Gender (in)equality, maritime economies, and numeracy development in Greece during the 19th and 20th centuries

● Kleoniki Alexopoulou
Panteion University and Research Centre for the Humanities
ORCID: https://orcid.org/0000-0002-7929-5969

● Joerg Baten
University of Tuebingen, CEPR and CESifo
ORCID: https://orcid.org/0000-0001-5029-501X

Abstract

We study the history of human capital in Greece during the nineteenth and twentieth centuries. We investigate the numeracy skills of the population both at national and regional levels. Furthermore, we test the effect of gender equality, as well as geographic, demographic and socio-economic factors such as agricultural specialisation (crops, livestock), trade and industry development, urbanisation, and migration on numeracy. We find that the gender gap is highly correlated with numeracy and its effect fades out around 1910. We show that the maritime orientation of the island economies was highly complementary with early numerical human capital and increasing gender equality.

Keywords: numeracy, gender equality, maritime economies, Greece.

JEL Codes: N33, N34, I21, I24.

1. Introduction

Human capital – and numeracy in particular – is one of the most important factors for long-run development (Hanushek and Woessmann 2012; Acemoglu et al. 2014; Baten and Juif 2014). But evidence on human capital is very scarce for the regions of the former Ottoman Empire.[1] This study assesses numerical human capital formation on the territory of modern Greece (partly provinces of the Ottoman Empire in the earlier periods). Measuring the time trends of numeracy between the mid-nineteenth and the mid-twen-

1. On GDP and real wages, see Pamuk (2006). For a review of numeracy, see Ghanem and Baten (2016).

Received: 31 October 2022 – Fecha de recepción: 31 de Octubre de 2022
Accepted: 16 August 2023 – Fecha de aceptación: 16 de Agosto de 2023

Revista de Historia Industrial – Industrial History Review, Vol. XXXII, no. 89, November 2023. 27-64.
ISSN: 1132-7200. https://doi.org/10.1344/rhiihr.40926

tieth century is the first major contribution of this study. As a second contribution to the literature, we retrieve data from multiple censuses of the same period and examine potential determinants of numeracy in a cross-sectional dataset of Greek regions.

Considering the historical background, there are several important historical events to take into account when evaluating the evolution of human capital in those regions, because these events created cultural differences, and border and migration effects on human capital. First and foremost, the independence of Greece in 1830 had dramatic impacts. In 1821, the Greeks rose up against the Ottoman Empire after 400 years of foreign rule. The Greek War of Independence lasted nine years and resulted in the liberation of some parts of Greece. Until the late twentieth century, Greece went through a tumultuous history marked by numerous wars and regime changes. The Balkan wars, the Greco-Turkish war, two World Wars, a civil war and a military dictatorship up until 1974 left their scars on the history of modern Greece. How did human capital develop in these turbulent times? What was the impact of annexing new territories and receiving currents of migrants and refugees from Asia Minor?

We analyse socio-economic and cultural factors that could have played a role in human capital formation in modern Greece. The geographic setting we are using is particularly interesting, as it represents the boundary between Europe and Southwest Asia and includes border areas and multi-cultural regions, where many ethnicities and religions co-existed. This results in strong geographic differences, for example, in gender equality levels (see also Benos, Karagiannis and Tsitou 2023 on population exchange, which we only consider via the migration effect).

Human capital levels are measured through basic numeracy and literacy skills. We estimate numeracy levels by measuring the extent of the age-heaping phenomenon (A'Hearn et al. 2009). Apart from the numerous incidents of violence and conflict, the study principally focuses on socio-economic determinants such as agricultural specialisation, multiculturalism, and geography (such as the 'small island effect', e.g., the fact that knowledge about shipping, boats and trade requires certain quantitative skills, combined with the incentive for women to acquire numeracy since men were often away aboard the ships). Furthermore, we test whether the gender gap correlates with numeracy levels. We find that higher gender equality contributed to increasing numeracy levels, confirming the argument of De Moor and van Zanden (2010) that 'girl power' mattered for development (Carmichael et al. 2016; Baten and de Pleijt 2022.).

This article is organised as follows. Section 2 provides an overview of the literature on human capital formation and the methodology of age heaping, and is followed by a description of general numeracy trends in the historical

and regional context of nineteenth- and twentieth-century Greece in Section 3. Section 4 presents numeracy levels at the province/district level from a comparative perspective and analyses potential explanatory variables, such as socio-economic and cultural factors. Section 5 concludes.

2. Age-heaping and numeracy: a short survey

Human capital consists of a wide set of skills and is challenging to measure. The two most common indicators used for the nineteenth century and earlier to assess human capital are literacy and numeracy rates. Literacy defines one's ability to read and write. An early source for literacy was the signature rate on legal documents, especially marriage certificates (Reis 2005). For most European countries literacy rates are recorded only from the mid-nineteenth century, and the data on developing countries is even more scarce and inaccurate. As a consequence, many studies on numeracy rates have been published to complement earlier research on literacy (a recent overview: Tollnek and Baten 2016).

Numeracy is the ability to comprehend and work with numbers. Basic numeracy skills imply the understanding of fundamental arithmetic operations such as addition, subtraction, and basic skills to judge quantitative proportion (e.g., if I need to move a heap of wood, is it more efficient to walk and carry a small weight several times, or to bring a wheelbarrow from the farm and walk only once?). Thus, numeracy could increase productivity also in farm work (Tollnek and Baten 2017), while some authors have argued that literacy was sometimes not directly useful for agricultural populations (Mokyr 2005). A productive farmer was a person who would also be able to consider numerous weather indicators, for example. An incorrect decision about the specific day when the hay cutting, or the grain harvest, should begin could cause substantial income or welfare losses. In addition, the treatment of cattle diseases and the protection of crops against insects and parasitic plants were more efficient if a farmer was more educated and numerate (Tollnek and Baten 2017). Moreover, farmers who were able to count could negotiate the prices for their goods with intermediaries or directly with consumers on the market. Of course, basic numeracy is also a precondition for financial decision-making, job selection (Brooks and Pui 2010), and administrative decisions (A'Hearn et al. 2009), but most of the population was still active in agriculture or low-skilled craft production during our period of study.

How can basic numerical skills be quantified? Self-reported age data often displays 'heaping', which describes the tendency to report one's age in round numbers, particularly in multiples of five (25, 30. etc.). Individuals lacking a certain knowledge of their age or the ability to calculate it correct-

ly, tend to report numbers ending in 5 or 0. Thus, ages that are multiples of 5 are over-represented in census data and other sources. They indicate that people either live in a society in which the exact age of a person is not important, or they lack the mathematical skills to calculate it.

The ability to accurately report one's age requires that either families or public administrations take exact records of it, based on a sufficient understanding of the function of a calendar (A'Hearn et al. 2009) and thus of basic arithmetic operations. If instead a certain age is merely associated with a particular life-event, e.g., physical changes or certain privileges and duties (ibid), inaccuracy in age-reporting and thus age-heaping will be the consequence. As a result, in a society with a generally low education level, a tendency to report ages as multiples of 5 is likely to be observed. Whipple's index (introduced by the demographer George C. Whipple) measures the degree

$$W = \frac{\Sigma\,(n_{25} + n_{30} \ldots + n_{65} + n_{70})}{\frac{1}{5}\Sigma_{i=23}^{72}\, n_i} \times 100$$

to which people 'heap' their age. It is calculated with the following formula:

An index value of 500 means that there is perfect age heaping, i.e., there are only ages which are multiples of five in the distribution, while a value of 100 indicates no age heaping at all.[2] In order to obtain the share of people that reported their age correctly, A'Hearn et al. (2009) perform a linear transformation of Whipple's index, which results in the so-called ABCC values:

$$ABCC = \left\{1 - \frac{W - 100}{400}\right\} \times 100 \; \textit{if}\; W \geq 100;\; \textit{else}\; ABCC = 100$$

If all ages reported are multiples of 5, ABCC equals 0. Otherwise, if ABCC equals 100, there is no age heaping at all and everyone reported their age correctly. As basic numeracy is usually determined in the first decade of life, ABCC estimates are conventionally aggregated by birth decades.

A'Hearn et al. (2009) find a positive, significant and robust correlation between literacy and numeracy for many regions of the world at different times. More precisely, they look at literacy and numeracy in the US census of 1850, 1870 and 1900, as well as for 16 European countries between 1350

2. Note that the index only includes ages from 23 to 72. For ages younger than 23, there might be a strong distortion due to a concentration of ages around 20 in military data, respectively, and for ages over 72 a tendency to deliberately overstate one's age is observed (A'Hearn et al. 2009). Hence, these two age groups are omitted.

and 1840. Basic numeracy was also used as a tool to study the "European human capital revolution" (Tollnek and Baten 2017). Numeracy rates increased faster in Western and Central Europe than in Southern Europe during the sixteenth and seventeenth centuries, preparing the following industrial, commercial and educational revolutions (A'Hearn et al. 2009). In the same vein, a study by Reis (2005) reveals huge differences in literacy rates in Europe for the years around 1800, leaving more southern and eastern regions far behind the northwest.

As it is standard in the literature, we report all information on age-heaping-based numeracy by birth decades. The reason is that the numeracy studied in this research area is a very basic one, typically acquired during the first ten years of life (Crayen and Baten 2010).[3] When we consider the birth decades of the Greek population born in the 1900s, 1910s and later, we calculate all explanatory variables (such as cattle numbers per capita, etc.) for the same period of birth, as any potential effect should take place during this early period of life.

In the case of Greece, there are no studies that exclusively focus on numeracy and literacy on a regional level, after the dissolution of the Ottoman Empire. The study by Lemontzoglou (2020) focuses on the relationship between land inequality and literacy in late nineteenth-century Greece. Asteriou and Agiomirgianakis (2001) examine the connection between human capital levels and economic growth in Greece, but they solely cover the period between 1960 and 1994. They take into account enrolment rates in primary and secondary education and universities as well as public expenditure on education.

According to Crayen and Baten (2010), there were considerable differences between industrialised countries and the Middle East, which generally had lower numeracy values, especially before the end of the nineteenth century. Within the Middle East, they observe a better performance in northern and north-western regions than in the southeast. Ghanem (2018) finds that in the case of Turkey, there was a substantial gap between metropoles like Istanbul and the more disadvantaged rural Turkish regions.[4]

3. Moreover, this basic numeracy did not change substantially during later ages, except for the difference between the age group 23–32 and later age groups (the former is rounding often on multiples of 2, such as saying 'I am 28', and not always on 30, for example. Hence all recent studies apply an adjustment of 25% to the age group 23–32, because the rounding on 28 would not be identified by Whipple's index).

4. Looking at Turkey in particular, it can be stated that literacy rates were generally rather low until the early twentieth century (Ghanem and Baten 2016). Ghanem (2018) describes the numeracy evidence for Turkey, among other countries; she finds that the Ataturk reforms had a substantial positive impact. There was a continuous increase thereafter. In 1935, 29.4% of males and 9.8% of females were literate as opposed to 93.9% and 80.6% respectively in 2000 (State Institute of Statistics Prime Ministry Republic of Turkey, 2000).

Crayen and Baten (2010) also use ABCC values to analyse the human capital development in various countries of Europe. In their study, they highlight the negative outliers of the European countries: Greece and Cyprus. In the late nineteenth century, they both started with very high age-heaping levels (low numeracy). In the case of Greece, the authors assume that the numeracy retardation could have been caused by the educational institutions of the Ottoman Empire. This is discussed in greater detail in Ghanem and Baten (2016). Hippe and Baten (2012) draw similar conclusions: countries which formerly belonged to the Ottoman Empire, such as those in the Balkans, performed worse in terms of numeracy than other European countries during the late nineteenth century. The human capital revolution that took place in the West did not occur in the Ottoman Empire before 1900 (Hippe and Baten 2012), in contrast with the high levels of elite numeracy in the Middle East around 700– 1000 CE and in Southeast Europe during the Byzantine era (Keywood and Baten 2021; Baten 2019).

For Greece, we are using the numeracy data based on the censuses of 1951 and 1971 for the birth decades of the 1870s and thereafter, while for earlier years some adjustments are needed – which will be described in Section 4.

3. Historical context and comparative numeracy development

3.1 Socio-economic transformations in the late Ottoman Empire

"The Ottoman Empire was one of the greatest, most extensive, and longest-lasting [1300–1922] empires in the history of the world" (Quataert 2005, also on the following). In the course of its history, it ruled over territories in West Asia, North Africa and Southeast Europe. In 1683, the Ottoman forces made a second attempt to conquer Habsburg Vienna, however without success. This marked a turning point in the so far quite continuous expansion of the Ottoman Empire. Nevertheless, the Empire occupied the states of Southeast Europe for more than two centuries, especially the territories of today's Bulgaria, Serbia, Greece, and Romania. The empire was finally dissolved in 1922.

Major socio-economic transformations occurred during the Ottoman era, both in Greece and the neighbouring core area of the Ottoman Empire in today's Turkey. We briefly describe the development in the latter region, as it provides a useful point of comparison for Greece. Early Greek human capital history cannot be understood without taking the neighbouring development in modern Turkey into account.

The economy of the Ottoman Empire was in substantial crisis in the decades around 1800. Industrial exports did not grow to the same extent as in West-

ern Europe (Pamuk and Williamson 2010). The higher productivity of Western Europe (and Northern England in particular), resulted in lower production and limited export success for the Ottoman economy (Pamuk and Williamson 2010). At the end of the eighteenth century, exports turned towards raw cotton, cereals, tobacco and wool, while imports shifted to tropical commodities such as sugar and coffee, and industrial products from Western Europe. This change towards more agricultural exports occurred at a time when agricultural prices grew. The most extreme example is cotton, which had its price peak in the 1860s, during the 'cotton famine' when the U.S. South could not deliver cotton to the English factories anymore, and Egypt and many regions of the Ottoman Empire stepped in (see Ghanem and Baten 2016). Such developments were linked to a rather slow pace of human capital accumulation (Pamuk 2006).

Do developments of numeracy in the Anatolian centre of the Ottoman Empire and in Greece tally with the economic development and comparative advantage outlined above? The development of our numeracy estimate for the centre of the Ottoman Empire corresponds with the income and trade development we have just described (see Figure 1). During the eighteenth century, numeracy was at a very low level – compared to England, for example, which had numeracy values between 90 and 95 percent (Baten et al. 2014). Numeracy in the centre of the Ottoman Empire had reached c. 30 percent by the early 1800s. However, the period around 1800 was characterised by a tendency toward closing the gap, until values around 50 percent were reached in the 1820s.

The following four decades reflect the stagnation of the period that was characterised by the 'curse of agricultural export resources': exports of agricultural goods yielded export revenues and modest economic growth, yet did not result in a dynamic numeracy development. Only toward the late nineteenth century did numeracy growth resume, driven by (1) modest industrial development, (2) the massive commercialisation of agriculture and rural life, and (3) a modest trend toward more gender equality in some regions, as we will see below in further detail. Between the 1820s and 1860s, numeracy in the region of today's Turkey stagnated.

Our numeracy series for Greece starts in the 1840s on a quite similar level. However, between the 1840s and 1850s, Greece began to diverge from Turkey, moving from around 50 percent to around 65 percent numeracy, and continuing to grow from the 1870s onwards. This development is confirmed by using a completely different source, namely the "1881 Addendum" published by the Ministry of Interior, i.e., a census which was performed in the independent Greek territory in 1879 and was expanded to include Thessaly and Arta in 1881.

Only after 1850, industrial production in Ottoman Anatolia became more important, but on a very modest scale, focusing on goods such as carpets and

raw silk. However, in the nineteenth-century Ottoman Empire, coastal areas and especially port cities were growing faster, due to the increasing importance of international trade (Pamuk and Williamson 2010). There are numerous examples showing this trend, from Salonica in Greece to Izmir in Anatolia and Beirut in Lebanon (Issawi 1982).

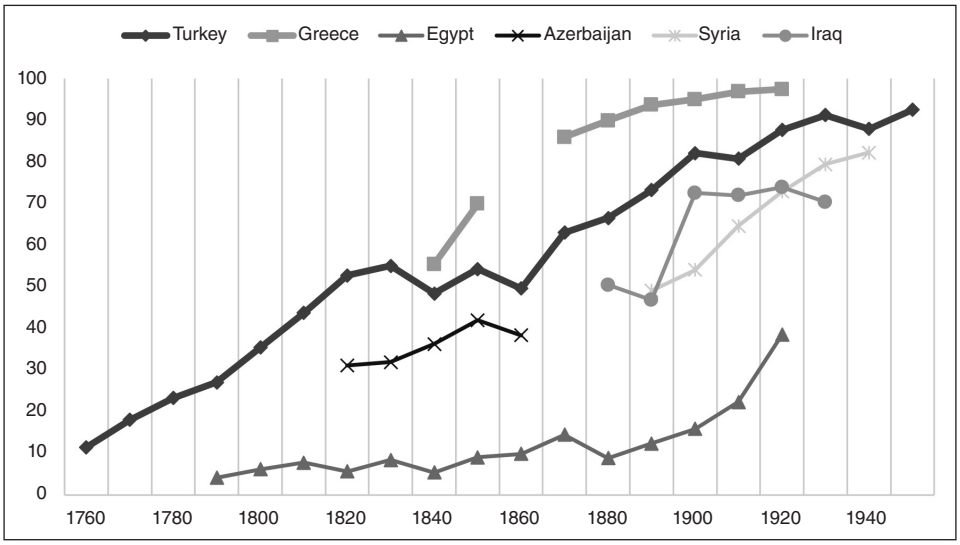
Furthermore, significant improvements in shipping overseas and river transport took place, especially when steam engines emerged at the end of the nineteenth century (Quataert 2005). The rise in steamships fostered further commerce. However, sea transport particularly benefited those regions that maintained strong ties with Europe, unlike regions such as central Anatolia. Circumstances changed when landlocked Ottoman regions obtained a railroad network, even though it was relatively small compared to the networks of other countries (Quataert 2005).

Agricultural production remained a significant part of total production during the late Ottoman era. Furthermore, for the period 1872–1916, an increasing amount of agricultural goods was produced for commercial purposes and productivity in agriculture modestly increased. This was due to the general boom of international trade, increasing Europeans' purchasing power, and led to the expansion of railroads that supplied increasingly populated urban areas within the Empire. The increased commercialisation of agriculture might have contributed to the growth in numeracy during the late nineteenth century (Figure 1).

The end of World War I and the subsequent Treaty of Sèvres marked the end of the Ottoman Empire. However, numeracy continued to grow in the 1920s and 1930s in the newly created Turkish state (Figure 1). National movements and the distribution of lost territories led to the proclamation of the Republic of Turkey in 1923 by Mustafa Kemal Atatürk. The new-born state promoted "a series of modernizing reforms covering all aspects of life" (Yilmaz, 2013). The aim of Turkey's founder was to build a secular state, which implied the abolition of the caliphate as well as the introduction of the Latin alphabet. High gender equality in education was another aim of the new era, as we will describe in detail in the following section, and might have contributed to the 1920s and 1930s increase in numeracy (Ghanem 2018).

Modern Greece also faced major demographic changes and socio-economic transformations over the two last centuries. The three-fold increase of the area of Greece and the seven-fold increase of the total population during the period between 1860 and 1950 were the results of the gradual integration of provinces previously ruled by foreign forces into the national boundaries (Valaoras 1960, pp. 123-124). Other major demographic changes were: first, a mass overseas emigration in the early twentieth century that affected male labour availability; second, the exchange of populations under the Treaty of Lausanne in 1923, when more than one million refugees from Asia Minor,

FIGURE 1 ▪ *Numeracy trends in Ottoman Anatolia/Turkey, Greece and neighbouring countries, 1760s-1950s (birth decades)*



Sources: for the comparison countries Azerbaijan, Egypt, Iraq, Syria, as well the later part for Greece and Egypt, we used Crayen and Baten (2010), and the update of their estimates which they published in www.clio-infra.eu (last accessed 30 May 2023). For the Turkish series we used evidence compiled by Ghanem and Baten (2016) and Ghanem (2018). Moreover, Baten (2021) suggested a regional weighting of the available evidence to come closer to the true average for modern Turkey. The birth decades of Greece before the 1910s are based on the publications of the Ministry of Interior for the early censuses in 1870, 1879, 1907 and 1928, as well as the 1971 individual census evidence available from www.ipumsi.org (last accessed 30 May 2023).

Note: The early part of the Greek trend was not caused by the changes in Greek territory, as discussed in the text.

Eastern Thrace and Southern Bulgaria entered the country; third, the disproportionate losses during the two World Wars (ibid, pp. 124-125).

Internal migration from interior mountainous areas to plains and outmigration from plains and islands to European cities were persistent phenomena throughout the history of Greece and especially during wars, natural disasters, and economic crises. "In the first 80 years of the nation's history, the ratio of urban to rural growth was almost negative; from 1900 to 1920 it was 1:1, and in the last 20 years it has been 4:1" (Baxevanis 1965, p. 87). Both migration and subsequent urbanisation were disproportionate to the country's population and size. They were related to structural transformations in the economy and had an impact on gender equality.

According to Petmezas (2013), the so-called "demographic transition" was structurally connected with transformations in Greek agriculture. Greece depended for a long time on exports of semi-luxury agricultural products such as tobacco, olive oil and currants (Baxevanis 1965, p. 89). The expansion of the Aegean littoral is associated with urbanisation and the migration of farm populations, while the development of commercialised agriculture in

Thessaly and the rapid growth of the capital Athens are considered major turning points (Baxevanis 1965, p. 92). Moreover, the five largest cities were all ports (ibid, p. 85) and hosted 85% of industrial activities (Baxevanis 1965, p. 93). The inland cities functioned primarily as gathering, food processing and consumption centres rather than as 'seats of learning'. They did not manage to create cultural bonds with the outside world, as Athens and Thessaloniki did (ibid).

Because of all these hurdles to development, we observe that numeracy growth in Greece was initially not far above the Ottoman Anatolian level. However, socio-economic and demographic changes in Greece occurred rapidly, over a short period of time; compared to the slower transformations in Europe, where the process of industrialisation lasted for centuries rather than decades (Psychogios 1985). Thus, it is plausible that literacy and numeracy expanded at a fast pace in Greek regions.

3.2 Education and gender inequality in the Ottoman Empire and Modern Greece

After discussing the underlying factors of numeracy development in the Ottoman Empire and Modern Greece, we now turn to proximate determinants of educational outcomes, namely the school policies, which are described in the literature in a more qualitative than quantitative way, again considering the developments in Ottoman Anatolia as a relevant comparison. The Ottoman education system was divided into three educational levels: elementary school (maktab), secondary higher education (madrasa), and palace school (enderun maktab) (Somel 2001). In maktabs, two school subjects were of particular importance for daily life: writing (kitab) and arithmetic (hisab). Due to the great importance given to mathematics by the Ottomans, the students at maktabs were encouraged to develop basic numeracy skills, which prepared them for secondary school level mathematics. The courses at madrasa schools involved syntax, logic, geometry and arithmetic, and the graduates of Madrasas were supposed to have high numeracy skills. However, the number of pupils were extremely low (Ghanem and Baten 2016; Pamuk 2006).

The declining political and economic power of the Ottoman Empire from the early eighteenth century made institutional modernisation necessary. The years between 1839 and 1876, the so-called Tanzimat, are marked by a series of milestone reforms that played a crucial role in the modernisation of the Ottoman Empire. "Tanzimat was a period during which the state's participation in Ottoman society increased" (Shaw and Shaw 1977). During this period, the main objectives of the educational system included: the expansion of elementary education facilities; the construction of middle schools (rushdiye) to link primary and secondary-higher education; the increase of the number of female

students in secondary-higher education, and the foundation of modern universities. However, we see in Figure 1 that it took several decades before the reforms yielded positive effects, as numeracy only improved after the 1860s.

In the case of modern Greece, most of the population was illiterate, and no school was functioning during the revolutionary period (1821–1828). Right after the national revolution, the foundation of schools and the formation of a homogenous and centralised education system was a priority. Compulsory and free education was declared for all Greek citizens at the First National Assembly of Epidaurus. Most of the early educational institutions were constructed in Aegina and Nafplio, as these were the first government centres of Greece in the period 1827–1834. Kapodistrias, the first governor of Greece, had a preference for elementary, agricultural and technical schools over universities (Pirgiotakis 1988). Influenced by the ideas of the Enlightenment, Kapodistrias made the first attempt to build an educational system independent from the Greek Church (Charila 2006, pp. 36-37). He believed that a combination of literacy (at least primary education) and the establishment of property rights would lead to economic development. In 1832, after Kapodistrias' murder, a brief civil war broke out in the country and a substantial decrease in operating schools was observed: only 60 schools survived, mainly on the Greek islands, out of 121 that were operating until 1830.

Higher education started to be provided by the Greek state only after the reform of King Otto in 1834-1836, when a combination of Bavarian and French education policies was adopted. According to the 'Bavarian plan', in 1834 the law about primary schools passed, institutionalising compulsory primary education for all children between five and twelve years (Bouzakis 2009). Greece was one of the first countries that fostered a free and public seven-year educational system, which nevertheless was not fully implemented (Pirgiotakis 1988).

In the period 1830–1870, a general increase in school enrolment took place. The number of primary schools also increased from 71 in 1830 to 252 in 1840, 1,029 in 1869 and 2,278 in 1889 (Tsoukalas 2006, p. 392). A shift from primary education to secondary took place in 1870, which is considered a rupture point by Dimaras (1990). However, primary and secondary schools were constructed solely in the capitals of prefectures/districts, so children from rural areas did not have the chance to enrol. Also, schools in 138 municipalities (39% of the total) had no female students; in 1879, 112 municipalities remained without female students (Lemontzoglou 2020, p. 29). Women had a better position in the islands, where more females were enrolled in schools, but this was rather an exception. Overall, female literacy reached 6 percent in 1870, 7 percent in 1879, and 17 percent in 1907 (Lemontzoglou 2020, p. 393).

In 1910, primary schools already numbered 3,551. Education reforms passed in 1917 and 1929, introducing new schooling levels. By 1920, female lit-

eracy increased to 27 percent and by 1928 had reached 36 percent, compared to literacy rates of 56 and 64 percent respectively for the male population (Tsoukalas 2006, p. 393). Contrary to the common perception, Tsoukalas argues that the "penetration of the school network" in Greece was done at a fast pace from the liberation onwards in terms of both primary and secondary education: Greece could not reach the literacy levels of Western Europe, however it was very close to Italy and in a much better position than other Balkan and Eastern European regions as well as Iberian countries (Tsoukalas 2006, p. 392).

4. Numeracy levels of Greek regions: sources and data

In the following sections we will assess the differences of numeracy across Greek regions and their potential determinants in a series of cross-sections.

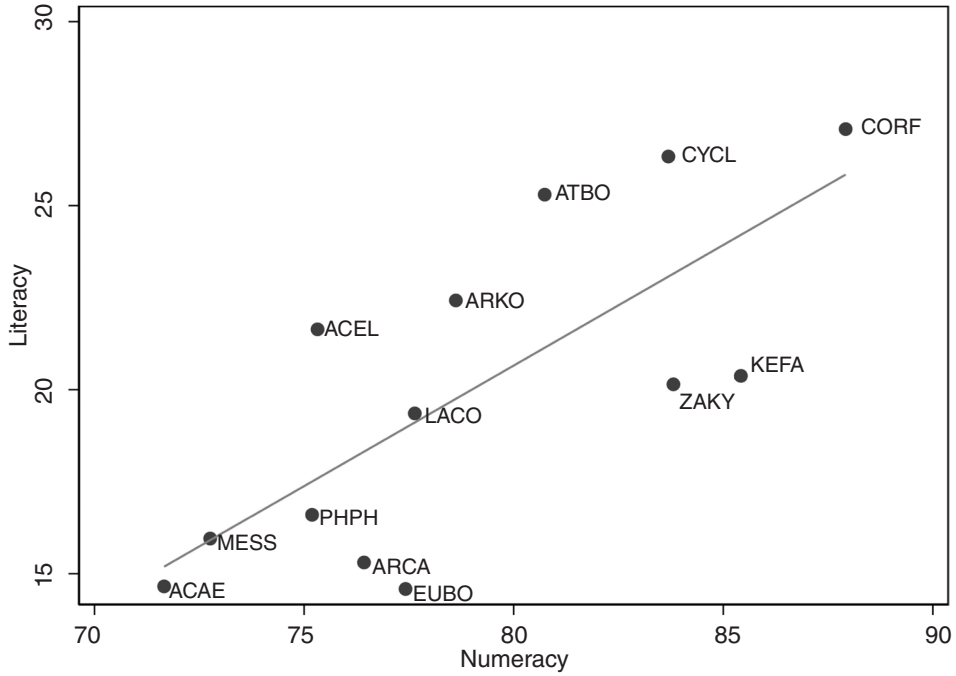
The estimate for the 1870s is tentative, because a relatively old age group was used for this estimate. However, similar data from earlier censuses reconfirm the movement between the 1870s and the 1880s. For the 1840s and the 1850s in Greece, we are using the censuses of 1870 and 1879. Those refer to the earlier, smaller territory of Greece relative to the later territory of modern Greece. However, we studied those early territories in comparison to those of the later territorial extent. For the birth decades of the 1900s, we find that the regions of the early Greek territorial extension had the same numeracy as the territories that were added later. Hence, the early and the later territorial state are probably comparable.

We needed an adjustment for the fact that the early Greek censuses of 1870 and 1879 only included individual ages up to age 25 (see details on this adjustment in Appendix A).[5] The result of the national trend estimates for Ottoman Anatolia and Greece can be seen in Figure 1, which will be discussed in the following section, in the context of general changes in Ottoman Anatolia. Apart from these time trend estimations we calculated numeracy by region in both countries.

Before performing this analysis, we study whether numeracy is a reliable indicator of human capital formation, by comparing it with literacy. Usually, numeracy and literacy are highly correlated, which is confirmed also in the case of Greece. Figure 2 shows the positive relationship between the two indicators for late nineteenth century Greece. Please note that we have only evidence for literacy for an earlier period (before 1850), and numeracy for the

5. Please note that the early Greek censuses suffered from under-registration of males aged 18-24, because this age group was eligible for military service. However, this affects the whole age group and not necessarily those people who are rounding or not rounding their age. On the underreporting issue see Siampos (1973), here especially pp. 57-58). We thank a referee for this hint.

FIGURE 2 ▪ *Literacy and numeracy in Greece per region around 1860*



Source: Population census of the Kingdom of Greece in 1907 (birth decade 1870s).

Note: Numeracy evidence refers to the birth decade 1870s, literacy refers to the 1850s and earlier.

birth decade of the 1870s. Hence, we need to assume that interregional differences of literacy and numeracy did not change substantially in these two or three decades. Baten and Hippe (2018) studied this intensively and confirmed that interregional differences were quite stable in nineteenth-century Europe.

The higher the numeracy rates are in our sample, the higher the average corresponding literacy rates. In the case of Greece, the regions of Aetolia and Akarnania, Messinia, Phokis and Phtiotis, Arcadia and Euboea had the lowest literacy and numeracy rates of all Greek regions at the time. In contrast, the islands demonstrated the highest numeracy and literacy rates. The literacy evidence is consistent with the findings of Lemontzoglou (2020) on late nineteenth century Greece.

Although the highest literacy levels for men were observed in Attika and Peloponnesus, the highest literacy levels for women were observed in Attika and the Aegean islands (Lemontzoglou 2020, p. 14). In general, it is observed that literacy rates were still low for all parts of Greece, being under 30 percent. The introduction of compulsory schooling had taken place 36 years earlier, in 1834, but still there was much illiteracy (Tsoukalas 2006; Hippe and Baten 2012).

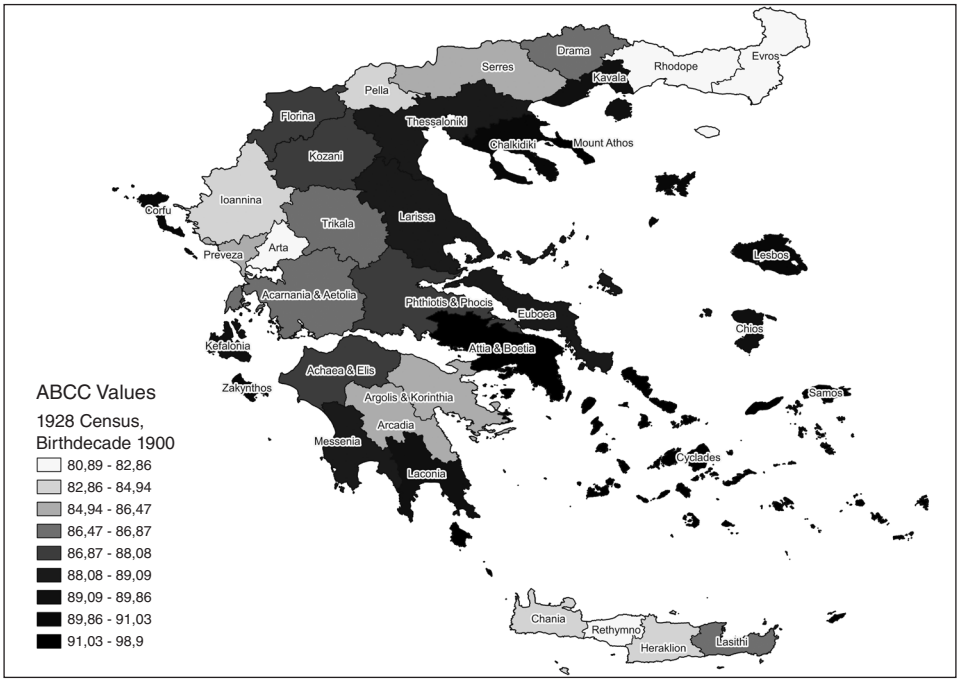
Zakynthos and Kefalonia were more numerate than literate. On the other hand, Corfu and the Cyclades Islands, while having similar numeracy rates, show higher literacy rates than the other islands. Overall, the Ionian islands were annexed to the Greek Kingdom only in 1864. Their relatively higher literacy and numeracy levels were also influenced by the British education policies.

Figure 3 shows overall numeracy in the different regions of early-twentieth-century Greece, confirming the high numeracy level on small islands and in Attika, but also Chalkodiki. Figure 4 shows the gender gap in the same areas of the country.

The gender gap in western and north-eastern Greece, Peloponnese as well as Crete was quite large. In contrast, the Cyclades demonstrated almost the same numeracy rates for both genders – in line with the high literacy rates reported by Gavalas (2008). This is also compatible with various historical studies on gender roles and marriage patterns in insular Greece.

Many primary and secondary sources show that since the early nineteenth century, Aegean islands were in many cases inhabited by more women, who were the households' heads, either because they never married or because they were widows (Dimitropoulos 2004). As an example, which confirms this re-

FIGURE 3 ▪ *Numeracy levels (ABCC) in Greece, birth decade 1900*



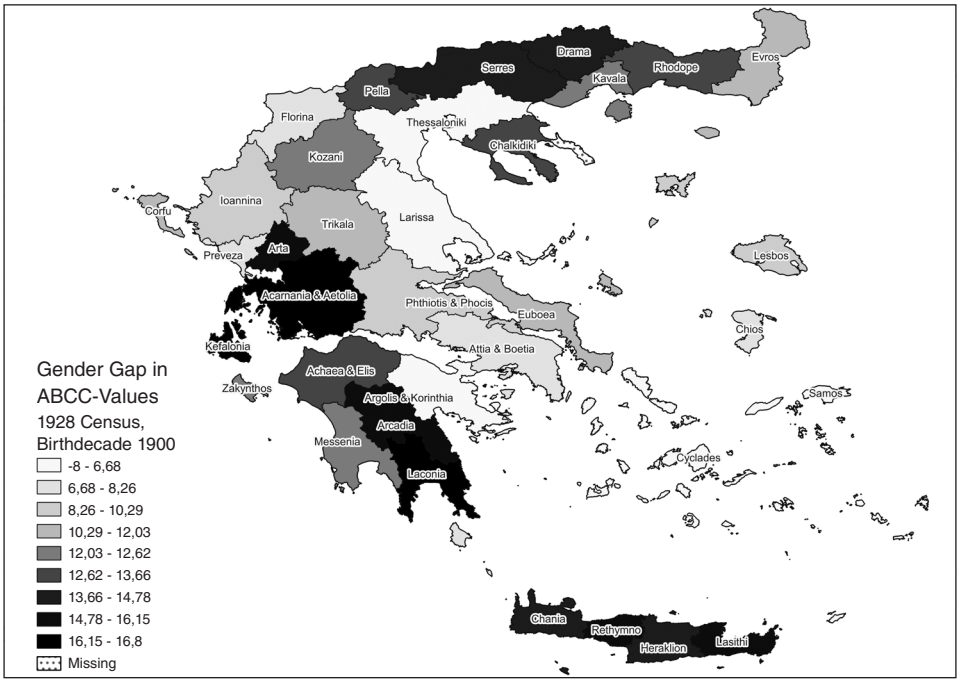
Source: Population census of the First Hellenic Republic in 1928 (birth decade 1900s).

Note: The darker the colour the higher the region's numeracy.

sult for educational gender equality, the indicator "share of female household heads" can be considered for the largest town on the island of Syros: the share of female headship in Hermoupolis, the capital of Syros, was as high as the ones north-western European regions. "Females headed 14, 16 and 21 percent of households in 1861, 1870 and 1879 respectively" (Hionidou, 1999, p. 409).

Also, Tsoukalas (2006) observed high migration from areas where smallholdings prevailed, and an almost total absence of migration where share cropping existed. He views out-migration from the countryside as a process of upward social mobility and the most important 'tool' of those migrants in achieving such social mobility was education, provided freely and rather equitably by the Greek state from an early date (Tsoukalas 2006, pp. 517-526). Concerning the islands and especially Cyclades, men were often absent due to either long-term or circular out-migration from the islands to Greek and European cities. Moreover, another reason for men being absent was their involvement in long-distance trade and the shipping industry, as often happened in Mykonos (Hionidou 2003). In mid-nineteenth century Syros, most men's activities centred around the port, with the majority working as sailors (Bafounis 1984, pp. 229, 231).

FIGURE 4 ▪ *Gender gap in numeracy levels in Greece, birth decade 1900*



Source: Population census of the First Hellenic Republic in 1928 (birth decade 1900s).

Note: The darker the colour the higher the region's gender gap.

region. Admittedly, the lack of potential male partners due to mass migration in the late nineteenth and early twentieth centuries also contributed to lower marriage rates for women (Tapia and Raftakis, 2022, p. 330). Plus, strict custom rules regulated widowhood, and remarriage was not socially accepted (Tapia and Raftakis, p. 331). However, in all European countries and regions, higher age at marriage was correlated with higher female autonomy, as Baten and de Pleijt (2022) show by comparing several other indicators of female autonomy. Hence, the strongest influence on higher ages at marriage was probably higher female autonomy due to the mechanism described above.

5. Econometric results: correlates of numeracy levels within modern Greece

5.1. Potential explanatory variables

In order to study how socio-economic and cultural factors might have played a role in long-term human capital formation across areas of Greece, we reconstruct and study the following variables:

Gender gap in numeracy. This is defined as male numeracy minus female numeracy. An important factor in numeracy development might have been higher or lower female autonomy (De Moor and van Zanden 2010, on the North Sea region; critical on this region, Dennison and Ogilvie 2014). Late marriage might have resulted in more work experience for women, strengthening their position (on the following, see Baten et al. 2017). Even after marriage and childbirth, when the traditional restricted role of women made them responsible for their children, the basic educational investment per child might have depended on the female human capital attained in the labor market before marriage. We argue that a low gender gap in numeracy is a suitable indicator of female autonomy (even if not without problems, as discussed below), because it reflects the different educational investments of both schools and households in female children. This has implications for their own human capital as well as that of their offspring: women who did not gain as much numeracy – because limited female autonomy prevented them – also tended to provide less teaching and self-learning encouragement to their children. They were less able to teach important competences such as numeracy and other skills, and they sometimes valued these skills less because they did not "belong to their sphere" (Baten et al. 2017).

The small island effect. This is defined as a dummy identifying whether a place of a statistical unit was a small island. We observe on most small islands of Greece relatively high levels of numeracy ('small' islands do not include Crete/Euboia). What could have caused this effect? For example, living on an

island, one needs to be aware of climate conditions as well as have basic knowledge of shipping, boats, and trade, which requires certain quantitative skills. Shipping also requires some feeling for proportions. Without numeracy skills, one soon ends up professionally unsuccessful, or dead. Moreover, the higher numeracy levels on the small islands could have been caused by a combination of the island effect itself and a lower gender gap: a significant part of the male population was often away from their homes. Many men worked in maritime transport and travelled for long periods and, as a result, women became more independent.[6]

During the later period, men of working and reproducing age migrated massively from these islands (Hionidou 2003). Both unskilled but also skilled labour migrated, hence transferring human capital to other parts of Greece or to European cities, so that we would expect the island effect to disappear during later phases of development.

Contact/colonialism (and the interaction with the island effect). This is defined as a dummy variable identifying if a place had been in contact with Venetian and/or other foreign rule. The Ionian Islands including Corfu, Kefalonia and Zakynthos were for long periods under Venetian and later French and British rule. This might have benefited human capital formation (Hippe and Baten 2012). The long-term presence of Francs and Venetians in the Ionian Islands influenced the development of social institutions, such as education and marriage patterns. Catholic fraternities played a considerable role in this. Locals adopted a more westernised marriage pattern, with a higher average age at marriage and narrow age gap between spouses (Gavalas 2008).

Agricultural specialisation. Cash crops or livestock keeping might impact on regional income and the local availability of nutrients for consumption, as transport was still relatively expensive during the nineteenth and the early twentieth century. For agricultural specialisation (grain, vineyards, goats, sheep, cows, fishing), we used the Greek agricultural statistical publications of 1911, 1929 and 1950, and interpolated for the decades in between. Production is normalised per land or per capita, depending on the crop/livestock (see Table 2).

Urbanisation. This variable is also elaborated as a dummy to identify urban vs rural regions. Usually, we would expect higher numeracy in urban centres, as it is easier to organise schools in cities than in rural areas, and urban centres were also centres of trade. However, cognitive abilities – a precondition for human capital formation – also depends on nutrition and health. In some urban centres, nutrition and health were rather poor, hence educational outcomes were lower than in the countryside (Ghanem 2018; Baten and Llorca-Jaña 2021). For instance, this hypothesis could hold in the cases of

6. Moreover, both men and women, and especially those coming from the upper classes, had access to education and learned how to read and write (Costa 1988, p. 171).

Thessaloniki and Athens during the refugee influx from Asia Minor in the early 1920s or during the financial crisis in the late 1920s.

Shipping industry. This factor, processed as a dummy variable, might have mattered for human capital formation and specifically numeracy levels, as it is an industry that requires high skills and intuition regarding numerical relations.

Refugees. This variable is defined as refugees per population. They are cultural factors that have had positive or sometimes negative effects on human capital development.

5.2 Regression results for the Greek regions

We first study the correlates of numeracy in Greece (descriptive statistics concerning the birth decade 1900–1909 in Table 1). The dependent variable is numeracy in the Greek prefectures. We use small panels of two decades each

TABLE 1 ▪ *Variables for Greece (birth decade 1900–1909)*

Variable	Mean	Std. Dev.	Min	Max
Numeracy	97.00	2.06	91.20	100.87
Gender gap	4.93	4.63	-8.00	16.64
Urban	0.13	0.33	0	1
Small island	0.21	0.41	0	1
Grain per land	22.69	7.57	13.03	46.37
Vineyards per land	3.42	3.06	0.94	11.63
Goat p.c.	0.67	0.41	0.14	1.75
Sheep p.c.	0.99	0.64	0.10	2.74
Cows p.c.	0.15	0.10	0.01	0.42
Fishing per pop.	2.97	1.55	0.53	6.44
Refugees per pop.	19.16	21.17	0.63	70.30
Contact Venetian/Francs	0.47	0.50	0	1
Shipbuilding (1/0)	0.16	0.36	0	1

Sources: For agricultural specialisation (grain, vineyards, goats, sheep, cows, fishing), we used the Greek agricultural statistical publications of 1911, 1929 and 1950, and interpolated for the decades in between. For the demographic variables (urbanisation), we used Greek population censuses for 1879, 1907, 1928, and 1951; Contact with Venetians/Francs/British, small island and shipbuilding are dummy variables that we created based on maps and secondary literature. Refugees per population refer to 1928. We need to assume that the interregional differences of the refugee effect were relatively constant. They were reported in 1928 population censuses I and II: real population and ages [πραγματικός πληθυσμός και ηλικίες].

Notes: The gender gap is defined as male numeracy minus female numeracy. It is not a-priori clear that the average and the gap need to be mechanically correlated. We can sometimes observe a gender gap of numeracy of 20 percent or so in a situation of high overall numeracy, and in other countries and periods we observe a similar gap in a situation of low numeracy.

so that the analysis does not suffer from small numbers of observations, given the limited number of Greek regions. To be more precise, we include the 1900s and 1910s in the first column, as well as the 1910s and 1920s in the second, and so on, for example. We are particularly interested in the relationship between the gender gap in numeracy and average numeracy.

In the regression analysis (Table 2), we observe a significantly negative effect of the numeracy gap in the first panel, which would support the hypothesis about gender inequality reducing numeracy. However, during the following decades, this factor became insignificant.

We also study the small island economies of Greece, which have some of the characteristics that might be related to higher or lower numeracy. The "small island economy" variable has a substantial effect in the first decades; living on one of the small islands increases numeracy by 1.8 or 1.5 percentage points in the first two panels. A lower gender gap and a higher numeracy level of women in the islands might have played a role in this. Gavalas (2008) finds that girls married later on the islands. This finding is in line with the argument of Baten and de Pleijt (2022) that higher ages of marriage indicate 'girl power' and lead to higher numeracy (on the theory, see De Moor and van Zanden 2010; Carmichael et. al. 2016). This is compatible with several ethnographic and anthropological studies on the independence of women in small Greek islands and their role in the local economy as well as within the family (Dimitriou 1988; Papadopoulou 2009; Delis 2015).

After the 1920s, the small island effect disappears. The fading of the small island effect could be partially explained by a gradual convergence between islands and the mainland in terms of cultural practices and social institutions. Gavalas (2008) shows that marriage patterns in Greece started converging after the mid-twentieth century.

The small island effect could also be determined by maritime activities, such as fishing and ship building. However, we explicitly control for both variables, which are mostly negative and insignificant, leading to the conclusion that these are most likely not the underlying causes of the small island economy effect. Moreover, we know that official state education on the islands was not proportionally more developed than in other regions. For instance, Tseres (2006) demonstrates that education indicators were low for the Ionian islands in 1879 and 1907, especially concerning female school enrolment rates (Tseres 2006, p. 77). The contact with Venetians and Francs during the early modern period had consistently positive coefficients, even though they were only two times significant, and do not remove the significance of a separate small island effect for the first two panels. Hence, we are left with the other characteristics of island economies as the most prominent explanatory factors, such as the participation of women in the economy, who had to be particularly active during the temporary absence or permanent migration of males.

TABLE 2 ▪ *Regressions of numeracy (ABCC index) in Greece*

	(1)	(2)	(3)	(4)
Birth decade	**1900–1910**	**1910–1920**	**1920–1930**	**1930–1940**
Age group	**53-72**	**43-62**	**33-52**	**23-42**
Gender gap	–0.10**	0.04	–0.08	0.02
	(0.048)	(0.383)	(0.487)	(0.605)
Urban	–1.57***	–0.05	0.55	0.21
	(0.004)	(0.926)	(0.240)	(0.580)
Small island (1/0)	1.82***	1.47**	0.20	–0.64
	(0.006)	(0.048)	(0.716)	(0.404)
Grain (p_land, logs)	1.97**	2.15*	1.23	1.45
	(0.028)	(0.053)	(0.291)	(0.106)
Vineyards (p_land, logs)	–1.04**	–0.03	0.05	–0.09
	(0.027)	(0.936)	(0.906)	(0.860)
Goats p.c. (logs)	0.57*	0.57	0.47*	0.66
	(0.079)	(0.179)	(0.087)	(0.114)
Sheep p.c. (logs)	0.08	–0.19	0.46	1.58***
	(0.885)	(0.818)	(0.550)	(0.007)
Cows p.c. (logs)	–0.63*	–0.57	–0.39	–0.37
	(0.061)	(0.138)	(0.404)	(0.285)
Fishing share (logs)	–1.04	–0.44	–1.18	–2.89***
	(0.177)	(0.633)	(0.133)	(0.003)
Refugees p.c. (logs)	–0.45*	–0.18	–0.01	0.01
	(0.070)	(0.521)	(0.970)	(0.964)
Contact Venetian/Francs (1/0)	0.71	1.17*	1.44**	0.82
	(0.383)	(0.068)	(0.025)	(0.244)
Ship building (1/0)	–0.37	–0.37	–0.84	–0.26
	(0.627)	(0.604)	(0.142)	(0.710)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Constant	91.66***	89.16***	93.89***	95.55***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	68	68	68	68
R-squared	0.609	0.280	0.190	0.358

Sources: See Table 1. Robust inference is conducted using clustered standard errors for each prefecture.

* p-value <0.1 ** p-value<0.05 and *** p-value<0.01. We include time fixed effects and region fixed effects; the time fixed effect is a dummy variable for one of the two decades included, and region fixed effects in the Greek case is based on the north-south division. We created 'super-regions' (matched regions) for Greece based on the prefecture level (see Appendix B) in order to match the prefectures and regional units of the early twentieth century and 1971. However, given that the explanatory variables and the dependent variable do not always have the same regional structure, we combined several smaller regional units into one larger unit that can be calculated for both the explanatory variables and the dependent variable. In what follows, we call these regions super-regions. We added the age brackets to clarify how we used the cohort data evidence to document the birth decades.

It is also interesting to study the urban penalty or urban advantages in numeracy. The literature on nutrition and health during the nineteenth century is full of observations about the existence of an urban penalty: often, the large industrial cities of the nineteenth century were characterised by very poor nutritional status and health conditions were also very disadvantageous (Meinzer et al. 2019). Therefore, it is not clear that we would necessarily expect a positive situation in urban agglomerations compared to rural ones in terms of numeracy. Although Lemontzoglou (2020) shows that urbanisation had a positive effect on literacy in the 1870s, education – and numeracy in particular – depends on the nutrition of children (Baten et al., 2014), and cognitive abilities might have been more limited in poor urban areas because of severe malnutrition. This has been observed in other studies e.g., for the Egyptian metropoles of Alexandria and Cairo, as well as the Chilean capital of Santiago (Llorca-Jaña et al. 2019; Baten and Llorca-Jaña 2021; Ghanem 2018; Saleh 2013). In the case of Greece, we can observe this urban penalty for the first panel of our Greek numeracy data collection, but later the urban penalty disappears and becomes not statistically different from zero.

Nutrition and agricultural specialisation can also be measured directly, by looking at the share of grain per land or the number of goats and sheep. We generally observe a positive, although not always significant, influence. Vineyards in the first panel have a significantly negative effect, perhaps because raisins produced in vineyards were a cash crop that did not always benefit the nutrition of the whole population in the first phase of its introduction, as less nutrients were available and affordable locally, especially for low-income groups (Moradi and Baten 2005). It seems that goats and sheep were very important for Greek nutrition, certainly more than cows.

One of the challenges of the Greek sample is that we only have data on numeracy by residence province, rather than by birth province (in Appendix C, we investigate whether selective migration caused the bias and conclude that the bias was not substantial). In the 1920s there was a strong influx of refugees into Greece, therefore we need to control for this variable. A significant part of the refugees derived from urban centres of Asia Minor, such as Izmir or Istanbul. They were often numerate and literate people, involved in trade and other economic activities. The refugees were relatively better-educated than the native inhabitants, as literates reached 50.8 percent of the refugee population, compared to 49.8 percent literates of the general population (Avgousti, 2023, p. 20).[7]

7. Moreover, this was also the time of the mass migration to the US. Could this have also influenced the numeracy levels of Greece at the time, given that a large share of Greek men had left the country? Stolz and Baten (2012) studied this for the long nineteenth century period including the 1910s. In the case of the 1830s to 1870s, some very education-biased migration waves could be observed, where the education bias in the 1880s to 1910s was already very

However, their living conditions in Greek cities, such as Thessaloniki and Athens, were very poor. We only observe a significant influence of refugees for the early panel, which reflects the birth period of the time before the migrants came. The fact that this variable is negative indicates that the refugees either went often to places with a lower level of development, or that the earliest birth cohort of migrants born in the 1900s and 1910s were already suffering from discrimination. Admittedly, this is a preliminary consideration and more research on the numeracy of refugees is needed.

Table 3 offers a longer time-perspective on the relationship between the gender gap and the small island effect as potential explanatory variables, and numeracy as a dependent variable.[8] We observe that among the birth decade of the 1850s there was a substantial gender gap effect (Figure 5). It was still large in the 1870s, but began to decline in the 1900s. The last significant coefficient is in the 1900s–1910s panel. Similarly, the small island effect is larger and very significant in the first five birth periods; the maximum was reached in the 1870s. The R-square is high for the first four time units. Hence, these two variables, namely gender gap and small island effect, can explain a high share of Greek variation of numeracy, but this effect disappeared during the twentieth century.

TABLE 3 ▪ *The gender gap and small island effect in Greece since the 1850s*

	1850s	1870s	1900s	1900s–1910s	1910s–1920s	1920s–1930s	1930s–1940s
Gender gap	–0.94***	–0.67*	–0.22**	–0.09*	0.01	–0.11	0.00
	(0.000)	(0.068)	(0.046)	(0.089)	(0.934)	(0.226)	(0.960)
Small island	2.68**	11.0***	3.63***	1.51***	1.36***	0.37	–0.81
	(0.038)	(0.000)	(0.000)	(0.004)	(0.002)	(0.369)	(0.368)
Time FE	–	–	–	Yes	Yes	Yes	Yes
Constant	74.25***	76.71***	89.0***	96.05***	97.35***	98.18***	97.81***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	59	26	34	72	72	72	72
R-squared	0.68	0.58	0.34	0.439	0.116	0.070	0.059

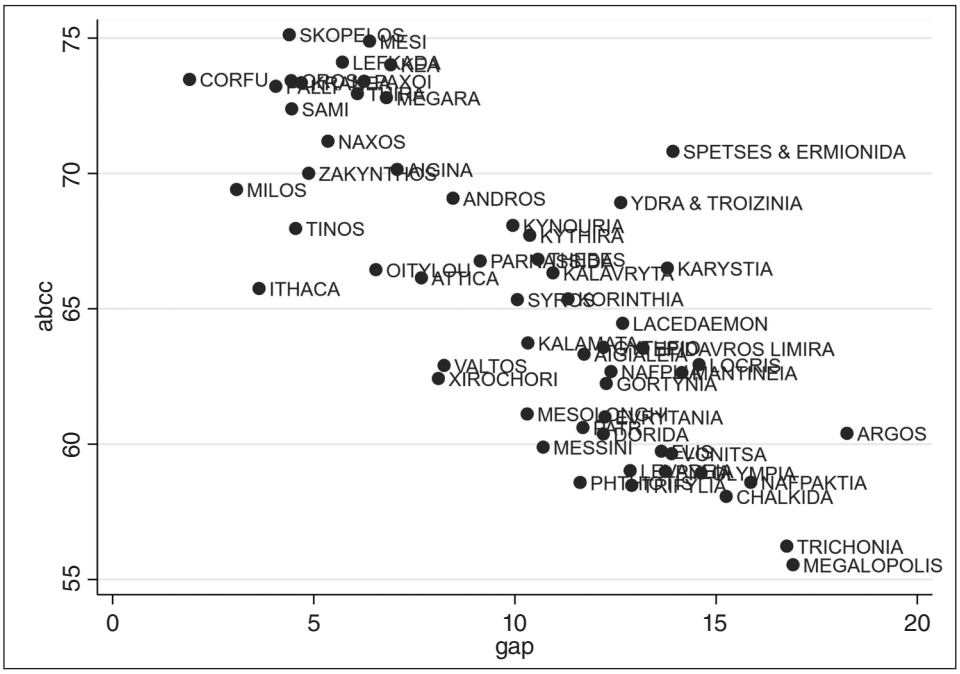
Sources: Greek censuses of 1879, 1907 and 1928, source for 'small island': see Table 1.

Notes: The 1880s and 1890s are missing, because the early Greek censuses contained only single-year age statements for the youngest ages, and these decades could not be covered by the available single-year age material. Time fixed effects are included as a dummy for the second birth decade. Robust inference is conducted using clustered standard errors for each prefecture. * p-value <0.1 ** p-value<0.05 and *** p-value<0.01.

limited for European countries (comparing the education in the home county with the migrant education, not the education in the target country with migrant education), admittedly the boundary effect might have played a role (numeracy cannot exceed 100%).

8. We cannot include all the other controls for such a long period of time, hence the analysis in Table 4 is limited to the two main explanatory factors from Table 3.

FIGURE 5 ▪ *Earlier evidence on Greek gender gap effect (birth decade 1850)*



Source: Population census of the Kingdom of Greece in 1879.

Notes: The Y axis displays the ABCC index (numeracy) for the 1850s birth decade, while the X axis shows the numeracy gender gap in the same period.

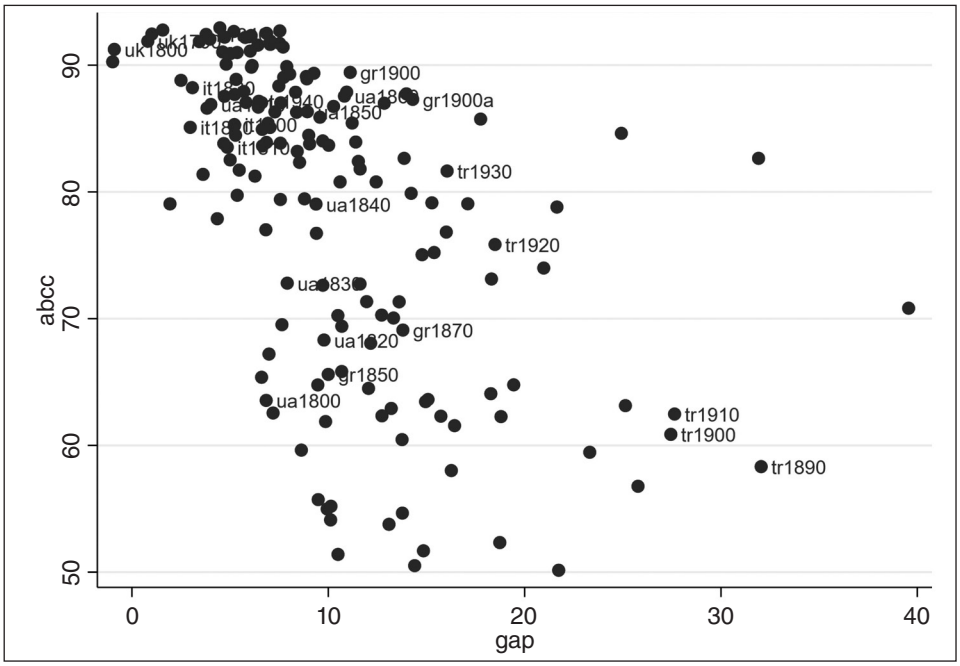
5.3 Gender gap and average numeracy: a mechanical relationship?

An important question is whether the correlation between the gender gap and average numeracy is rather 'mechanical', because the first rise in numeracy might always happen due to the accumulation of men's human capital first (thus a growing gender gap) followed by a rise in women's numeracy, which would lead to a further increase in numeracy towards 100 percent but a declining gender gap.

We tested whether there is a mechanical relationship between the gap and average numeracy level in an international comparison (Figure 6). The variable "gender gap in numeracy" has been used by several other studies (e.g., Manzel and Baten 2009), and has been carefully evaluated.

Thanks to a comparative perspective, an additional strategy to assess whether average numeracy might be just mechanically correlated with the gender gap in numeracy is to study a large sample of countries and periods and to assess whether this maps into a 1:1 line, or whether there are notable deviations between the two variables. Here we looked at all countries of the

FIGURE 6 ▪ *Gender gap and numeracy in international comparison: no 'mechanical' relationship between the gap and numeracy levels*



Sources: For Greece and Turkey, see text and notes to Figure 1. For all other countries: Crayen and Baten (2010), and their update on www.clio-infra.eu, last accessed 30 May 2023.

Notes: The Y axis displays the ABCC index (numeracy), while the X axis shows the numeracy gender gap in the same period

Middle East and Eastern Europe on which we could obtain data and some other selected countries from Western Europe (Italy and UK) that might be interesting comparison cases (Crayen and Baten 2010). Overall, we observe a negative relationship between the gender gap of numeracy and the average level of numeracy. We limit observations to numeracy lower and equal to 90, because of the fact that numeracy is bounded at 100 by construction and this could bias the picture of the correlation analysed. We observe a very strong variation of gender gaps for the same levels of numeracy. Therefore, the high variation of gender gaps and human capital expansion in international comparison suggests that the relationship between gender in equality and numeracy is highly context dependent. In Appendix D, we also assessed the direction of causality using an instrumental variable analysis for similar data on the area of modern Turkey. We find that gender equality of numeracy had an impact on average numeracy that can be interpreted as being causal.

6. Conclusions

In this study, we traced the long run development of numeracy in various Greek regions, particularly in the nineteenth and twentieth centuries. We discussed the economic and institutional background that might have accounted for the initially low level of numeracy. We created several panels on numeracy, including data on a series of quantitative and qualitative explanatory variables retrieved from population censuses, agricultural statistical yearbooks, and administrative reports of Greece. We used the age heaping method to estimate regional numeracy levels (ABCC index). We identified strong correlations between gender equality and numeracy levels. In Greece, the gender gap is highly correlated with numeracy, although the gender-gap effect fades out around 1910.

The underinvestment of the Ottoman Empire into secular education mattered, and it did cast a long shadow on regions that left the Empire. However, there are several other influential factors beyond cultural and religious dichotomies: within the Ottoman imperial core, urban and industrial centres developed more advanced human capital and higher gender equality. In the case of the modern Greek state, we observe high regional differentiation in literacy and numeracy levels as well as important shifts over time. Among the Greek regions, cultural traditions initiated by contact with Venetian and British settlers and merchants mattered. Moreover, the maritime orientation of the island economies was highly complementary to early numerical human capital and increasing gender equality. Due to the frequent absence of males (working often for the shipping industry or out-migrating), the household and labour activity of women was stimulated. Finally, the mass influx of refugees from Asia Minor into Greece during the first half of the twentieth century, as well as urbanisation, had a mixed effect on human capital development.

While we observed above that gender equality has in fact a causal effect, we would still emphasise the 'small island effect' as the more original result of our article, because it was observed for the first time here (and potential endogeneity issues do not apply). However, even if we would suggest this implicit ranking of the relevance of our findings, we believe that the determinants of numerical skills are multi-dimensional. We need to consider a large number of factors to understand the multi-faceted nature of human capital history.

Acknowledgements

We would like to thank Anastasios Stavropoulos, Marios Tsologlou, Rima Ghanem, Mina Schmachtel, Tim Holzapfel, Georgia Iosifidou,

Dominik Hees, Jonathan Bosoni, Laura Maravall, Elisabeth Kempter and Tom Keywood for their assistance and/or suggestions in data collection, elaboration and mapping. We also owe gratitude to the participants of the 13th European Historical Economics Society Conference at the Paris School of Economics (August 2019), the Greek Economic History Association Seminar at the National Hellenic Research Foundation in Athens (January 2020), and the 8th International Ioannina Meeting on Applied Economics and Finance (IMAEF) in Kefalonia (June 2022) for their insightful comments. Particularly, we would like to thank Gabriele Cappelli, Apostolos Delis, Alkiviadis Kapokakis, Gelina Harlaftis, Ulas Karakoc, Socrates Petmezas, Tryfonas Lemontzoglou and Andreas Kakridis, as well as the editors, guest editors and anonymous reviewers of RHI-IHR. Last but not least, we are grateful for the financial support provided by the German Science Foundation (grant no. DFG BA 1503/18-1). The usual disclaimer applies.

Author contribution statement

Kleoniki Alexopoulou: framework, investigation, dataset, writing, visualisation, supervision. Joerg Baten: framework, methodology, software and code, formal analysis, visualisation, supervision.

References

Acemoglu, Daron, Francisco A. Gallego, and James A. Robinson. 2014. 'Institutions, Human Capital, and Development', *Annual Review of Economics*, 6 (1): 875-912.

A'Hearn, Brian, Jörg Baten, and Dorothee Crayen. 2009. 'Quantifying Quantitative Literacy: Age Heaping and the History of Human Capital', *The Journal of Economic History*, 69 (3): 783-808.

Akarli, Engin D. 1992. 'Economic Policy and Budgets in Ottoman Turkey, 1876–1909', *Middle Eastern Studies*, 28 (3): 443-476.

Asteriou, Dimitrios, and George. M. Agiomirgianakis. 2001. 'Human Capital and Economic Growth: Time Series Evidence From Greece', *Journal of Policy Modeling*, 23 (5): 481-489.

Avgousti, Venetia *[Αυγουστή, Βενετία]*. 2023. *Οι πρόσφυγες του Πειραιά μετά τη Μικρασιατική Καταστροφή*. Μεταπτυχιακή Διπλωματική Εργασία, Πανεπιστήμιο Πελοποννήσου.

Bafounis, Giannis [Μπαφούνης, Γιάννης]. 1984. Γάμοι στην Ερμούπολη (1845-1853). Δημογραφικά Φαινόμενα μιας Μοντέρνας Πόλης του Ελληνικού 19ου Αιώνα. *Μνήμων*, 9: 211-245.

Baten, Jörg. 2021. 'A Regional Weighting Procedure to Estimate Numeracy for the Territory of Modern Turkey'. Working Paper. Tuebingen: University of Tuebingen.

Baten, Jörg. 2019. 'Elite Numeracy in the Middle East over the Past Two Millennia'. Working Paper. Tuebingen: University of Tuebingen.

Baten, Jörg, Dorothee Crayen, and Kerstin Manzel. 2008. 'Zahlenfähigkeit und Zahlendisziplin in Nord- und Westdeutschland, 16.-18', *Economic History Yearbook,* 49 (2): 217-229.

Baten, Jörg, Dorothee Crayen, and Hans-Joachim Voth. 2014. 'Numeracy and the Impact of High Food Prices in Industrializing Britain, 1780-1850', *Review of Economics and Statistics*, 96 (3): 418-430.

Baten, Jörg, and Alexandra M. de Pleijt. 2022. 'Female Autonomy Generated Successful Long-term Human Capital Development: Evidence from 16th to 19th Century Europe', *World Development,* 158:1-17.

Baten, Jörg, and Ralph Hippe. 2018. 'Geography, land inequality and regional numeracy in Europe in historical perspective', *Journal of Economic Growth*, 23: 79-109.

Baten, Jörg, and Dácil Juif. 2014. 'A story of large landowners and math skills: Inequality and human capital formation in long-run development, 1820–2000', *Journal of Comparative Economics*, 42 (2): 375-401.

Baten, Jörg, and Manuel Llorca-Jaña. 2021. 'Inequality, Low-Intensity Immigration and Human Capital Formation in the Regions of Chile, 1820-1939'. *Economics & Human Biology*, 43: 101030.

Baxevanis, John. 1965. 'Population, internal migration and urbanization in Greece', *Balkan Studies*, *6* (1): 83-98.

Beltrán Tapia, Franciso J., and Michail Raftakis. 2022. 'Sex ratios and gender discrimination in Modern Greece', *Population Studies,* 76 (2): 329-346.

Bouzakis, Sifis. 2009. 'Historiography of the Greek education: Creation, development, influences, perspectives (1824-2006)', *Educational Research and Reviews*, 4 *(*12): 596-601.

Brooks, Margaret E., and Shuang Yueh Pui. 2010. 'Are individual differences in numeracy unique from general mental ability? A closer look at a common measure of numeracy', *Individual Differences Research* 8 (4): 257-265.

Carmichael, Sarah G., Alexandra de Pleijt, Jan Luiten van Zanden, and Tine De Moor. 2016. 'The European Marriage Pattern and its Measurement', *Journal of Economic History,* 76 (1): 196-204.

Charila, Thomais Ismini [Χαρίλα, Θωμαϊς Ισμήνη]. 2006. *Η στοιχειώδης εκπαίδευση στην Αγγλία, τη Γαλλία και την Ελλάδα κατά το 19ο αιώνα (1800-1870)*. PhD Thesis, Αθηνών: Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών (ΕΚΠΑ). Σχολή Φιλοσοφική.

Costa, Janeen Arnold. 1988. 'The History of Migration and Political Economy in Rural Greece: A Case Study', *Journal of Modern Greek Studies*, 6 (2): 159-185.

Crayen, Dorothee, and Jörg Baten. 2010. 'Global trends in numeracy 1820–1949 and its implications for long-term growth', *Explorations in Economic History*, 47 (1): 82-99.

Delis, Apostolos. 2015. *Mediterranean wooden shipbuilding: Economy, technology and institutions in Syros in the nineteenth century*. Leiden: Brill.

Delis, Apostolos. [Δελής, Απόστολος] 2010. Ερμούπολη (Σύρος): Το Ναυπηγικό Κέντρο της Ιστιοφόρου Ναυτιλίας, 1830-1880. PhD Thesis, Κέρκυρα: Ιόνιο Πανεπιστήμιο.

Dennison, Tracy, and Sheilagh Ogilvie. 2014. 'Does the European Marriage Pattern Explain Economic Growth?', *The Journal of Economic History* 74 (3): 651-93.

Dennison, Tracy, and Sheilagh Ogilvie. 2016. 'Institutions, Demography and Economic Growth', *The Journal of Economic History* 76 (1): 205-17.

De Moor, Tine, and Jan Luiten van Zanden. 2010. 'Girl Power: The European Marriage Pattern and Labour Markets in the North Sea Region in the Late Medieval and Early Modern Period', *Economic History Review* 63(1): 1-33.

Dimaras, Alexis. 1990. *The reform that never took place*, 2 vol. Athens: Hermes.

Dimitriou, Sibylla. [Δημητρίου, Σ.] 1988. 'Gender Roles and Symbolic Systems on an Aegean Island'. PhD Thesis, London: University of London. School of Oriental and African Studies.

Dimitropoulos, Dimitris [Δημητρόπουλος, Δημήτρης]. 2004. 'Μαρτυρίες για τον πληθυσμό των νησιών του Αιγαίου, 15ος–αρχές του 19ου αιώνα' [Evidence for the population of the Aegean islands, 15th–beginning of 19th century], *Τετράδια Εργασίας, Ινστιτούτο Ιστορικών Ερευνών* [The Research Notebooks, Institute of Historical Research], EIE, 27: 9-360.

Gavalas, Vasilis S. 2008. 'Marriage patterns in Greece during the twentieth century', *Continuity and Change*, 23 (3): 509-529.

Ghanem, Rima. 2018. 'Mathematical Economics of Human Capital in the Middle East in Long-Run Perspective'. PhD Thesis, Tuebingen: University of Tuebingen.

Ghanem, Rima, and Jörg Baten. 2016. 'Middle East, north Africa and central Asia'. In *A history of the Global Economy: From 1500 to the Present*, edited by Jörg Baten, 208-248. Cambridge; New York: Cambridge University Press.

Hanushek, Erik A., and Ludger Woessmann. 2012. 'Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation', J*ournal of Economic Growth*, 17: 267-321.

Hionidou, Violetta. 2003. '"They used to go and come." A century of circular migration from a Greek island, Mykonos 1850 to 1950', *Annales de démographie historique*, 2: 51-77.

Hionidou, Violetta. 1999. 'Nineteenth-century urban Greek households: the case of Hermoupolis, 1861–1879', *Continuity and Change*, 14 (3): 403-427.

Hippe, Ralph, and Jörg Baten. 2012. 'Regional inequality in human capital formation in Europe, 1790–1880', *Scandinavian Economic History Review*, *60* (3): 254-289.

Issawi, Charles. 1982. *An Economic History of the Middle East and North Africa*. New York: Columbia University Press.

Keywood, Tom, and Jörg Baten. 2021. 'Elite Violence and Elite Numeracy in Europe from 500 to 1900 CE: A Co-Evolution?'. *Cliometrica*, 15 (2): 319-389.

Lemontzoglou, Trifonas. 2020. 'Access to land, the agriculture trap, and literacy: Evidence from late nineteenth-century Greece', *The Journal of European Economic History*, 49 (3): 11-53.

Llorca-Jaña, Manuel, Damian Clarke, Juan Navarrete-Montalvo, Roberto Araya-Valenzuela, and Martina Allende. 2019. 'New anthropometric evidence on living standards in nineteenth-century Chile', *Economics and Human Biology*, 36: 100819.

Llorca-Jaña, Manuel, Juan Navarrete-Montalvo, Roberto Araya-Valenzuela, and Federico Droller. 2019. 'The physical stature of men in nineteenth century Chile: another case of stagnation during an export boom', *Revista de Historia Económica / Journal of Iberian and Latin American Economic History,* 37 (2): 239-270.

Manzel, Kerstin, and Jörg Baten. 2009. 'Gender Equality and Inequality in Numeracy – the Case of Latin America and the Caribbean, 1880-1949', *Revista de Historia Económica – Journal of Latin American and Iberian Economic History* 27 (1): 37-74.

Meinzer, Nicholas J., Richard. H. Steckel, and Jörg Baten. 2019. 'Agricultural Specialization, Urbanization, Workload, and Stature in Richard Steckel et al'. In *The Backbone of Europe: Health, Diet, Work and Violence over Two Millennia*, edited by Richard H. Steckel, Clark Spencer Larsen, Charlotte A. Roberts, and Joerg Baten, 231-252. Cambridge: Cambridge University Press.

Ministry of Interior. 1871. *Greece - Population census, 1870*. Athens: National Printing House.

Ministry of Interior. 1881. *Greece - Population census, 1879*. Athens: National Printing House.

Ministry of Interior. 1884. *Tables of Provinces of Epirus and Thessaly in the 1881 Census.* Athens.

Ministry of Interior. 1884. *Tables of Provinces of Epirus and Thessaly in the 1881 Census.* Athens.

Ministry of Interior, Census Division. 1909. *Greece - Population census, 1907*, vol. 1 and 2. Athens

Ministry of National Economy, Statistics Division. 1915. *Agriculture - Census, 1911*. Athens.

Ministry of National Economy, General Statistics Service of Greece. 1934. *Agriculture Statistics and Livestock Statistics*, 1929. Athens.

Mokyr, Joel. 2005. 'Long-Term Economic Growth and the History of Technology', *Handbook of Economic Growth*, 1 (1): 1113-1180.

Moradi, Alexander, and Jörg Baten. 2005. 'Inequality in sub-Saharan Africa: new data and new insights from anthropometric estimates', *World Development* 33 (8): 1233-1265.

National Statistical Service of Greece. 1958. *Agriculture - Census, 1950*. Athens.

National Statistical Service of Greece. 1961. *Greece - Population census, 1951.* Athens.

Pamuk, Şevket. 2006. 'Estimating Economic Growth in the Middle East since 1820', *Journal of Economic History,* 66 (3): 807-828.

Pamuk, Şevket, and Jeffrey G. Williamson. 2010. 'Ottoman de-industrialization, 1800–1913: assessing the magnitude, impact, and response', *The Economic History Review*, 64 (S1): 159-184.

Papadopoulou, Alexandra [Παπαδοπούλου, Αλεξάνδρα]. 2009. Ναυτιλιακές επιχειρήσεις, διεθνή δίκτυα και θεσμοί στη σπετσιώτικη εμπορική ναυτιλία, 1830-1870: οργάνωση, διοίκηση και στρατηγική. PhD Thesis, Κέρκυρα: Ιόνιο Πανεπιστήμιο.

Petmezas, Socrates. 2013. 'Agriculture and economic growth in Greece'. In *Agriculture and Economic Development in Europe since 1870,* edited by Pedro Lains and Vicente Pinilla*,* 353-374. London: Routledge.

Pirgiotakis, Joannis. 1988. *Schulreformen in Griechenland*. Köln/Wien: Böhlau

Psychogios, [Ψυχογιός, Δ. Κ.]. 1985. 'Οικονομικός και κοινωνικός μετασχηματισμός αγροτικών κοινοτήτων' [Economic and social transformation of agricultural communities], Επιθεώρηση Κοινωνικών Ερευνών - *The Greek Review of Social Research*, 58: 3-31.

Quataert, Donald. 2005. *The Ottoman Empire, 1700-1922.* Cambridge: Cambridge University Press.

Reis, Jaime. 2005. 'Economic Growth, Human Capital Formation and Consumption in Western Europe Before 1800'. In *Living Standards in the Past: New Perspectives on Well-Being in Asia and Europe*, edited by Robert Allen, Tommy Bengtsson, and Martin Dribe, 195-226. Oxford: Oxford University Press.

Saleh Mohamed. 2013. 'A Pre-Colonial Population Brought to Light: Digitization of the Nineteenth Century Egyptian Censuses', *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, 46 (1): 5-18.

Shaw, Stanford. J., and Ezel Kural Shaw. 1977. *History of the Ottoman Empire and Modern Turkey: Volume 2, Reform, Revolution, and Republic: The Rise of Modern Turkey 1808-1975*. Cambridge: Cambridge University Press.

Siampos, Georgios S. 1973. *Demographike Ekseliksis tes Neoteras Ellados (1821–1985)* [Demographic Evolution of Modern Greece 1821–1985]. Athens: S. Tzanettis Press.

Somel, Selçuk Aksin. 2001. *The modernization of public education in the Ottoman Empire, 1839-1908: Islamization, autocracy, and discipline*. Leiden: Brill.

State Institute of Statistics Prime Ministry Republic of Turkey. 2000. *Türkiye statistik Yilli 1999*.

Stolz, Yvonne, and Jörg Baten. 2012. 'Brain Drain in the Age of Mass Migration: Does Relative Inequality Explain Migrant Selectivity?', *Explorations in Economic History*, 49 (2): 205-20.

Tollnek, Franziska, and Jörg Baten. 2016. 'Age-Heaping-Based Human Capital Estimates'. In *Handbook of Cliometrics*, edited by Claude Diebolt and Michael Haupert, 131-154. Berlin/Heidelberg: Springer.

Tollnek, Franziska, and Jörg Baten. 2017. 'Farmers at the Heart of the "Human Capital Revolution"? Decomposing the Numeracy Increase in Early Modern Europe', *Economic History Review,* 70 (3): 779-809.

Tseres, Dimitris S. [Τσερές, Δημήτρης Σπ.]. 2006. *Η μέση εκπαίδευση στη Λευκάδα 1829-1929*. Αθήνα: Ινστιτούτο Νεοελληνικών Ερευνών, Ε.Ι.Ε.

Tsoukalas, Konstantinos. 2006 [1977]. *Eksartese kai Anaparagoge. O Koinonikos Rolos ton Ekpaideutikon Mechanismon sten Ellada (1830–1922)* [Dependence and Repro-

duction. The Social Role of Education Mechanisms in Greece 1830–1922]. Athens: Themelio.

Valaoras, Vasilios G. 1960. 'A reconstruction of the demographic history of modern Greece', *The Milbank Memorial Fund Quarterly*, *38* (2): 115-139.

Yilmaz, Kaya. 2013. 'Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences', *European Journal of Education*, *48* (2): 311-325.

Appendix A: How can the Greek census of 1879 be adjusted to calculate the numeracy of the age group 23–32

We have evidence in the Greek census of 1879 about the age group ranging from 21 to 30 and this age group does not allow us to calculate the standard ABCC measure which is usually based on the age group 23–32. How can we make adjustments on this unusual numeracy index based on a given particular age group? We take a large global sample covering a wide variety of different ages which was also used in a study by Crayen and Baten in 2010. Of this global sample we form artificial age groups between age 21 and 30 and calculate numeracy indices based on this age bracket. Then, we merge these particular numeracy indices with the standard estimates based on the age group 23–32 and run a regression of the standard measure on the special measure which ranges only from 21 to 30. This gives us the formula: abcc2332 = 12.3606 + 0.8733*abcc2130, with a very high R-squared measure of 0.93 and 427 the number of observations. This allows us to estimate the standard ABCC measure also for the Geek regional cross-section in 1879.

Appendix B: 'Super-regions' for Greece

In order to combine the district structures of 1928 and 1971, we needed to form 'super-regions' that combine both district structures in a way that we sometimes take two districts from one year, and three districts from the other year. Sometimes only names changed, and we could assign one to one. This procedure is admittedly approximative (small differences might continue to exist), but it is the only possibility to combine regional structures that changed considerably.

Departments 1971	Departments 1928	No.
	Aetolia and Akarnania	1
Achaia	Achaia and Ilis	2
	Aghion Oros	3
Argolida	Argolis and Korinthia	4
Arkadia	Arkadia	5
Arta	Arta	6
	Attiki and Boetia	7
Chalkidiki and Aghion Oros	Chalkidiki	3
Chania	Chania	8
Chios	Chios	9
Dodekanissos		10
Drama	Drama	11
	Euboia	7
Etolia and Akarnania		1
Evia		7
Evros	Evros	14
Evrytania		15
Florina	Florina	16
Fokida		15
Fthiotida		15
Grevena		19
Ilia		2
Imathia		21
Ioannina	Ioannina	22
Iraklio	Iraklion	23
Karditsa		24

(Continued on next page)

Departments 1971	Departments 1928	No.
Kastoria		16
Kavala	Kavala	26
Kefallinia	Kefallonia	27
Kerkyra	Kerkyra	35
Kilkis		29
Korinthia		4
Kozani	Kozani	19
Kyklades		31
Lakonia	Lakonia	32
Larissa	Larissa	33
Lassithi	Lasssithi	34
Lefkada		35
Lesvos	Lesvos	36
Magnissia		37
Messinia	Messinia	38
Pella	Pella	39
Pieria		40
	Phokis and Pthiotis	15
Prefecture of Athens		7
Prefecture of East Attiki		7
Prefecture of Pireas		7
Prefecture of West Attiki		7
Preveza	Preveza	41
Rethymno	Rethymno	42
Rodopi	Rodopi	43
Samos	Samos	44
Serres	Serres	29
Thesprotia		22
Thessaloniki	Thessaloniki	45
Trikala	Trikala	24
Viotia		7
Xanthi		43
Zakynthos	Zakynthos	35
	Cyclades islands	31

Appendix C: Were there substantial differences between numeracy by birth region and numeracy by region of residence?

We need to consider how large the differences are between numeracy by birth region and numeracy by region of residence. In our study of Greek regions, only evidence about the numeracy by the region of residence is shown, hence it would be important to know whether the differences between the two measurement concepts is substantial or if it is only a small difference. For neighbouring Turkey (considering the territory of the modern state), the differences can be assessed because both determinants – region of birth and region of residence – are given. Generally, a strong positive selectivity of migrants to the large urban centres is expected, because one could imagine that especially people from poor and rural areas migrate to the urban centres since they expect to increase their income substantially based on their skills and their educational level. Although this does not have to be the case for every individual migrant. In general, both birth region and region of residence have some justification in their assessment of numeracy. Hence, age in which numeracy is mostly attained is probably between five and ten. Therefore, it is a bit closer to the point of birth than the point in time in which residence is chosen. For most people it remains the same, but for migrants typically the new residence is chosen between age 20 and 30. If we compare the region of birth and the region of residence for Turkey, we find that there is a very close correlation between the two determinants. For example, the district of Sanliurfa and that of Adiyaman shows very low numeracy by the province of birth and very low numeracy by the province of residence. Whereas on the other side of the distribution, regions such as Bilecik were doing quite well in both aspects. Looking more at individual districts, it is evident that Istanbul as the largest urban centre attracted more skilled migrants. The numeracy by residence was higher than the numeracy of those who were born in Istanbul. But considering the whole country, this selectivity of migration was not as substantial. In conclusion, we can be relatively sure that numeracy by region of residence is also informative if this is only available as, for example, in the case of Greece.

FIGURE C1 ▪ *Numeracy by province of birth and by province of residence do not make a difference (here: Turkey, 1920s–1960s birth decades)*

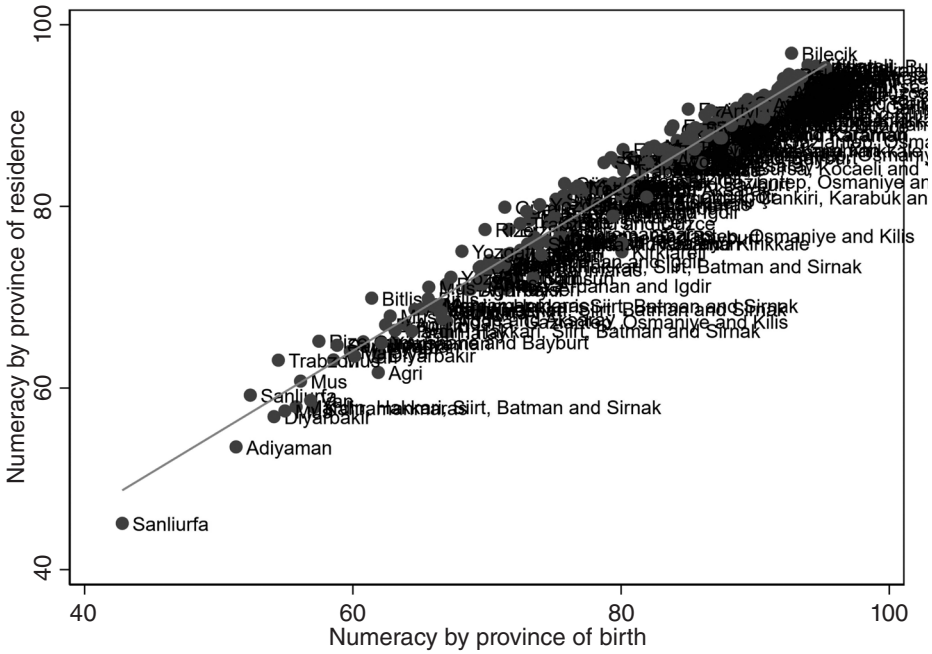


Figure C1: Estimating numeracy trends for Ottoman Anatolia, 1760s–1900s

Appendix D: Which direction of causality?

We need to consider the possibility of endogeneity in our regressions, because there might be the direction of causality issues between the two variables "gender gap" and "average numeracy". Therefore, we use Two-Stage Least Square (2SLS) regressions employing an instrumental variable strategy that would allow a consistent estimate of the relationship between the numeracy gap and the average numeracy, even if endogeneity would be present. This strategy also reduces measurement error and omitted variable bias issues.

Dennison and Ogilvie (2014) discussed whether a relationship between female autonomy and numeracy (and other human capital) formation really existed. Endogeneity is clearly an important issue in this part of the debate (see the response of Carmichael et al. 2016; Dennison and Ogilvie's re-response 2016). We argue here that female autonomy institutions do play a role for numeracy development differences. We address the endogeneity question explicitly by considering gender-biased agricultural specialisation. An important component is soil suitability, which in some regions favoured cattle farming

relative to grain agriculture (the two main components of the European agricultural sector). In cattle farming and dairy production, women often had a stronger role, because females contributed more to household incomes: upper body strength did not play such a large role in this agricultural specialisation, and skills were transferred from mother to daughter, for example about cattle disease prevention and hygienic behaviour. In contrast, grain agriculture required more upper body strength and hence gave males a stronger role. This reduced female autonomy (Voigtlaender and Voth 2013; Alesina et al. 2013; Ogilvie 2003).

We follow the instrumental variable strategy of Baten et al. (2017), who suggested to use the relative suitability for pasture (relative to cereal soil suitability). We take the ratio between pasture suitability of a region (which is good for specialising in animal husbandry) relative to cereal suitability as an instrumental variable. We can test this for Turkey, as this larger country includes a sufficient number of cases. The first stage results indicate that the instrument is relatively strong, as the F-statistic is higher than 10. In the two models it is 11.7 and 10.3, respectively. In the second stage we observe that the effect of the ABCC gap has a consistent influence on average numeracy.

However, the exclusion restriction is an issue that always needs to be discussed in the context of IV estimation. For example, we could imagine that nutritional benefits mattered for agricultural specialisation in animal husbandry and that this was not caused by the numeracy gap, but rather had a directly positive effect on the dependent variable. Hence, we include all the nutritional variables that we discussed in our regression model above, because this might control for the direct nutritional benefits. Nobody can be sure that the exclusion restriction is perfectly satisfied but we can at least substantially reduce the likelihood of a problem by including these nutritional variables. It should also be emphasised that the relative soil quality instrument represents more long run attitudes and institutional settings of gender equality rather than short run effects, whereas the nutritional variables are more dependent on issues such as population growth or cattle disease events which are impacted in the short run (longer discussion in Baten et al. 2017).

The results of this section can be summarised as follows: The exogenous component of the gender gap of numeracy has a substantial causal impact on average numeracy, because we could instrument the gender gap with the relative soil suitability which benefits gender equality. Hence, in these districts of Turkey the gender equality was likely to be higher and we are basing our regression models on the exogenous part of the variation.

■

(Des)igualtat de gènere, economies marítimes i desenvolupament de la capacitat numèrica a Grècia durant els segles XIX i XX

Resum

Els autors d'aquest article estudien la història del capital humà a Grècia durant els segles XIX i XX i investiguen les capacitats numèriques de la població tant en l'àmbit nacional com regional. A més, comproven l'efecte de la igualtat entre homes i dones, així com de factors geogràfics, demogràfics i socioeconòmics, com ara l'especialització agrícola (cultius, bestiar), el desenvolupament del comerç i la indústria, la urbanització i la migració, sobre les capacitats numèriques. Constaten que a Grècia la bretxa de gènere està altament correlacionada amb la capacitat numèrica i el seu efecte s'esvaeix al voltant de 1910, i demostren que l'orientació marítima de les economies insulars era en gran part complementària amb el capital humà numèric primerenc i l'augment de la igualtat de gènere.

Paraules clau: capacitat numèrica, igualtat de gènere, economies marítimes, Grècia.

Codis JEL: N33, N34, I21, I24.

■

(De)igualdad de género, economías marítimas y desarrollo de la capacidad numérica en Grecia durante los siglos XIX y XX

Resumen

Los autores de este artículo estudian la historia del capital humano en Grecia durante los siglos XIX y XX, e investigan las capacidades numéricas de la población tanto a nivel nacional como regional. Además, comprueban el efecto de la igualdad entre hombres y mujeres, así como de factores geográficos, demográficos y socioeconómicos, como la especialización agrícola (cultivos, ganado), el desarrollo del comercio y la industria, la urbanización y la migración, sobre las capacidades numéricas. Constatan que, en Grecia, la brecha de género está altamente correlacionada con la capacidad numérica, y su efecto se desvanece alrededor de 1910, y demuestran que la orientación marítima de las economías insulares era en gran medida complementaria con el capital humano numérico temprano y el aumento de la igualdad de género.

Palabras clave: capacidad numérica, igualdad de género, economías marítimas, Grecia.

Códigos JEL: N33, N34, I21, I24.