slaves" and it is not possible to know what kinds of activity they carried out. However, as they were a significant group in the labor market, I decided to integrate them.

FIGURE 2.4. ABCC PER SKILL. 1680-1840



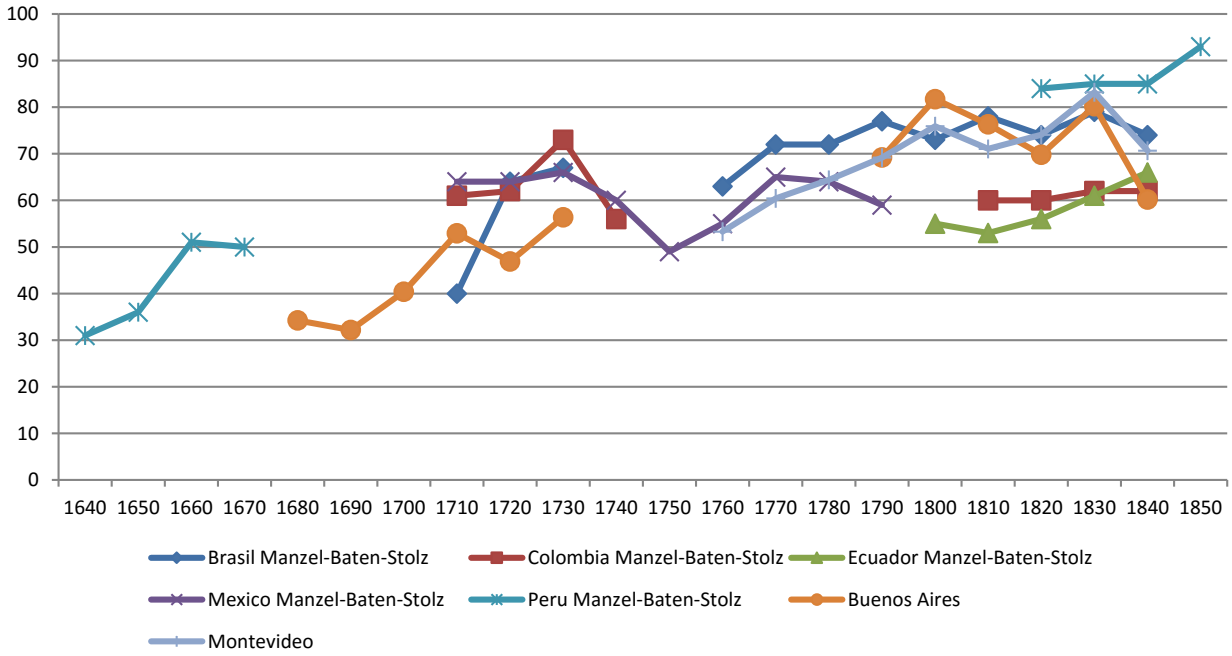
Sources: Buenos Aires 1744 Censo Militar. Documentos para la Historia Argentina. Montevideo 1769 Apolant, Ob. Cit, Buenos Aires 1771 Ravignani 1955. Maldonado 1780 AGN BA IX 20-4-3, Montevideo 1823 AGN 464, Canelones 1826 AGN 279, Censo de Montevideo 1836 AGN 146, Extramuros de Montevideo AGN 148, Extramuros de Montevideo AGN 465, Partido de Manga 1836 AGN 148, Padrón de Santa Lucía 1836 AGN 279, Padrón de las Piedras AGN 279, Padrón de Pando 1836 AGN 279, Padrón de Maldonado 1836 AGN 283, Padrón de Minas 1855 AGN 287, Padrón de Minas 1855 (urbano) AGN 287, Padrón de Montevideo 1858 AGN-AGA 267. Buenos Aires 1855.

FIGURE 2.5. ABCC REGION. 1680-1840



Sources: Buenos Aires 1744 Censo Militar. Documentos para la Historia Argentina. Montevideo 1769 Apolant, Ob. Cit, Buenos Aires 1771 Ravignani 1955. Maldonado 1780 AGN BA IX 20-4-3, Montevideo 1823 AGN 464, Canelones 1826 AGN 279, Censo de Montevideo 1836 AGN 146, Extramuros de Montevideo AGN 148, Extramuros de Montevideo AGN 465, Partido de Manga 1836 AGN 148, Padrón de Santa Lucía 1836 AGN 279, Padrón de las Piedras AGN 279, Padrón de Pando 1836 AGN 279, Padrón de Maldonado 1836 AGN 283, Padrón de Minas 1855 AGN 287, Padrón de Minas 1855 (urbano) AGN 287, Padrón de Montevideo 1858 AGN-AGA 267. Buenos Aires 1855.
* This figure is presented by birth decades.

FIGURE 2.6 ABCC COMPARED. 1640-1850



Sources: Brasil, Ecuador, Perú, Colombia, México: Manzel, Baten and Stolz (2012). Montevideo 1769: Apolant (1965), Montevideo 1823 AGN 464, Censo de Montevideo 1836 AGN 146, Extramuros de Montevideo AGN 148, Extramuros de Montevideo AGN 465, Padrón de Montevideo 1858 AGN-AGA 267.
Buenos Aires: Buenos Aires 1744 Censo Militar. Ravignani, Documentos para la Historia Argentina, Buenos Aires 1771 Ravignani 1955, Censo del estado de Buenos Aires de 1855.

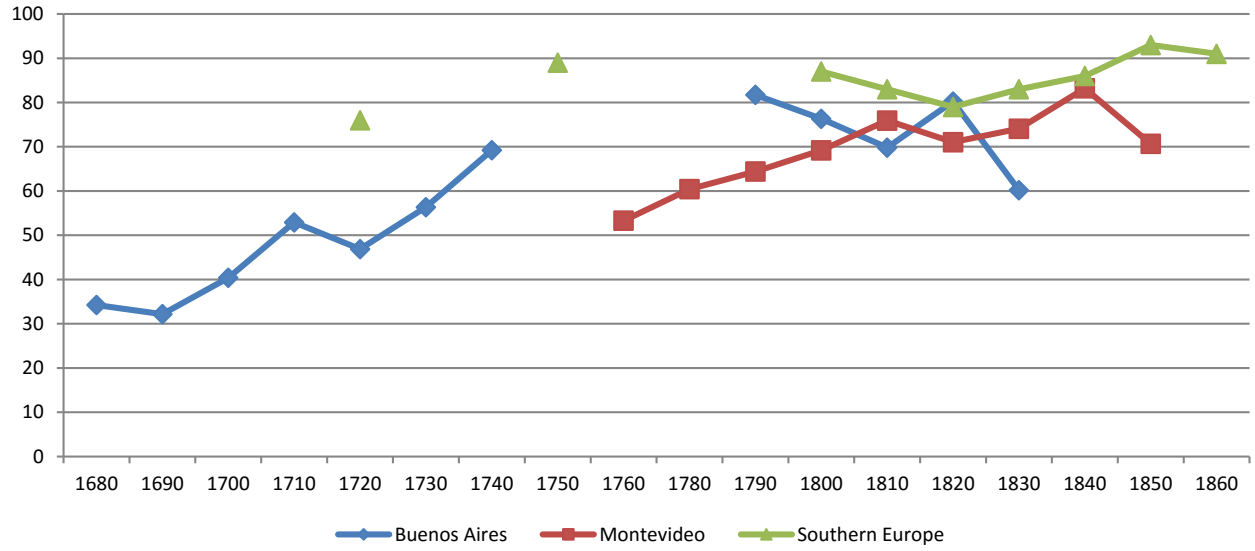
From these figures, it is possible to determine two key facts: first, in all the years and periods analyzed, the unskilled workers have the lowest ABCC level (between 40% and 50%). As expected, those who are in the lowest and most precarious positions in the labor market are the least educated regarding numeracy. The ABCC level of the slaves is between 20% and 40% (the lowest, as expected). The workers in the higher positions of the labor market have higher numeracy levels (between 70% and 90%); consequently, they probably had the possibility of attaining higher salaries. The categories "skilled/semi-skilled" have significant high numeracy levels for the period. These findings may seem obvious, but demonstrate that the idea that basic numerical education was important in achieving a better position in the labor market is robust. Second, the index tends to improve over time, and this fact is not linked to the qualification. As expected, mathematical capabilities become more necessary over time. The end of the period

shows the gap between the categories. Figure 2.5 displays the numeracy trends all the censuses analyzed. In this figure, the difference between the regions is not significant except "*Montevideo extramuros*" that has the lowest ABCC level in the second half of the period. As previously, there is an increasing trend. At the beginning of the period, the ABCC index is around 40% and 60% and at the end of the period reaches 90% and 100%.In the last part of the period, all the regions tend to converge.

Figure 2.6 displays the numeracy trends for Montevideo and Buenos Aires in comparison with data from Brazil, Peru, Mexico, Ecuador and Colombia. As for Figure 4, Figure 5 shows an incremental increase in the numeracy levels in all regions. At the end of the period, there is a lag for Ecuador and Colombia, but the rest converge regarding ABCC levels (between 70% and 90%). This fact means that independently on the qualification, the ABCC index tends to improve over time. Apparently, education in numeracy became more significant in the last decades of the period. Even though I cannot confirm that these were societies in which education was highly prevalent (compulsory primary education came later), it seems that to get a position in the labor market the worker needed at least basic numerical education.

Figure 2.7 displays the numeracy levels for Montevideo, Buenos Aires and Southern Europe. The trends for Buenos Aires and Montevideo start to increase around 1800; Southern Europe already had high ABCC values during this period in comparison to the Río de la Plata region. Hence, it is possible to confirm that Southern Europe reached higher levels of numeracy in early times while Montevideo and Buenos Aires started to converge after gaining independence from Spain. However, the ABCC levels for Río de la Plata are lower than those for Europe over the whole period.

FIGURE 2.7. ABCC BUENOS AIRES, MONTEVIDEO, SOUTHERN EUROPE. 1680-1860



Sources: South Europe: Stolz, Baten and Reis (2009), Tollnek and Baten (2011).
Montevideo 1769: Apolant (1965), Montevideo 1823 AGN 464, Censo de Montevideo 1836 AGN 146, Extramuros de Montevideo AGN 148, Extramuros de Montevideo AGN 465, Padrón de Montevideo 1858 AGN-AGA 267. Buenos Aires: Buenos Aires 1744 Censo Militar. Ravignani, Documentos para la Historia Argentina, Buenos Aires 1771 Ravignani 1955, Censo del estado de Buenos Aires de 1855.

*Southern Europe in 1630 (1680) refers to the average value of Spain and Portugal in the period 1600-49 (1650-99), see Juif and Baten (2013).

2.6 DETERMINANTS OF NUMERACY

Tables 2.4 to 2.6 (Appendix 4) identify the possible determinants of the formation of Human Capital in the Río de la Plata region. As pointed out above (cf. Section 3.1), due to the limited availability of data, it is not possible here to run a complete model of human capital determinants; however, I identify some potential variables that could explain in part the numeracy levels of the population. These variables are as follows:

1. Qualification: I created dummy variables using Armstrong (1972)'s occupational taxonomy to analyze whether these categories are determinants of the Human capital formation.
2. Age group: I included the age groups created for the age-heaping estimates. I used only the 23–32 years cohort because those in their twenties tended to display a different age-heaping pattern, similar to that of older persons, in that they have the tendence to heap

in multiples of five, but also they concentrated ages in multiples of two. Thus, is expected a positive bias in the group aged 33–72 years.

3. Farmer/Merchant/slave: I created dummy variables for those occupations that are over-represented in all the registers. I selected one linked to the urban areas (merchant) and another to the countryside (farmer). I included the slaves and expected them to have a negative coefficient.
4. Economic sector: I included the economic sectors as dummy variables.
5. Manual/intellectual: I created two dummy categories for the manual workers and the intellectual workers based on the economic sectors.
6. Census years: I included the census years because the differences between them introduce biases in the data set.

The results of the regressions are reported in Tables 2.4–2.6. Table 2.4 displays the marginal effects of a logistic regression in which the dependent variable is 1 if the individual reported an age that was not a multiple of five and 0 otherwise. I run a logistic regression because the dependent variable is binary.

The marginal effects were multiplied by 125, so that they could be interpreted as percentage changes in numeracy, taking into account the fact that 20% of ages would correctly end in 0 or 5.[13] The first two models include all the data from the registers and the last includes only the merchants, ranchers, farmers and slaves.

As expected, all Armstrong's (1972) categories are positive in relation to the unskilled workers. This fact means, for example, that the semi-professional workers were 14% more numerate than the unskilled workers. The semi-skilled workers also have a positive coefficient but lower (6%). I expected that the age cohort 23–32 would be more numerate than the rest of the groups. The

[13]A detailed explanation of this is provided in Crayen and Baten (2009) "Global trends in numeracy 1820-1949 and its implications for long term growth, Explorations in Economic History. http://www.journals.elsevier.com/explorations-in-economic-history

results of the regressions confirm that, for example, the cohort aged 53–62 is 19% less numerate than the group aged 23–32. As was pointed in the numeracy trends, mathematical abilities seem to improve with time. When the data set limits to ranchers, merchants, farmers and the slave population, the coefficient of the 53–62 cohort is even higher (almost 22%).

Column 3 (Table 2.4) displays the result of the logistic regression with the population restricted as previously described. The reference categories, in this case, are ranchers and the 23–32 age group. As expected, the slaves are almost 30% less numerate than the ranchers. The categories of merchants and farmers are also negative but not significantly so.

Table 2.5 displays the marginal effects of a logistic regression linked to the main economic sectors. The reference categories, in this case, are the primary sector (related to basic productivity activities) and the 23–32 age group. I had no previous hypothesis concerning the behavior of coefficients in this case because the variable economic sectors include the population in manner different from qualification ranking. However, as already pointed out, the analysis of the economic sectors is complementary to previous studies. In the first column are the economic sectors; in the second column I also include the age groups.

The tertiary sector seems to have almost 10% more numeracy than the primary sector. When I include the age groups this coefficient remains significant. The tertiary sector contains all the workers linked to professional activities and public positions, thus explaining the higher numeracy levels. The secondary sector is more numerate than the first but with a lower coefficient (5%). As in Table 2.4, in this regression, the age group 23–32 seem to have better numeracy.

Table 2.6 displays the marginal effects of the logistic regression linked to the kind of job, i.e. manual and intellectual. In this table, I included data from the census and year. As expected, intellectual positions demonstrate approximately 10% higher numeracy than manual; however, my previous hypothesis concerning this coefficient was even higher. About the census, I established as a control category the census of Buenos Aires in 1771 as it has high

geographical and occupational coverage. As I expected, the last census for Montevideo and Buenos Aires (1858) and Minas (1855) showed higher numeracy levels (around 19%). This fact confirms the statement that numeracy improves with time.

2.7 CONCLUSIONS

I have studied the formation of Human capital for the Río de la Plata region, taking into account the qualification of the workers and the distribution of the economic sectors. I approximated Human capital through the mathematical capabilities given by the declaration of age. Through the data analysis, I have arrived at the following key findings:

1. This society was relatively homogeneous regarding labor force qualifications: few workers had no skills at all. However, the occupational distribution showed greater representation in the lower and medium skill positions. Although the majority of the labor force had a skill, i.e. they were trained in traditional handmade work (linked to leather) or in land management (farmers, ranchers, etc.), the jobs related to more high educational achievement were restricted to a small part of the population. This fact means that although there were no significant inequalities regarding the occupational category in this society, the less-qualified positions predominated. At the same time, this structure remained constant over the whole period, although at the end there was a diversification of the occupations. This society was and open and frontier civilization in which the labor force was scarce and the land was abundant. The opportunity to participate in the labor market was almost equal for the major part of the active population.
2. The distribution of the economic sectors shows that the primary and tertiary sectors were those most represented in all the periods analyzed. Although it is not possible to examine the evolution of economic areas in a period, the high presence of the primary

and tertiary sectors suggests that the occupational basis of these societies derived from early colonial times. This conclusion is in accord with Cuesta (2006a) findings concerning Buenos Aires.

3. The ABCC index shows that the workers classified in the lowest and most precarious positions in the labor market were the least educated regarding numeracy. The workers in higher positions had higher numeracy levels. In the same line, the slaves had the lowest numeracy levels even compared with the unskilled workers. This fact means that mathematical capabilities seem to explain –at least partially– the position achieved in the labor market.

4. The numeracy show a growing trend for the whole period. This fact means that the people registered in censuses close to 1860 declared their age more accurately than those recorded in 1744. Independently of occupational category and qualifications, the tendency to heap ages became lower over time. This trend can be interpreted taking into account the differences between society in 1744 and close to 1860: in 1744, the mechanisms for attaining the highest positions in the labor market were not linked to numeracy to any significant extent, whereas by 1860, numerical education mattered. There is no doubt that numeracy and literacy levels are crucial for professional development, but the capabilities required to attain better positions in the labor market were not the same for the whole period. Apparently, mathematical education and Human capital training became more relevant over time. Meanwhile, in 1744, education and literacy were a privilege for a few people; at the end of this period, these were extended to a larger part of the population. The reasons are probably the recognition that education is crucial to obtain higher developmental levels in a particular activity. Furthermore, the increase of the mathematical capabilities of the population around the 1860s is related to the insertion of the *Río de la Plata* economy to the international market through the exportation of meat and derivatives. This fact forced to adopt and

promote the metric system and to know how to operate with currency. This fact also coincides with the expansion of the population, which is reflected in increasing urbanization, services and general commercial activities. During this period, the *Río de la Plata* region was a central territory in one of the areas with the highest population growth in Latin America. This was accentuated in the 1860s with economic modernization.

5. Remarkable are the differences between the numeracy trends of Montevideo and Buenos Aires and other countries of Latin America (especially Ecuador and Colombia). This fact may explain the current differences in the economic path of the Latin American countries since the roots of the Human capital formation were given before the colonization.

6. Even though it is not possible to confirm that these societies were equal regarding Human capital formation, some facts might explain the relative advantage of Río de la Plata in terms of equity and development in comparison with other countries of Latin America: the relative homogeneity of the formation of Human capital, the relatively small size of the population and the way in which the institutions were implemented (as pointed out by the literature); together, these factors did not allow the powerful consolidation of major social differences as in another Latin American societies.

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2.9 . APPENDIX

DATA DESCRIPTION

TABLE 2.2. SOURCES

Year	Book	Region	Original data	Total registers (individuals recorded)
174	Militarycensus. Documentos para la Historia Argentina. Vol 10	Buenos Aires	Age, birthplace, occupation, race	3.190
176	Edited by Apolant 1967	Montevideo	Geographical location, name, marital status, ethnicity, age, occupation, animals	2.528
177	EditedbyRavignani 1955	Buenos Aires	Age, occupation marital status, race	24.638
178	AGN BA IX 20-4-3	Maldonado	Name, age, occupation	3.223
182	AGN 464	Montevideo	Name, age, marital status, birthplace, race, class, occupation	2.156
182	AGN 279	Canelones	Geographical identification, name, age, marital status, birthplace, race, occupation	2.205
183	AGN 146	Montevideo	Geographical identification, name, age, birthplace, marital status, occupation, children, dependents, slaves, colons, servants, aggregates.	5.690
183	AGN 148	Montevideo	Geographical identification, name, age, birthplace, marital status, occupation, children, dependents, slaves, colons, servants, aggregates.	2.870
183	AGN 465	Montevideo (extra muros)	Name, age, birthplace, marital status, occupation, children, dependents, slaves, colons, servants, aggregates.	1.971

183	AGN 148	Montevideo (extra muros)	Name, age, birthplace, marital status, occupation, race	523
183	AGN 279	Canelones (Santa Lucía)	Name, age, birthplace, marital status, occupation, race.	585
183	AGN 279	Canelones Las Piedras	Geographical identification, name, age, birthplace, marital status, occupation, observations	1.225
183	AGN 279	Canelones Pando	Name, age, birthplace, marital status, occupation, class	3.126
183	AGN 283	Maldonado	Location, name, age, birthplace, class, marital status, occupation.	1.124
1855	AGN 287	Minas (rural)	Geographical identification, individual number, name, color, age, birthplace, marital status, occupation, health status	1.185
1855	AGN 287	Minas (urban)	Geographical identification, individual number, name, color, age, birthplace, marital status, occupation, health status	632
1858	AGN 288	Montevideo	Geographical location, name, age, birthplace, occupation.	1.730
1858		Buenos Aires	Geographical location, name, age, occupation	2.219
Total				**60.820**

TABLE 2.3. ABCC PER SKILL

Census year	Armstrong	ABCC	N
1744	Professional	53	118
1744	Semiprofessional	76	301
1744	Semi-skilled	50	356
1744	Skilled	43	632
1744	Slave	27	177
1744	Unskilled	39	191
1771	Professional	46	825
1771	Semiprofessional	66	346
1771	Semi-skilled	57	1458
1771	Skilled	57	901
1771	Slave	46	3909
1771	Unskilled	59	347
1780	Professional	92	233
1780	Semiprofessional	79	214
1780	Semi-skilled	82	347
1780	Skilled	64	905
1780	Unskilled	51	452
1823	Professional	78	598
1823	Semiprofessional	73	522
1823	Semi-skilled	61	859
1823	Skilled	56	463
1823	Unskilled	53	264
1826	Semiprofessional	67	498
1826	Semi-skilled	73	30
1826	Skilled	81	398
1826	Unskilled	72	678
1836	Semiprofessional	72	151
1836	Semi-skilled	79	113
1836	Skilled	78	1268
1836	Slave	20	151
1836	Unskilled	66	274
1855	Professional	110	183
1855	Semiprofessional	89	182
1855	Semi-skilled	73	806
1855	Skilled	75	1066
1855	Unskilled	69	724
1858	Professional	64	30
1858	Semiprofessional	74	197
1858	Semi-skilled	80	235
1858	Skilled	86	135
1858	Unskilled	67	163

REGRESSIONS

TABLE 2.4 DETERMINANTS OF NUMERACY (AS PERCENTAGES)

	(1)	(2)	(3)
Dependent variable	Numerate	Numerate	Numerate
Estimation technique	Logit (mfx)	Logit (mfx)	Logit (mfx)
Data included	All	All	Only merchant, ranchers, farmers, slaves
professional	10.2125**	12.9625***	
	(0.05)	(0.01)	
Semi-professional	14.9625***	16,1875***	
	(0.00)	(0.00)	
Skilled	8.7625***	10,9375***	
	(0.00)	(0.00)	
Semi-skilled	6.7125***	7,275***	
	(0.00)	(0.00)	
age 33-42		-11,2875***	-14.15***
		(0.00)	(0.00)
age 43-52		-17.4375***	-17.3***
		(0.00)	(0.00)
age 53-62		-18.925***	-21.7***
		(0.00)	(0.00
age 63-72		-7.3625***	-16.1***
		(0.00)	(0.00)
Farmer			-2.237
			(0.46)
Merchant			-1.962
			(0.58)
Slave			-29.0875***
			(0.00)
Observations	24.162	24.162	5.342
Pseudo R-squared	0.0035	0.014	0.037

Note: P-values in parenthesis *** p<0.01, ** p<0.05, * p<0.1
Model 1. Constant refers to Unskilled
Model 2. Constant refers to Unskilled and age group 23-32
Model 3. Constant refers to Ranchers and age group 23-32
I scaled the coefficients of all independent variables up by 125, for a more convenient interpretation of changes in numeracy . See Juif and Baten (2013) Appendix C for the details.

TABLE 2.5. DETERMINANTS OF NUMERACY. ECONOMIC SECTORS

	(1)	**(2)**
Dependent variable	Numerate	Numerate
Estimation technique	Logit (mfx)	Logit (mfx)
Data included	All	All
Secundary sector	5.2***	5.775***
	(0.00)	(0.00)
Tertiary sector	9.875***	9.575***
	(0.00)	(0.00)
Age 33-42		-10.85***
		(0.00)
Age 43-52		16.4375***
		(0.00)
Age 53-62		-17.625***
		(0.00)
Observations	24.162	23.393
Pseudo R-squared	0.0024	0.012

Note: P-values in parenthesis *** p<0.01, ** p<0.05, * p<0.1
Model 1. Constant refers to Primary sector
Model 2. Constant refers to Primary sector and 23-32 age group
I scaled the coefficients of all independent variables up by 125, for a more convenient interpretation of changes in numeracy . See Juif and Baten (2013) Appendix C for the details.

TABLE 2.6. DETERMINANTS OF NUMERACY. HANDICRAFTS AND INTELECTUAL JOBS

	(1)	**(2)**
Dependent variable	Numerate	Numerate
Estimation technique	Logit (mfx)	Logit (mfx)
Data included	All	All
intelectual	9.875***	9.875***
	(0.00)	(0.00)
Year_1780		13.875***
		(0.00)
Year_1823		4.05***
		(0.00)
Year_1826		16.425***
		(0.00)
Year_1836		16.75***
		(0.00)
Year_1855		17.775***
		(0.00
Year_1858		18.975***
		(0.00)
Observations	24.162	24.162
Pseudo R-squared	0.0012	0.012

Note: P-values in parenthesis *** p<0.01, ** p<0.05, * p<0.1
Model 1. Constant refers to handicrafts
Model 2 Constant refers to handicrafts and Census Buenos Aires 1771
I scaled the coefficients of all independent variables up by 125, for a more convenient interpretation of changes in numeracy . See Juif and Baten (2013) Appendix C for the details.

3. HUMAN CAPITAL AND INEQUALITY IN THE POTOSI REGION DURING THE (POST) SILVER BOOM PERIOD

Abstract

During the first half of the 17th century, the Cerro Rico of Potosi had been the richest deposit of silver in the world. However, as is debated in the field of economic history, wealth regarding natural resources is, in many cases, harmful to the further development and the formation of Human Capital. In this Chapter, we analyze the Human capital characteristics of three main areas of the Andean economy: Potosi, La Paz, and Oruro. Measuring basic numeracy skills through the age heaping technique, we found that the region in the locality of the silver mines was the most affected regarding Human Capital. The characteristics of the labor markets under consideration seem to have played a key role in the qualification of the Human capital. In this context, Oruro is positioned as the leader regarding mathematical capabilities.

This Chapter is based on a paper in collaboration with Jörg Baten (University of Tübingen).

None of the cities that belonged to the Spanish Crown - except for México - had such a suggestive and important course in the Peruvian Viceroyalty as Potosi. The colorful history of this colossal silver mountain starts when the Inca, Huyana Cápaj, wanted to excavate it, almost a century before the arrival of the Spanish conquerors. The legend says that a terrifying noise paralysed him. A mysterious voice ordered him in Quechua, 'Do not remove the silver of this mountain; it is intended for other owners'. The Spanish conquerors in 1545 did not pay attention to such a mandate and started to exploit the Potosi mines. Treasure-seekers from Spain and many other parts of the world arrived in this inhospitable place to extract the silver of the Cerro Rico, the mountain with a sugarloaf shape which rises majestically 4,890 meters above sea level. When the colonies of Virginia and Massachusetts Bay were just 'little infants', unaware of their prosperous future, Potosi had yielded such amounts of silver that its name was a universal symbol of unprecedented wealth, as Don Quijote points out to Sancho Panza. In Spain, the expression 'worth a Potosi' was and is a popular expression. The phrase 'as rich as Potosi' was also frequent in English literature.[14]

3.1 INTRODUCTION

Potosi was one of the richest areas of the Peruvian Viceroyalty. The economic history of this area is one of the main topics of the Colonial Period in Latin America due to their large profitable primary resource, the silver mines. Many researchers are involved in the analysis of this area from different points of view. However, the study of Human Capital from an empirical point of view is scarce.

One of the points of agreement among the authors is that the colonial heritage of this region is the main reason for the current Latin American underdevelopment. Young (1994) emphasizes that the extractive institutions set up by the colonialists persisted long after the colonial regime ended (Young, 1994). For example, in Latin America, the full monopolies and regulations created by Spain remained intact after independence for most of the 19th century (Acemoglu, Johnson and Robinson, 2001). These authors highlight that the dysfunctional institutions originated in those colonies, where the main objective of the Crown was to transfer primary resources to the metropolis (Spain). These extractive institutions were responsible for the

[14] Luis Capoche (1959), Relación general de la villa imperial de Potosi

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concentration of power and social inequality. The scholars involved with the institutional hypothesis argue that the institutions generated in the regions with an abundance of natural resources were the most affected regarding inequality and current development. One of the most representative works regarding this hypothesis is "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution" of Acemoglu, Johnson and Robinson (2002). The European intervention appears to have created an institutional reversal among the conquerors and the colonies as the Europeans introduced institutions encouraging investment in regions that were relatively poor and sparsely populated in the pre-colonial times. This hypothesis is strongly accepted by the scholars and has a continuity in the works of Engerman and Sokoloff (1997, 2000), and Easterly and Levine (2002), who emphasize the adverse effects of the plantation complex in the Caribbean and Central America; and Bruhn and Gallego (2012) which explain the within-country variation in economic development across the Americas.

Engerman and Sokoloff (1994) argue that the Spanish colonies in Mexico and Peru were characterized early in their histories by extreme inequality, partially because of their natural resources. In these cases, the vast population of natives and the Spanish practices of colonization, the native labor and the abundant mineral resources destined only for members of the elite, encouraged the extreme concentration of land and therefore inequality. These colonies were characterized by large enterprises which tended to exploit the primary natural resources, and by an unequal distribution of wealth. This kind of settlement relied on the labour of natives with low levels of Human capital instead of slaves; the elites were racially distinct from the bulk of the population (Engerman and Sokoloff, 1994). The main argument of these authors is that the abundance of unqualified Human capital was certainly a major contributor to the extremely unequal distribution of wealth and income.

Juif and Baten (2013) point out that, even though they agree with the obstacles to development in this kind of colonization, the small Human capital investment in the Inca Empire might have

initiated a path-dependent process of agriculture which was not Human capital intensive in the following centuries.

Other studies highlight the positive relationship between pre-colonial technology capabilities and Gross Domestic Product per capita today (Comin, Easterly and Gong, 2010). This study contributes to the understanding of the underdevelopment of this region today, assuming that institutions created by both the conquerors and in pre-colonial history play a central role in its economic performance.

In the following sections, we will analyze the Human capital of the rural areas in the locality of Potosi, in comparison with the cities of La Paz and Oruro through the age heaping technique.[15] The Chapter contributes to the understanding of the economic and social characteristics of the biggest mining economy of the colonial era in Latin America. The analysis of the Human capital performance of this region contributes to the explanation of the current economic backwardness of Bolivia and the rest mining economies of Latin America.

Section 2 gives a brief description of the geography and society in the pre-Columbian and colonial eras. Section 3 discusses the methods and describes the sources. Section 4 presents the potential determinants of numeracy. Section 5 contains the numeracy trends of the region and the numeracy in comparison with two economies of Latin America. Section 6 concludes, and references and the statistical appendix are in Sections 7 and 8.

3.2. SOCIAL AND GEOGRAPHICAL CHARACTERISTICS OF THE REGION IN THE PRE-COLUMBIAN AND COLONIAL ERAS

About two-thirds of Bolivia´s territories consist of tropical and semitropical lowlands, from the Pacific coast deserts of the Atacama region in the west to the vast stretches of eastern plains

and part of the Amazon and Pilcomayo River. The main settlements were established in the highlands from earliest times until today (Klein, 2003:1). The reason is that the high plateau, known as *Altiplano*, contains a wealth of mineral deposits that have been exploited from pre-Columbian times to the present day and made this region as one of the great mineral zones of the world (Klein, 2003). Given the extraordinary importance of minerals, root crops and cameloid products in the Andean economy, the highlands remained the primary zone of exploitation for the people of pre-conquest Bolivia. This geographical and resource condition favored the establishment of dense settlements. The first native pre-Columbian population was the Aymara and Inca civilizations. Both were organized in sophisticated corporations and class structures. One of those was the *ayllus*, or kin groupings, with each *ayllu* divided into an upper class (*hanansaya*) and lower class (*urinsaya*) to which everyone belonged. The Aymara also had regional chiefs or *caciques* who extracted free labor from the *ayllu* members they governed. Also in Inca times, there existed a kind of servant or slave who depended directly on the nobility; these were called *Yanaconas* (Klein, 2003:14).

When the Spaniards arrived in these regions, the civilization was integrated regarding social and economic institutions. The Spanish Crown created a Viceroyalty dependent on the Crown of Spain. According to Lopez Beltran (1988), in the Peruvian Viceroyalty there was an economically dominant region, Potosi, organised around the productivity of the silver mines; a mercury industry, Huancavelica, the closest to Lima even late in development; the area of Cuzco, with great population density and in-depth social organisation, but which had only a brief period of glory; and the points of exit and discharge of Lima and Arequipa. Completing the pattern space that corresponds to Peru, a fifth region is added: Tucumán; together with the provinces of Córdoba and Rio de la Plata are part of the main link and exit route to the Atlantic Ocean.

The successful administrative organization of the Peruvian Viceroyalty (imposed in a short time) can be explained by the exploitation of primary economic resources, organized and

integrated into the Inca Empire. The empire was extended from North to South from the Pacific coast to Chile, and from the East by the high valley of the Andean Mountains (Cordillera de Los Andes).

The pre-Columbian civilization found by the conquerors was favorable to the interests of the Spanish Crown. The availability of natural resources promoted the expansion: rich mineral treasures, good farmland in the most diverse climate, considerable livestock and a potential international commercial route to the Pacific coast, crucial for the export economy. The region had a significant demographic potential, with Human groups highly organized and integrated, with their culture and a social conscience able to respond to the requirements of a state organization (López Beltrán, 1988).

One of the main points of the colonial administrative body was the collection of the indigenous tax (*tributo indigena*). From the time of the Inca Empire, the native population had had different kinds of obligations linked to the state's organization. The primary requirement was to pay a tax and the possibility of paying with personal service, crops or money depending on the period. In the colonial times, Spain made a profit from the early times of the conquest, regulating and legalizing tax collection. This payment was used to self-finance the colonial bureaucracy and to increase the income of the state. It was also used to reward the conqueror soldiers with a commission (*encomienda*). The annual payment to the King and the *encomenderos* (those who have the privilege of the income guaranteed by the Crown) had a direct influence on the economy as it regulated all the labor market and the work system of the indigenous people and their communities. This tax also normalized land and property, and the provision of personal services to the state or private organizations. The tribute not only determined the socioeconomic development of the indigenous sector, but it was also a powerful mechanism that the Spanish

Crown obtained, firstly through the tax payment, secondly with the land appropriation, and finally with the silver mine fund.

The mining production had several cycles. Our research focuses on the post-silver boom, after the era of 'big production.' According to the literature, there was an increase in mineral production between 1573 and 1610. This growth occurred due to the innovative reforms to production carried out by the Viceroy Toledo. One of these innovations was an amalgam system for the concentration of minerals. This method required an expensive infrastructure in which large metal mills (*moliendas*) were necessary, powered by hydraulic energy (*ingenios*). The labor force was organized and collected through the *Mita* system. During this period, the monetization process started to be more fluent, and the economic exchange within the region became dynamic (Tándeter, 1992). The time after the production boom is described in the literature as a 'decline and crisis era' and is dated between 1611 and 1730. The main cause of the production decline is attributed to the lack of technology innovation. New exploitation systems were tested with no success. While the costs of the extraction, production and work were increasing, the quantity and quality of the minerals were declining. Furthermore, the income of the Spanish Crown was lower in a period of economic scarcity.

Although our data are from the end of the 1600s, the decline process was slow, and the mineral production was still significant in this period. Towards the mid-1770s, Potosi accounted for 40% of silver produced in the Viceroyalty of Peru. In 1776, the Viceroyalty was divided; the Potosi region was brought together with the rest of the current territory of Bolivia and Paraguay, and Argentina and Uruguay formed the new Viceroyalty of Rio de la Plata. Potosi then accounted for almost 65% of the silver production of the new jurisdiction and, between 1779 and 1784; precious metals exceeded 80% of the area's total exports. Around 1790, the mining industry also provided 32% of Crown revenues in the Viceroyalty (Tándeter 1990).

3.2.1. HUMAN CAPITAL: EDUCATION AND LABOUR MARKET

The education and qualifications of the native population seem not to have been an important factor for the Spanish conquerors. The education first brought to America by the Europeans was hardly more than ornamental culture; literacy was not necessary and African slaves were not educated at all (Gomes, 1993). There is evidence that some small part of the native population received institutional education, but only the sons of the local indigenous nobility (*caciques*). The schools were opened up from the end of the 16th century, and the motives for education were mainly religious and cultural (Escobari de Querajazu, 2001). Part of the literature points out that a significant proportion of the population was excluded from the educational system. Rama and Tedesco (1979) argue that the cultural and educational system gave symbolic legitimacy to the differentiations contained in the social structure. The upper and middle classes, mainly urban and racially white, controlled the culture and the media. Meanwhile, the rest of the population, living under different ethnic and linguistic conditions, was outside the channels through which knowledge was spread (Rama and Tedesco, 1979). These authors analyze the likely causes of the 'backwardness' of Latin America regarding education in comparison with Europe and United Sates. While in Europe and North America, the process of achieving universal literacy was mostly political and not merely for economic reasons, the situation in Latin America was different: literacy was the result of an increase in the number of schools which was promoted essentially by the state. The process of the expansion of education developed by the state had limitations linked to economic factors and the ability of the dominant social sectors to perform under political pressure. In Latin America, there were different ways to impart education. The region that we analyze is one of the most underprivileged regarding Human capital formation. In this case, the expansion of education was adapted to the production requirements. As Rama points out, in these cases, the rate of increase has been notoriously slower than in other countries, and it has not been able to change

the situation of important sectors of the population, mainly those living in rural areas. In many native communities, the indicator of being educated was to learn Spanish (Rama and Tedesco, 1979).

Furthermore, there was a distinction between education for women and men. The Spanish literature of this period assigned a limited territory to women's education and taught behavioral patterns linked to the patriarchal societies of Spain and Spanish America (Bethell, 1990). Andean and Hispanic conceptions of gender roles co-existed in colonial Bolivia, even though they conflicted in many instances, and the ideas imposed by the colonial power tended to dominate. Spanish patriarchy and the Spanish legal system destroyed much of women's political and even personal authority and undermined the economic prerogatives they had held before the Conquest. The demand for women to fill the most unskilled positions in households forced many of them into degrading personal service. It is certainly possible that, in some instances, Indian men sought to improve their positions by disinheriting women or sending them to work for colonists. Furthermore, women suffered occasionally from sexual abuse. They could be deprived of childcare, and apparently risked being harassed if they attempted to work in occupations dominated by men. However, the fact that, in the Andean family, the wife and other female relatives were important parts of the household economy may have to some extent mitigated women's oppression (Zulawski, 1990).

The education of indigenous woman before the Spanish colonization consisted of practical training in those tasks linked to their gender, which was related mainly to the handicraft- pottery and animal husbandry-. Most women of colonial times either slave or free, white or *mestiza*[16],

could only aspire to achieve informal education and some rudimentary knowledge imparted by Catholicism. This fact occurred until the end of the 18th century when was an outcry in public and private schools. In fact, at the end of the colonial period, the acceptance of the importance of women's education was one of the main changes in social attitudes concerning women (Bethell, 1990).

3.2.3. EDUCATION AND THE PRODUCTION SYSTEM

The consequences of American silver production have been the object of academic debate for a long time. Its role in the price revolution of the 16th century is still in dispute. The mining generated sufficient purchasing power to stimulate not merely trans-Atlantic and Pacific commerce, but also long-distance internal trade. Potosi received cloth from Quito, mules from Buenos Aires, sugar and *coca* from Cuzco, and brandy from Arequipa. The Merchants and the miners built their fortunes upon the industry (Brading and Cross, 1972).

As Tándeter (1981) points out, the Spanish Crown organized over almost two and a half centuries (from 1570 to 1819) a forced migration system of work for the Potosi mines. The annual forced migration to the mines, called *Mita,* was an extreme instance in which almost the whole of the labor force of the mines were Indians. Viceroy Toledo institutionalized this migration in 1570. In this policy, a seventh part of the male population between 18 and 50 years old from a set of 16 provinces of the Peruvian Viceroyalty, were forced to work every year in the Potosi mines. The affected area was considerable, so some of the migrants had to walk for over a month to arrive at the mines. The migrants were required to work for a miner entrepreneur for one in every three weeks during the year of the stay in Potosi. The laws imposed by the Viceroy established the amount of salary for a week of labor. Those salaries were lower than those set out in the free labor market.

In the Mita, the maintenance of the workforce was encouraged in the community. This fact was possible because the forced migrants used to bring with them the essential food and clothes to survive during the stay in the mines, which was approximately 12 or 14 months, depending on the distance from their towns. This situation forced many native people to migrate to the towns free of the *Mita* system; they were known as "forastero indios." Those who did not choose this radical alternative could instead make a payment to the chief of the tribe who was in charge of making a list of future migrants. This mechanism meant that the richest people had the option of being free of the forced migration. The chief of the tribe (*cacique*) received from these people an annual 'tax.' These wealthy natives were known in Quechua as Colque-haques, Tasa-runas o Colque-runa-haques, or 'rich man,' 'money man,' 'wealthy man' (Tándeter, 1981).

The origin of the free labor force is even older than the involuntary labor force. Before the European invasion of 1532, many mineral reserves were exploited in the region dominated by the Inca. Potosi was unknown until 1545 when the *Yanaconas* (those natives free from the *encomienda* system) started to operate the mines as independent workers. The *Yanaconas* used to control all the processes: the mineral extraction and the foundry of the metals in small hand-craft ovens. At the end of the 1570s, the *Yanaconas* ceased to be free workers and started to be employees. The supply of free workers in Potosi was not generous at any time in the 18th century. The indigenous population of Alto Peru became scarcer until 1750 (Tándeter, 1981). We do not have reliable data about the population in Potosi, but some estimation of the travelers indicate that the population would have fallen from 150,000 inhabitants in 1650 to 70,000 in 1700. In the census of 1779, the number of residents registered was 22,622.

The *Mita* income (*renta mitaya*) was the major production relationship in this industry. According to the silver prices from the international market, the massive and regular exploitation of the Potosi mines could survive because of this production system. The organization of the work process and the wage levels of the migrants are in contradiction with this institution and its ordinances. The mining companies were able to maximize the transfer of

the value of the indigenous communities to their productive sphere. The free market at this time had a weak overall worker organization. Recruitment was challenging and irregular, and labor discipline was unsatisfactory for the mining companies (Tándeter, 1981).

The Toledean administration made a comprehensive list of all the indigenous communities to receive tax from all the indigenous between the ages of 18 and 50. For this reason, many natives involved in this system were forced to leave their homes to go to places where they could be considered outsiders. These Indians were, most of the time, incorporated into the *haciendas* in the countryside; also, they could be a *rentier*, a *colono* or a settler in other communities (López Beltrán, 1988).

The mandatory work system created by Toledo fragmented the native society; both the demographic decline and the social fragmentation explain the process of decline in the 17th century in this region. The labor force of Potosi and the surrounding towns and villages was one of the primary consumers of the agrarian products of the rest of the areas. With the population in decline, the whole system collapsed (López Beltrán, 1988).

3.3 METHODS AND DATASET

3.3.1 METHODS

We analyse in this Chapter the Human capital qualifications of the population registered in three population registers: the census of Potosi (mainly the rural areas), the census of La Paz, and the census of Oruro. We approximate Human capital using the age heaping technique. The ability to count, or numeracy, is a significant indicator of Human capital. The idea underlying this is that, in pre-modern times when census takers, army recruitment officers or prison officials asked an individual his or her exact age, only a certain number of the population were able to do so. Depending on the level of numeracy education received, many of the registered tended to round their age, e.g., 40, when in fact, they were 39 or 41 (Manzel, Baten et al., 2008).

The approximation in age manifests itself in the 'heaping' phenomenon. Individuals tended to choose an 'attractive' number such as those ending in 5 or 0 (A`Hearn, Baten et al., 2009).

The quality of age reporting can be measured by means of age heaping indices to detect the degree of preference or avoidance for certain ages. Among standard indices such as Bachi, Myers, Whipple and Zelnik,[17] the Whipple index is the most widely applied.[18] The original Whipple index is obtained by summarising the number of persons in the age range 23–62 inclusive, and calculating the ratio of reported ages ending in 0 or 5 to one-fifth of the total sample. It assumes a linear distribution of ages in each five-year age range, i.e., a continuous and linear decrease in the number of persons of each age within the age range considered. Low ages (0–22 years) and high ages (63 years and above), for which the linearity assumption is not plausible, are excluded from the calculation (Spoorenberg and Dutreuilh, 2007).

$$Wh = \left(\frac{\sum (Age25 + Age30 + ...Age60)}{1/5 \times \sum Age23 + Age24 + Age25 + .. + Age62)} \right) \times 100 \quad (1)$$

For an easier interpretation, A'Hearn, Baten and Crayen (2009) suggested another index, called the ABCC index.[19] It is a simple linear transformation of the Whipple index and yields an estimate of the share of individuals who correctly report their age:

$$ABCC = \left(1 - \frac{(Wh - 100)}{400}\right) \times 100 \text{ if } Wh \geq 100; \text{ else } ABCC = 100. \quad (2)$$

The index takes the values between 0 and 1. A value 0 means a total age heaping meanwhile a value 1 means not heaping at all.

[17] The methods used to calculate these indices are in Shyrock and Siegel (1976:115–119).
[18] A'Hearn, Baten, and Crayen (2009) argue that this is the only index that fulfils the desired properties of scale independence (a linear response to the degree of heaping) and that it offers a reliable ranking of samples among which the degree of heaping varies.
[19] The name results from the initials of the authors' last names plus Greg Clark's, who suggested this in a comment on their paper. Whipple indices below 100 are normally caused by random variation of birth rates in the 20th century in rich countries. They are not carrying important information, hence normally set to 100 in the ABCC index.

The age groups 23–32, 33–42, etc.,[20] are used in order to apply the index to several birth decades. The birth decades from 63 to 72 are omitted because it provides an insufficient number of observations, especially in the case of the 17th and 18th centuries, when the life span was shorter than in subsequent centuries.[21]

An advantage of the age heaping methodology is that data are more available than in other Human capital proxies, such as signature ability or school attendance. In general, all population registers have the age as one of the main datasets.

3.3.2 DATABASE

The conquerors, the missionaries, and the chroniclers naturally took an interest, even for practical reasons, in the size of the aboriginal populations they visited or conquered (Sánchez Albornoz, 1974). To define the exact number of indigenous who were forced to migrate to the *Mita*, Viceroy Toledo ordered to make lists of the population. Those lists were called *visitas;* the annual visits were structured from 1570. In these inspections are recorded the settlers of the territories between Quito (Ecuador) and Tarija Lipez (Bolivia) (López Beltrán, 1998).

For this Chapter, we collected three different sources: the population record of Potosi and west Oruro of 1683, a census of La Paz of 1682 and a census of the city of Oruro of 1735. The number of registers and the variables included are different in each case.[22]

[20] This method has two advantages: it spreads the preferred ages, such as 25 or 30, more evenly within the age groups; and it adjusts for the fact that more people will be alive at age 50 than at age 54 and at age 55 than at age 59 (Crayen and Baten, 2009).

[21] Given that adults aged 23 to 32 round on multiples of two as well as five, we use the adjustment method suggested by Crayen and Baten (2009) to increase the Whipple value (minus 100) by 24% before calculating the ABCC value.

[22] A detailed description of the data set is given in the Appendix

a. Potosi census and west Oruro 1683

The census of Potosi was conducted between 1682 and 1683. According to Cole (1985), the Spanish Crown and its Council of the Indies had been pressing for a population count in Alto Peru since the 1650s because the census was fundamental to the outline of a new *repartimiento de la mita*. The Viceroyalty office was ordered to enumerate the indigenous people serving in the *Mita* that each *corregimiento* was bound to send to Potosi and assign them to the *azogueros* (mill and mines owners). Both the census and the abolition of '*Mita* service in silver' were meant therefore to increase the production of silver at Potosi and thus to enlarge the royal share of that production (Cole, 1984). The implementation of the census was tough. The biggest obstacle was the issue of which agent should carry it out. In 1680, the general consultant Francisco de Valera made a proposal for a procedure to perform the census. The local officials of Alto Peru would perform a coordinated census that would keep the cost low and minimize the impact of Indian mobility during the count. The church would be in charge of checking the accuracy of their work. The whole process was supposed to be finished in two years. However, the complete census implementation lasted five years and had many irregularities. Despite this, the census showed the Crown the decrease in the population of Alto Peru; the Indian population had declined by nearly half since 1573 (Cole, 1984).

Taking into account the possible omissions in this census, we consider that we have representative data to analyze Human capital creation since we have 13,577 registers. In the dataset, we mainly have the registers of the rural area of Potosi. One factor to take into account is that a large part of the young population is not surveyed. We assume that this population emigrates to the *Mita* service and they are probably registered on the accurate list of the *Mita*. The distribution of the population according to the gender is 56% male and 43% female.

b. La Paz census

The city of La Paz was founded in 1548 as a dual city: La Paz where only the Spanish inhabitants were allowed, and in the surroundings, the small indigenous villages, San Pedro y Santiago (Escobari, 2001). The dataset (N=201) is from the parish registers of the reductions, and it is mainly a list of the *Indios* called *forasteros* (those *Indios* who had escaped from the obligation to go to the *Mita*). Hence, in this dataset, we have only native people (no Spanish, no 'don') with the peculiarity that they were forced emigrants of their communities. In 1646, the *forasteros indios* were 25% of the total population of La Paz and, in the early 18th century, the share of *forasteros* living among the population in La Paz had reached about 50%, which is why the administration also started to tax the newcomers (Klein, 2003:63). Apparently, in this register, there is no presence of the traditional Inca castes (*Hanansaya* and *Urinsaya*), but we have to take into account that these castes are concentrated in some regions in general outside the cities. As they were inhabitants of La Paz and exiled from their communities, we can estimate that they were mainly urban servants. Hence we expect a negative bias in this data set. In this register, we do not have data about fertility and family size.

c. Oruro Census

San Felipe de Austria de Oruro (today Oruro) is located in the Bolivian highland plateau and was the second mine center in Alto Peru. It was founded officially in 1606 and had its mining boom in the 17th century. As well as Potosi, Oruro had a mining crisis in the 18th century.
The census of Oruro was conducted in 1735 to control the inhabitants' tax liabilities. Since the foundation of Oruro, the population structure had been influenced by the immigration of indigenous people of the region. As a forced labor market was prohibited, only free and salaried workers worked in the silver mines. For this reason, many qualified workers were attracted by

the labor market of Oruro due to the better conditions of life. Many indigenous people escaped from the *Mita* obligations to work as a free worker (Escobari, 2001).

The institutional administration in Oruro was not as aristocratic as other Spanish colonies in Latin America; instead, the political power developed some democratic characteristics. For example, in the 17th century, the *mestizos* (a mixture between the native and the Spanish population) were able to reach influential positions in political institutions (Klein, 2003). Furthermore, the first anti-colonial rebellion against the Spanish Crown occurred in Oruro. In the year 1739, Spanish immigrants, *Indios* and *Mestizos* came together to defend the independence of Oruro (Escobari, 2001).

The dataset (N=367) consists of 52% male and 47% female. We do not have information about the fertility and family size in this dataset. Neither is there any presence in these registers of the traditional Inca castes *Urinsaya* and *Hanansaya*. Due to the favorable conditions of the labor market we expect a positive bias in this data set regarding Human capital formation.

3.4 HUMAN CAPITAL DETERMINANTS AND NUMERACY TRENDS

The aim of this Chapter is to analyze the determinants of human capital formation in Bolivia in the 17th century. To do so, and according to the population registers and the literature, we select some variables that probably have incidences in Human capital formation. We made three groups of variables of plausible inferences in Human capital formation: social variables linked to fertility and family size, social variables related to social class conditions, and regional variables.

3.4.1 SOCIAL VARIABLES LINKED TO FERTILITY AND FAMILY SIZE

The relationship between education and fertility has been examined since the beginning of the study of economics and demography. Malthus and his successors in both fields have proposed

numerous theories about why more education is usually associated with lower fertility but, according to some authors, the evidence shows that the relationship is not as uniform as is believed (Hill Cochrane, 1979). Apparently, the relationship between fertility and education depends on the society and the stage of this society in the demographic transition. According to Easterlin's model of fertility determination, in the poorest countries, poor health, malnutrition, high mortality and sexual taboos cause desire for fertility to exceed natural fertility, and thus the real fertility rate is determined by health and sexual behavior patterns. As development proceeds, natural fertility increases and desired fertility fall. In the earlier stage of the demographic transition fertility is higher for those of higher status, and in the later stage, it is lower. Thus it is hypothesized that education tends to increase the natural supply of children. Education also reduces the desired family size and the cost of regulating fertility. Hence, education initially increases the fertility of a society. Eventually, however, more education results in lower fertility (Hill Cochrane, 1979). The education of women is a key variable in family size. The argument commonly accepted about women's education suggests that it is linked with three major changes in the orientation towards children.

First, education transfers women's priorities away from a large number of children as they are concerned about the quality of the education: that means that a better-educated child is a more costly child. An obvious but less common documented variation of this argument is that a better-educated woman's greater investment in children can ensure more and better old age support from these kids and hence can co-exist with, rather than replace, strong expectations of better old age support from those well-educated children. Second, better-educated women are more capable of supporting themselves economically, relying on their savings and income for economic security in emergencies and old age. Third, the need for a son to legitimize a woman's position in her husband's home decreases; more educated women can derive prestige from other non-domestic sources (United Nations, 1993).

Although studies about the human fertility in colonial Spanish America are scarce, the genealogical data, census and other statistical sources suggest that an extended maternity period was the norm for the majority of women in all social strata. However, the high infant mortality rate shortened this maternity period. The groups of indigenous women and slaves apparently had lower fertility levels because of several reasons: family breakdown due to compulsory labor, long separation periods and irregular conjugal life, diseases, and a poor diet. Contraceptive practices were apparently not standard for the bulk of the population, but abortive methods were used (Bethell, 1990).

The variables that we include in the regression analysis related to fertility are the number of children; the age of the woman at the time of delivering the first son; marital status, and gender. Furthermore, we include age groups to identify and control the cohorts in which the age is more accurately declared. We controlled for the age group 23–32 as this group usually has a different heaping pattern: the older a person gets, the more they tend to heap the age to the multiples of five, but also to the multiples of two (Juif and Baten, 2013). We expect a positive bias of this age group in comparison to the age groups 33–62.

Table (3.2) displays the results of the marginal effects of a logistic regression. We run a logistic regression as our dependent variable is a binary variable. The marginal effects were multiplied by 125 so that they can be interpreted as percentage changes of numeracy, taking into account that 20% of ages would correctly end on 0 or 5. The dependent variable (numerate) takes the value 1 when the person declares an age which is not a multiple of 5 and 0 when a person declares an age which is a multiple of 5. We ran three models linked to social variables and fertility. In all of them, we included the age groups variables to control for the youngest group (23–32). In model (1) we included all the population between 23 and 62 years old (6,882 registers) and we controlled for women who do not have any children.

As would be expected, those women who have from four to eight children have 9% less numeracy skill in comparison with those who do not have children; meanwhile, those who have

between one and three children have 7% less numeracy skill at all significance levels. However, the difference is not significant if we consider the number of children. Hence, we can argue that women who have children have, in general, less numeracy than those with no children; however, once they have a child, the differences in the numeracy values do not change considerably. Regarding the age of the woman at the first child and taking into account only the female population with kids (model 3); we can affirm that those who had the first child at up to 31 years old have 32% more numeracy skill than the female population in the age range 14 to 19 years. This coefficient decreases with the age of the woman. This fact is consistent with the literature that points out that the more years that a woman invests in her education, the longer she delays marriage and children.

In model (2) we changed the dummy variables concerning the number of children for a continuous variable named ‘number of children,' but this change has no significance.

Apparently being female has a significant correlation with numeracy. As previous research has indicated, during most of history, female children received less education than male (Juif and Baten, 2013; Friesen, Baten and Prayon, 2012). Furthermore, the Spanish literature of the 16th century related to women’s education was focused on their instruction as a wife and mother, and clearly made a distinction between male and female education (Bethell, 1990). This fact is consistent with our models since female is always a negative association. In model (3) we dropped the female variable as we are considering only the female population.

3.4.2 SOCIAL VARIABLES LINKED TO SOCIAL CLASSES AND GEOGRAPHY

Two of the main facts that explain Human capital formation are the social situation and the geographical location. Many facts influenced the social stratification in Bolivia in the colonial period but one of the most significant social differentiations was to be indigenous or to be

Spanish. About Human capital formation, and especially the ability to count, it is known that the numerical system of the native communities in Bolivia was different to the numerical system of the European civilization. When the Spanish arrived in the Andean region, they found a sophisticated culture with its numerical system. The record-keeping system of the Inca Empire has been the subject of a considerable amount of interest on the part of Andean scholars since the beginning of this century. The system, a combination of recording techniques and interpretive knowledge, was based on the manipulation of knotted-string devices called -in the native language- *khipus* or 'knots'. *Khipus* were composed of a variable number of 'pendant strings,' made of spun, plied, and often dyed cotton and camelid fibers that were attached to thicker 'primary cords.' Various types and numbers of knots were tied into the pendant strings, usually in clusters at different levels, or tiers, as measured from the point of attachment of the pendant lines to the first cord. In many cases, knots were accorded numerical values based on their position on the lines and expressed in the decimal system that was used by the Inca for recording quantitative data (Urton, 2005). The *khipus* is a knotted string device somewhat similar to those used in other older civilizations (Jacobsen, 1964). *Khipus* were the only system of written numbers and it was used for a decimal order, with knots that represented singles, tens, hundreds, and higher numbers (Menninger, 1934; Espinoza Soriano, 1997). Hence, and according to Juif and Baten (2013), it is consistent to argue that the Inca and Aymara civilization would have a preference for multiples of five.

Apart from the differences between the numerical systems, the indigenous communities were part of the lowest social stratification, taking into account the presence of the Spanish. The indigenous communities were forced to emigrate to the mines and to provide different kinds of services to the Spanish Crown. One of these was the indigenous tribute. However, there was also an evident social differentiation among the indigenous communities. Some of the social positions that are possible to identify are linked to tax categories. About the peasant population, the state officials classified rural people into three categories: *originarios, forasteros,* and

Yanaconas. These groups were linked to the taxes that the indigenous had to pay. *Originarios* were those native people with their land and animals. They were subordinate to the local *caciques* and were forced to work in the *Mita* system. They used to pay the higher amount of tribute.

Forasteros were indigenous with no land and no animals. They used to work as laborers on large farms. As the category suggests, the *forasteros* were mainly migrants who escaped from their communities and from the *Mita* obligations. The *forasteros* used to pay fewer tributes than the *originarios,* approximately half of the amount.

Finally, the *Yanaconas* were the lowest category regarding tributes and social position. The *Yanaconas* were the indigenous who lived in the Spanish *haciendas* whose tribute was paid by their chief, by exchange they had to give personal service. For one day, the *Yanaconas* worked the land for their livelihood, the rest of the week they served the big landowner, carrying water, cleaning pens, feeding the livestock, sowing, reaping, and carrying crops to the local markets of the region (Santamaria, 1977).

In our dataset we identify six indicators of social status: (1) the indigenous and Spanish by their last names; (2) the Spanish named 'don'; (3) regions classified into an *ayllu*; (4) the *Hanansaya*/*Urinsaya;* (5) the *forasteros indios*, and (6) the indigenous *Colque* and *Colquema* (in Aymara, 'wealthy man'). From these indicators, we created different social variables to include in the models of social influences in Human capital formation.

About the first measure, we have 3,784 indigenous last names and 1,326 Spanish last names (including 'don' which only accounts for 17 registers). Due to the characteristics of the census in this category, it is mainly males (67% in the indigenous and 64% in the Spanish group). This fact is explained by the tendency to register the last name of the head of the household. In many cases, the female population is registered only with the name.

The *ayllu* communities and the *Hanansaya*/*Urinsaya* social positions are possible to identify by region. In our dataset, there are 3,946 areas classified into the *ayllu* category, 2,672 registers

of the *Hanansaya* and 2,798 of the *Urinsaya.* Both *Hanansaya* and *Urinsaya* account for almost the 40% of the whole dataset. The *forastero* category is only registered in the census of La Paz and we have 201 observations. Finally, we identify 290 registers of *Colque* and *Colquema* last names.

Table (3.3) displays the marginal effects of a logistic regression in which the dependent variable is the dummy numerate. We ran two models: in the first one, we included only the social variables linked to social stratification; in the second, we included the regional variables to have a complete model.

Contrary to what we expected, *Colque* and *Colquema* last names have a negative sign but no significance in the model. As we said above, *Colque* and *Colquema* means 'wealthy man' in Aymara and we expected a positive sign taking into account the possible connection between the name and the social position. Furthermore, we assumed that wealthy people access education channels easily. This last name is one of the most frequent of indigenous; however, probably the small number of observations causes the no significance in the model.

To be Spanish and to have no ethnic classification both have positive associations in comparison to the indigenous, but the Spanish category has no significance in the model. This fact is in agreement with our expectations about the differential in numeracy skills between the native communities and the Spanish.

As we expected in the model (1) the lower class of the Inca system (*Urinsaya)* has 3% less numeracy skill than the upper class *(Hanansaya)* but is of no significance in our model. Those who were not classified into these classes have 4% more numeracy skill than both traditional Inca castes.

The *forasteros indios* have nearly 10% less numeracy than the rest of the population, with significance in our model. This result is in agreement with the description of this social category. While they are not the lowest category regarding social position and tax payments (this would be the *yanaconas*), the *forasteros* were indigenous with no property such as land or

animals and, as we described above, they used to work as salaried workers in the *haciendas*. We can estimate that for the *indios forasteros* the access to educational channels was challenging and the mathematical capabilities were not essential for their daily tasks.

We integrated the regional differences in numeracy skill in the model (2) to have a complete panorama of the social and geographical determinants of Human capital formation. The regions included in the model are controlled by Oruro. The data display that the rural areas of Potosi and La Paz are less numerate than Oruro (10% and 17%). Since the coefficients of La Paz and Potosi have negative signs and are significant at all standard significance levels, we can conclude that the numeracy level in Oruro was significantly higher than in the other regions. Furthermore, it seems that the rural areas of Potosi were the most backward regarding numeracy. Probably the proximity of Cerro Rico means that many inhabitants of this region had to work in the mines, either as free or forced labor. Through this data, we can affirm that numeracy skill was hardly affected at all by the nearness of the mines.

3.5 NUMERACY TRENDS IN BOLIVIA AND THE REGION

Figure (3.2) displays the results of the numeracy trends by regions. The main highlight of this Figure is that Oruro has the highest numeracy in the area. Although the registers of Oruro are late in the time, the numeracy trends are strong enough that is possible to estimate an early differentiation in Human capital formation. Some facts probably explain this high performance. As mentioned above, Oruro was an equal society regarding access to political power and was predominantly made up of free, salaried workers since forced labor was prohibited. Due to the fact that in Oruro the labor force was free, we can estimate that the most qualified laborers were able to move to Oruro to have a better quality of life. Furthermore, as Juif and Baten (2013) argue, individuals migrate to other regions when they expect a higher living standard in the new location. However, in the early modern period, the cost of travel was very high. Migration

requires an investment in resources and psychological conditions that mainly were owned by the most educated and wealthy (Juif and Baten, 2013). Given the data displayed, it is possible to estimate that better institutional environment and better work conditions are beneficial for the formation of Human Capital. On the other side, those institutions which forced the workers to carry out norms linked only with the exploitation of the natural resources are detrimental for the Human capital formation. These are the cases of La Paz and Potosí. These regions had similar numeracy trends. This fact is in agreement with the type of population of these areas: in Potosi, a large part of the population was forced to migrate to the silver mines; the kind of labor qualification that they needed was probably not so high. In La Paz, we have the registers of the *forastero indios*. As we described above, we expected low levels of numeracy skills.

In the same figure are displayed the results of the comparison between Bolivia and two of the late settlement economies of Latin America: Montevideo and Buenos Aires. The data show that the numeracy levels in Oruro remain high when we compare with the Rio de la Plata region. Apart of Oruro, the numeracy trends of La Paz, Potosí, Montevideo and Buenos Aires are similar and continuous throughout the time, however, the numeracy trends of Rio de la Plata is notoriously increasing. The differences between these two regions have been analyzed in depth by the literature. In the first place, these regions had different types of native societies. As we describe above (section 2), in Bolivia there was a sedentary, indigenous community and, for this reason, contact with the conquerors was different as well. Meanwhile, in the Rio de la Plata the native society was not sedentary. Due to the high mobility of the population, the complete lack of stable settlements, and their confrontational character, they had few contact points with the white and sedentary population. The result of this interaction was to avoid each other with some recurrent conflicts, except the Jesuit Missions (Bethell, 1990). The pre-Columbian society in each territory and the late interaction with the conquerors created a distinctive Human capital formation.

In figure 3.3 we compare the numeracy trends of Potosí, La Paz and Oruro with some of the old settlements economies of Latin America: Mexico, Peru, Colombia and Brazil. The trends are similar to the Rio de la Plata; the difference is that Peru has the worst numeracy performance of all the regions. Oruro remains with the highest numeracy trends. The trends in Mexico, Colombia and Brazil are similar and continuous throughout the time.

3.6 SUMMARY AND CONCLUSIONS

We studied in this Chapter the Human Capital formation of the Andean region using three databases: the census of the rural areas of Potosi in the locality of Cerro Rico (1683), the census of La Paz (1684) and the census of Oruro (1735). Using the age heaping technique and numeracy as explanatory variables, we ran five regression models to identify the possible determinants of the Human capital formation. Furthermore, we analyzed the numeracy trends in the region in comparison with two other Latin-American countries. From the data displayed we can arrive at four final remarks.

(1) Our data shows that the reproductions patterns of the Potosi region, La Paz, and Oruro in the 17th century are similar to those of educated women. The high level of numeracy is strongly related to the age of the woman at the first child: the numeracy level is higher when the initiation of fertility is later. This fact was probably a kind of rationality in which the delay to marriage and maternity played a key role regarding educational levels. When we analyze the family size, the data display higher levels of numeracy in those women with fewer children, however, the improvements in numeracy for having smaller families is not so high. In all the models, the female population shows lower levels of numeracy in comparison with the male population. As

with the reproduction pattern, this inequality reproduces the behavior of the Spanish patriarchal society in which women were relegated regarding Human capital formation.

(2) We found lower numeracy levels in the lower castes of the Inca system (*Urinsaya*), and the worst numeracy levels in the *forastero indios* living in La Paz. These remarks show different levels of Human capital formation within the native communities. In this phase of the colonization the differences regarding Human Capital were probably not only linked to the origin (*Indio* or Spaniard) but with a complex net of social positions in which the Spaniards, indigenous and *mestizos* occupied different roles concerning society and institutions.

(3) The rural areas of Potosi were the most negatively affected regarding numeracy. Probably the proximity to one of the most productive primary resources of the period was detrimental for Human capital formation. The evidence shows that a large part of the rural areas of Potosi was destined for the forced migration to the *Mita* and apparently the migrants were the lower-qualified laborers. The opposites were the *forasteros indios* of La Paz and the workers of Oruro. The evidence shows that the poorest levels of Human Capital were the *forasteros indios* because they escaped from the *Mita* obligations. According to the low numeracy, it is possible to conclude that, for those indigenous, the channels to access basic education might be tough and the labor conditions were weak and unstable.

(4) Oruro shows the highest numeracy within the region and still higher when we compare with two of the late settlement economies in Latin America, Montevideo and Buenos Aires. The democratic tradition of this city, in which the first independence rebellion occurred, could have influenced the Human Capital formation of the inhabitants. Furthermore, the existence of work regulations may have attracted more qualified labor force to the region. That result is controversial if we consider that, today, this area is one of the poorest and most unequal economies in Latin America and the world.

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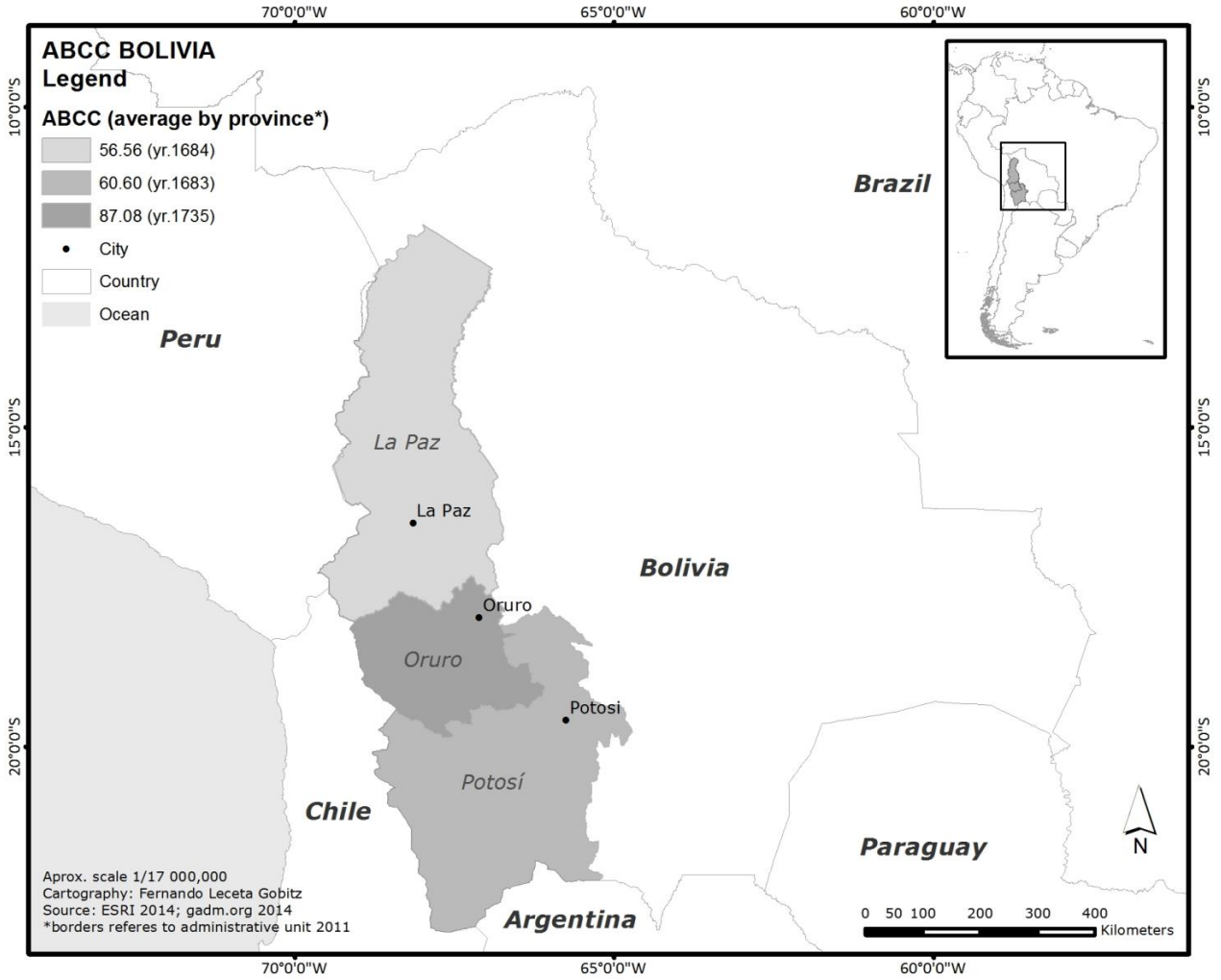
3.8 APPENDIX

TABLE 3.1. VARIABLES DESCRIPTION

%	Potosí census 1683	La paz Census 1684	Oruro census 1735
Indigenus	25,8	0,0	0,0
Spanish	6,2	0,0	0,0
Don	0,3	0,0	0,0
Fememin	41,3	46,5	47,4
Anansaya	16,4	0,0	0,0
Urinsaya	13,6	0,0	0,0
Ayllu	19,4	0,0	0,0
Colque (last name)	3,7	0,0	0,0
Forastero indio	0,0	100,0	0,0
Fertility 14-19 years old	4,5	0,0	0,0
Fertility 20-25 years old	13,0	0,0	0,0
Fertility 26-30 years old	5,8	0,0	0,0
Fertility more than 31	2,9	0,0	0,0
ABCC	60,60	56,56	87,08
Selectivity hipothesis	Negative. Mita requirements	Negative. Forasteros	Positive. Free labor market
Number of cases	6302	202	367

FIGURE 3.1. DATA LOCALIZATION



Sources: Potosí and West Oruro Census 1683, La Paz census 1683, Oruro Census 1735

TABLE 3.2. DETERMINANTS OF HUMAN CAPITAL: SOCIAL DETERMINANTS OF NUMERACY

	(1)	(2)	(3)
Dependent variable	numerate	numerate	numerate
Estimation technique	Logit (mfx)	Logit (mfx)	Logit (mfx)
Population included	All	All	Only woman with children
Reference categories	23-32, no fert, no child, male, single	23-32, no fert, male, single	23-32, child 1-3, fert 14-19
Age group 33-42	-5,1875***	0,15	-17,6
	(0.00)	(0.95)	(0.00)
Age group 43-52	13,6875***	24,2625***	-20,9625***
	(0.00)	(0.00)	(0.00)
Age group 53-62	0,175	8,875*	36,0125**
	(0.96)	(0.07)	(0.03)
1 to 3 children	-7,1375***		
	(0.00)		
4 to 8 children	-9,075***		-1,825
	(0.01)		(0.68)
Fertility: more than 31 years	16,525***	40,525***	32,875***
	(0.00)	(0.00)	(0.00)
Fertility: 26 to 30 years	14,4625***	41,4875***	18,65***
	(0.00)	(0.00)	(0.00)
Fertility: 20 to 25 years	11,6125***	41,35***	9,325***
	(0.00)	(0.00)	(0.01)
Fertility: 14 to 19 years	16,6625***	46,4375***	
	(0.00)	(0.00)	
Woman	-11,8625***	-32,175***	
	(0.00)	(0.00)	
Widowed	-13,05***	0,625	
	(0.01)	(0.96)	
Married	-5,1875	11,1375	
	(0.12)	(0.39)	
number-child		0,6125	
		(0.49)	
Pseudo R-squared	0.012	0.028	0.027
Observations	6,882	4,621	2,007

pval in parentheses

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

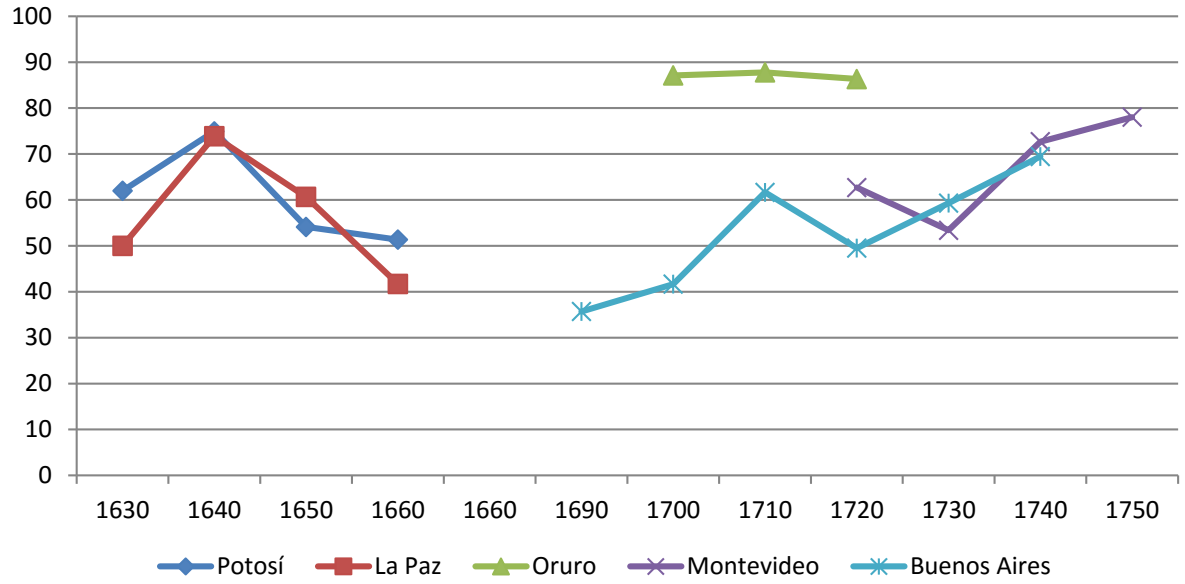
* All the marginal effects are multiplied by 125

TABLE 3.3. DETERMINANTS OF HUMAN CAPITAL: SOCIAL AND GEOGRAPHICAL DETERMINANTS OF NUMERACY

	(1)	(2)
Dependent variable	numerate	numerate
Estimation technique	Logit (mfx)	Logit (mfx)
Population included	All	All
Reference categories	no colque, indig, no don, no forastero, Anansaya, no ayllu, 23-32	indig, no don, no colque, Anansaya, no ayllu, 23-32, Oruro
Colque (last name)	-0,975	-1,075
	(0.82)	(0.80)
Spanish	0,525	0,625
	(0.88)	(0.85)
No class of ethnia	5,5750***	4,00**
	(0.00)	(0.02)
Don	4,2375	5,125
	(0.77)	(0.71)
Urinsaya	-2,9125	-0,3375
	(0.24)	(0.89)
Noclass	3,5875*	4,45**
	(0.06)	(0.02)
Ayllu	-0,9375	0,8375
	(0.68)	(0.72)
Forastero indio	-9,875**	
	(0.03)	
Age group 33-42	-6,7625***	-6,8125***
	(0.00)	(0.00)
Age group 43-52	13,2625***	13,025***
	(0.00)	(0.00)
Age group 53-62	0,95	1,1375
	(0.78)	(0.73)
Potosí		-10,1875***
		(0.00)
La Paz		-17,2625***
		(0.00)
Pseudo R-squared	0.0090	0.011
Observations	6,919	6,919

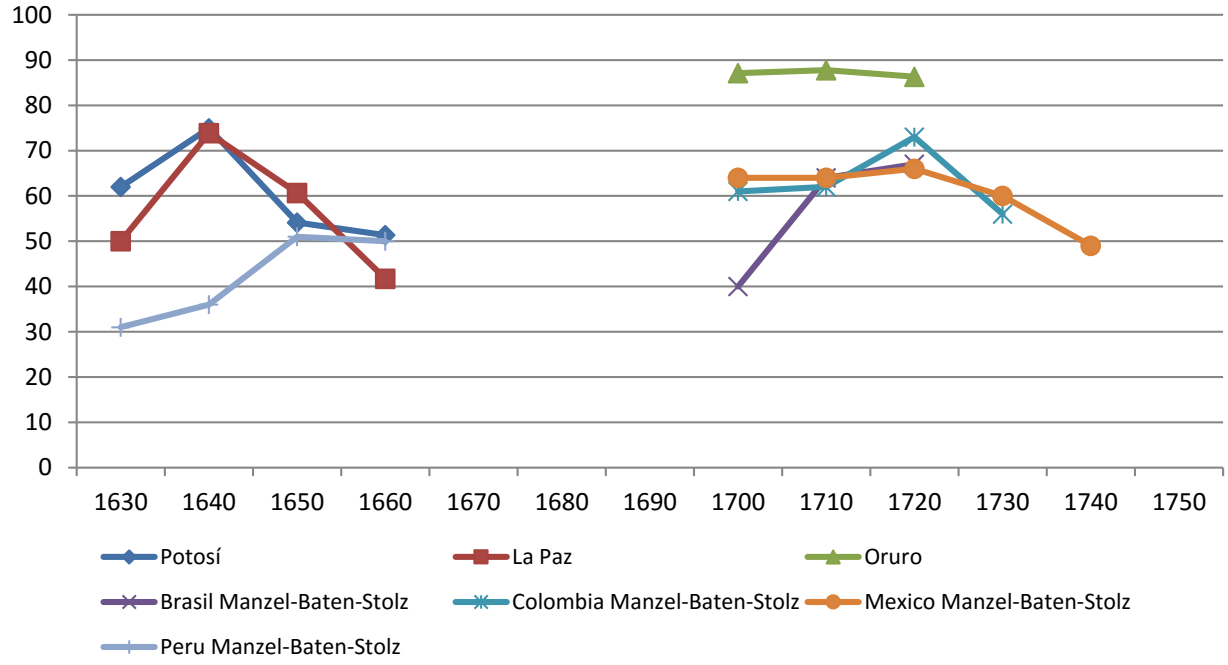
pval in parentheses
*** p<0.01, ** p<0.05, * <0.1
All the marginal effects are multiplied by 125

FIGURE 3.2. POTOSÍ, LA PAZ, ORURO AND RIO DE LA PLATA. 1630-1750



Sources: Potosí and West Oruro Census 1683, La Paz census 1683, Oruro Census 1735, Buenos Aires 1744 Censo Militar. Documentos para la Historia Argentina. Montevideo 1769 Apolant (1965) *Padrones olvidados de Montevideo en el siglo XVIII. Padrón Aldecoa (1772-1773).*
*The year of the horizontal axis represent the first year of a half century of birth

FIGURE 3.3. ABCC TRENDS. POTOSÍ, LA PAZ, ORURO AND THE OLD SETTLEMENTS ECONOMIES



Sources: Brasil, Ecuador, Perú, Colombia, México: Manzel, Baten and Stolz (2012). West Oruro Census 1683, La Paz census 1683, Oruro Census 1735

4. Regional differences in Early Human Capital in Southern Latin America. Rethinking the institutional hypothesis

Abstract

The determinants of the economic disadvantage of Latin America related to Europe is one of the central debates in economic history. Recent research focused on the institutions generated in the colonial period to explain this disadvantage. But who created those institutions? In which level did Human capital influence the creation of institutions? This paper reviews the debate around institutional determinants of economic growth in Latin America. It argues that the formation of Human capital varies widely within countries in Latin America, and the roots of early Human capital were given before the early 1750s

Keywords: Human Capital, Numeracy, Latin America, Growth, Pre-industrial Economies.

Keywords: Human Capital, Numeracy, Latin America, Growth, Pre-industrial Economies.

JEL: I25, N30, N36, O40, P40

4.1 INTRODUCTION

"Institutions and culture first; money next; but from the beginning and increasingly, the payoff was to knowledge."[23]

One of the more influential debates in the Economic History is the economic disadvantage of Latin America related to Europe. Among the main theories in which this disadvantage is explained, those linked to the institutional explanation had acquired a predominant role, mainly those institutions promoted by the conquerors when they settled and exploited the regions (Acemoglu, Jhonoson and Robinson 2001, 2002). These authors provide evidence that colonial factors can explain differences in economic development. Those explanations argue that "depending on the local conditions, colonizers either set up extractive or inclusive institutions in a given country." This argument is complemented with the idea that the "institutions promoted by the conquerors were related to natural resources, hence the main economic activity of the country, and a little further, with the main economic activity of the regions within the countries" (Bruhn and Gallego, 2012). These works examined the conditions under which Latin American countries were more affected by colonization and are inserted into the debate about how the institutions conditioned the economic development.

Excluding some works, the point of these researchers tends to compare the economic performance of Latin America from a national perspective, taking into account institutional, geographical and economic factors. This Chapter contributes mainly to the following:

a. The analysis of Human capital formation in the pre-modern societies of Latin America.

[23] Landes, David (1998), The Wealth and Poverty of Nations: Why some are so rich and some so poor, London, Little brown

b. The incorporation of regional analysis. The aim is to analyze whether the regional inequalities in education aggravated or smoothed within countries during the period 1650 - 1850.

Some of the questions that encourage this Chapter are: Are there differential patterns of formation of Human Capital in Latin America? Which were the differences on Human capital formation within the regions and countries? Did the countries most affected by the colonization also have worse performance in human capital indicators? Were the primary natural resources linked to the formation of Human Capital? Were the different economic systems of exploitation related to the human capital formation? Was the early Human capital formation necessary for the current economic growth?

I collected data from parish registers (death and marriages registers) from nine countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru, Paraguay and Uruguay from the period 1650 to 1900. The objective is to have a representative panorama of the main geographical regions. From these registers, I will approximate to Human capital formation in each national province and geographical area. I will use the age heaping technique (numeracy) as a proxy for Human capital formation.

The Chapter is organized into seven sections. Section (2) discusses the theoretical background with a focus on institutional theory and the central debate around it. The main literature related to the topic is presented in this section. Section (3) describes the historical background with particular focus on the early factor endowments of each region and the literature related to the initial Human Capital in Latin America. Section (4) presents the methods: the age heaping technique and the data set. Section (5) analyses the numeracy trends at the cross-country and regional level, the cartography approach and the inequalities of the local distribution of Human Capital. Section (6) presents the results of the regressions and analyses the possible determinants of early Human capital formation and current economic development. Section (7) concludes. Tables and figures are provided in the Appendix.

4.2 INSTITUTIONS, HUMAN CAPITAL

4.2.1 INSTITUTIONS AS DETERMINANTS OF ECONOMIC GROWTH

One of the most emblematic works with focus on the institutional determinants of economic growth is "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution" (Acemoglu, Johnson, and Robinson, 2002). In this theory is discussed the relation between economic development and geography. These authors argue that, the European intervention in the former colonies created a *reversal of fortune* as they introduced institutions which encouraged investment in the poorer and sparsely populated regions of the pre-colonial era, but they created "extractive institutions" in those areas rich in natural resources and densely populated (Acemoglu, Johnson, and Robinson, 2002). The definition of institutions comes from the work of North (1991): *"Institutions are the human constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been developed by human beings to create order and reduce uncertainty in exchange (…) they define the choice set and therefore determine transaction and production costs and hence the profitability and viability of success in economic activity. They connect (…) the past with the present and the future; history in consequence is largely a story of institutional evolution. Institutions provide the incentive structure of an economy; as that structure evolves, it shapes the direction of economic change towards growth, stagnation, or decline"* (North 1991).

Many scholars support the idea of the institutional determinism. The common factor among the authors is that the institutions created in colonial times have formed the basis of the current systems, which are highly responsible for the present economic growth. But, why they created "better" institutions in sparsely populated areas? The idea underlining is because this fact

enabled Europeans to settle and develop institutions encouraging investment. In contrast, "those densely populated and relatively prosperous areas made extractive institutions more profitable for the conquerors." Colonizers "established extractive institutions in places where the net benefits of having extractive institutions exceeded the net advantages of setting up inclusive institutions". (Acemoglu, Johnson, and Robinson, 2002).

The variables that seem to be related to the net profit of the institutions for these authors are the settler mortality, the pre-colonial population density and the natural environment for activities with strong economies of scale. However, the potential settler mortality should be related to the population density. Why would the colonizers have high chances to die in a densely populated area? The explanation is that "in places where the mortality rate from the disease for Europeans was relatively high, the odds were against the creation of settler colonies with inclusive institutions, and the formation of extractive institutions was more likely." Finally, these colonial institutions, once set up, have tended to persist.

The institutional hypothesis of AJR is strongly accepted by other scholars and it is closely associated with the work of Coatsworth (1993), Engerman and Sokoloff (1997, 2000), and Easterly and Levine (2002), who emphasize the adverse effects of the plantation complex in the Caribbean and Central America working through political and economic inequality.

Other paper linked to the institutional hypothesis is "Good, bad and ugly economic activities: do they matter for the economic development?" (Bruhn and Gallego 2012). This Chapter uses an argument related to AJR to explain within-country variation in economic development across the Americas, and one of the main contributions is the regional approach. The authors argue that "colonizers engaged in different economic activities in different regions of a country. Some of these activities were "bad" since they tended to create extractive institutions and encouraged fewer Europeans to settle in the area; other activities were "good" and created inclusive institutions and encouraged more Europeans to settle the region; and the rest of the activities were "ugly" since they used the native population as an exploitable resource" (Bruhn and

Gallego 2012). This hypothesis makes a classification into different kind of institutions depending on the primary economic resource of the region. As it is a regional approach, their results vary within the geographical areas not depending on political delimitations.

Many authors involved with the institutional hypothesis claim that the period in which the institutions were shaped was during the Colonial era. Some characteristics such as the factor endowments, the risk of settler mortality, the pre-colonial population density and the early "wealth" of the conquered area were key factors in this institution's shape. With some variances among the scholars, this hypothesis is strongly supported.

4.2.3 THE LINK BETWEEN INSTITUTIONS AND HUMAN CAPITAL FORMATION.

How could the institutions have determined the formation of Human Capital? Or was the Human capital brought by the colonizers a key factor in the creation of institutions? This idea is also large debated in the literature, and some scholars consider the Human Capital brought by the colonizers before the institutions (e.g. Glaeser et al. 2004).

These authors criticized the approach given by AJR given above (s.f. 4.2.1); they suggest that the main thing that the Europeans brought to their colonies was Human capital, and they expanded it very differentially across them. In regions where they brought better Human capital the economy was developed with better conditions and the society came to be organized more efficiently. Areas where they brought worst Human capital failed.

However, according to AJR (2001), "extractive institutions were intended to transfer as much as possible of the resources of the colony to the colonizer." This fact did not require the introduction of extensive civil rights, protection of property rights, or checks and balances against government power. It also did not need significant settlements of Europeans in the colonies. For this reason, this kind of institutions discouraged investment in physical and Human capital and had negative impact on long-run levels of development. With the setup

of inclusive institutions, on the other hand, it was possible to put into place constraints on government expropriation, an independent judiciary, and property rights enforcement, equal access to education, civil liberties, and unlimited immigration from Europe. This fact is one of the reasons why Europeans settled these regions. Inclusive institutions lead to high long-run levels of development.

But Glaeser et al. (2004) revisit this hypothesis. These authors discuss whether political institutions cause economic growth, or whether, growth and human capital accumulation promote institutional improvement. They highlight that Human capital is a more fundamental source of economic growth than institutions. They discuss the way in which the new intuitionalists set up the standard measures of institutions and they argue that "These measures are not constructed to reflect either constraint on government or permanent features of the political landscape. Instead, they are highly volatile and mean-reverting. They are barely correlated with the available objective measures of constitutional constraints on government. Yet these are the variables used to show that institutions cause growth". (Glaeser et al 2004).

Through some estimation these authors arrived at the suggestive results like the initial level of education in the population is a strong predictor of the current economic growth. They link this result with theories of growth in which Human capital generates externalities like technological innovation (e.g. Lucas 1988). Furthermore, they argue with an alternative interpretation in which Human capital leads to more benign politics, political stability, and less violence: "Human capital externality is not technological nut political: courts and legislatures replace guns" (Glaeser et al. 2004). This view is connected with Lipset (1966) theory. Lipset argued that "educated people are more likely to resolve their differences through negotiation and voting than through violent disputes. Education is needed for courts to operate and to empower citizens to engage with government institutions". Literacy, for example, encourages the spread of knowledge about the government's malfeasance. According to this view, countries differ in their stocks of human and social capital—which can be acquired through policies pursued even

by dictators—and institutional outcomes depend on a large extent on these endowments (Djankov et al. 2003). The hypothesis of Lipset has received considerable support in the work of Przeworski, (Alvarez et al. 2000) and Barro (1999). They both emphasize the need for secure property rights to support investment in human and physical capital, and they both see such security as a public policy choice. However, the institutional view considers the pro-investment policies as a consequence of political constraints on government (Glaeser et al 2004).

Two of the main variables involved in the set-up of the institutional measures are the potential settler mortality and the pre-colonial population density. These variables are questioned by Glaeser et al. when they highlight that even though the mortality risk or the native pre-colonial population density could have shaped some of the Europeans settlement decisions, it is clear that the Europeans brought with them more than a limited government, instead of this "they brought themselves, and therefore their know-how and Human Capital" (Glaeser et al. 2004). However, these authors explain in their conclusions that they do not mean that the institutions do not matter for development –that theory would be difficult to hold-, they illustrate through some models that the Human capital brought by the colonizers was before (or created) the institutions.

This theory has an answer in the recent paper of Acemoglu, Gallego, and Robinson (2014). These authors focused on historically determined differences in Human capital controlling by the institutional effect. In their results, they show that the impact of the institutions in the long run development is robust, while the consequences of the Human capital indicators are diminished. Specifically about the question, if the institutions precede Human capital and *vice versa,* these authors display evidence that colonizers of South America were more educated than the British and other colonizers of North America. They made reference to Lockhart (1972) who provided information about the travelers who accompanied Pizarro on his conquest of Peru. Through their ability to sign (literacy) this author concludes that the travelers were enough educated. As Engerman and Sokoloff (2011) stresses, by the 19th century literacy and

educational attainment was higher in North America than in Latin America, however, according to Acemoglu, Gallego and Robinson (2014) this fact has nothing to do whether Europeans brought much or little Human capital with them at the time they settled. This fact has "everything to do with institutions that later developed in different colonies" (Acemoglu, Gallego and Robinson 2014).

Many scholars involved in this topic attempt to explain the origins of the inequality or economic backwardness of the underdeveloped countries. The construction of different measures of institutions and Human capital to explain the economic growth is one of the biggest efforts in Economic History. In this Chapter, I also use a proxy of Human Capital (the numeracy) and other variables as potential explanations of the Human capital formation and the regional differences in Southern Latin America. However, it is difficult to consider that only some variables can explain such kind of phenomena. It is also hard to believe that the Human capital formation was not closely linked to institutions. And finally, it is hard to analyze one of these facts as a precursor of the other.

In this way, this Chapter attempts to make a contribution to the debate on the origins of Latin America divergence taking into account that this discussion is complex and has multiple explanations.

4.3 HISTORICAL BACKGROUND

4.3.1 THE LINK BETWEEN EARLY FACTOR ENDOWMENTS AND INSTITUTIONS/HUMAN CAPITAL.

Latin America covers an area of 20,541,000 km², approximately 14 percent of the world´s land surface. Although so large, and so long, Latin America has certain features that provide cultural unity. Most important, perhaps, is its location in a particular part of the world relatively remote from outside influences. In such a vast area, almost every kind of climate is to be expected and all types of vegetation are encountered Cole (1965). According to Cole (1965), the inhabitants

of pre-Columbian America could be divided into hunters and gatherers on the one hand and cultivators on the other. The cultivators were two main kinds, shifting and sedentary. Shifting cultivation was found mainly in the tropical forest areas, sedentary agriculture in the temperate forest (Southeast USA), drier areas and mountainous regions. By about 1600 a different spatial distribution of economic activities in the Americas had emerged, and this remained without modification until the early 19th century. According to this author, it is possible to distinguish the following types of economies: a) almost all the sugar and other tropical crops are grown on plantations for export to Europe were produced along the 6,000 km line. Sugar was produced in small quantities elsewhere, but largely for local consumption. b) The mining areas of Mexico, Peru and *Minas Gerais* in Brazil were not determined by the distance from Europe but by the occurrence of accessible deposits of gold, silver and later precious stones. c) In lands that were neither humid nor densely forested nor excessively dry, the raising of livestock, especially cattle, developed in the colonial period. These areas are relatively thinly populated; the cattle were either loosely organized in large *estancias* or left to roam wild (*ganadería extensiva*). Cattle were mainly used in the colonies for a large number of purposes such as Saddler, storing water and carrying liquids, making clothing and so on. The most extensive areas of cattle were in the northern part of Mexico, the northern part of Argentina, the land behind the coast of Brazil, Uruguay, the llanos of Venezuela, and Cuba (Cole 1965).

Some theories of economic development for Latin America have put considerable attention on the structural features of the region. For example, the land-tenure system, which was inherited from the Iberian Peninsula, was seen as an obstacle to development; and the legal and administrative apparatus, which was inherited from the colonial powers, was considered to be a barrier to private entrepreneurship and efficient decision making in the public sector. However, the institutional and structural landscape inherited from the colonial period was not homogeneous and has changed significantly over time (Bulmer Thomas 2003).

The institutional hypothesis concerning the factor endowments and the "good" and "bad" activities (c.f. 4) goes further with the commodities lottery highlighted by Bulmer-Thomas. This author stresses that the factor endowments differ regarding their relative demand. Some goods, such as meat, have enjoyed and still enjoy relatively high-income elasticity of demand. Others, such as coffee, have seen income elasticity decline over time, as this product has moved from being a luxury good to being an article of basic consumption. Some commodities such as gold have no close substitute, whereas others like cotton face competition from synthetic products, so that the price elasticity of demand is high (Bulmer-Thomas 2003). Hence, from this point of view factor endowments not only had promoted "good" or "bad" institutions (better or worst Human capital?), but they also faced different rivals throughout time. Again, which kind of Human capital was required by each commodity? Why is it relevant to analyze the early Human capital formation?

4.3.2 Human capital in Latin America: Brief literature review

The formation of Human Capital is considered one of the most important drivers of economic growth, not only nowadays but also in earlier periods, especially during the transition from the Malthusian stagnation to the modern growth. This fact was highlighted by many scholars such Romer (1990), Lucas (1988) and more recently by the unified growth theory supported by Galor (2005), Galor and Moav (2002), Galor and Weil (2000). However, the importance of Human capital was not always recognized in Latin American historiography.

According to the literature, some of the colonial settlements were created and their resources shipped back to the Old World for profit. Education was for the colonizers, the only transmission of an ornamental culture (Gomes 1993; Azevedo 1963).

Once the independence was achieved, the Latin American countries kept their export-oriented economies based on mining and agricultural products, such as coffee, sugar, cacao, and

wheat. Some countries, like Argentina, Chile, Costa Rica and Uruguay, developed their educational systems and received benefits (Furtado 1970; Prebisch 1963). In this context the whole continent, in particular the countries with strong mining economies were affected by investment in Human Capital formation.

Recent research reveals the importance of the set-up of Human capital indicators to analyze the Regional Differences in Europe (Hippe and Baten 2011). As the researchers devoted to the reconstruction of early regional GDP, the construction of Human capital indicators in the local perspective contributed to the analysis of regional inequalities in education in Europe. However, the regional differences in Human Capital in Latin America are still unexplored. This Chapter is a contribution toward filling this gap in the literature.

Concerning the national level, many efforts have been made to analyze the Human Capital trajectories of the different countries of Latin America. Taking into account databases of Latin America and developed countries, studies have found that inequality in education was higher in Latin America before the 20th century. Globalization in the 20th century seems to have had positive effects by reducing educational inequality (Baten and Mumme 2010). Regarding numeracy (mathematical skills), they argue that "Latin America was on a path of convergence with Western Europe during the early 18th century and there was stagnation of numeracy levels in the 19th century". Furthermore, they found that the differences between the countries increased in this period (Manzel, Baten and Stolz 2011).

In this Chapter, I will introduce a regional analysis of the Human capital formation in Latin America. The aim is to analyze differences among the regions and possible divergences of Human capital formation within the countries. Furthermore, I will add an analysis of the potential determinants of the Human capital formation.

4.4. METHODS

4.4.1 DATA

The data collected are marriage registers from Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, Peru, Paraguay and Uruguay in the period 1600 to 1850 from the website familysearch.org. The internet site of family search was developed by the Mormons with the aim to compile a different kind of parish registers, population registers and census of various regions of the world. The primary objective was to create a genealogical database in which each person could find their roots. The site contains a vast database of information about gender, age, family relations and precedence among others. This information came from birth registers, death registers, marriages registers, and census. In this paper I collected the marriage records since the primary data to analyze is the age and presumably, bride and groom could declare the age themselves. I compiled a relative large database of marriages registers (N=109,273) of the countries mentioned above by provinces. I used the National and current territorial definitions to classify the different provinces. Depending on the year of the register I collected from 40 to 55 provinces of the whole continent, but unfortunately, it was not possible to find the same number of records for each period since the data availability is no continuous throughout time. Furthermore, the regional specification is not well defined for all the countries. The following table displays the number of registers per country.

TABLE 4.1 REGISTERS PER COUNTRY

Country	1700	1750	1800	1850	Total
Argentina	168	5,135	37,383	2,884	45,571
Bolivia	67	661	293	204	1,240
Brasil	22	967	10,527	9,583	21,101
Chile	439	3,484	15,399	2,472	21,972
Colombia	-	421	3,496	3,797	7,715
Ecuador	-	122	1,422	760	2,305
Paraguay	-	62	931	1,161	2,154
Peru	1.091	4.338	-	-	5,772
Uruguay	-	64	100	80	245
Total	1,790	15,254	69,551	20,941	108,075

The marriages records are lists of the people who got married in the local parish. The data collected are the names of the grooms, gender, birth and marriage place, and age. The advantage of having the birth, marriage and death place is that it is possible to collect regional data within the countries. The main outcome variables of this analysis are age and birthplace. From the total of the registers were omitted those persons younger than 23 years and older than 62. The amount of records given the previous restrictions is 109,273 (a table displays the detail in the appendix). With the ABCC index calculated from the age, I approximate to Human capital formation in the different provinces of Latin America.

4.4.2 AGE HEAPING FROM MARRIAGE REGISTERS

Even though recent research has introduced indicators on Human capital formation for early periods, data availability is still a limiting factor. Unfortunately, evidence on regional inequality of Human Capital in Latin America before modernization is scarce. As Human capital cannot be measured directly, it has to be approximated by related, quantifiable variables. Examples of such proxies employed for modern times include literacy, numeracy, enrollment rates, years of

schooling or books per capita (e.g., A´Hearn et al. 2009; Baten and van Zanden 2008; Benavot and Riddle 1988).

Most of the methods used to measure Human Capital formation (literacy and school enrollment) are not able to estimate Human capital levels before the second part of the 19th century. For instance, school enrollment data is rather scarce in Latin America as compulsory education started after 1870 (Rama and Tedesco 1979). Literacy rates are obtained by signature rates in a significant number of studies (Reis 2005; Mitch 1993; Schofield 1991) but unfortunately this indicator is not always available to compare the regions of Latin America on a larger scale.

Trough the age heaping technique I was able to avoid some of the limitations of the lack of data as usually the age appears in a big part of documents such as census and parish registers. This fact is the reason why this technique has been used in recent studies (e.g., A´Hearn, Baten et al. 2009; Baten and Mumme 2010; Manzel, Baten and Stolz 2011; Juif and Baten 2013; Friesen, Baten and Prayon 2012).

The age heaping method investigates the numeric skills of a population. It uses the declarations made in different documents such as census or parish registers. In this Chapter, it is calculated by using a transformed Whipple index. The quality of age reporting can be measured by means of age-heaping indices to detect the degree of preference for or avoidance of certain ages. Among standard indices (Bachi 1951; Myers 1976; Zelnik 1961),[24] the Whipple index is the most widely applied.[25] The usual objection of this technique is that factor other than Human capital could also be attributed to the age heaping. For instance, intentionally false age declarations, which were made to avoid the negative consequences of being part of a specific age group, and bad state administrations played some role. However, other studies have already

[24] The methods used to calculate these indices are in Shyrock and Siegel (1976: 115–119).

demonstrated that educational investments play the most important role in age heaping when they are included in models of multiple regressions, and that other institutional factors have no systematic impact (Crayen and Baten 2010). Furthermore, age heaping is highly correlated with literacy indicators, which has already been demonstrated by previous research (e.g., Crayen and Baten 2010).

The original Whipple index is obtained by summing the number of people in the age range 23–62 (inclusive) and calculating the ratio of reported ages ending in 0 or 5 to one-fifth of the total sample. As pointed out above (c.f. 3.1), the index assumes a linear distribution of ages in each range of five years, i.e. a continuous and linear decrease in the number of persons of each age within the age range considered. Low ages (0–23 years) and high ages (72 years and above), for which the linearity assumption is not plausible, are excluded from the calculation (Spoorenberg and Dutreuilh 2007). Thus:

$$Wh = \left(\frac{\left(Age25 + Age30 + Age35 + ...Age60\right)}{1/5 \times Age23 + Age24 + Age25 + ... + Age62} \right) \times 100$$

A'Hearn et al. (2009) suggested another index for an easier interpretation: the ABCC index.[26] This is a simple linear transformation of the Whipple index and yields an estimate of the share of individuals who correctly report their age. The index takes the values between 0 and 1. A value of 0 means total age heaping whereas a value of 1 means no heaping at all.[27]

[26] The name results from the initials of the authors' last names plus Greg Clark's, who suggested this in a comment on their paper. Whipple indices below 100 are normally caused by random variation of birth rates in the 20th century rich countries. They do not carry important information; hence, they are normally set to 100 in the ABCC index.

[27] To visualize the evolution of the ABCC index by birth decades, I calculated the birth decade of each group by the median age. For example, in the cohort 23–32 years old, I calculated the birth decade of those who are 27 years old. Furthermore, I excluded from the calculation those cases that were less than 30 registers.

I calculated the age heaping of marriages registers. Other studies in which the ABCC was calculated with parish registers have demonstrated that that heaping in marriages registers seem to be less pronounced than in death registers or census (Plötz 2013, Bucher 2013). For this reason, I corrected the ABCC values by a correction factor (see Bucher 2013).[28]

To make the analysis more robust I studied the relation of the ABCC with two of the most used Human capital indicators: school enrolments in 1900 and literacy in 1900[29] in the national level. The information about school enrollment is from the estimation of Benavot and Riddle (1988). Enrolment ratios are calculated by taking the number of students at a particular educational level (primary, secondary and tertiary) and standardizing this number by a measure of the school age population. These the estimations of these authors are based in primary enrolments, therefore, children between 6 and 10 years old. Unfortunately, this information is available for some of the countries considered in this study and covers the national level[30].

Furthermore, I studied the relation between literacy in 1900 and numeracy. Literacy rates were taken from the Moxlad database[3132]. The literacy rates are defined by the share of individuals in the population that are able to read and write. Although both, literacy and primary school enrolments are indicators of a later period, I considered that the initial mathematical abilities could influence in subsequent educational levels. The following table (4.2) display basic information about these indicators. In the distribution of the three indicators, Argentina and Uruguay are always at the top of the list and Bolivia at the bottom. The ABCC estimations from Brazil are probably overestimated since the performance of this country in literacy and school enrollment in 1900 is verly low. The subsequent regional analysis will provide more information on this issue. Table 4.3 and 4.4 show a positive and significant relation between

[28] I limit the data to the years above 23 and below 72 years old. Under 23 years it is possible that the individuals did not declare the ages themselves. Ages above 72 may be prone to a selection bias because those only who still alive can be counted (see Crayen and Baten 2010)

[29] Unfortunately there is no registers of school enrollments and literacy in the 1850s.

[30] Data is available for Argentina, Brazil, Chile, Colombia, Perú and Uruguay.

[31] http://www.lac.ox.ac.uk/moxlad-database

[32] Data is available for Argentina, Brazil, Chile, Colombia, Perú and Uruguay.

numeracy/primary school enrolments and numeracy/literacy. In both cases, the relationship is positive and significant. In the case of literacy (Table 4.3), the relationship loses significance once I include the control variables of geography. In the case of school enrolments in 1900 (Table 4.4) the relationship is positive and significant and remain significant once I controlled by the geographical variables. From this results, it is possible to argue that the ABCC it is a significant indicator to study the early Human capital by complementing the analysis of the conventional indicators of education.

TABLE 4.2. ABCC 1800, LITERACY 1900 AND SCHOOL ENROLMENTS 1900

Literacy 1900		ABCC 1800		School Enrolments 1900	
Uruguay	54	**Uruguay**	85,27	**Argentina**	33,9
Argentina	52	**Argentina**	66,22	**Uruguay**	28,3
Chile	43	Brazil	65,44	Chile	21,7
Perú	38	Colombia	51,83	Colombia	15,8
Colombia	32	Perú	46,33	Perú	12,5
Brazil	25,6	**Bolivia**	44,32	Brazil	10,2
Bolivia	17	Chile	44,11	**Bolivia**	7,9

Sources: Abcc familysearch.org, school enrolments: Benavot and Riddle (1988), literacy: Moxlad database.

TABLE 4.3. RELATIONSHIP BETWEEN NUMERACY AND LITERACY

	Model 1	Model 2
Estimation technique	OLS	OLS
Dependent variable	ABCC	ABCC
literacy_1900	0.23**	0.11
	(0.016)	(0.332)
dist_sea		7.94***
		(0.007)
altitude		-3.06**
		(0.025)
rainfall		0.41
		(0.113)
Constant	52.44***	54.53***
	(0.000)	(0.000)
Observations	133	132

R-squared	0.04	0.22

Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 4.4. RELATIONSHIP BETWEEN NUMERACY ANDSCHOOL ENROLMENTS

	Model 1	Model 2
Estimation technique	OLS	OLS
Dependent variable	ABCC	ABCC
School enrolment in 1900	0.39***	0.33**
	(0.002)	(0.018)
dist_sea		9.10***
		(0.002)
altitud		-2.52*
		(0.051)
rainfall		0.45*
		(0.086)
Constant	53.78***	51.74***
	(0.000)	(0.000)
Observations	133	132
R-squared	0.06	0.25

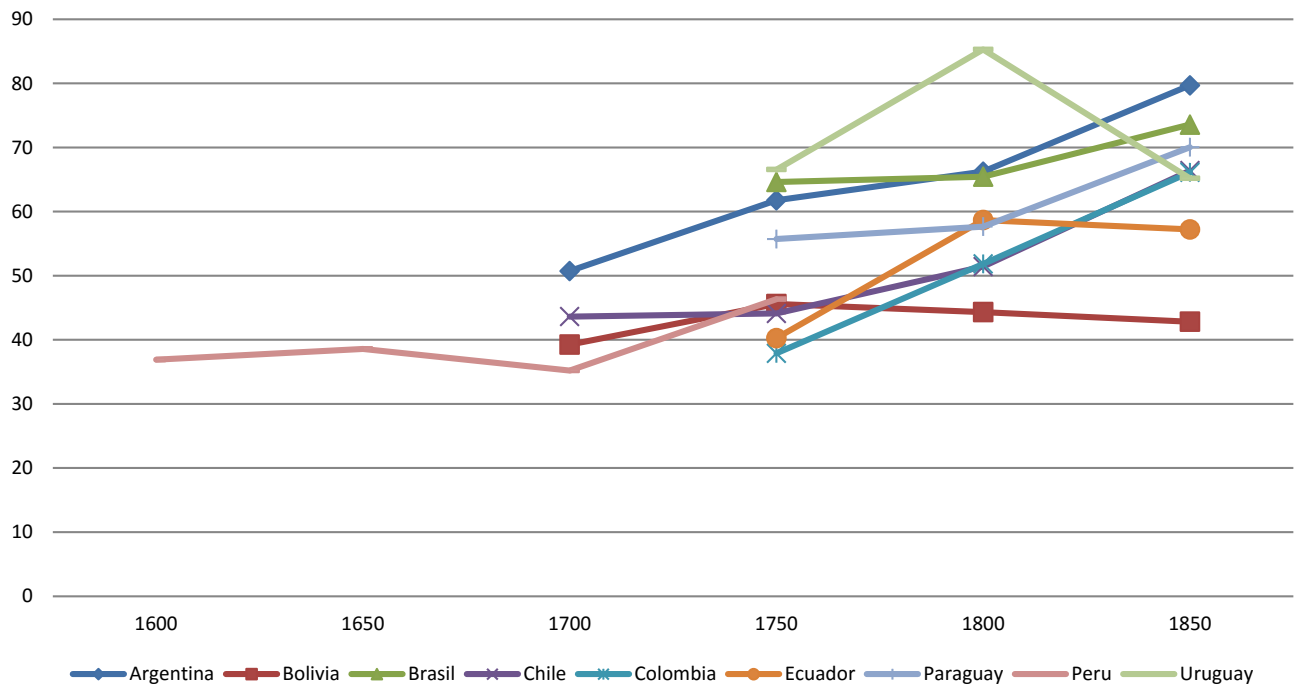
Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.5 NUMERACY TRENDS: CROSS-COUNTRY AND REGIONAL LEVELS

To have a general idea of the distribution of numeracy among the Latin American countries, I calculated the ABCCs for nine South American countries between 1650 and 1850. All the trends are presented in half decades, taking into account the birth decade of the person. The results of the trends are related to some stylized facts of the institutional hypothesis. The general trends can be interpreted as educational levels/Human capital formation of the countries considered.

Figure 4.1 displays the results of the numeracy trends at cross-country level in the marriages registers[33]. The pattern of the numeracy trend is consistent with the institutional hypothesis given above (Sections 2.c and 2.d).

FIGURE 4.1. NATIONAL TRENDS 1600-1850



Source: familysearch.org

In this figure Argentina, Uruguay and Brazil have the highest numeracy meanwhile Bolivia remains with the lowest. The high levels of numeracy in Argentina and Uruguay follow the institutional hypothesis in two ways:

1. In the first place they are countries of relative late colonization and were relatively *sparsely populated* until the conquerors established the settlements (except the Jesuitical

[33] It is necessary to clarify here that each country trend does not have data of all the provinces. For example Brazil has a good performance in numeracy throughout the period but the marriages registers – with the current administrative borders- are from: Alagoas, Goias, Parana, Bahia, Maranhao, Pernambuco, Brasilia, Rio de Janeiro, Rio Grande do Sul, Minas Gerais, Parana, Paraiba and Ceará. From Amazonas there is registers of 1750 but unfortunately the quantity of the registers is not enough to calculate the numeracy all over the period.

missions in the South of Brazil and North Uruguay). The literature considers these territories as settlement economies. This concept was created by the economic historiography to describe the patterns of the extra-European regions of template weather (Nurkse 1961; Armstrong 1978; Fogarty, Gallo and Diéguez 1979; Fogarty 1977; Denoon 1983; Platt and Di Tella, 1985; Schedvin 1990; Cain and Hopkins 1993; Lloyd 1998; McAloon 2002; Bértola and Porcile 2002). These regions, unlike the tropical countries, reached high-income levels in the early 20th century. This fact is associated with the institutional hypothesis, which highlights that the sparsely populated territories benefited from "better institutions" as the conquerors settled these areas replicating their institutions.

2. In the second place, these territories are mainly *livestock economies* (especially the Pampa Argentina, Uruguay and the South of Brazil). That means that the primary natural resources of these societies were the leather (before the refrigeration of meat) and after modernization the meat and other derivatives of the cow. According to the institutional hypothesis economic activities such cattle or agriculture shaped better institutions compared to plantation or mining economies.

At least two of the assumptions of the institutional theory are confirmed –with some differences- in the numeracy trends at the cross-country level. Lower settled regions in the pre-colonial era and cattle economies show high numeracy values throughout time. In the case of Brazil, there is a discrepancy between the literacy levels of this period given by (Engerman, Mariscal, and Sokoloff, 2009) and (Newland, 1992). The previous figure displays a cross country trend, thus does not reflect the weight of each region within the countries. In the case of Brazil the previous conclusion is no entirely confirmed by the data since a big part of the registers are from the South of Brazil, and the trend reflects the numeracy of the rest of the provinces.

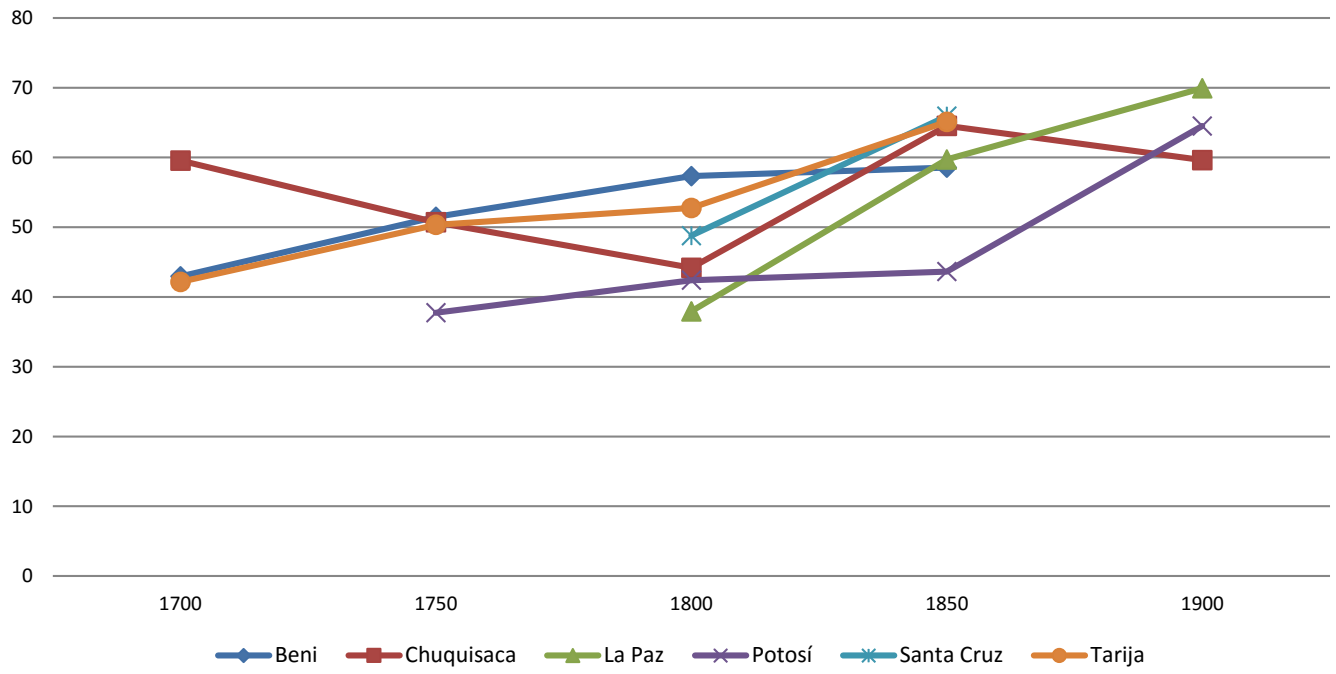
This figure shows that Bolivia has the lowest levels but also Peru and Colombia have low numeracy rates. Peru and Bolivia were countries of early colonization and were *densely populated* by native civilizations when the conquerors arrived at these territories. The natural resources of these economies were also different from the new settler economies: the primary resource was *mining* (the silver and other metals). According to the literature in these economies was established, since the pre-colonial period, an extractive institution with the objective of exploiting the silver mines. Furthermore, the amount of native population allowed the Spaniards to incorporate labor force in precarious conditions. One of the most studied examples of this situation occurred in the Potosí mines with the creation of the *mita* system (Tándeter 1992). The institutional hypothesis that claims that the territories affected by "bad" institutions are confirmed in the lower numeracy trends of Bolivia, Peru, and Ecuador. Densely populated regions and mining and plantation economies seem to have been detrimental to the formation of Human Capital. This assumption is empirically demonstrated in the numeracy trends throughout time.

Other countries under analysis such as Paraguay, Chile, and Ecuador have medium numeracy levels and, for example, Chile converges in the early 1850s with the countries of better performance. While a large part of the territory is devoted to cattle—mainly the Central Valley—the North of Chile, *Norte Chico* and *Norte Grande*, are dedicated to mining. These provinces were border of Peru, Bolivia, and North Argentina and were a strong regional exchange area in the period under analysis. The Norte Chico abounded in high-grade ores, the mining of which required little in the way of capital, and whose processing required only simple technical methods. Some of these were ingenious: the *trapiche,* the ore-grinder for gold and silver, seems to have been a local innovation (Collier and Sater 2004). It is not surprising that in such a miscellaneous economy, the requirements for Human capital formation were different and linked to the primary activity of the region.

In sum, the results show that the Human capital requirements of each economy were diverse. Furthermore, the formation of Human capital of the old and new settlements economies was also different. Was it relevant for the livestock economies to have "better" Human capital? Were these mining extractive economies detrimental for Human capital formation?

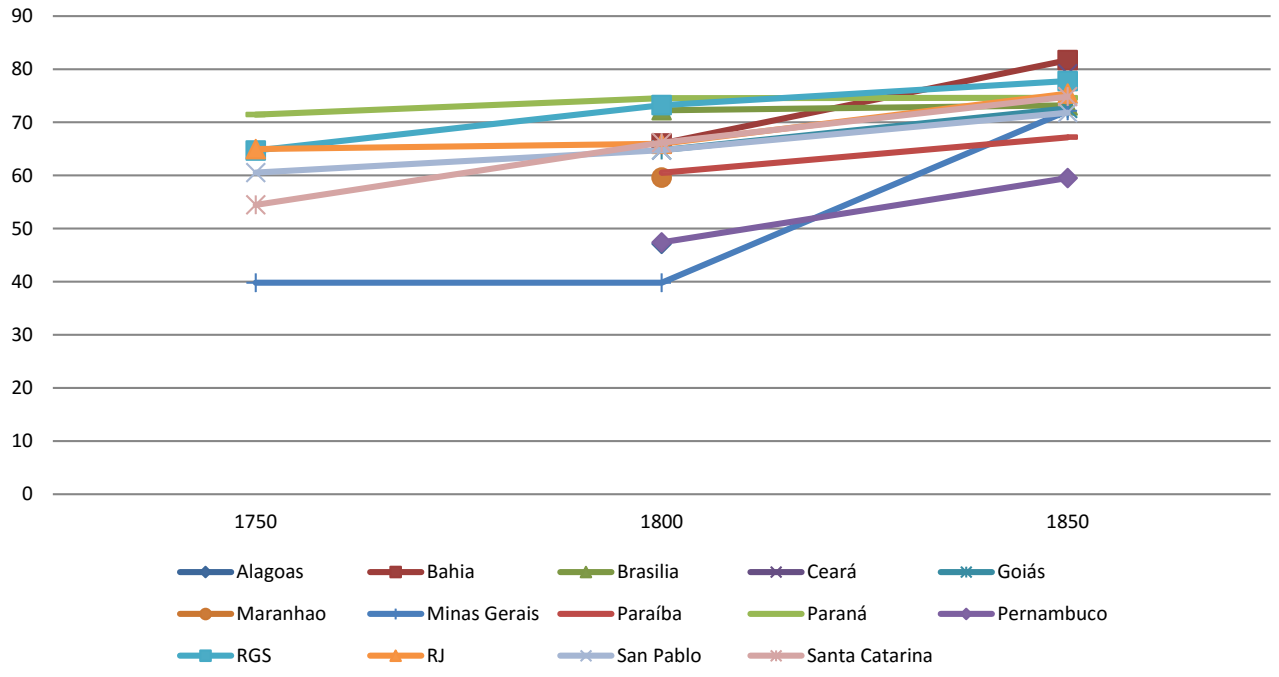
Figures 4.2–4.9 display the regional trends of numeracy in each country.[34] The figures have some similar patterns: in all the countries the ABCC values have a positive trend throughout time.

FIGURE 4.2. ABCC TRENDS BOLIVIA. 1700-1900



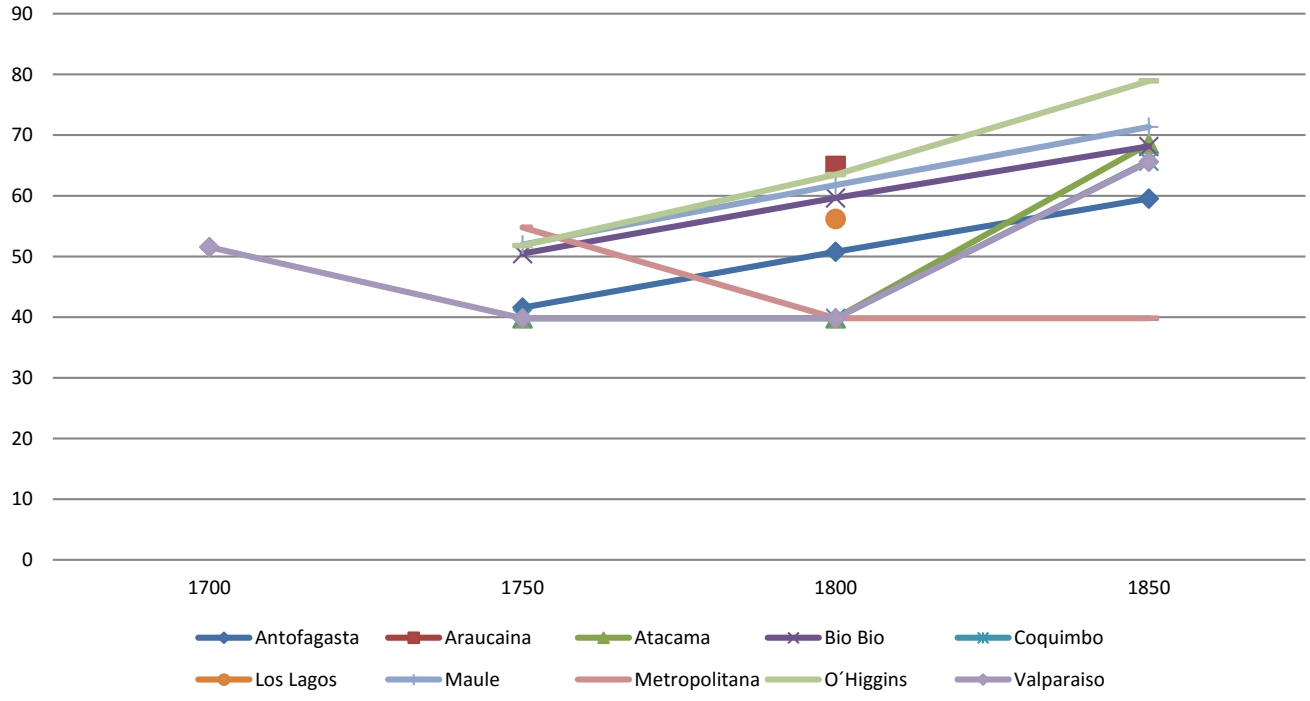
Source: family search.org

FIGURE 4.3. ABCC TRENDS BRAZIL. 1750-1850



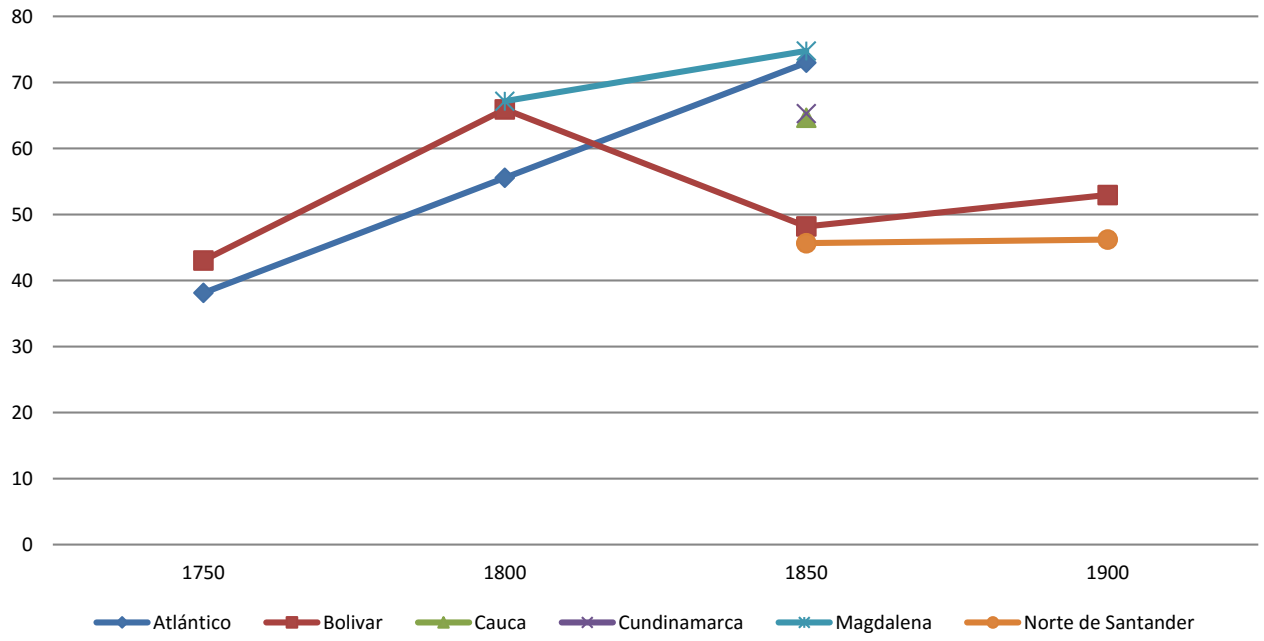
Source: family search.org

FIGURE 4.4. ABCC TRENDS CHILE. 1700-1850



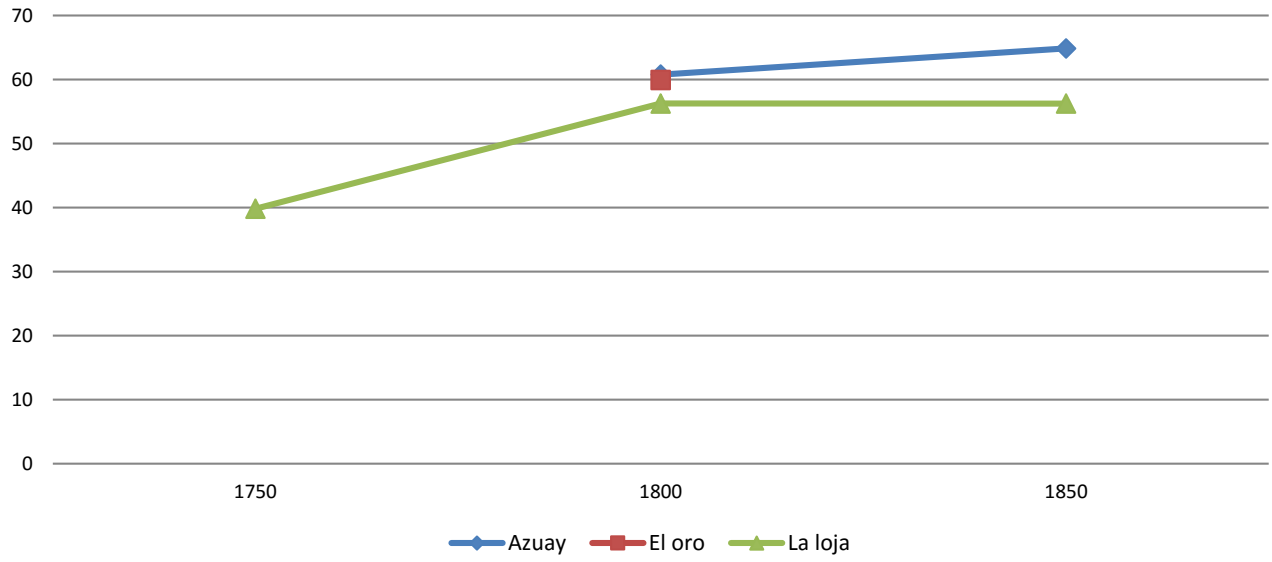
Source: family search.org

FIGURE 4.5. ABCC TRENDS COLOMBIA 1750-1900



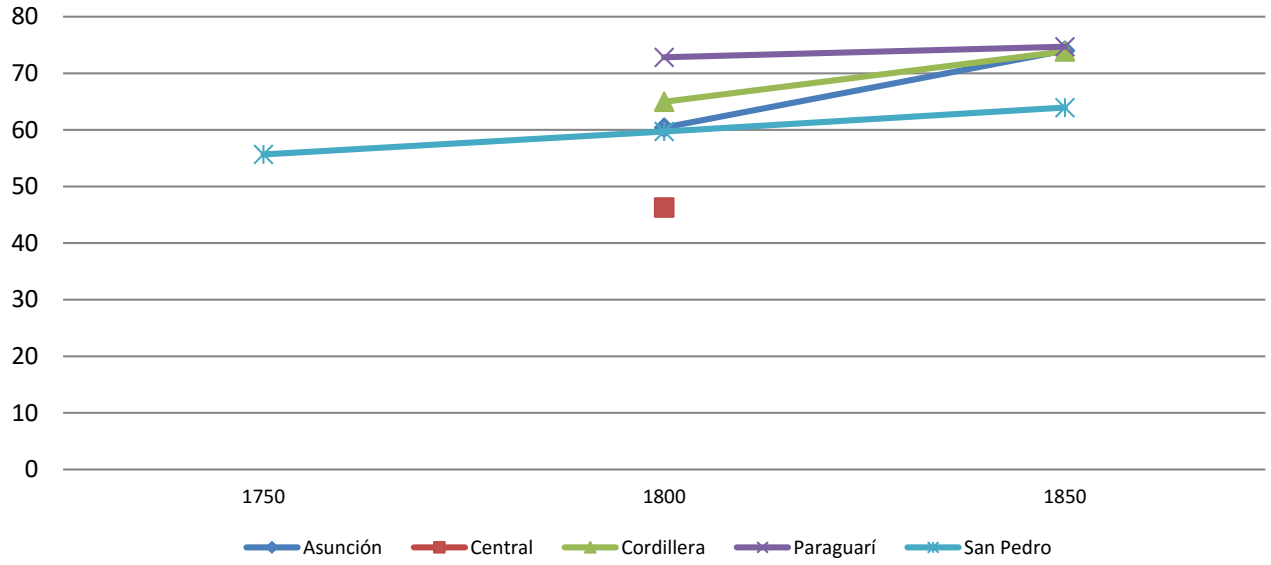
Source: family search.org

FIGURE 4.6. ABCC TRENDS ECUADOR. 1750-1850



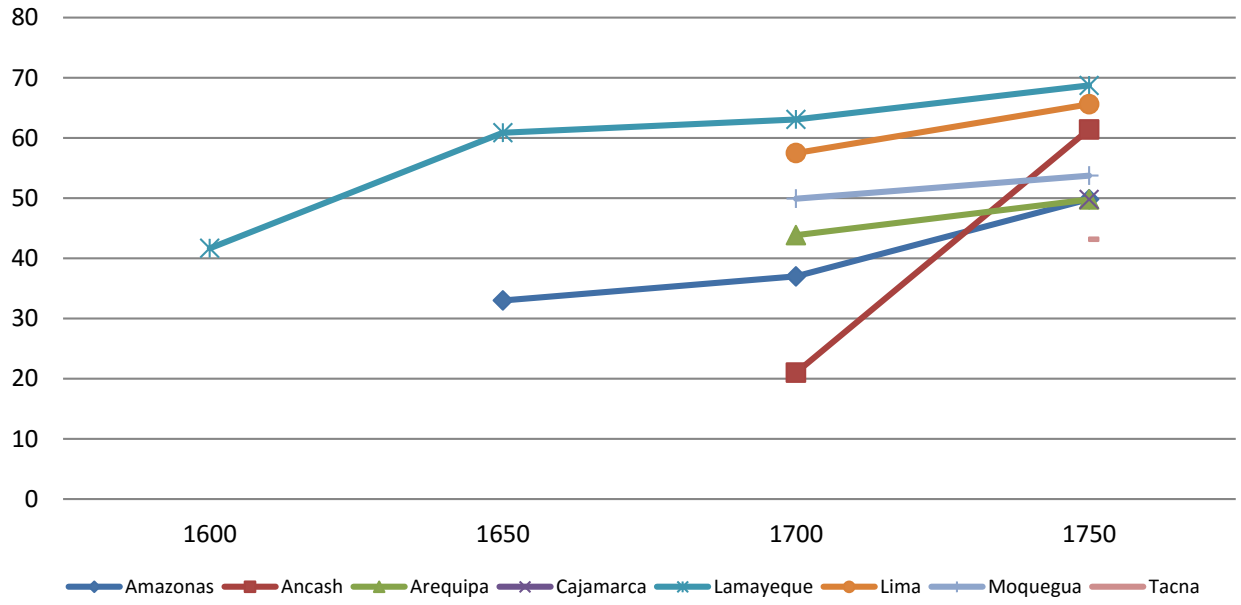
Source: family search.org

FIGURE 4.7. ABCC TRENDS PARAGUAY. 1750-1850



Source: family search.org

FIGURE 4.8. ABCC TRENDS PERU. 1600-1750



Source: family search.org

For some countries, the gap in Human capital formation remains until the 19th century (especially in Peru and Colombia). The provinces specialized on mining have remarkably lower numeracy levels in comparison with the rest of the country. These are the cases of Minas Gerais

in Brazil, Potosí in Bolivia and Loja in Ecuador. Minas Gerais (Figure 5) has almost 30% lower than Paraná[35]. This pattern changes at the end of the period since there is a convergence of nearly all the provinces. However, Pernambuco remains with the lowest numeracy rates around 1850. Pernambuco was a tropical plantation economy and with Bahia (Northeast area) the largest region in the colonial period (Meade 2004). According to the literature (c.f. 4) this area has a typical factor endowment that was beneficial for the early times but detrimental once technical changes had been developed in the agricultural production. Furthermore, in the plantation economies (sugar in the case of Pernambuco), a lot of slaves were exploited (Meade 2004).

Potosí (Figure 3) has between 25 and 30% lower numeracy rates in comparison with the other provinces of Bolivia. However, in the 1900s Potosí converged with Chuquisaca and La Paz, but the ABCC values remained low (64%). Potosí was one of the oldest Spanish foundations in Latin America. The village was founded in 1545 and was the center of the silver miner boom from the 16th to the 18th century. In 1650, at the zenith of silver production, Potosí boasted 160,000 inhabitants (five times its current population). Major silver production occurred during the 16th and first half of the 17th centuries, with the first veins producing unprecedented quantities of pure silver. But by 1560 production began to falter and Mining entered into a crisis. One problem was a severe shortage of laborers to work the mines; a second was the depletion of the almost pure surface deposits. With lower-content and less-accessible ore, the process of extraction became more complex and costly in labor and capital. To this end, the Spanish colonial viceroy Francisco de Toledo reintroduced a draft Indian labor system adapted from the Incan *mita* system, thereby ensuring practically free unskilled labor to the mine and mill owners. Other changes included a new mining code, a rationalized taxation structure, royal

[35] Paraná was devoted to agriculture, one of the main resources was Yerba Mate and more recently Café (Prado 1979)

control of silver production, and a royal mint in Potosí (Morales 2010). According to Klein (2003) and Cole (1985), these developments dramatically reordered the mining economy and the social and economic life of the Indians. Apparently, these policies were detrimental for the formation of Human Capital and the future development of the region. Both examples—Potosí and Minas Gerais—are associated with the Human capital formation in a mining economy. Furthermore, they connect with the institutional hypothesis, which claims that some factor endowments that were beneficial for colonial economies were detrimental for future development. In the case of Potosí, it is possible to add that early Human capital formation was a key factor for later economic growth, since this economy is today one of the poorest and unequal in the world.[36] Although this assumption cannot be considered entirely for Minas Gerais, since it is not one of the poorest regions, the levels of current inequality are unquestionable (Amann and Baer 2010).

The ABCC of the currents limits of the National capitals differ depending on the country under consideration. For example, in Argentina, Buenos Aires features the highest numeracy after Entre Ríos and becomes the best numerated in the 1850s, with almost 90% ABCC. Asunción is as well the third in ABCC values in Paraguay and converges with Paraguarí and Cordillera in the 1850s with approximately 75% ABCC. Lima is the second best numerated of Peru in throughout 1700–1750. Finally, in this period the National capital of Brazil was Rio de Janeiro and was the third of the better numerated of Brazil after Paraná and *Rio Grande do Sul*. However, in Bolivia and Chile, the pattern of the national capitals is different. In the early 1800s, La Paz had the lowest ABCC of Bolivia but later converged with the other regions. However, *Santiago de Chile* in Chile begins the 1750s with higher numeracy but at the end of the period, the ABCC decreases to 40%, becoming the least numerated of Chile. These

[36] This fact will be discussed in Section 6. Additional empirical information is in Appendix 4.

examples suggest that the formation of Human capital was not always linked to the central administration but rather with the primary natural resource of the region.

Several results can be highlighted from the numeracy trends. Empirical evidence approximates to some of the assumptions of the institutional hypothesis:

1. Higher numeracy trends appear in the lowest populated regions before the conquest and in the cattle economies.
2. Lower numeracy trends appear in the densely populated native regions before the conquest and in the mining and plantation economies.

Furthermore, the evidence shows that the national capital was not the highest numerated in every country. Hence, depending on the country the formation of Human capital was not always linked to the central administration. At the very beginning, the formation of Human capital seemed to be related to the economic activity of the region and not with a primary purpose to provide core competencies to the labor force.

4.6 CARTOGRAPHY APPROACH

The cartographic analysis complements the numeracy trends. The aim is to identify some patterns of the distribution of the numeracy levels by regions. Figures 4.10 - 4.12 (in the Appendix) display the ABCC index calculated from the marriage registers for three selected years: 1750, 1800 and 1850. Cartographical evidence shows that some geographical characteristics seem to be determinant for Human capital formation. In the first place, the countries located on the Southern Atlantic Ocean have higher numeracy values than the countries in the Pacific. This factor is related to the colonization period since the oldest settlements (excluding Central America) started in the Pacific Ocean (Quito in 1534, Lima in

1535, Santiago de Chile in 1541, and Potosí 1545).[37] Some of these regions were also densely populated in the pre-Columbian period. The only exception on the Atlantic Ocean is Recife, founded in 1526 (Cole 1965). Provinces such Buenos Aires and Corrientes (Argentina), Soriano (Uruguay) and *Rio Grande do Sul* (Brazil) have high numeracy values throughout time. As in the numeracy trends analyzed above (Section 4.a) these two facts are related with the institutional hypothesis that claims that the lower populated territories before the conquest and the economies with economic activities not linked to mining or plantations had higher economic growth. This literature highlights that the introduction of technological change made the gap among the regions more pronounced (Acemoglu, Johnson and Robinson 2002). However, the analysis of Human capital formation in these three benchmarks allows to confirm that the basis of the numeracy (mathematical skills) were given before the introduction of technological change. The cartography shows that already in 1750 the numeracy of the Southern Atlantic territories was higher than in other regions.

In the second place, the provinces with access to the sea had higher numeracy levels than the countries located in the center of the continent. This fact is especially emphasized in Potosí, Santa Cruz, Chuquisaca, La Paz and Beni throughout time. Apparently, these regions were affected for early "bad" institutions and by the geographical location. All these facts will be analyzed deeply in the regression analysis; however, the inclusion of the cartographical analysis is to display in pictures some of the aims of the study.

4.7 INEQUALITIES OF REGIONAL HUMAN CAPITAL DISTRIBUTION

Based on the previous cartographic impressions, it is possible to observe statistically the regional differences in the distribution of Human capital within countries.

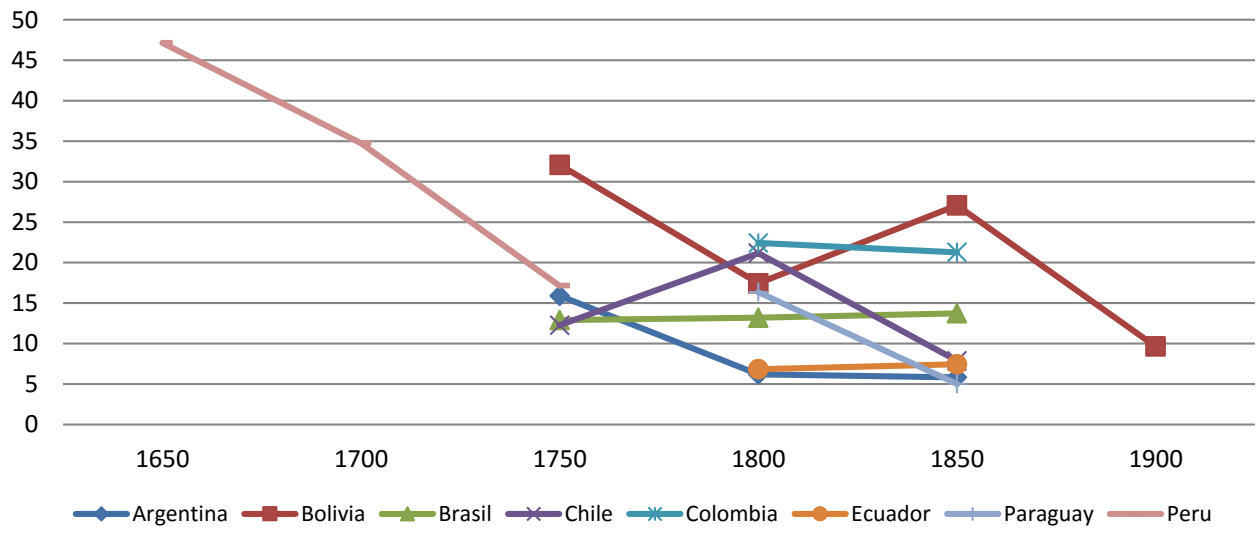
[37] The Portuguese colonisation made some early settlements in the Atlantic as well (Recife 1526, Salvador 1549, and Rio de Janeiro 1567).

I measured the regional inequality by using the coefficient of variation (CV). Using the CV has the advantages that it is a dimensionless number and that it allows comparisons between the different countries, even though they have different means. It is defined as the standard deviation of regional ABCC values of a country (σ) divided by the average ABCC value of a country (μ), multiplied by 100:

$$CV = \frac{\theta}{\mu} * 100$$

Figure 4.9 displays the coefficients of variation by countries. In general, regional variation is decreasing throughout time in most countries.

FIGURE 4.9. REGIONAL VARIATIONS WITHIN COUNTRIES. COEFFICIENT OF VARIATION. 1650-1900



Source: familysearch.org

Considerable differences in the Coefficient of variation (CV) can initially be found in Peru and Bolivia, both one of the lowest numerated since the 1750s. In the case of Peru the CV is notoriously high in the early period; however, it tends to converge in the last years. Furthermore,

the coefficients of variation of Ecuador and Brazil are constant throughout time. That means that the inequalities in education in those countries did not change throughout time.

The high CV coincides with the lowest numeracy values, as Peru and Bolivia are two of the countries with lowest levels of Human capital formation throughout time. However, the CV shows a low trend in countries with mixed economies (cattle-mining/cattle-plantation) like Chile and Brazil. Only the regions with strong mining economies have high levels of inequality in Human capital formation.

According to this approach, it is possible to conclude that the differences of human capital within the countries are detrimental to the national Human capital formation since those countries with high regional variation are also the least numerate.

4.8 Determinants of human capital formation and current economic growth

The aim of the regression analysis is to illustrate the institutional hypothesis put forward in Sections 4.2.1 and 4.2.2 in two parts. The most illustrative are (1) the analysis of the Human capital determinants. (2) The relation between current GDP and Human capital formation, specifically, in which way early numeracy affected the current levels of GDP. The sources of the corresponding variables are detailed in the Appendix.

I divided the possible determinants of Human capital in two vectors of variables: historical/institutional and geographical and climate variables. The leading group of explicative variables is historical and institutional since they follow the institutional hypothesis. I displayed geographical and climate as control variables. Additionally, I included a group of variables to control the country/time effects with country and half decade dummy variables and the age group 23-32 since they usually have a different heaping pattern. In this case, is expected a positive bias of the 23-32 age group.

Two separate tables (table 4.5 and table 4.6) analyse the determinants of Human Capital and determinants of current GDP. The aim to study the determinants of current GDP is to verify if there is a statistical relation between current GDP and early numeracy.

The two vectors of possible determinants of Human capital are the following:

a). **Historical/institutional variables**: These variables are potential determinants of Human capital formation that occurred in the pre-colonial and colonial periods. The reason to consider the pre-colonial and colonial periods as key factors is linked to the institutional hypothesis (Section 2.a and 2.b). I include in this category the pre-colonial population density based on the work of (Bruhn and Gallego 2012) and the primary colonial activity and systems of land tenancy following the work of Cole (1965). I divide these activities into four groups: mining system, the plantation system, a combination of Hacienda/farm system and no pre-colonial system. Part of these land tenure systems started in pre-colonial times and continued throughout time, such the examples of the plantation economies and the shifting economies (tribes of the Amazonas). The hacienda system is a kind of land ownership that took place after the colonization and remains throughout time. These variables are directly related to policies of land distribution.

b). **Geographical and climate control variables**: I include the climate (average degrees), altitude, average rainfall, the distance of the sea and a landlocked dummy as control variables.

c). **Country/time control variables**: I include dummies variables of each country by half decades (1750, 1800 and 1850)

d). **Age group 23-32**: I organized the age-heaping-based numeracy estimates by age group because usually, the age group belonging to the twenties displays a different heaping pattern. They tend to heap less the age in than the 33-62 age groups.

4.8.1 POTENTIAL HUMAN CAPITAL DETERMINANTS

According to the results of the numeracy trends I expect that high levels of population density and mining and plantation economies are negatively related to the formation of Human Capital. This hypothesis is associated with the institutional assumption that densely populated areas were more propitious in generating extractive institutions. Moreover, some activities such as mining or plantations could be detrimental to long-run development. My hypothesis is that these variables are as well negative for Human capital formation. But who shaped those "bad" institutions? How educated was the population (regarding mathematical skills) in the conquest? How was the educational level after the independence? Which were the determinants of the Human capital formation in these communities?

I tested the previous hypothesis by running the following reduced form of logistic regression model:

$$Num = Zrc\alpha + Xrc\beta + Wre + Erc$$

Where Z refers to the vector of the historical/institutional variables (pre-colonial population density, pre-colonial activities: mining, plantation, farm/hacienda, and shifting) and W to the control variables (climate and geographic variables, countries/half decade and age group 23-32).

The results are reported in Table 4.5. Column 1, 2 and 3 display the marginal effects of a logistic regression in which the dependent variable (numerate) is 1 if the individual reported an age that is not multiple of five, and cero otherwise. I run a logistic regression because the dependent variable is binary. Furthermore, the marginal effects were multiplied by 125 so they can be interpreted as percentage changes of numeracy, taking into account that the 20% of the ages would correctly end in a multiple of five. (See A`Hearn, Baten, and Crayen, 2009).

TABLE 4.5. DETERMINANTS OF HUMAN CAPITAL FORMATION (AS PERCENTAGES)

	Model 1	Model 2	Model 3
	numerate	numerate	numerate
Estimation Technique	logit mfx	logit mfx	logit mfx
Dependent variable	numerate	numerate	numerate
Data included	All	All	All
log Pre-colonial Population density	-1.125***	-1.525***	-1.9375***
	(0.00)	(0.00)	(0.00)
System comb. Farm/hacienda		3.2875***	3.0375***
		(0.00)	(0.00)
System plantation		1.025	0.575
		(0.47)	(0.71)
System mining		-1.5625*	-0.0875
		(0.06)	(0.93)
System shifting		-13.525***	-10.425***
		(0.00)	(0.00)
Rainfall			0.75***
			(0.00)
Altitude			-4.8625***
			(0.00)
Distance from sea			4.8375*
			(0.09)
Argentina 1750	8.0875***	2.325	0.7
	(0.00)	(0.15)	(0.73)
Argentina 1800	17.3375***	10.6875***	9.5***
	(0.00)	(0.00)	(0.00)
Argentina 1850	23.4125***	19.925***	19.025***
	(0.00)	(0.00)	(0.00)
Brasil 1800	17.3375***	14.9625***	10.275***
	(0.00)	(0.00)	(0.00)
Brasil 1850	22.1125***	20.25***	17.2***
	(0.00)	(0.00)	(0.00)
Bolivia 1750	-6.3875***	-8.4625***	0.975
	(0.01)	(0.00)	(0.74)
Bolivia 1800	-5.475	-7.5125**	-0.175
	(0.13)	(0.04)	(0.96)
Bolivia 1850	7.6875**	6.075	14.175***
	(0.03)	(0.11)	(0.00)
Chile 1750	5.225***	2.3125	-1.6625
	(0.00)	(0.16)	(0.44)
Chile 1800	10.5875***	8.1625***	4.1625***
	(0.00)	(0.00)	(0.02)
Chile 1850	15.675***	13.3***	10.225***
	(0.00)	(0.00)	(0.00)
Colombia 1750	9.075	-10.4125	-8.5375

	(0.19)	(0.14)	(0.23)
Colombia 1800	4.85	3.675	5.0625
	(0.02)	(0.09)	(0.03)
Colombia 1850	20.8625***	20.025***	21.275***
	(0.00)	(0.00)	(0.00)
Peru 1750	-3.45**	-3.15**	3.425**
	(0.02)	(0.04)	(0.04)
Paraguay 1750	-0,35	-1,4875	-5,8875
	(0.97)	(0.88)	(0.60)
Paraguay 1800	12.6125***	11.625***	11.25***
	(0.00)	(0.00)	(0.00)
Paraguay 1850	17.9125***	17.0625***	16.65***
	(0.00)	(0.00)	(0.00)
Uruguay 1750	18,4375	14,3875	12,5625
	(0.01)	(0.07)	(0.14)
Uruguay 1800	27.575***	25.05***	24.2***
	(0.00)	(0.00)	(0.00)
Uruguay 1850	12,8875	8,05	8,5875
	(0.03)	(0.22)	(0.21)
Ecuador 1750	-10.9375*	-12.25**	-3.525
	(0.07)	(0.05)	(0.56)
Ecuador 1800	6.85***	5.4625***	9.675***
	(0.00)	(0.00)	(0.00)
Ecuador 1850	10.025***	8.775***	14.0875***
	(0.00)	(0.00)	(0.00)
Age 33 - 42	-4.2375***	-4.325***	-3.9***
	(0.00)	(0.00)	(0.00)
Age 43-52	-5.9875***	-6.075***	-6.2375***
	(0.00)	(0.00)	(0.00)
Age 53-62	-6.4625***	-7.0125***	-7.75***
	(0.00)	(0.00)	(0.00)
Observations	90,271	90,271	82,946
Pseudo R-squared	0.023	0.023	0.023

pval in parentheses

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

Constant refers to Brazil 1750, no pre-colonial system, age 23-32

The coefficients of all independent variables are scaled up by 125 for a more convenient interpretation of changes in numerate.

The variables are included step by step to identify the role of the control variables. In the three models, there is a negative and significant relation between pre-colonial population density and numerate. Hence, those regions more populated in the pre-colonial times have a relatively bad

performance in numeracy. Columns 2 and 3 include the pre-colonial primary activity: mining, plantation, shifting, the combination of farming and Hacienda (cattle)[38]. In both cases, the combination of farm/hacienda is positively related with numerate and significant. The mining economies are negatively related with numerate in the second model. However, this variable loses significance in the third example (when I include the control variables weather and geography). Relevant is that those economies devoted to the recollection (pre-colonial shifting economies) are high negative related with numeracy. All the columns include the country/half decade control variables and the age groups 23-32 years old.

From the results of these models is possible to estimate that mining and shifting economies were detrimental for the Human capital formation, on the contrary, the combination of farm and cattle economies was beneficial. Furthermore, those regions with high population density were worst regarding numeracy in relation to the settler economies. These results are in relative concordance with the institutional hypothesis since the large populated regions before the conquest, and mining economies are negatively related to the institutional performance.

4.8.3 Potential determinants of current GDP. Is early human capital related to the current economic growth?

The aim of the following regressions is to analyze the determinants of the current GDP, especially if the early numeracy could be a determinant of economic development. I collected the data of current regional GDP per capita from the 2000 values from the world development indicators. The gross state product of each region is divided by the present population and converted to per capita values. To deal with the problem that some of the values are not comparable across regions, I used the log of the value, and I include country and half decade

[38] In this case the reference category is no pre colonial main activity.

control variables. Hence, the variables and estimated effects of the regressions can be interpreted as log deviations from country means. The basic form of the regression is:

$$GDPrc = earlynumeracy + Brc\beta + Crc\delta + Nc + E$$

Where B refers to the set of historical/institutional variables mentioned above; C to the geographical and climate, country/half decade and age groups control variables; E is the error term.

Table 4.6 reports the results. The aim of this regression is to prove if there is a relation between the early Human capital and the current GDP. In other words, the objective is to test if the pre-modern Human capital was necessary for the present economic growth. Apparently, it was but in a small degree. The results displayed in Table 6 shows that there is a positive and significant relation between the current GDP and numerate, however, the coefficient is low.

TABLE 4.6. DETERMINANTS OF CURRENT GDP. IS EARLY HUMAN CAPITAL LINKED TO THE CURRENT ECONOMIC GROWTH?

	Model 1	Model 2	Model 3	Model 4
Estimation technique	OLS1	OLS	OLS	OLS
Dependent variable	Log current GDP	Log current GDP	Log current GDP	Log current GDP
Numerate	0.042**	0.0028*	0.0023*	-0.000
	(0.018)	(0.058)	(0.099)	(0.959)
System plantation		-0.73***	-0.61***	-0.60***
		(0.000)	(0.000)	(0.000)
System mining		-0.10***	-0.14***	-0.13***
		(0.000)	(0.000)	(0.000)
System shifting		0.20***	0.24***	0.23***
		(0.000)	(0.000)	(0.000)
No system		0.07***	-0.15***	-0.15***
		(0.000)	(0.000)	(0.000)
Altitude			-0.08***	-0.07***
			(0.000)	(0.000)
Rainfall			-0.02***	-0.02***

			(0.000)	(0.000)
distance sea			-0.13***	-0.12***
			(0.000)	(0.000)
Brasil 1800	-0.06***	0.00	0.01	0.00
	(0.000)	(0.938)	(0.112)	(0.860)
Brasil 1850	0.04***	0.05***	0.04***	0.02*
	(0.000)	(0.000)	(0.000)	(0.079)
Bolivia 1750	-1.38***	-1.42***	-1.14***	-1.16***
	(0.000)	(0.000)	(0.000)	(0.000)
Bolivia 1800	-1.41***	-1.43***	-1.23***	-1.23***
	(0.000)	(0.000)	(0.000)	(0.000)
Bolivia 1850	-1.54***	-1.55***	-1.32***	-1.34***
	(0.000)	(0.000)	(0.000)	(0.000)
Chile 1750	-0.22***	-0.19***	-0.06***	-0.06***
	(0.000)	(0.000)	(0.000)	(0.000)
Chile 1800	-0.26***	-0.25***	-0.07***	-0.09***
	(0.000)	(0.000)	(0.000)	(0.000)
Chile 1850	-0.21***	-0.17***	-0.04***	-0.06***
	(0.000)	(0.000)	(0.001)	(0.000)
Colombia 1750	-0.55***	-0.56***	-0.57***	-0.53***
	(0.000)	(0.000)	(0.000)	(0.000)
Colombia 1800	-0.56***	-0.56***	-0.56***	-0.55***
	(0.000)	(0.000)	(0.000)	(0.000)
Colombia 1850	-0.56***	-0.56***	-0.57***	-0.58***
	(0.000)	(0.000)	(0.000)	(0.000)
Peru 1750	-0.26***	-0.25***	-0.17***	-0.17***
	(0.000)	(0.000)	(0.000)	(0.000)
Paraguay 1750	-1.07***	-1.09***	-1.19***	-1.14***
	(0.000)	(0.000)	(0.000)	(0.000)
Paraguay 1800	-1.05***	-1.07***	-1.18***	-1.16***
	(0.000)	(0.000)	(0.000)	(0.000)
Paraguay 1850	-1.06***	-1.09***	-1.20***	-1.20***
	(0.000)	(0.000)	(0.000)	(0.000)
Uruguay 1750	-0.34***	-0.34***	-0.38***	-0.38***
	(0.000)	(0.000)	(0.000)	(0.000)
Uruguay 1800	-0.36***	-0.36***	-0.38***	-0.37***
	(0.000)	(0.000)	(0.000)	(0.000)
Uruguay 1850	-0.32***	-0.33***	-0.38***	-0.38***
	(0.000)	(0.000)	(0.000)	(0.000)
Ecuador 1750	-1.56***	-1.57***	-1.44***	-1.41***
	(0.000)	(0.000)	(0.000)	(0.000)
Ecuador 1800	-1.52***	-1.53***	-1.41***	-1.42***
	(0.000)	(0.000)	(0.000)	(0.000)
Ecuador 1850	-1.56***	-1.57***	-1.44***	-1.46***
	(0.000)	(0.000)	(0.000)	(0.000)
Age 33-42				-0.02***
				(0.000)

Age 43-52				-0.03***
				(0.000)
Age 53-62				-0.06***
				(0.000)
Constant	9.14***	9.15***	9.23***	9.23***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	90,643	90,643	83,561	82,946
R-squared	0.65	0.74	0.79	0.79

pval in parentheses

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

Constant: Brazil 1750, System farm/hacienda, Age 23-32 (model 4)

In the first model (column 1) I related only current GDP and numerate including the control variables of country/half decade. In the second I incorporated the institutional/historical pre-colonial primary activity. In this case, the constant refers to the combination of farm/hacienda system. As expected plantation and mining pre-colonial economies are negative and significantly related to the current GDP, however, the shifting economies remained positive. When I include the control variables of climate and geography, the relation between mining and plantation with GDP remain significant. Moreover, the relationship between early numeracy and current GDP remain significant and positive even if the historical/institutional and control variables are included in the model. The inclusion of the age group 23-32 as control variable makes that the relation between current GDP and early numeracy loose significance.

Like the results of the Logit model, these results are as well in concordance with some of the arguments of the institutional hypothesis. However, the study of the relation between current GDP and early numeracy was not explored before. From the results, it is possible to estimate that those regions which performed better Human capital in the pre-modern times have relatively higher levels of current GDP. Hence, since early periods Human capital could have influenced the economic development.

4.9 CONCLUSIONS

This Chapter explores the differences in the formation of Human capital within countries in Latin America. From the empirical evidence it is possible to confirm some hypotheses set up previously by the institutional literature: (1) higher numeracy trends appear in the lowest populated regions before the conquest and in the cattle economies; lower numeracy trends appear in the densely populated native areas before the conquest and in the mining and plantation economies. These two facts agree with the institutional hypothesis, which claims that depending on natural resources were shaped "good" or "bad" institutions. These "good" or "bad" institutions seem to have promoted "better" or "worse" Human capital.

(2) Some of the determinants that are negatively related to the formation of Human Capital are the mining and shifting pre-colonial activities and the densely populated areas before the conquest. The combination of family farm and hacienda system seems to have a positive influence on the formation of Human Capital.

Furthermore, this Chapter arrives at some original conclusions that are not explored by the literature: (3) the national capital was not in every country the highest numerated in comparison with other regions. Depending on the country the formation of Human capital was not always linked to the central administration. At the very beginning, the formation of Human Capital seems to be related to the economic activity of the region and not with a primary purpose to provide necessary skills to the workforce. (4) The institutional hypothesis claimed that the gap between the developed and undeveloped countries started in the colonial period. However, the key factor to make the gap deeper was the introduction of technological change into production. Regarding the formation of human capital, it is possible to highlight that the roots of early Human capital were given before in the beginning of the 1750s, hence before the introduction of technological change. The cartography shows that already in 1750 the numeracy of the

Southern Atlantic territories was higher than other regions. (5) Through the coefficient of variation by countries, it is possible to conclude that the inequalities of Human capital within the countries are a detriment to the formation of Human Capital. Those countries with high levels of inequalities within regions also have the worst performance in numeracy. (6) Finally, the regressions results show that the early formation of Human Capital is relevant for current economic growth.

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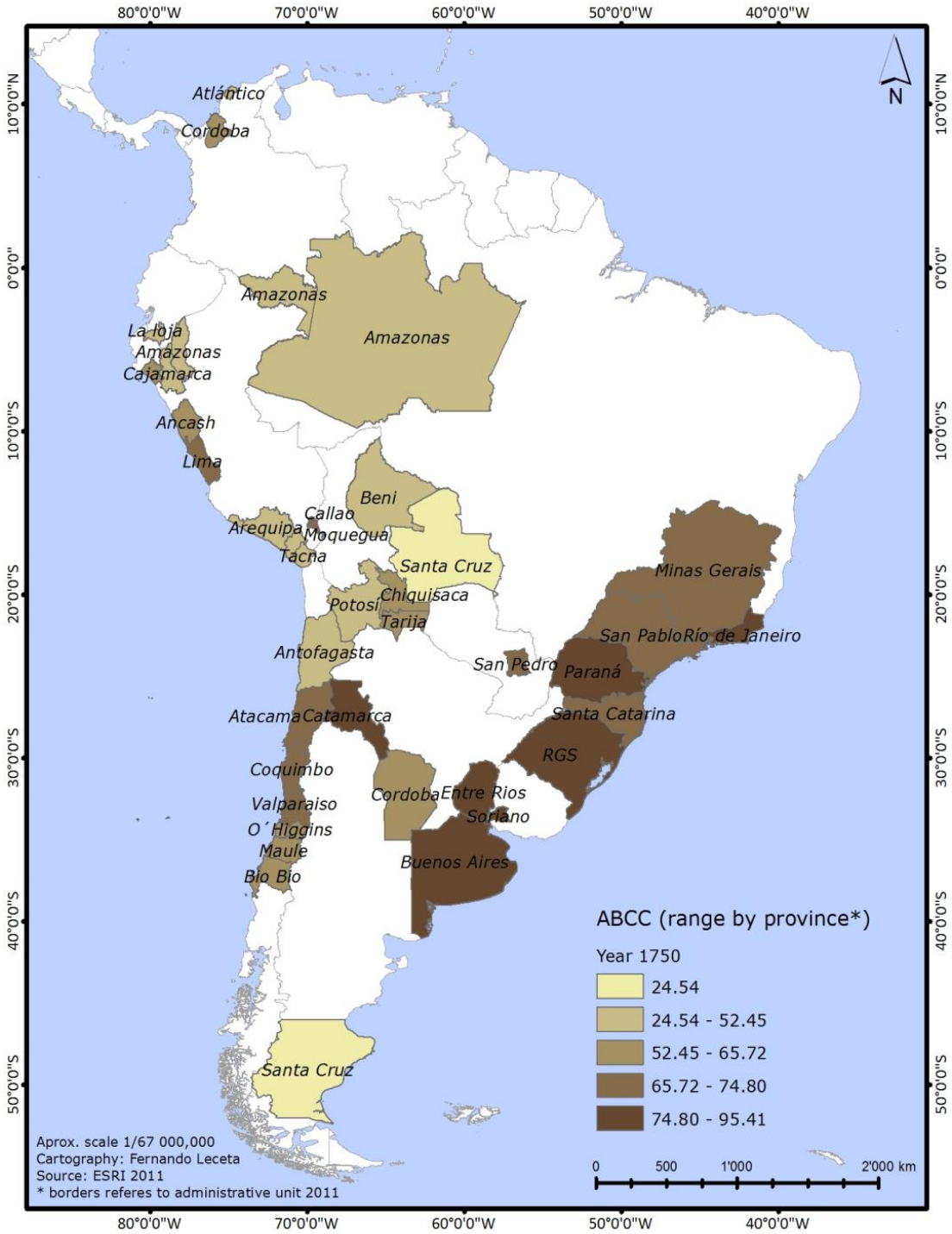
4.11 APPENDIX

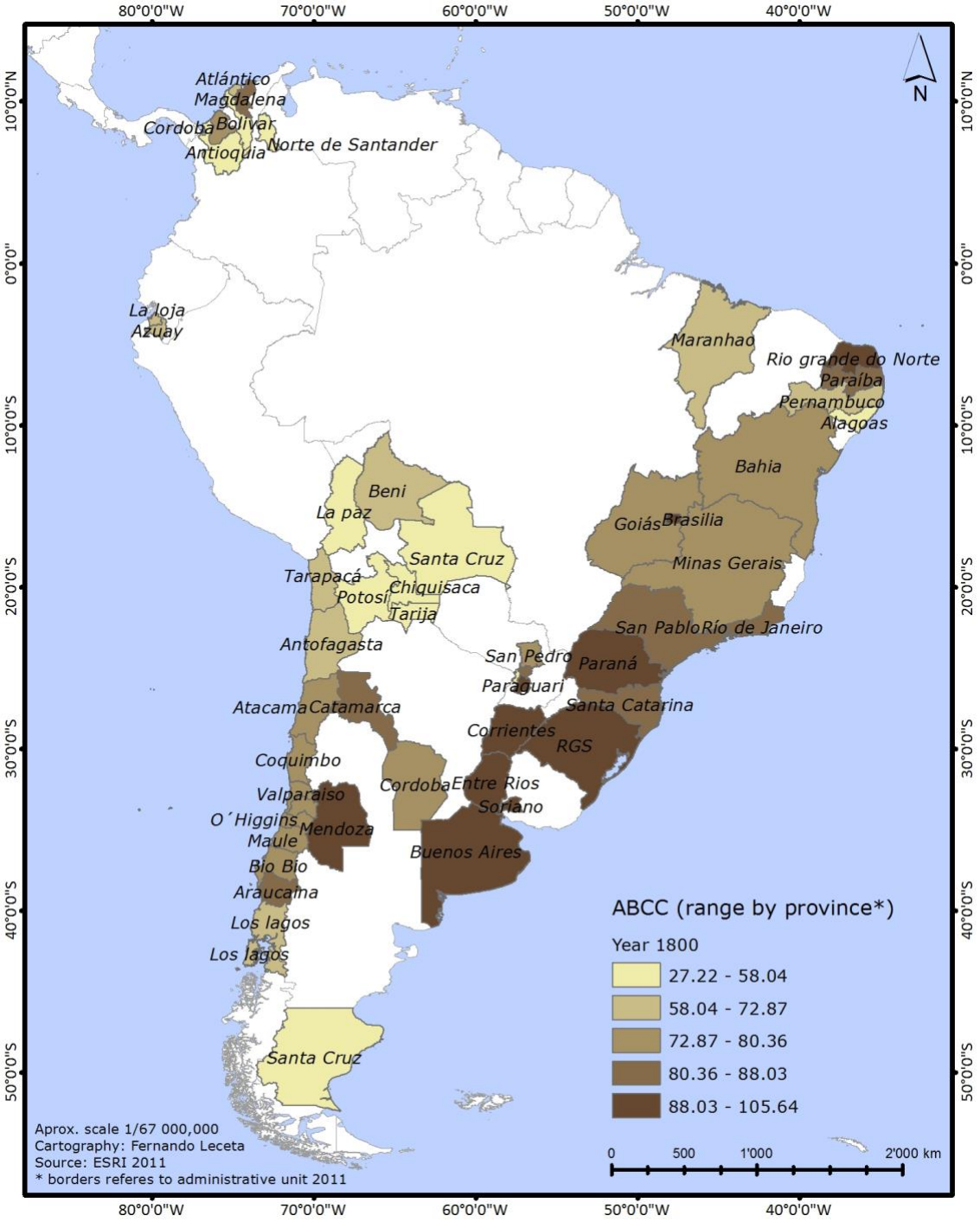
Appendix 1. Cartography

FIGURE 4.10 ABCC PER PROVINCE. 1750



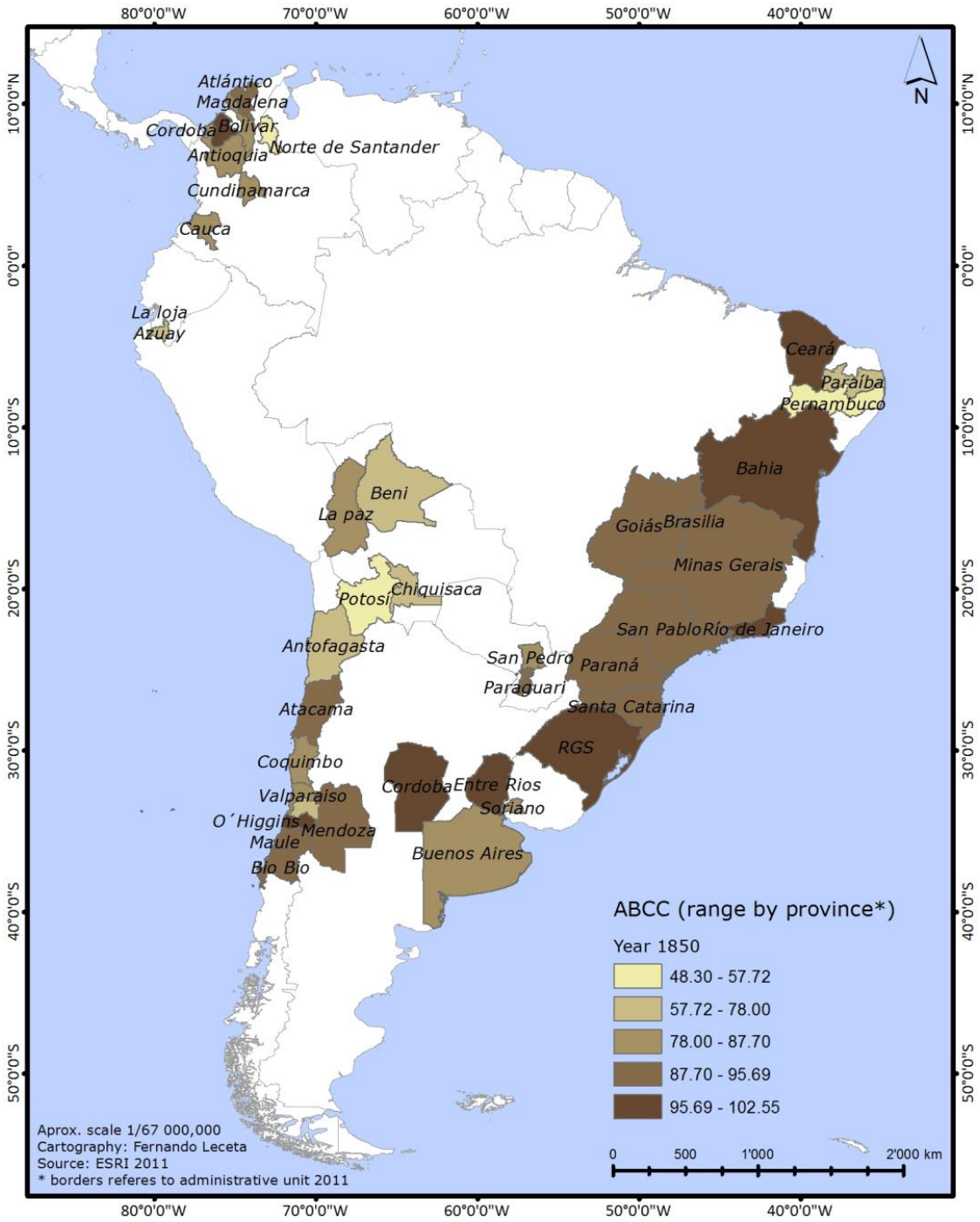
Source : familysearch.org

FIGURE 4.11. ABCC PER PROVINCE. 1800



Source: familysearch.org

FIGURE 4.12. ABCC PER PROVINCE. 1850



Source: familysearch.org

APPENDIX 2. SOURCES AND SUMMARY STATISTICS

TABLE 4.7. VARIABLES AND SOURCES

Variable	**Source**
Dependent: Numerate	Familysearch.org
Dependent GDP 2000	World Development Indicators
Historical/institutional variables	
Log Pre-colonial population density	Bruhn and Gallego (2012)
Land tenure syst. Plantation	Cole (1965)
Land tenure syst. Hacienda	Cole (1965)
Land tenure syst. Family farm	Cole (1965)
Land tenure syst. Shifting cultivation	Cole (1965)
Geographical	
Total Rainfall (by provinces)	Bruhn and Gallego (2012)
Altitude (by provinces)	Bruhn and Gallego (2012)
Prop land 100 km sea (by country)	Mac Arthur and Sanchs (2001)

TABLE 4.8. SUMMARY STATISTICS

Variable	Observations	Mean	Std. Dev.	Min	Max
Dependent					
numerate	108403	0.676116	0.4679585	0	1
lypp	90643	8.994.356	0.4007221	7.13	9.894
Historical/ institutional					
System farm/hacienda	108403	0.5362859	0.4986839	0	1
System plantation	108403	0.0191877	0.1371848	0	1
System mining	108403	0.0909108	0.2874835	0	1
System shifting	108403	0.0115679	0.106931	0	1
No pre colonial system	108403	0.1257438	0.3315619	0	1
Log Pre-colonial population density	90931	-0.4854169	1.805.108	-6.91	4.606
Control Variables:					
Geographical/weather					
rainfall	90760	1.874.595	2.937.118	0.0173	31.47
altitud	83957	0.407711	0.6244703	0	4.409
dist_sea	90385	0.4102926	0.3963077	0	2.45

5. HUMAN CAPITAL AND WEALTH DISTRIBUTION IN AN OLD REGIME ECONOMY. MONTEVIDEO AND ITS SURROUNDINGS. 1750–1855

Abstract

This paper attempts to make a contribution to the wide-ranging literature on the colonial origins of inequality in Latin America in two different ways. Firstly, we analyze the wealth distribution in Montevideo and its surroundings between 1751 and 1855 through welfare ratios, slave tenancy and other assets. Secondly, we examine the possible determinants of early Human capital formation and wealth. The aim is to discuss the characteristics of the pre-modern wealth distribution and to establish a link between inequality and Human capital formation. The study employed a large dataset of census and population registers of Montevideo and its surrounding areas from 1780 to 1855, nominal wages of Montevideo from 1760 to 1857, and a list of family assets of 165 families of Montevideo in 1751. The Gini coefficient of slaveholders, the real income and patrimony, show a low and middle concentration of the distribution. Furthermore, we find evidence that one of the main ways to achieve wealth was the social status (given by the position in the labor market) and the life course.

Keywords: Wealth distribution, inequality, Human capital, numeracy, Rio de la Plata
JEL: N36, I21, I24, J24

This Chapter is based on a paper intended for publication. I received the collaboration of María Inés Moraes in the development of the paper. Data about wealth and income distribution was provided by María Inés Moraes and the Uruguayan research group "Pre-modern economies in Rio de la Plata" http://pueblosynumeros.fcs.edu.uy/

5.1 INTRODUCTION

The origin of inequality in Latin America is one of the most explored subjects in economic history. The relevance of the topic emphases on the explanation of the current economic divergence. Most of the research is devoted to analyzing the institutions that generated the inequality (Acemoglu, Johnson and Robinson 2001, 2002, 2012; Bruhn and Gallego 2012) and the economic performance of Latin America in the long term (Coatsworth 1993, 1998, 2005). Regarding Rio de la Plata, until the early 1980s, the research linked to the inequality in the economic history of this region in the period between the Bourbon reforms and the 1860s was centered on the existence of large cattle ranches. The large *estancias* were described not only as drivers of agrarian production and exportable expansion but also as the ground in which the main social and political features of the rural society were rooted. This society was characterized by a profound inequality between the landowners and the rest of the population (Sala de Touron 1991; Reyes Abadie, Bruschera et al. 1966; Sala de Touron, De la Torre et al. 1967). More recent research has questioned this argument, finding evidence of a more complex rural society, characterized by diverse forms of coexistence of those big properties with small farms devoted to the production of different primary goods (Gelman 1989; Barsky 1997; Gelman 1998; Moraes and Pollero 2003).

This Chapter has two aims: the first is the study of wealth distribution in Montevideo and its surroundings between 1751 and 1855. Data of slave tenancy, recorded in various population censuses is used to approximate the wealth of families, and the results are compared to the tenancy of other assets, such as livestock and real estate. We calculated the real wage and we compare it with the stock of wealth. The second objective is to identify the relation between the early Formation of Human Capital and wealth. The relevance of this question is based on the idea that, in pre-modern societies, other mechanisms than education were important in

achieving wealth. Through these two aims, we contribute to the study of the origins of the inequality and economic divergence in Latin America in the period before the agro-export boom.

We used a large database which contains data about early Human capital (approximated by the numeracy), wealth and income. Population registers, nominal wages and list of properties of Montevideo in the period 1760-1860 are the main group of sources collected in the National Archive of Montevideo (AGN), and Judicial Archive of Montevideo.

Among the questions to answer in this study are the characteristics of the wealth and income distribution in Montevideo and the villas and towns in the countryside in the pre-modern period; and the relation between early Human capital and wealth.

The Chapter is structured as follows: Section 5.2 gives a brief historical background of the region; Section 5.3 describes the literature regarding wealth distribution in Rio de la Plata; Section 5.4 describes the literature concerning Human capital formation and discusses the pertinence of using slave tenancy as a proxy for wealth; Section 5.5 describes the data and methods; Section 5.6 and 5.7 analyses the results, and Section 5.8 gives a summary and conclusions. A detailed table of the data description is given in the appendix.

5.2 HISTORICAL BACKGROUND

Montevideo was founded by the authorities of the Spanish Crown as a military fortress on the banks of the Rio de la Plata in 1726, to control the threat of a Portuguese occupation of that imperial frontier. Over the next three decades, an agrarian economy emerged around the city, able to feed the community of soldiers, bureaucrats, and families. The Crown conceded a territory of around 1.4 million hectares to the city which, in the beginning, was unable to control and occupy the land due to the shortage of Europeans and the fleeting presence of groups of

native people. As the Indians had been repelled since 1760, Montevideo became the largest port of the Rio de la Plata and the total population of the city, and its hinterland experienced fast growth; there were around 25,000 to 30,000 people living there in 1810. Therefore, land abundance and labor scarcity were the hallmarks of this agrarian economy in the entire colonial period (Moraes 2011).

The tenancy of land was arranged according to individual property rights: the land was plotted in ranches (*estancias*) and farms (*chacras*) owned by families. *Estancias* and *chacras* were devoted to cattle ranching, wheat farming and the production of fruit and vegetables. Besides the meat for the local population, hides and salted meat exported to the Atlantic markets were the main husbandry products. In both types of units, family labor was the main source of Human energy. However, the slaves were used too to complement the waged laborers. The slaves were more frequent in agrarian units devoted to farming, meanwhile waged workers were more common in units devoted to cattle ranching. While wage labor was required seasonally to supplement family labor when necessary; slaves usually performed as the more stable workforce of the unit. They were foremen or *capataces* at the ranches, an especially skilled worker at the farms, in both cases a permanent and confident worker in a context of high turnover (Moraes 2011).

The period 1810-1860 is characterized by two main facts: the first is the Revolution and the independence wars which produced a high institutional instability; the second is the decline of the agrarian economy (due to the general weakness). The studies devoted to this period highlight that the economic indicators suffered a moderate fall and stagnation (Sala, Alonso and Rodríguez 1991; Etchechury 2013). After 1860, the modernization of the rural areas, the development of the sheep farming and the agro-exportation boom transformed this region in one of the wealthiest economies in Latin America.

5.3 Inequality and wealth distribution in the Rio de la Plata region

The discussion about the origins of the extreme inequality in Latin American countries is a major issue in economic history. Many authors have pointed out that the present situation is the result of long historical processes in which inequality, Human capital, and economic growth are key factors. Two main hypotheses are committed to the analysis of the economic backwardness of Latin America: the first one argues that the present situation of Latin America is caused by the extractive institutions generated in the colonial period (the 'colonial legacy' hypothesis). Of course, not all Latin American countries suffered from such exploitative situations. Part of the literature argues that the institutions generated in the colonial period were linked to the natural resources. Colonizers engaged in diverse economic activities in different regions of a country, depending on local conditions and natural resources. One example of this argument is that extractive institutions were implemented in those regions where the natural resources were abundant. Extractive institutions were intended to transfer as much as possible of the resources of the colony to the colonizer (North, Summerhill and Weingast 1999; Acemoglu, Johnson and Robinson 2001, 2002, 2012; Bruhn and Gallego 2012). This literature agrees that the colonial heritage placed Latin America in the current economic situation since these institutions persisted over time and influence economic outcomes today.

The second one analyses the economic performance of Latin America in relation to other regions of the world in the long term. Contrary to the first hypothesis, this literature suggests that many countries of Latin America were well-positioned in the colonial period Vis á Vis Anglo-Saxon America, but the wars of independence and the costs of the creation of the new states negated the former trend and Latin

American economic growth fell during most of the 19th century until the beginning of the first globalization era (the 'lost decades' hypothesis) (Coatsworth 1993, 1998).

Empirical approaches to income and wealth distribution based on pre-statistical sources are scarce. Depending on the period, the methodologies and sources used to estimate inequality in Rio de la Plata (mainly in Argentina) can be grouped into three categories:[39] i. Ratios between salaries and land prices or GDP (mainly for periods after the 1870s), ii. The study of direct taxes of individual patrimony, and iii. The study of the post-mortem inventories.

i. Many authors used the ratio between the real wage of unskilled labourers and prices of the land as a proxy of the labor/capital ratio. This indicator is mainly used in works with a large amount of observations and long periods of time: an upswing of the ratio across time would reveal that wage-earners are in a better condition than before. This ratio has also been employed to compare inequality among countries (Williamson 2002; Bértola and Porcile 2002; Bértola and Williamson 2003; Bértola 2005; Prados de la Escosura 2005).

ii. Direct taxes are intensively used to estimate the inequality of the early 19th century in Argentina. An example is a study of Gelman and Santilli (2006) which estimates the inequality of the early 19th century using an economic census of Buenos Aires from 1839. The advantage of this source is that it is possible to find this data for periods before the 1870s. Although this source has some possible bias,[40] the study of inequality through direct taxes remains significant in the region (Santilli, 2010; Parolo and Fandos 2009; Bragoni 2009; Djenderendjian and Martirén 2009; Mata 2009; Frid 2008; Djenderendjian and Schmit 2008; Guzmán 2009).

[39] These categories are based on the work of Alvarez Beatriz (2010).
[40] There is a possibility of under-declaration of wealth by the head of the household with the objective of paying less tax.

iii. The post-mortem inventories are a significant source for the study of inequality in the region. Works that attempt to estimate inequality (mainly in Argentina) use lists of settlers in Buenos Aires and its surroundings from rural and urban areas. Although this source has some potential bias,[41] it is often used for the study of inequality (Garavaglia 1999; Johnson 1994; Johnson 1998; Johnson and Frank 2006)

Uruguayan historiography has participated in significant debates about Latin American economic backwardness from the perspective of the Rio de la Plata economies. The leading literature is devoted to comparing the relative performance of Uruguay in the period 1870–2000 (Bértola 2005; Bértola, Castelnovo et al. 2005; Camou and Maubrigades 2005; Bértola, Camou et al. 2008; Álvarez, Bértola and Porcile 2007). Among the main results, the literature points out the different phases of income distribution after the 1870s. Bértola (2005) identifies three phases: the first is the beginning of the 1870s to the first decade of the 20th century in which inequality increases; the second one runs from 1910 to 1950 in which there is a mild fall in inequality and a strong fall in the 1950s; the third phase is characterised by a strong increase in inequality from the 1960s.

Until now, there have been no studies of the area of Montevideo and its surroundings about the inequality before and up to the agro-export boom. The main reason is the difficulty in accessing the sources and the construction of indicators. However, this area is the most populated of the current territory of Uruguay, and there are a considerable number of sources, in comparison to the North of the country, that allow a study of inequality. In this sense, this Chapter attempts to fill this gap in the literature.

[41] Some potential biases are age and socioeconomic status. Probably the people leaving a legacy are older and wealthier than the rest of the population.

5.4 THE FORMATION OF HUMAN CAPITAL IN LATIN AMERICA AND RIO DE LA PLATA

There is an agreement in the literature that Human capital formation is a key factor in Latin American economic performance. The research involved in Human Capital studies has two main lines of inquiry: the first one is related to the studies of labor markets and social stratification in which is included the education. Traditional research into Human capital, labor markets and social structure in Latin America is based on the idea of an extremely hierarchical society, in which the main ways to climb the social pyramid in the pre-modern period were marriage, inheritance and Crown concessions. The colonial society has often been assumed to be corporate or organic, differing from individualistic and competitive societies (Bethell 1990; Hoberman and Socolow 1992). In this kind of society, education was a privilege of a few people. Hence, the general level of education in Latin America was low.

According to Rama and Tedesco (1979), the cultural and educational system of Latin America gave symbolic legitimacy to the differentiations contained in the social structure. The high and middle social sectors, belonging to rural areas and mainly Spanish descendants, controlled the main information channels. Meanwhile, the rest of the population, living under different ethnic and linguistic conditions, was outside the channels through which knowledge was spread (Rama and Tedesco, 1979). Furthermore, some researchers argue that the form of education brought to America by the Europeans was hardly more than ornamental culture; literacy was unimportant and African slaves were not educated at all (Gomes, 1993).

However, in a subsequent period, specifically in Buenos Aires, some of the educational characteristics were rather different. Newland (1992) argues that elementary schooling was exclusively in the private sector in the mid-19th century, as Rosas had taken financial support away from the state school system in 1838. Educational possibilities were based on a relatively

large and dynamic group of private schools. The income level of the population and the private schools allowed the dissemination of education relatively broadly: the enrolment rates for children between seven and 13 years old in the first half of 19th century were about 50% (Newland 1992).

The second line of research is devoted to analyzing and comparing the Human Capital formation of Latin America in the long run. Taking into account the large databases of Latin America and developed countries, studies have found that inequality in education was higher in Latin America before the 20th century. 20th-century globalization seems to have had positive effects by reducing educational inequality (Manzel, Baten and Stolz 2012). When the scholars analyze Human capital formation through the numeracy rates, they argue that Latin America was on a path of convergence with Western Europe during the early 18th century and there was a stagnation of numeracy levels in the 19th century. Furthermore, they found that the differences between the countries increased in this period (Manzel, Baten and Stolz 2012).

One of the shared agreements in the literature is that the existence of a 'colonial legacy,' derived from the formation of extractive institutions in the colonial period, caused the delay or impoverishment of the formation of Human Capital. This kind of institution, instead of 'educating' workers, used them for economic interests (Acemoglu, Johnson and Robinson 2001, 2002, 2012; Bruhn and Gallego 2012). However, not every country and region in Latin America suffered from this kind of exploitation. The literature is going forward in giving a more sophisticated analysis of the different Latin American countries. This difference is based mainly on the primary natural resources (Bruhn and Gallego 2012).

5.4.1 FREE LABOUR MARKET AND SLAVERY

One of the characteristics of the rural labor market of the Rio de la Plata region was the abundance of land and the scarcity of free workers. Some of the agricultural activities required an intensive labor force in a given season. In these cases, the free labor market was scarce and the workforce was expensive. For this reason, the slaves were a central factor in this economy and one of the main characteristics of the colonial rural areas. According to Amaral (1987), for agricultural producers it was more profitable to employ slaves in those tasks independent of the season. The free workforce was profitable only for certain tasks or periods. However, it was expensive and unnecessary to employ them continuously (Amaral 1987). According to Garavaglia and Gelman (1995), slavery represented a stabilizing element since they were the core of permanent workers on the medium and large properties. The use of slaves was extensive in cattle ranches and farms from Buenos Aires to Rio Grande do Sul. According to Garavaglia (1993), slaves were the most important sector of the dependent labor force. By 1815, the African population in Buenos Aires was about 20.5%, one of each man older than 12 was black or *mulato*[42] (Garavaglia 1993). According to Osório (2004), the slave population of Rio Grande do Sul in the period 1787–1807 ranged between 28% and 36%. The slaves were involved in crops in the main cropper province of Buenos Aires (San Isidro), and in the cattle expansion of Rio Grande do Sul in the first half of the 19th century (Garavaglia 1993; Osório 2004). In 1805, slaves were one-third of the population of Montevideo. Frega (2004) points out that there was a decrease in the numbers of slaves from 30% in 1805 to 25% in 1819 after the 1811 revolution.

Regarding slavery, Mallo (2005) argues that traditionally the regions of the new world are divided in two: the slavery societies and societies with slaves. In the first group are the United States, Cuba, Brazil, Haiti and the territories of the French Caribbean. In these regions, slavery was considered one of the major wealth resources and the basis of a plantation economy. The slaves were also concentrated among a few owners. Slavery as an institution, an economic system and a form of wealth was widely distributed among these economies. According to Schwartz (1982), Over 80 percent of the Bahian engenhos had between twenty and one hundred slaves. Large mills with direct control over more than one hundred slaves were concentrated along the coast. They were few and controlled less than 30 percent of the plantation slaves. Slavery in Brazil was broadly distributed among the free population, providing the economic basis of the society as a whole and an extremely common and accessible form of investment (Schwartz 1982).

In the second group is included the majority of Spanish America. In these regions, slavery was one of the different types of labor supply, and the slaves were involved in almost all the economic activities: housework, work with crafts, in the rural areas with crops and cattle, in the building industry, and service in the port. In these societies, slaveholding was extensive since many owners had one or two slaves (Mallo 2005). However, the presence of the slaves was less extended than in the slavery societies. Slavery was also an institution but was not one of the main resources of wealth. Nevertheless, even in these societies, it is possible to find some owners with a lot of slaves linked mainly to large properties raising cattle and, in some cases to commercial activities (Boruki 2005).

Bentancur (1997) argues that, in the 1830s, three kinds of coactive works coexisted in Uruguay involved with different racial groups: the slaves, those named *colonos (*servants*)*, and diverse forms of apprenticeship. Servants and apprentices were hidden ways of forced work given the scarcity of free laborers. The *colonos* were employed people who arrived from Spain (Vascos,

Galician and Canarios) with a strict and coactive contract controlled by the authorities. Some forms of apprenticeships were forced work which involved mainly children (Bentancur 1997).

The slaves were also required to work for other owners due to labor scarcity. In general, the salary was retained by the slaveholder. According to Boruki et al. (2004), this practice was extended to Montevideo and its surroundings. Through this resource, when they could obtain payment, the slaves were able to buy some goods and even their freedom (Boruki, Stalla and Chagas 2004).

The abolition of slavery in Uruguay took place during the wars against Rosas (1839–1851) in a pressing situation which allowed the incorporation of slaves into military service. The final resolution was in December 1842; however, it is possible to find the remnants of slavery for two decades after the abolition. Furthermore, the semi-slave work remained at the border with Rio Grande do Sul until the slavery abolition in Brazil in 1888 (Boruki 2005).

But, is slaveholding representative of wealth? Is it possible to estimate wealth through slaveholding? According to the literature, slaveholding represented an investment for the owner. The slaves formed a stable workforce in periods of labor scarcity. The investment in slaves meant in this period an investment in physical capital, even though these economies often combined three kinds of work: the free, slave and familiar labor force.

5.5 METHODS

The study of wealth and income distribution and the relation between early Human capital and wealth require different groups of sources and methods. The collection of the original sources was one of the large efforts of this paper since required different kind of documents. In this section, we first describe deeply the sources collected and the descriptive statistics, second we

explain the index to approximate to the early Human capital formation given by the age heaping technique, and finally we describe the methods to estimate wealth and income inequality.

5.5.1 DATA AND DESCRIPTIVE STATISTICS

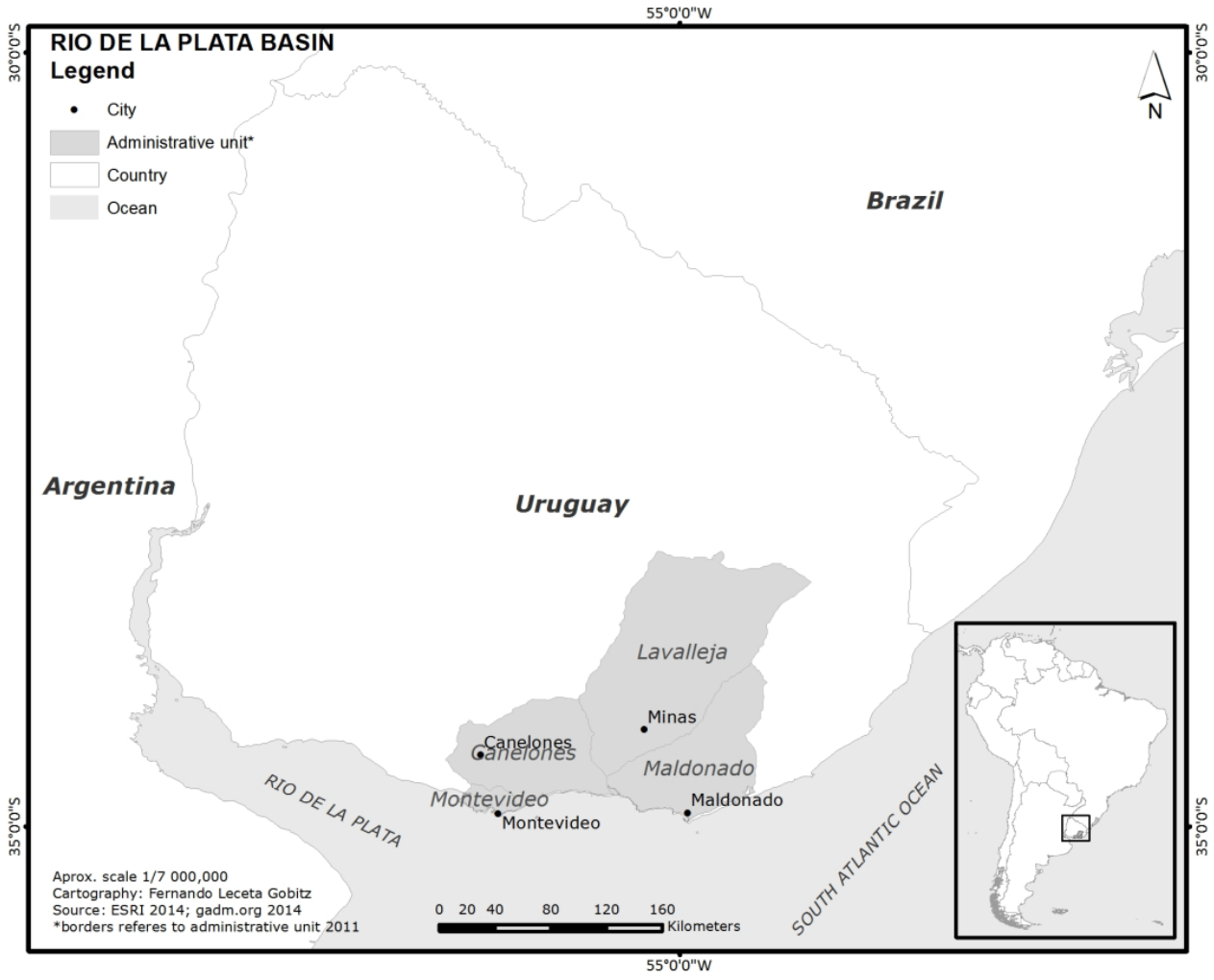
In order to carry out the objectives given above we collected three different datasets:

(1) **Census and population registers** of Montevideo and its surroundings from 1780 to 1855. They cover four southern provinces of the current limits of Uruguay including the capital. The census/benchmarks collected are Maldonado 1780, Canelones 1791,[43] Montevideo city and Montevideo countryside (*extramuros*) 1836, Canelones 1836,[44] and Minas 1855.[45] The complete database has 16,856 registers. In somewhat circa 8,200 cases occupational information is available, too. Such information is particularly interesting since allows more precise inferences about social status, skills, and wages levels. All in all these registers provide data on the household relationship, the age, occupation, and the number of slaves per head of household. We exclude all individuals younger than 23 and older than 72 years from all analyses, due to distinct rounding behaviours, small sample sizes, and exaggeration tendencies (among the old). In general, the census and registers are regular population counts. In some cases the goal was to count the population to collect taxes, in others, it was linked to political elections. The motivation to collect population data for the study of inequality is based on one of the aims of this Chapter: to test the links between wealth and the early Human capital.

[43] It has data from two different towns: Toledo and Sauce, and Pantanoso.
[44] The registers are mainly from the region of Pando
[45] This is a sample of the census of 1855. In the Minas census, one in three homes was selected in urban areas and one in four in rural areas. In the case of Montevideo, one in 10 homes were selected in the old city and one in three in the new city, always taking into account the total number of homes in both cases. A more detailed explanation is provided in Pollero (2001) '*Familia y fecundidad en el Uruguay. La inmigración en la conformación de la familia uruguaya. 1850–1908*' Tesis de maestría en estudios migratorios. Facultad de Humanidades y Ciencias de la Educación. Montevideo.

Hence, we collected registers where the age was registered (to approximate the numeracy) and the number of slaves and occupation (to approximate the wealth and income).

FIGURE 5.1. DATA LOCALIZATION



(1) The second source is a **list of family assets in Montevideo in 1751**. The information contained in this record is the name of the head of the household and a list of the properties (houses, land estates, cattle, slaves, etc.) valued at market prices. The list has information about 165 families. The government order the creation of this record with the purpose of collecting taxes to pay for an expedition against the Indians (AGN-AGA, Caja 2, Carpeta 39, 1751). The advantage of this register is that it is possible to analyze deeply and specifically the distribution of wealth. Furthermore, it is possible to compare

the slave distribution with those contained in the population registers. However, as it is not a register of the whole population, it is biased towards people who have some property, as those who do not have goods are not registered. Furthermore, through this source, it is not possible to study the skills or education of the head of the household since there is no information about this.

(2) The third sources are **nominal wages of Montevideo** collected from four different documents. The aim was to build up wages categories i.e. "low, middle and upper" to analyze the wage divergence. The sources collected are the following: 1. Nominal wages of the workers involved in the construction of the wall of Montevideo (1760-1788); 2. Nominal wages of the workers involved in the construction of the Cathedral (*Iglesia Matriz*) from 1788-1808; 3. Nominal wages of the workers of the Spanish Crown (1767-1799); and 4. And nominal wages of workers linked to the police of Montevideo (1841-1857). The nominal wages were grouped in two sub-periods (1780-1791/1836-1855) according to the benchmarks of the population registers. All in all, the database of wages contains about 45 different occupational categories from which it is possible to build up categories such low, middle and upper wages levels and "unskilled and skilled"[46] workers. The wages were imputed to the occupational categories of the census.

These sources will contribute to the study of inequality and Human capital formation in Montevideo and its surroundings from the colonial period to the economic modernization. In the following two sections (5.5.2 and 5.5.3) we explain the age heaping technique as a proxy of Human capital formation and the occupational taxonomy and real wages estimation to analyze the income and wealth distribution.

A detailed table with a description of the dataset is available in the appendix.

[46] One of the most common examples are the workers of the constructions with the categories of labourer and foreman (*peón and capatáz*)

5.5.2 AGE HEAPING TECHNIQUE AND HUMAN CAPITAL

As is often in pre-industrial and pre-modern societies, data such as school enrollment or literacy rates are scarcely available for late colonial and early republican period in Latin America. To estimate Human capital, this study, therefore, uses the phenomenon of age heaping which has become a standard method in Human Capital research. Scholars like Bachi (1951) and Myers (1954) recognized a stronger tendency towards age heaping in societies featuring relatively poor levels of education (A'Hearn et al., 2009). The ability of an individual to report her exact age rather than a number rounded to a multiple of five is treated as a measure of basic numeracy. The idea of this index is that, in pre-modern times when census takers, army recruitment officers, or prison officials asked an individual his or her exact age, only a certain number of the recorded people were able to provide it. Depending on their numerical education, many of the registered tended to round their age, for example, saying 40 when they were 39 or 41 (Manzel, Baten et al. 2008). The approximation in age manifests itself in the 'heaping' phenomenon. Individuals tended to choose an 'attractive' number such as those ending in five or zero (A`Hearn, Baten et al. 2009).

The quality of age reporting can be measured by means of age heaping indices to detect the degree of preference or avoidance for certain ages. Among standard indices (Bachi, Myers, Whipple, Zelnik),[47] the Whipple index is the most widely applied.[48] The original Whipple index is obtained by summing the number of people in the age range 23–62 inclusive, and calculating the ratio of reported ages ending in zero or five to one-fifth of the total sample. As we point out above, the index assumes a linear distribution of ages in each range of five years, i.e., a continuous and linear decrease in the number of persons of each age within the age range considered. Low ages (0–23 years) and high ages (72 years and above), for which the linearity

[47] The methods to calculate these indices are in Shyrock and Siegel (1976: 115–119).
[48] A'Hearn, Baten and Crayen (2009) argue that this is the only index that fulfils the desired properties of scale independence (a linear response to the degree of heaping) and that it offers a reliable ranking of samples among which the degree of heaping varies.

assumption is not plausible, are excluded from the calculation (Spoorenberg and Dutreuilh 2007).

$$(1) \qquad Wh = \left(\frac{\left(Age25 + Age30 + Age35 + ...Age60\right)}{1/5 \times Age23 + Age24 + Age25 + ... + Age62} \right) \times 100$$

For an easier interpretation, A'Hearn, Baten and Crayen (2009) suggested another index: the ABCC index.[49] It is a simple linear transformation of the Whipple index and yields an estimate of the share of individuals who correctly report their age:

$$(2) \quad ABCC = \left(1 - \frac{(Wh - 100)}{400}\right) \times 100 \text{ if } Wh \geq 100; \text{ else } ABCC = 100$$

The index takes the values between zero and one. A value of zero means a total age heaping, while a value of one means not heaping at all.

To visualize the evolution of the ABCC index by birth decades, we calculated the birth decade of each age group, taking into account the middle age of the age group. For example in the age group 23–32, we calculated the birth decade of those who are 27 years old. The figures of the ABCC index by the Armstrong taxonomy are presented by birth decades and by half-birth decades, and not by the year of the census.

An advantage of the age heaping methodology is that age is more widely available information than other Human capital proxies, such as signature ability or school attendance. In general, all population registers have the age as one of the main categories.

As Reis (2008) points out, age heaping is a very basic measure of human capital. It is especially useful in the study of human capital development in Latin America during the 17th and 18th centuries, when more advanced Human capital indicators were quite scarce and, instead of

[49] The name results from the initials of the authors' last names plus Greg Clark's, who suggested this in a comment on their paper. Whipple indices below 100 are normally caused by random variation of birth rates in 20th century rich countries. They are not carrying important information, hence normally set to 100 in the ABCC index.

offering insights into a broad spectrum of a given population, provided only a limited one, of the socioeconomic elite (Reis 2008).

Through this index, we will approximate the education required for the Human capital equation. High levels of numeracy would indicate an educated workforce (at least in basic terms), while low levels would indicate a poorly instructed workforce/population.

The census data provides records of the respondent's occupations in about 8,200 cases. Including job-related information, we used Armstrong´s groups and an estimation of the real wages or more precisely welfare ratios trough the nominal wage data described above (section 5.5.1).

5.5.3. OCCUPATIONAL TAXONOMY AND REAL WAGES: WEALTH AND INCOME DISTRIBUTION

a. Armstrong occupational taxonomy

We include Armstrong´s (1972) occupational taxonomy to link the economic task and social strata to wealth. The taxonomy was primarily based on two factors: industrial groups (to trace the economic contours of society) and social ranking. The taxonomy of social ranking was initially created to analyze a social class scale in England at the beginning of the Industrial Revolution. The society which existed in Western Europe before the Industrial Revolution was hierarchical in character. Pre-industrial society is viewed as a kind of pyramid, with the monarchy at the apex, then the peerage, the gentry, farmers, laborers and finally paupers (Armstrong 1972). The ranking was based on the occupations declared in the population census as this was the data available in early registers. The taxonomy consists of five groups ranked from unskilled to professional.[50]

[50] See the detail of the taxonomy in the Appendix.

b. Real wage estimation

Following the approach used by Allen (2001), Allen et al. (2011), and Arroyo Abad et al. (2012), we used wage and price data to estimate welfare ratios. The salaries were collected from the sources described above (section 5.1) and the price of the basket is imputed from the basket of Buenos Aires in the equivalent period from Abad et al. (2012). The baskets are measured in the number of bare-bones subsistence baskets for a family one wage earner can afford. A welfare ratio of one means that the annual income of the worker is enough to cover the annual living expenses of a family of two adults and two children at the subsistence level[51]. We adopted the composition of the bare-bones basket developed for Argentina by Arroyo Abad (2012). We defined three groups of income: A lower, middle, and upper-income class taking into account the annual salary and the specification of the occupation. Dividing annual nominal wages (measured in grams of silver) of the three income groups at each census benchmark by the cost of the subsistence basket in each period, we obtain the respective welfare ratios. They may be biased to some degree as a result of the application of Buenos Aires prices to all individuals covered in the wage sample of Montevideo. Even if a bias in the calculated welfare ratio needs to be acknowledged, this bias would affect all income groups and has, therefore, no effect on the relative positions.

Although the nominal wages are a direct indicator of income, it is worthy to remark that the waged labor in the colonial period coexisted with another kind of work: the forced work of the indigenous and apprentices, the slave work, and the familiar work (mainly for the subsistence). Furthermore, the salary was not the only income of the worker. Depending on the worker, part of the tasks was paid with food, clothing, and accommodation (Moraes and Thul 2014).

[51] As an illustration of what the subsistence level means in today´s terms, note that Allen et al. (2012) calculated the cost of their subsistence basket in 2005 US Dollar prices, and found out that the subsistence consumption requires a per-capita daily income of US $1.30, which almost equals the (extreme) poverty line used by the World Bank of US$ 1.25.

Nevertheless, taking this fact into consideration, we can approximate to the income distribution with the nominal wages registered in the sources since another kind of income is unfortunately not available in the historical documents collected. Table 5.1 displays the results of the welfare ratios to be included in the further regressions.

TABLE 5.1. WELFARE RATIOS 1780-1855

Welfare ratios[52]		
	1780-1791	1836-1855
Lower	1,14	1,06
Middle	3,41	6,36
Upper	25,61	46,65

Sources: AGN, AGA, Libro 161. 1775-1783: Archivo General de Indias (AGI), Buenos Aires, 445. 1784-1788: AGI, Buenos Aires, 446. 1789-1798: AGI, Buenos Aires, 448.
AGNBA, Sala IX, 03-02-05, División Colonia, Sección Gobierno Montevideo, Iglesia Matriz, Cuentas, 1781-1808. Archivo General de la Nación, Uruguay, Archivo General Administrativo, Libros N° 963, 968, 977, 979, 1000, 1009, 1012, 1018.

5.6 WEALTH DISTRIBUTION IN MONTEVIDEO AND ITS SURROUNDINGS

Table 5.2 displays the Gini coefficients of the three sources mentioned above: the census and population registers of Montevideo and towns/villas of the countryside; the taxation list of assets of Montevideo in 1751 and the welfare ratios. In this section, the emphasis will be given in the wealth distribution through the slaveholding and the patrimony of the taxation list of Montevideo 1751.

About the taxation list, we compare the slave distribution with other active assets such as properties, cattle, and other animals. The quantity and value of the taxed goods are registered in the original document. We calculated the Gini coefficient through the values: for example, a slave costs 200 *pesos* but, depending on the gender or age, they might cost less, for example,

[52] Welfare ratio is the ratio between nominal wages and the cost of the bascket of consumption goods. It was calculated following Allen (2001) and Allen et. Al (2011). Their estimation assumes a household of 4 people but only 3 consumption basckets (as the consumption of children is lower), and a 5% addition for rents.

100 *pesos*. We took into account only the value of the slaves and not the quantity, although in the final results the coefficient would probably be highly similar.

The aim of these coefficients is to compare the distribution of the stock (slaves, cattle, land, etc) and flow (wages) of wealth. The first part of the figure corresponds to the slave distribution of the different regions and in the years selected. In general terms, the slave distribution is quite homogeneous since the Gini coefficients fluctuate between 0.37 and 0.40. To compare with other economies, Vidal Luna and Klein (2004) argue that the average figure of the slave distribution's Gini coefficient in this period for Sao Paulo was 0.53, while for Minas Gerais in 1804 ranged from 0.43 to 0.64. In the case of USA (a sample of Southern states) in 1790 the figure was 0.60, while in 1830 was 0.59. All these figures highlight the relative equality of Montevideo´s society.

It is remarkable that the higher coefficients correspond to urban areas (Montevideo and Minas). Furthermore, the census of Minas from 1855 was collected after the abolition of the slavery; however, slaves are registered in the household and are likewise distributed as in the previous years.

The second part of the figure displays the Gini coefficients of the taxation list of Montevideo in 1751. It is noteworthy that the slave distribution is similar to the distribution of the census (0.44). However, the general wealth is more concentrated (0.52), and the Gini coefficient of the cattle is the highest of the distribution (0.61).

Finally the welfare ratios of Maldonado-Canelones 1780/1791 are almost as concentrated as the cattle distribution of the taxation list (0.58). However, the period 1836-1855 displays a more homogeneous coefficient (0.49).

All in all, the Gini coefficients show a relatively low and medium concentration of wealth and income. Remarkable is that the distribution of the welfare ratios shows more representative

results since the nominal wages of the different occupational categories are imputed in the whole active population; while the slaves and the assets of the taxation list show the distribution of the population with properties. The data analysis suggests that the distribution of the stock of wealth is in general more equal that the distribution of income (except cattle). For example, the Gini coefficient of the slaves shows an equal distribution of wealth since most of the slaveholders had one or two slaves. This fact is predictable since a large part of the rural workforce were the family members.

TABLE 5.2. WEALTH DISTRIBUTION: GINI COEFFICIENTS

Regions and year (Pop. registers)	Gini coefficient
Distribution of slaves	
Maldonado 1780–Canelones 1791	0.35491
Montevideo 1836	0.40599
Montevideo countryside 1836	0.38048
Minas 1855	0.40585
Montevideo 1751 (Taxed goods)	
General wealth	**0.52028**
Cattle	**0.61496**
Slaves	0.4381
Welfare ratios	
Maldonado Canelones 1780-1791	**0.58319**
Montevideo Minas 1836-1855	0.49716

Sources: Maldonado 1780 AGN Buenos Aires IX 20–4–3; Montevideo 1836 AGN -AGA 148, 465, Montevideo countryside 1836 AGN -AGA 465, 279; Minas 1855 AGN -AGA 287; Montevideo 1751 AGN-AGA, Caja 2, Carpeta 39. Nominal wages: AGN, AGA, Libro 161. 1775-1783: Archivo General de Indias (AGI), Buenos Aires, 445. 1784-1788: AGI, Buenos Aires, 446. 1789-1798: AGI, Buenos Aires, 448.
AGNBA, Sala IX, 03-02-05, División Colonia, Sección Gobierno Montevideo, Iglesia Matriz, Cuentas, 1781-1808. Archivo General de la Nación, Uruguay, Archivo General Administrativo, Libros N° 963, 968, 977, 979, 1000, 1009, 1012, 1018.

Table 5.3 displays the results (as percentages) of the slaveholding by region/year (including the non-slaveholders). The table is displayed by periods to analyze the differences among the regions and before and after the abolition of slavery (in 1842). The table displays in the first place the slaveholding as a percentage of the total sample and in the second place as a percentage of the census.

TABLE 5.3. SLAVEHOLDING BY REGION/YEAR

Percentage of the total sample	Maldonado 1780	Montevideo 1791	Canelones, Montevideo 1836	Minas 1855
Non slave holders	22.8	1.6	41.5	10.3
1 and 2 slaves	1.8	0.2	9.5	2.8
3 to 5 slaves	1.3	0.1	4.1	1.5
more than 6 slaves	0.1	0,1	1.8	0.5
Percentage of the census				
Non slave holders	87.7	80.9	73.0	68.0
1 and 2 slaves	6.9	11.8	16.6	18.5
3 to 5 slaves	4.9	4.4	7.3	9.9
more than 6 slaves	0.6	2.9	3.2	3.6

Sources: AGN -AGA 279, Montevideo and surroundings 1836 AGN -AGA 148, 465, 279; Minas AGN-AGA 287

The results presented in Table 5.3 shows a society in which the majority of the population did not have slaves. The percentage of non-slaveholder fluctuates between 87% and 68%. Surprisingly this percentage decreases throughout the time, even when the slavery was abolished (the case of the last census). Among the slaveholders the distribution is not homogenous; however; most of the slaveholders had one or two slaves. Remarkable is that the concentration of 6 slaves or more takes place in the period after the official abolition of slavery (1855).

Furthermore, the census records considerable occupational information for the almost 850 slaveholders and permit the ranking of these slaveholders according to their productive or economic sector. Table 5.4 displays the results of the slaveholders according to the economic sector.

TABLE 5.4. SLAVEHOLDING BY ECONOMIC SECTOR

Percentage of the economic sector	Primary sector	Secundary sector	Tertiary sector

1 and 2 slaves	15.0	5.4	38.7
3 to 5 slaves	7.2	2.8	19.7
more than 6 slaves	3.7	0.3	7.3
Total	**25.9**	**8.4**	**65.7**
Percentage of the census			
1 and 2 slaves	57.9	63.5	58.8
3 to 5 slaves	28.0	32.9	30.0
more than 6 slaves	14.2	3.5	11.2
Total	100.0	100.0	100.0

The proportion of the slaveholders with one or two slaves is homogenous in the three economic sectors, however; the big slaveholders belong mainly to the primary and tertiary sectors. The tertiary sector, which is represented mostly by the commerce and services, is the sector in which are required more slaves. This fact is contradictory with the classical image of the big landowners with a lot of slaves.

To identify if the slave ownership is concentrated in a given occupation, we made an identification of the most frequent occupation according to the slaveholding. Table 5.5 displays the results.

TABLE 5.5 RANKING OF OCCUPATIONS ACCORDING TO WEALTH IN SLAVES

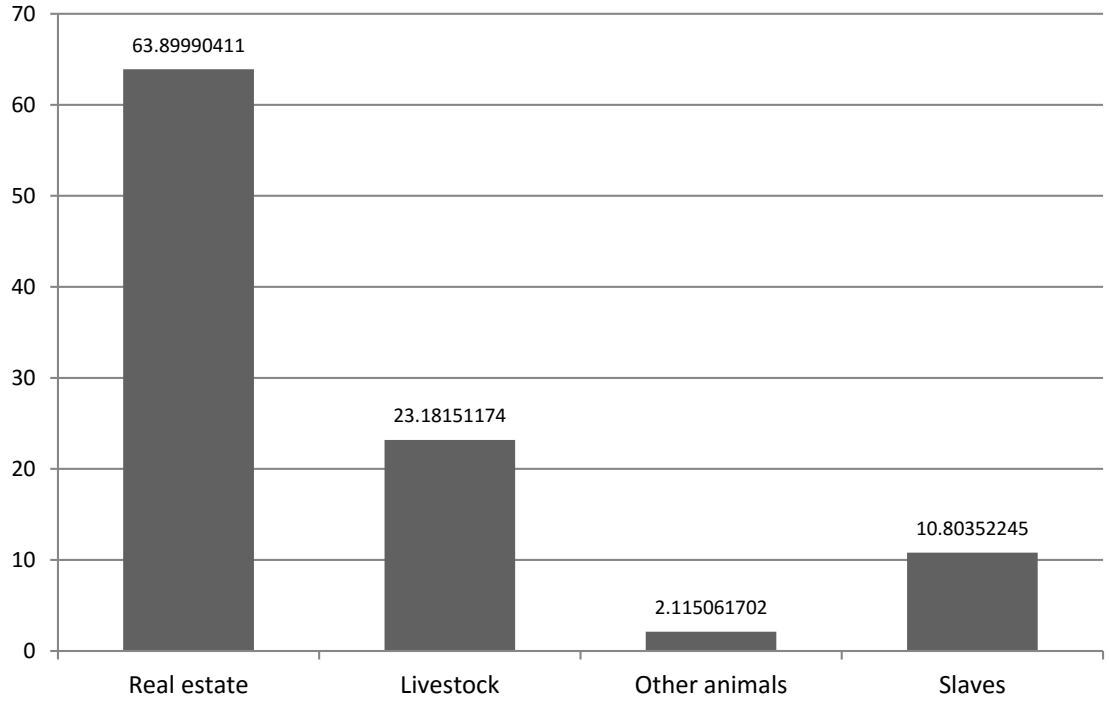
Percentage of the frequent occupational categories by economic sector	1 and 2 slaves	3 to 5 slaves	More than 6 slaves
Primary sector			
Landowner	21.9	7.3	6.5
Farmer	30.4	6.7	13.6
Tertiary sector			
Carpenter	3.7		7.2
Commerce	34.1	**83.7**	**63.1**
Pulpero (small rural store)	5.6		
Tendero (small store)	4.4	2.2	
Craftsman			3.9
Shoemaker			5.7
Total	100.0	100.0	100.0

Occupations like Landowner and farmers have similar patterns of slaveholding since they own in general one or two slaves. Contrary to what was expectable the farmers owned more slaves than the landowners. The merchants are the category with more proportion of slaves of the total sample. Remarkable is the concentration of the category three to five slaves in the commerce, which makes this occupational category as one of the big owners of slaves of the total sample. This concentration of the slaves in the commercial activities shows the slavery linked to the urban activities. Furthermore, breaks the image of a society in which the big rural production was the way to climb the social ranking. Apparently, activities such commerce made possible the accumulation of wealth.

Regarding the rural production, these results show that the slaves participate in the production and integrate the homes. As was described in Section 5.4.1 slavery was one of the different types of labor supply; however, they coexisted with the free workers and the apprentice (kind of forced work). The slaves were involved in almost all the economic activities: housework, work with crafts, in the rural areas with crops and cattle, in the building industry, and service in the port (Mallo 2005).

The following figures (5.2 and 5.3) display the results of the wealth composition in Montevideo 1751. All the categories represent the values of the goods in *pesos*. Figure 5.2 shows that the main component of wealth was the real estate (64%). In second place were cattle with 23% and in third place were the slaves with 11%. The rest (2%) is represented by other animals, mainly horses and sheep.

FIGURE 5.2 PERCENTAGE OF GOODS BY HOUSEHOLD. MONTEVIDEO 1751

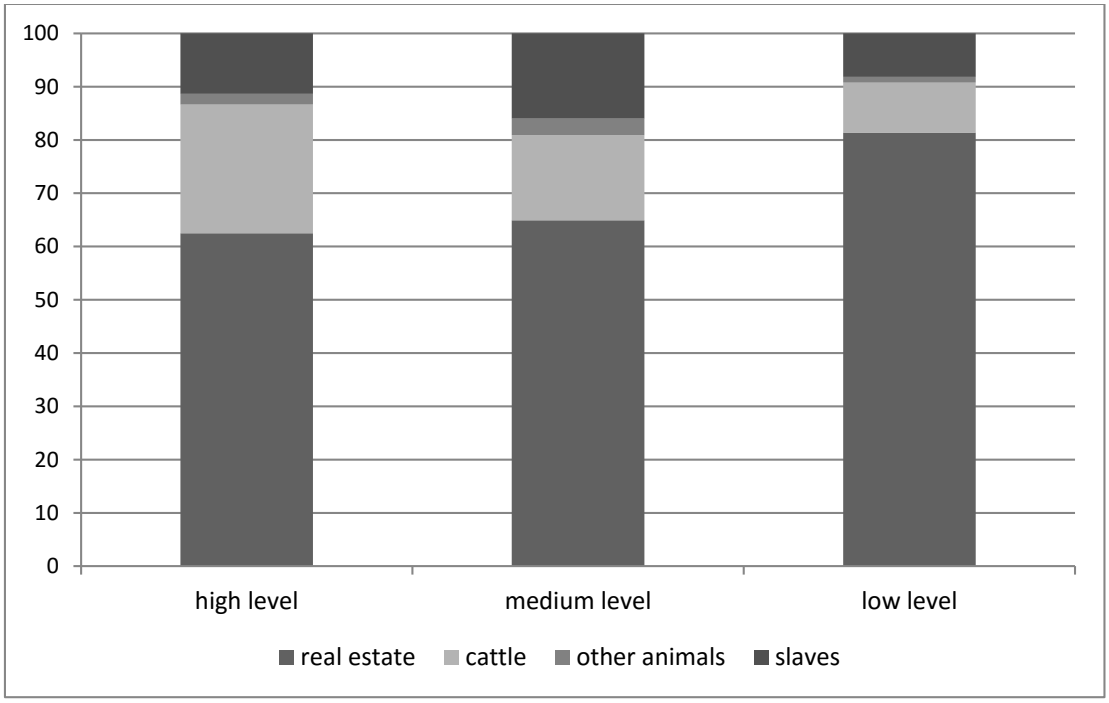


Source: AGN-AGA, Caja 2, Carpeta 39

The total value of the patrimony was grouped in three strata to identify the low, medium and high levels of wealth (regarding patrimony). Figure 5.3 displays the results of the distribution of wealth by these three levels of wealth.

From this figure, it is possible to arrive at three main remarks. Firstly, the weighting of real estate in general wealth decreases with the income level. The wealth of the low-income level is composed of nearly 80% real estate (houses and land); while the real estate in the high-income level represents 62% of the total wealth. Secondly, the weighting of cattle in general wealth increases with income. In the high-income level, cattle represents 24% of the general wealth and, at the low level, cattle is only 9.3%. Thirdly, slaves are as important as livestock in the medium level of income; they are 16% of the total wealth and livestock is 15.9%. In the high and low-income levels, the slaves represent the third category of the position of the whole patrimony.

FIGURE 5.3, PERCENTAGE OF ASSETS BY WEALTH



Source: AGN-AGA, Caja 2, Carpeta 39

Finally the category 'other animals' represents a very low percentage in all the income levels. Other kinds of goods were not taken into account in this taxation list.

All in all, the analysis of the wealth and income distribution of Montevideo and surroundings gives the idea of a society with a medium and low concentration. However, wealth is not homogenous distributed and cattle represents the asset more unequal distributed with a Gini coefficient of 0.61. The distribution of wealth trough the slaveholding show that the in urban areas the distribution is more concentrated than the rural regions. This fact connects to the relative intensive use of the slaves in the tertiary economic sector, mainly in the commercial activities. Regarding the wealth levels, the real state is the most common property in the low strata and the slaves are a small proportion of the whole patrimony. However; the high and medium strata of wealth incorporate more slaves in the general wealth. Furthermore, cattle is visibly more concentrated in the high strata. Finally, the Gini coefficients of the welfare ratios

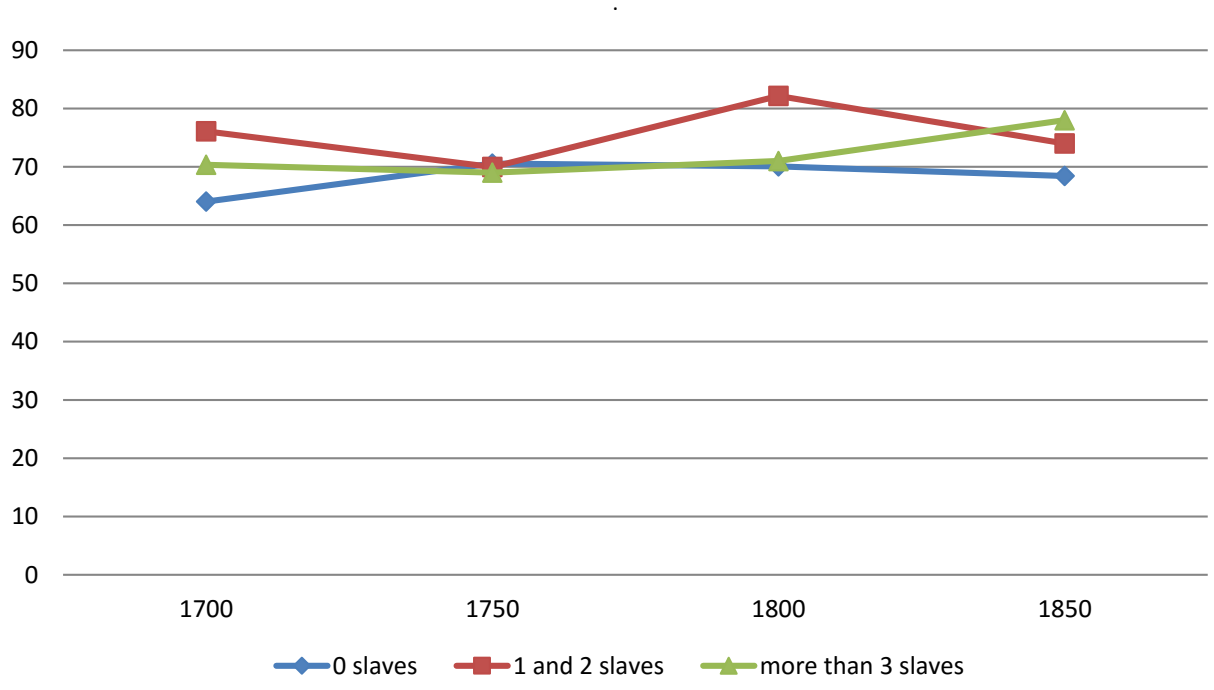
show a relative medium concentration of income since they show a fluctuation between 0.58 in 1870/1791 and 0.49 in 1836/1855.

5.7 HUMAN CAPITAL AND WEALTH

Was Human capital formation related to wealth? Was education relevant in achieving wealth? In this section, we link the basic mathematical capabilities (numeracy) to wealth. As we outlined in the methodological section, numeracy is approximated by the ABCC index and wealth/ income are given by the slaveholding and the welfare ratios. In this case, we used only the population census since it includes registers of the age, occupation and number of slaves per home. We include as well the Armstrong occupational taxonomy[53] to improve the analysis. We analyze this relation through the numeracy trends by half year.

Figure 5.4 displays the results of the numeracy trends by number of slaves, including the individuals who did not have slaves.

FIGURE 5.4. ABCC TRENDS SLAVEHOLDERS MONTEVIDEO, CANELONES, MALDONADO, MINAS. 1700-1850



[53] See details in the Appendix.

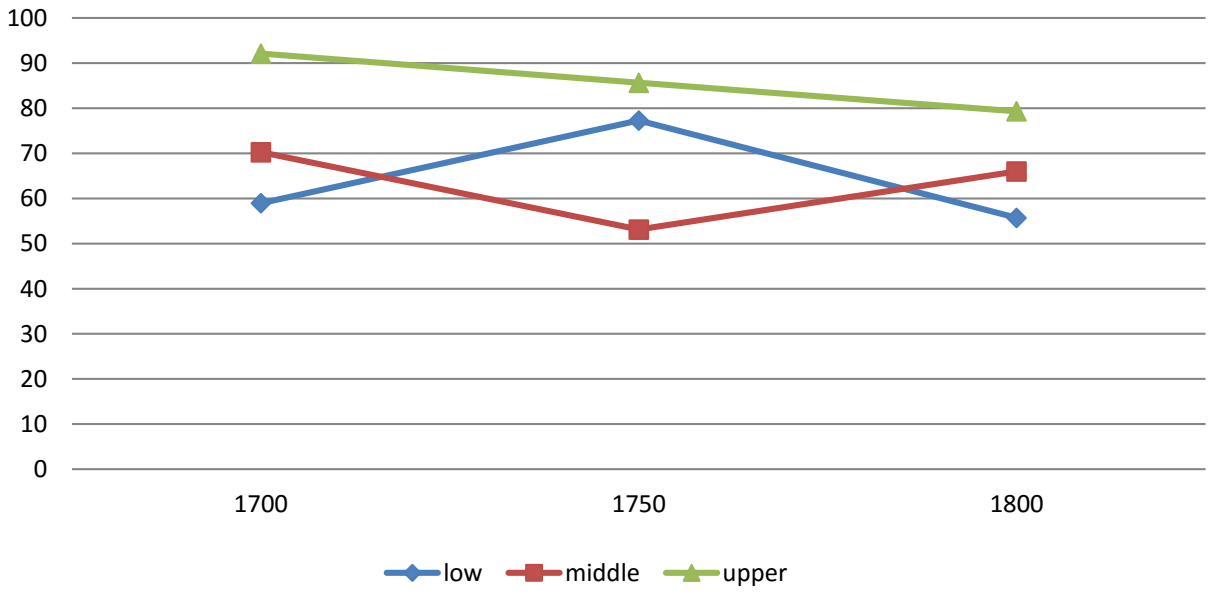
Note: the results are in half century of the year of birth.

Sources: Maldonado 1780 AGN Buenos Aires IX 20-4-3; Montevideo 1836 AGN -AGA 148, 465, Montevideo countryside 1836 AGN -AGA 465, 279; Minas 1855 AGN -AGA 287

This figure shows that the heads of households who did not have any slaves were also less numerate (the ABCC index is around between 60 and 80). However, there were no differences in the numeracy trends between the small and big slaveholders. The ABCC trend of those heads of households with one or two slaves is around 70 and 80, following the trend of the significant slaveholders. These results mean that basic numeracy was required to have a slave, however, there was no difference in the numeracy requirements to be a big slave holder.

Similar is the pattern of the ABCC trends by welfare ratios. Figure 5.5 displays the results. The upper position is clearly the most numerated; however, the middle and low position show similar patterns. Numeracy is in this case related to the highest positions of income but seems not to be significant to achieve middle-income positions.

FIGURE 5.5. ABCC TRENDS WELFARE RATIOS. MONTEVIDEO, CANELONES, MALDONADO, MINAS. 1700-1800

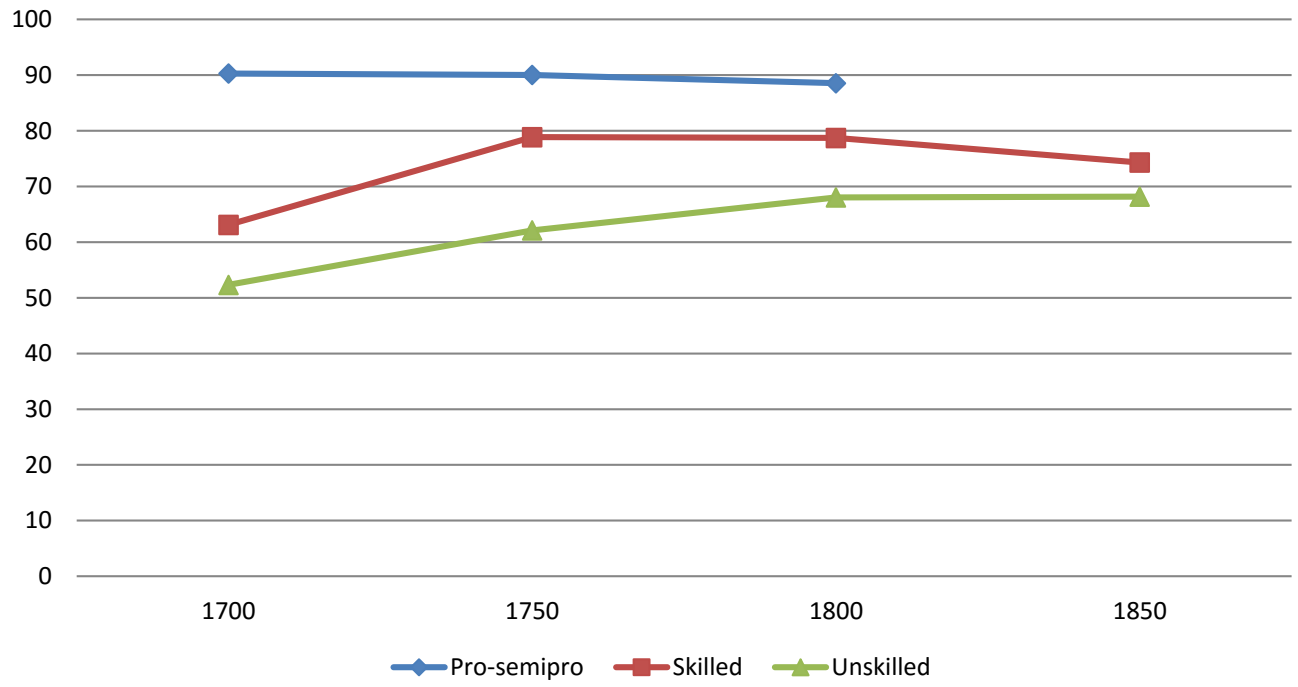


Note: the results are in half century of the year of birth.

Sources: AGN, AGA, Libro 161. 1775-1783: Archivo General de Indias (AGI), Buenos Aires, 445. 1784-1788: AGI, Buenos Aires, 446. 1789-1798: AGI, Buenos Aires, 448. AGNBA, Sala IX, 03-02-05, División Colonia, Sección Gobierno Montevideo, Iglesia Matriz, Cuentas, 1781-1808. Archivo General de la Nación, Uruguay, Archivo General Administrativo, Libros N° 963, 968, 977, 979, 1000, 1009, 1012, 1018.

Finally, when we consider the Armstrong occupational taxonomy as the position in the labour market and in the social ranking, numeracy became significant regarding the qualification (and status). Figure 5.6 displays the results of the numeracy trends by the Armstrong occupational taxonomy.

FIGURE 5.6. ABCC TRENDS BY ARMSTRONG OCCUPATIONAL TAXONOMY. MONTEVIDEO, CANELONES, MALDONADO, MINAS 1700-1850



Note: the results are in half century of the year of birth.
Sources: Maldonado 1780 AGN Buenos Aires IX 20–4–3; Montevideo 1836 AGN -AGA 148, 465, Montevideo countryside 1836 AGN -AGA 465, 279; Minas 1855 AGN -AGA 287

In this figure, the unskilled workers had lower numeracy trends than the rest (between 40 and 60), and the professionals and semi-professionals had the higher trend (around 90). These results mean that numeracy was significant to achieving a good position in the labor market. The workers with low numeracy levels were also those with the weakest and most precarious positions in the labor market.

From both numeracy trends, it is possible to sum up some remarks: basic numerical education was important in achieving a good position in the labor market and a medium level of wealth; however, apparently other mechanisms not related to education played a significant role in obtaining greater wealth. These mechanisms are not analyzed in this Chapter, however, the literature review suggests that the marriage and the patronage (*padrinazgo*) were an important mechanism of social mobility and achievement of wealth (Bethell, 1990).

5.8 ECONOMETRIC ANALYSIS

To estimate potential wealth/income effects on Human capital, we model an individual´s chance of being numerate as a logistic function of a set of independent variables. Numeracy is a binary variable defined as 1 if the reported age of an individual is no multiple of five, and 0 otherwise. The fact that 20 % of the population is expected to report a multiple of five is adjusted. Following Juif and Baten (2013), the regression tables displays the marginal effects multiplied by 125, which allows an interpretation as percentage changes of numeracy.

Armstrong taxonomy variables

We included dummy variables of the Armstrong occupational taxonomy to identify potential determinants of Human capital formation linked to the labor market and the social ranking. As we described above (section 5.5.3) the dummies are professional, semi-professional, skilled, semi-skilled and unskilled.

Welfare ratios

Following the approach used by Allen (2001), Allen et al. (2011), and Arroyo Abad et al. (2012), we used wage data from Montevideo (section 5.3b) and price data from Buenos Aires

to estimate welfare ratios. The nominal wages were imputed in the Census according to the occupational categories and benchmarks of the original. For example, we defined occupations with low income to all the unskilled workers like laborers, pawns, domestic service. The upper strata are related to the professional and white collar categories, like doctors, priests, bishops, administrative of the Viceroyalty and big merchants. The middle positions are imputed to the small commerce and foreman. Most of the occupational categories of the original sources were imputed without inconvenient in the population registers; however, the professional presented more difficulty. These nominal wages were taken mostly from the sources of workers of the police described above (section 5.5.1) and are more representative of the second period (1836/1855).

The prices are measured in the number of bare-bones subsistence baskets for a family one wage earner can afford. We adopted the composition of the bare-bones basket developed for Buenos Aires by Arroyo Abad (2012). In Allen, 2001, the relative living standard of unskilled laborers in Europe between 1300 and 1914 was calculated using a standardized consumption basket of goods taken from Strasburg around 1750. This very basic basket was called the 'bare-bones basket,' contrasting with the 'respectable basket' that had been used initially for intra-European comparisons. Its core consists of the cheapest staple food necessary to survive. In Argentina and Chile,-according to these authors- wheat was the cheapest staple, but the meat was also not expensive and was consumed in large quantities. This basket includes a 'low meat diet' and was not more expensive than the basket of other countries of Latin America, because of these very low prices of meat. They took the quantities of consumption of goods as textiles, heating and soap of a basket of Western Europe (Arroyo, Davies and Van Zanden 2012).

We defined three groups of income: A lower, middle, and upper-income class and we create dummy variables from these categories.

Slaveholding (number of slaves per home)

We included the number of slaves per home as a proxy of wealth. As was described above (Section 6) only 14% of the active population of the census was a slaveholder, in our database 896 registers. We decided to include this variable in the analysis as is the only one that gives a proxy of wealth in the population census.

Time and regional control variables

We created dummy variables to control possible time and local effects. We controlled as well for the 23-32 age group as it manifests different heaping patterns (Crayen and Baten 2009).

Table 5.6 presents pairwise correlations between selected explanatory variables due to identifying problematically high correlations. The main focus of this study lies on the welfare ratios (low medium and upper) and the number of slaves per home.

TABLE 5.6 PAIRWISE CORRELATIONS. EXPLANATORY VARIABLES

	Slaves	Maldonado 1780	Minas 1855	Montevideo 1836	Welfare upper	Welfare middle	Welfare low
Slaves	10.000						
Maldonado 1780	-0.1154 0.0000	10.000					
Minas 1855	0.0538 0.0018	-0.1659 0.0000	10.000				
Montevideo 1836	0.0451 0.0089	-0.2687 0.0000	-0.1661 0.0000	10.000			

Welfare upper	0.1292	-0.0894	0.2447	-0.0895	10.000		
	0.0000	0.0000	0.0000	0.0000			
Welfare middle	-0.0884	0.2975	0.2316	-0.0258	-0.1400	10.000	
	0.0000	0.0000	0.0000	0.0424	0.0000		
Welfare low	-0.0738	0.1952	0.0101	0.0965	-0.0636	-0.1451	10.000
	0.0000	0.0000	0.4260	0.0000	0.0000	0.0000	

When checking all combinations among all explanatory variables no problematically high correlation is indicated. For example, there is a negative but not high correlation between the number of slaves and the welfare ratios middle and low, in fact, it is possible to estimate that the low-income strata did not have any slave (wealth/patrimony) at all. We take this into consideration to analyze with caution this combination.

5.8.1 EMPIRICAL RESULTS

The following table (5.7) presents results of the marginal effects of a logistic regression. In all cases numerate is the dependent variable. The charts display the marginal effects multiplied by 125 and P-values in parentheses. We opted for a logistic regression as the dependent variable is binary.

TABLE 5.7. POTENTIAL DETERMINANTS OF HUMAN CAPITAL FORMATION

Models	1	2	3	4	5
Estimation technique	Mxf Logistic regression	Mxf Logistic regression	Mxf Logistic regression	Mxf Logistic regression	Mxf Logistic regression
Dependent variable	Numerate	Numerate	Numerate	Numerate	Numerate
Welfare middle	8.4***	10.35***	12.0125	11.4625	10.9875
	(0.00)	(0.00)	(0.30)	(0.34)	(0.36)
Welfare upper	17.35***	17.81***	20.5875**	20.3125*	15.6

	(0.00)	(0.00)	(0.05)	(0.06)	(0.18)
Numbre slaves		0.05	0.0125	0.425	0.325
		(0.93)	(0.99)	(0.51)	(0.61)
Semiskilled			17.625*	19.5**	28.15***
			(0.06)	(0.03)	(0.00)
Skilled			-3.1124	-0.725	7.075
			(0.79)	(0.95)	(0.57)
Semipro			0.625	0.9	13.2875
			(0.96)	(0.95)	(0.31)
Professional			18.5625	17.8625	29.3125**
			(0.33)	(0.36)	(0.05)
Age group 33-42				-4.05	-4.9375*
				(0.15)	(0.08)
Age group 43 52				-8.5***	-10.4***
				(0.01)	(0.00)
Age group 53-62				-16.8***	-18.75***
				(0.00)	(0.00)
Maldonado 1780					-15.45***
					(0.00)
Minas 1855					-14.375***
					(0.00)
Montevideo 1836					-8.4**
					(0.02)
Observations	6,194	3,365	3,365	3,207	3,207
Pseudo R-squared	0.024	0.024	0.024	0.024	0.024

Note: pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Model 1 Constant refers to welfare low. Model 3 constant refers to welfare low, unskilled. Model 4 constant refers to welfare low, unskilled Age group 23-32; Model 5 constant refers to welfare low, unskilled Age group 23-32, Canelones 1791.
The coefficients of all independent variables are scaled up by 125 for a more convenient interpretation of changes in numerate.

Model (1) – (2) present a basic set of explanatory variables applied to the data set with information about occupations (welfare ratios) and number of slaves (as a proxy of wealth). In both models, welfare ratios middle and upper are positive and significant related to numerate.

Remarkable is that the welfare ratio upper has a high positive coefficient. That means that having high-income levels has a strong effect in numeracy. The number of slaves per home has no significant effect and very low coefficients in all the models.

Model (3) - (5) repeats the setting of (1-2) but includes the dummies of the Armstrong occupational taxonomy and the regional and birth decade effect. In models 3 and 4, the upper welfare ratio remains with high and significant effect on numerate. However, once we included the regional effect (5) loses significance. The semiskilled dummy of the Armstrong taxonomy is strongly and positive related to numerate, even when we include the birth decade and regional control variables. The professional category (specification 5) shows as well a high and significant effect on numeracy. All the age groups included (33-72) show negative and significant effect on numerate in relation to the 23-32 age group. The pseudo R-squares do not differ in any of the models.

All in all the results displayed in this section report a positive and significant effect of income and social status (like in the Armstrong taxonomy) on numeracy. For a pre-modern period, that means that being wealthy was one of the ways to achieve a basic education. This fact is especially significant when we consider the income and the social ranking of the workers given by the position in the labor market.

How important was the early Human capital to achieve high levels of wealth? The usual tendency is to consider Human capital as a key factor in the achievement of wealth. However, is widely known that pre-modern societies had different mechanisms to achieve wealth, one example is through the marriage (Bethell 1990). In this case reaching wealth trough marriage probably increases mainly the stock of capital, but not necessary the flow of income. We test this question by running four OLS models in which the dependent variable is the welfare ratio. As we describe above, the welfare ratios are calculated from the nominal wages, hence we have a large panorama of the different wage strata.

Table 5.8 displays the results.

TABLE 5.8. POTENTIAL DETERMINANTS OF INCOME

Model	1	2	3	4
Estimation technique	OLS	OLS	OLS	OLS
Dependent variable	welfare ratio	welfare ratio	welfare ratio	welfare ratio
Numerate	2.640***	1.657***	1.625***	0.620
	(0.000)	(0.006)	(0.008)	(0.246)
	(0.000)	(0.685)	(0.638)	(0.000)
Semi pro		31.279***	30.684***	27.610***
		(0.000)	(0.000)	(0.000)
Skilled		13.01***	9.801***	4.867***
		(0.000)	(0.000)	(0.000)
Semiskilled		1.810	1.644	3.301***
		(0.164)	(0.207)	(0.004)
Professional		30.410***	30.673***	29.994***
		(0.000)	(0.000)	(0.000)
Age group 33-42			0.115	-0.845
			(0.879)	(0.202)
Age group 43-52			4.184***	0.856
			(0.000)	(0.247)
Age group 53-62			3.159***	0.273
			(0.001)	(0.743)
Maldonado 1780				-18.760***
				(0.000)
Montevideo 1836				-16.096***
				(0.000)
Minas 1855				-7.567***
				(0.000)
_cons	9.265***	0.326	-4.13	17.481***
R2	0.01	0.19	0.21	0.40
N	2,241	2,241	2,124	2,124

Note: pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Model 2 constant refers to unskilled. Model 3 constant refers to unskilled Age group 23-32; Model 4 constant refers to unskilled 23-32, Canelones 1791.

Model (1) analyzes only the relation between numerate and income. According to the results, numeracy has a positive and significant impact on real income; however, this impact is not too high. Model (2) - (4) repeats the setting of (1) but includes the dummies of the Armstrong occupational taxonomy and the regional and birth decade effect. In almost all the cases numerate is positive and significant relate to income, however, once we include the regional control variables loses significance. Remarkable is that the Armstrong dummy semi-professional and professional have a very high positive coefficient in relation to the welfare ratio. These coefficients remain high and significant even when we include the geographical and birth decades control variables. Like in the logistic regression we controlled by the birth decades 23-32 years old. In this case, the groups 33-62 have a positive and significant impact on real income in comparison with the 23-32 years old age group. This fact is more pronounced in the age group in the age cohort 43-52 meaning that the life course has a positive impact on wealth. The R2 increases when including step by step all the set of explanatory variables.

The previous results allow concluding that early Human capital formation was a significant factor to achieve high levels of real income; however, the social status given by the position in the labor market seem to be more important.

5.9 SUMMARY AND CONCLUSIONS

This Chapter had two aims: the first was to analyze wealth distribution in Montevideo and its surroundings in the period before the economic modernization. The second was to link the basic educational capabilities to wealth and the analysis of the potential determinants of wealth and early Human capital. We used three kinds of sources wich registers the information required for our analysis. In the first place population records and census, from which we obtained numeracy (from age) and wealth (from the quantity of slaves); in the second place a list of taxed goods from 165 heads of households in Montevideo in 1751. Through this source, it was

possible to compare the slave structure of both sources and the slave distribution with other goods (such as cattle, properties, and other animals); and in the third place nominal wages from Montevideo in the between 1760 and 1857 which allowed estimating the inequality in the real income.

The results obtained allow us to arrive at the following conclusions:

1. Real estate and cattle seem to be key factors of wealth in this economy. Almost the totality of the registered families had a house or land. This fact is more evident in the lower social strata since real estate represents 80% of the total wealth.
2. The slaves are a significant group in this economy. They are the third most significant asset behind cattle. In the middle social strata, slaves are as important as cattle. Nevertheless, in the lower social strata, the slaves represent the least proportion of wealth. Cattle, however, remain significant.
3. It is remarkable the relative smooth distribution of slave-owning in both of the sources and the concomitant small size of holding. The percentage of non-slaveholders fluctuates between 87% and 68% of each sample throughout the period. Around 7% and 18% of the registered had only one or two slaves. Hence, the big slaveholding was not extended in this society. The only activity which concentrated more quantity of slaves was the commerce. The comparison of the Gini coefficients of slaveholding with economies such Bahia and the South United States reinforce the idea of the relative wealth homogeneity of Montevideo´s economy.
4. There is a difference in the distribution of the patrimony. Slaves are more equally distributed than other assets, and the most unequal distributed good is cattle with a Gini coefficient of 0.60. Furthermore, the distribution of the real income is similar to the distribution of livestock with a coefficient of 0.58 in the period 1780-1791. All in all the

Gini coefficients of wealth and income show measurements of low and medium concentration.

5. Was wealth a potential determinant of early Human capital? Apparently, the income and the position in the labor market had a positive effect on the early formation of Human Capital. This fact is more pronounced in the population with high income and in the upper positions of the labor market (i.e. professionals) even when we controlled for time and local variables. Having a good position and a high income seem to be a way to achieve a basic education.
6. And was basic education important for wealth? Apparently, numeracy had a positive impact on wealth, although the coefficient of the regression is not too high. The position in the labor market plays a significant role in the real income, especially in the case of the professionals. For example, in the case of the slaveholding, the numeracy trend shows that those who do not have slaves are visibly less numerate than those who have. However, the differences in numeracy between the big slaveholders and those who only have a few slaves are not visible over time. It seems that basic education (numeracy) was important to obtain a slave, but once a person acquired a slave, they could as easily acquire a large number of them. Probably the mechanisms to access great wealth were different from education.
7. The life course and social status given by the position in the labor market seem to have been important factors in the achievement of wealth.

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5.11 APPENDIX

Data and sources

TABLE 5.8. DESCRIPTION OF THE DATA SET

Region	Year	Number of registers	Source	Archive
Maldonado	1780	3224	Population register	AGN Buenos Aires IX 20-4-3
Minas	1855	1477	Population register	AGN -AGA 287
Montevideo city	1836	5652	Population register	AGN -AGA 148, 465
Montevideo countryside	1836	2871	Population register	AGN -AGA 465
Pando	1836	3106	Population register	AGN -AGA 279
Sauce y Pantanoso	1791	102	Population register	AGN -AGA 279
Toledo	1791	259	Population register	AGN -AGA 279
Montevideo	1751	165	List of taxed goods	AGN-AGA, Caja 2, Carpeta 39
Montevideo	1788-1808	10 occupational categories	Nominal wages (Construction of Montevideo´s wall)	AGNBA, Sala IX, 03-02-05, División Colonia, Sección Gobierno Montevideo, Iglesia Matriz, Cuentas, 1781-1808.
Montevideo	1773-1779	20 occupational categories	Nominal wages (Construction of the Cathedral)	AGN, AGA, Libro 161. 1775-1783: Archivo General de Indias (AGI), Buenos Aires, 445. 1784-1788: AGI, Buenos Aires, 446. 1789-1798: AGI, Buenos Aires, 448. Archivo General de la Nación, Uruguay, Archivo General Administrativo, Libros N° 963, 968, 977, 979, 1000, 1009, 1012, 1018.
Montevideo	1841-1857	10 occupational categories	Nominal wages (Police of Montevideo)	

TABLE 5.9. ARMTRONG OCCUPATIONAL TAXONOMY

1. Unskilled	Manual workers who usually do heavy unskilled work. Pawns (rural areas), labourers (urban areas).
2. Semi-skilled	Workers who have acquired some level of skill through formal training or experience, e.g. tradesmen's assistants, painters, etc.
3. Skilled	All qualified trades-people, usually after an apprenticeship or other formal training, and also "modern" tasks, such as drivers. Farmers, big owners – estancieros – (rural areas), small traders (urban areas); offices (carpenters, shoemakers).
4. Non-manual intermediate or semi-professional	Lower-level "white collar" (non-manual) workers, such as clerks, technicians, nurses, etc.; skilled workers in managerial positions or technicians.
5. Professionals	Council and crown employees, large-scale traders and merchants. Those who possess upper secondary, college or university qualifications, or substantial training and superior status.

6. SUMMARY AND CONCLUSIONS OF THE THESIS

This thesis analyzed diverse issues of the Human capital formation in Latin America before modernization. The recollection of the databases, the application of different techniques, and the interpretation of the results allow the drawing of some conclusions.

First, not all the Latin American countries (and regions) suffered the scarce formation of human capital in the same way. In Chapter Four I argued that the Human Capital was more qualified in the less populated regions of Latin America before the conquest, and in the livestock economies, and was less qualified in the densely populated native areas before the conquest and in the mining and plantation economies. These two facts agree with the institutional hypothesis, which claims that depending on natural resources were shaped 'good' or 'bad' institutions. These 'good' or 'bad' institutions also seem to have promoted 'better' or 'worse' human capital. On the other hand, the institutional hypothesis claimed that the gap between the developed and undeveloped countries started in the colonial period. Concerning the formation of human capital, it was possible to highlight that the roots of numeracy existed before that period, in the early 1750s, hence before the introduction of technological change. The cartographical analysis in Chapter Four showed that in 1750 the numeracy of the Southern Atlantic territories was already higher than other regions.

Second, the Latin American countries that developed mining economies were the most affected regarding human capital formation. This remark is linked to the previous one and was analyzed in depth in Chapter Three by the study of one of the biggest mining economies of the Peruvian Viceroyalty. The analysis of these societies, in which the system called *Mita* was extended, made it possible to conclude that the nearby mining areas were the most affected regarding numeracy. The proximity to one of the most productive primary resources of the period was detrimental for human capital formation. According to the low numeracy levels, it is possible

to argue that, for those indigenous involved in a forced work system, the channels to access basic education might be tough, and the labor conditions were poor and unstable.

Third, one of the deepest analyses of this thesis was the society and economy of the *Río de la Plata region* in the pre-modern period. This analysis –as previously– was inserted into the debate of the origins of Latin America's divergence and inequality. One of the main results of this study was that the Río de la Plata societies were relatively homogeneous regarding labor force qualifications: the occupational distribution showed greater representation in the lower and medium positions. However, the jobs linked to higher educational achievement were restricted to a small part of the population. When analyzing the wealth structure, we find a similar result: the majority of the population was in the low and medium levels of wealth. Hence, apparently, this society was relatively homogeneous regarding occupational qualifications and wealth.

Throughout this work, I assessed some facts that might explain the relative advantage of Río de la Plata regarding equity and development in comparison with other countries in Latin America. The first was the relative homogeneity of the formation of human capital, the relatively small size of the population, and the way in which the institutions were implemented (as pointed out by the literature); together, these factors did not allow the consolidation of large social differences as in other Latin American countries.

Fourth, the human capital formation was increasingly important over time. In the pre-modern period, the human capital formation was not the only way to achieve better positions in the labor and social market. Furthermore, it was not the only mechanism to achieve wealth. These mechanisms were not analyzed in this thesis; however, based on the literature it is possible to estimate that pre-capitalist mechanisms, like marriage or apprenticeships, were also important.

The role of Human Capital changed over time and turned into a crucial driving factor of well-being and economic growth. Furthermore, those countries or regions with higher educational

levels are today the leading areas regarding economic and social development. Through this fact, it is possible to assess the necessity for more and better policies to improve the formation of human capital and invest in education, especially in the poorest countries.

At this point, it is pertinent to think about further research to complement the previous analysis and to contribute to the current debate on the origins of the economic divergence of Latin America. In the first instance, it would be important to make more contributions using the age heaping technique, especially in the regions with scarce analysis. Additionally, regional databases to enrich the national trends would make it possible to enlarge the analysis, since this is currently restricted by national borders. Another important contribution would be the construction of different measures of human capital to complement the study of education in the pre-modern period and to compare the age heaping technique with other indicators. Finally, more and improved databases and specialized empirical analysis would be significant to enlarge the debate of the origins of the economic and social disadvantages of the underdeveloped regions.