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**The Fight Against
Geography: Malaria and
Economic Development in
Italian Regions**

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Summary

Geography has long been considered as a fundamental prerequisite for economic development and growth. In recent years, a growing number of papers have considered the role of physical geography as a determinant of regional growth and development by considering it as a source of “intrinsic advantage”. Malaria is considered to be strictly related to poverty and its geographically-related origin is now widely recognized, i.e. it is endemic only in certain areas of the globe whose environmental and climatic characteristics are ideal for the proliferation of mosquitoes which are the vector for the transmission of the disease. The World Health Organization is currently setting a series of policies aiming to eradicate the disease from Africa, with the specific goals to preserve human lives and possibly to boost economic growth in those areas. Among the several malaria parasites, the worst, *Plasmodium falciparum*, has infested Italian regions for centuries until the complete eradication occurred in the period 1945-1950. In this paper I provide an empirical assessment of the economic outcomes of malaria eradication in Italian regions. By making use of both macroeconomic and microeconomic data, I found support to the hypothesis that malaria eradication boosts productivity growth and that in the long run it leads to an increase in human capital. In particular, I found that the presence of malaria reduced significantly regional growth over the period 1891-1961, while its eradication increased the years of schooling for both males and females respectively, although my evidence points at a larger support for a very long run impact of eradication actions through an intergenerational spillover effect.

Keywords: Geography, Regional Growth, Malaria

JEL Classification: J100, N300, O100, R100

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The Fight Against Geography: Malaria and Economic Development in Italian Regions^{*}

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May 2010

Abstract

Geography has long been considered as a fundamental prerequisite for economic development and growth. In recent years, a growing number of papers have considered the role of physical geography as a determinant of regional growth and development by considering it as a source of “intrinsic advantage”. Malaria is considered to be strictly related to poverty and it is now widely recognized its geographically-related origin, i.e. it is endemic only in certain areas of the globe whose environmental and climatic characteristics are ideal for the proliferation of mosquitoes which are the vector for the transmission of the disease. The World Health Organization is currently setting a series of policies aiming to eradicate the disease from Africa, with the specific goals to preserve human lives and possibly to boost economic growth in those areas. Among the several malaria parasites, the worst, *Plasmodium falciparum*, has infested Italian regions for centuries until the complete eradication occurred in the period 1945-1950. In this paper I provide an empirical assessment of the economic outcomes of malaria eradication in Italian regions. By making use of both macroeconomic and microeconomic data, I found support to the hypothesis that malaria eradication boosts productivity growth and that in the long run leads to an increase in human capital. In particular, I found that the presence of malaria reduced significantly regional growth over the period 1891-1961, while its eradication increased the years of schooling for both males and females respectively, although my evidence points at a larger support for a very long run impact of eradication actions through an intergenerational spillover effect.

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1. Introduction

Geography has long been considered as a fundamental prerequisite for economic development and growth. Adam Smith argued that high transport costs were at the heart of Asian and African underdevelopment (Sachs and McCord, 2008). In this respect, theories of economic geography have only recently introduced transport costs into models of economic growth by looking at firm location decisions and the spatial concentration of economic activities as depending on the accessibility of places (Krugman, 1991).

However, geography has a long tradition in explaining actual economic outcomes in terms of physical geography or in terms of the geography of human relations. High transport costs is only one of the possible channels through which physical geography may shape the economic landscape of countries, regions and cities. A number of other factors is also likely to affect economic development, e.g. geological risks, weather conditions and uncertainty, the quality of land, etc. In particular, adverse weather conditions, jointly with poor living standards, may enhance the diffusion of diseases that in some cases may lower economic productivity (Diamond, 1997) or negatively affect the quality of institutions (Acemoglu et al., 2002; Easterly and Levine, 2003).

There is now a considerable body of literature which proposes estimates of the impact of physical geography on economic growth and regional development by considering geography as a source of “intrinsic geographical advantage” (Sachs and McCord, 2008). Bloom and Sachs (1998) and Gallup et al. (1999) have noted that tropical areas are considerably poorer than areas in the temperate zone.

The so-called “geography view” of development argues that the effects of tropical ecology on human health and on the productivity of agriculture is of considerable

magnitude. Low productivity in the food sector may, in turn, have adverse effects on nutrition levels which, in the long run, has negative repercussions on human capital investment and labor productivity (Diamond, 1997).

One of the feature of tropical ecology is the fact that it provides a congenial environment for the diffusion of malaria. Figure 1 shows indeed that malaria is widely diffused in the tropical areas, notably countries with lowest level of development. Average per capita GDP in malarious countries in 1995 was \$ 1,526 compared with \$ 8,268 in non malarious countries (Sachs and Malaney, 2002). Sachs and Malaney (2002) have in fact estimated an average loss by 10% of total income in 31 African countries due to malaria morbidity.

[Figures 1]

Armed with this body of evidence, the World Health Organization (WHO) has launched in 1998 the Roll Back Malaria program with the aim to reduce malaria diffusion by 50% in 2010 and by 75% in 2015, although those results are now far from bring reached.

Although the economic impact of such interventions is still under scrutiny (Acemoglu and Johnson, 2007; Bloom et al., 2009), it is important to study cases of countries where eradication programs were successfully implemented, given the great social relevance of the eradication of pervasive diseases such as malaria. In the present paper I will consider the Italian case, where malaria was definitively eradicated only at the beginnings of the Fifties with sound economic outcomes. The average annual growth rate of Italy during the pre-eradication period (1913-1938) was 1%, while in the post eradication period (1950-1955) the growth rate was 5.3%. In the same periods, the

growth rates of Western Europe were 0.9% and 2.3% respectively (Gallup and Sachs, 2001). This figure is merely descriptive as it obviously lacks of causality, however, it points at an issue which seems worth being investigated. In particular, in the present paper I will provide estimates from a difference-in-difference framework in which the main source of identification comes from the geographical variation in the malaria mortality rates among Italian regions and provinces. Hence, I will focus on the poverty trap imposed by malaria diffusion in the South and how its eradication (the “fight against geography”) lead to an increase of growth rates especially for Southern regions. This article is organized as follows. After reviewing the economics of malaria (section 2) and presenting the social history of the disease in Italy (section 3), I will first provide estimates of the impact of malaria on regional growth by making use of historical macroeconomic time series. I find that the presence of malaria in Italian regions lowered economic growth over the period 1891-1961.

Secondly, by making use of microeconomic data, I will evaluate the eradication of malaria in Italy in terms of human capital accumulation (section 4). I find that the eradication policy increased human capital investment as it increased the years of schooling by about 0.3 years per males and 0.4 per females, although the estimates vary across the specifications. I also find evidence of an intergenerational effect (section 5) as the eradication of malaria seems to have increased education of the next generation by 0.07 years on average, although I found support for a larger spillover effect between mothers and daughters. Section 6 contains conclusions.

2. The economic outcomes of malaria

The effect of health on economic development and growth is lively debated in the international literature. Weil (2007) points out how this large body of research can be classified into two main strands: the macroeconomic literature and the microeconomic one. The macroeconomic literature presents empirical evidence on the impact of health outcomes on GDP per capita, GDP growth or total factor productivity. Most of these studies find a positive effect of health, as measured by life expectancy increase, on growth, reporting elasticities of 0.06-0.57, depending on other covariates and on the sample used (Bloom et al., 2004).

Malaria is a protozoal infection transmitted to human beings by mosquitoes. The classic symptom of malaria is bouts of fever with spikes on alternating days. Headaches, malaise, fatigue, nausea and anemia are also common. Severe forms of the disease can result in organic failure, delirium, impaired consciousness, and generalized convulsions, followed by persistent coma and death.

Differently from other diseases, the presence of malaria is strictly related to the morphological characteristics of places which make the environment a congenial habitat for the diffusion of mosquitoes (the main vector for the transmission of the disease).

Since the work by Weller (1958), malaria has been often associated to poverty and cross-country analyses have found that malaria morbidity is an important long term development and growth factor. Gallup and Sachs (2001) find that , after controlling for other variables, malarial countries grew 1.3% less than non malarious countries. Furthermore, they estimate that a 10% reduction in the malaria index is associated with 0.3% higher growth.

This evidence is one of the main rationales for the Rolling Back Malaria Program set up by the WHO mainly in African countries to eradicate (or to reduce the burden of) the disease. The program has also the objective to benefit of a sort of double dividend in terms of long term growth. Acemoglu and Johnson (2007) question, however, the relevance of health for growth, by studying the long run effect of the demographic transition of the Forties and Fifties induced by massive interventions to eradicate certain diseases, among them being malaria¹.

Although interesting, the macroeconomic approach does not shed light on the transmission channels from malaria eradication to economic growth. In particular, endemic malaria does affect the demographic structure by increasing child mortality rate. Moreover, because of its geographically related nature and hence for the presence of external costs, public expenditure for eradication interventions are nevertheless necessary. As a consequence, high infection rates are often associated to less funds devoted to schooling and hence to human capital investment. In addition, it can be easily argued that higher uncertainty on the length of life leads to lower human capital investment which produces economic benefits only in the long run.

Given these limitations, the microeconomic approach is particularly useful since it may focus on specific channels of transmission once a good identification strategy is set. As most of the microeconomic literature on the outcomes of health, the literature on the economics of malaria has focused on the long term effects of exposure to the disease *in utero* or during early childhood. The reasons for this choice are in the extensive evidence on the link between health during critical periods and later outcomes. For example, Stein et al. (1975) find that children born during the Dutch famine in the

¹ The article has been also criticized by Bloom et al. (2009) for the identification strategy proposed, with a following reaction in Acemoglu and Johnson (2009).

World War II experienced lower growth during childhood. Similarly, Almond (2006) finds that children born during the 1919 pandemic influenza had fewer years of schooling, as also found by Meng and Qian (2006) for the Chinese Great Famine².

Similarly, most of the microeconomic literature on malaria has focused on the *in utero* and early childhood exposure to assess its long term effect. Lucas (2005) studies the cases of Paraguay, Sri Lanka and Trinidad and Tobago and finds that 10% reduction in malaria diffusion leads to an increase of 0.39-0.93 years of education. The closest papers to the present one are the ones by Bleakley (2010a) and Cutler et al. (2009). In particular, Bleakley (2010a) proposes the use of a three-dimensional pseudo-panel to estimate the eradication in the USA, Brazil, Colombia and Mexico, while Cutler et al. (2007) study the case of India. In both articles a difference-in-difference approach is used to compare educational and economic outcomes of cohort of individuals born in the post campaign years with the ones of individuals born in the pre-eradication period, further differencing on malarial vs non-malarial areas.

Barreca (2010) proposes an instrumental variables identification strategy and find that 10 more deaths per 100,000 decreased the years of schooling by 0.4 years in the USA. Burlando (2009), by exploiting difference in altitude and hence in exogenous malaria morbidity, finds that the disease decreases children's schooling by 0.75 years on average.

In the present paper I contribute to the literature by studying the Italian case, which presents a high variability of infection rates among provinces and regions with an associated uneven geography of development. For these reasons, anti-malarial programs set up by early Italian governments can be seen as a tremendous effort to reduce the

² For a review of the literature on this point, see Bleakley (2010).

burden of adverse geographical conditions (a sort of fight against geography), especially in Southern regions. In order to put the analysis in an historical perspective, in the following section I will sketch the long process that led to the eradication of malaria in Italy.

3. The eradication of malaria in Italian regions

As stated in the previous sections, the actions launched by the WHO to eradicate malaria from African countries are expected to generate also positive economic outcomes. In this vein, as argued by Snowden (2006), the case of Italy is particularly interesting because of the long lasting period of public interventions to fight malaria which dramatically affected most of the less developed regions, prompting a great geographical variation in the morbidity of the disease. Of the several malaria parasites, the worst, *Plasmodium falciparum*, has infested Italian regions for centuries, although also *Plasmodium vivax* and *Plasmodium malariae* were also present in some areas.

The influential and fascinating work by Snowden (2006) provides a social history of the malaria eradication program which can be divided into four main phases.

The first phase ranges from Italian Unification to 1904. The territorial pervasiveness of malaria in Italian regions was one of the main social issues faced by the Government in the aftermath of the Unification of the country, occurred in 1861 (Amorosa et al., 2005). At that time, almost one third of Italian municipalities were under malaria threat. To have an idea of the burden imposed by the disease, it should be sufficient to observe that life expectancy in malaria areas was only 22.5 years, while it was 35.7 years in relatively safe areas. The economic costs of such disease in terms of health care

expenditure and lost of productivity was particularly high, so that Italian Government decided to engage in a vast scale campaign to eradicate malaria.

Interestingly, Southern regions were the most affected with mortality rates ranging from 62.1 per 100,000 inhabitants in Campania to the incredibly high 298.2 in Sardegna (figure 2). The North was relatively less beaten by the disease, with an average death rate of less than 10 deaths for malaria per 100,000 inhabitants³.

[Figure 2]

The second phase of the eradication process ranges from 1904 to 1928. In fact, prior to the studies carried out by the physicians Giovanni Battista Grassi and Angelo Celli, malaria was considered to be a miasma, that is a disease caused by the environment, in particular via some gases produced by certain types of terrain. Grassi instead argued that the disease was transmitted through the mosquitoes and that it could have been controlled by using the quinine. In 1904, Grassi conducted the first large scale experiment in the Agro Pontino, in the surroundings of Rome, and convincingly demonstrated the validity of his theories. Given the declining price of quinine induced by the increase of Java production, the Government engaged in a program called “Chinino di Stato” (i.e. State quinine or public quinine) consisting in the free distribution of the medicine through a network of public health care offices. The effect of such a program was tremendous, leading to a decrease in the number of deaths from 15,593 in 1900 to 6,333 in 1914. However, during World War I, as physicians employed in the anti-malaria program were sent to the war front, malaria rolled back,

³ The regions of Trentino-Alto Adige and Friuli Venezia Giulia were actually annexed only after World War I.

with a subsequent increase in the number of deaths up to 11,487 in 1918 and a subsequent decrease to 2,274 deaths.

The third phase begins with the so-called “Legge Mussolini” (i.e. the Mussolini Act) in 1928. In that act, by recognizing the failure of the quinine in eradicating malaria in Italian regions, Mussolini aimed to reclaim entirely marshlands in the Agro Pontino in Latium (the so-called *bonifica integrale*) in order to settle new cities and to eradicate malaria. With the employment of advanced technology for hygienic and hydraulic control, malaria was almost eradicated in the area. However, land reclamation interventions put in place during the fascist period were limited to certain areas and insufficient to guarantee the complete eradication of malaria in Italy.

The fourth phase is the phase of the ultimate eradication of malaria by means of DDT, as firstly introduced by American troops in 1944 and massively used by the Italian government in the years 1945-1950 and whose outcome was the complete eradication of the malaria.

[Figure 3]

Figure 3 plots mortality rates in the first half of the XX century and shows how, apart the period of World War I, the death toll of malaria has remained stable across the decades, with a sudden decline in coincidence with the introduction of DDTs, although the most important contribution is certainly due to the use of quinine.

According to Snowden (2006), the anti-malaria program in Italy has been a long lasting effort in which the most significant action was the massive distribution of the quinine in rural areas. However, in this paper, I am mainly interested in the final eradication of

malaria, which may allow a clearer identification of the model. In addition, the evaluation of the introduction of the quinine would be very problematic because of the small number of individuals born before the intervention (i.e. before 1904) in my dataset.

Before I present the results on the long run impact of malaria eradication, I will firstly provide some rudimentary (and, in a certain sense, descriptive) evidence on the short-run burden of malaria in terms of regional growth.

4. Malaria and regional growth

Understanding the impact of malaria on economic development through macroeconomic evidence is not an easy task since it is difficult to identify the channels of transmission. Notwithstanding, in this section I propose an analysis of the economic burden of malaria in Italian regions in terms of growth in the first half of the XX century. Estimates might not be accurate because of measurement error or because of unclear causality, however, I believe the following correlations are nevertheless important to point out the economic relevance of malaria over the period under scrutiny. My empirical framework builds upon the models proposed by Acemoglu and Johnson (2007) and by Bloom et al. (2003) in which, in a neoclassical model of economic growth, the authors propose health conditions as a factor capable to influence economic development and growth.

I construct a balanced panel of 16 Italian regions observed every twenty years over the period 1891-1961. In my small panel, the only exception is for the observations during the Thirties, for which data are available for 1938 instead of 1931, however, in what follows I will make use of average annual growth rates, so that the panel is not an

unequally spaced panel (Baltagi and Song, 2006; Baltagi and Wu, 1999). The dependent variable of my regressions is the growth in value added per capita obtained from Felice (2005a; 2005b; 2007) and expressed in real 2001 terms.

As explanatory variables of regional growth, I consider life expectancy, literacy and mortality rate of malaria.

Life expectancy data are from Felice (2007) while malaria death rates (as defined by death for malaria per 100,000 inhabitants) are from Mazzarone (1997), Novello (2003) and from the *Statistiche sanitarie* produced by ISTAT. It should be mentioned that Gallup and Sachs (2001) and McArthur and Sachs (2001) make use of the proportion of population at risk of *falciparum* malaria transmission to measure the burden of malaria, while this variable is not available in my case. However, there is no particular reason to consider my measure (the malaria mortality rate) as not appropriate to proxy the burden of geography as expressed by malaria morbidity.

As a control, I made use of a human capital index constructed by Felice (2007) which considers the analphabetism rate and the schooling rate (defined as the ratio between the number of inhabitants having attended at least one year of school on total population) with time-varying weights. Those time-varying weights change according to the decreasing relevance of analphabetism and the increasing importance of the schooling rate⁴. As this assumption could be strong and weights arbitrary, in what follows, I will also show results of alternative specifications where only analphabetism is used.

⁴ In particular, the human capital indicator, hk_{it} , for region i at time t is computed as:

$$hk_{i,1891,1911} = 2/3 * \text{analphabetism} + 1/3 * \text{schooling rate}$$

$$hk_{i,1938} = 0.55 * \text{analphabetism} + 0.45 * \text{schooling rate}$$

$$hk_{i,1951} = 0.5 * \text{analphabetism} + 0.5 * \text{schooling rate}$$

$$hk_{i,1961} = 2/3 * \text{analphabetism} + 1/3 * \text{schooling rate}$$

Table 1 reports summary statistics for the main variables. It is found that the average value added per capita was €2,068, while the annual growth rate was 4% on average over the considered time period. Life expectancy was 52.1 years with extremely large variation.

[Insert tables 1, 2 about here]

Let us now consider the impact of malaria on regional growth. My first specification considers average annual growth rate as a function of malaria and other controls, as expressed in the following equation:

$$(1) \quad growth_{it} = \alpha + \mu_t + \beta va_pc_{i1891} + \gamma hk_{it-1} + \delta malaria_{it-1} + \varepsilon_{it}$$

where $growth_{it}$ is the average annual growth rate of region i between time $t-1$ and t , μ_t denotes a vector of time dummy variables, va_pc_{i1891} is the value added per capita of region i in 1891 (i.e. the initial level of economic development). All variables are expressed in logs. Table 2 reports results of the estimation of equation (1). In particular, the second column reports estimates considering the whole sample of Italian regions and shows a slight process of regional convergence over the period 1891-1961, as denoted by the coefficient relative to va_pc_{i1891} , and the relevance of human capital. Interestingly, the coefficient associated with malaria is negative and equal to -0.002 implying that a malaria death rate of about 150 (as an approximation of the average death rate in the Mezzogiorno in 1891) would have resulted in a regional growth rate lower of about 1% per year. Models 2 and 3 in table 2 report estimation results for the

subsamples relative to Northern and Central-Southern regions respectively. The estimates show a quite surprising result as it seems that the economic burden of malaria was three times higher in the North than in the South, as from coefficient estimates. However, as from figure 2, it is evident how the death rates greatly varied across regions, with an average death rate of 9.37 in the North and about 108 in the Centre-South. If the eradication program would have not occurred and the malaria death rates would have been constant over the considered time period, those figures would have implied a decrease in the growth rate of Northern regions of 0.45% in absolute values, and a reduction for the Centre-South of 0.94%. Hence, the economic cost of malaria was substantially higher in the Centre-South than in the North.

[Insert table 3 about here]

One of the problems associated with equation (1) is the fact that it fails in considering time-unvarying heterogeneity in an appropriate way. For this reason, I estimate the following slightly different specification:

$$(2) \quad growth_{it} = \alpha + \mu_t + \lambda_i + \beta va_pc_{it-1} + \gamma hk_{it-1} + \delta malaria_{it-1} + \varepsilon_{it}$$

where λ_i denotes a full set of region-specific dummies and va_pc_{it-1} is the log of value added per capita in region i at time $t-1$.

Results in model 4 in table 2 confirm the sign and significance of the coefficients associated with human capital and malaria. However, in this case a substantial increase in the magnitude of the coefficient of *malaria* can be observed. Similar results emerge

also when the dataset is divided into two subsamples and in such cases the coefficient for Northern regions is -0.011, while it is -0.005 for Central-Southern regions. In such cases, the burden of malaria in terms of economic growth was -2.46% per year in the North and -2.51% in the Centre-South, hence there is a substantial reduction in the gap between the areas.

In table 3, I report some further robustness checks and some extensions of the baseline model. In particular, one may argue that the definition of the human capital indicator as proposed by Felice (2007) and used in the regressions reported in table 2, might be biased because of presumably arbitrary weights on the components. For this reason, I make instead use of the percentage of analphabets in each region to control for the level of education. The results of fixed effects estimation are reported in models 1-3 in table 3. While the coefficient for analphabetism has the expected negative sign and is significant, it should be nonetheless noted that the changes occurring in the coefficients for *malaria* are very small if one compares the estimates in table 3 to the ones in table 2 (models 4-6). By controlling for life expectancy, in models 4-6, it is found a substantial stability in the coefficients for malaria, lying between -0.004 in Central-Southern regions and -0.009 in the North.

All those results point at an economic cost of malaria in terms of growth ranging from 1% to 2.5%. Interestingly, those results are in line with the findings of Bloom et al. (2003) and Sachs and Malaney (2002).

As stated previously and highlighted in Acemoglu and Johnson (2009), macroeconomic evidence is difficult to interpret in terms of causality since the general equilibrium effects of diseases eradication may have different and even opposite effects on development. In addition, although I consider the growth rate as a function of the initial

period mortality rate for malaria with region-specific and time dummies, I cannot exclude that malaria mortality is endogenous, due to an omitted variable bias. However, my estimates point out at a negative (short run) correlation between malaria diffusion and regional growth. These estimates seem to confirm the intuition that the eradication of malaria in Italian regions may have had positive and even persisting effects, whose analysis could be conducted by studying the behavior of individuals before and after the eradication in malarial and non-malarial areas. In the next section, I will provide some evidence on the human capital accumulation effect on individuals born in the post eradication era in previously malarial areas.

5. The long run effect of malaria eradication

In the previous section I have estimated the short run growth effect of malaria diffusion in Italian regions. However, the eradication of the disease is likely to have had relevant effects appearing in the long run. In addition, I have privileged a macroeconomic approach which fails in providing a direct causality on the link between health and economic outcomes. In order to tackle both issues, in the present section I will focus on microeconomic outcomes of malaria eradication in the long run.

As extensively discussed in Bleakley (2010b) and also mentioned in section 2 of this article, the quality of the environment in which a child grows in the early months of his life is crucial in determining the adult outcomes, especially in terms of educational attainment. If this theory is correct, as supported by existing and aforementioned evidence, I should expect that individuals born in malarial regions after the eradication of the disease would have attained higher educational levels than previous cohorts; or, in other terms, that the difference in educational attainment between individuals born in

malarial areas and individuals born in non-malarial areas should have decreased after malaria eradication.

To estimate the impact of the eradication, I use a difference-in-difference approach comparing educational outcomes of individuals born before the eradication and individuals born after the final anti-malaria campaign. Further differencing is also applied to divide individuals across regions with high infection rates and regions with low malaria diffusion.

My methodology is based on the work by Bleakley (2007a) and further applied by Cutler et al. (2007). In particular, it consists in running regressions of the following form, for individual i in birth cohort c in region r :

$$(3) \quad Outcome_{icr} = \beta_0 + \beta_1(Post)_c \cdot (High)_r + \gamma_r + \alpha_c + \mathbf{X}\beta_2 + \varepsilon_{icr}$$

where $Post$ indicates that individual's birth cohort is after the eradication period and $High$ indicates whether individual i 's region was a high prevalence region prior to eradication. γ and α are region and birth cohort fixed effects, and \mathbf{X} is a vector of individual characteristics, including gender, father's years of schooling and the dimension of the city the individual lives in.

The data I make use of are from the Bank of Italy Survey of Household Income and Wealth (SHIW). In particular, the waves conducted in the years, 1977, 1978, 1980, 1981, 1982, 1983, 1984, 1986, 1987.

The SHIW contains only levels of education in terms of attained degrees. I calculated the years of schooling by approximation on the basis of each level of education attainment. I define less than primary as zero years, primary as five years, middle as

eight years, secondary as thirteen years and college as eighteen years. However, in what follows I will also use as a dependent variable the probability to attain a high school or a university degree.

I consider regions with high infection rates Basilicata, Calabria, Lazio, Puglia, Sardegna and Sicilia, hence for those regions $(High)_r=1$. The post treatment cohort is considered to be that of individuals born after 1950, while the cohort of people born in the period 1945-1950 is initially excluded from the analysis as this is considered to be the treatment period. In addition, I exclude individuals born in Trentino Alto Adige and Friuli Venezia Giulia because of the later annexation of those regions. Given figure 3, the choice to limit the treatment period to the years 1945-1950 seems corroborated by the sudden decline of the mortality rate. In the following analysis, I also exclude individuals born after 1908 in order not to confound the effect of the final eradication with the Quinine Laws. Also to be noted is the overall stability of the mortality rate starting from 1923 up to 1946. This is a desirable feature, especially in the case in which I limit the analysis to the 1940-1955 cohorts.

Also to be noted is the fact that the vector of parameters associated to birth cohorts, α , captures the effect of changes occurring in compulsory schooling laws as those laws are applied all across regions.

The difference-in-difference model in equation (3) has some identifying assumptions which are worth being discussed (Bleakley, 2010a).

First, the treatment, i.e. the eradication campaign with the DDT, was substantially exogenous to individual/household decision to invest in human capital. This assumption seems to be reasonable since at the time the eradication took place, interregional migration flows were particularly low, so that individuals did not self-select by locating

in areas with low malaria morbidity. This implies that households did not choose the area in which to live according to malaria diffusion, which in turn influenced the treatment. In addition, the advent of the DDT technology was completely exogenous as it came with the American troops at the end of World War II.

Second the specification in (3) advances the implicit assumption that the eventual gains from eradication were higher in regions with higher malaria incidence. Figure 4 reports the decrease in malaria mortality rate as a function of initial mortality. As expected, the trend line has a positive slope, prompting for a larger health gain from the eradication campaign in regions with higher morbidity. Given the correlations presented in the previous section, this would imply a larger economic gain in more affected areas.

[Figure 4]

Third, the final eradication campaign must be confined to a specific and even short period. As reported above, Italy has been on the forefront in the fight of malaria, with sound benefits especially from the use of quinine. However, as shown in figure 3, the mortality rate has been substantially stable across the first half of XX century (with the sole exception of World War I), with a sudden break in correspondence of the introduction of DDT.

Table 4 reports estimates of equation (3) by using different dependent variables and by differentiating between males and females. I found that malaria eradication increased years of schooling by 0.62 years on average. Interesting, the effect was larger for females (0.72 years) than for males (0.60 years). It is also important to determine if the increase in the years of schooling occurred because of a wider access to secondary

school or whether the impact was more important in the case of university education⁵. To this end, I ran logistic regressions on high school and university completion. The estimates for β_l are mildly close for both cases, although malaria eradication seems to have had a slightly larger impact on the probability to graduate. In addition, also in these cases, a larger impact on female school achievements with respect to male education is estimated.

[Insert tables 4 and 5 about here]

In table 5, panels A, B, C, I include the treatment cohort, i.e. individuals born in the years 1945-1950. Estimates are slightly lower than in the previous case, i.e. 0.55 years of schooling increase. Similar results are found when estimating the probability to attain a high school or a university degree.

At this point, it must be stated that in the 1977-1989 waves of the SHIW, only the region of residence of individuals is provided, while there is no information regarding the region of birth. In absence of interregional migration flows this lack would not constitute a problem. However, over the years 1955-1970, about 1% of total South population moved to Northern areas annually. To overcome this problem, I make use of the waves 1989, 1991, 1993, 1995, 1998 of the SHIW, in which both the regions of birth and of residence are provided, while the variable *High_r* is computed according to the region of birth.

⁵ I focus only on high school and university education because, starting from 1960-1961, both elementary and middle school education was compulsory.

Panels D, E, and F in table 5 present the results. As expected, results are lower and lie between 0.31 and 0.4 increase in the years of schooling⁶. Also to be noted is the fact that when I exclude emigrants and consider only householders, average estimates turn out to be not significant on average and marginally significant for males.

[Insert tables 6 about here]

To corroborate further my results, table 6 reports results considering only individuals born in the period 1940-1955. Interestingly enough, results do not differ significantly from the ones in Panels D, E in table 5.

In order to have reliable estimates of the eradication campaign, we need that the treatment should be temporally limited and with variation of the mortality rate across space. The fact that, as from figure 2, it is possible to observe a clear North-South divide is a warning that my variable $(Post)_c \cdot (High)_r$ may be measuring also other factors not necessarily related to the eradication of malaria. On this point, however, it must be stated that, given the strict and conservative hypothesis I have made on the treatment period, it seems that over the years 1945-1950 the only confounding factor that is foreseeable is the Marshal Plan. No data are currently available on the expenditure of such program at regional level over the years, however, the literature agrees on the fact that only starting in 1952-1953 such investment became relevant (Fauri, 2010). However, in order to overcome those potential limitations, I have also conducted an analysis at sub-regional (provincial) level which allows for an analysis of

⁶ I report only results where the dependent variable is the number of years of schooling and omit the results on the probability to attain high school and university degrees. However, they can be obtained from the author upon request.

the eradication within the South. In particular, I have digitalized the map “Carta della malaria dell’Italia” (figure 5a) that was drawn by Luigi Torelli in 1882 and reports the virulence of malaria across the Italian space. Figure 5b reports the digital map in which I have identified the provinces affected by malaria.. The SHIW waves 1989, 1991, and 1993 contain the province of birth and of residence; hence the variable $High_r$ has been computed according to the digital map in figure 5b.

[Insert figures 5a, 5b, and table 7 about here]

The advantage of this approach is clearly that of identifying more precisely treatment/control groups. However, the disadvantage is that the map has been drawn more than sixty years before the treatment period of my interest, and, more importantly, before the introduction of the quinine, which lowered considerably malaria mortality especially in the North, although there is no reason to think that the geography of endemic malaria changed considerably in the South after 1882. Table 7 reports the results of such analysis at provincial level and it can be noted that my estimates are very close to the most reliable ones, presented in the previous tables. Even the most restrictive sample, that is the one considering variations within the South and for individuals born in the period 1940-1955, provides estimates of about 0.3 years increase, with large differences between males and females.

Under the most restrictive assumptions, my estimates point at an increase of 0.3 years of schooling due to malaria eradication, a result which is slightly larger than what Bleakley (2010a) has found for the US (about 0.11-0.26 years), although smaller than what

Bleakley (2010a) has estimated for Brazil (0.99 years) and Burlando (2009) for Ethiopia (0.75 years).

6. The inter-generational effect of malaria eradication

In the previous section I have presented evidence on the effect of malaria eradication on human capital accumulation. Although my results are not exceptionally large, they could have generated intergenerational spillover. There is in fact a large literature documenting a positive correlation between parental education and children's schooling (see for instance, Black et al., 2003; Checchi et al., 2006; Chevalier, 2004; Oreopoulos et al., 2003). Most of the literature uses parental education as an explanatory variable of children educational attainment. However, the causal effect of parents' education could be endogenous because of an omitted variable bias, mostly associated to other intergenerationally transmitted skills or values or other family background characteristics. To tackle this issue, a large literature has used exogenous variations in compulsory schooling laws as an instrument for parental education (Chevalier, 2004; Oreopoulos et al., 2003). In my case, the variable $(Post)_c \cdot (High)_r$ could be suspected to be such instrument. However, the exclusionary restriction of an exogenous instrument is that it is not correlated to any variable influencing children outcomes. In my case it is not reasonable to exclude that $(Post)_c \cdot (High)_r$ is correlated with general health conditions of parents which very often produce better children outcomes (Almond and Chay, 2006).

Given these issues, in order to estimate the intergenerational effect of malaria eradication, I opt for a simple reduced form equation as (Almond and Chay, 2006):

$$(4) \quad Outcome_{icr} = \beta_0 + \beta_1 (Post)_c^p \cdot (High)_r^p + \gamma_r + \alpha_c + \delta_c^p + \mathbf{X}\beta_2 + \varepsilon_{icr}$$

Where the treatment variable $(Post)_c^p \cdot (High)_r^p$ now refers to parents of individual i , vector δ_c^p contains a set of parents' birth cohort dummies.

[Insert table 8 about here]

In table 8, Panel A, I document the results in which $(Post)_c^p \cdot (High)_r^p$ takes value 1 if only one of the parents of individual i was born after the eradication campaign in a malarial region. Interestingly enough, the estimated coefficients are positive and significant, although not particularly large and amounting to 0.07 years increase. In Panel B, I consider two different treatment variables, i.e. separately for mothers and fathers. In this case, and qualitatively in line with Black et al. (2003), I found a larger spillover effect between mothers and daughters.

7. Conclusions

Every year there are 300 to 500 million clinical cases and one to three million deaths, mostly of children, are attributable to malaria. The economic burden of such geographically-related disease is also staggering. Poor countries continue to stay behind and are entrapped in a poverty trap also because of the diffusion of such disease. WHO has launched a new program, the Roll Back Malaria program, which has a financial endowment smaller than the funding used for the *Titanic* movie (Narasimhan and Attaran, 2003).

The paucity of the budget can be probably found, among other things, also in the fact that some economists have questioned the economic relevance of health benefits.

In this paper, I contributed to the growing literature on malaria eradication by proposing an analysis of the Italian case. In the aftermath of the Unification, the diffusion of malaria was considered as one of the main problems of the country, deeply affecting the geography of development, and further reducing the growth of regions more affected by the disease, as pointed out in my simple macroeconomic evidence. By considering the final eradication campaign occurred during the years 1945-1950, I have found that the most conservative estimates point at an average increase of 0.3 years of schooling, slightly larger for females. Furthermore, I found evidence of a small intergenerational spillover of the eradication which proved to be larger between mothers and daughters.

Malaria is a disease very related to first nature geography and its eradication can be forcefully thought to be a “fight against geography”, or at least against a part of geography. Italy has succeeded in this fight, as did U.S. and many other countries. Certainly, the geography of development in Italy is still uneven, but, given my evidence, it could have been even more unequal if malaria had not been eradicated.

References

- Acemoglu, D. and Johnson, S. (2007), Disease and development: the effect of life expectancy on economic growth, *Journal of Political Economy*, 115:925-985.
- Acemoglu, D. and Johnson, S. (2009), Disease and Development: A reply to Bloom, Canning and Fink, MIT, mimeo.
- Acemoglu, D., Johnson, S., Robinson, J.A. (2002), Reversal of fortune: geography and institutions in the making of modern world income distribution, *Quarterly Journal of Economics*, 117:1231-1294.
- Almond, D. (2006), Is the 1918 Inuenza Pandemic Over? Long-term Effects of In Utero Inuenza Exposure in the Post-1940 U.S. Population, *Journal of Political Economy*, 114(4):672-712.

- Almond, D. and Chay, K.Y. (2006), The Long-Run and Intergenerational Impact of Poor Infant Health: Evidence from Cohorts Born During the Civil Rights Era, Columbia University, mimeo.
- Amorosa, L.F. Jr., Cobellini, G., Coluzzi, M. (2005), Lessons learned from malaria: Italy's past and sub-Saharan's future, *Health & Place*, 11(1):67-73.
- Baltagi, B.H. and Song, S.H. (2006), Unbalanced panel data: a survey, *Statistical Papers*, 47:493-523.
- Baltagi, B.H. and Wu, P.X. (1999), Unequally spaced panel data regressions with AR(1) disturbances, *Econometric Theory*, 15:814-823.
- Barreca, A. (2010), The long term economic impact of an *in utero* and postnatal exposure to malaria, *Journal of Human Resources*, forthcoming.
- Black, S.E., Devereux, P.J., Salvanes, K.G. (2003), Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital, IZA Discussion Paper N. 926.
- Bleakley, H. (2007a), Disease and development: evidence from hookworm eradication in the American south, *Quarterly Journal of Economics*, 30:73-117.
- Bleakley, H. (2010a), Malaria eradication in the Americas: a retrospective analysis of childhood exposure, *American Economic Journal: Applied*, 2(2):1-45.
- Bleakley, H. (2010b), Health, Human Capital and Development, *Annual Reviews of Economics*, forthcoming.
- Bloom, D.E., Canning, D., Sevilla, J. (2003), Geography and poverty traps, *Journal of Economic Growth*, 8:355-378.
- Bloom, D.E., Canning, D., Sevilla, J. (2004), The effect of health on economic growth: a production function approach, *World Development*, 32(1):1-13.
- Bloom, D.E., Canning, D., Fink, G. (2009), Disease and Development Revisited, Harvard School of Public Health, mimeo.
- Bloom, D.E. and J. Sachs (1998), Geography, Demography, and Economic Growth in Africa, *Brookings Papers on Economic Activity*, 2:206-295.
- Burlando, A. (2009), Does Malaria Reduce Education? Findings from the Ethiopian Highlands, Boston University, mimeo.
- Cecchi, D., Fiorio, C.V., Leonardi, M. (2006), Sessanta anni di istruzione in Italia, *Rivista di Politica Economica*, (luglio-agosto):285-318.
- Chevalier, A. (2004), Parental Education and Child's Education: A Natural Experiment, University College Dublin, Center for Economic Research WP04/14.
- Cutler, D., Fung, W., Kremer, M., Singhal, M. (2007), Mosquitoes: the long-term effects of malaria eradication in India, NBER Wp. 13539.
- Diamond, J. (1997), *Guns, germs and steel: the fate of human societies*, New York: W.W. Norton & Co.
- Easterly, W. and R. Levine (2003), Tropics, germs, and crops: the role of endowments in economic development, *Journal of Monetary Economics*, 50(1):3-39.

- Fauri, F. (2010), *Il Piano Marshall e l'Italia*, Bologna: il Mulino.
- Felice E. (2005a), Il reddito delle regioni italiane nel 1938 e nel 1951. Una stima basata sul costo del lavoro, *Rivista di Storia Economica*, 21(1):3-30.
- Felice E. (2005b), Il valore aggiunto regionale. Una stima per il 1891 e per il 1911 e alcune elaborazioni di lungo periodo (1891-1971), *Rivista di Storia Economica*, 21(3):273-314.
- Felice E. (2007), *Divari regionali e intervento pubblico. Per una rilettura dello sviluppo in Italia*, Bologna: Il Mulino.
- Gallup, J.K. and Sachs, J.D. (2001), The economic burden of malaria, *American Journal of Tropical Medicine and Hygiene*, 64(1,2):85-96.
- Gallup, J.L., Sachs, J.D., and A. Mellinger (1999), Geography and Economics Development, *International Regional Science Review*, 22(2):179-232.
- Krugman, P. (1991), Increasing Returns and Economic Geography, *Journal of Political Economy*, 99(3):483-499.
- Lucas, A. (2005), Economic effects of malaria eradication: evidence from the malaria periphery, Brown University, mimeo.
- Mazzarone, R. (1997), La malaria in Basilicata, *Rassegna Storica Lucana*, 17(25-26):93-115.
- Meng, Xin and Nancy Qian (2006), The Long Run Health and Economic Consequences of Famine on Survivors: Evidence from China's Great Famine, Discussion Papers 5989, CEPR December.
- Narasimhan, V. and Attaran, A. (2003), Roll Back Malaria? The scarcity of international aid for malaria control, *Malaria Journal*, 2(8).
- Novello, E. (2003), *La bonifica in Italia. Legislazione, credito e lotta alla malaria dall'Unità al fascismo*, Milano: Francoangeli.
- Oreopoulos, P., Page, M.E., Stevens, A.H. (2003), Does Human Capital Transfer From Parents to Child? The Intergenerational Effects of Compulsory Schooling, NBER Wp 10164.
- Sachs, J.D. and Malaney, P. (2002), The economic and social burden of malaria, *Nature*, 415:680-685.
- Sachs, J.D. and McCord, G.C. (2008), Geography of regional development, in S. N. Durlauf and L.E. Blume (eds.), *The New Palgrave Dictionary of Economics*, Palgrave MacMillan.
- Snowden, F. (2006), *The conquest of malaria: Italy 1900-1962*, Yale University Press.
- Stein, Z., M. Susser, G. Saenger, and F. Marolla (1975), *Famine and Human Development: The Dutch Hunger Winter of 1944-1945*, London: Oxford University Press.
- Weller T.H. (1958), Tropical medicine. *Encyclopedia Britannica*. Chicago: William Bennet.

Weil, D.N. (2007), Accounting for the effect of health on economic growth, *Quarterly Journal of Economics*, 30:1265-1306.

Table 1: Summary statistics

	Value added per capita	Growth rate	Malaria	Life expectancy	Human capital index
Mean	2068.73	0.04	23.60	52.11	0.54
Median	1852.20	0.01	1.30	52.52	0.58
Maximum	4762.80	0.12	298.20	68.31	0.80
Minimum	814.59	-0.01	0.10	35.80	0.14
Std. Dev.	924.00	0.04	53.77	10.97	0.17
Observations	63	63	63	63	63

Table 2: The growth cost of malaria

	(1) Whole sample	(2) Northern regions	(3) Central and Southern regions	(4) Whole sample	(5) Northern regions	(6) Central and Southern regions
Constant	0.171 (3.827)***	0.226 (3.081)***	0.166 (2.727)***	0.160 (1.513)	-0.253 (-1.109)	0.173 (1.941)**
Value added per capita (t-1)				-0.015 (-1.027)	0.039 (1.309)	-0.016 (-1.261)
Value added per capita in 1891	-0.018 (-3.232)***	-0.026 (-2.609)**	-0.017 (-2.369)**			
Human capital (t-1)	0.006 (2.901)***	0.006 (1.980)**	0.010 (1.762)*	0.004 (1.627)*	0.071 (2.661)**	0.018 (1.778)**
Malaria (t-1)	-0.002 (-2.012)**	-0.003 (-2.862)**	-0.001 (-2.912)***	-0.008 (-2.540)**	-0.011 (-3.498)***	-0.005 (2.582)**
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific dummies	No	No	No	Yes	Yes	Yes
R ²	0.944	0.970	0.964	0.966	0.988	0.975
N. of regions	16	5	11	16	5	11
N. Obs.	63	19	44	63	19	44

Notes: All variables are in logarithms and *T*-statistics in parentheses. ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$

Table 3: Robustness checks

	(1) Whole sample	(2) Northern regions	(3) Central and Southern regions	(4) Whole sample	(5) Northern regions	(6) Central and Southern regions
Constant	0.198 (1.175)	-0.028 (-0.042)	0.176 (0.883)	0.536 (2.655)***	0.006 (0.019)	0.650 (3.045)***
Value added per capita (t-1)	-0.024 (-1.306)	-0.002 (-0.032)	-0.026 (-1.172)	-0.017 (-1.160)	0.052 (1.561)	-0.016 (-1.006)
Analphabetism (t-1)	-0.008 (-2.806)***	-0.032 (-2.708)***	-0.015 (-1.883)*			
Human capital (t-1)				0.135 (1.838)*	0.097 (2.821)***	0.029 (1.809)*
Malaria (t-1)	-0.004 (-2.199)**	-0.009 (-1.941)*	-0.003 (-2.213)**	-0.006 (3.931)***	-0.009 (-2.840)***	-0.004 (-2.765)***
Life expectancy (t- 1)				0.089 (2.207)**	0.086 (1.249)	0.117 (2.653)***
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region- specific dummies	No	No	No	Yes	Yes	Yes
R ²	0.978	0.980	0.981	0.970	0.990	0.980
N. of regions	16	5	11	16	5	11
N. Obs.	63	19	44	63	19	44

Notes: All variables are in logarithms and *T*-statistics in parentheses. ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$

Table 4: The long run impact of malaria eradication on educational outcomes

<i>Panel A: Years of schooling</i>			
	(1) Whole sample	(2) Male	(3) Female
$(Post)_c *(High)_r$	0.62 (11.28)	0.60 (9.07)	0.72 (9.16)
N. obs.	130,303	64,660	65,643
R ²	0.46	0.59	0.43
<i>Panel B: High school education</i>			
	(4) Whole sample	(5) Male	(6) Female
$(Post)_c *(High)_r$	1.41 (10.63)	1.27 (5.16)	1.90 (12.82)
N. obs.	130,303	64,660	65,643
Pseudo R ²	0.33	0.35	0.28
<i>Panel C: College education</i>			
	(7) Whole sample	(8) Male	(9) Female
$(Post)_c *(High)_r$	1.59 (14.52)	1.17 (2.75)	1.90 (14.95)
N. obs.	130,303	64,660	65,643
Pseudo R ²	0.38	0.49	0.26

Notes: Panel A reports OLS estimates of equation (3) where the dependent variable are the years of schooling. Panels B and C report logistic regression estimates of equation (3) where the dependent variable is either the individual completed high school and university respectively. All regressions have a full set of years of birth dummy variables, regional dummies, gender, father's years of schooling, the dimension of the city the individual lives in. Individuals born in the period 1945-1950 are excluded from the analysis. Odds ratios are reported for models (4)-(9), t and z statistics are in parentheses. All coefficients are significant at 99%.

Table 5: Robustness checks – Inclusion of the treatment cohort and the role of interregional migration

<i>Panel A: Years of schooling</i>			
	(1) Whole sample	(2) Male	(3) Female
$(Post)_c *(High)_r$	0.55 (8.81)	0.46 (9.00)	0.62 (5.79)
N. obs.	152,861	75,736	77,125
R ²	0.41	0.55	0.39
<i>Panel B: High school education</i>			
	(4) Whole sample	(5) Male	(6) Female
$(Post)_c *(High)_r$	1.33 (9.60)	1.24 (5.24)	1.68 (10.84)
N. obs.	152,861	75,736	77,125
Pseudo R ²	0.30	0.30	0.25
<i>Panel C: College education</i>			
	(7) Whole sample	(8) Male	(9) Female
$(Post)_c *(High)_r$	1.51 (14.05)	1.13 (3.41)	1.71 (13.53)
N. obs.	152,861	75,736	77,125
Pseudo R ²	0.36	0.46	0.22
<i>Panel D: Years of schooling (Whole sample 1989-1998)</i>			
	(10) Whole sample	(11) Male	(12) Female
$(Post)_c *(High)_r$	0.34 (7.42)	0.31 (4.76)	0.39 (6.26)
N. obs.	112,685	55,396	57,289
R ²	0.44	0.44	0.46
<i>Panel E: Years of schooling (Emigrants are excluded)</i>			
	(13) Whole sample	(14) Male	(15) Female
$(Post)_c *(High)_r$	0.36 (7.51)	0.40 (5.73)	0.36 (5.37)
N. obs.	98,605	48,642	49,963
Pseudo R ²	0.47	0.46	0.49
<i>Panel F: Years of Schooling (Emigrants excluded and only householders)</i>			
	(16) Whole sample	(17) Male	(18) Female
$(Post)_c *(High)_r$	0.30 (1.69)	0.33 (1.69)	0.49 (1.07)
N. obs.	11,862	9,387	2,475
Pseudo R ²	0.22	0.16	0.38

Notes: Panel A reports OLS estimates of equation (3) where the dependent variable are the years of schooling. Panels B and C report logistic regression estimates of equation (3) where the dependent variable is either the individual completed high school and university respectively. All regressions include a full set of years of birth dummy variables, regional dummies, gender, father's years of schooling, the dimension of the city the individual lives in.. Individuals born in the period 1945-1950 are included in the analysis. Odds ratios are reported for models (4)-(9), t and z statistics are in parentheses. All coefficients are significant at 99%.

Table 6: Robustness checks – Only cohorts 1940-1955

<i>Panel A: Years of schooling (Emigrants excluded)</i>			
	(1)	(2)	(3)
	Whole sample	Male	Female
$(Post)_c *(High)_r$	0.36	0.36	0.44
	(6.87)	(4.59)	(6.05)
N. obs.	90,593	44,471	46,122
R ²	0.51	0.50	0.53
<i>Panel B: Years of schooling (Emigrants excluded, treatment cohort included)</i>			
	(4)	(5)	(6)
	Whole sample	Male	Female
$(Post)_c *(High)_r$	0.20	0.20	0.24
	(4.38)	(3.04)	(3.83)
N. obs.	110,571	54,286	56,285
R ²	0.44	0.44	0.46

Notes: All regressions include a full set of years of birth dummy variables, regional dummies, gender, father's years of schooling, the dimension of the city the individual lives in.. Individuals born in the period 1945-1950 are included in the analysis. t and statistics are in parentheses. All coefficients are significant at 99%.

Table 7: Robustness checks – Provincial level analysis

<i>Panel A: Years of schooling</i>			
	(1) Whole sample	(2) Male	(3) Female
$(Post)_c *(High)_r$	1.07 (14.49)	0.87 (9.84)	1.35 (12.72)
R ²	0.30	0.38	0.34
N. Obs.	96,595	47,545	49,050
<i>Panel B: Years of schooling (treatment cohort included)</i>			
	(4) Whole sample	(5) Male	(6) Female
$(Post)_c *(High)_r$	0.90 (13.00)	0.83 (9.94)	1.05 (10.61)
R ²	0.27	0.34	0.31
N. Obs.	119,153	58,621	60,532
<i>Panel C: Years of Schooling (emigrants excluded)</i>			
	(10) Whole sample	(11) Male	(12) Female
$(Post)_c *(High)_r$	0.23 (3.86)	0.24 (2.71)	0.29 (3.58)
R ²	0.32	0.23	0.40
N. Obs.	70,661	33,864	36,767
<i>Panel D: Years of Schooling (Only Southern provinces; only 1945-1950 cohorts)</i>			
	(13) Whole sample	(14) Male	(15) Female
$(Post)_c *(High)_r$	0.28 (3.16)	0.19 (3.07)	0.32 (4.12)
R ²	0.26	0.19	0.34
N. obs.	50,639	23,709	26,930

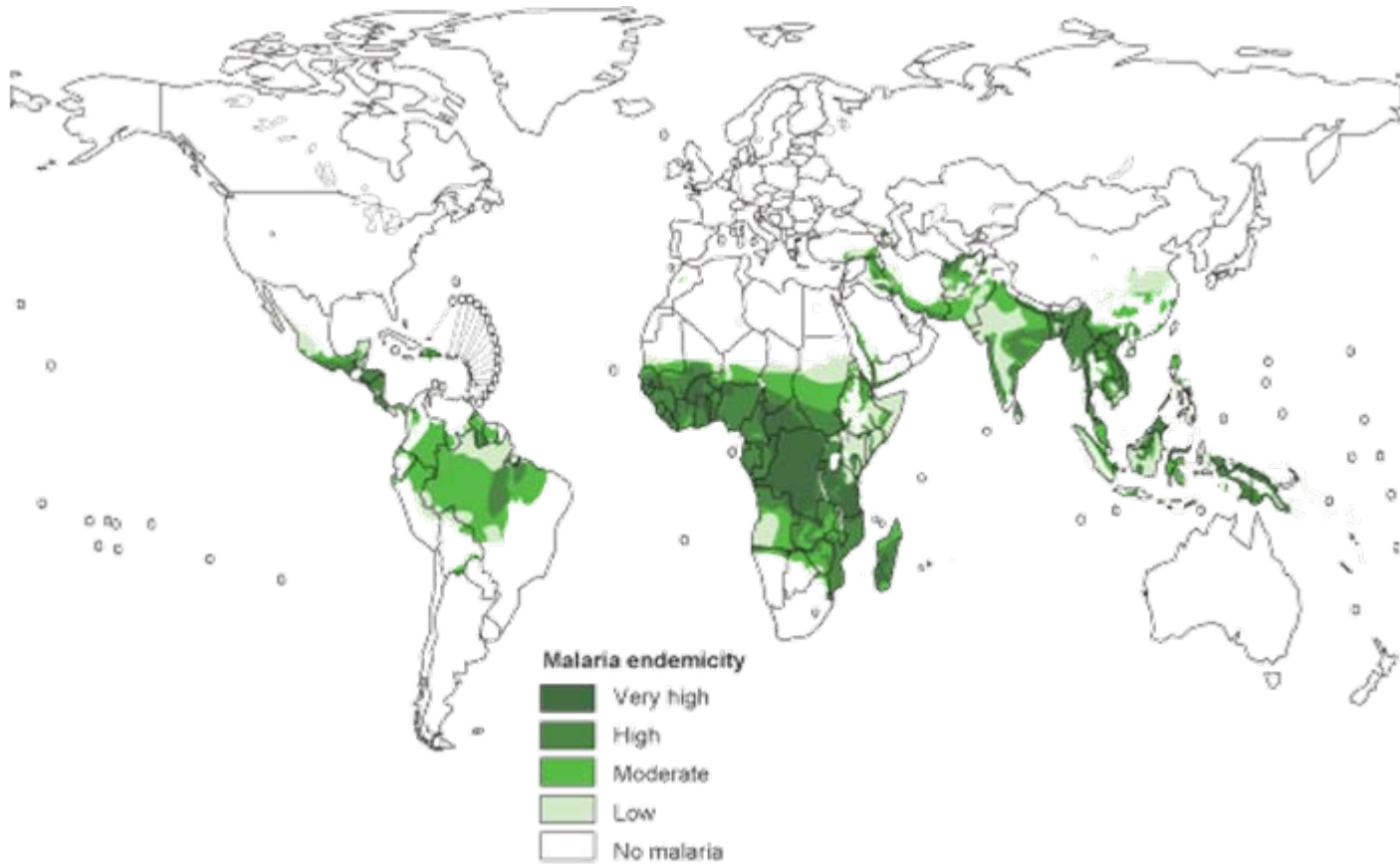
Notes: Panel A reports OLS estimates of equation (3) where the dependent variable are the years of schooling. Panels B and C report logistic regression estimates of equation (3) where the dependent variable is either the individual completed high school and university respectively. All regressions include a full set of years of birth dummy variables, regional dummies, gender, father's years of schooling, the dimension of the city the individual lives in and a full set of interactions between *Post* and province dummies. *t* statistics are in parentheses. All coefficients are significant at 99%, with the sole exception of those in Panel C.

Table 8: The intergenerational transmission channel (Cohort restriction)

<i>Panel A: Years of schooling (At least one parent)</i>			
	(1)	(2)	(3)
	Whole sample	Male	Female
$(Post)_c *(High)_r$	0.01	0.01	0.02
	(2.99)	(3.24)	(2.12)
N. obs.	90,228	44,226	46,002
R ²	0.26	0.26	0.28
<i>Panel B: Years of schooling (Emigrants excluded, treatment cohort included)</i>			
	(4)	(5)	(6)
	Whole sample	Male	Female
$(Post)_c *(High)_{rFather}$	0.08	0.07	0.07
	(7.14)	(8.19)	(6.23)
$(Post)_c *(High)_{rMother}$	0.09	0.07	0.10
	(8.12)	(9.12)	(9.27)
N. obs.	88,120	46,108	42,002
R ²	0.29	0.29	0.31

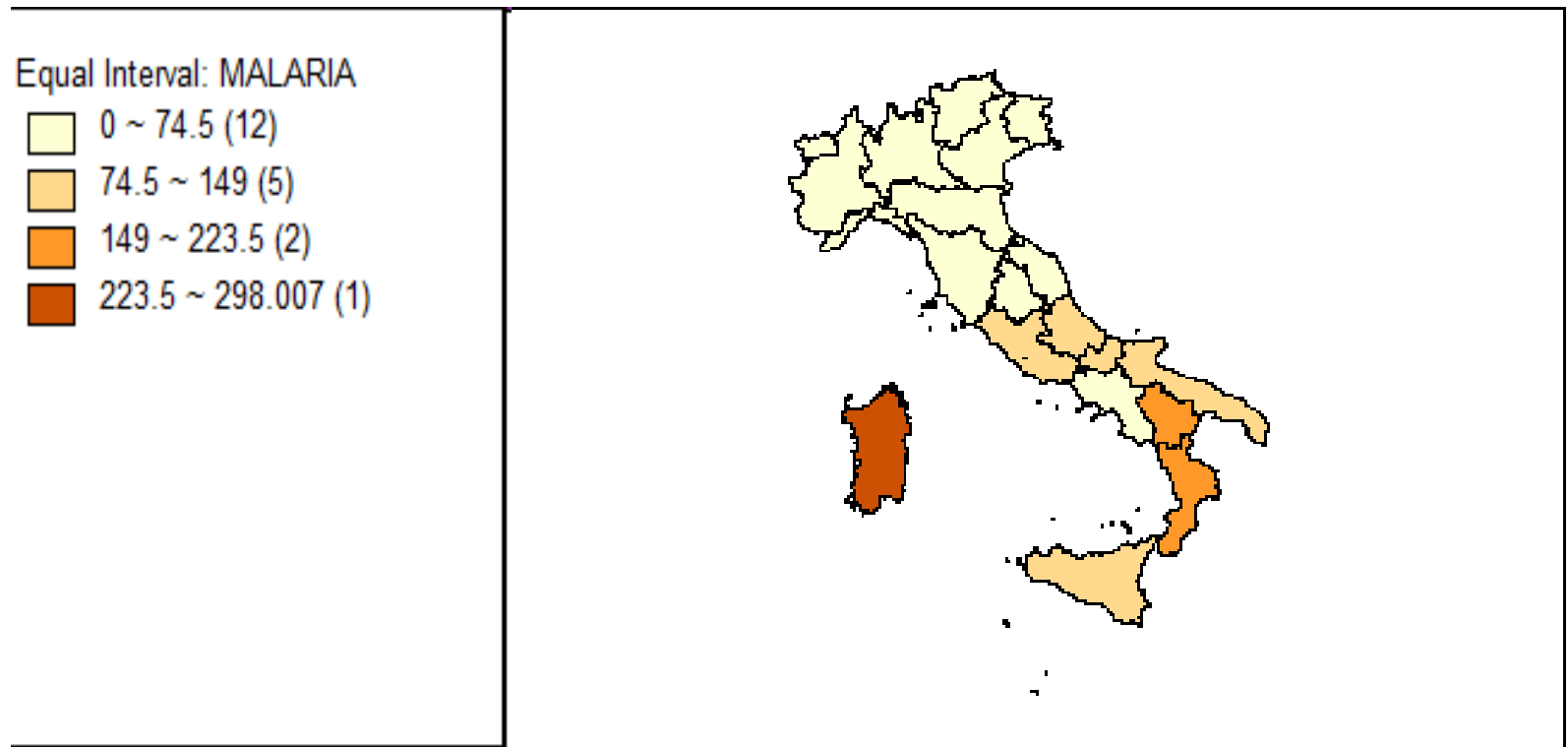
All regressions include a full set of years of birth dummy variables, regional dummies, gender, parents' birth cohorts dummy variables, the dimension of the city the individual lives in. t statistics are in parentheses. All coefficients are significant at 99%, with the sole exception of those in Panel C.

Figure 1: World distribution of malaria (2006)



Source: WHO

Figure 2: Distribution of malaria mortality rates in Italian regions (1891)



Source: See the text.

Figure 3: Malaria mortality over the time

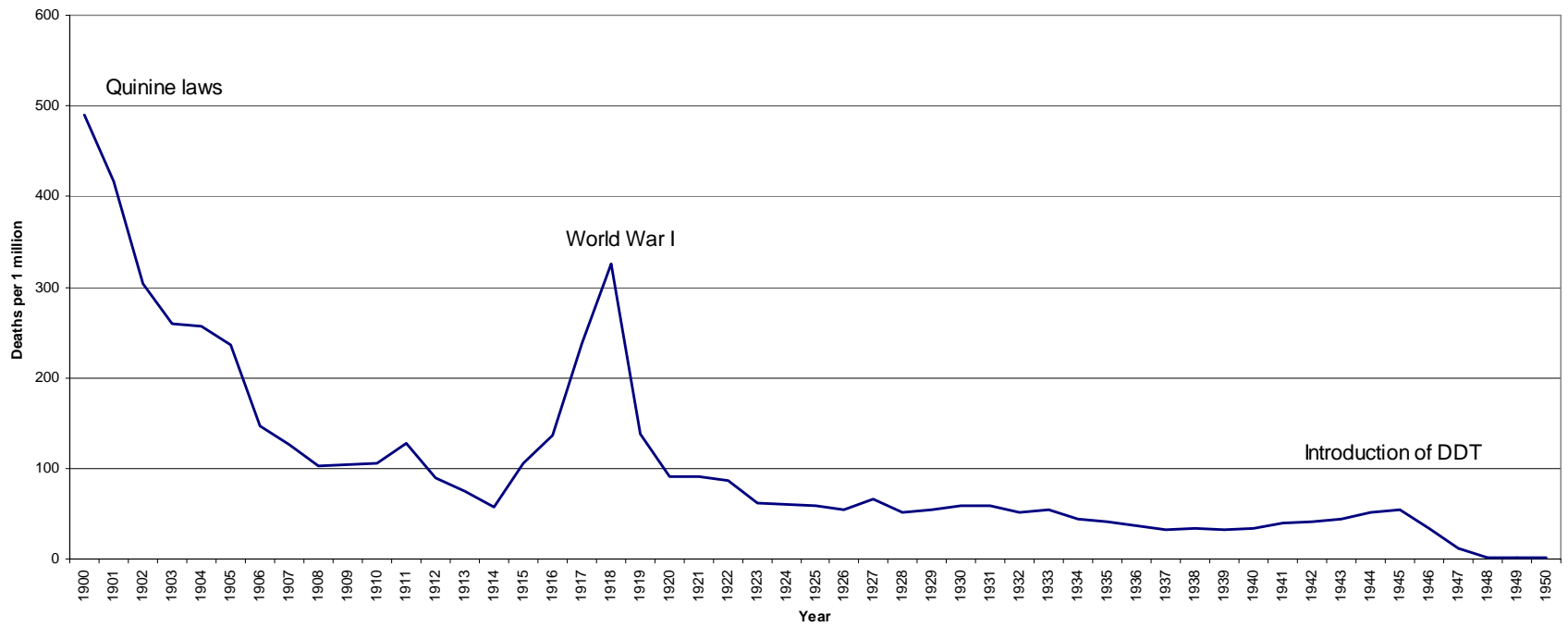


Figure 4: Mortality convergence

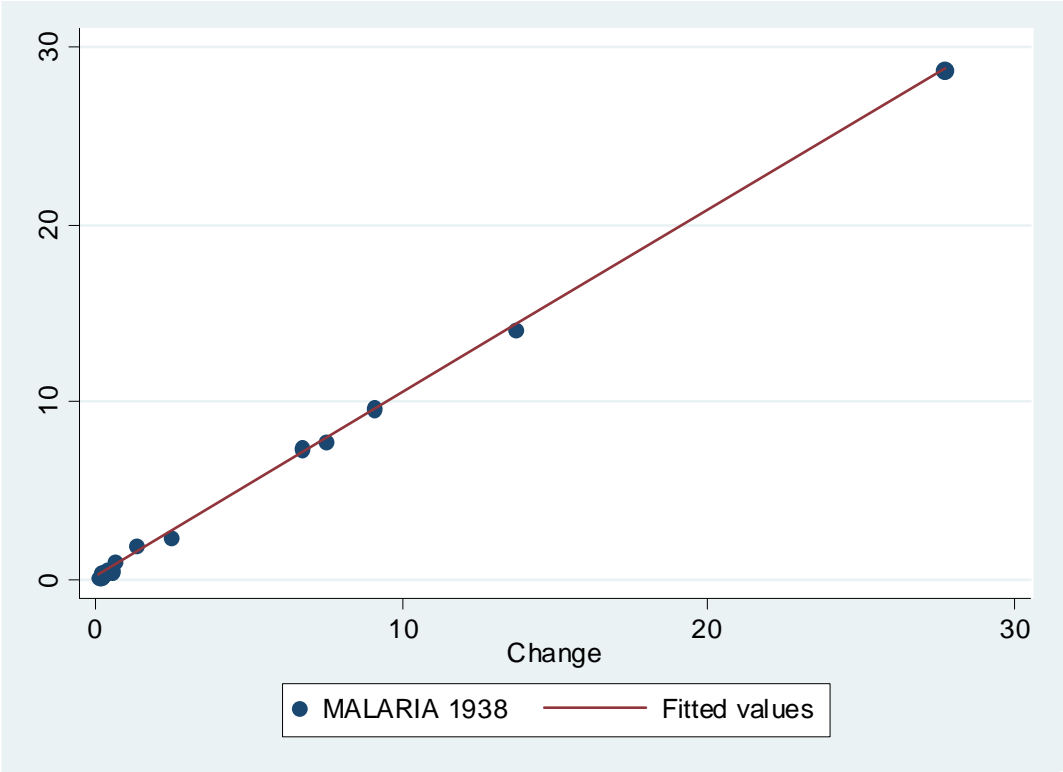
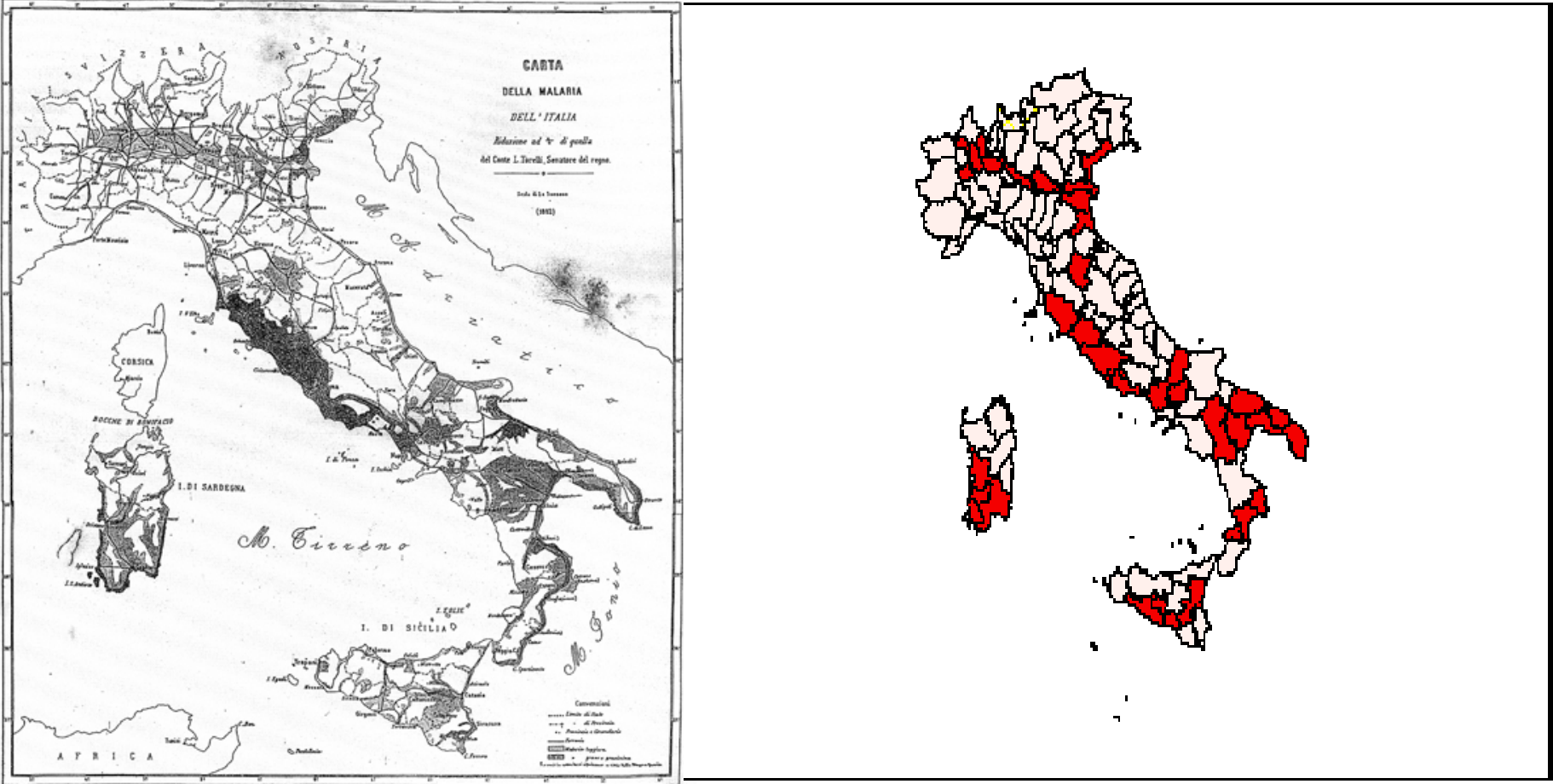


Figure 5: Distribution of malaria morbidity in Italian provinces (1882)



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