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# Two Italies? Genes, intelligence and the Italian North–South economic divide

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ABSTRACT

The thesis that socio-economic disparities between Southern and Northern Italian regions are explained by genetic differences in the average IQ is examined (Lynn, 2010a, 2012). Historical data on income, infant mortality and life expectancy, offer scant support to a possible nexus between IQ differences and socio-economic development. The ancient history of Southern Italy is also inconsistent with a supposed Phoenician and Arab adverse genetic impact on the average IQ of Southern populations. The paper proposes that regional IQ differences reflect North–South disparities in education and socio-economic development levels. The significant increases in mean scholastic achievement tests, registered in the Italian South in the period 2003–2012, support this conclusion.



## 1. Introduction

The divide between the advanced North and the less developed South is a pre-eminent feature of the economic development of Italy. Since the end of 19th century, that is a few years after the unification of Italy (1861), volumes have been written on the causes of the economic and social backwardness of the South, the so-called "Questione meridionale". Scholars have mainly pointed out the historic, institutional and also geographic aspects that hampered the industrialization of Southern regions (Nitti, 1900; Barbagallo, 1980; Pescosolido, 1998; Bevilacqua, 2005; Daniele & Malanima, 2011b, 2014), or focused on the role of some culture-related traits, included in the broad concept of "social capital", in the comparative economic development of the North and the South (Banfield, 1958; Putnam, Leonardi & Nanetti, 1993).

At the end of 19th century, a different theory was proposed, which aimed to explain more the North–South cultural and social differences, rather than the economic inequalities. The social anthropologists Cesare Lombroso, Giuseppe Sergi and Alfredo Niceforo, sustained that the inhabitants of the South were culturally, anthropologically and psychologically different from those of the North. In the words of Sergi (1898), there were "two Italies", inhabited by people of two diverse descents. In a similar fashion, Friedrich Vöchting (1951) suggested that the backwardness of the South had a racial root: due to historic dominations and migrations, the Italian Mezzogiorno — according to Vöchting — was inhabited by a "Mediterranean race", whose peculiar ethos was scarcely suitable to social and economic progress.

Extending his research on racial differences in average cognitive abilities from international to regional level, Richard Lynn (2010a) argued that the socio-economic divide between the North and South of Italy depends on differences in average intelligence quotients (IQs) of their respective inhabitants. Lynn derived regional IQ scores from assessment scores of the Program for International Student Assessment-PISA 2006 (OECD, 2006), showing how these "regional IQs" are significantly related to some variables concerning Italian regions, both today and in the past, such as: stature, per capita income, infant mortality, literacy and years of education. On the basis of these correlations, Lynn maintained that: "regional differences in intelligence are the major factor responsible for the regional differences in Italy in per capita income and in the related

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variables of stature, infant mortality, and education" (Lynn, 2010a, p. 94).

In Lynn's view, the comparatively lower average IQ of Southern people would be explained by the fact that, in the course of history, some parts of the South of Italy, including Sardinia and Sicily, had had immigration inflows of populations from the Middle East and North Africa. Relating this argument to the thesis that race/population IQ differences are, in part, heritable (Lynn, 2006; Lynn & Vanhanen, 2012a,b; Rushton, 1995), and on the basis of studies that report a comparatively lower average IQ of populations of the Middle East and North Africa (Lynn & Vanhanen, 2006; Lynn & Meisenberg, 2010), Lynn argued that the diffusion of genes from those populations determined a comparatively lower average IQ of the inhabitants of Southern Italy.

As was easily predictable, Lynn's (2010a) paper provoked a heated debate in Italy. Some scholars reacted critically to Lynn, both on methodological and historical grounds (Beraldo, 2010; Cornoldi, Giofrè, & Martini, 2013; Cornoldi, Belacchi, Giofrè, Martini, & Tressoldi, 2010; D'Amico, Cardaci, Di Nuovo, & Naglieri, 2012; Daniele & Malanima, 2011a; Felice & Giugliano, 2011; Robinson, Saggino, & Tommasi, 2011). In replying to his critics, Lynn (2010b, 2012a) provided further evidence of a North–South IQ gap of about 10 points, and showed that Italian regional IQ differences are related to the frequencies of genetic markers for the percentages of North African ancestry in the Southern populations.

Support for Lynn's thesis has been provided by Piffer and Lynn (2014), who considered, for five Italian macro-regions, the mean scores of 15-year old students in the PISA Creative Problem Solving test, a measure of the ability to solve problems in non-routinely situations. According to Cattell's conceptualisation, Piffer and Lynn interpreted these test scores as a measure of fluid intelligence, reporting a 9.2 IQ points difference between the North-West and the South. Finally, Templer (2012) showed how, in Italy, regional IQs are associated with some biological variables (such as cephalic index, eye colour and hair colour, multiple sclerosis rates and schizophrenia rates), which differ between middle European and Mediterranean populations. These relationships indicate how average IQ is higher in the Northern Italian regions, genetically more similar to middle Europeans, even though, as the author pointed out, this does not allow us to derive unequivocal inferences regarding heritable differences in regional IQs.

Lynn's findings on Italy (2010a,b, 2012a) are consistent with those presented by the same author for Spain. In the case of Spain, in fact, Lynn (2012b) found a North–South gradient in PISA-derived IQs and significant correlations between these IQs and socio-economic variables, so concluding that, as in Italy, regional IQ differences are related to the percentage of Near Eastern and North African ancestry in the population.

The present paper deals with Lynn's thesis that the North–South divide in Italy is fundamentally due to differences in average IQ. Following the approach by Daniele and Malanima (2011a), the analysis aims first to verify whether an IQ-development link may also be found in the past, that is considering historic data covering the first years following Italian political unification. Secondly, the role of some socio-economic factors in regional school achievement disparities is examined. Finally, some historical aspects related to Lynn's argumentations are discussed.

## 2. Intelligence and socio-economic development

### 2.1. Genes, IQ and economic development

At the international level, average IQ scores and socio-economic development levels are positively and strongly related. In their books, Lynn and Vanhanen (2002, 2006) showed how national IQs are significantly correlated to per capita GDP, years of schooling, life expectancy, poverty rates, and with some institutional features such as economic freedom and the degree of democratization. Based on these findings, they maintained that "national IQ explains a significant part of the variations in various measures of human conditions" (Lynn & Vanhanen, 2006: 291). Lynn and Vahnanen's results have been confirmed and extended by numerous studies, mainly by psychologists (for a review: Lynn & Vanhanen, 2012a,b), but also by some economists (Jones & Schneider, 2006; Ram, 2007; Weede & Kampf, 2002). Significant relationships between IQ and socio-economic development levels, measured by GDP per capita and other indicators, have also been found at national and regional levels, for the British Isles (Lynn, 1979), the United States (Kanazawa, 2006a; McDaniel, 2006) Italy (Lynn, 2010a,b; Templer, 2012), Japan (Kura, 2013) and Finland (Dutton & Lynn, 2014).

A crucial point of the mentioned literature is the explanation of international/regional IQ differences. In the evolutionary perspective by Lynn (1991), Rushton (1995) and Kanazawa (2008), racial IQ differences evolved over the course of millennia, after Homo sapiens left his ancestral environment, the African savannah, about 70,000–60,000 years ago, progressively colonizing the rest of the world, so encountering different climates and environments. Diversely to the warm climate of Africa, in the temperate, subarctic or arctic latitudes of Eurasia, our ancestors faced new evolutionary problems, mainly keeping warm and obtaining food, which required new cognitive adaptations. In the course of the millennia, novel problems of adaptation selected for greater cognitive abilities that were then genetically transmitted. According to Lynn (1991, 2006), this led to heritable differences in average intelligence among races — consequently, among populations and nations which would explain the empirical relationship between latitude, skin colour and average population IQ.

Regional IQ variations would reflect these racial differences too. In the case of Italy, Lynn (2010a, 2012) argued that the North–South gradient in average IQs would be due to genetic admixtures, which occurred in the course of history, when Phoenician and Arab populations settled in some areas of the South. The genetic heritage of these populations, influencing the average IQ of the Southern Italians, therefore had long lasting consequences on economic and social regional developments.

### 2.2. Lynn's results for Italy

As already mentioned, Lynn (2010a) derived regional IQs from the OECD-PISA 2006 assessment for 15-year-old students. Since the PISA tests resulted in scores in science, reading and mathematical ability, in his database Lynn averaged the results of the tests regarding these three subject areas and expressed them in standard deviation units in relation to the British mean. These figures were converted into conventional IQs by multiplying them by 15. The IQ score obtained in the North of Italy was 100, thus equal to the British, and in the South it was 90, with Sardinia at 89.

Lynn reported the correlations among these PISA-IQs and diverse measures of the social and economic developments of Italian regions: average stature of conscripts in 1855, 1910, 1927 and 1980; income in 1970 and 2003; infant mortality in 1955–1957 and 1999–2002, literacy in 1880, and years of education in 1951, 1971 and 2001. The correlations among the variables are statistically significant, being higher than 0.74, and are mainly in the range between 0.85 and 0.95. IQ is highly and positively correlated to income per head in 1970 and 2003, to years of education in 1951, negatively, as expected, to infant mortality from 1955 onwards, and highly related to the average stature of conscripts (≈0.92). In his reply to criticisms, Lynn (2010b) presented data from IQ tests indicating a lower average IQ for the Southern regions. Furthermore, Lynn (2012a) offered evidence to support the thesis that the North–South IQ gradients reflect genetic differences, reporting high positive correlations between latitude and some markers (percentage of blond(e)s and frequency of the xR1a allele) of northern European ancestry, and a high negative correlation between latitude and the frequency of the haplogroup E1b1b allele (−.84) as a marker for the percentage of North African and Middle Eastern ancestry in populations. He concluded that these correlations "support the thesis that the percentage of central and northern European ancestry in the populations across the Italian regions is a significant determinant of the IQs" (Lynn, 2012a, p. 258).

## 3. IQ, school achievement and socio-economic development

### 3.1. School achievement data

In the following analysis data from OECD-PISA 2011–12 in maths, science and reading comprehension tests, available from the 20 Italian regions, were used to derive "regional IQs". Following Weiss (2009) and Lynn (2010a), for each of the three subjects (mathematics, science, reading), IQ scores were obtained by setting the PISA scores of the United Kingdom at 100, with a standard deviation of 15. The IQs for the Italian regions were given by the mean of the scores obtained in the three test subjects. Table 1 reports the correlations between regional IQs and single subject scores.

PISA-IQ scores have been supplemented with data from scholastic assessments (2012–2013) conducted by the Italian National Institute for the Evaluation of Instruction (INVALSI, 2014). These assessments, aimed at evaluating students' competencies in reading and mathematics, involved 13,232 Schools, 141,784 classes and 2,862,759 students of the primary, lower secondary schools, and upper secondary schools, that are at the 2nd, 5th, 6th, 8th, 10th grades, distributed throughout all the Italian regions. Diversely to PISA assessments, that regard 15-year old students, INVALSI assessments test the competencies of children and adolescents at ages 7–8, 10–11, 11–12, 13–14 and 15–16. In a statistically representative sample, composed of 9047 classes and 189,493 students from all Italian regions, INVALSI observers verified the administration of the tests in order to avoid possible bias in data. From this sample, the INVALSI derived the average assessment scores for the Italian regions; scores were reported in a scale analogous to that used in international tests, based on the Rasch model, with the Italian average set to 200 with a standard deviation of 40 (data are available at: http://www.invalsi.it)[1].

In the present paper, mean regional test scores in maths for all school levels are used. Given that, in Italy, the upper secondary schools (10th grade), are divided into different branches (lyceums, technical and professional schools), the scores for lyceums and technical schools are considered separately. For the 2nd, 5th, 6th and 8th grades, the data used in this paper regard only native Italian students, while for lyceums and technical schools data cover both native and non-Italian-native students[2].

The INVALSI tests follow the methodology of similar international assessments. In particular, tests in mathematics comply with the criteria developed in international research on the theme by IEA-TIMSS — International Association for the Evaluation of Educational Achievement, Trends in International Mathematics and Science Study (INVALSI, 2014; Montanaro, 2008).

The correlations between PISA-IQs and average math achievements are very high, ranging from 0.74 for the 2nd grade to 0.94 in technical schools, 10th grade (Table 2). PISA-IQs are, in particular, highly correlated (0.93), with math scores at 6th and 8th grades, and in technical institutes, and slightly lower with scores at 2nd and 5th grades and in lyceums.

### 3.2. School achievements and biological indicators

The matrix of correlations between PISA-IQs, math scores and the biological variables reported by Templer (2012) for 18 Italian regions is reported in Table 3. Given the high relationships existing among PISA IQs and math test scores, it is not surprising to find strong associations among all the reported variables. For the Livi cephalic index (CI), correlation coefficients range between 0.59 and 0.93, for Biasutti CI between 0.69 and 0.85, for multiple sclerosis rates between 0.55 and 0.64, and for schizophrenia rates between 0.36 and 0.66. For the percentages of people with black hair and black eyes the correlations are negative and very high (except for math scores at 2nd grade).

Overall, these findings are analogous to those obtained by Templer (2012), and support his conclusion of a North–South gradient in average PISA-IQs. Since Northern Italians are genetically more similar to middle Europeans, while in Southern Italian to Mediterranean populations (Cavalli-Sforza, Menozzi, & Piazza, 1994) there is a substantial correlation between scholastic achievement test scores, the considered biological

**Table 1**
Correlation between IQ and assessment scores.

| | PISA IQ | Math | Science | Reading |
|---|---|---|---|---|
| PISA-IQ | 1 | 1.00 | 1.00 | 0.99 |
| Math | | 1.00 | 0.99 | 0.98 |
| Science | | | 1.00 | 0.97 |
| Reading | | | | 1 |

[1] In the 8th grade the test is taken in the context of a diploma examination. The procedure adopted by INVALSI avoids the possible phenomena of cheating that, probably, may have affected the average performance score of primary schools in some Southern regions in past assessments (INVALSI, 2011, 2014).

[2] Data only for native students was not available in the online database. It is worthy to note that scores for professional schools are not used, but give analogous results to those for technical schools.

**Table 2**
Correlations between regional IQs and INVALSI math assessments (ability).

| | PISA IQ | Maths 2nd grade | Maths 5th grade | Maths 6th grade | Maths 8th grade | Maths lyceums | Maths technical |
|---|---|---|---|---|---|---|---|
| PISA-IQ | 1.00 | 0.74 | 0.84 | 0.93 | 0.93 | 0.85 | 0.94 |
| Maths 2nd grade | | 1.00 | 0.82 | 0.77 | 0.81 | 0.66 | 0.78 |
| Maths 5th grade | | | 1.00 | 0.92 | 0.88 | 0.81 | 0.82 |
| Maths 6th grade | | | | 1.00 | 0.90 | 0.90 | 0.91 |
| Maths 8th grade | | | | | 1.00 | 0.76 | 0.88 |
| Maths lyceums | | | | | | 1.00 | 0.90 |
| Maths technical | | | | | | | 1.00 |

5% critical value (two-tailed) = 0.468 for n = 18.

**Table 3**
Regional IQs, math scores and biological variables.

| | Livi CI | Biasutti CI | MS rates | Schizophrenia | Black hair | Black eyes | Latitude |
|---|---|---|---|---|---|---|---|
| PISA-IQ | 0.82 | 0.76 | 0.58 | 0.62 | −0.81 | −0.73 | 0.90 |
| Maths 2nd grade | 0.59 | 0.70 | 0.55 | 0.36 | −0.72 | −0.37 | 0.77 |
| Maths 5th grade | 0.79 | 0.85 | 0.63 | 0.57 | −0.89 | −0.76 | 0.88 |
| Maths 6st grade | 0.84 | 0.81 | 0.64 | 0.66 | −0.86 | −0.83 | 0.89 |
| Maths 8rd grade | 0.76 | 0.69 | 0.61 | 0.62 | −0.82 | −0.62 | 0.88 |
| Maths lyceums | 0.93 | 0.83 | 0.57 | 0.56 | −0.78 | −0.82 | 0.88 |
| Maths technical | 0.85 | 0.77 | 0.56 | 0.58 | −0.79 | −0.72 | 0.90 |

Correlation coefficients, using the observations 1–18; 5% critical value (two-tailed) = 0.468 for n = 18.

variables, and latitude. Associations among variables cannot, however, prove that regional differences in average cognitive abilities are heritable. Furthermore, in Templer's study, data regarding the biological characteristics of individuals (such as the cephalic indices, schizophrenia rates or eye colour) are from very far back in time (as at the end of 19th century), while mean regional IQ scores are taken from recent assessments. So, data on biological characteristics and IQ test scores refer to different epochs, that is to totally different individuals and populations, and this limits our possibility of deriving conclusive inferences from the presented correlations.

### 3.3. IQ and regional development

In order to test Lynn's (2010a) hypothesis, that genetically-rooted regional differences in average IQ explain social and economic inequalities, both today and in the past, in this section some indicators of regional development levels in the first years following Italian national unification are used. These indicators are: GDP per capita in 1871 (Felice, 2013), in 1891 and 1911 (Daniele & Malanima, 2011b)[3], infant mortality in 1863–66 and in 1883–86 (SVIMEZ, 2011) and life expectancy at birth in 1861 and 1871 (Vecchi, 2011). The reason for using these social and development indicators is straightforward: average income, life expectancy and infant mortality are, commonly, considered among the most reliable proxies of living standards and socio-economic development. Data on literacy rates for 1871, and average years of schooling in 1951, 1971 and 2001 (Felice, 2007, p. 147) are also considered. The sample includes 18 Italian regions, excluding Valle d'Aosta and Molise, for which historical data for the considered social and economic variables are not available. These two regions account, however, for only about 0.7% of Italian population.

The correlations between IQs, math achievements and socio-economic indicators are given in Table 4. Regional IQs are strongly correlated with GDP per capita in 2012 (0.86), but weakly with the same variable in the years 1871 (0.37), 1891 (0.04) and 1911 (0.23). The relationship between IQ and infant mortality, measured in 1863–66 is high and *positive* (0.82), while it is insignificant for the years 1883–86 (−0.09): that is, in the first years after Italian political unification, regions that now have higher PISA-IQ scores had *higher* not *lower* infant mortality. The correlation between IQ and life expectancy is weak for 1861 (0.31) and moderate for 1871 (0.47).

The relationships between math scores and per capita income in 1871 are positive, those with income in 1891 are negative or insignificant, and those with income estimated for 1911 are weak. The correlations between per capita income in 2012 and math scores range between 0.75 and 0.88. The relationship between maths in lyceums and income (0.78) is lower than that in technical schools (0.86). Math scores are, then, positively related to infant mortality in 1863–66, and weakly (or negatively) to the same variable for 1883–86. Finally, the correlations between math scores and life expectancy are positive, even though correlation coefficients for 1871 are notably higher than those regarding the year 1861.

The correlations between regional IQ, math assessments, literacy rates in 1871 and average years of education in 1951, 1971 and 2001 are reported in Table 5. It is important to note how in Italy, at the time of Unification, there were profound regional imbalances in educational levels: in the South, 87% of the population was illiterate, and in the North, 67% (SVIMEZ, 1961). Regional educational differences long persisted, hampering the modernization of the South (Ballarino, Panichella, & Triventi, 2014). Not surprisingly, as shown by Lynn (2010a) and Templer (2012), average IQs and math test scores are highly related to literacy and educational levels.

[3] Felice (2013) provided regional GDP estimates from some years starting from 1871, while the estimates by Daniele and Malanima (2011b) cover the period subsequent to 1891. The two series present some differences, in particular for the period 1891–1911, even though the correlation between them is very high.

**Table 4**
Regional IQs, math scores and socioeconomic indicators.

| | GDP pc 1871 | GDP pc 1891 | GD pc 1911 | GDP pc 2012 | Infant mortality 1863–66 | Infant mortality 1883–86 | Life expect. 1861 | Life expect. 1871 |
|---|---|---|---|---|---|---|---|---|
| PISA IQ | 0.37 | 0.04 | 0.23 | 0.86 | 0.82 | −0.09 | 0.31 | 0.47 |
| Maths 2nd grade | 0.11 | −0.08 | 0.08 | 0.75 | 0.63 | −0.25 | 0.13 | 0.36 |
| Maths 5th grade | 0.23 | −0.07 | 0.18 | 0.77 | 0.58 | −0.06 | 0.14 | 0.46 |
| Maths 6th grade | 0.35 | 0.09 | 0.28 | 0.85 | 0.75 | 0.03 | 0.31 | 0.48 |
| Maths 8th grade | 0.36 | 0.03 | 0.25 | 0.88 | 0.73 | −0.18 | 0.40 | 0.60 |
| Maths lyceums | 0.36 | 0.01 | 0.25 | 0.78 | 0.81 | 0.12 | 0.24 | 0.51 |
| Maths technical | 0.20 | −0.15 | 0.08 | 0.86 | 0.92 | 0.08 | 0.19 | 0.48 |

Correlation coefficients, 5% critical value (two-tailed) = 0.468 for $n = 18$.

In Table 6 the correlations between educational measures and the main indicator of economic development, that is per capita income, in the various years are given. The results are striking: both literacy rates and years of education are highly linked to income (with the exception of income in 1891, moderately related). More precisely, both literacy and average years of education are better predictors of income levels than regional IQs. For the year 2001, the correlation between years of education and income is 0.86, the same as found for regional IQs.

The results of this section may be summarized as follows:

1) At the regional level, average IQs and current per capita GDP are highly related: for the year 2012, the correlation is 0.86. The link between IQ and regional development is, instead, much weaker when data for the years 1871, 1891 and 1911 are considered. Regional IQs and infant mortality rates in 1863–66 are positively correlated, contrarily to that which would be expected based on Lynn's assumptions;
2) Analogous results are obtained when, instead of PISA-IQ scores, math test scores are used. In this case, some differences between the results for the different grades may be observed. For the 2nd and 5th grades the correlations are, in general, lower than those obtained for the successive levels. Some differences may be also found between the results for the lyceums and technical schools;
3) Regional IQs and mean math scores are highly related to regional education levels both today and in the past. Literacy rates and education levels are better predictors of current and past income levels than IQs and math scores.

### 3.4. IQ and regional socio-economic environment

In this section, the links between regional IQs, math achievements and some socio-economic indicators are tested. Initially, three variables are considered at the regional level: the share of poor families (under the national poverty line); the share of families living in conditions of material deprivation; the share of children who have access to public services such as childcare or kindergarten (all data are referred to 2011 and are from Istat, http://noi-italia.istat.it). In Italy, the incidence and intensity of poverty are considerably higher in the South than in the rest of the country and, similarly, the distribution of public childcare services for children aged 0–3 and kindergarten is also profoundly unequal. In the North–East, for example, over 20% of children benefit from this type of public assistance and kindergarten, in the South the share is below 10%, and falls to 2–3% in some poor regions, such as Campania and Calabria (Istat, 2013). Table 7 reports the matrix of correlations. It is easy to see how the correlations of these three indicators with PISA-IQs are very high: −0.84 for poverty rates, 0.72 for childcare and kindergarten use, and 0.72 for economic deprivation rates. Similar, or even higher, correlations are obtained for math scores. These results are in line with those indicating a positive relationship between childcare attendance, poverty and educational outcomes in Italy (Del Boca, Pasqua, & Sardi, 2013).

There are diverse variables that may also offer a picture of regional average living standards. Among these are household consumption data. Diversely to per capita GDP — which measures the average production capacity of each individual, independently by his/her occupational status and age — household consumption is a more reliable proxy of actual living standards. Household consumption depends, in fact, not only on produced income, but also on public subsidies and transfers. Thanks to public redistributive policies, in Italy, North–South differences in average consumption levels are lower than those regarding per capita GDP. Table 8 reports the correlation between school assessment scores and average monthly household consumption in 2013 (http://dati.istat.it). Consumption expenditure is reported as a total (first column) and for three distinct categories of expenditure: (a) food and beverages; (b) education; (c) and for leisure time, entertainment and culture. Regional average consumption expenditure

**Table 5**
Regional IQs, math scores and education levels.

| | Literacy 1871 | Year of education 1951 | Year of education 1971 | Year of education 2001 |
|---|---|---|---|---|
| PISA-IQ | 0.62 | 0.79 | 0.69 | 0.69 |
| Maths 2nd grade | 0.40 | 0.65 | 0.58 | 0.67 |
| Maths 5th grade | 0.60 | 0.70 | 0.57 | 0.65 |
| Maths 6th grade | 0.58 | 0.80 | 0.68 | 0.71 |
| Maths 8th grade | 0.60 | 0.81 | 0.71 | 0.74 |
| Maths lyceums | 0.70 | 0.82 | 0.68 | 0.61 |
| Maths technical | 0.55 | 0.77 | 0.64 | 0.63 |

**Table 6**
Education levels and per capita income.

| | GDP pc 1871 | GDP pc 1891 | GDP pc 1911 | GDP pc 2012 |
|---|---|---|---|---|
| Literacy 1871 | 0.50 | 0.31 | 0.62 | 0.62 |
| Year of education 1951 | 0.62 | 0.25 | 0.56 | 0.92 |
| Year of education 1971 | 0.71 | 0.38 | 0.66 | 0.87 |
| Year of education 2001 | 0.67 | 0.32 | 0.52 | 0.86 |

**Table 7**
Regional IQs, math scores and social indicators.

| | Poverty rates | Kindergarten | Deprivation rates |
|---|---|---|---|
| PISA-IQ | −0.84 | 0.72 | −0.72 |
| Maths 2nd grade | −0.81 | 0.78 | −0.82 |
| Maths 5th grade | −0.84 | 0.72 | −0.84 |
| Maths 6st grade | −0.86 | 0.78 | −0.72 |
| Maths 8rd grade | −0.91 | 0.83 | −0.83 |
| Maths lyceums | −0.79 | 0.65 | −0.64 |
| Maths technical | −0.84 | 0.76 | −0.75 |

**Table 8**
Regional IQs, math scores and household consumption expenditure.

| | Total consumption | For food | For education | For entertainment and culture |
|---|---|---|---|---|
| PISA-IQ | 0.90 | 0.07 | 0.51 | 0.88 |
| Maths 2nd grade | 0.75 | 0.08 | 0.46 | 0.77 |
| Maths 5th grade | 0.83 | 0.31 | 0.53 | 0.83 |
| Maths 6st grade | 0.89 | 0.21 | 0.56 | 0.89 |
| Maths 8rd grade | 0.87 | 0.08 | 0.36 | 0.85 |
| Maths lyceums | 0.85 | 0.20 | 0.59 | 0.88 |
| Maths technical | 0.90 | −0.09 | 0.63 | 0.92 |

(in current Euros) is calculated with respect to the Italian average, set at 100. Results show how regional IQs and math achievements are highly linked with total average consumption expenditure, and also with expenditure on education, entertainment and culture. The correlations with food consumption are, instead, very weak. The monetary average consumption expenditure on food in the South and in the North of Italy is, in fact, practically identical. This is explained by Engel's well-known law, according to which the share of food consumption expenditure tends to decrease when income increases.

These findings are inconsistent with the idea that regional IQ differences may depend on nutritional conditions, while supporting the idea that school achievement tests and, possibly, average cognitive abilities, are related to regional socio-economic environments and, particularly, to educational and cultural factors.

It is noteworthy that, in previous analyses, the magnitude of correlation coefficients for 2nd and 5th grades was, generally, lower than for subsequent grades. This may be interpreted as being consistent with Lynn's thesis, since there are studies suggesting that the heritability of IQ tends to increase with age (Bouchard, 2013). The conclusion that shared environment has no effect on adult IQ is, however, still controversial. For example, Kaplan (2012) stated that the evidence on the effects of the shared environment on adult IQ is mixed or inconclusive. More prudently, in their comprehensive review on intelligence, Nisbett et al. (2012) maintain that: "What we can say with some confidence at present is that shared environment effects, as typically measured, remain high at least through the early 20s. After that age, data are sparse and longitudinal studies almost nonexistent, except for much older adults" (Nisbett et al., 2012, p. 8). The implications of studies on the "age hypothesis", however, cannot be directly applied to the case scrutinized in the present paper. In this case, in fact, scholastic achievement tests are considered, not standard IQ test scores, and, furthermore, data regard regional averages, not individuals.

### *3.5. Changes in regional mean PISA assessment scores*

In Italy, PISA mean scores exhibited an increasing trend from 2003 to 2013 assessments. Table 9 reports the mean performance in maths and reading for the five Italian macro-regions. Between 2003 and 2012, the mean national score in maths rose by 19 points, and that in reading by 14 points. These national trends were almost entirely due to the performances of the South and South-Islands regions, where the mean scores increased by 36 and 23 points for mathematics, and by 30 and 19 points for reading assessments. In the Northern regions, instead, the variations were negligible or, even, negative.

Fig. 1 plots, for the five Italian macro-regions, the relationship between mean scores in the 2003 assessment, and changes in scores between 2003–2012. It is easy to see how there is a strong negative link between scores in 2003 and subsequent variations both for maths ($R^2 = 0.86$) and for reading ($R^2 = 0.79$). As shown by these significant negative relationships, the notable improvement of the Southern regions — coupled with the stagnating (or declining) performance of Northern ones — has determined a process of convergence in mean assessment scores in Italy.

It is of note that these trends are perfectly consistent with those documented at the international level both for average IQs (Flynn, 1999, 2012) and scholastic achievement test scores, such as PISA and TIMMS (Meisenberg & Woodley, 2013). At the regional level, the case of Germany presents some analogies with that of the Italian regions. In the course of the 1990s, after reunification, previous differences in IQ between East and West German conscripts rapidly diminished, given the strong gains, of 0.5 IQ points per annum, recorded for East German conscripts (Roivainen, 2012). It does not result that former East and West Germans had any genetic differences but, rather, they lived in diverse socio-economic and institutional contexts. In each case,

**Table 9**
PISA test scores in maths and reading in Italy, 2003–2012.Source: OECD-PISA assessments, various years.

| | Maths | | | | Reading | | | | Diff. 2012–2003 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2006 | 2009 | 2012 | 2003 | 2006 | 2009 | 2012 | Maths | Reading |
| North West | 510 | 487 | 507 | 509 | 511 | 494 | 511 | 514 | −1 | 3 |
| North East | 511 | 505 | 507 | 514 | 519 | 506 | 504 | 511 | 3 | −8 |
| Centre | 472 | 467 | 483 | 485 | 486 | 482 | 488 | 486 | 13 | 0 |
| South | 428 | 440 | 465 | 464 | 445 | 443 | 468 | 475 | 36 | 30 |
| South-Islands | 423 | 417 | 451 | 446 | 434 | 425 | 456 | 453 | 23 | 19 |
| Italy | 466 | 462 | 483 | 485 | 476 | 469 | 486 | 490 | 19 | 14 |

The last two columns report the differences between 2012 and 2003.

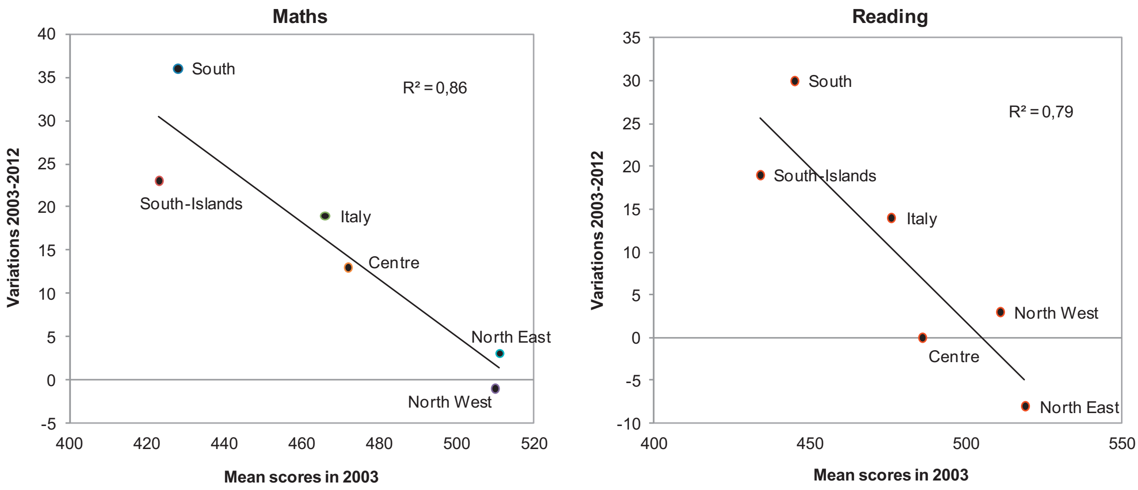


**Fig. 1.** Relationships between PISA mean scores in maths and reading in 2003 and variations between 2003 and 2013 in five Italian regions.

given the short time span, it would be pointless to attribute the rapid convergence in IQ test scores between the "two Germanies" to genetic factors. The German case indicates, instead, how institutional changes and improvement of socio-economic conditions may exert a powerful effect on measured cognitive abilities (Roivainen, 2012).

Similarly to what happened in Italy, where less developed regions have had greater improvement in mean test scores, also at the international level gains in mean IQs, and in scholastic achievement scores are related to the modernization stages of nations: IQ gains are higher for those countries that begin the modernization process, and lower, negligible or even negative, for developed nations (Nisbett et al., 2012, p. 11; Meisenberg & Woodley, 2013). In other words, low-scoring countries/regions tend to show a rising trend relative to higher-scoring countries/regions.

## 4. Genes and the history of the Italian South

According to Lynn (2010a, p. 99): "The diffusion of genes from the Near East and North Africa may explain why the populations of southern Italy have IQs in the range of 89–92, intermediate between those of northern Italy and central and northern Europe (about 100) and those of the Near East and North Africa (in the range of 80–84)". In his reply to criticisms, Lynn (2012a), cited studies that show how the proportion of North African genes in the Italian regions is higher in the South than in the North.

Because of its geographical position, the Italian South was much more interested by the migratory movements of the Mediterranean populations than the North. Effectively, genetically the Italian Southern regions are similar to Greece and other Mediterranean countries, while the Northern regions more similar to central European countries (Cavalli-Sforza et al., 1994). Phoenicians founded some colonies in Sardinia around 750 BC and, later, on Sicily, mainly in the North-West area of this Isle (Markoe, 2000). Much more important was the Greek colonisation. In the 8th century BC, Greeks founded flourishing and populous colonies in Southern Italy (*Magna Graecia*) and Sicily. It has been estimated that towards 400 B.C., Greek inhabitants represented about 10% of the whole population living on the island, while the influence of the Phoenicians was quite superficial: "whereas the Phoenicians directed their main colonizing efforts towards the coasts of North Africa, Spain, Malta, Sardinia and the western triangle of Sicily, the Greeks settled mainly along the Southern and western shores of the mainland and also along the fertile coastal belt of Sicily" (Piazza, Cappello, Olivetti, & Rendine, 1988, p. 206). High percentages of Greeks also lived in Southern Italy on the whole (Piazza, 1991). It is not surprising that the main genetic influence in the South is Greek, while the Phoenician is very marginal. The case of Sardinia — one of the Southern regions considered by Lynn — is unique: this region results as being genetically different from all other Italian regions, including Sicily (Piazza et al., 1988, p. 204).

For Sicily, a genetic map based on the variation of Y-chromosome lineages drawn up by Di Gaetano, Cerutti, Crobu, et al. (2009), exhibits a similarity with Greece. The homogeneous distribution across the whole island of the haplogroup E3b1a2-V13, in particular, shows how Greek colonisation resulted in a genetic similarity between Greek and Sicilian populations, while genes from North-West Africa are much less widespread on the island. According to this research, the genetic contribution of Greek chromosomes to the Sicilian gene pool can be estimated at about 37%, whereas the contribution of North African populations is estimated at around 6%.

In the course of history multiple interactions within North Africa and Europe occurred: the Roman occupation of North Africa, that lasted until the 5th century AD; the intense trade (including that of slaves) between Southern Europe, especially Italy and Spain, and North Africa; the Arab expansion in the Mediterranean, in the 8th century, and the conquests of the Iberian peninsula and Sicily. The conquest of Sicily by the Saracens started in 827 AD. Islamic domination ended in 1091 when the Normans established their rule on the Isle. In 1220, Frederick II, expulsed the Saracens from Sicily and confined them in some towns in Southern Italy (mainly in Girifalco in Calabria, Acerenza in Basilicata and Lucera in Apulia). In 1239, the majority of the Saracens present in Italy were confined by Frederick II in Lucera, where the Muslim community reached about 20,000 persons. The community was destroyed in 1300

(Taylor, 1999). In the rest of Italy, the Saracens did not create settlements, except the minor communities of Bari and Taranto, in Apulia that lasted about 25 years (847–871). Saracen raids, however, were frequent, but not solely, along the coasts of Sardinia, Corsica and Southern Italy. In 840, the Arabs attacked Marseilles, Arles and Rome. Around 890, Arabs coming from Andalusia established themselves in La Garde Frainet (Fraxinetum), in Provence, from where they controlled the Alpine passes and mounted frequent raids in Piedmont and neighbouring regions. In 934–935, the entire area between Genoa and Pisa suffered from Arab attacks (Baldwin, 1969, p. 51).

Obviously, African ancestry is highest in south-western Europe and decreases in northern latitudes (Botigué, Henn, Gravel, et al., 2013). The genetic legacy of medieval Arab rule in Southern Europe, in particular, has been investigated, among others, by Gérard, Berriche, Aouizerate, Dieterlen, and Lucotte (2006) and Capelli et al. (2009). The study by Gérard et al. (2006) analysed Y-chromosome diversity, considering haplotype V and subhaplotypes Vb (Berber) and Va (Arab) in some Mediterranean countries. For Italy, the reported frequency of haplotype V was 3.1% in Rome, 17.2% in Naples, 28.2% in Sicily and 9% in Sardinia. In comparison, in France, the frequency of the same haplotype was 11.8% in Perpignan, 11.3% in Basque France and 11.1 in Marseilles, while in Spain the frequency found in Andalusia was 40.9% and in Cataluña (Barcelona) 12.9%. Capelli et al. (2009) screened the frequencies of North West African specific haplogroups as markers of male medieval North African genetic contribution. Their results indicate how the total frequencies of North West African chromosomes range between 0 and 19% across Southern Europe. In Spain, the highest frequencies were in Cantabria (18.6%), and Galicia (7.1%). Overall, for Spain the frequency is 7.7%, for Portugal 7.1%, and for Peninsular Italy 1.7%. For the Northern Italian region Veneto, the total frequency of North West African chromosomes is 1.8%. In the regions of Central Italy, Central-Tuscany 2.4%, North-East Latium 1.8% and Marche 1.4%. In Southern Italy the frequencies exhibit a large variation: for West Calabria no genetic influence is reported; for East Campania the share of North West African types is 4.8%, in North-West Apulia 6.5%, in South Apulia 1.4%, and in Sicily 7.5% (Capelli et al., 2009, p. 850). The genetic legacy of the Saracens is, thus, strictly consistent with historical knowledge and concerns the Southern regions and part of the Centre-North of Italy, although at quite different levels. The traces of African ancestry in Europe are not, however, only those left by Arabs. A recent study by Moorjani, Patterson, Hirschhorn, et al. (2011), shows how almost all Southern European populations have inherited 1%–3% of African genes, due to recent population mixture dating back, on average, to 55 generations ago. The African ancestry proportion estimated for Southern Italy is 2.7%, a value that is significantly lower than that estimated for other populations, including Italian Jews and Ashkenazi Jews from Northern Europe, for whom the detected Sub-Saharan ancestry is, respectively, 4.9% and 3.2% (Moorjani et al., 2011).

Is the Arab genetic legacy detrimental to economic development? If the data from Gérard et al. (2006) are taken, it is easy to document how many of the Italian, French and Spanish regions with relatively high frequencies of Y-chromosome haplotype V have, nowadays, considerably higher development levels than many other European regions that, it is supposed, do not have Arab ancestry. In 2011, for example, the GDP per capita in Cataluña was 20% higher than in the Flevoland region (Nederland), and 76% higher than in the West Wales (UK). The Languedoc-Roussillon, the region of Perpignan, had a GDP per capita 12% higher than in South Yorkshire (UK), not dissimilar to that of Kent (UK), of Thüringen (Germany), and notably higher than that of West Wales[4]. In Sardinia and Sicily, the GDP per capita was analogous, or also higher, than the mentioned regions of Great Britain.

Is it possible, then, to infer that the genetic legacy of Levantine and North African populations is responsible for an alleged lower average IQ in Southern Italians? First, it can observed that, diversely to that for individuals, for which there is a consensus that IQ is largely heritable (Deary, Penke, & Johnson, 2010), at the current state of science, there is no direct evidence of heritable differences in general intelligence between races or populations (Nisbett et al., 2012; Sternberg, Grigorenko, & Kidd, 2005). The role of genes in the differences in IQ between races/populations is, in fact, based on indirect arguments, among which the evolutionary one (Hunt, 2012). In addition, the interpretation of racial differences in IQ is, inevitably, strictly related to how intelligence is conceived and defined (Fagan & Holland, 2002; Marks, 2007). For example, Fagan and Holland (2007), defining intelligence as information processing ability, and IQ as a measure of knowledge, demonstrated that race is unrelated to the *g* factor. For these reasons, the specific question whether the genetic influence of the Phoenicians or the Moors may have determined a lower IQ among Southern Italian populations can, at the moment, hardly be proved on a scientific basis.

Secondly, we have no IQ data for Phoenicians, Greeks, Moors, and the populations who left their genetic legacy in the South of Italy, but only current IQ data, based on samples whose representativeness is, in some cases, disputable. But we have dozens of historical testimonies to the notable cultural levels of the Phoenicians, Greeks and Moors, and of those populations that created the first, great, ancient civilisations in the Mediterranean and in the Middle East, that is exactly in those countries whose actual populations Lynn supposes to be genetically less intelligent.

We all know the immense inheritance of Ancient Greece for the world's culture. With regard to the Phoenicians, there is indisputable historical evidence of the notable social and cultural developments they reached. Excellent shipbuilders and sailors, the Phoenicians established important trade network all over the Mediterranean and beyond the Strait of Gibraltar. They founded important cities such as Byblos, Sidon, Tyre and Carthage, main colonies that grew into one of the most powerful and prosperous states in the ancient world. The Phoenicians created a purely phonetic alphabet of twenty-two letters, a system later adopted by most Western languages (Markoe, 2000). Analogous considerations may be made for the Arabs of the 7–10th centuries. During their rule in the Mediterranean, the Arabs introduced Europe to new and important knowledge in various fields such as mathematics, philosophy, astronomy, arts and agriculture (Halm, 2006). If we judge on the basis of historic heritage, rather than on current IQ scores, it is very difficult to imagine that the Phoenicians,

[4] All these regions belong to the NUTS 2 level of the European Union classification. Regional per capita GDP is in purchasing power parity (European Commission, 2014).

Greeks, Arabs and the other populations that left their genetic legacy in the South of Italy were less intelligent than their contemporaries who inhabited the Northern regions of Europe.

## 5. Discussion

### 5.1. International and regional differences in test scores

A crucial point in Lynn's (2010a) paper on Italy regards the use of PISA assessments as a measure of cognitive abilities at regional level. It is important to point out how PISA, TIMMS or other school tests are not conceived to test general intelligence but, properly, performance assessments in some academic subjects, and students' ability to use their knowledge and skills to meet real-life challenges (OECD, 2012, p. 22; Heckman & Kautz, 2012). However, there are studies that show how, at the international level, IQ test scores and PISA scores are strongly correlated (≈0.90) (Lynn, Meisenberg, Mikk, & Williams, 2007; Lynn & Meisenberg, 2010; Meisenberg & Lynn, 2011), so it has been proposed that they measure identical or closely related constructs (Rindermann, 2007).

There is a large strand of economic research on the determinants of international differences in school attainments. The basic econometric model typically employed in the literature is specified as Eq. (1):

$$T = a + a_1 F + a_2 R + a_3 I + a_4 A + e \tag{1}$$

in which $T$ is the outcome of an educational process, as measured by test scores, $F$ a vector capturing students and family background characteristics, $R$ a vector of school resources, $I$ measures institutional aspects of school and educational systems and $A$ is a measure of individual ability (Hanushek & Woessmann, 2011).

In this framework, Woessmann, Luedemann, Schuetz, and West (2009) estimated a model for a sample composed of 219,794 students from 8245 schools in 29 countries. Their results are striking: the estimated model explains 39% of the achievement variations at the student level and 87% at the country level. In other words, while unobserved factors such as ability differences are important at the *individual* level, the measurable factors included in the model explain the largest part of the *between-country variation* in school achievements. As Hanushek and Woessmann (2011, p. 116) maintain: “These basic result patterns are broadly common to all studies of international production functions estimated on the different international student achievement tests”.

The findings of economic research are consistent with those of psychological studies. In a comprehensive review, Rindermann and Ceci (2009) pointed out how international differences in the cognitive competencies of students are explained by the characteristics of national educational systems, among which pre-school education, student discipline, quantity of education, attendance at additional schools, early tracking, the use of centralized exams and high-stakes tests, and adult educational attainment, that is by factors that can modified by means of educational policies.

The research on the determinants of differences in test scores among Italian regions all leads to results analogous to those of international studies. For example, Montanaro (2008), examining the TIMMS and PISA results, noted that socio-economic background and families' characteristics significantly affect students' performances in these tests. In the first years of education, regional disparities in test scores are very modest and can mainly be attributed to students with less favourable family backgrounds. Other studies (Bratti, Checchi, & Filippin, 2007; Checchi, 2007) indicate how the North–South divide in Italian students' capabilities in mathematics (as measured by PISA 2003) is largely explained by factors related to regional socio-economic environment, such as school infrastructures and the local labour market, in terms of both employment probability and the presence of irregular and illegal economies. Bratti et al. (2007) found that about 75% of the North–South differential in math scores is accounted for by resource differences, while geographical differences in “school effectiveness” account for the remaining share. By using INVALSI test scores in a sample of 21,336 students, Agasisti and Vittadini (2012) showed how, in Italy, regional differentials in achievements are almost entirely explained by regional development levels. Agasisti and Longobardi (2014), using OECD-PISA data, confirmed how not only the family's socio-economic background, but also territorial contexts play a fundamental role in influencing students' performances, particularly those of students from disadvantaged families.

Overall, the findings of studies are perfectly consistent with present paper's results, that show how regional PISA-IQs and math scores are highly related to socio-economic variables. The idea that regional variations in IQs are explained by socio-economic factors is also supported by the significant increments in mean PISA scores registered, between 2003 and 2012 assessments, in the Southern regions. These changes may be explained only by environmentally factors, including improvements in educational resources and policies, and, almost certainly, not by enhancement in nutrition (as pointed out in Section 3). Given the magnitude of variations, the comparative performances of the Northern and the Southern areas may not, furthermore, be explained by differences in the shares of immigrant students, even though their share is higher in Northern Italy (Cornoldi et al., 2013). Notably, these trends are consistent to those observed at the international level for IQs (Flynn, 2012), for scholastic achievement tests (Meisenberg & Woodley, 2013), and for regional IQs (Roivainen, 2012). All in all, existing evidence supports the idea that interregional disparities in school achievement test scores do not reflect inherited differences in average intelligence. The results of standard IQ tests conducted in Italy, such as Raven's progressive matrices, reinforce this conclusion (D'Amico et al., 2012). So, the most reasonable interpretation of average PISA-IQs is that they are a possible alternative measure of human capital quality, analogous to international school assessments.

If it is assumed that mean IQs and PISA assessments measure the *same* or *closely related* constructs, as suggested by Rindermann (2007), it follows that — as shown in studies on the determinants of international variations in school achievements — *international/regional* IQ differences may also be explained by cultural, social, economic or institutional variables rather than by other unobservable factors, including possible differences in populations' general intelligence. The hypothesis that environmental factors have a large role in explaining IQ variations between populations and nations is perfectly consistent with the heritability of $g$ for individuals (Dickens & Flynn, 2001).

*5.2. Heritability, school achievements and socio-economic conditions*

For individuals, IQ and achievements test scores exhibit a correlation that usually ranges between 0.60 and 0.70 or, in some cases, is higher (Naglieri & Bornstein, 2003). For example, in a longitudinal study of 70,000 English children, Deary, Strand, Smith, and Fernandes (2007) found a correlation between intelligence and educational achievement of 0.81. In a research conducted on a national twin sample of 11,117 16-year olds in the UK, Shakeshaft et al. (2013), concluded that individual differences at the end of compulsory education (age 16) are largely genetic (58%), and not primarily dependant on the quality of schools or teachers or the family environment.

It is recognized, however, how the nexus between IQ and education is reciprocal, and how, in addition, both cognitive abilities and educational achievement are influenced by environmental factors (Ceci & Williams, 1997). The positive effect of education on IQ has been amply investigated, at least since the study of Neisser et al. (1996). It is, conversely, documented that children deprived of schooling for long periods of time tend to experience a significant decline in IQ (Ceci, 1991). The effect of an additional school year on average IQ has been estimated by several studies. For example, considering a representative sample of young American men and women between 14 and 21 years of age, Hansen, Heckman, and Mullen (2004), found that schooling increases the AFQT score on average between 2.8 and 4.2 points per additional year of education. In a study conducted in Sweden, Falch and Sandgren Massih (2011) have estimated that one year of schooling increases IQ by about 3.7 points, on average. Similar results have been obtained by Brinch and Galloway (2012) for Norway, in research that suggest how the beneficial effects of education on IQ do not regard solely to early childhood, but extend also to early adulthood. The significant impact of secondary and upper secondary education on cognitive abilities has also been found by Gustafsson (2001). Further evidence has been provided by Webbink and Gerritsen (2013) who, using data from the TIMMS-program, found that a year of school time increases performance in tests with 0.2 to 0.3 standard deviations for 9-year olds and with 0.1 to 0.2 standard deviations for 13-year olds.

Both cognitive abilities and educational performances are, in turn, strongly influenced by environmental factors. Turkheimer, Haley, Waldron, D'Onofrio, and Gottesman (2003) demonstrated that the share of IQ variance explained by genes and the environment is correlated to SES (socio-economic status) in a non-linear way. In relatively poor families, 60% of the variance in IQ scores is accounted for by the shared environment. In this case, genetic contribution is negligible. In rich families, the result is almost exactly the reverse. The suggested explanation for the lower ability of children from lower SES is, thus, genetic only in part. Improvements in the educational system might, in fact, be very effective in reducing the difference. After controlling for SES, there is some evidence that even a minimal increase in parent involvement plays a positive role in the mastery of basic skills (Gorard & Huat See, 2008). Research referring to the USA (Lara-Cinisomo et al., 2004) shows that the main factors associated with the educational achievement of children are not race, ethnicity, or immigrant status, but, to a much greater extent, the socio-economic environment, including parental education levels, neighbourhood poverty, parental occupational status, and family income. In a study conducted on a sample of 14,835 children from the Twins Early Development Study, Von Stumm and Plomin (2015) have shown how the effect of SES on IQ tends to increase during childhood through adolescence. They found how children from low SES families scored on average 6 IQ points lower at age 2 than children from high SES backgrounds. When the children had reached the age of 16 years, the difference between the two groups was almost tripled.

Early childhood represents a crucial period for brain development. Studies indicate how children from low SES backgrounds have limited access to cognitively stimulating materials and experiences, receive less attention from adults and tend to experience greater levels of stress than children from high SES backgrounds (Bradley & Corwyn, 2002). Low SES rearing conditions can, therefore, exert an adverse influence on brain development. There is neuro-physiological evidence that social inequalities are associated with alteration in the prefrontal cortex in children from low SES (Kishiyama, Boyce, Jimenez, Perry, & Knight, 2009). In a study on a group of 23 healthy 10-year-old children, Jednoróg et al. (2012) found that SES affect children's brain structures. Lower SES children, in particular, are associated with smaller volumes of gray matter in bilateral hippocampi, middle temporal gyri, left fusiform and right inferior occipito-temporal gyri, according to both volume- and surface-based morphometry. At the cognitive level, the study confirms how reading and verbal abilities are those most affected by SES.

An adverse early childhood environment may have long lasting effects on individual lives, and is related to many social outcomes, such as low education, crime, teenage pregnancy, unemployment and income inequality (Conti & Heckman, 2013; Duncan, Magnuson, Kalil, & Ziol-Guest, 2012; Heckman, 2008). The importance of family and environment for the formation of cognitive abilities, including IQ, and for subsequent educational and economic outcomes, is particularly evident in the cases of adverse childhood experiences or trauma (Tomer, 2014) as is paradigmatically demonstrated by children growing up in orphanages (van IJzendoorn, Luijk, & Juffer, 2008). In brief, in a sort of vicious cycle, socio-economic environment influences the formation of cognitive skills and academic performances of individuals and which, in turn, influence subsequent social outcomes, so replicating those conditions that determine the intergenerational transmission of inequalities.

## 6. Conclusions

This paper has examined Lynn's (2010a) hypothesis that socio-economic inequalities between the Italian regions are explained by genetically-rooted differences in average intelligence. Data on income, infant mortality and life expectancy for the first years or decades following the political unification of Italy have been used. Regional IQ estimates, derived from PISA test scores, have been supplemented by data on math test scores from Italian national assessments. Results show how both IQ and math test scores are strongly related to *current* socio-economic development of Italian regions. But, when historical data on income, infant mortality or life expectancy are used, a different picture emerges: the correlations are insignificant, weak, or, as in the case of infant mortality, do not support the suggested link between "regional intelligence" and socio-economic development at all.

The hypothesis that the lower scores of the Italian Southern regions in PISA tests may derive from the genetic legacies of the Phoenicians and Arabs, seems inconsistent with the historical inheritance of those populations (and of the others that populate the Mediterranean basin) for the world's culture. In antiquity, the Mediterranean, including the Italian South, North Africa and the Middle East was certainly the most advanced region of the World. Were these Mediterranean populations — that share some common biological traits, as pointed out by Templer (2012) — genetically less intelligent than their contemporaries living at higher latitudes? In addition, practically all Southern Europeans have inherited 1–3% African ancestry (with an average mixture date consistent with North African gene flow at the end of the Roman Empire and subsequent Arab migrations), with proportions similar to, sometimes higher than, those estimated for Southern Italy; the proportion of African ancestry is, for example, higher even among Jewish populations, including the Ashkenazi Jews from Northern Europe (Moorjani et al., 2011).

All in all, these results offer scant evidence in support of the thesis that regional development disparities are due to genetically-rooted differences in IQ. If the differences in economic development were actually due to hereditary differences in intelligence, the link between IQ and development should have been found in the past. But neither the historical knowledge, nor the data offer support for this hypothesis. The results are, rather, consistent with those findings that indicate a link between socio-economic development and school achievements. In Italy, research shows how the lower performance of Southern regions in PISA or INVALSI assessments may be explained by socio-economic factors, while the results of standardized intelligence tests do not indicate significant differences in performance between children of the North or the South of Italy (D'Amico et al., 2012). In synthesis, regional differences in school achievement tests, and derived IQs, may be explained by differences in factors related to socio-economic contexts, including educational quality and opportunities.

It is possible to counter-argue that the poorer socio-cultural conditions of Southern regions are not the *cause*, but the *consequence* of lower average cognitive abilities of Southern populations, genetically less intelligent than those of the North (see, for example, Kanazawa, 2006b). But, although, this argument may appear tautological or, at best, based on indirect evidence, there is much direct scientific evidence on the influence of environmental factors on school achievement and IQs, both at individual and national levels.

If one looks back on Italian history, the thesis that the North–South socio-economic divide is explained by genetic differences in intelligence is not tenable. In the past, in fact, the South of Italy has been, at times, more advanced than the North. During Roman antiquity, for example, or in the high Middle Ages. The North and Centre were more advanced than the South in the late Middle Ages. The economic decline of Italy, from the 17th until the end of the 19th century, reduced internal economic differences (Malanima, 2002). At the time of political unification, in 1861, Italy was a relatively backward country; the North–South differences in per capita GDP were very modest, there were very small differences in some indicators, such as life expectancy at birth or infant mortality, while nutrition standards were higher in the South (Daniele & Malanima, 2011b; Davis, 2006; Vecchi & Coppola, 2006). Profound disparities, instead, existed in educational levels. At the end of the 19th century, industrialisation involved the North much more than the South (Ciccarelli & Fenoaltea, 2013), consequently regional inequality increased. The North–South disparity in average income passed from 20% on the eve of World War I, to about 50% in 1951. Nowadays, per capita income in the South is 57% of that of the Centre-North (Istat, 2013). As in other countries, the evolution of regional economic inequality is, in Italy, strictly related to the process of the geographic concentration of economic activities in the Northern regions (Daniele & Malanima, 2014).

From 1861 onward, Italian economic development has been characterized by profound inequalities. Income and education levels grew faster in the North with respect to the South, while infant mortality diminished quickly in the more developed regions. In particular, differences in education have long persisted, exacerbating social and economic inequalities (Ballarino et al., 2014). Massive emigration from the South contributed to worsen the divide, since emigration, in Italy like elsewhere, was selective. As shown by a number of studies, North–South differences in school achievements reflect the historical imbalances between the two parts of Italy. For Italian regions, education levels, measured by literacy rates and average years of education, are strongly related to socio-economic development, proxied by per capita income.

Regional differences in IQs, therefore, reflect not only differences in quality, but also in the quantity of education. In other words, as at the international level (Hanushek & Woessmann, 2011; Marks, 2007), regional average IQ scores may be considered an alternative measure of human capital, since they are endogenous to the development process, and not an exogenous cause. The notable improvements in scholastic achievement tests registered in the Italian Southern regions in the period 2003–2012, which corresponded to negligible, or even negative, variations in the Northern regions, support the idea that regional differences are due to environmental factors. It follows that — as happened in Germany — regional difference in school achievements (and PISA-derived IQs) could be reduced through the implementation of appropriate policies, aimed at closing the historical North–South socio-economic gap.

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