Climate the Emergence of Global Income Differences: Supplementary Appendix

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1. Data on UV radiation

NASA has developed the measure labeled UV-R in the text, and it is the end result of a somewhat complex mathematical calculation.[1] It takes as inputs total ozone column, the earth-sun distance, solar zenith angle[2], surface irradiance under clear skies, cloud optical thickness[3], and cloud attenuation factor[4], which all can be determined at a high resolution. NASA then expresses the resulting UV-R measure in units such that it speaks directly to how exposed people on the planet are to sunburn, as a consequence of UV-R. Or, put differently, the variable becomes an "index of the potential for biological damage due to solar irradiation, given the column ozone amount and cloud conditions on each day." In practice, this is done by attaching greater weight to UV-R with shorter compared to longer wavelengths. The weighting function is chosen such that it speaks to the susceptibility of Caucasian skin of getting sunburned as a consequence of UV-R, regardless of whether or not there are Caucasians at a particular location.[5] As a result, NASA formally labels our measure of UV-R the "Erythemal Exposure Data", with erythema meaning sunburn. Nevertheless, the variation we extract from the data in the context of our regressions derives from UV-R, and not from this particular choice of units (i.e., weights assigned to UV-R wave lengths), as they are the same everywhere on the planet. Moreover, the UV-R wavelengths that go into the measure are also the relevant wavelengths as far as cataract is concerned, i.e., below 400 nm (see e.g. Roberts, 2011).

Five remarks on our measure are important. First, while it does involve an input measuring the thickness of the ozone column, this is unlikely to make the resulting measure endogenous. As noted in the paper, local economic activity does not map into local ozone thickness in any simple way. Second, the measure does not factor in the effects from smoke plumes, originating from for example biomass burning. This would otherwise have been another way in which the UV-R measure could be endogenous to local conditions. Third, since distance to the sun depends on latitude and elevation, and since solar zenith angle also depends on latitude, the UV-R index is strongly correlated with these two factors. As a result, we control for them in the regressions. Fourth, surface irradiance under clear skies is calculated using the so-called Total Ozone Mapping Spectrometer (TOMS), which is a satellite instrument for measuring ozone values. TOMS calculates the irradiance incident on a horizontal surface at the terrain altitude of a given location. In the algorithm employed by TOMS, all inputs are *exogenous* to economic activity; in fact, they are largely explained by latitude and elevation.[6] Specifically, the inputs are solar zenith angle, azimuth angle, column ozone amount, pressure at the reflecting surface, and effective reflectivity at the reflecting surface. The first two measures are functions of latitude. Column ozone is not explained by local economic activity. Pressure is terrain height pressure, which is a function of elevation. Reflectivity at the surface in turn is simply assumed constant across the globe. Finally, remarks one to four imply that the remaining variation across countries and regions is effectively the result of the influence from cloud attenuation. We control for precipitation in our regressions, for which reason we are left with the variation in cloud attenuation that is orthogonal to precipitation. How can we understand this variation?

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[1] See http://ozoneaq.gsfc.nasa.gov/media/docs/erynotes.pdf.

[2] Solar zenith angle (SZA) is the angle between the local zenith (i.e. directly above the point on the ground) and the line of sight from that point to the sun. This means that the higher the Sun is in the sky, the lower the SZA is.

[3] Optical thickness is a measure of the fraction of UV radiation, which is not absorbed on a path. Clouds are formed by small water droplets or ice crystals, so UV-R is scattered when passing through them, resulting (in general) in extinction or diminished transmissivity of the atmosphere (Calbó et al. 2005).

[4] Attenuation depends on different cloud properties in complicated and partly unknown ways.

[5] This particular choice of units is presumably motivated by a demand by e.g. meteorologists, who wish to give the public a sense of the daily risk of sunburn, with an eye to potential risks of eventually contracting skin cancer.

[6] See http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20010044085.pdf.

Climatic research has demonstrated that cloud attenuation of UV depends on many different properties of the cloud cover, including cloud amount, cloud thickness, cloud type, relative position between the sun and the clouds, and the number of cloud layers (see Calbó et al., 2005). Surface UV-R is sometimes affected by clouds in such a manner that it is higher under partially cloudy than under cloudless conditions, an effect known as *cloud enhancement* (Calbó et al., 2005; Yordanov et al. 2013). However, the magnitude of cloud enhancement is not well established. More generally, clouds are one of the major uncertainties in the estimation and forecasting of UV-R trends. Calbó et al. (2005, pp. 7-8) argue that clouds are "probably the factor that introduces most uncertainty when describing UV flux variability" and "the effects of clouds are quite complex and depend on cloud characteristics (usually unknown or only partially known)". Consequently, the variation we use for identification is impossible to pin down further, given the present state of knowledge. Yet, given the complexity and the many unknowns in the relationship between UV-R and clouds, it may be appropriate to think of the residual UV-R variation as essentially random for the purposes of our empirical analysis. Below we also provide a direct test of whether economic activity appears to impact on our UV-R measure; anticipating our results, we find no such indication.

For the 1x1 latitude-longitude pixel-level analysis (Tables 3-4 and 8 in the main text), we rely on the simple average of the raw UV-R data. Following Dell, Olken and Jones (2009) and Acemoglu and Dell (2010), we compute population-weighted averages for the 2x2 and 4x4 pixel level analysis as well as for the cross-country analysis. We use gridded population levels from the GECON Yale 3.4 database to compute the population weights in the 2x2 and 4x4 pixel level analysis.[7] For the cross-country analysis we compute population weights based on NASA's Socioeconomic Data and Applications Center Gridded Population of the World dataset,[8] and on country-grid definitions from the U.S. Board on Geographic Names' database of foreign geographic names and features.[9]

1.1 Is UV-R predicted by economic activity?

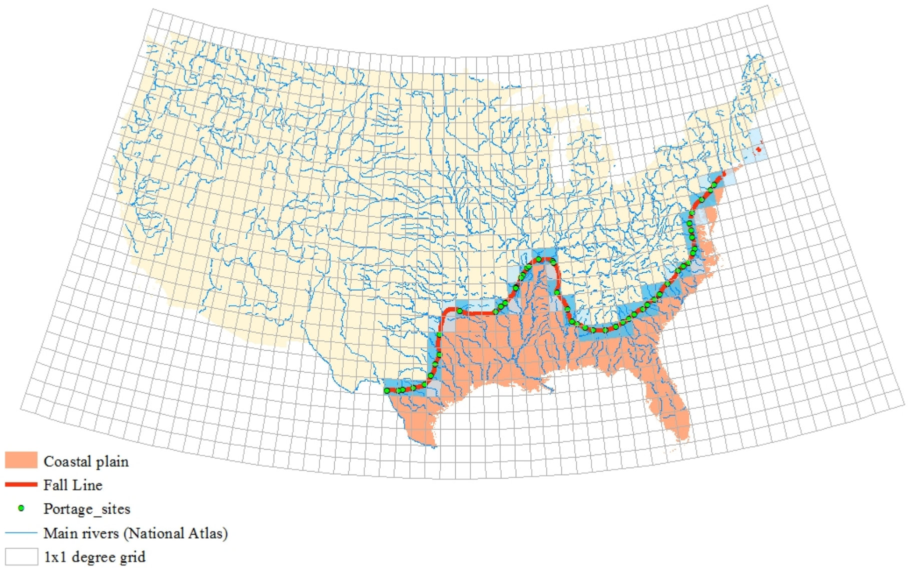
While we believe that it is possible to dispel the worry that UV-R could *somehow* be endogenous to economic activity, others may be less sanguine. Hence, it seems worthwhile supplementing the above remarks by some direct evidence that reverse causality does not seem to be a worry.

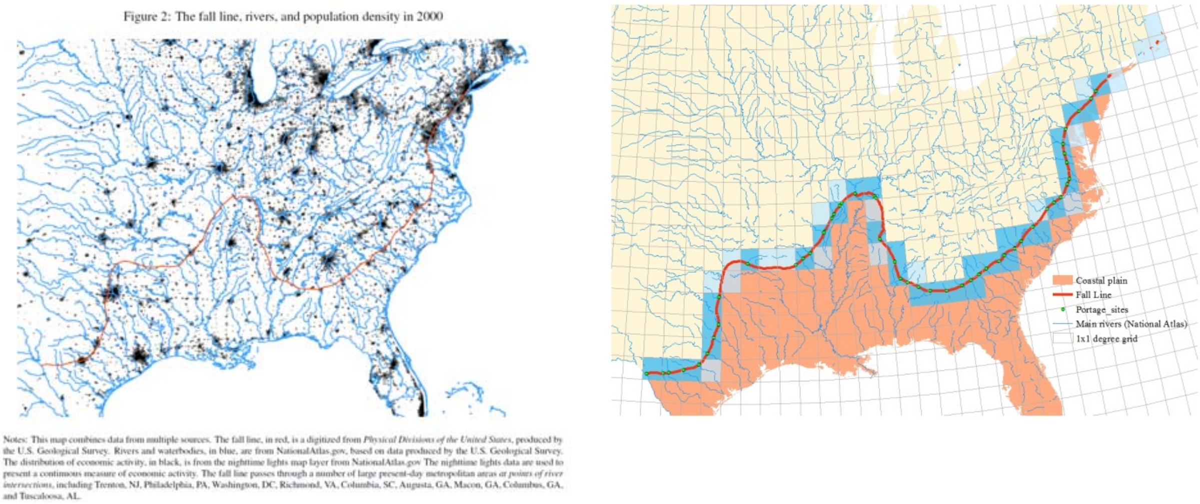
In order to perform such a check we draw on the recent study by Bleakley and Lin (2012).[10] The authors document a remarkable degree of path dependency in the location of US cities. Briefly, the argument is the following. Historically, during the era of the sailboat, goods would often be transported to inland locations via navigable rivers. Yet rapids would determine the extent to which the inland could be reached. Bleakley and Lin document that to this day many cities in the US are located at intersection points between the Fall Line (a geomorphological feature in the southeastern United States) and rivers connected to the ocean. Naturally, today these sites have lost their natural advantage, but they remain a significant determinant of urban centers (and therefore economic activity). The basic question is whether UV-R tends to be greater, conditional on latitude and elevation, in pixels featuring the relevant intersection points (labeled *portage sites* by Bleakley and Lin), compared to neighboring pixels.

[7] GECON Yale data are available at http://gecon.yale.edu.
[8] NASA's Socioeconomic Data and Applications Center is hosted by Earth Institute at Columbia University. The gridded population data are available at
http://sedac.ciesin.columbia.edu/gpw/global.jsp?file=gpwv3&data=pdens&type=ascii&resolut=one&year=15.
[9] U.S. Board on Geographic Names data are available at http://geonames.usgs.gov.
[10] We thank an anonymous referee for suggesting this check.

In order to construct the relevant data for the test, we did the following. Bleakley and Lin identify the location of portage sites based on the (a) intersection of rivers and the Fall Line as well as (b) historical and archival documents.

Portage sites on the US Fall Line





Left: Figure 2 in http://isites.harvard.edu/fs/docs/icb.topic607832.files/fallllline_draft3.3_chartpack.pdf (Bleakley and Lin, 2012). Right: Our data.

We do not have access to the archival-based data, but following (a) we can create a dataset for parts of the US. Specifically, following Bleakley and Lin we approximate the location of portage sites as the intersection of the main rivers in the US (with data from the National Atlas of the US Geological Survey) and the Fall Line (defined as the line that separates the Coastal Plains on the Atlantic coast from other physiographic provinces of the US—for example the plateaus in the Appalachian highlands, the Piedmont, and the Central lowlands and the Great Plains in the Interior highlands of the country).[11] [12] We identify 50 portage sites on the Fall Line, which are located within 32 of the 52 pixels of 1x1 degree latitude/longitude that span the Fall Line, as shown in the maps above.

As our measure of economic activity (used to examine whether the portage sites conveys information over and above economic activity in our sample of pixels) we employ nightlights, described in Section 1.3 below.

[Table A1 about here]

Table A1 reports the results. In column 1-3 we regress an indicator of whether the pixel contains a portage site on economic activity, measured by nightlights. Moving from left to right we add, first, distance to the equator and, second, both distance to the equator and elevation. Conditional on latitude and elevation, the portage site indicator is significant, indicating higher economic activity, presumably for the reasons laid out in Bleakley and Lin.

The next three columns ask whether portage sites predict UV-R. Of particular interest is the specification where we partial out latitude and elevation, as we do when we examine the impact of UV-R on economic activity in the text. Inspection of the table shows that portage sites convey virtually no information over and above UV-R once we partial out the two other determinants of UV-R. This supports that UV-R is not endogenous to economic activity.

1.2 Correlates with UV-R

In Tables A2-A4 we examine the explanatory power of our controls on UV-R in the cross-country dataset as well as in the pixel dataset. Two features are noteworthy. First, the results show that latitude and elevation influence UV-R in the manner expected. Second, the results show that in our full specification we are extracting the bulk of the variation in UV-R by our control strategy; depending on the sample, we take out 95% or more. We are confident that the residual variation is essentially random, as discussed in Section 1.

[Tables A2-A4 about here]

2. Other data

Labor productivity, income per capita, and historical measures of prosperity (cross-country)

- Real GDP per worker and per capita in 2004, from the Penn World Tables.
- Real GDP per capita 1700-1950, from Maddison (2003).
- Population density in year 1, 1000, and 1500, from Ashraf and Galor (2011).

Cataract (and other diseases) incidence (cross-country)

The World Health Organization (WHO) quantifies the burden of any specific disease as the equivalent number of years of "healthy" life lost due to the incidence (mortality and morbidity) of that disease. This

[11] Data for the physiographic divisions in the conterminous US comes from the US Geological Survey (http://water.usgs.gov/GIS/dsdl/physio.gz) and data for the main rivers was selected from the North American Atlas – Hydrography, from the US Geological Survey (http://pubs.usgs.gov/of/2009/1150/gis/basemap/hydro_lmeta.htm).

[12] See Bleakley and Lin, Figure 2 http://isites.harvard.edu/fs/docs/icb.topic607832.files/fallline_draft3.3_chartpack.pdf.

measure of Disability-Adjusted Life Years (DALY) can be interpreted as an estimate of the gap between current health status and an ideal health situation where the entire population lives to an old age, free of disease and disability.[13]

Our measure for the incidence of cataract in each country corresponds to the number of DALYs due to the incidence of this disease in 2004, expressed as a frequency of per 100,000 people in the population. Data for the incidence of other diseases corresponds to DALYs per 100,000 people for trachoma, skin cancer (melanoma and other skin carcinomas), HIV/AIDS, malaria, and hookworm disease, and intestinal nematode infections.

All data from WHO (2008) are available at
http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html.

Timing of the fertility decline (cross-country)

Year of the fertility transition for countries around the world are from Rehrer (2004). The criteria for pinpointing the date of the transition: "[…] has been set at the beginning of the first quinquennium after a peak, where fertility declines by at least 8% over two quinquennia and never increases again to levels approximating the original take-off point" (Reher, 2004, p. 21).

Geography and climate (cross-country)

- Continent dummies (Africa, Asia, America, Europe, Oceania) and latitude, from Nunn and Puga (2010).
- Elevation mean (average of elevation extremes), from CIA Factbook. Data available at http://www.nationmaster.com.
- Mean distance to coast or rivers, from Gallup, Sachs and Mellinger (1999).
- Agricultural suitability index, from Ashraf and Galor (2011).
- Percentage of land in tropical and subtropical zones, from Ashraf and Galor (2011).
- Area weighted average number of frost days per year, 1901-2012, constructed from the Climatic Research Unit's (CRU) gridded dataset available at http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__dataent_1256223773328276.
- Area-weighted average air temperature (C degrees) and total precipitation ('000 mm/year), 1980-2008. Constructed from the GECON 3.4 dataset. Data available at http://gecon.yale.edu.

Pre-industrial history (cross-country)

- Time passed since the Neolithic revolution, from Putterman (2008).

Human capital and fertility (cross-country)

- Average schooling in 1870, 2000, 2010, from Morrison and Murtin (2010).
- Fertility rate 1960's, 1970s, 1980s, 1990s, 2000s (total births per woman), from World Bank's WDI.

Indicators of institutions, natural resources, trust, culture (cross-country)

[13] See http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/index.html.

- Malaria ecology index, from McCord, Conley, and Sachs (2010).
- Freedom House's rating of political rights, 2002.
- Rule of law 1996-2000, from Nunn and Puga (2010).
- Percentage of mineral fuels in manufacturing exports, 2000, from World Bank's WDI.
- Gem diamond extraction 1958-2000 (1000 carats), from Nunn and Puga (2010).
- Migratory distance from Ethiopia, from Olsson and Ahlerup (2012).
- Slave exports 1400-1900, from Nunn and Puga (2010).
- Fraction of population of Euro descent, from Putterman and Weil (2010).

Nightlights (pixel)

The data are produced by satellites and sensors operated under the US Department of Defense's Version 4 Defense Meteorological Satellite Program Operational Linescan System (DMSP-OLS), available at http://www.ngdc.noaa.gov/eog/dmsp/downloadV4composites.html.

We resampled the raster corresponding to nighttime lights imagery in 2004 from a raw resolution of 30 arc seconds to a 1x1 degrees grid using bilinear interpolation in ArcGIS.

Figure A1. Nighttime lights imagery. Raw data, 30 arc seconds resolution. Satellite F15, 2004, average visible band digital number. From DMSP-OLS Nighttime Lights Global Composites (Version 4). http://maps.ngdc.noaa.gov/viewers/dmsp_gcv4/

Real grid cell product per capita (pixel)

Real (PPP 1995 USD) gross product per capita, cell of 1-degree latitude by 1-degree longitude, constructed with data from GEcon Yale data version 3.4, available at http://gecon.yale.edu.

Language fixed effects (pixel)

For each pixel we assign a unique dummy variable, which picks up a particular ethnic language, as recorded in the World Language Mapping System Database version 3.01 (WLMS). WLMS contains polygons for the linguistic homelands of 7,219 ethnic languages spoken in the world.[14] In all the cases where a pixel only involves one language, the mapping is straightforward. In some instances, however, multiple ethnic languages share a pixel. In these instances we assign the pixel to the language, which is geographically the most widespread within the pixel. Moreover, in some pixels there are no languages recorded in WLMS. What this means is that in these pixels there are no particular ethnic languages being spoken. Therefore, we assign a separate dummy, which then constitutes the excluded category within each country.

As an illustration, consider Bolivia. In Bolivia we find 8 ethnic languages spoken across 40 pixels (or 40% of the territory).[15] The remaining pixels in the country are coded as places where there are no predominant ethnic language spoken in Bolivia. In a similar way we construct pixel level language dummies for the rest of the pixels in the world.

In our grid of 1x1 resolution, we end up with 1,228 language fixed effects (see for example column 3 in Table 4), of which 1047 correspond to a specific ethnic language.

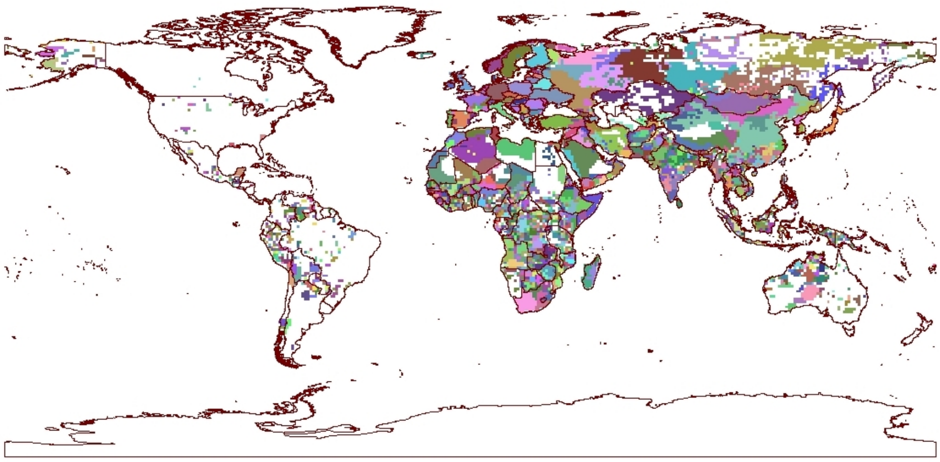


Figure A2. Indicator of a predominant ethnic language: 1047 ethnic languages in 181 countries. Data from WMLS v 3.01.

<u>Geography and climate controls (pixel)</u>

- Latitude (degrees)
- Elevation (m above sea level)
- Temperature (average annual level 1980-2008, C degrees)
- Precipitation (average annual level 1980-2008, '000 mm)
- Area (sq km)
- Distance to ice-free ocean (km)
- Distance to major navigable river (km)

All variables are from GEcon Yale dataset.

[14] The World Language Mapping System dataset is available at http://www.worldgeodatasets.com/language/.

[15] These languages are Aymara, Chiquitano, Eastern and Western Bolivian Guarani, Guarayu, and North and South Bolivian Quechua.

Table A5-A6 contains the summary statistics for the individual samples (cross-country and pixel level, respectively).

[Tables A5-A6 about here]

3. Robustness checks of the reduced form

3.1 The influence from individual continents in the cross-country setting

As discussed in the manuscript, our main cross-sectional regressions invoke continent fixed effects: Africa, Americas, Asia, Europe and Oceania. A question is whether any one of these continents is driving the results. In the following checks of this possibility, we focus on the full specifications (i.e., we allow for full set of controls) in the interest of brevity; Table A7 involves latitude and elevation in levels, whereas Table A8 uses the latitude and elevation fixed effects specifications.

[Table A7-A8 about here]

Moving from left to right we omit the five continents one at a time. As seen, no particular continent is driving the UV-R/income correlation.

3.2 Skin cancer and tropically clustered diseases

A potential concern with the results reported in the main text is that UV-R is capturing tropically clustered diseases. Of separate interest is the issue of whether prevalence of skin cancer exerts an influence on the partial correlation between UV-R and income.

As demonstrated in Tables A9 and A10, adding skin cancer prevalence to the full specification has no implications for the point estimate associated with UV-R.[16] The identification of UV-R with eye disease is therefore unlikely to be jeopardized by skin cancer.

[Tables A9 and A10 about here]

Turning to tropically clustered diseases, it could be the case that UV-R is spuriously correlated with other diseases that in turn exert an impact on productivity. In particular, previous research has highlighted a set of tropically clustered diseases, which might influence growth: malaria, hookworm, and HIV/AIDS.[17] To this list we further add intestinal nematode infection as well as trachoma, the latter being an infectious eye disease that is more prevalent in the geographic tropics yet epidemiologically has nothing to do with UV-R. As seen from Tables A9 and A10, the inclusion of any of these diseases alongside our full set of geographic controls does not render the influence of UV-R insignificant.

3.3 Institutions and culture

The cross-country analysis in the main text does not explicitly deal with two sets of fundamental determinants of income, which may correlate with both UV and prosperity: institutions and cultural values.

[16] The data for the alternative diseases such as skin cancer that we refer to in this section also derive from the WHO and represents YLD, just as our cataract data.

[17] On Malaria, see Gallup and Sachs (2001)—for a skeptical assessment of malaria's influence, see Depetris-Chauvin and Weil (2013); on Hookworm, see Bleakley (2007); on HIV, see e.g. Papageorgiou and Stoytcheva (2005)—and for a skeptical assessment of HIV's influence, see Young (2005). HIV/AIDS is obviously not a tropical disease, but it tends to be more prevalent in populations located in the geographical tropics, Sub-Saharan Africa in particular.

Of course, institutions and cultural values are not exogenous, but represent the outcome of historical processes. As a result, the analysis above may actually have accounted for their influence inadvertently. More specifically, if institutions and culture are determined by underlying climatic and/or geographical characteristics, the latter controls may be capturing at least some of the influence from the former on prosperity in Tables 1 and 2.[18] The objective of this section is to assess whether this is likely or not, in the cross-country setting.

In the regressions to follow we include both fundamental determinants of culture and institutions in our full specification as well as direct measures of institutions in the empirical model. In the latter case we note that institutions obviously are endogenous, for which reason the reported (OLS) results are most likely uninformative about the impact of institutions on prosperity. However, these checks do allow us to gauge the sensitivity of the UV-R/prosperity nexus to the inclusion of institutions measures into the regression specification.

In Tables A11-A14 we therefore add a number of variables that have featured in the cross-country literature on growth and development. These include malaria ecology (a measure of disease environment); political rights and the rule of law (two direct measures of the quality of institutions), oil and diamonds (two measures of natural resource curse problems); slave exports and migratory distance from Ethiopia (two underlying determinants of trust), and finally fraction of the population of European descent (a deep determinant of both culture and institutions).[19] As can be seen, including these variables has little influence on the link between UV-R and GDP per capita (respectively GDP per worker). Inspection of the tables reveals that UV-R remains significant in all cases. We take this as an indication of a stable and robust gradient between UV-R and income.

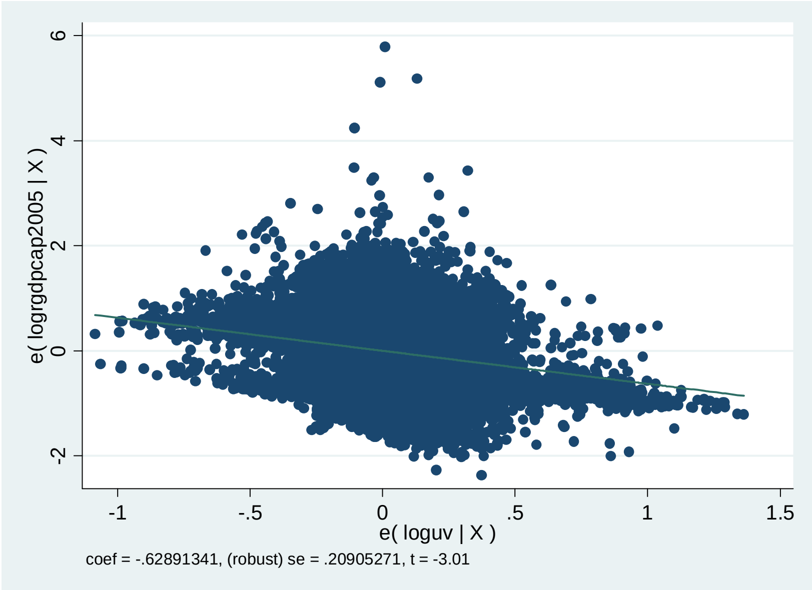
[Tables A11-A14 about here]

3.4 Residual plots (pixel analysis)

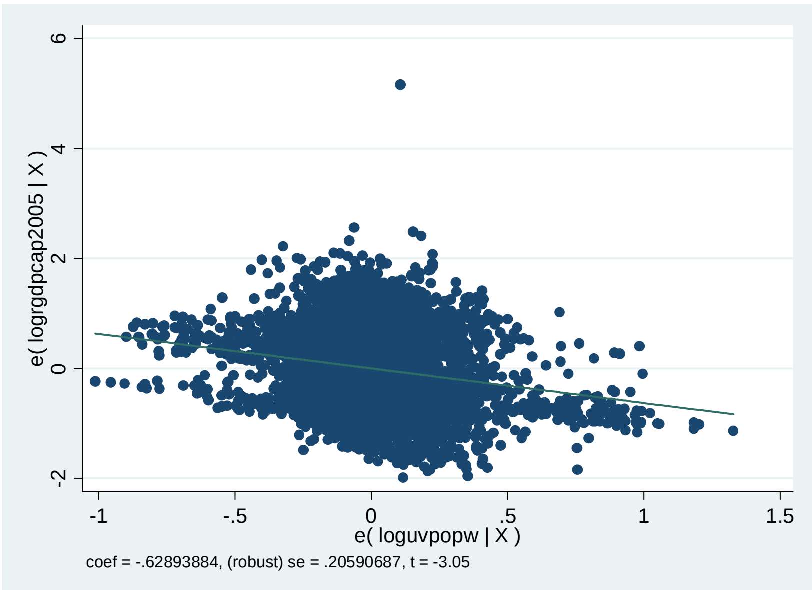
Below we provide simple visualizations of the correlation between UV and economic activity measured by GDP per capita in 2005. We first examine the raw correlation (without any controls, except for a constant term) at the 1x1, 2x2, and 4x4 level of aggregation. Subsequently we depict the partial link between UVR and economic activity, conditional on a full set of controls that involves country fixed effects. As should be clear, the link between UV and GDP per capita does not seem to be driven by any particular set of observations.

[18] See example Durante (2010) and Michalopoulos (2012) for evidence of climate's impact on culture, and Olsson and Hansson (2011) for the impact of geography on institutions.

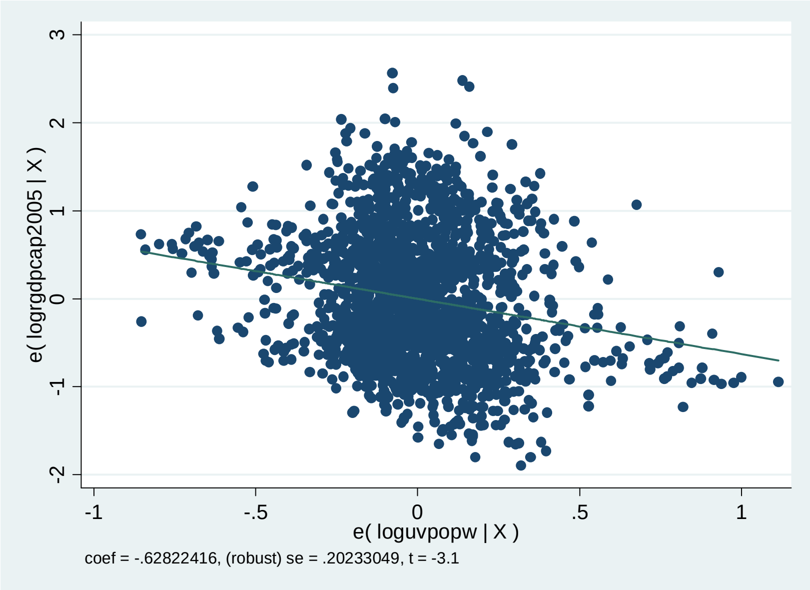
[19] Nunn and Wantchekon (2012) argue that slave exports, especially in Africa, led to societies characterized by lower trust levels. Ashraf and Galor (2013) argue that migratory distance from Africa, by affecting genetic diversity in society, has an effect on trust today.



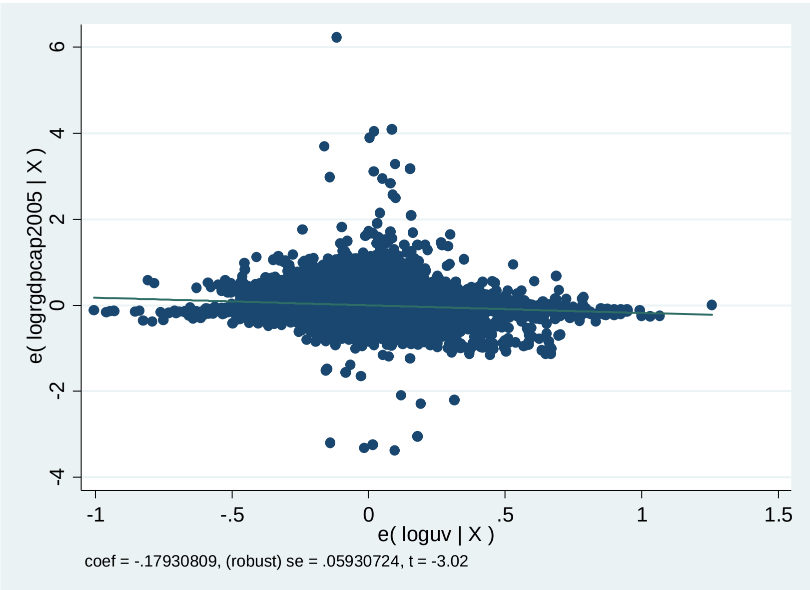
The partial correlation between UV-R and log GDP per capita in 2005 at the 1x1 level of resolution, no controls. *Notes*: The figure depicts the (partial) correlation between UV-R and GDP per capita in 2005 while controlling only for a constant term. Hence the slope of the depicted regression lines correspond to the estimates reported in Table 3 column 1.



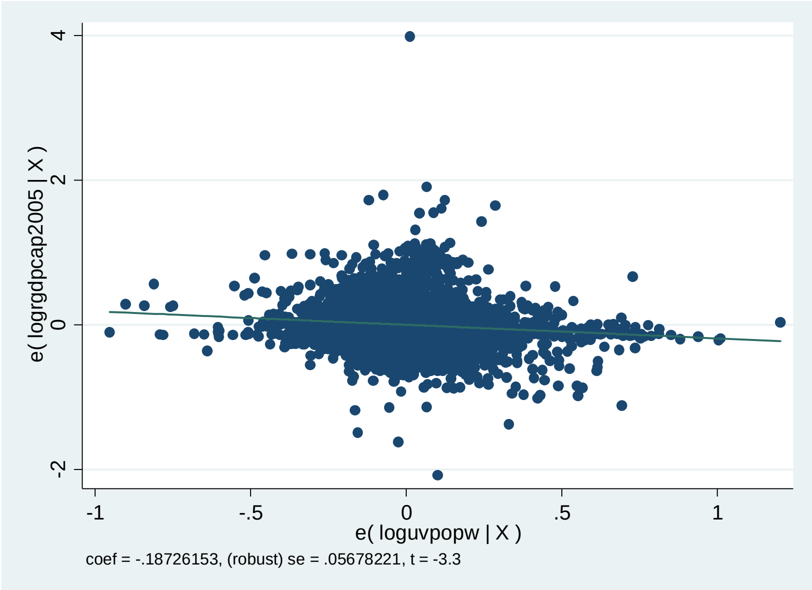
The partial correlation between UV-R and log GDP per capita in 2005 at the 2x2 level of resolution, no controls. *Notes*: The figure depicts the (partial) correlation between UV-R and GDP per capita in 2005 while controlling only for a constant term. Hence the slope of the depicted regression lines correspond to the estimates reported in Table 3 column 4.



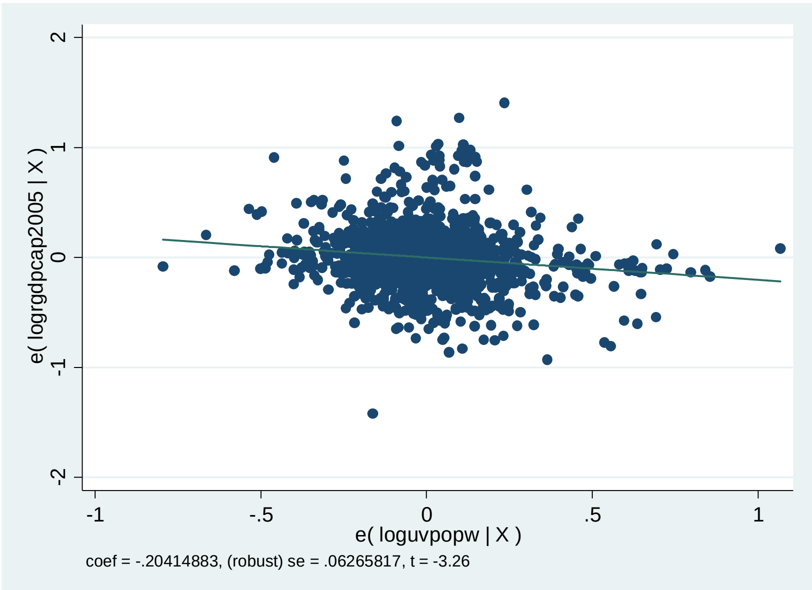
The partial correlation between UV-R and log GDP per capita in 2005 at the 4x4 level of resolution, no controls. *Notes*: The figure depicts the (partial) correlation between UV-R and GDP per capita in 2005 while controlling only for a constant term. Hence the slope of the depicted regression lines correspond to the estimates reported in Table 3 column 7.



The partial correlation between UVB-R and log GDP per capita in 2005 at the 1x1 level of resolution, conditional on a full set of controls. *Notes*: The figure depicts the (partial) correlation between UV-R and GDP per capita in 2005 while controlling for the influence of a full set of controls, including country fixed effects. Hence the slope of the depicted regression lines correspond to the estimates reported in Table 3, column 2.



The partial correlation between UV-R and log GDP per capita in 2005 at the 2x2 level of resolution, conditional on a full set of controls. *Notes*: The figure depicts the (partial) correlation between UV-R and GDP per capita in 2005 while controlling for the influence of a full set of controls, including country fixed effects. Hence the slope of the depicted regression lines correspond to the estimates reported in Table 3, column 5.



The partial correlation between UV-R and log GDP per capita in 2005 at the 4x4 level of resolution, conditional on a full set of controls. *Notes*: The figure depicts the (partial) correlation between UV-R and GDP per capita in 2005 while controlling for the influence of a full set of controls, including country fixed effects. Hence the slope of the depicted regression lines correspond to the estimates reported in Table 3, column 8.

4. Further results on the proposed mechanism

4.1. Simulating vision under severe cataract

Cataract is a highly debilitating condition with respect to reading. The figure below, which compares normal vision to severe cataract, provides an illustration of this fact. Severe cataract makes it impossible, for all practical purposes, to carry out work tasks that require careful attention to details such as reading. Cataract not only affects the acuity of vision but also the brightness and the clarity of colors. As the ability to read is particularly important in work assigned to skilled personal, it follows that eye disease in general, and cataract in particular, would work to lower *expected work life* as a skilled worker, in the absence of treatment.[20] As discussed in the main text, such treatment, in the form of cataract surgery, has not been available for most of human history, and may even be largely inaccessible in poor countries today.

Figure B1. Simulated cataract: Normal near vision (left), severe cataract (right). Source: http://www.cataracteye.com/simulation.html

4.2. The influence of cataract on work-life expectancy

In this section we perform a calculation of the influence of cataract on work-life expectancy. In terms of the required input data we rely on two ophthalmological surveys of visual impairment carried out in two very different geographical locations: the Indian state of Punjab and Rotterdam in the Netherlands. Punjab is located in a high UV region, whereas Rotterdam is located in a low UV region.[21] As a result, we would expect to see significant differences in cataract incidence across these two locations. This expectation is supported by the data depicted in Figure 3 in the main text. The figure, which plots measures of age-specific prevalence rates of cataract in the two areas, reveals a marked difference: In Punjab, essentially the same prevalence rate is found in the age group 40-49 as what can be detected in Rotterdam among individuals in the age group 70-79. We will use these data below to calculate the difference in expected work life (as a skilled worker) between Punjab and Rotterdam. But before we turn our attention to these calculations, we need to address an important question: How well do the said prevalence rates speak to *historical* eye disease at these two locations?

The ophthalmological fieldwork in Punjab, which is reported in Chatterjee et al. (1982), was carried out in 1976/77. In the 1970s India was a very poor country with the majority of the population earning their

[20] Of course, the problem is much broader than mere reading. Think about a cabinetmaker or a jeweler, who is unable to pay attention to the fine details of the woodwork or the jewelry, respectively.

[21] In the context of our satellite data on UV-R described below, we find that Punjab and Rotterdam are located respectively at the 60th and 32nd percentile in the global (grid based) distribution of UV-R.

livelihood in agriculture, which in effect exposed them to non-trivial amounts of UV-R.[22] Consequently, the recorded prevalence rates are probably a sensible approximation to a generic pre-industrialized context in the area.

Rotterdam is likely a different story. This survey, which is reported in Klaver et al. (1998), was carried out in 1990/93. Ideally, we want to have a survey for Rotterdam (or a similar geographic location) prior to industrialization for a better comparison with Punjab. The reason is that many contemporary inhabitants of Rotterdam are working indoors, implying less exposure to UV-R and therefore potentially lower age-specific cataract than what was the case historically. At the same time, cataract prevalence is also affected by life style factors such as smoking, which almost surely work to increase cataract prevalence in 1990/93 compared to the pre-industrial level of prevalence. In any event, a pre-industrial survey is not available, so it is frankly unclear if the prevalence rates reported in the Rotterdam survey exceed, or fall short of, the pre-industrial counterparts.

In order to deal with the problem of missing pre-industrial prevalence data in a conservative way, we deliberately make assumptions that will bias our calculations against finding a major difference in expected work life between Punjab and Rotterdam. In particular, we exploit two circumstances in connection with the survey designs: (i) the Rotterdam survey actually considers a cluster of eye diseases, and not just cataract as in the Punjab survey; (ii) the Rotterdam survey focuses on persons of 55 years or older, and not individuals aged 30 or older as in the Punjab survey. In the calculations below, however, we assume that the Rotterdam prevalence rates only refer to cataract. In so doing, we are artificially inflating cataract prevalence in Rotterdam, thereby lowering the likely gap in expected work life between Rotterdam and Punjab due to cataract. Moreover, we assume that individuals in Rotterdam belonging to the age group 30-54 experience the same cataract prevalence as the age group 55-59.[23] In practice, prevalence rates will be much smaller. The potential positive bias in our calculations of the expected work life differential between Punjab and Rotterdam, due to the late timing of the Rotterdam survey, and the negative bias that we impose, may well balance out.

To make further progress we need to make a few additional assumptions. First, we assume that individuals use cross-sectional prevalence rates as an indication of the risk of cataract. This is reasonable if individuals look to the experience of older family members when forming their expectations. A fully rational individual, however, might employ cohort-specific prevalence in the same context, but such data is not available to us. In any case, it is quite common in the literature to employ cross-age-group information to gauge life-cycle developments; see e.g. Hall and Jones (2007). Consequently, we follow this practice. Second, we assume that individuals leave the skilled labor force upon contracting cataract according to the prevalence rates recorded in the surveys. In order to understand why this assumption is justifiable, a few additional remarks on the surveys are required. A critically important aspect of both surveys is that they speak to the prevalence of *severe* cataract. Both studies involved careful eye examinations of the subjects, allowing the ophthalmologists to record visual acuity. As a result, we know that the prevalence rates in Punjab and Rotterdam speak to individuals with corrected visual acuity of 20/60 or worse. In practice, 20/60 visual acuity means that the individual is only able to see the first few lines on the familiar Snellen chart; it therefore implies a substantially reduced vision, which inevitably makes it very hard, or even impossible, for

[22] In the 1970s the employment rate in agriculture in India hovered around 80% (e.g., Bhalla, 1989).
[23] In all calculations the prevalence rate in age group 20-29 is nil.

an individual to perform tasks in skilled occupations, as this usually requires an ability to read.[24] From this perspective it seems reasonable to treat the prevalence rates as 'exit rates' from skilled occupations.[25] Third, we assume that individuals expect to work until they expire. As a result, we do not distinguish between the adult population and the labor force. With the historical period we are focusing on in mind, we view this as a reasonable assumption. Consequently, individuals may leave the skilled labor force for one of *two* reasons: either they contract severe cataract or they simply die.

With these three assumptions in place, we first calculate expected work life in Punjab and Rotterdam with and without cataract, and then we proceed to calculate the difference in expected work life between these two locations that is a result of cataract. Since cataract prevalence is negligible before the age of 20, we focus on calculating expected work life at the age of 20. We proceed by invoking the following recursive equation, in which e(x) is remaining expected work life at age x:

$$e(x) = \lambda \cdot q(x) + \left[1 - q(x)\right] \cdot \left[1 + e(x+1)\right]$$

In the equation, λ is the share of the year a person, who exits the labor force during this particular year, will actually end up having spent in the labor force during this year; we set $\lambda = 0.5$. q(x) is the age specific exit probability, and 1-q(x) is therefore the probability of remaining in the labor force from age x to age x+1. The exit probability will reflect *age-specific mortality* and *eye disease incidence*.

In our calculations we limit life to the age of 70. This ensures that we obtain a level of life expectancy at age 20 that roughly coincides with the one observed in Punjab around the time of the survey. From this assumption follows that q(70) = 1, in turn implying that e(70) = 0.5 since $\lambda = 0.5$. With e(70) thus established, we iterate backwards with e(69) = 0.5q(69) + (1-q(69))(1+e(70)) using the age-specific exit probabilities (i.e., the q(x)'s) until we arrive at e(20). As already noted, we stop iterating at e(20) since cataract prevalence before the age of 20 is negligible. In order to calculate the q(x)'s in the baseline scenario *without* cataract risk, we use age-specific mortality rates for Punjab as reported in Chatterjee et al. (1982). We assume that *the same* age-specific mortality rates are about appropriate for pre-industrial Rotterdam. Using these we obtain e(20) = 47, which means that a person aged 20 can expect to work (live) for 47 additional years, i.e., until the age of 67.[26]

To gauge the impact of severe cataract on expected work life as a skilled laborer we simply add the probability of contracting cataract (measured as the cataract prevalence rate) to mortality risks in order to get a *modified exit probability*. More specifically, q(69) for a person living in Punjab will be 2.45% (age-specific mortality rate) plus 42% (the age-specific cataract rate in the age interval 60-69), and so on and so forth. Doing the backwards iteration gives us e(20) = 32 years with Punjab based age-specific cataract rates and

[24]Ophthalmologists distinguish between "corrected" and "uncorrected" visual acuity. In the former case subjects are allowed to wear glasses (if available). Formally, a visual acuity of 20/60 means that at a 20 feet distance to the familiar test chart for eyesight, the individual can read letters that a person with 20/20 vision (the reference standard) can read at a 60 feet distance.

[25] According to the WHO "low vision" is defined as visual acuity between 20/60 and 20/200. The surveys discussed in the text therefore fall in this category. According to the National Eye Institute, "low vision" means that "[a]ctivities like reading, shopping, cooking, writing, and watching TV may be hard to do" (cf. http://www.nlm.nih.gov/medlineplus/visionimpairmentandblindness.html).

[26] According to Saikia et al. (2012) actual life expectancy at age 20 was 69.8 in Punjab in 1979. For comparison, life expectancy at birth was 65 years at the time of the survey (Chatterjee et al., 1982).

e(20) = 46 with Rotterdam based visual impairment prevalence rates. In the case of Punjab, cataract risk therefore reduces an individual's expected work life as a skilled laborer by 15 years, whereas in the case of Rotterdam the reduction is only a single year. Hence the difference in expected work life as a skilled laborer as of the age of 20 between these two locations is 15-1 = 14 years.[27]

4.3. UV-R and the timing of the fertility transition

The general message from Table A15 is that countries exposed to more UV-R have experienced the fertility decline at a later date. In column 1 we note that UV-R can account for around 60% of the variation in the date of fertility decline; when all our controls are added simultaneously we can account for about 80% of the global variation in the timing of the fertility decline.

[Table A15 about here]

UV-R is always significant and carries the expect sign, with one exception: in column 9 the estimate appears to loose significance. While UV-R is significant in the full specification where latitude and elevation enters (log) linearly as controls (column 8), the same is not true when we introduce latitude and elevation fixed effects (column 9). The most obvious reason why UV-R turns insignificant is variance inflation due to multicollinearity. The variance inflation factor for UV-R in column 9 is 32.44 (not reported in the table); i.e., multicollinearity in the specification is increasing the variance on the UV-R estimate by a factor of 32 compared with the counterfactual of zero multicollinearity. The simplest way to check this explanation is to re-run the regression without the inclusion of controls for latitude and elevation. By omitting latitude and elevation, we reduce the extent of variance inflation due to multicollinearity. At the same time, nothing is lost in terms of explanatory power by dropping latitude and elevation, as they are jointly insignificant in both columns 8 and 9; the relevant F-tests are reported at the bottom of Table A15. Column 10, which reports the regression result, reveals a strongly significant estimate for UV-R. Undoubtedly, this is explained by a dramatic fall in the variance inflation factor on the UV-R estimate; it drops from 32 to 13 (not reported in the table). Since a lowering of variance inflation—while keeping the overall explanatory power of the model constant (due to the insignificance of latitude and elevation)— markedly increases the significance of UV-R, it seems safe to conclude that multicollinearity is responsible for the one-off insignificance of UV-R in column 9.

4.4. UV-R, cataract, the fertility transition and comparative development

Table A16 reports the results of the "horserace" regressions discussed in the text. In the main text we focused on GDP per worker, the results below concern GDP per capita. The results are very similar, as can be seen.

[Table A16 about here]

4.5. UV-R, human capital accumulation and fertility rates

On the human capital front we obtained data on years of schooling in the population from Murtin and Morrison (2009); data covers the period from 1870-2005. With this data in hand we ask whether UV-R holds predictive power vis-à-vis growth in years of schooling 1870-2005, which is a meaningful indicator of (average) human capital *investments* over this period. Since the fertility transition took place after 1870 in

[27] Observe that since life expectancy at birth in Punjab, at the time of the survey, was 65 (Chatterjee et al., 1982), and since (severe) cataract prevalence below the age of 20 is virtually zero, the reduction in work life in Punjab from cataracts, evaluated at birth, would be roughly 65-52 = 13 years. In Rotterdam, by contrast, cataracts would not affect expected work life, evaluated at birth; that is, assuming the same life expectancy at birth as in Punjab.

almost all countries around the world (Reher, 2004), we should expect to see UV-R being negatively correlated with average human capital investments, due to its influence on the timing of the fertility transition.

Our testing strategy mimics the reduced form approach. That is, we sequentially add our controls by group (or individually), and then collectively. The only difference is that since human capital growth is subject to considerable mean reversion we also control for the initial (1870) level in each specification. In order to ensure that we only capture post fertility transition investments, we limit the sample to countries that underwent the fertility transition after 1870. In the end, this only leads to the loss of one country, namely Sweden.

[Table A17 about here]

The general message from Table A17 is that UV-R is a significant predictor of human capital investments. However, the influence from UV-R is not precisely estimated in column 8, although it is statistically significant in the other full specification (column 9). One reason why one may find the specification adopted in column 9 more appealing is that it dominates the one in column 8 based on the adjusted R^2 criteria (such a model selection criteria can be rationalized on formal statistical grounds). But it is clear that in the full specification the estimate becomes a bit wobbly. This is almost certainly due to multicollinearity, which is aggravated in the present case because of the relatively small sample of countries. As an illustration, in column 9 the variance inflation factor is 62 (not reported). Consequently, despite the staggering number of geo-controls, it is actually remarkable that UV-R retains significance. Hence, we view these results as consistent with the hypothesis of a negative influence of UV-R on human capital investments after 1870.

In Table A18 we repeat the test, but now focusing on fertility. We rely on average fertility rates, 1960-2000. In general UV-R is a strong predictor of average fertility, though once again multicollinearity seems to influence the precision of the estimates in the full specification. Hence, these results suggest quite strongly that UV-R has worked to increase fertility levels during the 20th century, conceivably by affecting the timing of the fertility transition.

[Table A18 about here]

The consequences of adding the timing of the fertility transition (TFT) in the two settings are shown in Tables A19 and A20. The general impression in both cases is that UV-R looses significance (statistically and economically) when the TFT is added as a control. Meanwhile, TFT is itself strongly significant in all cases. These results support the idea that the timing of the fertility transition has influence both investments in human capital 1870-2005 as well as 20th century fertility rates. Moreover, the results are consistent with the theory that UV-R is operating through TFT. At the same time, the occasional significance of UV-R despite controlling for TFT could be viewed as supporting a modest post fertility transition effect of UV-R on human capital accumulation. If indeed UV-R, via eye disease, is influencing the return to skill formation, it may in fact impact on the long-run steady state level of human capital. If so, UV-R would impact growth conditional on TFT for the usual convergence reasons. This eventuality is not conclusively refuted by the results reported in Tables A19 and A20.

[Tables A19-A20 about here]

Overall, the results discussed in this section provide further support in favor of the take-off account. High levels of UV-R have served to delay the onset of the fertility transition, thereby stifling human capital investments since 1870 as well as supporting high fertility rates during the 20th century.

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Table A1
Location of historical portage sites in the US and exposure to UV radiation: Pixel level analysis within the US

	1	2	3	4	5	6
Dependent variable:	**(log) Intensity of lights by night, 2004**			**(log) UV**		
1[Portage site in pixel]	0.27	0.48*	0.45*	0.09**	0.01	0.01
	[0.26]	[0.24]	[0.24]	[0.04]	[0.01]	[0.01]
	(0.12)	(0.08)	(0.1)	(0.04)	(0.01)	(0.01)
Observations	52	52	52	52	52	52
R-squared	0.02	0.14	0.15	0.09	0.95	0.95
Partial R-squared	0.02	0.05	0.05	0.09	0.02	0.02
Controlling for:	-	(log) Latitude	(log) Latitude, (log) elevation	-	(log) Latitude	(log) Latitude, (log) elevation
Number of controls	-	1	2	-	1	2

Notes: OLS regressions. The dependent variable is an index of the intensity of ligths at night in 2004, produced by NASA. The dependent variable in columns 4-6 (UV) is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). Each observation is for a geographic pixel of 1x1 degree of latitude and longitude. 1[Portage site in pixel] is an indicator of the estimated presence of a historical portage site on the US Fall Line. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors reported in brackets. Conley standard errors, robust to spatial autocorrelation, are reported in parentheses. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively, based on the clustered standard errors. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A2
Determinants of exposure to UV: Cross country analysis

	1	2	3	4	5	6	7	8
					(log) UV			
1[Continent = Africa]	0.33*						0.037	0.18
	[0.17]						[0.13]	[0.15]
1[Continent = Asia]	0.049						-0.028	0.16
	[0.18]						[0.12]	[0.13]
1[Continent = Europe]	-0.81***						-0.44***	-0.10
	[0.18]						[0.14]	[0.15]
1[Continent = America]	0.25						0.052	0.20
	[0.18]						[0.13]	[0.14]
1[Continent = Oceania]	dropped						dropped	dropped
	..						..	..
(log) Latitude		-0.37***					-0.057***	
		[0.044]					[0.015]	
(log) Elevation		0.10**					0.13***	
		[0.042]					[0.020]	
Latitude FEs[a] (F-statistic)			426.01[a]					15.45[a]
			(0.00)[a]					(0.00)[a]
Elevation FEs[a] (F-statistic)			7.09[a]					5.35[a]
			(0.00)[a]					(0.00)[a]
(average 1990-2008) Temperature (C degrees)				0.053***			0.034***	0.0089
				[0.0036]			[0.0050]	[0.0056]
(average 1990-2008) Precipitation ('000 mm)				0.000012			-0.000050*	-0.00004
				[0.000020]			[0.000027]	[0.000027]
Distance to coast (km)					-0.14		0.061	-0.0024
					[0.10]		[0.039]	[0.034]
Distance to rivers (km)					0.069		-0.0083	0.021
					[0.069]		[0.017]	[0.015]
(log) Country area (sq km)					0.04		-0.029***	-0.0071
					[0.026]		[0.0080]	[0.0077]
Year of Neolithic Transition ('000 years)					-0.066***		0.0048	0.0083
					[0.013]		[0.0087]	[0.0091]
(log) Agricultural suitability index						-0.045*	0.021*	0.016
						[0.024]	[0.012]	[0.013]
KG Tropical/subtropical region						0.20**	0.003	-0.063*
						[0.081]	[0.054]	[0.037]
(average annual 1901-2012) Frost days						-0.036***	-0.0035	-0.0078**
						[0.0041]	[0.0039]	[0.0034]
Observations	147	147	147	147	147	147	147	147
R-squared	0.75	0.56	0.95	0.75	0.16	0.73	0.94	0.97
Additional controls	Continent FEs	Latitude, elevation (levels)	Latitude, elevation (FEs)	Precipitation, temperature	Distance to ocean, rivers, area, timing Neolithic revolution	Agricultural suitability, tropical area, frost	All controls (with latitude and elevation levels)	All controls (with latitude and elevation FEs)
Number of additional controls	4	2	14	2	4	3	15	27
Joint significance of the additional control variables (p-values for the H0: all regressors are jointly insignificant):								
Continent FEs	0.00							
Latitude, elevation (levels)		0.00						
Latitude, elevation (FEs)			0.00					
Precipitation, temperature				0.00				
Distance to ocean, rivers, area, timing Neolithic revolution					0.00			
Agricultural suitability, tropical area, frost						0.00		
All controls (with latitude and elevation levels)							0.00	
All controls (with latitude and elevation FEs)								0.00

Notes: OLS regressions. The dependent variable (UV) is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

a: F-statistic and p-value in parentheses for the joint significance of latitude and elevation FEs reported instead of individual coefficients in columns 3 and 8.

Table A3
Determinants of exposure to UV: Pixel level analysis

Dependent variable:	(log) UV											
Granularity:	1x1				2x2				4x4			
	1	2	3	4	5	6	7	8	9	10	11	12
(log) Latitude	-0.50***			-0.06***	-0.49***			-0.05***	-0.50***			-0.05***
	[0.01]			[0.00]	[0.02]			[0.00]	[0.02]			[0.01]
(log) Elevation	0.18***			0.24***	0.19***			0.23***	0.17***			0.22***
	[0.00]			[0.00]	[0.01]			[0.01]	[0.01]			[0.01]
(average 1990-2008) Temperature		0.05***		0.05***		0.05***		0.05***		0.05***		0.05***
		[0.00]		[0.00]		[0.00]		[0.00]		[0.00]		[0.00]
(average 1990-2008) Precipitation		-0.03***		-0.02***		-0.04***		-0.02***		-0.04***		-0.02***
		[0.00]		[0.00]		[0.00]		[0.00]		[0.01]		[0.01]
(log) Pixel area (sq km)			0.14***	0.01***			0.11***	0.01***			0.10***	0.02***
			[0.01]	[0.00]			[0.01]	[0.00]			[0.01]	[0.00]
Distance to ocean (km)			-0.23***	0.05***			-0.23***	0.06***			-0.23***	0.07***
			[0.01]	[0.00]			[0.01]	[0.01]			[0.02]	[0.01]
Distance to major rivers (km)			0.02***	0.00			0.02***	-0.01**			0.02***	0.00
			[0.00]	[0.00]			[0.01]	[0.00]			[0.01]	[0.00]
Distance to capital (km)			-0.28***	-0.02***			-0.29***	-0.01**			-0.28***	0.00
			[0.00]	[0.00]			[0.01]	[0.00]			[0.01]	[0.01]
Observations	18,245	18,245	18,245	18,245	5,652	5,652	5,652	5,652	2,036	2,036	2,036	2,036
R-squared	0.50	0.80	0.40	0.91	0.50	0.82	0.39	0.91	0.52	0.83	0.36	0.92
Controls	Latitude, elevation (levels)	Precipitation, temperature	Area; distance to ocean, rivers, capital	All controls (with latitude and elevation levels)	Latitude, elevation (levels)	Precipitation, temperature	Area; distance to ocean, rivers, capital	All controls (with latitude and elevation levels)	Latitude, elevation (levels)	Precipitation, temperature	Area; distance to ocean, rivers, capital	All controls (with latitude and elevation levels)
Number of controls	2	2	4	8	2	2	4	8	2	2	4	8
Joint significance of the control variables (p-values for the H0: all regressors are jointly insignificant):												
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable (UV) is an index of the exposure to ulraviolet radiation (weighted by pixel population in the 2x2 and 4x4 grids; see Supplementary Appendix for details). Each observation is for a geographic pixel of 1x1, 2x2, or 4x4 degrees of latitude and longitude, respectively. Robust standard errors reported in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% levels. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A4
Determinants of exposure to UV: Pixel level analysis with country and language Fes

Dependent variable:	**(log) UV**					
Granularity:	**1x1**		**2x2**		**4x4**	
	1	2	3	4	5	6
(log) Latitude	-0.05**	-0.05***	-0.05**	-0.05**	-0.07**	-0.08**
	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]
(log) Elevation	0.18***	0.16***	0.18***	0.16***	0.18***	0.17***
	[0.02]	[0.01]	[0.02]	[0.02]	[0.02]	[0.02]
(average 1990-2008) Temperature	0.03***	0.03***	0.04***	0.04***	0.04***	0.04***
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
(average 1990-2008) Precipitation	-0.06***	-0.06***	-0.07***	-0.07***	-0.07***	-0.08***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
(log) Pixel area (sq km)	0.00	0.01	0.00	0.01*	0.00	0.01
	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]	[0.01]
Distance to ocean (km)	0.08***	0.08***	0.07**	0.07**	0.05	0.05
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
Distance to major rivers (km)	-0.14***	-0.15***	-0.12***	-0.13***	-0.10**	-0.11***
	[0.04]	[0.03]	[0.04]	[0.03]	[0.04]	[0.04]
Distance to capital (km)	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
Observations	18,245	18,245	5,652	5,652	2,036	2,036
R-squared	0.95	0.96	0.95	0.96	0.96	0.96
Controls	All controls (with latitude and elevation levels)					
Number of controls	8	8	8	8	8	8
Fixed effects	Country	Language	Country	Language	Country	Language
Number of fixed effects	181	1,228	181	858	181	444
Std errors clustered by	Country	Language	Country	Language	Country	Language
Joint significance of the control variables (p-values for the H0: all regressors are jointly insignificant):						
	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable (UV) is an index of the exposure to ulraviolet radiation (weighted by pixel population in the 2x2 and 4x4 grids; see Supplementary Appendix for details). Each observation is for a geographic pixel of 1x1, 2x2, or 4x4 degrees of latitude and longitude, respectively. Standard errors clustered by country or predominant language reported in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively, based on the clustered standard errors. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A5
Summary statistics: Cross-country data

	N obs.	Mean	St dev	Median	Min	Max
Main variables and controls						
Real GDP per worker, 2004	145	23,527	23,852	15,409	934	107,000
Real GDP per capita, 2004	147	10,848	12,366	5,856	354	68,390
Exposure to UV, av per sqm, 1990 and 2000, pop weighted. (NASA)	147	192.19	77.74	204.89	42.66	328.53
Continent indicator: Africa	147	0.31	0.46	0	0	1
Continent indicator: Asia	147	0.27	0.44	0	0	1
Continent indicator: Europe	147	0.24	0.43	0	0	1
Continent indicator: America	147	0.17	0.38	0	0	1
Continent indicator: Oceania	147	0.02	0.14	0	0	1
Latitude - Nunn and Puga (2010)	147	20.72	25	20.26	-41.81	64.48
Average (max min) elev m above sea level (Source: Nationmaster)	147	1.59	1.04	1.41	0.03	4.5
Average area-weighted precipitation ['000 mm] (Source: GECON 3.4)	147	1	0.71	0.83	0.03	3.31
Average area-weighted temperature [C degrees] (Source: GECON 3.4)	147	17.73	8.27	21.42	-4.55	28.89
Total area [sq km] (Source: GECON 3.4)	147	890,000	2,150,000	251,000	2,635	17,200,000
Mean distance to coast	147	0.43	0.46	0.28	0.02	2.37
Mean distance to river	147	1	1.11	0.68	0.02	9.41
Time passed since Neolithic revolution ('000 years)	147	4.86	2.4	4.1	0.4	10.5
Agricultural Suitability Index - Ashraf and Galor (2011)	147	0.39	0.24	0.38	0	0.95
% of land in Tropical and Subtropical Zones - Ashraf and Galor (2011)	147	0.36	0.43	0.01	0	1
Average number of frost days (area-weighted frost-days)	147	9.38	10.37	3.36	0	29.8
Fertilty and education						
Year of fertility decline - Rehrer (2004)	121	1966.49	30.23	1975	1865	2000
Fertility rate 1960's, total (births per woman) (WDI)	147	5.36	1.89	6.13	1.84	8.13
Fertility rate 1970's, total (births per woman) (WDI)	147	4.95	2.03	5.71	1.58	8.22
Fertility rate 1980's, total (births per woman) (WDI)	147	4.41	2.04	4.54	1.40	9.08
Fertility rate 1990's, total (births per woman) (WDI)	147	3.68	1.86	3.32	1.23	7.99
Fertility rate 2000's, total (births per woman) (WDI)	147	3.11	1.63	2.64	1.21	7.32
Average fertility 1960-2000	147	4.3	1.79	4.6	1.62	7.66
Average scholing in 1870 - Morrison and Murtin (2009)	62	1.38	1.78	0.72	0.04	6.17
Average scholing in 2000 - Morrison and Murtin (2009)	62	7.45	3.39	7.31	1.02	13.12
Average scholing in 2010 - Morrison and Murtin (2009)	62	7.75	3.36	7.73	1.13	13.32
Average scholing in 2000 and 2010	62	8.04	3.34	8.12	1.25	13.62
Years (per 100000 people between 15 and 59, 2004) lost due to disability from the incidence of:						
Cataracts	147	347.31	306.54	253.28	8.35	948.86
Melanoma and other skin cancers	147	18.61	17.01	13.22	0.08	70.48
Trachoma	147	27.85	75.34	0	0	440.37
HIV/AIDS	147	3,282	8,315	173.89	0.64	60,288
Hookworm disease	147	16.93	20.45	4.61	0	67.12
Malaria	147	77.59	129.87	2.04	0	511.88
Intestinal nematode infections	147	17.24	20.49	4.73	0	67.62
Measures of historical prosperity						
Est GDP/cap 1820, Maddison (2000)	42	813.19	356	696	397	1838
Est GDP/cap 1900, Maddison (2000)	41	2,003	1,168	1729	533	4492
Est GDP/cap 1950, Maddison (2000)	111	2,583	3,595	1259	289	28878
Population density year 1500	145	6.32	8.9	2.44	0.02	46.64
Population density year 1000	140	3.63	4.39	1.17	0.01	19.87
Population density year 1	127	2.62	3.73	0.79	0.01	23.8
Indicators of institutions, natural resources, trust, culture:						
Malaria Ecology, pop-weighted, Sept 2003 version	147	3.73	6.77	0.12	0	31.55
Freedom House rating of political rights, 2002	147	3.59	2.14	3	1	7
Rule of law 1996-2000 - Nunn and Puga (2010)	147	-0.15	1	-0.33	-2.2	2.02
WB region indicator: East Asia and Pacific	147	0.1	0.3	0	0	1
WB region indicator: Europe and Central Asia	147	0.3	0.46	0	0	1
WB region indicator: Latin America and Caribbean	147	0.16	0.36	0	0	1
WB region indicator: Middle East and North Africa	147	0.11	0.31	0	0	1
WB region indicator: North America	147	0.01	0.12	0	0	1
WB region indicator: South Asia	147	0.05	0.21	0	0	1
WB region indicator: Sub-Saharan Africa	147	0.27	0.45	0	0	1
WHO region indicator: Africa	147	0.27	0.44	0	0	1
WHO region indicator: Americas	147	0.17	0.38	0	0	1
WHO region indicator: Eastern Mediterranean	147	0.12	0.33	0	0	1
WHO region indicator: Europe	147	0.31	0.46	0	0	1
WHO region indicator: South East Asia	147	0.05	0.21	0	0	1
WHO region indicator: Western Pacific	147	0.09	0.28	0	0	1
% of mineral fuels in manufacturing exports, 2000, WDI	120	17.65	27.89	4.63	0	99.64
Gem diamond extraction 1958-2000 (1000 carats) - Nunn and Puga (2010)	147	7,600	35,314	0	0	264,000
Migratory distance from Ethiopia - Olsson and Ahlerup (2009)	147	8,515	6,902	5645	0	26,836
Slave exports 1400-1900 - Nunn and Puga (2010)	147	106,000	401,000	0	0	3,610,000
Fraction of population of Euro desent (Weil/Putterman)	145	0.35	0.42	0.03	0	1
Indicators of technology diffusion from the technological frontier:						
Distance from the capital to the tech frontier (US) - great circle dist ('000 km)	147	5.55	2.56	5.23	0	14.39
Distance from the centroid to the tech frontier (US) - great circle dist ('000 km)	147	5.59	2.51	5.28	0.97	14.22

Notes. Data sources and definitions in the Supplementary Appendix.

Table A6
Summary statistics: Pixel level data

	N obs.	Mean	St dev	Median	Min	Max
1x1 degree						
Gross cell product per capita, 2005 ('000 USD)	17,074	13.9	26.2	8.1	0	2,344.8
Lights digital number, 2004 (F152004. Source: DMSP NASA)	18,245	3.59	5.04	2	1	63
Exposure to UV - av 1990, 2000 (Source: NASA)	18,245	155.15	93.43	153.49	13.33	428.56
Latitude (degrees)	18,245	29.34	30.94	36	-56	74
Elevation (m above sea level)	18,245	632.47	801.65	360.00	-46.05	6,300.00
Area of grid cell (sq km)	18,245	7,233	3,621	7,435	2	12,415
Distance to ice-free ocean ('000 km)	18,245	0.74	0.67	0.57	0	2.98
Distance to major navigable river ('000 km)	18,245	1.66	1.26	1.48	0	9.99
Distance to capital ('000 km)	18,245	1.13	1.39	0.56	0	9.86
2x2 degrees						
Gross cell product per capita, 2005 ('000 USD)	5,389	13.6	23.8	7.5	0	1,317.9
Lights digital number, 2004 (F152004. Source: DMSP NASA)	5,652	3.61	3.95	2.33	1	63
Exposure to UV - av 1990, 2000 (Source: NASA)	5,652	160.04	92.7	165.08	11.93	410.75
Latitude (degrees)	5,652	27.8	30.72	32.83	-55.5	74.67
Elevation (m above sea level)	5,652	596.85	754.91	349.28	-28.98	5,343.37
Area of grid cell (sq km)	5,652	23,149	15,507	22,447	5	49,430
Distance to ice-free ocean ('000 km)	5,652	0.68	0.66	0.49	0	2.95
Distance to major navigable river ('000 km)	5,652	1.66	1.31	1.45	0	9.99
Distance to capital ('000 km)	5,652	1.07	1.38	0.51	0	9.88
4x4 degrees						
Gross cell product per capita, 2005 ('000 USD)	1,929	12.9	15.3	6.9	0	286.1
Lights digital number, 2004 (F152004. Source: DMSP NASA)	2,036	3.72	3.99	2.46	1	61
Exposure to UV - av 1990, 2000 (Source: NASA)	2,036	165.05	91.76	176.42	13.33	399.96
Latitude (degrees)	2,036	26.32	30.52	31.29	-55.5	75.92
Elevation (m above sea level)	2,036	581.41	714.48	354.51	-27.58	5,200.00
Area of grid cell (sq km)	2,036	64,760	58,030	48,224	5	198,000
Distance to ice-free ocean ('000 km)	2,036	0.61	0.65	0.37	0	2.9
Distance to major navigable river ('000 km)	2,036	1.67	1.38	1.44	0	9.99
Distance to capital ('000 km)	2,036	0.98	1.36	0.45	0	9.84

Notes. Data sources and definitions in the Supplementary Appendix.

Table A7
Real GDP per capita, real GDP per worker, and exposure to UV: excluding continents one at a time

	1	2	3	4	5	6	7	8	9	10
Dependent variable:	**(log) Real GDP per capita, 2004**					**(log) Real GDP per worker, 2004**				
Excluded continent:	America	Africa	Asia	Europe	Oceania	America	Africa	Asia	Europe	Oceania
(log) UV	-1.83***	-1.58**	-1.84***	-2.46***	-1.56***	-1.65***	-1.47**	-1.81***	-2.15***	-1.44***
	[0.54]	[0.65]	[0.45]	[0.59]	[0.47]	[0.50]	[0.57]	[0.46]	[0.54]	[0.43]
Observations	122	102	108	112	144	120	100	108	110	142
R-squared	0.69	0.54	0.78	0.60	0.66	0.69	0.55	0.75	0.61	0.66
Partial R-squared	0.09	0.07	0.12	0.13	0.07	0.08	0.07	0.12	0.10	0.07
Additional controls	All controls (with latitude and elevation levels)									
Number of additional controls	14	14	14	14	14	14	14	14	14	14
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):										
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable in columns 1-5 is (log) real GDP per capita, and in columns 6-10, (log) real GDP per worker; in both cases measured in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. All controls are: (log) absolute latitude (degrees), (log) elevation ('000 m), (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A8
Real GDP per capita, real GDP per worker, and exposure to UV: excluding continents one at a time

	1	2	3	4	5	6	7	8	9	10
Dependent variable:	**(log) Real GDP per capita, 2004**					**(log) Real GDP per worker, 2004**				
Excluded continent:	America	Africa	Asia	Europe	Oceania	America	Africa	Asia	Europe	Oceania
(log) UV	-1.63**	-2.07**	-2.00***	-1.86**	-1.55**	-1.36**	-1.86**	-1.76***	-1.49*	-1.30**
	[0.65]	[0.82]	[0.67]	[0.86]	[0.66]	[0.63]	[0.78]	[0.66]	[0.83]	[0.64]
Observations	122	102	108	112	144	120	100	108	110	142
R-squared	0.75	0.64	0.82	0.65	0.72	0.75	0.64	0.81	0.66	0.72
Partial R-squared	0.05	0.09	0.10	0.04	0.05	0.04	0.09	0.08	0.03	0.04
Additional controls	All controls (with latitude and elevation FEs)									
Number of additional controls	26	26	24	25	26	26	26	24	25	26
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):										
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable in columns 1-5 is (log) real GDP per capita, and in columns 6-10, (log) real GDP per worker; in both cases measured in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. All controls are: latitude FEs, elevation FEs, (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A9
Real GDP per capita, skin cancer, tropically clustered diseases, and exposure to UV radiation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dependent variable:	**(log) Real GDP per capita, 2004**													
(log) UV	-1.64***	-1.47***	-1.78***	-1.11**	-1.13***	-1.02**	-0.86*	-1.71***	-1.65***	-2.02***	-1.33**	-1.39**	-1.23*	-1.33**
	[0.47]	[0.43]	[0.49]	[0.47]	[0.43]	[0.47]	[0.46]	[0.63]	[0.62]	[0.65]	[0.63]	[0.61]	[0.63]	[0.67]
(log) Melanoma and other skin cancers	0.011						0.017	0.015						0.013
	[0.13]						[0.10]	[0.13]						[0.11]
(log) Trachoma		-0.097**					-0.023		-0.037					0.006
		[0.047]					[0.046]		[0.051]					[0.050]
(log) HIV			0.06				0.084**			0.096**				0.10**
			[0.040]				[0.037]			[0.044]				[0.045]
(log) Hookworm disease				-0.29***			0.36				-0.25***			0.41
				[0.092]			[0.35]				[0.088]			[0.31]
(log) Malaria					-0.26***		-0.25***					-0.20***		-0.21***
					[0.059]		[0.066]					[0.070]		[0.077]
(log) Intestinal nematode infections						-0.32***	-0.57						-0.28***	-0.61*
						[0.094]	[0.35]						[0.087]	[0.31]
Observations	147	147	147	147	147	147	147	147	147	147	147	147	147	147
R-squared	0.67	0.68	0.67	0.69	0.72	0.7	0.75	0.73	0.73	0.74	0.74	0.75	0.75	0.78
Partial R-squared	0.08	0.11	0.09	0.15	0.21	0.16	0.29	0.06	0.06	0.09	0.11	0.13	0.12	0.23
Additional controls	All controls (with latitude and elevation levels)							All controls (with latitude and elevation FEs)						
Number of additional controls	15	15	15	15	15	15	15	27	27	27	27	27	27	27
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable is (log) real GDP per capita in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. All controls are: (log) absolute latitude (degrees) or latitude FEs (in columns 8-10), (log) elevation ('000 m) or elevation FEs (in columns 8-10), (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A10
Real GDP per worker, skin cancer, tropically clustered diseases, and exposure to UV radiation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dependent variable:	**(log) Real GDP per worker, 2004**													
(log) UV	-1.52***	-1.40***	-1.60***	-1.07**	-1.10***	-0.99**	-0.83*	-1.46**	-1.44**	-1.70***	-1.17*	-1.17*	-1.08*	-1.14*
	[0.43]	[0.41]	[0.44]	[0.43]	[0.41]	[0.43]	[0.44]	[0.62]	[0.61]	[0.63]	[0.60]	[0.60]	[0.59]	[0.64]
(log) Melanoma and other skin cancers	0.047						0.016	0.026						0.013
	[0.12]						[0.10]	[0.13]						[0.11]
(log) Trachoma		-0.072					-0.015		-0.012					0.014
		[0.046]					[0.046]		[0.051]					[0.050]
(log) HIV			0.036				0.075*			0.073*				0.089**
			[0.038]				[0.038]			[0.042]				[0.043]
(log) Hookworm disease				-0.25***			0.24				-0.20**			0.30
				[0.089]			[0.40]				[0.091]			[0.35]
(log) Malaria					-0.24***		-0.23***					-0.19***		-0.20**
					[0.061]		[0.067]					[0.072]		[0.078]
(log) Intestinal nematode infections						-0.28***	-0.44						-0.23**	-0.47
						[0.094]	[0.40]						[0.095]	[0.35]
Observations	145	145	145	145	145	145	145	145	145	145	145	145	145	145
R-squared	0.67	0.67	0.67	0.69	0.71	0.69	0.73	0.72	0.72	0.73	0.73	0.75	0.74	0.77
Partial R-squared	0.07	0.09	0.08	0.13	0.20	0.14	0.26	0.05	0.05	0.07	0.08	0.13	0.09	0.20
Additional controls	All controls (with latitude and elevation levels)							All controls (with latitude and elevation FEs)						
Number of additional controls	15	15	15	15	15	15	15	27	27	27	27	27	27	27
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable is (log) real GDP per worker in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. All controls are: (log) absolute latitude (degrees) or latitude FEs (in columns 8-10), (log) elevation ('000 m) or elevation FEs (in columns 8-10), (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A11
Real GDP per capita and exposure to UV: Additional robustness checks

	1	2	3	4	5	6	7	8	9	10	11	12
Dependent variable:	**(log) Real GDP per capita, 2004**											
Controlling for:	Malaria ecology	Freedom House rating of political rights, 2002	Rule of law 1996-2000	WB Region indicators[a]	WHO Region indicators[a]	% of mineral fuels in manufacturing exports, 2000	Gem diamond extraction 1958-2000 (1000 carats)	Migratory distance from Ethiopia	Slave exports 1400-1900	Fraction of population of Euro desent	Distance from capital to tech frontier (US)	Distance from centroid to tech frontier (US)
(log) UV	-1.60***	-1.73***	-1.18***	-1.33**	-1.67***	-1.39***	-1.74***	-1.69***	-1.65***	-1.72***	-1.65***	-1.70***
	[0.46]	[0.47]	[0.41]	[0.52]	[0.50]	[0.51]	[0.47]	[0.47]	[0.47]	[0.46]	[0.49]	[0.50]
Coefficient on the control variable:[a]	-0.016	-0.094**	0.64***	2.79[a]	0.73[a]	0.004	3.6e-06**	0.000035	5.40E-08	0.23	0.0018	0.022
	[0.013]	[0.046]	[0.084]	(0.02)[a]	(0.60)[a]	[0.0029]	[1.7e-06]	[0.000038]	[1.2e-07]	[0.47]	[0.071]	[0.074]
Observations	147	147	147	147	147	120	147	147	147	145	147	147
R-squared	0.67	0.68	0.78	0.70	0.68	0.70	0.68	0.67	0.67	0.69	0.67	0.67
Partial R-squared	0.08	0.11	0.38	0.16	0.26	0.10	0.10	0.08	0.08	0.10	0.08	0.08
Additional controls	All controls (with latitude and elevation levels)											
Number of additional controls	15	15	15	15	14	15	15	15	15	15	15	15
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):												
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable is (log) real GDP per capita in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. Definitions and sources for control variables noted in each column are explained in the Supplementary Appendix. All controls are: (log) absolute latitude (degrees), (log) elevation ('000 m), (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

a: F-statistic and p-value in parentheses for the joint significance of latitude and elevation FEs reported instead of individual coefficients in columns 4 and 5.

Table A12
Real GDP per worker and exposure to UV: Additional robustness checks

	1	2	3	4	5	6	7	8	9	10	11	12
Dependent variable:	**(log) Real GDP per worker, 2004**											
Controlling for:	Malaria ecology	Freedom House rating of political rights, 2002	Rule of law 1996-2000	WB Region indicators[a]	WHO Region indicators[a]	% of mineral fuels in manufacturing exports, 2000	Gem diamond extraction 1958-2000 (1000 carats)	Migratory distance from Ethiopia	Slave exports 1400-1900	Fraction of population of Euro desent	Distance from capital to tech frontier (US)	Distance from centroid to tech frontier (US)
(log) UV	-1.48***	-1.60***	-1.06***	-1.26**	-1.52***	-1.28***	-1.64***	-1.56***	-1.54***	-1.63***	-1.48***	-1.51***
	[0.42]	[0.43]	[0.39]	[0.48]	[0.48]	[0.45]	[0.43]	[0.43]	[0.43]	[0.41]	[0.44]	[0.44]
Coefficient on the control variable:[a]	-0.015	-0.085*	0.58***	2.13[a]	6.48[a]	0.0039	4.2e-06**	0.000027	6.60E-08	0.082	-0.022	-0.0062
	[0.013]	[0.044]	[0.087]	(0.06)[a]	(0.00)[a]	[0.0027]	[1.7e-06]	[0.000036]	[1.3e-07]	[0.44]	[0.067]	[0.071]
Observations	145	145	145	145	145	120	145	145	145	143	145	145
R-squared	0.67	0.68	0.77	0.69	0.67	0.7	0.68	0.67	0.67	0.69	0.67	0.67
Partial R-squared	0.08	0.10	0.35	0.14	0.25	0.10	0.11	0.08	0.07	0.09	0.07	0.07
Additional controls	All controls (with latitude and elevation levels)											
Number of additional controls	15	15	15	15	14	15	15	15	15	15	15	15
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):												
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable is (log) real GDP per worker in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. Definitions and sources for control variables noted in each column are explained in the Supplementary Appendix. All controls are: (log) absolute latitude (degrees), (log) elevation ('000 m), (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

a: F-statistic and p-value in parentheses for the joint significance of latitude and elevation FEs reported instead of individual coefficients in columns 4 and 5.

Table A13
Real GDP per capita and exposure to UV: Additional robustness checks

	1	2	3	4	5	6	7	8	9	10	11	12
Dependent variable:	**(log) Real GDP per capita, 2004**											
Controlling for:	Malaria ecology	Freedom House rating of political rights, 2002	Rule of law 1996-2000	WB Region indicators[a]	WHO Region indicators[a]	% of mineral fuels in manufacturing exports, 2000	Gem diamond extraction 1958-2000 (1000 carats)	Migratory distance from Ethiopia	Slave exports 1400-1900	Fraction of population of Euro desent	Distance from capital to tech frontier (US)	Distance from centroid to tech frontier (US)
(log) UV	-1.70***	-1.65***	-1.17**	-1.66**	-1.58**	-1.46**	-1.76***	-1.71***	-1.72***	-1.98***	-1.62**	-1.59**
	[0.64]	[0.61]	[0.55]	[0.68]	[0.67]	[0.67]	[0.62]	[0.62]	[0.62]	[0.59]	[0.62]	[0.63]
Coefficient on the control variable:[a]	-0.0025	-0.089**	0.59***	5.66[a]	1.20[a]	0.004	0.0000021	-0.000013	1.60E-07	0.15	-0.077	-0.068
	[0.015]	[0.045]	[0.082]	(0.00)[a]	(0.31)[a]	[0.0030]	[1.9e-06]	[0.000048]	[1.2e-07]	[0.37]	[0.074]	[0.078]
Observations	147	147	147	147	147	120	147	147	147	145	147	147
R-squared	0.73	0.74	0.81	0.76	0.73	0.76	0.73	0.73	0.73	0.75	0.73	0.73
Partial R-squared	0.06	0.09	0.36	0.18	0.21	0.09	0.06	0.06	0.06	0.08	0.07	0.06
Additional controls	All controls (with latitude and elevation FEs)											
Number of additional controls	27	27	27	27	26	27	27	27	27	27	27	27
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):												
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable is (log) real GDP per capita in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. Definitions and sources for control variables noted in each column are explained in the Supplementary Appendix. All controls are: latitude FEs, elevation FEs, (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

a: F-statistic and p-value in parentheses for the joint significance of latitude and elevation FEs reported instead of individual coefficients in columns 4 and 5.

Table A14
Real GDP per worker and exposure to UV: Additional robustness checks

	1	2	3	4	5	6	7	8	9	10	11	12
Dependent variable:	**(log) Real GDP per worker, 2004**											
Controlling for:	Malaria ecology	Freedom House rating of political rights, 2002	Rule of law 1996-2000	WB Region indicators[a]	WHO Region indicators[a]	% of mineral fuels in manufacturing exports, 2000	Gem diamond extraction 1958-2000 (1000 carats)	Migratory distance from Ethiopia	Slave exports 1400-1900	Fraction of population of Euro desent	Distance from capital to tech frontier (US)	Distance from centroid to tech frontier (US)
(log) UV	-1.44**	-1.40**	-0.95*	-1.47**	-1.41**	-1.20*	-1.54**	-1.47**	-1.47**	-1.76***	-1.36**	-1.33**
	[0.62]	[0.60]	[0.53]	[0.66]	[0.65]	[0.62]	[0.61]	[0.60]	[0.61]	[0.57]	[0.60]	[0.61]
Coefficient on the control variable:[a]	-0.0034	-0.089**	0.54***	5.26[a]	4.16[a]	0.0037	3.0e-06*	-0.000024	1.70E-07	0.067	-0.09	-0.077
	[0.016]	[0.041]	[0.087]	(0.00)[a]	(0.00)[a]	[0.0028]	[1.8e-06]	[0.000046]	[1.3e-07]	[0.34]	[0.073]	[0.077]
Observations	145	145	145	145	145	120	145	145	145	143	145	145
R-squared	0.72	0.73	0.8	0.75	0.73	0.77	0.73	0.72	0.73	0.75	0.73	0.73
Partial R-squared	0.05	0.09	0.32	0.14	0.20	0.08	0.06	0.05	0.06	0.07	0.06	0.06
Additional controls	All controls (with latitude and elevation FEs)											
Number of additional controls	27	27	27	27	26	27	27	27	27	27	27	27
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):												
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions. The dependent variable is (log) real GDP per worker in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. Definitions and sources for control variables noted in each column are explained in the Supplementary Appendix. All controls are: latitude FEs, elevation FEs, (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

a: F-statistic and p-value in parentheses for the joint significance of latitude and elevation FEs reported instead of individual coefficients in columns 4 and 5.

Table A15
Timing of the fertility decline and exposure to UV

	1	2	3	4	5	6	7	8	9	10
Dependent variable:	**Year of the fertility decline**									
(log) UV	52.4***	34.4***	53.2***	45.1***	58.2***	53.5***	62.8***	35.3***	24.0	39.2***
	[3.75]	[6.24]	[5.05]	[14.7]	[7.09]	[4.41]	[5.58]	[10.3]	[16.0]	[9.36]
Observations	121	121	121	121	121	121	121	121	121	121
R-squared	0.63	0.77	0.63	0.69	0.65	0.68	0.69	0.8	0.83	0.8
Partial R-squared	0.63	0.26	0.48	0.08	0.38	0.61	0.49	0.08	0.02	0.02
Additional controls	-	Continent FEs	Latitude, elevation (levels)	Latitude, elevation (FEs)	Precipitation, temperature	Distance to ocean, rivers, area, timing Neolithic revolution	Agricultural suitability, tropical area, frost	All controls (with latitude and elevation levels)	All controls (with latitude and elevation FEs)	All controls (no latitude and elevation controls)
Number of additional controls	-	3	2	14	2	4	3	2	14	12
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):										
Continent FEs		0.00								
Latitude, elevation (levels)			0.92					0.42		
Latitude, elevation (FEs)				0.00					0.35	
Precipitation, temperature					0.01					
Distance to ocean, rivers, area, timing Neolithic revolution						0.00				
Agricultural suitability, tropical area, frost							0.00			
All controls (with latitude and elevation levels)								0.00		
All controls (with latitude and elevation FEs)									0.00	
All controls (no latitude and elevation controls)										0.00

Notes: OLS regressions. The dependent variable is the year of fertility decline (Rehrer, 2004). UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. All regressions include a constant term. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A16
Real GDP per capita, fertility decline, cataract prevalence, and exposure to UV

	1	2	3	4	5	6
Dependent variable:	**Year of the ferility decline**	**(log) Real GDP per capita, 2004**				
	OLS	OLS	OLS	OLS	OLS	2SLS-IV
(log) UV	35.3***	-1.50***			-0.53	
	[10.3]	[0.54]			[0.51]	
Year of the ferility decline			-0.022***		-0.019***	-0.017***
			[0.0055]		[0.0055]	[0.0054]
(log) Cataract prevalence, 2004				-0.30***	-0.20**	-0.59
				[0.085]	[0.091]	[0.37]
Observations	121	121	121	121	121	121
R-squared	0.80	0.67	0.72	0.68	0.73	0.69
Partial R-squared	0.08	0.06	0.18	0.07	0.22	0.12
Additional controls	All controls (with latitude and elevation levels)					
Number of additional controls	14	14	14	14	14	14
Endogenous variable						(log) Cataract prevalence, 2004
Instrument						(log) UV
Kleibergen Paap F statistic						0.079
Anderson Rubin weak id Chi-sq test (p-value)						8.79
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):						
All controls (with latitude and elevation levels)	0.00	0.00	0.00	0.00	0.00	0.00

Notes: OLS regressions in columns 1-6, and a 2SLS-IV regression in column 7. The dependent variable in column 1 is the timing of the fertility decline (Reher, 2004). The dependent variable in columns 2-6 is (log) real GDP per capita in 2004. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). Cataract prevalence is measured as the number of years lost due to disability, for incident cases of this disease (expressed as a rate per 100,000 people between 15 and 59), estimated by WHO (2004). The R-squared from an OLS regression where all listed additional controls where partialled is reported as the Partial R-squared in each column. All controls are: (log) absolute latitude (degrees), (log) elevation ('000 m), (average 1990-2008) temperature, (average 1990-2008) precipitation, (log) country area (sq km), distance to ocean (km), distance to major rivers (km), (log) area (sq km), timing passed since the Neolithic revolution ('000 years), (log) agricultural suitability index, the percentage of land in tropical and subtropical zones, and (area weighted, average) number of frost days per year. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A17
Human capital investments and exposure to UV

	1	2	3	4	5	6	7	8	9
Dependent variable:	**Growth in years of schooling, 1870-2005**								
(log) UV	-0.27***	-0.38***	-0.41***	-0.84**	-0.11	-0.30**	-0.22*	-0.4	-0.97**
	[0.082]	[0.11]	[0.13]	[0.36]	[0.14]	[0.12]	[0.13]	[0.40]	[0.44]
(log) Years of schooling, 1870	-0.79***	-0.86***	-0.81***	-0.84***	-0.89***	-0.81***	-0.84***	-0.91***	-0.97***
	[0.052]	[0.050]	[0.048]	[0.076]	[0.048]	[0.047]	[0.051]	[0.052]	[0.074]
Observations	62	62	62	62	62	62	62	62	62
R-squared	0.90	0.93	0.91	0.92	0.92	0.92	0.91	0.96	0.97
Partial R-squared	0.08	0.09	0.09	0.06	0.01	0.09	0.03	0.03	0.10
Additional controls	-	Continent FEs	Latitude, elevation (levels)	Latitude, elevation (FEs)	Precipitation, temperature	Distance to ocean, rivers, area, timing Neolithic revolution	Agricultural suitability, tropical area, frost	All controls (with latitude and elevation levels)	All controls (with latitude and elevation FEs)
Number of additional controls		3	2	13	2	4	3	2	13
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):									
Continent FEs		0.00							
Latitude, elevation (levels)			0.00					0.13	
Latitude, elevation (FEs)				0.01					0.00
Precipitation, temperature					0.01				
Distance to ocean, rivers, area, timing Neolithic revolution						0.06			
Agricultural suitability, tropical area, frost							0.04		
All controls (with latitude and elevation levels)								0.00	
All controls (with latitude and elevation FEs)									0.00

Notes: OLS regressions. The dependent variable is growth in years of schooling between 1870 and 2005. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression where all listed additional controls were partialled out is reported as the Partial R-squared in each column. The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A18
Fertility and exposure to UV

	1	2	3	4	5	6	7	8	9
Dependent variable:					**Average fertility rate, 1960-2000**				
(log) UV	2.77***	1.78***	2.91***	3.01***	2.51***	2.85***	2.64***	1.23**	0.95*
	[0.15]	[0.32]	[0.24]	[0.70]	[0.34]	[0.19]	[0.31]	[0.56]	[0.56]
Observations	147	147	147	147	147	147	147	147	147
R-squared	0.64	0.78	0.65	0.72	0.71	0.69	0.69	0.83	0.88
Partial R-squared	0.64	0.23	0.47	0.13	0.31	0.64	0.34	0.04	0.02
Additional controls	-	Continent FEs	Latitude, elevation (levels)	Latitude, elevation (FEs)	Precipitation, temperature	Distance to ocean, rivers, area, timing Neolithic revolution	Agricultural suitability, tropical area, frost	All controls (with latitude and elevation levels)	All controls (with latitude and elevation FEs)
Number of additional controls	-	4	2	14	2	4	3	2	14
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):									
Continent FEs		0.00							
Latitude, elevation (levels)			0.08					0.19	
Latitude, elevation (FEs)				0.00					0.00
Precipitation, temperature					0.00				
Distance to ocean, rivers, area, timing Neolithic revolution						0.00			
Agricultural suitability, tropical area, frost							0.00		
All controls (with latitude and elevation levels)								0.00	
All controls (with latitude and elevation FEs)									0.00

Notes: OLS regressions. The dependent variable is average fertility between 1960 and 2000. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A19
Human capital investments, timing of the fertility decline, and exposure to UV

	1	2	3	4	5	6	7	8	9
Dependent variable:					**Growth in years of schooling, 1870-2005**				
(log) UV	0.021	-0.21*	-0.17	-0.74**	0.09	-0.077	0.12	-0.28	-0.87*
	[0.12]	[0.12]	[0.13]	[0.33]	[0.15]	[0.14]	[0.15]	[0.41]	[0.45]
(log) Years of schooling, 1870	-0.83***	-0.86***	-0.86***	-0.87***	-0.92***	-0.85***	-0.87***	-0.90***	-0.97***
	[0.052]	[0.049]	[0.051]	[0.076]	[0.046]	[0.049]	[0.045]	[0.050]	[0.070]
Year of the fertility decline	-0.0074***	-0.0056**	-0.0071***	-0.0078***	-0.0059***	-0.0064**	-0.0085***	-0.0043*	-0.0045**
	[0.0023]	[0.0024]	[0.0022]	[0.0027]	[0.0021]	[0.0025]	[0.0024]	[0.0025]	[0.0020]
Observations	62	62	62	62	62	62	62	62	62
R-squared	0.91	0.94	0.92	0.93	0.93	0.93	0.93	0.96	0.97
Partial R-squared	0.00	0.03	0.01	0.05	0.004	0.005	0.01	0.02	0.09
Additional controls	-	Continent FEs	Latitude, elevation (levels)	Latitude, elevation (FEs)	Precipitation, temperature	Distance to ocean, rivers, area, timing Neolithic revolution	Agricultural suitability, tropical area, frost	All controls (with latitude and elevation levels)	All controls (with latitude and elevation FEs)
Number of additional controls	-	3	2	13	2	4	3	2	13
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):									
Continent FEs		0.00014							
Latitude, elevation (levels)			0.0069					0.22	
Latitude, elevation (FEs)				0.00062					0.0033
Precipitation, temperature					0.0085				
Distance to ocean, rivers, area, timing Neolithic revolution						0.15			
Agricultural suitability, tropical area, frost							0.0068		
All controls (with latitude and elevation levels)								0.000017	
All controls (with latitude and elevation FEs)									2.90E-09

Notes: OLS regressions. The dependent variable is growth in years of schooling between 1870 and 2005. UV is a population weighted index of the exposure to ulraviolet radiation (see Supplementary Appendix for details). Year of the fertility decline from Reher (2004). The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.

Table A20
Fertility, timing of the fertility decline, and exposure to UV

	1	2	3	4	5	6	7	8	9
Dependent variable:	**Average fertility rate, 1960-2000**								
(log) UV	0.69**	0.83**	0.80**	1.38*	0.34	0.66**	0.25	0.71	0.42
	[0.27]	[0.33]	[0.33]	[0.73]	[0.30]	[0.29]	[0.29]	[0.52]	[0.67]
Year of the fertility decline	0.040***	0.033***	0.040***	0.038***	0.037***	0.038***	0.040***	0.029***	0.026***
	[0.0044]	[0.0054]	[0.0043]	[0.0049]	[0.0043]	[0.0045]	[0.0046]	[0.0057]	[0.0052]
Observations	121	121	121	121	121	121	121	121	121
R-squared	0.77	0.82	0.78	0.81	0.82	0.78	0.8	0.87	0.9
Partial R-squared	0.05	0.48	0.70	0.48	0.60	0.71	0.63	0.34	0.29
Additional controls	-	Continent FEs	Latitude, elevation (levels)	Latitude, elevation (FEs)	Precipitation, temperature	Distance to ocean, rivers, area, timing Neolithic revolution	Agricultural suitability, tropical area, frost	All controls (with latitude and elevation levels)	All controls (with latitude and elevation FEs)
Number of additional controls	-	3	2	14	2	4	3	14	26
Joint significance of the additional control variables (p-values for the H0: all regressors [except UV] are jointly insignificant):									
Continent FEs		0.00							
Latitude, elevation (levels)			0.05						
Latitude, elevation (FEs)				0.01					
Precipitation, temperature					0.00				
Distance to ocean, rivers, area, timing Neolithic revolution						0.05			
Agricultural suitability, tropical area, frost							0.00		
All controls (with latitude and elevation levels)								0.00	
All controls (with latitude and elevation FEs)									0.00

Notes: OLS regressions. The dependent variable is average fertility between 1960 and 2000. UV is a population weighted index of the exposure to ultraviolet radiation (see Supplementary Appendix for details). Year of the fertility decline from Reher (2004). The R-squared from an OLS regression, where all listed additional controls are partialled out, is reported as the Partial R-squared in each column. Robust standard errors in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% level, respectively. All regressions include a constant term. All variables described in detail in the Supplementary Appendix.