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Human capital, culture and the onset of the demographic transition

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Abstract

This paper uses estimates of the dates at which different countries have experienced their demographic transitions to examine the main historical determinants of these transitions. We first show that genetic distance to the United Kingdom, a measure of cultural relatedness used in Spolaore and Wacziarg (2009), is positively associated with the onset of the demographic transition, implying that countries that have a larger genetic distance from the UK tend to experience later transitions. We then unveil a plausible mechanism that can rationalize this result. We show that genetic distance to the UK is negatively related to a country's initial human capital, measured as its schooling level in 1870. One interpretation of this finding is that a larger genetic distance is associated with higher barriers to technological diffusion and hence a lower demand for human capital. This low demand for human capital then delays the demographic transition by providing less incentives for households to switch from quantity to quality of children. Instrumenting initial human capital using genetic distance to the UK and alternative measures of adherence to Protestantism, we confirm the causal link between human capital and the onset of the demographic transition. Further, we show that the impact of cultural relatedness to the UK can be mainly attributed to its effect on educational levels.

Keywords: education, culture, fertility transition, unified growth theory

JEL Classifications: J10, N10, O18, I20

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1 Introduction

The transformation of an economy from a regime of Malthusian stagnation - a situation in which income per capita any technological improvement is counterbalanced by a similar increase in the population growth rate, so that income per capita fails to increase- to one of sustained growth is fundamentally linked to the process of the demographic transition. By turning to negative the relation between income and fertility, this transition plays a key role in fostering human-capital investment and thus income growth (e.g. Galor and Weil, 1999; 2000). As a consequence, one would expect that countries that first experienced the onset of demographic transition would be relatively richer than those that experienced it later on or that have not yet experienced it. Figure 1 shows a scatterplot of per-capita income in the year 2000 and the year at which each country experienced its demographic transition. These dates have been estimated by Reher (2004) and identify permanent declines in birth rates,[1] assigning the year 2000 as the transition date for countries that had not yet experienced the onset.[2] The relation between these two variables is strongly negative, which is consistent with the importance of experiencing a demographic transition to enter the sustained growth regime.[3]

FIGURE 1 HERE

A recent strand of the literature highlights the role of culture in explaining economic development across countries (Guiso et al., 2006; Spolaore and Wacziarg, 2009). Spolaore and Warcziarg (2009) explain a significant fraction of income differences across countries using their genetic distance (relative to the technological frontier), which, according to their view, should measure barriers to the adoption and diffusion of new technology from this frontier. Their measure of genetic distance captures the general relatedness between populations: the closer two populations are in terms of genetic distance, the smaller their differences in traits and social norms (e.g., beliefs, habits, biases, etc.). On the other hand, the literature emphasizes also the role of historical human capital in promoting a country's development. Expansion of education is often regarded as one of the fundamental factors in economic development. Comparative analysis suggests that, among several factors, historical differences in human capital might be responsible for different paths of development observed during and after the colonization period. For example, Glaeser et al. (2004) argue that European settlers brought their human capital where they settled in large numbers, thus fostering technological progress, growth and better institutions.

Following Spolaore and Warcziarg (2009), who use genetic distance to the United Kingdom (UK) and the United States (US) as a proxy for cultural relatedness to the technological frontier, we show that genetic distance to the UK (US) has been important in shaping the timing of the fertility (or demographic)transition across countries. This result is consistent with an indirect channel working through technology diffusion as in Spolaore and Wacziarg (2009, 2011). Larger genetic distance to the technological frontier would delay technology adoption and lower productivity and the demand

[1]These data has been recently used and cited in several papers like for instance Galor (2012) and Andersen et al. (2010).

[2]We drop these 12 observations to avoid arbitrariness.

[3]Another channel through which the demographic transition may spur a country's per-capita income is the so-called demographic gift, by which a lower population growth rate decreases the dependency rate through its effect on the population age structure (Bloom and Williamson, 1998).

for human capital, consequently leading to a late onset of the fertility transition. The mechanism we highlight here follows Galor and Weil (2000) who argue that increasing technological progress boosts the demand for human capital and, because of the higher return to education, households eventually trade quantity for quality of children. When a significant fraction of families decides to have fewer and more educated children, the onset of demographic transition takes place. Therefore, culture and informal institutions, by affecting incentives to innovate and accumulate human capital, might have shaped the timing of fertility transitions and, consequently, the current distribution of income across countries throughout the world. Our reasoning is that genetic distance to the UK, through its effect on technology adoption and human capital accumulation, facilitate the onset of the transition, but this does not necessarily mean that the technological frontier has to be the first country to experience such transition.[4]

In our analysis we use the UK as the main reference country since it was the technological leader until the early twentieth century. However, given that most of the fertility transitions in our sample took place after 1950, we also consider using the US as the reference country.[5] The timing of the demographic transition differs widely across countries, as shown in Table 1, which lists the years at which the different countries reached their demographic transition as estimated in Reher (2004). Figure 2 displays a histogram of these dates.[6] As the data show, most of the countries that experienced the transition in the late 19th and early 20th centuries, were located in Western Europe. In contrast, most countries belonging to Asia, Africa, and Latin America experienced a late transition (that is, after 1950).

TABLE 1 HERE

FIGURE 2 HERE

In this paper we exploit cross-country variation to shed light on the determinants of the fertility transition around the world. Several mechanisms have been proposed to explain the fertility transition: a rise in the demand for human capital (Galor and Weil, 2000), a rise in income during industrialization (Becker and Lewis, 1973; Becker, 1981), a reduction in child and infant mortality rates (Coale, 1973; van de Walle, 1986; Sah, 1991; Galloway et al., 1998; Eckstein et al., 1999; Kalemli-Ozcan, 2002), and a reduction in gender gaps (Galor and Weil, 1996; Goldin, 1990; and Lagerlöf, 2003).[7] Data limitations prevent us to run a formal horserace between these competing explanations of the triggers of the demographic transition. Instead, our goal is to explore the contribution of a specific variable to this process and rationalize the mechanism through which it operates. In particular, here we focus on a country's cultural relatedness to the technological frontier and show that its impact can be mainly attributed to its effect on human capital accumulation. We also test whether other measures of historical institutions - executive constraints and polity2 scores- are related to the

[4]There are other factors that are important in explaining the onset of fertility transitions across countries. In fact, the UK, which belongs to the group of "early" transitions (i.e. before 1950) is not the first country experiencing the onset - Sweden had its transition in 1865, according to Reher.

[5]In our largest sample 23 out of 124 countries experienced the onset of the transition before 1950, excluding the countries assigned a transition in the year 2000.

[6]Some of Reher's onset dates differ from other sources (Coale and Watkins, 1986 and Bailey, 2009). In Sections 3.3 and 4.3 we check the robustness of our results using alternative dates.

[7]Guinnane (2011) and Galor (2012) provide reviews of the factors behind fertility transitions.

onset of the demographic transition across countries. Contrary to the proxy of informal institutions (i.e. genetic distance), these alternative measures of historical formal institutions do not show a robust relationship with the year of the onset. This result is consistent with cultural relatedness to technological frontier favouring technology adoption (Spolaore and Wacziarg 2009, 2011) which foster human capital accumulation and the onset of the fertility transition (Galor, 2012). Figure 3 shows a strong positive correlation between the demographic transition years and genetic distance to the UK.

The main findings of our paper can be summarized as follows. First, a large genetic distance with respect to the UK (US) delays a country's demographic transition. Second, when we instrument a country's schooling levels in 1870 with genetic distance to the UK and the percentage of Protestants in the population -or alternatively with a country's physical distance from Germany- we find a strong causal effect of human capital on the onset of the demographic transition, as predicted by Galor and Weil (2000).The mechanism behind this relationship is as follows. Genetic proximity to the UK enhances a country's demand for human capital. Protestantism, on the other hand, is associated with a boost in the supply of human capital. These two effects enhance human capital accumulation which in turn induces families to reduce their offspring, triggering the demographic transition.

FIGURE 3 HERE

The paper is organized as follows. Section 2 summarizes the sparse empirical literature that has attempted to isolate different triggers of demographic transitions across countries. Section 3 describes the data and methodology used in the analysis. Section 4 presents the finding that genetic distance from the UK is a robust determinant of the onset of the demographic transition across countries. Section 5 illustrates the mechanism at work. Finally, Section 6 concludes.

2 Literature Review

Since our contribution is purely empirical, in this section we limit ourselves to discussing the empirical papers that analyze possible triggers of demographic (or fertility) transitions.[8] In the tradition of the so-called "demographic transition theory" (Notestein, 1945), the Princeton European Fertility Project (e.g., see Coale and Watkins, 1986) was one of the first comprehensive studies that used data from the 19th century to document different demographic transitions in Europe and analyze their possible triggers. The emphasis in this project, however, was mainly on cultural and sociological explanations, ignoring economic factors. More recently, the development of unified growth theories that seek to explain economic growth in the very long run has spurred interest in identifying the role of different socio-economic factors in explaining demographic transitions.

The first–and most common– methodological approach has been to study the correlation between fertility and income at different time periods. For instance, using a sample of countries in the 1960-1999 period, Lehr (2009) examines the existence of different regimes in terms of fertility dynamics. She finds that, at early stages of development, increases in productivity and primary schooling-enrolment are typically associated with increases in fertility. In contrast, at higher levels

[8] The literature review in Galor (2012) also includes theoretical papers.

of development, productivity and education are shown to be negatively associated with fertility, whereas the level of parents' human capital has a somewhat positive effect. In all periods, increases in secondary-schooling enrolment are correlated with drops in fertility rates. Murtin (2012) uses data for a large panel of countries since 1870 and concludes that education is the main trigger of changes in the birth rate and that the effect of health improvements is of second order. Becker et al. (2010) use data on Prussian counties in 1849 and identify a positive relationship between child quantity and education in a context in which the demographic transition has not yet taken place. Another finding of their study is that the initial level of education is a good predictor of the demographic transition that occurred in Prussia during the 1880-1905 period. Finally, Murphy (2009) analyzes historical French département data for the late 19th century and finds that both economic and cultural factors had an effect on different fertility patterns across these geographical units. In particular, education, measured as female literacy and child enrolment in primary schools, has a negative impact on fertility, whereas wealth is correlated with larger family sizes.[9]

A different approach is to use information on the years of the onset of demographic transitions in different countries to directly identify their main historical determinants. Andersen et al. (2010) use this strategy to analyze how cataract incidence explain cross-country variation in labour productivity. They argue that an earlier onset of vision loss reduces the return to human capital, and hence delays the demographic transition.

3 Data and Methodology

3.1 Baseline analysis

In our baseline analysis our main variable of interest is a proxy of informal institutions. Specifically we consider a measure of cultural relatedness, genetic distance to the UK (or the US) taken from Spolaore and Wacziarg (2009) -SW henceforth- aiming to capture cultural proximity to the technological frontier.[10]

We first investigate the effect of genetic distance to the UK on the timing of the fertility transition across countries by estimating the following model using ordinary least squares (OLS):[11]

$$log\, onset_i = \beta_1 + \beta_2 * log\, gendist_{i,UK} + \beta_3' X_i + \varepsilon_i \quad (1)$$

[9] There are several studies that focus on the closely related children's quantity-quality trade-off. For instance, Rosenzweig and Wolpin (1980) were the first to use exogenous variations in fertility to identify the effect of child quantity on child quality. They instrumented child quantity with increases in family size resulting from multiple births and show that child quantity significantly reduces children's education. Bleakley and Lange (2009) explore the causal effect of education on fertility by exploiting the eradication policy of the hookworm disease in southern states in North America. Their paper argues that this eradication increased the return to schooling and hence reduced the price of child quality. This exogenous change, in turn, increased school attendance and reduced fertility. Other relevant papers are Angrist et al. (2005), Black et al. (2005), and Qian (2009). See Schultz (2008) for a summary of this literature.

[10] Throughout our analysis we use the measure *weighted genetic distance* that accounts for sub-populations' genetic groups. The other measure provided by Spolaore and Wacziarg (2009), named *dominant genetic distance*, considers only the largest groups of each country's population.

[11] We take logs of the two key variables to reduce the impact of outliers.

where $log\,onset_i$ represents (the log of) the year of the onset of the demographic transition in country i, $log\,gendist_{i,UK}$ represents (the log of) genetic distance to the UK in country i, X_i is a set of country i control variables, and ε is a standard error term. X_i includes different sets of standard determinants of long-run development and productivity used in the literature. To account for the potential effect of geography and climate, we control for the absolute latitude of a country's centroid, the average distance to the nearest ice-free coast, the malaria ecology index, and a set of continental dummies (Africa, Asia, Europe, North America, and South America). The historical variables included in the regressions are population density in 1400 and the years passed since the Neolithic revolution (i.e. the agricultural transition).[12] We also control for the type of legal origins (British common law, French civil law, socialist law, German civil law, and Scandinavian law) and the 1900 shares of protestants, catholics and muslims.[13]

Table 2 in the Appendix contains the definitions and sources of all the variables used in the cross-sectional exercise.

TABLE 2 HERE

3.2 Bilateral analysis

In this section we follow an approach similar to SW. We assess whether the role of cultural relatedness to the technological frontier as a determinant of the demographic transition is still present using a bilateral approach considering countries pair by pair. One advantage of this approach is that it makes use of a much larger dataset and so it helps increasing the precision of our estimates. To do so, we regress the distance in the onset of the demographic transition between each pair of countries on their genetic distance relative to the UK (US) and on a set of controls very similar to those of SW aimed at capturing geographical, climatic, and historical differences which can be interpreted as distances. We account for the effect of geographical distances by including the absolute difference in latitudes and longitudes, the geodesic distance between countries, a dummy that takes a value of one if both countries in the pair are contiguous, a dummy that takes a value of one if at least one country is landlocked, a dummy that takes a value of one if at least one country is an island, and a measure of climatic similarity based on 12 Koeppen-Geiger climate zones.[14] We also add as covariates a set of dummies that take a value of one if two countries in a pair are located in the same continent. We include a measure of transportation costs based on freight rates for surface transport (sea or land).[15] To control for common historical and cultural characteristics we use a dummy taking a value of one if both countries in a pair share the same legal origins, and zero otherwise; a dummy taking a value of one if both countries in a pair share the same colonial origins, and zero otherwise; and a dummy taking a value of one if both countries share a common official language. As for climate, religious similarity is measures with the average absolute value difference, between two countries, in the percentages of religions followers in 1900 in each of 10 religious categories. All

[12] Data on the agricultural transition are from Louis Putterman's Agricultural Transition Year Country Data Set.

[13] Religion adherence is particularly important in our context as some religions differed substantially in the promotion of literacy and education (Ferguson, 2011).

[14] This is measured as the average absolute value difference in the percentage of land area in each of the 12 climate zones between two countries.

[15] Transportation-cost data is from http://www.importexportwizard.com/. The measure refers to 1000kg of unspecified freight transported over sea or land, with no special handling.

variables used in this section, along with their sources, are listed in Table 4 of the Appendix. Our estimation model in this case is the following:

$$|log\, onset_i - log\, onset_j| = \alpha + \beta |log\, gendist_{i,UK} - log\, gendist_{j,UK}| + \gamma' Q_{i,j} + \epsilon_{i,j} \qquad (2)$$

where $|log\, onset_i - log\, onset_j|$ represents the absolute value of the log difference in the year of the onset of the demographic transition between country i and j, $|log\, gd_{i,UK} - log\, gd_{j,UK}|$ represents the absolute value of the genetic (log) distance relative to the UK between country i and j and $Q_{i,j}$ includes the mentioned measures of geographical, climatic and historical distances between country i and j. Finally, $\epsilon_{i,j}$ is the error term associated with the country pair ij.[16] This approach allows us to investigate whether differences (and similarities) in culture (relative to the UK and the US) explain the distance in the timing of the onset of demographic transitions between pairs of countries. Specifically, we ask whether similar (different) timing in the onset is explained by similar (different) culture (relative to the UK and US), controlling for the effect of similar (different) geographical, climatic, and historical contexts.

TABLE 3 HERE

3.3 Robustness checks

Next we perform two robustness checks. First, we use alternative dates for the onset of fertility transitions for those who experienced an "early transition". Reher's dates might be criticized especially for some countries as France which are assigned a relatively late onset. To account for this, we use dates from Coale and Watkins (1986) and Bailey (2009) which are directly related to the European Fertility Project. Using alternative onset dates is a sensible thing to do, since some of Reher dates have been criticized on two grounds. First, some of the "early" transitions in Reher seem to take place too late. This seems to be the case for instance in France, where other sources suggest that the demographic transition took place around 1827 rather than 1900. Second, there seems to be too much bunching across demographic transition years in the Reher estimates- all the dates occur precisely at the beginning of a decade or exactly in the middle of it. Table 4 shows the discrepancies in the dates calculated by Reher (2004), Coale and Watkins (1986) and Bailey (2009). The first thing to notice is that the discrepancies only occur in Western countries, the ones that were the focus of Coale and Watkins (1986) and Bailey (2009). Second, the Coale-Watkins dates and the Bailey's ones are very similar in most cases. One exception is France, for which Coale-Watkins estimate that the demographic transition took place in 1827, while Bailey's date is 1814. There is also a ten year discrepancy for the case of Hungary. Most importantly, the Coale-Watkins and Bailey dates precede the Reher one's in all cases except for Hungary, Spain, and Sweden.

TABLE 4 HERE

[16]As Spolaore and Wacziarg (2009) point out, spatial correlation results from the construction of the dependent variable. We follow their strategy to address this issue by using two-way clustered standard errors.

The second robustness check we perform is to control for alternative measures of formal historical institutions, namely executive constraints and an index of democracy scores in 1850 and 1900.[17] Although there is no formal theory that directly links the demographic transition to the quality of institutions it can be the case that human capital promotion is enhanced by a well-functioning institutional framework.

4 Results: genetic distance to the technological frontier and the onset of fertility transition

4.1 Cross-section baseline regressions

Following SW, genetic distance might indirectly affect the timing of the fertility decline as it proxies for a cultural environment favourable to technological progress and adoption of innovations. This would favour education and human capital accumulation, then triggering an earlier onset of the demographic transition (Galor, 2012). Here we test for the existence of this indirect channel. In Section 5 we will provide evidence suggesting that this mechanism is plausible and that the effect of genetic distance from the technological frontier on the timing of the onset of the fertility transition is accounted by historical levels of educational attainments.

Table 5 shows the estimation results obtained by regressing the timing of the fertility transition on genetic distance to the UK. Specification 1 simply uses the log of genetic distance to the UK as regressor. Its impact is positive and statistically significant, suggesting that a larger genetic distance from the UK (i.e. a larger difference in the cultural environment with respect to the technological frontier) delays the onset of the demographic transition. This estimate is qualitatively similar if one adds geography and climate, history, legal origins, and religion as controls. Including all these regressors simultaneously in the same specification does not significantly alter the results (column 6); the same applies when considering genetic distance to the US (column 7) which, as mentioned above, it may be considered the technological frontier after 1950. [18]

The size of these estimates is quantitatively important. The coefficients from specification (6) suggest that, for instance, if Lesotho had been culturally as similar –in terms of genetic distance– to the British population as Spain, then it would have experienced a demographic transition twenty-eight years earlier than what the model predicts (in 1944 rather than 1972).[19]

TABLE 5 HERE

[17]The variables we use are *xconst* and *polity2* from the data set Polity IV and measure a country's institutional framework. See Marshall and Jaggers (2008) for a detailed description.

[18]The coefficient associated with a quadratic term - not reported here - is negative in all but the last two specifications, suggesting nonlinearities in the relationship between the timing of the DT and genetic distance to the technological frontier.

[19]To calculate this effect we use the values of the different covariates for Lesotho and Spain and the estimates of the different parameters to compute their predicted log transition year and we then use the exponential function to find out the actual year.

4.2 Bilateral analysis

Table 6 shows the OLS estimates obtained from the regression in equation (2). In column (1), where we do not add any control variable, larger differences in genetic distance (relative to the UK) are associated with larger time distances in the onset of demographic transition. In columns (2) to (5), we add different controls. In particular, column (2) adds measures of geographical differences, column (3) includes a measure of climatic similarity, column (4) includes a set of continental dummies, whereas column (5) adds the measure of transportation costs described above. Throughout all specifications, including column (6) where we add all the controls, larger genetic distances (relative to the UK) are associated with wider differences in the timing of the fertility transition. In columns (7)-(9) we add controls for similar legal origins, colonial history, language and religion, respectively. The inclusion of these variables affects neither the significance nor the size of the coefficient associated with the difference in genetic distance relative to the UK. These results again provide strong evidence of the importance of cultural differences–specifically relative to the technological frontier–in determining international differences in the onset of the demographic transition.

TABLE 6 HERE

4.3 Robustness checks

Using alternative dates of the onset of fertility decline for some of the transitions (mainly "early" ones, which correspond to Western countries) does not alter our main result as it can be noticed by looking at Table 7.[20] If anything, the association is strengthened as, in all cases, the coefficients of interest are larger in absolute value using these onset dates.

TABLE 7 HERE

We also test the role of formal institutions on the timing of demographic transition using different proxies as executive constraints and a democracy index scores measured in 1850 and 1900 (from the data set Polity IV, see Marshall and Jaggers 2008). The question we ask here is whether the effect of genetic distance to the technological frontier on the timing of the onset of the fertility transition is robust to controlling for early formal institutions.[21] Consistent with our hypothesis, Table 8 shows that the effect of genetic distance to the UK is still positive and significant in spite of the considerable drop in the number of observations while these proxies of formal institutions do not have a significant effect.

TABLE 8 HERE

[20]For the sake of brevity we only report the results using the alternative dates from Coale and Watkins (1986). Considering the Bailey (2009) dates gives us almost identical estimates.

[21]When using measures of formal institutional quality in 1900 we exclude four countries that experienced the onset of the transition before (or in 1900) to avoid reverse causality issues. These are: Hungary, Germany, Sweden and Uruguay.

5 Verification of the mechanism: genetic distance to technological frontier, education and fertility transition

In this section we provide evidence supporting the channel of causation we think might be driving our results. Specifically we show that the impact of cultural relatedness to the technological frontier on the onset of fertility transition can be attributed mainly to its effect on human capital accumulation. This is consistent with the idea that cultural relatedness to the technological frontier favoured technology adoption (Spolaore and Wacziarg 2009, 2011) which in turn fostered human capital accumulation and the onset of the fertility transition (Galor, 2012).

As a first step we show that genetic distance to the technological frontier is an important determinant of historical educational attainments. We use average years of education in the population aged 15-64 from Morrisson and Murtin (2009) in the year 1870 to capture historical schooling levels. As we can notice in Table 9, genetic distance to the UK has a negative and significant effect on schooling in 1870, in line with our reasoning, even after controlling for geography and climate, legal origins, history and religion.

TABLE 9 HERE

Our strategy to disentangle the mechanism at work goes as follows. We use genetic distance to the UK as an instrument for schooling levels in 1870 to assess the impact of historical education levels on the timing of the onset of fertility transitions across countries. In order to show that we can plausibly argue that genetic distance to the UK affected the onset of fertility transitions only through education –by favouring technology adoption– we use additional instruments so that we can use an overidentification test to check whether the instruments are valid. The additional instruments we use are the share of Protestants in 1900 and a country's (log) distance from Germany. The former is likely to capture heterogeneity in the incentives to get educated. As Ferguson (2011, pp. 259) points out, adherents to Protestantism had a big incentive to become educated, in order to be able to read and interpret the Bible by themselves –a crucial element of Protestantism–:

> *"Because of the central importance in Luther's thought of individual reading of the Bible, Protestantism encouraged literacy, not to mention printing, and these two things unquestionably encouraged economic development (the accumulation of 'human capital') as well as scientific study. This proposition holds good not just for countries like Scotland, where spending on education, school enrolment and literacy rates were exceptionally high, but for the Protestant world as a whole. Wherever Protestant missionaries went, they promoted literacy, with measurable long-term benefits to the societies they sought to educate; the same cannot be said of Catholic missionaries throughout the period of the Counter-Reformation to the reforms of the Second Vatican Council (1962-5)"*

Following Ferguson's argument, we also use as an additional instrument the (log) distance to Germany. This would capture the heterogeneity in the spread of the Protestant reform which started in Germany in the early 16th century.[22]

[22] The logic is similar to Becker et al. (2010) who use distance to Wittenberg as an instrument for education in a cross-county framework in 19th century Prussia.

Table 10 displays the results from the first and second stage of the IV regressions. We run regressions without additional controls in columns (1,2,5,6) and including the controls used previously, that is geography and climate, history and legal origins (columns 3,4,7,8). As it can be noticed, the instruments are well correlated with the endogenous variable and in all cases we cannot reject the null hypothesis that the instruments are valid. The Hansen-J test checks if genetic distance to the UK and the additional instrument have an effect on the onset of fertility transitions that goes beyond their effect on initial (historical) educational attainments. As we cannot reject instruments validity throughout all specifications, it's likely that genetic distance (which should capture cultural differences) with respect to the technological frontier affected the onset of fertility transitions through education and human capital accumulation. This result is in line with the reasoning that cultural distance to the technological frontier affected the diffusion of technology and this, consequently, affected the incentives for human capital accumulation, the quantity-quality trade off and the timing of the onset of fertility decline.

As we saw above, the estimated coefficients have a strong economic significance. Using the estimates from the last column of Table 10 we can make the following calculation. Suppose it would have been possible to rise the schooling level of a country like India in 1870 to the level of Switzerland, keeping everything else constant. In that case, our IV model predicts that India would have then experienced its demographic transition in 1925, rather than in 1966, forty-one years earlier.

TABLE 10 HERE

6 Conclusion

This paper contributes to our understanding of the main determinants of the demographic transitions across a large sample of rich and developing countries. We provide evidence suggesting that a specific type of informal institutions - or culture-, genetic distance to the technological frontier (the UK or the US), has been a crucial factor of the timing of the fertility transition across these economies. We provide evidence that genetic distance to the technological frontier affected the timing of the onset of the fertility transitions through an indirect channel working through technology diffusion as suggested in Spolaore and Wacziarg (2009, 2011). A larger genetic distance to the technological frontier would delay technology adoption and lower the demand for human capital, consequently leading to a late onset of the fertility transition (Galor, 2012). We first estimate a reduced form regression in which genetic distance to the UK is a strongly significant variable in explaining the timing of the demographic transitions across countries, even after controlling for a large set of geographical and historical variables. We show that these estimates are robust to considering a bilateral analysis that compares pairs of countries in terms of their onsets of the demographic transitions and their differences in terms of their distance to the UK and to different estimates of the demographic transition dates. Finally, we unveil a plausible mechanism that may be behind this reduced form. A large cultural difference with respect to the UK may be proxying a lower technological adoption and less incentives to accumulate human capital, which in turn may delay the onset of the demographic transition. We test this possible channel by instrumenting a country's initial levels of human capital with genetic distance from the UK, and two measure of the degree of spread of Protestantism, a religion known for its emphasis on the promotion of human capital among its followers. Our finding that cultural characteristics matter as triggers of demographic transitions may be seen as a bridge between the literature that emphasizes the importance of economic determinants of these transitions (e.g. Galor, 2012) and the one that points to purely cultural factors (e.g. Coale and Watkins, 1986).

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Table 1: Reher's (2004) estimates of the onset of the demographic transition

Albania 1965	Denmark 1910	Korea, Rep. 1960	Portugal 1925
Algeria 1975	Djibouti 1985	Korea, Dem. Rep. 1970	Qatar 1955
Angola 1995	Dominican Rep. 1965	Kuwait 1975	Romania 1935
Antigua 1960	Ecuador 1970	Kyrgyzstan 1965	Rwanda 1995
Argentina 1910	Egypt 1965	Laos 1995	Saudi Arabia 1980
Armenia 1965	El Salvador 1965	Lebanon 1965	Senegal 1980
Austria 1915	Eritrea 1990	Lesotho 1985	Seychelles 1955
Azerbaijan 1965	Ethiopia 1990	Liberia 1995	Singapore 1955
Bahamas 1965	Finland 1915	Libya 1980	South Africa 1975
Bahrain 1970	France 1900	Madagascar 1990	Spain 1910
Bangladesh 1980	Gambia 1985	Malawi 1980	Sri Lanka 1960
Barbados 1955	Georgia 1965	Malaysia 1965	Sudan 1980
Belgium 1905	Germany 1900	Mali 1995	Suriname 1965
Belize 1965	Ghana 1985	Mauritania 1980	Swaziland 1975
Benin 1985	Guatemala 1985	Mauritius 1960	Sweden 1865
Bhutan 1995	Guinea 1995	Mexico 1970	Switzerland 1910
Bolivia 1975	Guyana 1965	Mongolia 1975	Syria 1985
Botswana 1975	Haiti 1985	Morocco 1965	Taiwan 1955
Brazil 1965	Honduras 1985	Myanmar (Burma) 1975	Tanzania 1975
Brunei 1960	Hungary 1890	Namibia 1990	Thailand 1965
Bulgaria 1925	India 1960	Nepal 1995	Togo 1985
Burundi 1995	Indonesia 1970	Netherlands 1910	Trinidad and Tobago 1965
Cameroon 1980	Iran 1985	Nicaragua 1985	Tunisia 1965
Canada 1905	Iraq 1975	Niger 1985	Turkmenistan 1965
Central Afr. R. 1990	Israel 1955	Nigeria 1995	United Kingdom 1910
Chile 1960	Italy 1925	Norway 1905	United States 1925
China 1970	Ivory Coast 1985	Oman 1995	Uruguay 1890
Colombia 1965	Jamaica 1925	Panama 1970	Uzbekistan 1965
Comoros 1990	Japan 1950	Paraguay 1985	Venezuela 1965
Costa Rica 1965	Jordan 1975	Peru 1975	Vietnam 1980
Cuba 1920	Kenya 1980	Philippines 1955	Zambia 1980 Zimbabwe 1970

Excluding countries that were assigned the onset in the year 2000. These are: Afghanistan, Burkina Faso, Chad, Congo, Democratic Republic of Congo, Gabon, Guinea Bissau, Mozambique, Sierra Leone, Somalia, Uganda, Yemen.

Table 2: Variables and data sources: cross-section analysis

Variable name	Description and/or source
Onset of the demographic transition	Beginning of the first quinquennium after a peak where birth rates decline by at least 8% over two quinquennia and never increase again to levels approximating the original take-off point (Reher 2004; Bailey 2009)
Genetic distance to the UK (USA), weighted	Time elapsed since two populations last common ancestors (Spolaore and Wacziarg 2009)
Executive constraints in 1850 and 1900	Extent of institutionalized constraints on the decisionmaking powers of chief executives, whether individuals or collectivities (Polity IV, version 3, 2008)
Polity2 score in 1850 and 1900	Unified polity scale that ranges from +10 (strongly democratic) to -10 (strongly autocratic) (Polity IV, version 3, 2008)
Absolute value of latitude of country centroid	Nunn and Puga (2011); Gallup et al. (2001)
Average distance to nearest ice-free coast	In 1000 km (Nunn and Puga 2011)
Continental dummies	Nunn and Puga (2011)
Malaria ecology index	Sachs et al. (2004)
Population density in 1400	Population per square kilometre (Nunn and Puga 2011)
Years passed since the Neolithic revolution	Putterman (2006)
Legal origins	Common law, French civil law, German civil law, Scandinavian law, and Socialist law (Nunn and Puga 2011)
Shares of religion followers in 1900	Robert Barro's website
Average years of education (age 15-64)	Morrisson and Murtin (2009)
Geodesic distance to Germany	http://www.cepii.fr/anglaisgraph/bdd/distances.htm

Table 3: Variables and data sources: bilateral analysis

Variable name	Description and/or source
Onset of the demographic transition	Beginning of the first quinquennium after a peak where birth rates decline by at least 8% over two quinquennia and never increase again to levels approximating the original take-off point (Reher 2004; Bailey 2009)
Genetic distance to the UK (USA), weighted	Time elapsed since two populations last common ancestors (Spolaore and Wacziarg 2009)
Absolute value of latitude of country centroid	Nunn and Puga (2011); Gallup et al. (2001)
Continental dummies	Nunn and Puga (2011)
Dummy for landlocked	Nunn and Puga (2011)
Dummy for island	CIA Factbook
Dummy for countries' contiguity	http://www.cepii.fr/anglaisgraph/bdd/distances.htm
Legal origins	Common law, French civil law, German civil law, Scandinavian law, and Socialist law (Nunn and Puga 2011)
Colonial history	British, French, Portuguese, Spanish, and other European (Dutch, Belgian, and Italian) colonial origin for countries colonized since 1700 (Nunn and Puga 2011)
Area in each Kopper climatic zone	Gallup et al. (2001)
Absolute value of longitude of country centroid	Nunn and Puga (2011); Gallup et al.(2001)
Geodesic distance between countries	http://www.cepii.fr/anglaisgraph/bdd/distances.htm
Common official languages between countries	http://www.cepii.fr/anglaisgraph/bdd/distances.htm
Shares of religion followers in 1900	Robert Barro's website
Transportation costs	http://www.importexportwizard.com/

Table 4: Alternative fertility transitions dates

Country	Reher	Coale-Watkins	Bailey
Austria	1915	1907	1908
Belgium	1905	1881	1882
Denmark	1910	1898	1899
England	1905	1892	1892
Finland	1915	1912	1911
France	1900	1827	1814
Hungary	1890	1910	1900
Italy	1925	1913	1912
Netherlands	1910	1897	1897
Norway	1905	1903	1904
Portugal	1925	1916	1916
Russia		1922	1922
Spain	1910	1920	1919
Sweden	1865	1902	1897
Switzerland	1910	1887	1886

Coale and Watkins (1986) also provide transition dates for Germany, Greece, Ireland, Russia, and Scotland. We omit those here since Reher does not include these countries in his sample. Bailey (2009) adds Bulgaria and Wales to this list.

Table 5: Cross-section OLS: determinants of the onset of fertility transitions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Log) Genetic distance to the UK	0.0093***	0.0024**	0.0106***	0.0085***	0.004**	0.0034**	
	[0.0008]	[0.0012]	[0.0011]	[0.0008]	[0.0017]	[0.0016]	
(Log) Genetic distance to the USA							0.0055*
							[0.0028]
Geography and climate	no	yes	no	no	yes	yes	yes
History	no	no	yes	no	yes	yes	yes
Legal origins	no	no	no	yes	yes	yes	yes
Religion	no	no	no	no	no	yes	yes
R-squared	0.49	0.73	0.53	0.61	0.78	0.81	0.8
Observations	124	116	114	124	109	108	108

**, **,* denotes statistical significance at 1% , 5% and 10% levels, respectively. Estimation with robust standard errors (reported in squared brackets). All regressions include a constant. Dependent variable: (Log) Onset of the demographic transition as in Reher (2004).

Table 6: Bilateral analysis: OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Genetic log distance relative to the UK	0.0081***	0.0071***	0.0078***	0.0075***	0.0081***	0.006***	0.006***	0.0058***	0.0057***
	[0.0008]	[0.0008]	[0.0008]	[0.0008]	[0.0008]	[0.0008]	[0.0008]	[0.0009]	[0.0008]
Geography	no	yes	no	no	no	yes	yes	yes	yes
Climate	no	no	yes	no	no	yes	yes	yes	yes
Continental dummies	no	no	no	yes	no	yes	yes	yes	yes
Transportation costs	no	no	no	no	yes	yes	yes	yes	yes
Legal origins, colonial history and language	no	no	no	no	no	no	yes	no	yes
Religion	no	no	no	no	no	no	no	yes	yes
Observations	7260	6328	6328	7260	7260	6328	6328	5995	5995

**, **,* denotes statistical significance at 1% , 5% and 10% levels, respectively. Standard errors are clustered (two-way) and reported in squared brackets using the Stata command “cluster”. All regressions include a constant. Dependent variable: Absolute log difference in the onset of the demographic transition.

Table 7: Cross-section OLS: alternative onset dates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Log) Genetic distance	0.0106***	0.004***	0.0121***	0.01***	0.0051***	0.0044***	
to the UK	[0.0011]	[0.0014]	[0.0013]	[0.0014]	[0.0014]	[0.0013]	
(Log) Genetic distance							0.0064***
to the USA							[0.0022]
Geography and climate	no	yes	no	no	yes	yes	yes
History	no	no	yes	no	yes	yes	yes
Legal origins	no	no	no	yes	yes	yes	yes
Religion	no	no	no	no	no	yes	yes
R-squared	0.53	0.73	0.58	0.6	0.78	0.8	0.79
Observations	124	116	114	124	109	108	108

**, **,* denotes statistical significance at 1% , 5% and 10% levels, respectively. Estimation with robust standard errors (reported in squared brackets). All regressions include a constant. Dependent variable: (Log) Onset of the demographic transition as in Reher (2004) and Coale and Watkins (1986).

Table 8: Cross-section OLS: alternative measures of historical institutions

	(1)	(2)	(3)	(4)
(Log) Genetic distance to the UK	0.0077***	0.0079***	0.0071**	0.0073***
	[0.0025]	[0.0025]	[0.0025]	[0.0024]
(Log of) Executive constraints in 1850	-0.0007			
	[0.0014]			
Polity2 in 1850		0.0001		
		[0.0003]		
(Log of) Executive constraints in 1900			-0.0019	
			[0.0017]	
Polity2 in 1900				-0.0001
				[0.0002]
Geography and climate	yes	yes	yes	yes
History	yes	yes	yes	yes
Legal origins	yes	yes	yes	yes
R-squared	0.9	0.9	0.91	0.91
Observations	36	36	39	39

**, **,* denotes statistical significance at 1% , 5% and 10% levels, respectively. Estimation with robust standard errors (reported in squared brackets). All regressions include a constant. Dependent variable: (Log) Onset of the demographic transition as in Reher (2004). In columns (3,4) onsets taking place before 1900 are dropped.

Table 9: Cross-section OLS: determinants of historical schooling levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Log) Genetic distance	-1.009***	-0.4709*	-1.1583**	-0.9417***	-0.7135**	-0.9101***	
to the UK	[0.1355]	[0.2393]	[0.1893]	[0.1522]	[0.2741]	[0.2564]	
(Log) Genetic distance							-1.592***
to the USA							[0.5778]
Geography and climate	no	yes	no	no	yes	yes	yes
History	no	no	yes	no	yes	yes	yes
Legal origins	no	no	no	yes	yes	yes	yes
Religion	no	no	no	no	no	yes	yes
R-squared	0.52	0.66	0.59	0.68	0.77	0.85	0.83
Observations	68	67	66	68	65	65	65

**, **,* denotes statistical significance at 1% , 5% and 10% levels, respectively. Estimation with robust standard errors (reported in squared brackets). All regressions include a constant. Dependent variable: average years of schooling in the population aged 15-64 in 1870.

Table 10: Genetic distance to UK, education and onset of DT. Cross-section IV: first and second stage

Dependent variable	Schooling in 1870				(Log) onset of fertility transition			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	First stage				Second stage			
Schooling in 1870					-0.0089***	-0.0096***	-0.004***	-0.0034**
					[0.001]	[0.0012]	[0.0015]	[0.0014]
(Log) Genetic distance	-0.8085***	-0.7186***	-0.7616***	-0.4992*				
to the UK	[0.1237]	[0.1914]	[0.2272]	[0.2885]				
Share protestants	3.0883***		3.4475**					
in 1900	[0.8173]		[1.3713]					
(Log) Distance to		-0.3973*		-0.8239**				
Germany		[0.2039]		[0.3451]				
Geography and climate	no	no	yes	yes	no	no	yes	yes
History	no	no	yes	yes	no	no	yes	yes
Legal origins	no	no	yes	yes	no	no	yes	yes
First stage F-statistic	60.38	27.74	9.31	7.04				
Hansen p-value					0.44	0.66	0.83	0.44
Observations	64	63	61	60	64	63	61	60

**, **,* denotes statistical significance at 1% , 5% and 10% levels, respectively. Estimation with robust standard errors (reported in squared brackets). All regressions include a constant. Schooling is average years of education in the population aged 15-64. The onset of the demographic transition is taken from Reher (2004): countries assigned the onset of the demographic transition before 1870 are not included in the sample.

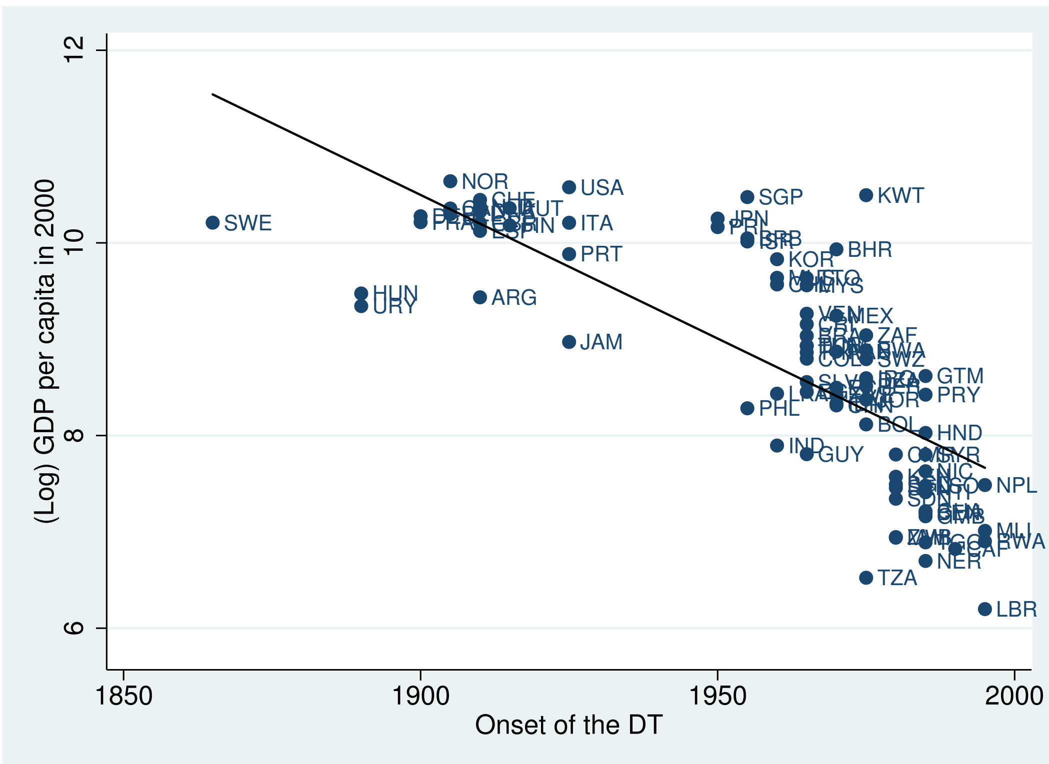

Figure 1: Onset of the demographic transition and GDP per capita in 2000

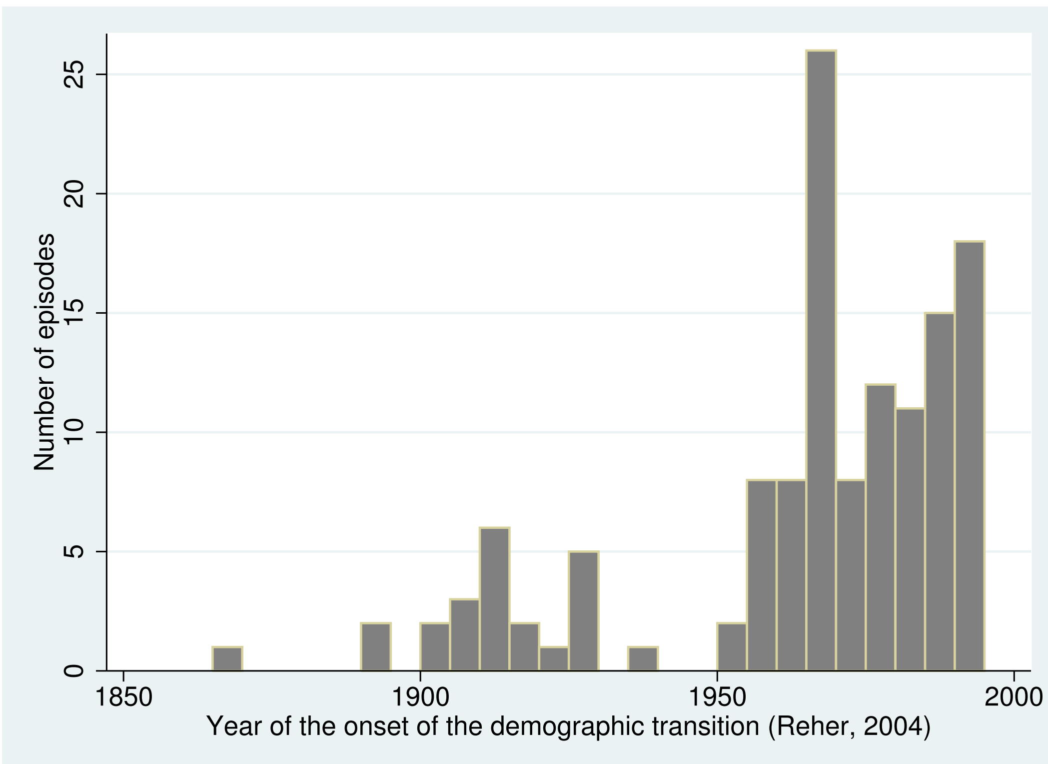

Figure 2: Year of the onset of the demographic transition (Reher, 2004)

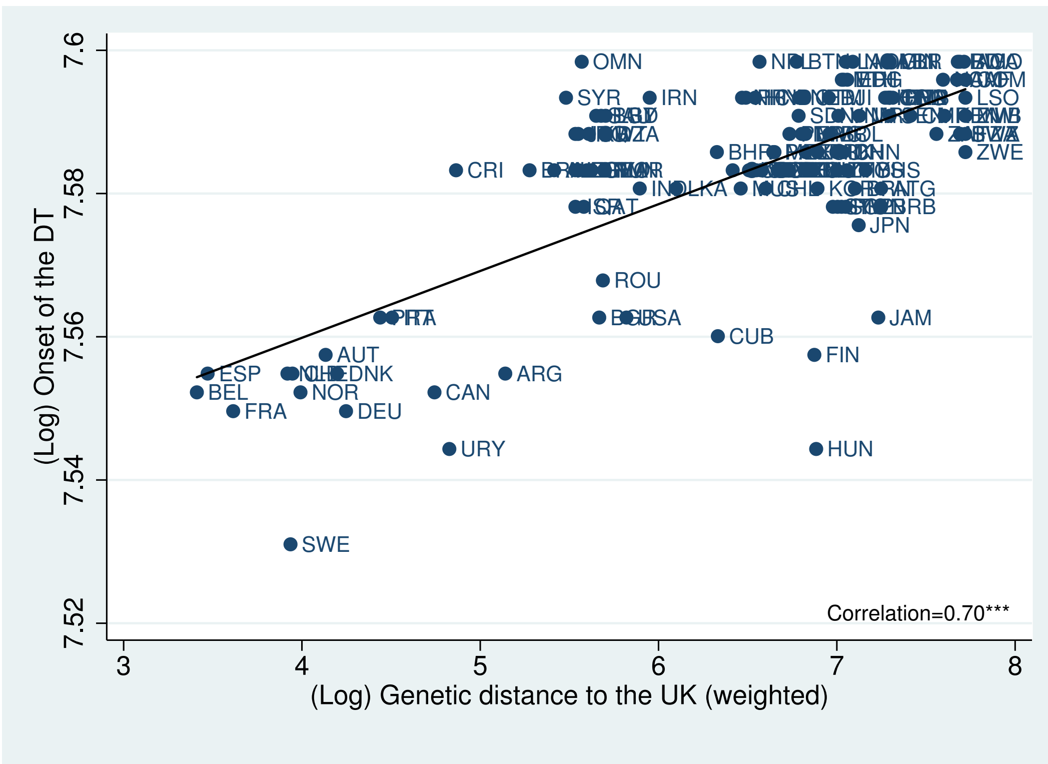

Figure 3: Genetic distance to the UK and the onset of the demographic transition