Demographic Transitions Across Time and Space

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Version: December 2018.

Abstract

The demographic transition, i.e., the move from a regime of high fertility/high mortality into a regime of low fertility/low mortality, is a process that almost every country on Earth has undergone or is undergoing. Are all demographic transitions equal? Have they changed in speed and shape over time? And, how do they relate to economic development? To answer these questions, we put together a data set of birth and death rates for 188 countries that spans more than 250 years. Then, we use a novel econometric method to identify start and end dates for transitions in birth and death rates. We find, first, that the average speed of transitions has increased steadily over time. Second, we document that income per capita at the start of these transitions is more or less constant over time. Third, we uncover evidence of *demographic contagion*: the entry of a country into the demographic transition is strongly associated with its neighbors, countries that are geographically and culturally close, having already entered into the transition even after controlling for other observables. Next, we build a model of demographic transitions that can account for these facts. The model economy is populated by different locations. In each location, parents decide how many children to have and how much to invest in their human capital. There is skill-biased technological change that diffuses slowly from the frontier country, Britain, to the rest of the world.

Keywords: Demographic Transition, Skill-Biased Technological Change, Diffusion.

JEL codes: ....

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1 Introduction

Demographic transition theory constitutes one of the most powerful ideas in economics and demography. The text book description of demographic transition is as follows:

> "The recent period of very rapid demographic change in most countries around the world is characteristic of the central phases of a secular process called the demographic transition. Over the course of this transition, declines in birth rates followed by declines in death rates bring about an era of rapid population growth. This transition usually accompanies the development process that transforms an agricultural society into an industrial one. Before the transition's onset, population growth (which equals the difference between the birth and death rate in the absence of migration) is near zero as high death rates more or less off set the high birth rates typical of agrarian societies before the industrial revolution. Population growth is again near zero after the completion of the transition as birth and death rates both reach low levels in the most developed societies." (Boongaarts 2009, page 2985).

In this paper we do two things: First, we put together and analyze data set on crude death rates (CDR) and crude birth rates (CBR) for 188 countries that spans more than 250 years. Following the text book description of the demographic transition, we then estimate for each country in our sample: i) initial (pre-transition) levels of the CDR and CBR, ii) the start dates of the mortality and fertility transitions, iii) the end dates of the mortality and fertility transitions, iv) final (post-transition) levels of the CDR and CBR. This procedure also allows us to estimate the length and the speed of each transition.

Looking at demographic transitions across time and space, we show that: 1) transitions are becoming faster, 2) the average level of GDP per capita at the start of a transition is more or less constant, 3) an important predictor of a country's transition is the prior transition of other countries which are "close" to it in a geographical and a linguistic sense, and which have similar legal systems.

We then build a model economy that can account for these facts. We consider an economy with multiple locations. Each location is populated by a representative household that decides how many children to have and how much to invest in their education. Having and educating children is costly. A production technology combines unskilled and skilled labor. Economy is initially in a Malthusian steady state with high but constant levels of mortality and fertility. At a certain point in time, technological progress becomes skill biased. This occurs first in the frontier country, Britain in our analysis, and then diffuses slowly to other locations. Skill-biased technological progress makes investment in children more valuable and parents react by reducing the number of children but educating them better. We first calibrate the model economy to

replicate the demographic transition in Britain. We then show that a simple mechanism of diffusion where skill-biased technological change travels from Britain to the rest of the world in a manner that only depends on geographic distance is able to generate sequences of demographic transitions, each happening faster than the previous one, exactly as we observe in the data.

Understanding the relationship between income and population is one of the oldest challenges in economics, going back to Malthus (1803) who developed a powerful model that links better technology with constant living standards. In a Malthusian world, technological change allows a higher income per capita which leads to higher population through higher fertility and lower mortality. In the presence of a fixed input such as land, this higher population translates into lower marginal productivities that decrease per capita income back to the stationary level previous to the technological advance. Malthus' model is quite successful at accounting for the main facts that prevailed until the nineteenth century, but it fails to explain the coexistence of growth in per capita income and low fertility. ? and ? develop the idea of a trade-off between quantity and quality of children to show that higher per capita incomes and low fertility can go together. The interest in this mechanism was revived with the presentation of an operational dynastic model of fertility in ? and ?.

Building on this initial work, ?, ??, ?, and, in particular, ??? present models that try to capture the historical evolution of population and output. Several recent papers, e.g., ?, ?, ?, and ?, present quantitative versions of these models that can account for historical evidence on demographic transitions for specific countries. ? and ? provide recent reviews of this literature.

Few recent papers study the historical evolution of fertility. ? document that genetic and linguistic distance from France was associated with the onset of the fertility transition in Europe. ? focus on the fertility and education transition in France during the 19th century, and show that a simple quality-quantity model can do a decent job in explaining variations of fertility across time and counties in France. ? focus on post-1960 transitions and emphasize the role of social norms and family planning programs in recent declines in fertility rates in developing countries. Our paper is also related to recent studies that provide an empirical analysis of demographic transitions across countries. ? looks at a broad panel of countries and compares earlier with later demographic transitions, with a particular focus on the role of mortality in driving fertility changes. ? also constructs a panel and .finds evidence for a robust effect of early childhood education on fertility decline. Building on these earlier contributions, our paper is the first to detect empirically a "demographic contagion" effect at a global scale, and to investigate it within a quantitative framework.

Finally, by proposing technology diffusion as a mechanism linking the process of the demographic transition in different countries, our analysis also borrows from recent literature on technology diffusion, such as ? and ?.

2 Demographic transitions: past and present

In this section, we propose a methodology for documenting the shape and speed of demographic transitions across time and space. For that purpose, we will compile and analyze country-level vital statistics and apply it to the historical data on the crude birth rate (CBR) and the crude death rate (CDR).[1] We focus on the CBR and the CDR instead of the other statistics such fertility rate or life expectancy because the CBR and CDR are easily measured from the data: a researcher only needs to count births, deaths, and total population. Thus, the CBR and CDR are available for long periods of time and across many different countries. In comparison, a fertility rate or a life expectancy require more involved computations, such as finding exact current age-specific fertility rates, which are often not available for historical data or subject to large measurement error.

In the textbook case, a demographic transition has four stages (**?**):

- In Stage 1, both the CBR and the CDR are high and stationary.
- In Stage 2, the CDR starts to decline while the CBR stays high.
- In Stage 3, the CBR also starts to decline.
- In Stage 4, both the CDR and the CBR stop falling and become stationary at a lower level.

We take this 4-stage demographic transition as a benchmark model of the evolution of the CBR and CDR and try to fit it to available data for each country. More concretely, for the CBR and the CDR, we estimate, for each rate, four variables to describe the data as best as possible: i) an initial (pre-transition) average level of the CBR and CDR; ii) the start dates of the declines of the CBR and CDR (which, in general will be different); iii) the end dates of the declines of the CBR and CDR (also, in general different); and iv) a final (post-transition) average level of the CBR and CDR. We do not impose that, either before or after the demographic transition, the average level of the CBR and CDR are equal to each other. The population of a country can be growing (the average CBR is higher than the average CDR) or declining (the average CBR is lower than the average CDR). Note, also, that we

2.1 Econometric model

Consider a dependent variable y_t observed for periods $t \in \{1, ..., T\}$. We will assume that y_t can be represented as a linear function of a vector x_t of k regressors and a residual. Furthermore,

[1] Recall that the CBR is the number of live births per year per 1,000 in a population. The CDR is the number of deaths per year per 1,000 in a population.

suppose that instead of being constant over time, the relationship between y_t and x_t evolves over time and can be broken into S distinct stages $s \in \{1, 2, ..., S\}$ connecting $S + 1$ distinct endpoints represented by $\{\tau_1, \tau_2, ..., \tau_{S+1}\}$, such that $\tau_1 = 1$, $\tau_{S+1} = T$, $\tau_s \in \{2, ..., T - 1\}$ for $s \in \{2, ..., S\}$ and $\tau_s < \tau_{s+1}$ for all $s \in \{1, ..., S\}$.

At each endpoint τ_s, $s \in \{1, ..., S + 1\}$, the dependent variable is defined by:

$$y_{\tau_s} = x'_{\tau_s}\alpha_s + \sigma_s\nu_{s,\tau_s}, \tag{1}$$

where $\nu_{s,t} \sim \mathcal{N}(0, 1)$ for all s, α_s is a $k \times 1$ vector of regression coefficients, and σ_s is a scalar that determines the volatility of the residual at point τ_s.

Now suppose that in each stage s, i.e., when $\tau_s < t < \tau_{s+1}$, the dependent variable is defined by:

$$y_t = x'_t f_s(\alpha_s, \alpha_{s+1}, t) + \varepsilon'_{s,t} g_s(\sigma_s, \sigma_{s+1}, t) \text{ for } \tau_s < t < \tau_{s+1},$$

where $\varepsilon_{s,t} \sim \mathcal{N}(0, 1)$ for all s, and f_s and g_s are continuous functions $f_s : \mathbb{R}^k \times \mathbb{R}^k \times \mathbb{R} \to \mathbb{R}^k$, $g_s : \mathbb{R}^+ \times \mathbb{R}^+ \times \mathbb{R} \to \mathbb{R}^+$ such that

$$\begin{aligned} f_s(\alpha_s, \alpha_{s+1}, \tau_s) &= \alpha_s, \\ f_s(\alpha_s, \alpha_{s+1}, \tau_{s+1}) &= \alpha_{s+1}, \\ g_s(\sigma_s, \sigma_{s+1}, \tau_s) &= \sigma_s, \end{aligned}$$

and

$$g_s(\sigma_s, \sigma_{s+1}, \tau_{s+1}) = \sigma_{s+1}.$$

While it is possible to analyze the more general class of transition functions we have defined above, we will restrict our attention to the simplest case where f_s and g_s are linear transitions with respect to time between the parameters at τ_s and τ_{s+1} for all $s \in \{1, ..., S\}$, i.e.,

$$f_s(\alpha_s, \alpha_{s+1}, t) = \frac{1}{\tau_{s+1} - \tau_s} \left[(\tau_{s+1} - t)\alpha_s + (t - \tau_s)\alpha_{s+1}\right], \tag{2}$$

and

$$g_s(\sigma_s, \sigma_{s+1}, t) = \frac{1}{\tau_{s+1} - \tau_s} \left[(\tau_{s+1} - t)\sigma_s + (t - \tau_s)\sigma_{s+1}\right]. \tag{3}$$

To apply this theoretical framework to the specific context under study, suppose that the dependent variable y_t is either the CBR or the CDR for a particular country and that $S = 3$ (i.e., there is a stage where y_t is stationary, another stage it is declining and a final stage it is stationary again). Furthermore, we are interested in modeling a situation in which there is a transition between two stable regimes, so let us assume that $\alpha_s = \alpha_{s+1}$, $\sigma_s = \sigma_{s+1}$, and $\nu_{st} = \nu_{s+1,t} = \varepsilon_{st}$ for $s \in \{1, 3\}$.

Substituting in for f_1 and g_1 as given by equations (2) and (3), we can write the model for y_t as

$$\begin{aligned} y_t &= d_{1t}[x_t'\alpha_1 + \varepsilon_{1t}\sigma_1] \\ &\quad + d_{2t}[x_t'\frac{1}{\tau_3 - \tau_2}\left[(\tau_3 - t)\alpha_1 + (t - \tau_2)\alpha_3\right] \\ &\quad + d_{2t}[\frac{1}{\tau_3 - \tau_2}\left[(\tau_3 - t)\sigma_1 + (t - \tau_2)\sigma_3\right]\varepsilon_{2t} \\ &\quad + d_{3t}[x_t'\alpha_3 + \varepsilon_{3t}\sigma_3], \end{aligned} \tag{4}$$

where $\{d_{st}\}_{s=1}^{3}$ are indicator functions given by

$$d_{1t} = 1\{t \leq \tau_2\}, \quad d_{2t} = 1\{\tau_2 < t < \tau_3\}, \text{ and } d_{3t} = 1\{t \geq \tau_3\}.$$

Equation (4) can then be rearranged as

$$\begin{aligned} y_t &= \left[d_{1t} + d_{2t}\left(\frac{\tau_3 - t}{\tau_3 - \tau_2}\right)\right]x_t'\alpha_1 + \left[d_{3t} + d_{3t}\left(\frac{t - \tau_3}{\tau_3 - \tau_2}\right)\right]x_t'\alpha_3 \\ &\quad + \left[d_{1t}\varepsilon_{1t} + d_{2t}\left(\frac{\tau_3 - t}{\tau_3 - \tau_2}\right)\varepsilon_{2t}\right]\sigma_1 + \left[d_{3t}\varepsilon_{3t} + d_{2t}\left(\frac{\tau_3 - t}{\tau_3 - \tau_2}\right)\varepsilon_{3t}\right]\sigma_3, \end{aligned} \tag{5}$$

where $\tau_2 \in \{1, ..., T-1\}$ and $\tau_3 \in \{\tau_2 + 1, ..., T\}$, with $\tau_2 \leq \tau_3$.

2.1.1 Estimation

The model, as we specified above, has $2k + 2$ free parameters: the k parameters in α_1, the k parameters in α_3, plus τ_2 and τ_3. We choose these parameters according to the criterion of minimizing the unweighted sum of squared errors. This means that for a given (τ_2, τ_3) pair, estimation of (α_1, α_3) reduces to ordinary least squares (OLS). The optimal (τ_2, τ_3) can then be located by a search algorithm across the possible values. To this end, let's define scalars

$$z_{1t} \equiv d_{1t} + d_{2t}\left(\frac{\tau_3 - t}{\tau_3 - \tau_2}\right)$$

and

$$z_{3t} \equiv d_{3t} + d_{2t}\left(\frac{t - \tau_2}{\tau_3 - \tau_2}\right).$$

Then given

$$\underset{1\times T}{y'} \equiv [y_1 \dots y_T],$$

and

$$\underset{2k\times T}{Z'} \equiv \left[\left[\begin{array}{c} z_{11}x_1 \\ z_{31}x_1 \end{array} \right] ... \left[\begin{array}{c} z_{1T}x_T \\ z_{3T}x_T \end{array} \right] \right],$$

the OLS estimators of (α_1, α_3) given (τ_2, τ_3) have the following closed-form expression:

$$\left[\begin{array}{c} \widehat{\alpha}_1 \\ \widehat{\alpha}_2 \end{array} \right] = [Z'Z]^{-1}Z'y.$$

Estimating σ_1 and σ_3 in this configuration is straightforward, except for the fact that the contribution of each variance to the total variance differs across periods and so the errors must be weighted accordingly.

Define

$$e_t \equiv y_t - [z_{11}x_1 \ z_{31}x_1] \left[\begin{array}{c} \hat{\alpha}_1 \\ \hat{\alpha}_3 \end{array} \right],$$

$$\underset{1\times T}{e_z^{1\prime}} \equiv [z_{11}e_1 \dots z_{1T}e_T],$$

and

$$\underset{1\times T}{e_z^{3\prime}} \equiv [z_{31}e_1 \dots z_{3T}e_T].$$

We calculate the following estimators for σ_1 and σ_3 given (τ_2, τ_3), which are asymptotically equivalent to the OLS estimators:

$$\widehat{\sigma}_1^2 = \left(\sum_{t=1}^{T} z_{1t} \right)^{-1} e_z^{1\prime} e_z^1$$

and

$$\widehat{\sigma}_2^2 = \left(\sum_{t=1}^{T} z_{3t} \right)^{-1} e_z^{3\prime} e_z^3.$$

Note that when $\sum_{t=1}^{T} d_{st} = 1$ and $\sum_{t=1}^{T} d_{2t} = 0$ for $s \in \{1, 3\}$, σ_s is not identified, but this is of little consequence as none of the estimators for the other parameters depend on the variance estimates.

While in general it may be interesting to include a larger number of regressors in x_t, the only specification of this model that we will use in the analysis that follows is the one where x_t contains only a constant term, $x_t' = 1$ for $\forall t$ and $k = 1$. Hence, before a transition start, i.e. while $t < \tau_2$, $y_t = \alpha_1$ (stage 1), between τ_2 and τ_3, y_t declines linearly (stage 2), and at τ_3, $y_t = \alpha_3$, (stage 3).

2.1.2 Restricted cases

A challenge in estimating the econometric model described above is data limitations. Even if the three-phase model is a useful characterization of the data, one or more of the phases might not observed, either because of data limitations or because the demographic transition is still on-going. In particular, we can five different cases, as illustrated in Figure 1 (we plot the five cases of CBR transitions, but an analogous figure exists for the CDR transitions).

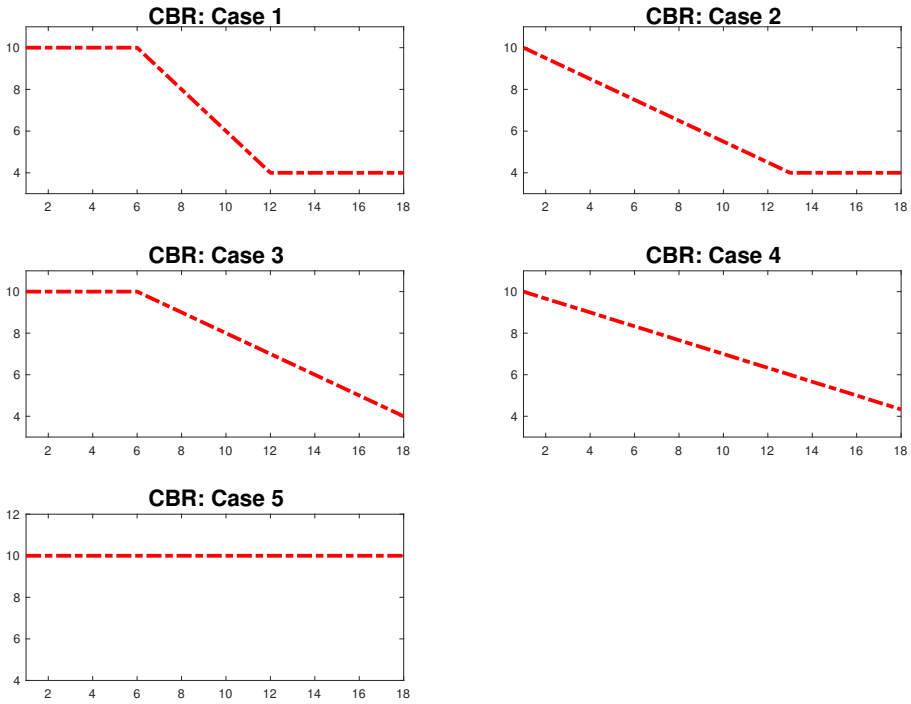


Figure 1: 5 cases of the CBR transition

In the top left panel, we have Case 1: all three phases are observed. In the top right panel, we have Case 2: only phases 2 and 3 are observed. In the middle row, we see Cases 3 (only phases 1 and 2 are observed) and 4 (only phase 2 is observed). In the bottom panel we see the rare Case 5, where only phase 1 is observed.[2] Case 2 will usually be associated with data limitations (i.e., vital statistics not going back in time for a sufficiently long period), while cases 3 to 5 will be more often linked with ongoing transitions.

To discriminate among all these different cases, we estimate, for each country in the data, all five cases. As documented in Table 1, Cases 2 to 5 are versions of Case 2 where some parameters values have been restricted. Furthermore, Case 1 nests Cases 2 and 3, Cases 2 and 3 both nest Case 4, and Case 4 nests Case 5.

[2]We only estimate a few Cases 5 for the CBR in our data and none for the CDR. Theoretically, we could also have Case 6, where only phase 3 is observed, but since no country in the data is in this situation, we ignore this sixth case.

Table 1: Different cases of the general model

	Parameter restriction	Explanation	Num. of parameters
Case 1	–	All 3 stages are observed	$2k+2$
Case 2	$\tau_2 = 1$	Only stages 2 and 3 are observed	$2k+1$
Case 3	$\tau_3 = T$	Only stages 1 and 2 are observed	$2k+1$
Case 4	$\tau_2 = 1, \tau_3 = T$	Only stage 2 is observed	$2k$
Case 5	$\tau_2 = 1, \tau_3 = T, \alpha_1 = \alpha_3$	Only stage 1 or 3 are observed	k

We select, among the five cases, the version of the model that has the best trade-off between fitting the data and less restrictions. That is, we select a less restricted case only if it does a significantly better job of fitting the data. In a first pass of such selection, we use a F-test at the 95% confidence level:

$$\frac{\frac{SSE^b - SSE^a}{m^a - m^b}}{\frac{SSE^a}{T - m^a}} \tag{6}$$

where a nests b, and, as mentioned in the previous section, $m^I = 2k + 2$. In a few cases, we override the statistical test by incorporating additional information, such as whether the last level of the variable observed is more typical of a final steady state or of a continuing transition.

3 Data

3.1 Vital statistics and GDP per capita

We merge data from different sources to obtain time series for CBRs and CDRs that are as long as possible for the greatest possible number of countries. From 1960 onwards, we rely on the World Bank Development Indicators. For many countries, we fill in 1950-1960 with data from the UNData service of the United Nations Statistics Division. To gather vital statistics before 1950, we start with data from **?**' classic book on the demographic transition and augment them with observations from **?**'s International Historical Statistics. We also use additional sources for few countries: **?** and **?** for Turkey, **?** for Switzerland, **?** for the US, and **?** for India. The resulting data set on CDRs and CBRs covers 188 countries from 1735 to 2014.

We take data on purchasing power parity GDP per capita (GDPpc), given in constant 2011 US Dollars purchasing power parity (PPP), from the 2018 version of Maddison's database.[3] We extend the end of the panel from 2011 to 2015 using data from the World Bank Development

[3](**?**). The database can be accessed here: https://www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2018

Table 2: Summary statistics of demographics and GDPpc

Variable	sample mean	st. Dev.	N. Obs.
crude death rate *(CDR)*, per 1000	13.7	7.6	15952
crude birth rate *(CBR)*, per 1000	30.3	11.9	15923
ln GDP per capita *(lnGDPPC)*	8.3	1.1	16761

Indicators. Table 2 shows the means and the standard deviations of the CBR, the CDR, and the log GDP per capita in our sample. Table 3 shows the correlations across the three variables. We see i) a clear and strong negative correlation between the CBR and the log GDP per capita; ii) a slightly less strong negative correlation between the CDR and the log GDP per capita; and iii) the positive comovement of the CBR and the CDR.

Table 3: Correlations among key variables

	CDR	CBR	lnGDPPC
crude death rate *(CDR)*, per 1000	1	0.49	-0.57
crude birth rate *(CBR)*, per 1000	0.49	1	-0.71
ln GDP per capita *(lnGDPPC)*	-0.57	-0.71	1

3.1.1 Projecting CDR backwards

Vital statistics for only a few countries are available back into the 19th century and for a great many not until after 1950. As a result, there are numerous countries for which the start of either the CBR or the CDR transition is not observed. Due to the fact that the CDR transition starts, on average, earlier than the CBR transition, there are many more "missing starts" for the CDR transitions than for CBR. In all, there are 89 countries for which the start of the CBR transition is estimated to be observed, but the beginning of the CDR transition is not.

One way to address this gap is to apply the 3-phase framework and project the CDR backward to an initial level which is predicted according to the country's initial CBR level and perhaps other observables. To this end, we estimate:

$$\alpha_i^d = \beta_0 + \beta_1 \alpha_i^b + \beta_2 \left(\alpha_i^b\right)^2 + \beta_3 s_i^b + \beta_4 s_i^d + \varepsilon_i, \tag{7}$$

where $s^b \equiv \frac{\alpha_{3,i}^b - \alpha_{1,i}^b}{\tau_{3,i} - \tau_{2,i}}$ and $s_i^d \equiv \frac{\alpha_{3,i}^d - \alpha_{1,i}^d}{\tau_{3,i} - \tau_{2,i}}$ are the calculated slopes for CBR and CDR, respectively, during the transition, and ε_i is a mean-zero *iid* error term.

The parameters of this equation are estimated using only the 24 countries for which both the CBR and CDR transitions are observed and that the CBR transition started prior to 1950. These earlier transitions are selected because the estimated gap of the CBR over the CDR is systematically higher for the later cohort, suggesting that these estimated initial levels may

not reflect the true, long-run pre-transition levels. Otherwise, these alternative CBRs would imply a counterfactually high rate of population growth before the onset of the demographic transition. Table 4 shows the results of the estimation of equation (7). T-ratios are given in parenthesees.

Table 4: CDR projections

β_0	β_1	β_2	β_3	β_4
-4.2538	0.9567	-0.0025	-1.6899	2.3285
18.1410	(1.0111)	(0.0138)	(5.5633)	(1.5349)
N = 23	R^2=0.730			

The estimated parameters are then used to predict initial CDR levels for 89 countries for which the start of the CBR transition is observed, but the start of the CDR transition is not. After removing outliers and unreasonable results, predictions for 77 countries remain.[4] This more than doubles the number of countries for which some estimate of the CDR transition start date is available, from 53 to 130 countries in total.

3.1.2 Extension of GDP per capita data

Recall that the main source for GDP per capita data that we use is the 2018 version of Maddison's database. While this database provides us with estimates for some countries going as far back as the year 1 CE, the time series for other countries does not start until the late 19th or early 20th centuries, long after many countries entered the CBR and CDR transitions.

To analyze the relationship between GDP per capita and demographic trends, we impute a value for GDP per capita in the year 1500 for most of the countries in our sample. We do this by recursively dividing countries into two sets.

The first set contains of two kinds of countries: i) those that are already assigned a value for year 1500 GDP per capita in Maddison's database; and ii) those which have a value for a year that is either prior to after 1500, but before any evidence of the onset of modern economic growth in such country. For the latter countries, the value for the closest year is assigned to the year 1500 directly (in a few cases where we have data from before and after 1500, but not 1500, we interpolate linearly). This approach (and the other imputations below) implicitly assume that economies before the the arrival of modern economic growth lived in a quasi-Malthusian world, with little or no long-run economic growth and small differences in GDP per capita.

[4]We exclude a projection if: (a) the predicted initial level of CDR is higher than the estimated initial level of CBR, as this would imply an initial zero population; (b) if the gap between the initial level of the CBR and the CDR is larger than the largest gap observed in the 24-country sample used to estimate the parameters, as this would imply a very high initial population growth rate; or (c) if the total length of the implied CDR transition is longer than the longest transition observed in the 24-country sample used to estimate the parameters, as this would imply an inordinately long transition.

In fact, in order to reduce the likelihood that we are projecting backwards levels of GDP per capita that are the result of early modern growth, we then remove from this set any country for which the closest GDP per capita value that can be assigned is for a year after 1650 *and* exceeds $1176, the mean GDP per capita for England during its first 50 years in the database (1262-1302). The removed countries are added to the second set. After the removals, the first set consists of 43 countries.

The second set consists of all countries that were not assigned a year 1500 value in the first step. Each of these countries is assigned an index country from the first group based on geographical proximity. A year 1500 GDP per capita value is then computed either by assuming that the ratio of GDP per capita in these two countries has remained constant from the year 1500 until the first year for which the Maddison database assigns them both a value or by simple assuming that the GDP per capita was the same in both countries. There are two oil-producing countries, the United Arab Emirates and Gabon, for which it is not possible to assign a valid index country because they began large-scale oil production prior to the first observation assigned to them in the Maddison database. No year 1500 estimate is imputed for them. Excluding the UAE and Gabon, the second set consists of 113 countries. There are 31 countries, most of them tiny island territories, for which we have have data on birth rates and death rates, but which are not included in Maddison's database.[5]

Table B1 in the appendix gives the details of the year 1500 GDP per capita imputations.

4 Results

Figure 2 displays time series of CBR and CDR, along with the fitted 3-phase transitions for each of these rates that we calculate, for six countries that represent different characteristic demographic transitions. The top panel in the left is the demographic transition of Great Britain/UK, a typical example on an early demographic transition, with the CDR that started falling in 1810 and stabilized by 1951 and a CBR that starts falling in 1880 and stabilizes around 1938. The top panel in the right is the demographic transition of Denmark, less early than the Great Britain/UK's, but representative of many other Western European countries. The bottom left panel is the demographic transition for Chile, a representative example of late transitions, with the CBR still not stabilized. Finally, Malaysia in an example of a late demographic transition for which we do not have a start date for the fall of the CDR. Table A in the Appendix documents the start and end dates of the demographic transition, if they can be estimated, for each country in our sample.

Figure 3 displays scatter plots of CDR and CBR, for every country in every year that they

[5]Maddison's database has data for Slovakia, but we exclude it to avoid double-counting, as for the majority of the covered time period Slovakia was part of Czechoslovakia.

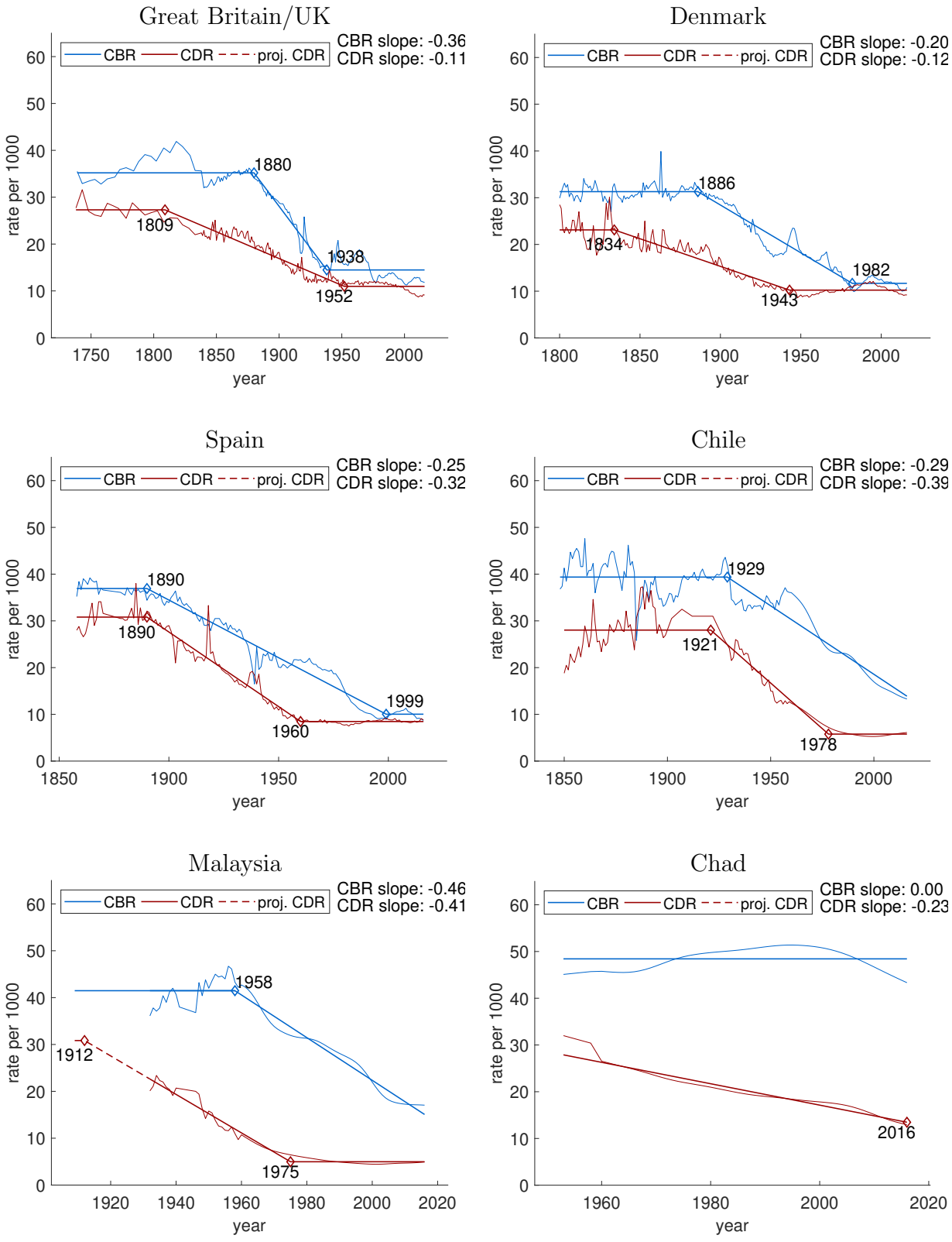


Figure 2: Six examples of demographic transitions.

are observed, against log GDP per capita. Superimposed onto the plots is the best fit for a 3-phase transition as specified previously, with log GDP per capita taking the place of time. While admittedly a crude first exercise, this structure provides a reasonably good fit for the panel data with R^2 coefficients of 0.334 and 0.533, respectively. According to this estimation, the "average" pre-transition CDR for the entire panel is 19.3 per year per 1000 people, and the pre-transition CBR for the entire sample is 44.5. The estimated post-transition CBR and CDR for the entire sample are 8.9 and 16.7, respectively. The crude death rate transition is estimated to start, on " average," when a country achieves a real GDP per capita of $1,604 constant 2011 constant US dollars PPP. The "average" start of the CBR transition is estimated to be at $1,064. The end of the CDR and CDR transitions are placed at $9,509 and $19,930, respectively.

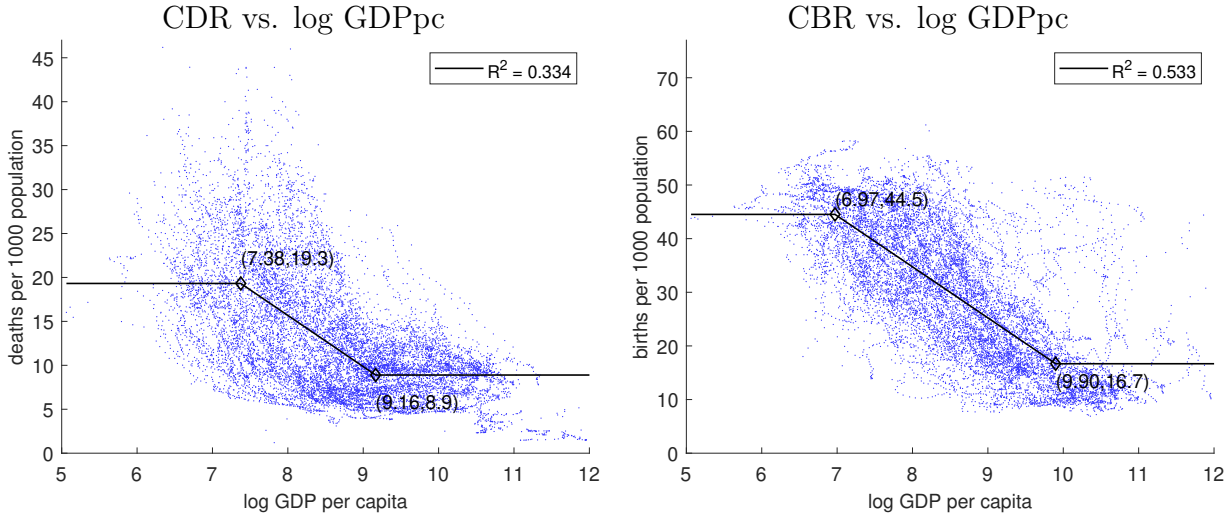


Figure 3: CDR and CBR vs. log GDPpc.

Table 5 documents the distribution of all countries in our sample according to different cases outlined in Table 1. Out of 188 countries, we have 46 countries that have completed the death transition and 43 countries that have completed the birth transition. The largest count of countries (102) is those in case 2 of death rates (stages 2 and 3 are observed, but not stage 1, most likely because of data limitations), but in different positions in their CBR transition.

we have for which we observe completed mortality and fertility transitions. If we focus on either just the mortality or fertility transitions, we have 46 countries (CDR) and 43 (CBR). The largest group of countries (102) is those that are in case 2 of death rates (stages 2 and 3 are observed), but in different positions in their birth rates transition. Putting together the 46 countries in case 1 of the CDR with these 102 countries, we see that most of the planet has already completed its mortality transition. The transition of birth rates is less finished, with 100 countries still in case 3, where the CBR has not stabilized yet and a few cases, such as

Chad, where it has not even started.

Table 5: Case counts

CDR \CBR	Case 1	Case 2	Case 3	Case 4	Case 5	Total
Case 1	27	2	17	0	0	46
Case 2	15	11	61	13	2	102
Case 3	0	0	7	0	0	7
Case 4	1	0	13	1	2	17
Case 5	0	10	2	1	3	16
Total	43	23	100	15	7	188

The distribution of the log GDP per capita levels at the start of both the CBR and CDR transitions appear to have uni-modal distributions, which may be adequately approximated by a normal distribution. Figure 4 plots the empirical frequency of log GDP per capita at the start of each type of transition.

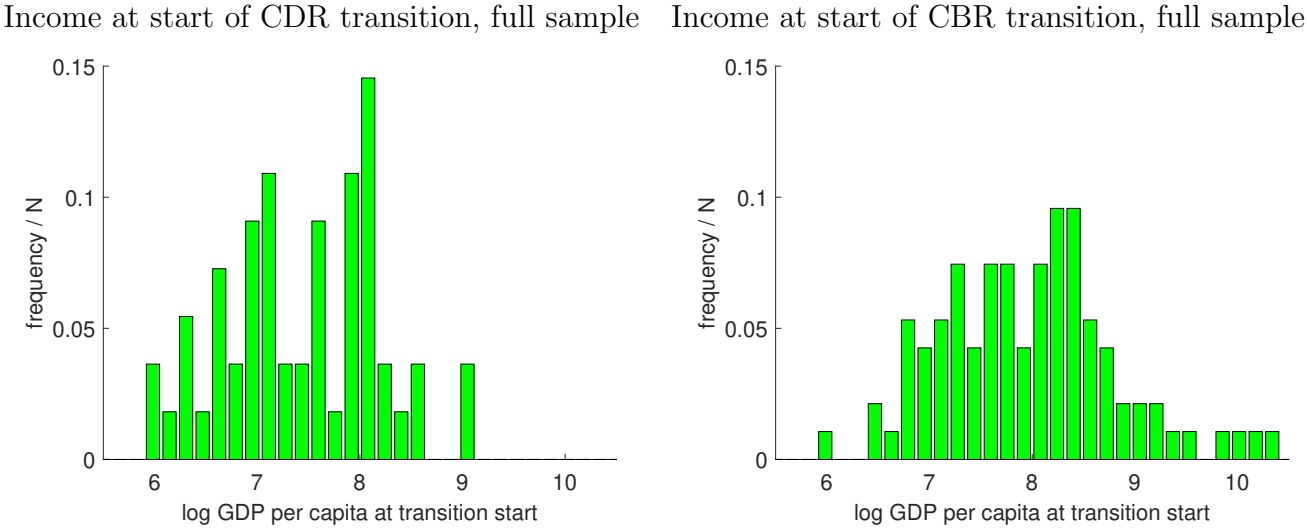


Figure 4: log GDP per capita at the start of each transition.

4.1 Are demographic transitions getting faster?

Table 6 reports summary statistics for some features of countries as they enter the CDR and CBR transitions, broken into groups according to the time period in which their transition started. A number of patterns are evident in these numbers. First of all, start dates of the CDR transitions are less concentrated over time than those of the CBR transition starts. They also peak sooner and there are only 12 countries that started its CDR transition before 1960. The pattern of CBR transition starts, in contrast, peaks dramatically in the 30 years between 1960 and 1990, and there have also been several transition starts since 1990.

Table 6: Countries entering transitions

	before 1870	1870-1900	1900-1930	1930-1960	1960-1990	after 1990	All
mn. trns. slope, CDR	-0.19	-0.25	-0.38	-0.59	-0.79	-0.93	-0.44
mn. initial CDR	26.67	26.30	23.88	27.06	26.12	22.28	25.57
mn. init. lnGDPpc	7.72	7.85	7.55	7.42	7.32	6.55	7.55
N, CDR	11	18	43	31	9	1	113

	before 1870	1870-1900	1900-1930	1930-1960	1960-1990	after 1990	All
mn. trns. slope, CBR	-0.19	-0.32	-0.33	-0.51	-0.58	-0.50	-0.51
mn. initial CBR	38.74	36.02	39.70	39.82	44.21	46.70	42.51
mn. init. lnGDPpc	7.47	8.39	7.92	7.93	8.03	7.19	7.96
N, CBR	4	11	6	20	70	9	120

We can also detect in Table 6 a tendency for countries in later transition groups to transition faster. The slope of the reduction in crude death and crude birth rates during the transition, i.e. the decline in the CDR and CBR per year, is much larger for transitions that start later. Figure 5 shows this pattern for all the countries in our sample with complete transitions. The two panels document the same fact with an alternative measure of: the total length of the crude death and crude birth rate transition measured from plateau to plateau.

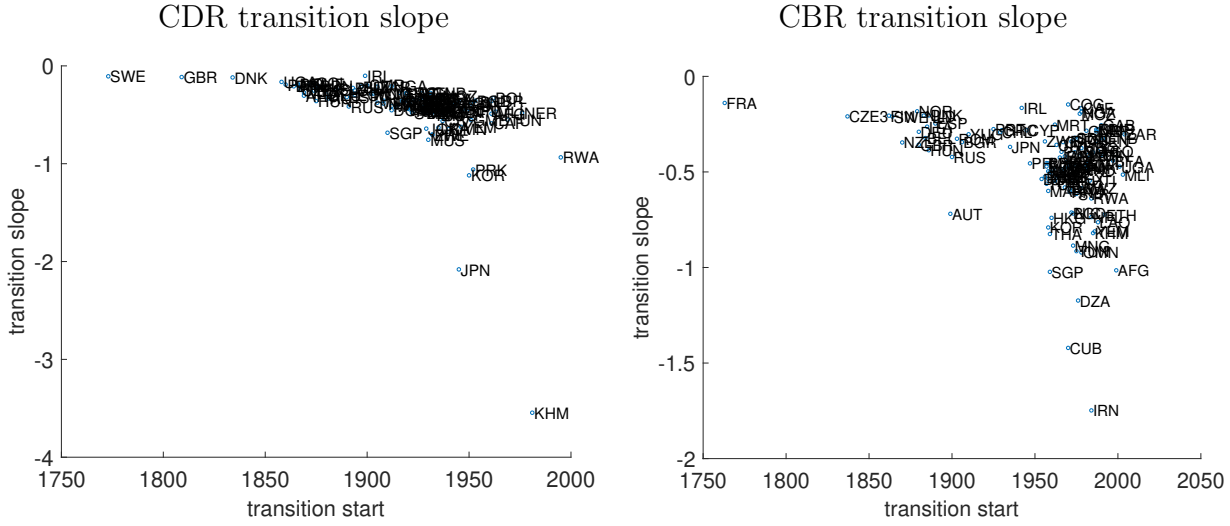


Figure 5: Transition slopes.

To measure the strength of this downward trend more precisely, we turn to a simple linear regression, which allows us to also control for some other factors in addition to timing, that may affect transition speed. We hypothesize that in addition to the timing of the transition start, the speed of the transition may also be affected by the level of GDP per capita at the transition start and by how high crude birth rates were initially. [6]

[6]The initial level of crude birth rate is highly correlated with the initial level of crude death rate, and including the initial level of crude death rate in the regression does not significantly affect the results.

Table 7: Transition Speed

Dependent variable	CDR slope	CBR slope	CDR length	CBR length
Cons	-0.16	0.74	160.91	268.54
	(-0.30)	(2.26)	(5.48)	(5.79)
ln GDPPC at start	0.02	-0.09	-0.36	-12.19
	(0.29)	(-2.84)	(-0.12)	(-2.25)
starting CBR /10	0.11	-0.01	-2.16	1.44
	(1.86)	(-0.29)	(-0.75)	(0.29)
start date /10	-0.06	-0.03	-7.05	-6.86
	(-5.66)	(-4.09)	(-13.39)	(-10.94)
N. Obs.	102	108	86	36
R^2	0.248	0.196	0.710	0.811

Table 7 displays the results of simple linear regressions for each measure of transition speed including these three variables. In each case, transition start date is significantly related to transition speed.

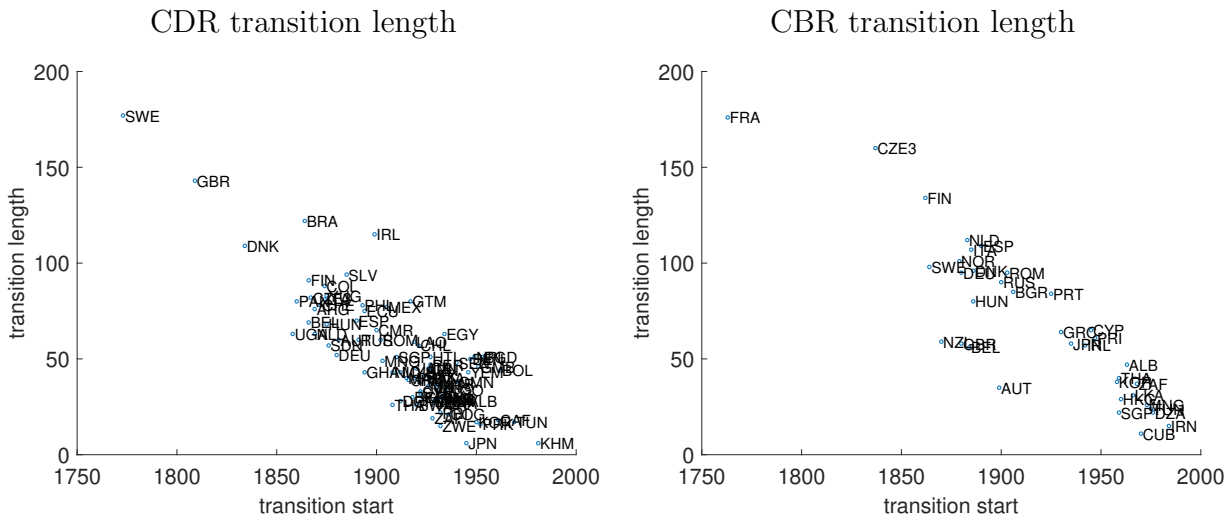
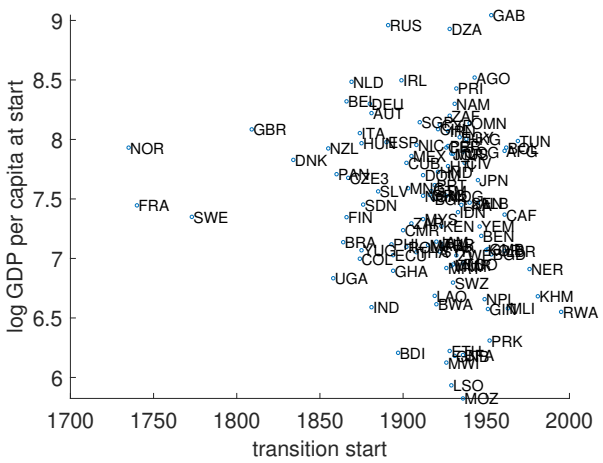


Figure 6: Transition lengths.

Another fact that emerges from Table 7 is that while the GDP per capita at the start of the CDR transition is lower for later transitions, there is no clear trend in the GDP per capita at the start of the CBR transitions. The GDP per capita is remarkably similar, for example, for the CBR transitions that started during the 1870-1900 period and during the 1960-90 period. Figure 7 shows scatter plots of log GDP per capita in each country at the start of its CDR and CBR transition, respectively.

Log GDPpc at the start of the CDR transition



Log GDPpc at the start of the CBR transition

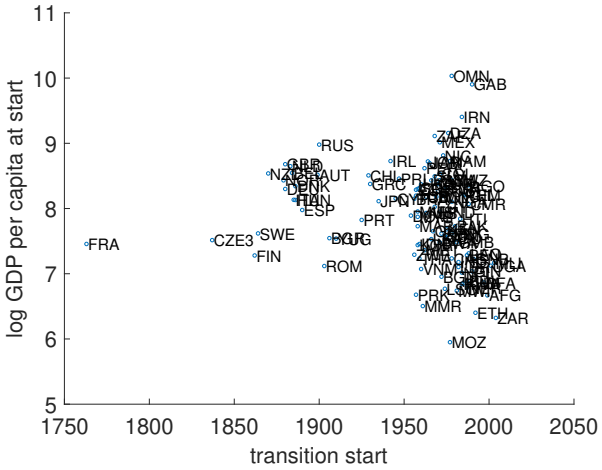


Figure 7: Log GDPpc at the start of transitions.

5 An empirical analysis of demographic transitions

In the previous section, we saw that the distributions of log GDP per capita levels at the start of transitions in crude birth rates or death rates are fairly stable over time and possess unimodal distributions. This suggests that a modeling strategy which links the level of log GDP per capita to transition takeoffs may have some explanatory power. One possible approach is to model the start of each transition as a random event whose probability of occurring depends on log GDP per capita and possibly other variables. Let T represent the time at which a one-off event, such as a birth rate or death rate transition, occurs. Suppose that the probability of the event occurring at time t in country i, conditional on not having occurred previously, can be expressed as:

$$\Pr(T^i = t | T^i \geq t) = G\left(\sum_{l=0}^{k-1} x_{l,it}\beta_l\right), \tag{8}$$

where $G(.)$ is a function bounded between 0 and 1. In the exercise that follows, we will assume that $G(.)$ is the logistic cumulative distribution function in line with the well-known Logit model. In this specification $(x_{0,it}, x_{1,it}, ..., x_{k-1,it})$ are a set of k explanatory variables.

Consider a world populated with N different countries indexed by $i \in \{1, 2, ..., N\}$ for which a set of variables $x_{it} \in X$ is observed time $t = 1$ until T. Let T^i represent the time at which a given one-off event occurs in country i, and let $\mathcal{I}_{it}$ be an indicator function taking the value 1 if the event occurs in country i at time t and 0 otherwise. Let $\Pr(T^i = t|T^i \geq t) = G\left(\sum_{l=0}^{k-1} x_{l,it}\beta_l\right)$ (according to 8). The parameters of this model can then be estimated by maximizing the

log-likelihood:

$$\log L_N = \sum_{i=1}^{N} \sum_{t=1}^{T_i} \log \left[\mathcal{I}_{it} G \left(\sum_{l=0}^{k-1} x_{l,it} \beta_l \right) + (1 - \mathcal{I}_{it})(1 - G \left(\sum_{l=0}^{k-1} x_{l,it} \beta_l \right)) \right]. \tag{9}$$

Table 8: GDPpc and CBR transition, Logit results

Variable	Estimates
Cons	-21.08
	(7.37)
lnGDPPC	2.08
	(1.85)
lnGDPPC ^{2}	-0.01
	(0.12)
LLn	-661.3
Psuedo-R^2	0.132
N. Obs.	48715

Table 8 summarizes the results of the logit estimation where the only explanatory variable is log GDP per capita. This specification is able to replicate well the distribution of log GDP per capita at the start of the transition as can be seen in Figure 8. It does not perform well, however, in replicating the distribution of transition starts over time or in predicting transition start dates for individual countries, as can be seen in Figures 9 and 10.

Next we extend the Logit analysis by including network effect. In particular, we estimate the following expression,

$$\Pr(T^i = t | T^i \geq t) = G \left(\sum_{l=0}^{k-1} x_{l,it} \beta_l + \beta_k \mathcal{A}_{it} \right),$$

where $\mathcal{A}_{it}$ is a measure of location i's access to transitions in other locations at time t, and is defined as

$$\mathcal{A}_{it} \equiv \left[\sum_{j=1}^{N} g_{ij} \mathcal{I}_{j,t-1}) \right]^{\psi}.$$

where $\mathcal{I}_{j,t} = 1$ if the transition has already started in country j, and g_{ij} measures the inverse of *the distance* between country i and country j. Hence, if a country j is very far from country i, then g_{ij} is close to zero, and as a result, whether or not country j has already started its transition has no effect on the probability that country i starts its transition. On the other hand, if country j is close to country i, then whether country $j's$ transition has a positive effect on the probability that country i also starts its transition.

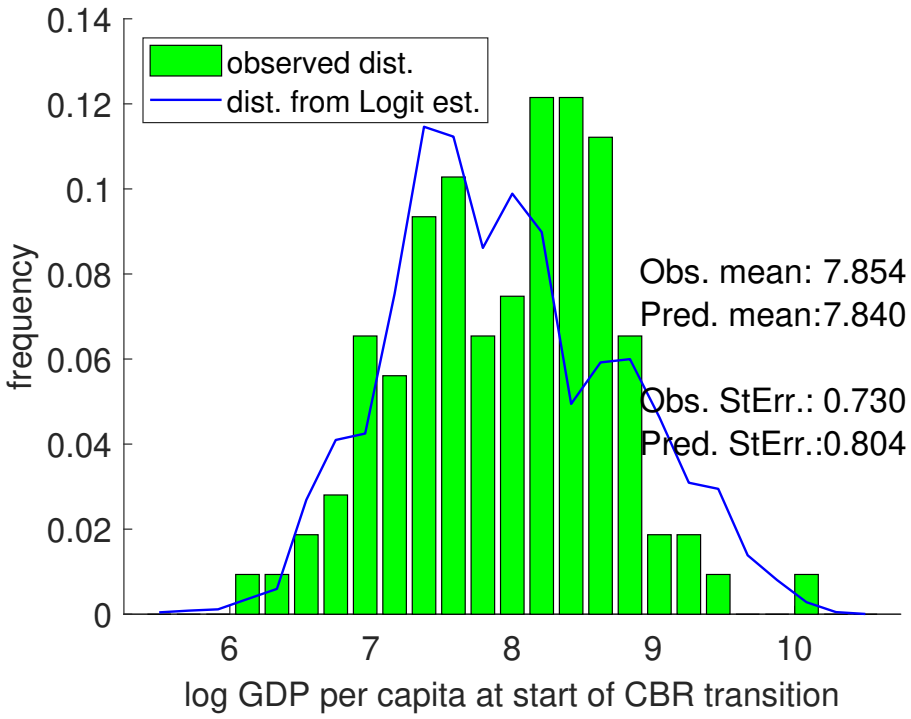


Figure 8: Distribution of log GDPpc at the start of the CBR transitions

Figure 9: Within Sample Predictions

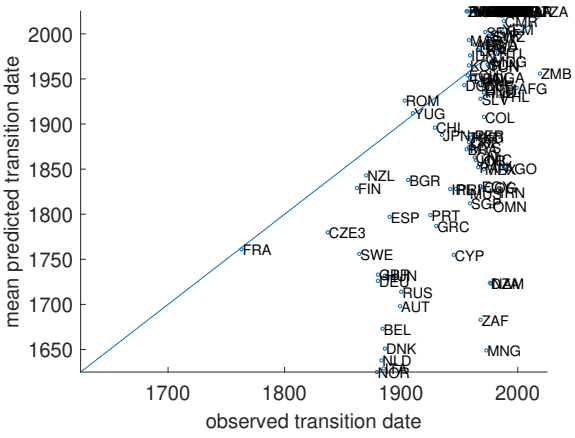
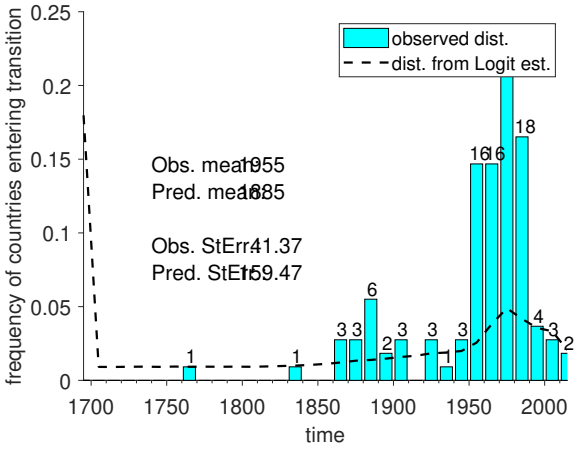


Figure 10: Distribution of Transtion Dates



Following **?**, we assume that the distance between two countries is given by

$$g_{ij} = \exp\{\mathbf{z}_{ij}'\gamma\},$$

where $\mathbf{z}_{ij}$ is a column vector of bilateral distance measures and γ is a vector of coefficients. The parameter vectors β and γ and the parameter ψ can be estimated using log-likelihood.

5.1 Bilateral country distance measures

We borrow data on measures of bilateral geographic, linguistic, religious, and legal distance from **?**, who investigate the effect of each of these distance measures on bilateral trade volumes in the second half of the 20th century.[7] The only measure of geographic distance we consider is great circle distance between capital cities. **?** construct and test several alternative measures of the degree of linguistic commonality between countries, ranging from the narrowest definition, simply recording whether the two countries share an official language or not, to more nuanced definitions based on the shares of population in each country that speak the same or similar languages. Here we use the measure based on the broadest definition of linguistic proximity which Melitz and Toubal call "LP2" , and which they constructed using data on the distribution of spoken languages and **?**'s calculation of linguistic similarity. To reflect connections that may exist between countries for historical reasons independently of shared language, we also consider Melitz and Toubal's index of shared religion and a dummy variable for common legal origins. Table 9 displays summary statistics for these variables, and the correlation table is given in Table 10.

Table 9: Distance measures, summary statistics

Variable	sample mean	st. Dev.	N. Obs.
ln Distance, km *(ldi)*	8.7	0.8	24668
Linguistic proximity *(lp2)*	0.6	0.7	24668
Common religion *(cmr)*	0.2	0.2	24668
Common legal system *(cml)* $\in \{0, 1\}$	0.2	0.4	24668

Table 10: Distance measures, correlations

	lp2	*ldi*	*cmr*	*cml*
ln Distance, km *(ldi)*	1	-0.36	-0.36	-0.28
Linguistic proximity *(lp2)*	-0.36	1	0.25	0.40
Common religion *(cmr)*	-0.36	0.25	1	0.22
Common legal system *(cml)* $\in \{0, 1\}$	-0.28	0.40	0.22	1

The linguistic, religious, and legal *proximity* measures (*lp2*, *cmr*, and *cml*) are transformed into *distance* measures by calculating *distance* = 1 - *proximity*. Missing bilateral distances are imputed to take the maximum theoretical value for that distance–1 in the case of 1- *lp2*, 1- *cmr*, and 1- *cml*, and (the natural log of) 20,015 km in the case of great circle distance *(ldi)*

[7] **?** follow a long literature in international trade that estimates the effects of language and other factors on international trade volumes. **?** provide a useful overview.

between capital cities.[8] Finally, log geographical distance *ldi* is divided by ln 20,015 so that this distance measure, too, is normalized to fall between zero and 1.

5.2 Demographic contagion

Table 11 shows the results of the logit regression described in the previous section. Specification (1) shows the results of the regression without including any inter-country influence. Specification (2) adds a simple global count of the number of countries that have begun the transition, and specification (3) adds some curvature to that sum, which is still global. The estimated value of ψ, being less than 1, implies that there are diminishing returns–the more countries have already entered the transition, the smaller the effect of each additional country on other countries' odds of entering the transition. Specifications (4) through (11) weight the influence of one transitioned country on other countries according to the inverse distance between them, as determined by various measures of distance. When included by themselves, all 4 measures of distance–geographic, linguistic, religious and legal, have highly significant estimated coefficients, with geographic distance having somewhat more explanatory power (as reflected in the log likelihood sum) than the others. Religious distance has the wrong sign, which means that it is probably correlated with some excluded factor and thus the coefficient does not reflect the real effect of religious distance. Specifications (9), (10) and (11) include more than one measure of distance simultaneously. Geographic distance retains a significant coefficient in all of these specifications, while linguistic and legal distance maintain positive, but not quite statistically significant point estimates.

In Figure 11, we take a closer look at the access to transitions measure implied by specification 11 (the distributions displayed in all of these figures are smoothed using a Gaussian kernel). Using the estimated parameters, access is calculated as

$$\mathcal{A}_{it} \equiv \left[\sum_{j=1}^{N} \exp[\mathcal{D}_{ij} + 0.16 \cdot \text{lp2}_{ij} + 0.04 \cdot \text{cml}_{ij}]\mathcal{I}_{j,t-1}\right]^{0.46},$$

where

$$\mathcal{D}_{ij} \equiv 2.25 \cdot \mathbf{1}\{\text{ldi}_{ij} < \ln 500\} + 1.46 \cdot \mathbf{1}\{\ln 500 \leq \text{ldi}_{ij} < \ln 1000\} + 0.56 \cdot \mathbf{1}\{\ln 1000 \leq \text{ldi}_{ij} < \ln 2000\}.$$

The top left panel of Figure 11 shows the distribution of this measure at different points in time–not surprisingly, as more countries transition, this distribution moves steadily to the right. The top right panel of Figure 11 shows the transition probabilities implied if each country is

[8] The circumference of the Earth is 40,030 kilometers, and so the maximum great circle distance between any two points on the globe is 20,015 kilometers.

Table 11: Determinants of the start of the CBR transition

cons	-21.08	-44.38	-38.87	-41.24	-35.25	-34.34	-38.13	-34.51	-32.90	-34.26	-32.43
	(7.37)	(8.89)	(8.70)	(9.03)	(9.07)	(8.26)	(8.58)	(9.02)	(8.73)	(8.83)	(8.91)
lnGDPPC	2.08	8.29	6.44	6.05	4.67	0.52	6.22	5.32	4.00	4.00	3.81
	(1.85)	(2.22)	(2.21)	(2.23)	(2.27)	(0.21)	(2.15)	(2.23)	(2.22)	(2.26)	(2.27)
lnGDPPC ^{2}	-0.01	-0.45	-0.34	-0.32	-0.24	-0.03	-0.33	-0.28	-0.21	-0.20	-0.19
	(0.12)	(0.14)	(0.14)	(0.14)	(0.14)	(0.01)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)
access		0.06	1.25	9.79	5.49	2.97	1.40	1.46	16.98	15.02	15.85
		(0.00)	(0.84)	(0.86)	(0.51)	(0.30)	(0.22)	(0.21)	(1.60)	(1.19)	(1.54)
geo dist.				4.05							
				(0.08)							
$<$ 500km					2.86				2.64	2.52	2.53
					(0.19)				(0.38)	(0.32)	(0.37)
500-1000km					-2.42				1.39	1.53	1.44
					(0.26)				(0.46)	(0.34)	(0.43)
1000-2000km					1.20				0.75	0.86	0.79
					(0.17)				(0.37)	(0.30)	(0.35)
ling. dist						1.35			1.18		0.69
						(0.00)			(0.82)		(0.84)
relig dist							0.16				
							(0.30)				
legal dist								0.32		0.25	0.18
								(0.08)		(0.26)	(0.29)
ψ, curv.			0.41	0.23	0.25	0.35	0.40	0.41	0.25	0.22	0.25
			(0.14)	(0.00)	(0.00)	(0.00)	(0.01)	(0.03)	(0.06)	(0.09)	(0.07)
LLn	-661.3	-489.7	-481.7	-477.3	-459.2	-480.6	-481.6	-479.1	-454.2	-454.0	-453.7
Psuedo-R^2	0.132	0.357	0.368	0.373	0.397	0.369	0.368	0.371	0.404	0.404	0.404
N. Obs.	48715	48715	48715	48715	48715	48715	48715	48715	48715	48715	48715

assigned its actual access to transitions value and GDP per capita equal to $2000. Here we can see that in 1850, 1900, and 1950, Access to Transitions in the great majority of countries was such that their probability of transition at only $2000 GDP per capita would have been relatively small. In the year 2000 this situation changes dramatically, and the lowest yearly probability of transition for any country with $2000 GDP per capita would be 10%.

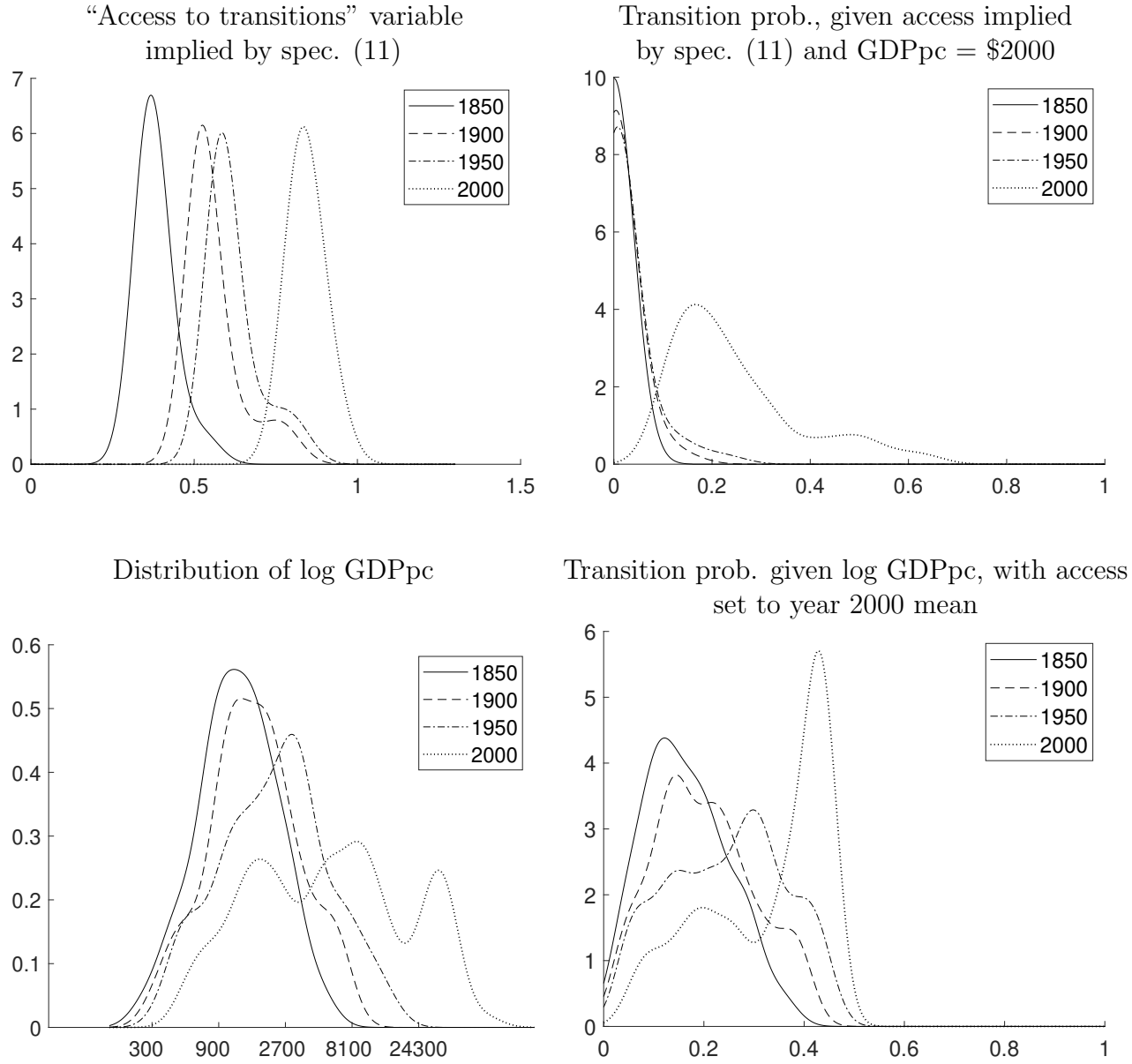


Figure 11: Demographic contagion.

The bottom left panel of Figure 11 shows the evolution of the distribution of GDP per capita over time. The bottom right panel of Figure 11 shows the distribution of the probability of transition, given the observed GDP per capita for each country, assuming they have the mean level of Access to Transitions for the year 2000. Here we see that, not surprisingly,

the distribution shifts right as time passes and more countries enjoy higher levels of GDP per capita. We also see the importance of the complementarity between a country's own level of development and the influence of its neighbors–even assigning all countries the mean level of access for the year 2000, even the richest country only in the year 2000 has a transition probability of 0.6. Compare this to the top right panel of Figure 11, where we see that even with a relatively low level of GPD per capita ($2000), in the year 2000 there are many countries whose probability of transition due to the influence of neighbors would be close to 1.

5.3 A recap

In summary, in this section we have documented three empirical findings. First, transitions in both fertility and mortality have been getting faster over time, according to all available measures. Second, in spite of this increase in the speed of the transitions, there is no clear trend in the level of GDP per capita at which countries enter the fertility transition. Finally, we have found suggestive evidence for a kind of "demographic contagion," whereby a transition in one country is statistically associated with following transitions in countries which are close to it geographically and linguistically, and have similar legal systems.

6 Model

In this section we build a model of endogenous fertility, education, and technology diffusion with the goal of accounting for the trends we have documented. In this model there will be a quantity-quality trade-off between how many children to have and how much to educate them, following classic work by **?**. We propose an economy with a skilled and an unskilled sector, as in **?**. An exogenous increase in the ratio of skilled to unskilled TFP raises the skill premium and induces parents invest in a smaller number of more educated children. In order to link fertility patterns across countries, we introduce technology diffusion in a manner similar to **?**, and allow the elasticity of catch-up growth to differ between the skilled and unskilled sectors. We show that if this elasticity is higher in the skilled sector, the skill premium will rise more sharply in countries that begin converging to the frontier later, leading to faster fertility transitions.

6.1 Consumer Preferences, Fertility, and Education Decisions

Consider a world that consists of different locations. Consumers in each location i live for two periods, one as children and one as adults. As children, consumers are under the care of their parents. As adults, they work, consume and choose how many children to have, n_{it}, and how much education, e_{it}, to provide for each of them. With an exogenous probability s_{it} a child survives to the adulthood.

Each unit of children requires a time commitment of τ_1, for a total time cost of $n_{it}\tau_1$. To achieve a level of education e_{it} for each child, parents must pay a total time cost of $n_{it}e_{it}\tau_2$. The level of education that children receive will determine their level of human capital when they are adults, given by

$$h_{i,t+1} = e_{it}.$$

Adults have a total time endowment of 1. They do not value leisure, and so supply $1 - \tau_1 n_{it} - \tau_2 n_{it} e_{it}$ units of time to the labor market. The income that parents receive per unit of labor depends on the equilibrium unskilled and skilled wages, w_{it}^U and w_{it}^S, and their level of human capital, h_{it}. In exchange for each unit of labor supplied, adults receive income

$$y_{it} \equiv w_{it}^U + h_{it} w_{it}^S.$$

Parents choose c_{it}, e_{it}, and n_{it} to maximize

$$\log(c_{it} - \bar{c}_i) + \log(s_{it} n_{it}) + \beta \log y_{i,t+1},$$

subject to

$$c_{it} = (1 - n_{it}(\tau_1 + \tau_2 e_{it}))y_{it},$$

and

$$y_{it+1} \equiv w^U_{it+1} + h_{it+1} w^S_{it+1} \text{ with } h_{it+1} = e_{it},$$

where $\bar{c}_i$ is a minimum consumption requirement.

Define the skill premium at time t as $\pi_{it} \equiv \frac{w^S_{it}}{w^U_{it}}$. Then the first order conditions of this problem are given by

$$\frac{[\tau_1 + \tau_2 e_{it}]}{1 - \frac{\bar{c}_i}{y_{it}} - [\tau_1 + \tau_2 e_{it}] n_{it}} = \frac{1}{n_{it}},$$

for n_{ii} and by

$$\frac{\tau_2 n_{it}}{1 - \frac{\bar{c}_i}{y_{it}} - [\tau_1 + \tau_2 e_{it}] n_{it}} = \beta \frac{1}{\frac{1}{\pi_{i,t+1}} + e_{it}},$$

for e_{it}. With simple algebra, the optimal decisions for e_{it} and n_{it} are given by

$$e_{it} = \frac{\beta \frac{\tau_1}{\tau_2} - \frac{1}{\pi_{i,t+1}}}{1 - \beta},$$

and

$$n_{it} = \frac{1}{2} \left(1 - \frac{\bar{c}_i}{y_{it}} \right) \frac{1}{\tau_1 + \tau_2 e_{it}}.$$

The human capital investment decision, e_{it}, is increasing in $\pi_{i,t+1}$ (the skill premium) and in $\tau_1$and is decreasing in τ_2. The number of children, n_{it} is decreasing in τ_1, τ_2 and e_{it}; and decreasing in $\bar{c}_i$

6.2 Production and Technology Diffusion

Time-t output for country i, Y_{it} is given by

$$Y_{it} = [(A_{it} S_{it})^\rho + (B_{it} [L^\omega_{it} + U^\omega_{it}]^{\frac{1}{\omega}})^\rho]^{\frac{1}{\rho}},$$

where where S_{it} represents the quantity of skilled labor employed and A_{it} represents the productivity of skilled labor, L_{it} represents the land endowment, U_{it} represents the quantity of unskilled labor employed, and B_{it} represents the productivity of the land and unskilled labor aggregate, and where $\frac{1}{1-\omega}$ represents the elasticity of substitution between land and unskilled labor and $\frac{1}{1-\rho}$ represents the elasticity of substitution between skilled labor and the land and unskilled labor aggregate.[9]

Factor shares for skilled labor and the land and unskilled labor aggregate are $\frac{A_{it}}{A_{it}+B_{it}}$ and

[9]This production function follows the setup used in **?**, with skilled and unskilled sectors as in **?**.

$\frac{B_{it}}{A_{it}+B_{it}}$ respectively, and TFP $\tilde{A}_{it}$ can be defined as

$$\tilde{A}_{it} \equiv A_{it} + B_{it}.$$

Given this production technology, the skill premium is given by

$$\pi_{it} = \frac{w_{it}^S}{w_{it}^U} = \left(\frac{A_{it}}{B_{it}}\right)^{\rho} \frac{S_{it}^{\rho-1}}{[L_{it}^{\omega} + U_{it}^{\omega}]^{\frac{\rho}{\omega}-1} \frac{1}{2} U_{it}^{\omega-1}}.$$

The world is composed of 1 frontier country, indexed as country 0, and n following countries in the set $N \equiv \{1, 2, ..., n\}$. Time is discrete, indexed by $t \in \{0, 1, 2, ...\}$. The effective distance of each follower from the frontier country at each point in time, d_{it} is a function of a time-invariant geographic distance d_i^g, a time-invariant linguistic and/or cultural distance, d_i^c, and potentially time-varying idiosyncratic barriers to the diffusion of information represented by $\phi_{0i}(t)$:

$$d_{it} = \phi_{oi}(t) + \phi_1(t) d_i^g + \phi_2(t) d_i^c,$$

The parameters $\phi_l(t)$ for $l \in \{1, 2\}$ are shared across countries and may vary over time. In particular, it is assumed that these parameters decline at a constant rate from their initial values:

$$\phi_j(t+1) = \phi_j(t)(1 - g_{\phi_j}) \text{ for } j \in \{1, 2\}.$$

The idiosyncratic barriers term, $\phi_{0i}(t)$, can be thought of as reflecting how " open" or " closed" country i is in terms of its policies and other non-geographical, non-linguistic factors that might affect knowledge flows into country i.

There are frontier levels of skilled and unskilled productivity, denoted $\bar{A}_t$ and $\bar{B}_t$ respectively. These are assumed to have the constant values $\bar{A}_0$ and $\bar{B}_0$ for all periods $t \in \{..., -3, -2, -1, 0\}$. There is a frontier country, aka Great Britain, indexed as country 1, which has the lowest barriers to diffusion of the frontier levels of technology. It is assumed that they do coincide for all periods leading up to period 0, prior to the start of frontier technology growth, the technology levels in the frontier and the frontier country are the same: $A_{0t} = \bar{A}_0$ and $B_{0t} = \bar{B}_0$ for all $t \in \{..., -3, -2, -1, 0\}$.

At time 1, frontier skilled labor productivity makes an unanticipated discrete jump to $\bar{A}_1 > \bar{A}_0$, while frontier unskilled productivity retains its former value $\bar{B}_1 = \bar{B}_0$. Starting in period 2, the growth rates for both types of productivity experience an unanticipated, discrete jump from 0 to g, such that for periods $t \in \{2, 3, 4, ...\}$,

$$\bar{A}_t = (1 + g)\bar{A}_{t-1}$$

and

$$\bar{B}_t = (1+g)\bar{B}_{t-1}.$$

For all time periods, productivity in each country grow at a rate that depends on their distance to the frontier d_{it} and their productivity level relative to the productivity level of the frontier, in accordance with the following laws of motion, inspired by **?**:

$$A_{i,t+1} = A_{it}\left(1 + ge^{-d_{it}}\frac{\overline{A}_t}{A_{it}}\right),$$

and

$$B_{i,t+1} = B_{it}\left(1 + ge^{-d_{it}}\frac{\overline{B}_t}{B_{it}}\right)^{\theta}$$

where $\theta > 0$ represents the relative elasticity of catch-up growth in unskilled TFP to the gap to the frontier. If $\theta < 1$, then the same gap with the frontier will lead to slower growth in unskilled TFP realtive to skilled TFP. If $\theta > 1$, then the same gap with the frontier will lead to faster growth in unskilled TFP realtive to skilled TFP.

6.3 Vital Statistics

Childhood survival rates are determined by the overall level of technology in a country, according to the following formula:

$$s_{it} = 1 - \frac{1 - s_i^0}{(A_{it} + B_{it})^{\zeta}}$$

where $\zeta > 0$. The CBR is given by

$$B_{it} = \frac{U_{it}n_{it}}{U_{it} + U_{it}s_{it}n_{it}} = \frac{n_{it}}{1 + s_{it}n_{it}}.$$

Similarly, the CDR is given by

$$D_{it} = \frac{U_{it} + U_{it}n_{it}(1 - s_{it})}{U_{it} + U_{it}s_{it}n_{it}} = \frac{1 + n_{it}(1 - s_{it})}{1 + s_{it}n_{it}}.$$

Finally, the population growth is given by

$$B_{it} - D_{it} = \frac{n_{it}s_{it} - 1}{1 + s_{it}n_{it}}.$$

7 A Quantitative Exercise

Now suppose we are in a world in which period 0 is 1775 and in which a model period lasts 25 years, and that there are 7 countries in the world: a frontier country (Great Britain), assumed to be on average effectively 50 kilometers from the notional " frontier" contained within its borders (in for example, London), a country that is 312.5 kilometers away (like Amsterdam, Netherlands from London, England), a country that is 625 kilometers away (like Geneva, Switzerland), a country that is 1250 kilometers away (like Vienna, Austria), a country that is 2500 kilometers away (like Moscow, Russia), a country that is 5000 kilometers away (like Baghdad, Iraq), and a country that is 10000 kilometers away (like Manila, Philippines).

Distances d_{it} are a function of physical distance only, i.e. we set ϕ_{0i} and ϕ_2 to zero:

$$d_{it} = \phi(t) d_i^g,$$

where d_i^g represents the physical distance in kilometers between London, United Kingdom, and the capital city of country i.

Suppose that all of these countries are initially identical in all aspects other than their distance from the frontier, and that they are all initially in a population steady state in which total births equal total deaths. In period 0, frontier technology starts growing, and the importance of distance for diffusion starts falling, in the manner described in the previous section.

Table 7 shows the parameter values. These parameters are chosen to match roughly the key features of the economic and demographic transition in the UK since 1700. They also produce a sequence of transitions, following the diffusion of technology from the UK to the rest of the world, that produces a world income distribution that is line with the data in 2000. Finally, the model economy generates demographic transitions that get faster over time. Table 8 shows how the model economy compares with the data along several dimensions.

Table 7: Parameters Values

Parameter	Description	Value
	Preferences	
β	altruism	0.8
$\bar{c}$	minimum consumption	2
τ_1	time cost of fertility	0.133
τ_2	time cost of education	0.05
	Technology	
ρ	substitutability between skilled, unskilled labor	0.8
ω	substitutability between land, unskilled labor	0.1
$\frac{\bar{A}_0}{\bar{B}_0}$	initial ratio between skilled and unskilled TFP	0.2
$\frac{\bar{A}_1}{\bar{B}_0}$	long-run ratio between skilled and unskilled TFP	0.5
s_0	initial infant mortality rate	0.5
	Growth and Diffusion	
ϕ_0	initial cost of distance	3.7
g_ϕ	rate of decline in cost of distance	0.4895
g	rate of technology growth	0.325
ζ	elasticity of mortality to technology	2
θ	elasticity of unskilled TFP growth to gap with frontier	.25

Table 8 lists 10 targeted moments, the sources that the target numbers are derived from, and the numbers produced by the model. Eight of these moments pertain to the United Kingdom. The UK's total population growth between 1700 and 2000, per capita income growth between 1700 and 2000 are compared against data from the Maddison 2010 database. The total drop in the crude birth rate and crude death rate in the UK between 1700 and 2000 is compared to the difference between the initial and final mean crude birth and death rates for the UK as estimated in Section 4 of this paper. The UK CBR and CDR in 1700 is compared against the initial mean CBR and CDR estimated in Section 4 of this paper.

The education variable e_{it} is interpreted in the following way: let $\widetilde{e}_{it}$ represent years of education, and let $\widetilde{e}_{it} = Ce_{it}$, where C is set so that $\widetilde{e}_{UK,2000} = 10.02$, the years of average education given for the UK in the year 2000 by the **?** dataset. Then the year 2000 college wage premium is calculated as the difference in total earnings between a notional agent in the UK

who has 15 total years of schooling versus one who only has 12 years, which is then compared to the 30% figure produced by **?**. The total growth in education in the UK in the model between 1900 and 2000 is also compared to the same figure from **?**.

Two of the moments in Table 8 are global–the population-weighted variance of log per capita GDP in the year 2000, and the rate at which the average transition length decreases over time. The population-weighted variance across the seven model countries in the year 2000 is calculated and compared with the population-weighted variance across ten major world regions in the year 2000 in the Maddison 2000 database. The slope of the transition length/time relationship is calculated as the coefficient on time of a regression of transition start date and a constant on the total length of the crude birth rate transition, in the model. The start of a model transition is defined as the point at which the crude birth rate declines by 0.5 persons per thousand from its initial level, and the end is defined as the point at which it reaches below 22 persons per thousand. This slope is compared against the slope of the linear fit line from the comparison between transition length and transition start date shown in Figure 6-B in Section 4 of this paper.

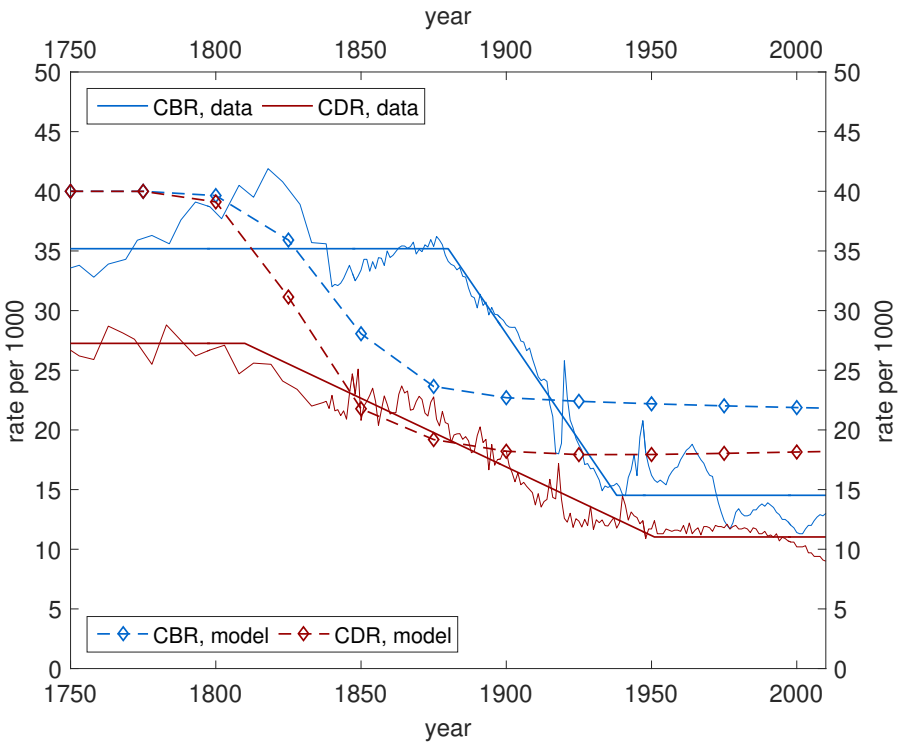
Table 8: Model versus Data

Moment	Source	Target	Model
Variance of log income, world, year 2000	Maddison 2010	0.98	0.57
UK GDP per capita growth, 1700-2000	Maddison 2010	1630%	1690%
UK population growth, 1700-2000	Maddison 2010	690%	590%
UK years of education growth, 1700-2000	**?**	260%	160%
UK year 2000 college wage premium (15 vs. 12 years)	**?**	30%	21%
UK drop in CBR 1700-2000	Section 4	20	18.12
UK CBR in 1700	Section 4	35.2	40
UK drop in CDR 1700-2000	Section 4	15	21.85
UK CDR in 1700	Section 4	26.8	40
Slope of transition length/time relationship	Section 4	-0.75	-0.80

Figure 12 compares the vital statistics as they evolve in themodel to the raw data and fitted 3-phase transitions estimated for Great Britain.

Figure 13 plots the pattern of the evolution of technology in the frontier country described in Section 6.2, in which both types of TFP begin growing, but skilled-complementary TFP experiences an initial discrete jump. Figure 14 shows how effective distance between the frontier country and the rest shrinks over time. As can be seen in the figure, the different countries become more and more similar in their levels of access to the frontier over time. Figures 15

Figure 12: Great Britain, model vs. data



and 16 shows the evolution of technology in two places, 625 km from London (Geneva) and 10,000 km from London (Manila). As can be seen figure, both countries initially experience no growth, even after growth has begun in the frontier. As the cost of distance falls, each country experiences a discrete growth takeoff, with the closer country taking off first. Catch-up growth induces a temporary oscillation of the ratio of skilled to unskilled TFP above its frontier, long-run level in each country. This is due to the assumption that $\theta < 1$, so that the catch-up growth is more elastic in response to the gap to the frontier in skilled than unskilled technology. In Manila, which takes off later, catch-up growth is more rapid, and this oscillation is larger and of greater duration.

As technology improves and diffuses to other countries, skill premium start to rise in each of these locations. As a result, parents choose higher and higher levels education for their children. Figure 17 plots the evolution of the skill premium in the various notional countries, and Figure 18 plots the evolution of education levels. Because of higher elasticity of catch-up growth to technological gap in the skilled sector, the skill premium rises faster in later-transitioning countries, and so the increase in education levels is also more rapid.

As parents educate their children more, they also produce fewer children overall–the classic quantity-quality tradeoff. Figure 19 shows the simulated path of the crude birth rate for the modeled countries. Because the rise in education levels is sharper in later-transitioning countries, so the fall in fertility is also more rapid, and the overall transition period shorter. Figure

Figure 13: Technology Frontier

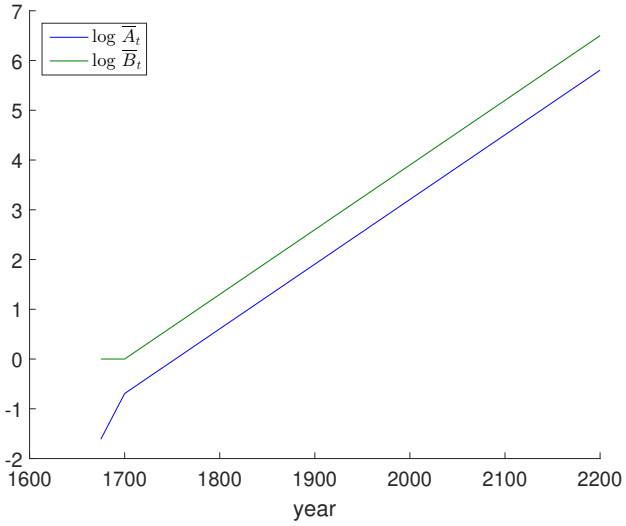


Figure 14: Distance from the Frontier

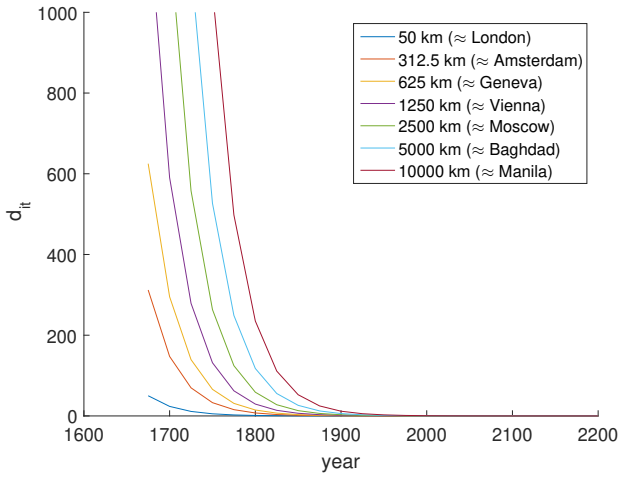


Figure 15: Technology in Geneva

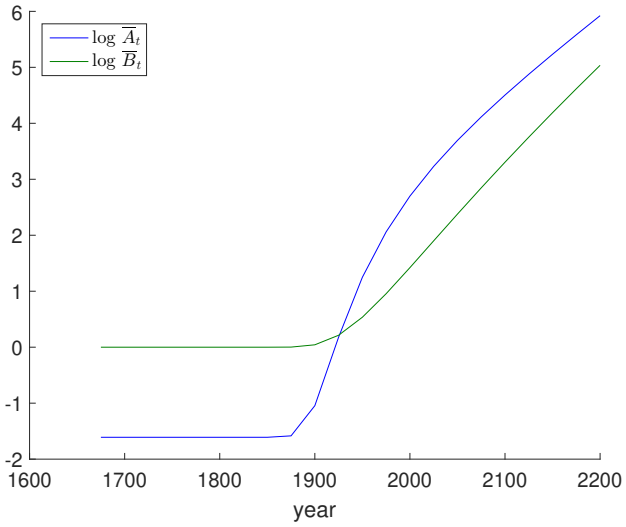


Figure 16: Technology in Manila

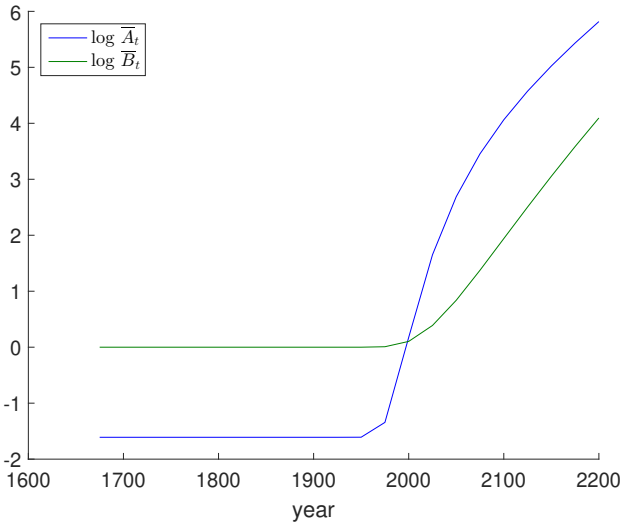


Figure 17: Skill Premium

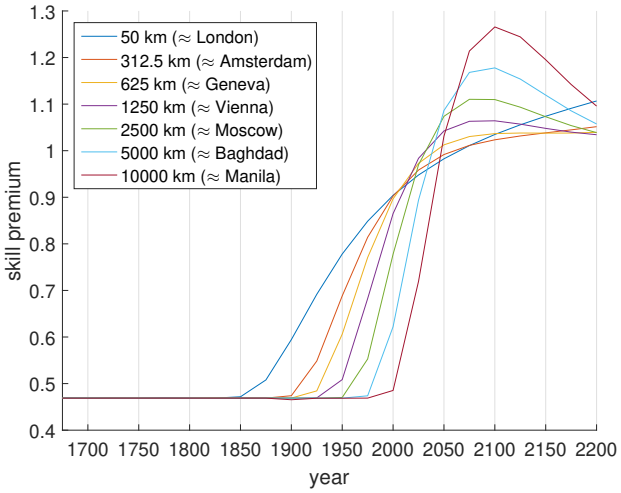


Figure 18: Education

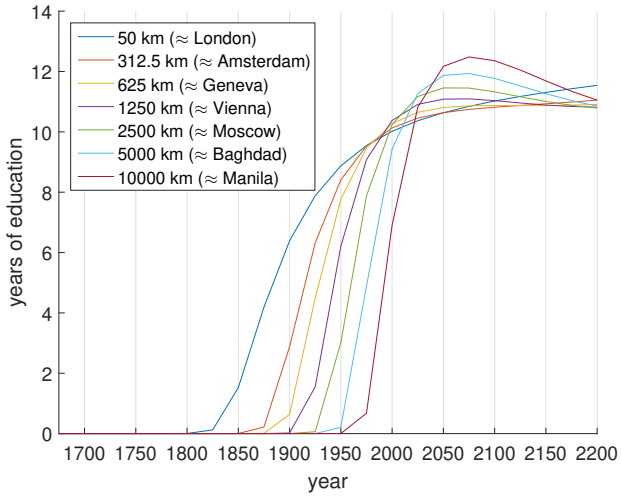


Figure 19: Fertility Transitions

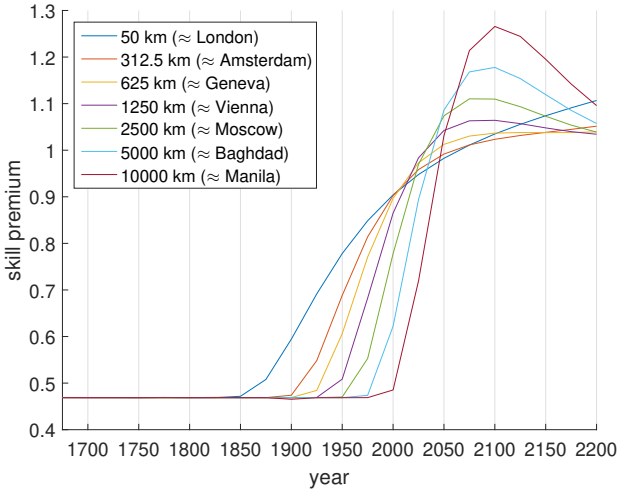
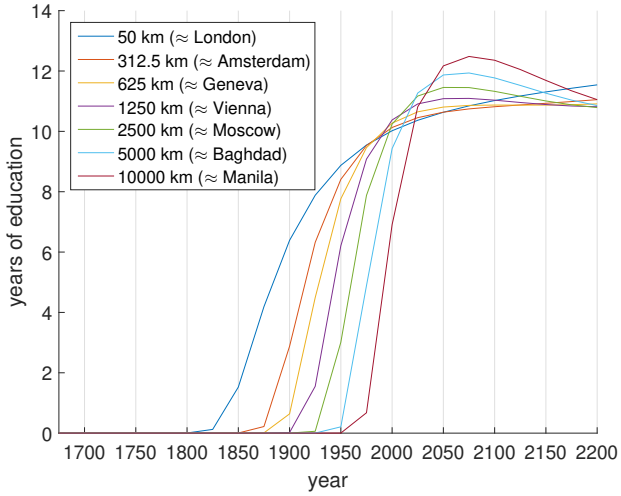


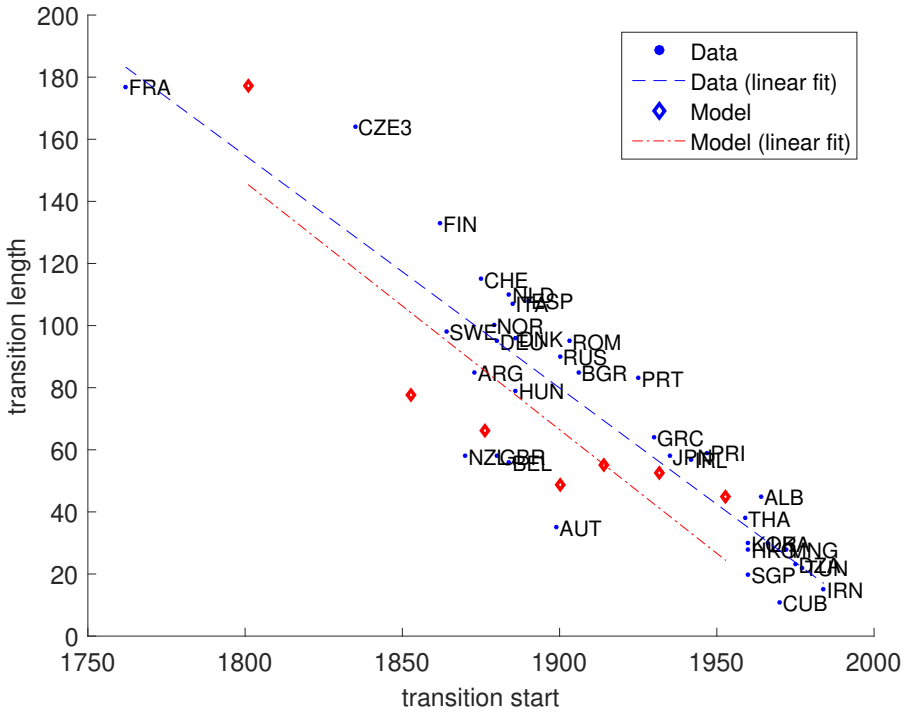
Figure 20: Transition Lengths



20 shows the length of each simulated transition. These vary in length from more than 120 years for the frontier country, to less than 80 years for the last model country to enter the transition.

Figure 21 compares the simulated transition lengths with transition lengths observed in the data. Here we see that this quantitative exercise is able to replicate the overall trend of accelerating transitions, and is able to account for roughly half of the overall decline in transition length over the observed period.

Figure 21: Transition Lengths, Model vs. Data



8 Conclusions

In this paper we have constructed a dataset consisting of birth rates and death rates, and GDP per capita for a panel of 188 countries and spanning from 1735 until 2014. We have proposed a way of measuring demographic transitions which lets the data pick likely start and end dates for fertility and mortality transitions, and used our results to show that: 1) transitions are becoming faster, 2) the average level of GDP per capita at the start of a transition is more or less constant, and 3) an important predictor of a country's transition is the prior transition of other countries which are "close" to it in a geographical and a linguistic sense, and which have similar legal systems.

We then build a model in the tradition of Barro, Becker and Lucas that can account for these facts. In addition to the standard quantity-quality trade-off between how many children to have and how much to educate them, there is also technological diffusion between countries. We conduct a quantitative exercise to show that a simple mechanism of diffusion where skill-biased technological change travels from Britain to the rest of the world in a manner that only depends on geographic distance is able to generate sequences of demographic transitions, each happening faster than the previous one, as we observe in the data, and the account for roughly half of the observed reduction in total transition time.

A Supplementary Tables

A CDR calculated by projecting backwards using the method described in Section 2 is indicated by ⋆.

Calculated Transition Start and End Dates				
	CDR		CBR	
Country	Start	End	Start	End
Afghanistan	1961	n/a	1999	n/a
Angola	1943⋆	n/a	1988	n/a
Albania	1945	1973	1963	2010
United Arab Emirates	1936⋆	1977	1956	n/a
Argentina	1869	1945	n/a	1959
Armenia	n/a	n/a	n/a	2001
Australia	n/a	1961	n/a	1987
Austria	1881	1941	1899	1934
Azerbaijan	n/a	1988	n/a	1999
Burundi	1897⋆	n/a	1987	n/a
Belgium	1866	1935	1884	1940
Benin	1947⋆	2001	1987	n/a
Burkina Faso	1936⋆	n/a	1997	n/a
Bangladesh	1953	2004	1972	n/a
Bulgaria	1918	1948	1906	1991
Bahrain	1923⋆	1979	1960	n/a
Bahamas, The	n/a	1967	n/a	n/a
Bosnia and Herzegovina	n/a	1964	n/a	2000
Belarus	n/a	n/a	n/a	1998
Belize	1913⋆	1972	1981	n/a
Bolivia	1962	2006	1969	n/a
Brazil	1864⋆	1994	1956	n/a
Barbados	1923	1957	1954	1987
Brunei Darussalam	1913⋆	1974	1954	n/a
Bhutan	1944⋆	2004	1976	n/a
Botswana	1920⋆	1977	1971	n/a
Central African Republic	1961	1979	1978	n/a
Canada	n/a	1955	n/a	2009
Switzerland	1872	1950	n/a	1996
Channel Islands	1976	n/a	1961	n/a

Calculated Transition Start and End Dates				
	CDR		CBR	
Country	Start	End	Start	End
Chile	1921	1978	1929	n/a
China	n/a	1972	n/a	2005
Cote dIvoire	1937⋆	1981	1963	n/a
Cameroon	1900⋆	2016	1988	n/a
Congo, Rep.	1936⋆	1974	1970	n/a
Colombia	1874⋆	1990	1971	n/a
Comoros	1929⋆	1999	1980	n/a
Cape Verde	1962	1997	1984	n/a
Costa Rica	1926	1971	1958	n/a
Cuba	n/a	1946	1970	1981
Cyprus	1922	1955	1945	2010
Czech Countries/Czechoslovakia	1867	1949	1837	1997
Germany	1880	1932	1880	1975
Djibouti	1939⋆	1979	1978	n/a
Dominica	1909⋆	1975	1969	1976
Denmark	1834	1943	1886	1982
Dominican Republic	1912⋆	1981	1954	n/a
Algeria	1928⋆	1993	1976	1998
Ecuador	1894⋆	1992	1957	n/a
Egypt, Arab Rep.	1934	1997	1968	n/a
Eritrea	1925⋆	n/a	1967	n/a
Spain	1890	1960	1890	1999
Estonia	n/a	n/a	n/a	n/a
Ethiopia	1928⋆	n/a	1992	n/a
Finland	1866	1957	1862	1996
Fiji	1869⋆	1976	1964	n/a
France	n/a	1990	1763	1939
Micronesia, Fed. Sts.	1849⋆	1986	1971	n/a
Gabon	n/a	1990	1990	n/a
United Kingdom	1809	1952	1880	1938
Georgia	n/a	n/a	n/a	2000
Ghana	1894⋆	1996	1967	n/a
Guinea	1951	n/a	1990	n/a
Gambia, The	1951⋆	1999	1981	n/a

Calculated Transition Start and End Dates				
	CDR		CBR	
Country	Start	End	Start	End
Guinea-Bissau	1931⋆	n/a	1991	n/a
Equatorial Guinea	n/a	n/a	n/a	n/a
Greece	1916	1955	1930	1994
Grenada	1889⋆	1973	1957	n/a
Guatemala	1917	1997	1971	n/a
Guam	n/a	n/a	n/a	n/a
Guyana (British Guiana)	1919	1962	1971	n/a
Hong Kong SAR, China	n/a	1949	1960	1989
Honduras	1921⋆	1992	1971	n/a
Croatia	n/a	n/a	n/a	2002
Haiti	1927⋆	2004	1983	n/a
Hungary	1875	1943	1886	1966
Indonesia	1933⋆	1983	1959	n/a
India	n/a	2013	1982	n/a
Ireland	1899	2014	1942	1999
Iran, Islamic Rep.	1927⋆	1997	1984	1999
Iraq	n/a	1992	n/a	n/a
Iceland	n/a	n/a	1963	n/a
Israel	n/a	1945	n/a	n/a
Italy	1874	1955	1885	1992
Jamaica	1920	1965	1965	n/a
Jordan	1929⋆	1980	1964	n/a
Japan	1945	1951	1935	1993
Kazakhstan	n/a	1971	n/a	1996
Kenya	1923⋆	1983	1975	n/a
Kyrgyz Republic	n/a	1992	n/a	n/a
Cambodia	1981	1987	1985	n/a
Kiribati	n/a	1996	n/a	n/a
Korea, Rep.	1950⋆	1970	1958	1996
Kuwait	1850⋆	1985	1973	1993
Lao PDR	1919⋆	2012	1988	n/a
Lebanon	n/a	1972	n/a	n/a
Liberia	1961	n/a	1982	n/a
Libya	1935⋆	1983	1971	1998

Calculated Transition Start and End Dates				
	CDR		CBR	
Country	Start	End	Start	End
St. Lucia	1903⋆	1978	1969	2010
Sri Lanka	1935	1962	1966	1997
Lesotho	1929⋆	1981	1974	n/a
Lithuania	n/a	n/a	n/a	2004
Luxembourg	n/a	n/a	n/a	n/a
Latvia	n/a	n/a	n/a	n/a
Macao SAR, China	n/a	1970	n/a	1969
Morocco	1915⋆	1993	1958	n/a
Moldova	n/a	n/a	n/a	2007
Madagascar	1926⋆	n/a	1978	n/a
Maldives	1961	1998	1981	n/a
Mexico	1905	1982	1971	n/a
Macedonia, FYR	n/a	1967	n/a	2005
Mali	1963	n/a	2003	n/a
Malta	n/a	n/a	n/a	2001
Myanmar	1930⋆	1990	1961	n/a
Mongolia	1903⋆	2002	1973	1999
Mozambique	1936⋆	n/a	1977	n/a
Mauritania	1926⋆	1989	1962	n/a
Mauritius	1930	1965	1958	n/a
Malawi	1926⋆	n/a	1981	n/a
Malaysia	1912⋆	1975	1958	n/a
Namibia	1931⋆	1982	1977	n/a
New Caledonia	1858⋆	1992	1968	n/a
Niger	1976	n/a	1987	n/a
Nigeria	1912⋆	n/a	1978	n/a
Nicaragua	1908⋆	1996	1973	n/a
Netherlands	1869	1932	1883	1995
Norway	n/a	1954	1879	1980
Nepal	1949⋆	2004	1984	n/a
New Zealand	n/a	n/a	1870	1929
Oman	1940⋆	1991	1978	n/a
Pakistan	1924⋆	1994	1980	n/a
Panama	1860⋆	1982	1966	n/a

Calculated Transition Start and End Dates				
	CDR		CBR	
Country	Start	End	Start	End
Peru	1927⋆	1989	1962	n/a
Philippines	1893⋆	1981	1985	n/a
Papua New Guinea	1943⋆	1986	1967	n/a
Poland	n/a	1957	n/a	2004
Puerto Rico	1932	1954	1947	2008
Korea, Dem. Rep.	1952⋆	1969	1957	n/a
Portugal	1919	1959	1925	2009
Paraguay	n/a	1994	n/a	n/a
French Polynesia	1868⋆	1987	1956	n/a
Qatar	n/a	1970	n/a	n/a
Romania	1902	1962	1903	1998
Russian Federation	1891	1951	1900	1990
Rwanda	1995	n/a	1984	n/a
Saudi Arabia	1938⋆	1988	1974	n/a
Sudan	1876⋆	2010	1974	n/a
Senegal	1940⋆	2001	1972	n/a
Singapore	1910	1961	1959	1981
Solomon Islands	1870⋆	n/a	1979	n/a
Sierra Leone	n/a	n/a	n/a	n/a
El Salvador	1885⋆	1996	1968	n/a
Somalia	1927⋆	n/a	2004	n/a
Suriname	n/a	n/a	1963	n/a
Slovak Republic	n/a	n/a	n/a	2004
Slovenia	n/a	n/a	n/a	1998
Sweden	1773	1950	1864	1962
Swaziland	1930⋆	1982	1978	n/a
Seychelles	1872⋆	1980	1965	2001
Syrian Arab Republic	1922⋆	1985	1975	n/a
Chad	n/a	2016	n/a	n/a
Togo	1936⋆	1987	1975	n/a
Thailand	1908⋆	1979	1959	1999
Tajikistan	n/a	2012	n/a	n/a
Turkmenistan	n/a	1992	n/a	n/a
Tonga	1805⋆	1974	1963	n/a

Calculated Transition Start and End Dates				
	CDR		CBR	
Country	Start	End	Start	End
Taiwan	n/a	1966	1955	n/a
Trinidad and Tobago	1897	1966	1961	2002
Tunisia	1969	1986	1975	1999
Turkey	n/a	1991	1957	n/a
Tanzania	n/a	n/a	n/a	n/a
Uganda	1858⋆	2016	2001	n/a
Ukraine	n/a	n/a	n/a	1999
Uruguay	n/a	1939	n/a	1941
United States	n/a	1954	n/a	1980
Uzbekistan	n/a	1995	n/a	n/a
St. Vincent and the Grenadines	1954	1975	1959	n/a
Venezuela, RB	1915	1975	1973	n/a
Virgin Islands (U.S.)	1911⋆	1974	1962	n/a
Vietnam	1929⋆	1981	1960	n/a
Vanuatu	n/a	1998	n/a	n/a
Samoa	n/a	1992	n/a	n/a
Yemen, Rep.	1946⋆	1996	1986	n/a
Serbia (Yugoslavia from 1900)	1875	1958	1910	n/a
South Africa	1928⋆	1972	1968	2005
Congo, Dem. Rep.	1905⋆	n/a	2004	n/a
Zambia	n/a	2016	n/a	n/a
Zimbabwe	1932⋆	1968	1956	n/a

Table A2: Country assignment to minor regions

Country	Min. Region #	Min. Region Name
Afghanistan	11	south asia
Angola	22	middle africa
Albania	33	central and eastern europe
UAE	12	middle east-asia minor
Argentina	42	southern south america
Armenia	12	middle east-asia minor
Australia	52	Australia and Pacific
Austria	33	central and eastern europe
Azerbaijan	12	middle east-asia minor
Burundi	22	middle africa
Belgium	31	northwestern europe
Benin	24	west africa
Burkina Faso	24	west africa
Bangladesh	11	south asia
Bulgaria	33	central and eastern europe
Bahrain	12	middle east-asia minor
Bahamas, The	41	Central America and Carribean
Bosnia & Herz.	33	central and eastern europe
Belarus	33	central and eastern europe
Belize	41	Central America and Carribean
Bolivia	42	southern south america
Brazil	42	southern south america
Barbados	41	Central America and Carribean
Brunei Dar.	51	southeast asia
Bhutan	60	east asia
Botswana	21	southern africa
CAR	22	middle africa
Canada	70	north america
Switzerland	31	northwestern europe
Channel Islands	31	northwestern europe
Chile	42	southern south america
China	60	east asia
Cote d'Ivoire	24	west africa

(continued on next page)

Country assignment to minor regions (continued)		
Country	Min. Region #	Min. Region Name
Cameroon	24	west africa
Congo, Rep.	22	middle africa
Colombia	41	Central America and Carribean
Comoros	23	east africa
Cape Verde	24	west africa
Costa Rica	41	Central America and Carribean
Cuba	41	Central America and Carribean
Cyprus	33	central and eastern europe
Czech C./-slvk/Rep.	33	central and eastern europe
Germany	31	northwestern europe
Djibouti	23	east africa
Dominica	41	Central America and Carribean
Denmark	31	northwestern europe
Dominican Rep.	41	Central America and Carribean
Algeria	80	north africa
Ecuador	42	southern south america
Egypt	80	north africa
Eritrea	23	east africa
Spain	32	southwestern europe
Estonia	33	central and eastern europe
Ethiopia	23	east africa
Finland	33	central and eastern europe
Fiji	52	Australia and Pacific
France	32	southwestern europe
Micronesia	52	Australia and Pacific
Gabon	22	middle africa
UK	31	northwestern europe
Georgia	12	middle east-asia minor
Ghana	24	west africa
Guinea	24	west africa
Gambia, The	24	west africa
Guinea-Bissau	24	west africa
Eq. Guinea	22	middle africa
Greece	33	central and eastern europe

(continued on next page)

Country assignment to minor regions (continued)		
Country	Min. Region #	Min. Region Name
Grenada	41	Central America and Carribean
Guatemala	41	Central America and Carribean
Guam	52	Australia and Pacific
Guyana	41	Central America and Carribean
Hong Kong	60	east asia
Honduras	41	Central America and Carribean
Croatia	33	central and eastern europe
Haiti	41	Central America and Carribean
Hungary	33	central and eastern europe
Indonesia	51	southeast asia
India	11	south asia
Ireland	31	northwestern europe
Iran	11	south asia
Iraq	12	middle east-asia minor
Iceland	31	northwestern europe
Israel	12	middle east-asia minor
Italy	32	southwestern europe
Jamaica	41	Central America and Carribean
Jordan	12	middle east-asia minor
Japan	60	east asia
Kazakhstan	14	central asia
Kenya	23	east africa
Kyrgyz Rep.	14	central asia
Cambodia	51	southeast asia
Kiribati	52	Australia and Pacific
Korea, Rep.	60	east asia
Kuwait	12	middle east-asia minor
Lao PDR	51	southeast asia
Lebanon	12	middle east-asia minor
Liberia	24	west africa
Libya	80	north africa
St. Lucia	41	Central America and Carribean
Sri Lanka	11	south asia
Lesotho	21	southern africa

(continued on next page)

Country assignment to minor regions (continued)		
Country	Min. Region #	Min. Region Name
Lithuania	33	central and eastern europe
Luxembourg	31	northwestern europe
Latvia	33	central and eastern europe
Macao, China	60	east asia
Morocco	80	north africa
Moldova	33	central and eastern europe
Madagascar	23	east africa
Maldives	11	south asia
Mexico	70	north america
Macedonia	33	central and eastern europe
Mali	24	west africa
Malta	33	central and eastern europe
Myanmar	51	southeast asia
Mongolia	14	central asia
Mozambique	23	east africa
Mauritania	80	north africa
Mauritius	23	east africa
Malawi	23	east africa
Malaysia	51	southeast asia
Namibia	21	southern africa
New Cal.	52	Australia and Pacific
Niger	24	west africa
Nigeria	24	west africa
Nicaragua	41	Central America and Carribean
Netherlands	31	northwestern europe
Norway	31	northwestern europe
Nepal	11	south asia
New Zealand	52	Australia and Pacific
Oman	12	middle east-asia minor
Pakistan	11	south asia
Panama	41	Central America and Carribean
Peru	42	southern south america
Philippines	51	southeast asia
Pap. New Guin.	52	Australia and Pacific

(continued on next page)

Country assignment to minor regions (continued)		
Country	Min. Region #	Min. Region Name
Poland	33	central and eastern europe
Puerto Rico	41	Central America and Carribean
Korea, D. Rep.	60	east asia
Portugal	32	southwestern europe
Paraguay	42	southern south america
Fr. Polynesia	52	Australia and Pacific
Qatar	12	middle east-asia minor
Romania	33	central and eastern europe
Russia	33	central and eastern europe
Rwanda	22	middle africa
Saudi Arabia	12	middle east-asia minor
Sudan	23	east africa
Senegal	24	west africa
Singapore	60	east asia
Solomon Is.	52	Australia and Pacific
Sierra Leone	24	west africa
El Salvador	41	Central America and Carribean
Somalia	23	east africa
Suriname	41	Central America and Carribean
Slovak Rep.	33	central and eastern europe
Slovenia	33	central and eastern europe
Sweden	31	northwestern europe
Swaziland	21	southern africa
Seychelles	23	east africa
Syria	12	middle east-asia minor
Chad	23	east africa
Togo	24	west africa
Thailand	51	southeast asia
Tajikistan	14	central asia
Turkmenistan	14	central asia
Tonga	52	Australia and Pacific
Taiwan	60	east asia
Trin. & Tob.	41	Central America and Carribean
Tunisia	80	north africa

(continued on next page)

Country assignment to minor regions (continued)		
Country	Min. Region #	Min. Region Name
Turkey	12	middle east-asia minor
Tanzania	23	east africa
Uganda	23	east africa
Ukraine	33	central and eastern europe
Uruguay	42	southern south america
United States	70	north america
Uzbekistan	14	central asia
St. Vin. & Gr.	41	Central America and Carribean
Venezuela	41	Central America and Carribean
Vir. Is. (U.S.)	52	Australia and Pacific
Vir. Is. (U.S.)	52	Australia and Pacific
Vietnam	51	southeast asia
Vanuatu	52	Australia and Pacific
Samoa	52	Australia and Pacific
Yemen, Rep.	12	middle east-asia minor
Serbia/Yugo.	33	central and eastern europe
South Africa	21	southern africa
Congo, Dem. Rep.	22	middle africa
Zambia	22	middle africa
Zimbabwe	22	middle africa

B Imputation of GDP per capita in 1500 CE

Table B1: Year 1500 GDPpc Imputations

Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Afghanistan	Iran, Islamic Rep.	1950	0.50	612
Angola	France	1975	0.25	438
Albania	Germany	1950	0.23	527
United Arab Emirates	(Excluded: First GDP per capita observation influence by natural resource boom.)			
Argentina	Chile	1950	1.71	1271
Armenia	Turkey	1980	0.65	546
Australia	(self)	1820		941
Austria	Germany	1850	0.99	2297
Azerbaijan	Iran, Islamic Rep.	1980	0.81	993
Burundi	Egypt, Arab Rep.	1950	0.17	198
Belgium	(self)	1500		2407
Benin	Egypt, Arab Rep.	1950	0.41	492
Burkina Faso	Egypt, Arab Rep.	1950	0.15	184
Bangladesh	India	1950	1.36	1433

(continued on next page)

Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Bulgaria	Turkey	1925	1.43	1204
Bahrain	(Excluded: First GDP per capita observation influence by natural resource boom.)			
Bahamas, The	(Not in Maddison 2018 dataset)	2010		
Bosnia and Herzegovina	Germany	1960	0.14	331
Belarus	Finland	1980	0.35	429
Belize	(Not in Maddison 2018 dataset)			
Bolivia	Peru	1950	0.82	760
Brazil	(self)	1800		1123
Barbados	Cuba	1950	0.71	303
Brunei Darussalam	(Not in Maddison 2018 dataset)			
Bhutan	(Not in Maddison 2018 dataset)			
Botswana	Egypt, Arab Rep.	1950	0.24	288
Central African Republic	Egypt, Arab Rep.	1950	0.40	479
Canada	United States	1820	0.74	660
Switzerland	(self)	1950		1050
Channel Islands	(Not in Maddison 2018 dataset)			

(continued on next page)

Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Chile	(self)	1810		744
China	(self)	1661		1083
Cote dIvoire	Egypt, Arab Rep.	1950	0.77	921
Cameroon	Egypt, Arab Rep.	1950	0.46	553
Congo, Rep.	Egypt, Arab Rep.	1950	0.85	1015
Colombia	(self)	1800		937
Comoros	India	1950	0.87	921
Cape Verde	Egypt, Arab Rep.	1950	0.46	544
Costa Rica	Mexico	1920	0.83	564
Cuba	(self)	1690		429
Cyprus	Greece	1950	0.95	1332
Czech Countries (Czechoslovakia 1900-1986, Czech Republic 1987-...)	Germany	1850	0.70	1624
Germany	(self)	1500		2315
Djibouti	Egypt, Arab Rep.	1950	0.99	1179
Dominica	Cuba	1950	0.39	167

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Denmark	Sweden	1820	1.53	2843
Dominican Republic	Cuba	1950	0.62	267
Algeria	Spain	1970	0.73	1074
Ecuador	Peru	1870	0.50	461
Egypt, Arab Rep.	(self)	1500		1190
Eritrea	(Not in Maddison 2018 dataset)			
Spain	(self)	1500		1477
Estonia	Finland	1980	0.51	618
Ethiopia	Egypt, Arab Rep.	1950	0.16	192
Finland	(self)	1600		1209
Fiji	(Not in Maddison 2018 dataset)			
France	(self)	1500		1748
Micronesia, Fed. Sts.	(Not in Maddison 2018 dataset)			
Gabon	(Excluded: First GDP per capita observation influence by natural resource boom.)			
United Kingdom	(self)	1500		1142
Georgia	Iran, Islamic Rep.	1980	0.86	1056

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Ghana	Egypt, Arab Rep.	1980	0.33	392
Guinea	Egypt, Arab Rep.	1950	0.21	254
Gambia, The	Egypt, Arab Rep.	1950	0.36	425
Guinea-Bissau	Egypt, Arab Rep.	1950	0.15	184
Equatorial Guinea	Egypt, Arab Rep.	1950	0.28	330
Greece	(self)	1		1400
Grenada	(Not in Maddison 2018 dataset)			
Guatemala	Mexico	1920	0.64	436
Guam	(Not in Maddison 2018 dataset)			
Guyana (British Guiana)	(Not in Maddison 2018 dataset)			
Hong Kong SAR, China	(self)	1820		961
Honduras	Mexico	1920	0.76	519
Croatia	Germany	1960	0.45	1033
Haiti	Cuba	1950	0.65	278
Hungary	Germany	1870	0.71	1655
Indonesia	(self)	1815		875

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
India	(self)	1600		1055
Ireland	United Kingdom	1930	0.69	787
Iran, Islamic Rep.	(self)	1		1225
Iraq	(self)	1150		1190
Iceland	United Kingdom	1950	0.72	826
Israel	(self)	1		1225
Italy	(self)	1500		3125
Jamaica	Cuba	1950	0.67	288
Jordan	(self)	1		1225
Japan	(self)	1450		829
Kazakhstan	Iran, Islamic Rep.	1980	1.20	1474
Kenya	Egypt, Arab Rep.	1950	0.46	553
Kyrgyz Republic	Iran, Islamic Rep.	1980	0.43	525
Cambodia	Vietnam	1950	0.49	378
Kiribati	(Not in Maddison 2018 dataset)			
Korea, Rep.	(self)	1820		462

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Kuwait	(Excluded: First GDP per capita observation influence by natural resource boom.)			
Lao PDR	Vietnam	1950	0.84	651
Lebanon	Iran, Islamic Rep.	1820	1.43	1749
Liberia	Egypt, Arab Rep.	1950	0.31	372
Libya	Egypt, Arab Rep.	1950	0.92	1100
St. Lucia	Cuba	1950	0.50	213
Sri Lanka	(self)	1820		799
Lesotho	Egypt, Arab Rep.	1950	0.12	144
Lithuania	Finland	1980	0.61	733
Luxembourg	Belgium	1950	1.38	3313
Latvia	Finland	1980	0.56	675
Macao SAR, China	(Not in Maddison 2018 dataset)			
Morocco	(self)	1820		703
Moldova	Turkey	1980	0.82	696
Madagascar	Egypt, Arab Rep.	1950	0.60	710
Maldives	(Not in Maddison 2018 dataset)			

(continued on next page)

Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Mexico	(self)	1550		683
Macedonia, FYR	Greece	1960	0.65	915
Mali	Egypt, Arab Rep.	1950	0.19	224
Malta	Greece	1950	0.43	603
Myanmar	(self)	1820		594
Mongolia	China	1950	2.89	3133
Mozambique	Egypt, Arab Rep.	1950	0.11	128
Mauritania	Egypt, Arab Rep.	1950	0.33	387
Mauritius	Egypt, Arab Rep.	1950	0.84	1005
Malawi	Egypt, Arab Rep.	1950	0.15	175
Malaysia	(self)	1820		1120
Namibia	Egypt, Arab Rep.	1950	1.28	1527
New Caledonia	(Not in Maddison 2018 dataset)			
Niger	Egypt, Arab Rep.	1950	0.30	353
Nigeria	Egypt, Arab Rep.	1950	0.61	725
Nicaragua	Mexico	1920	0.96	654

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Netherlands	(self)	1500		2617
Norway	Sweden	1820	1.74	3248
Nepal	(self)	1820		621
New Zealand	Australia	1850	0.53	494
Oman	Iran, Islamic Rep.	1950	0.73	889
Pakistan	Iran, Islamic Rep.	1950	0.26	322
Panama	Mexico	1910	1.13	770
Peru	(self)	1595		930
Philippines	(self)	1820		1094
Papua New Guinea	(Not in Maddison 2018 dataset)			
Poland	(self)	1500		1036
Puerto Rico	Cuba	1950	1.23	530
Korea, Dem. Rep.	(self)	1820		245
Portugal	(self)	1530		1284
Paraguay	Chile	1940	0.63	466
French Polynesia	(Not in Maddison 2018 dataset)			

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Qatar	(Excluded: First GDP per capita observation influence by natural resource boom.)			
Romania	Turkey	1923	0.95	801
Russian Federation	Finland	1960	0.89	1075
Rwanda	Egypt, Arab Rep.	1950	0.19	222
Saudi Arabia	Iran, Islamic Rep.	1820	1.57	1920
Sudan	Egypt, Arab Rep.	1950	0.60	711
Senegal	Egypt, Arab Rep.	1950	0.55	657
Singapore	Hong Kong SAR, China	1950	1.30	1249
Solomon Islands	(Not in Maddison 2018 dataset)			
Sierra Leone	Egypt, Arab Rep.	1950	0.28	338
El Salvador	Mexico	1920	0.68	463
Somalia	(Not in Maddison 2018 dataset)			
Suriname	(Not in Maddison 2018 dataset)			
Slovak Republic	(Excluded: To avoid duplicating Czech Republic/Czechoslovakia.)			
Slovenia	Germany	1960	0.42	974

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Sweden	(self)	1500		1864
Swaziland	Egypt, Arab Rep.	1950	0.29	340
Seychelles	Australia	1950	0.33	306
Syrian Arab Republic	Iran, Islamic Rep.	1820	0.33	403
Chad	Egypt, Arab Rep.	1950	0.31	369
Togo	Egypt, Arab Rep.	1950	0.33	396
Thailand	(self)	1820		795
Tajikistan	Iran, Islamic Rep.	1980	0.48	593
Turkmenistan	Iran, Islamic Rep.	1980	0.78	953
Tonga	(Not in Maddison 2018 dataset)			
Taiwan	(Not in Maddison 2018 dataset)			
Trinidad and Tobago	Cuba	1950	1.13	484
Tunisia	(self)	1820		718
Turkey	(self)	1500		844
Tanzania	Egypt, Arab Rep.	1950	0.36	434
Uganda	Egypt, Arab Rep.	1950	0.33	394
Ukraine	Turkey	1980	1.59	1343

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Year 1500 GDPpc Imputations (continued)				
Country	Comparison Country	Comp. Year	Comp. Mult.	Imputed GDPpc
Uruguay	Chile	1820	2.71	2020
United States	(self)	1650		897
Uzbekistan	Iran, Islamic Rep.	1980	0.48	594
St. Vincent and the Grenadines	(Not in Maddison 2018 dataset)			
Venezuela, RB	Colombia	1800	1.29	1210
Virgin Islands (U.S.)	(Not in Maddison 2018 dataset)			
Vietnam	(self)	1820		778
Vanuatu	(Not in Maddison 2018 dataset)			
Samoa	(Not in Maddison 2018 dataset)			
Yemen, Rep.	Iran, Islamic Rep.	1950	0.30	369
Serbia (Yugoslavia from 1900)	Germany	1870	0.29	664
South Africa	Egypt, Arab Rep.	1820	1.11	1317
Congo, Dem. Rep.	Egypt, Arab Rep.	1950	0.49	581
Zambia	Egypt, Arab Rep.	1950	0.62	734
Zimbabwe	Egypt, Arab Rep.	1950	0.36	427

C Model Testing and Selection

Table C1 displays the results of testing the each of the models I through V for each country for both CDR and CBR. The first five columns for each variable show the p-values of the F-tests used to choose between each pair of nested models. The "Recommended" model, in each of the columns labeled "R", is chosen according to the following set of rules. If the p-value for Model I versus both Model II or Model III is less than 0.05, then Model I is recommended. If either p-value is greater than or equal to 0.05, then we check whether the p-value for that model versus Model IV is less than to 0.05. If it is, that model, II or III, is recommended. If not, then we check whether the p-value for Model IV versus Model V is less than 0.05. It if it, Model IV is recommended, and if not, Model V is recommended.

In the case that Model I were rejected simultaneously for both Model II and Model III, the model between the two that had the lowest squared errors would be selected. This result does not actually occur for any country/variable pair in this sample.

The models that are chosen to be used for each country and each variable in our analysis are shown in the "C" columns. By default, these are the same models that were recommended by the statistical procedure, but a number of these recommendations have been overridden. As data coverage is limited, the econometric procedure we use is prone to overfitting short-run fluctuations and choosing a start date or an end date for a transition when the level or lack of stability in the variable indicate that this is more than likely not a start or end date. The majority of overrides are correcting these types of overfits, moving the model selection "down" the chain of nested models.

There are a handful of cases in which an override moves the model selection in the other direction, away from a more agnostic model towards one that sets a start or end date for a transition. In this small number of cases, the starting level of the variable is either very high, in the case of a transition start; or the final level is very low, in the case of a transition end; and the average slope surrounding this start or end is not too negative; that is is most likely that the transition start or end date is inside the sample. Of these, there are more that add an end date that the econometric method did not recommend, than there are that add a start date. There are zero overrides that add a CDR start date. There are only two overrides that add a CBR start date, the United Arab Emirates and the Dominican Republic. Each of these countries start the sample with birth rates in the high 40's or low 50's per thousand. This is close to the maximum rate observed for any country in any year, which justifies the assumption that the birth rate transition starts inside the sample for these two countries.

Table C1: Model Testing and Selection

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Afghan.	.00	.00	.00	.00	.00	I	III		.00	.00	.00	.00	.00	V	III	
Angola	.74	.00	.00	.74	.00	V	IV		.00	.00	.00	.00	.00	V	III	Final CBR is too high for transition to be complete.
Albania	.00	.00	.00	.00	.00	I	I		.00	.17	.00	.00	.00	V	I	Level and stability of CBR in last 5 years of data is consistent with transition completion.
UAR	.00	.00	.00	.00	.00	II	II		.23	.01	.01	.38	.00	II	III	Initial CBR level too high for transition to be ongoing.
Argent.	.04	.00	.00	.00	.00	I	I		.07	.00	.00	.00	.00	II	II	
Armenia	.00	.45	.00	.00	.00	V	V	CDR at low, relatively steady levels.	.62	.00	.00	.00	.00	II	II	
Austral.	.37	.00	.00	.57	.00	II	II		.05	.00	.00	.16	.00	II	II	
Austria	.00	.00	.00	.00	.00	I	I		.00	.00	.07	.00	.00	I	I	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Azerb.	.00	.00	.00	.00	.00	I	II	Initial CDR too low to be pre-transition.	.08	.00	.00	.65	.00	II	II	
Burundi	.00	.00	.00	.00	.00	V	IV		.00	.00	.00	.00	.00	I	III	Final CBR is too high for transition to be complete.
Belgium	.10	.00	.00	.91	.00	II	I		.00	.00	.00	.00	.00	I	I	
Benin	.00	.00	.00	.00	.00	II	II	Final CDR levels are low and stable enough.	.00	.00	.00	.00	.00	V	III	
Burkina F.	.00	.00	.00	.00	.00	V	IV		.00	.00	.00	.00	.00	V	III	
Banglad.	.00	.00	.00	.00	.00	II	I		.00	.00	.00	.00	.00	I	III	Change of trend in last few years not sharp enough to call transition complete.
Bulgaria	.00	.00	.00	.10	.00	I	I		.00	.00	.00	.00	.00	I	I	
Bahrain	.24	.00	.00	.00	.00	II	II		.00	.04	.11	.01	.00	I	III	
Bahamas	.00	.00	.00	.00	.00	II	II		.05	.67	.80	.05	.00	III	IV	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Bosnia & H..	.00	.00	.00	.00	.00	III	II		.00	.00	.00	.00	.00	II	II	
Belarus	.00	.00	.02	.00	.00	I	V	CDR at low, relatively steady levels.	.00	.00	.00	.00	.00	II	II	
Belize	.30	.00	.00	.00	.00	II	II		.00	.26	.00	.00	.00	V	III	
Bolivia	.00	.00	.21	.00	.00	I	I		.00	.00	.00	.00	.00	V	III	
Brazil	.69	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	
Barbados	.00	.00	.00	.84	.00	I	I		.00	.00	.52	.00	.00	I	I	
Brunei D.	.00	.00	.00	.00	.00	II	II		.01	.03	.07	.01	.00	I	III	
Bhutan	.00	.00	.00	.03	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.02	.00	.00	.00	I	III	
Botswana	.00	.00	.00	.00	.00	II	II		.00	.00	.07	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
CAR	.04	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	V	III	
Canada	.00	.00	.00	.00	.00	II	II		.00	.48	.48	.00	.00	V	II	Final CBR levels are too low and stable for transition to be ongoing.
Switz.	.00	.00	.00	.94	.00	I	I		.08	.00	.00	.34	.00	II	II	
Channel I.	.00	.00	.00	.00	.00	I	III		.11	.33	.74	.19	.00	V	III	
Chile	.00	.00	.35	.00	.00	I	I		.00	.00	.00	.00	.00	V	III	
China	.62	.00	.00	.00	.00	II	II		.46	.06	.08	.86	.00	V	II	Final CBR levels are too low and stable for transition to be ongoing.
Cote dIvoire	.00	.00	.00	.00	.00	I	II		.00	.00	.02	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Cameroon	.00	.00	.00	.00	.00	V	II		.00	.00	.00	.00	.00	V	III	Final CBR is too high for transition to be complete.
Congo, Rep.	.00	.01	.01	.00	.00	II	II		.00	.00	.00	.02	.00	I	III	
Colombia	.00	.00	.00	.00	.00	II	II		.00	.72	.00	.00	.00	V	III	
Comoros	.00	.00	.00	.00	.00	I	II		.00	.08	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.
Cape Verde	.16	.00	.00	.00	.00	II	I		.00	.14	.00	.00	.00	V	III	
Costa Rica	.00	.00	.00	.01	.00	I	I		.00	.14	.00	.00	.00	V	III	
Cuba	.00	.00	.00	.00	.00	II	II		.01	.02	.94	.13	.00	I	I	Final CBR levels too low for transition to be ongoing.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Cyprus	.00	.00	.00	.19	.00	I	I		.00	.38	.00	.00	.00	V	I	Final CBR levels too low for transition to be ongoing.
Czech.	.00	.00	.00	.18	.00	I	I		.00	.00	.02	.00	.00	I	I	
Germany	.00	.00	.00	.00	.00	I	I		.00	.00	.14	.00	.00	I	I	
Djibouti	.00	.00	.00	.00	.00	II	II		.00	.70	.00	.00	.00	V	III	
Dominica	.02	.00	.00	.00	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.54	.00	.00	I	I	
Denmark	.00	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	I	I	
Dominican R.	.00	.00	.00	.00	.00	II	II		.06	.00	.00	.76	.00	II	III	Final CBR not stable enough to call transition complete. Initial CBR level too high for transition to be ongoing.
Algeria	.45	.00	.00	.00	.00	II	II		.00	.00	.00	.07	.00	I	I	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Ecuador	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Egypt	.01	.00	.00	.76	.00	I	I		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Eritrea	.00	.53	.52	.00	.00	V	IV		.00	.00	.00	.00	.00	I	III	
Spain	.00	.00	.00	.00	.00	I	I		.00	.00	.17	.00	.00	I	I	
Estonia	.01	.00	.00	.26	.00	I	V	CDR at low, relatively steady levels.	.00	.00	.01	.20	.00	I	V	CBR at low, relatively steady levels.
Ethiop.	.00	.00	.00	.00	.00	V	IV		.00	.33	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.
Finland	.00	.00	.42	.00	.00	I	I		.00	.01	.00	.00	.00	I	I	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Fiji	.03	.00	.00	.92	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.00	.00	.00	V	III	
France	.00	.01	.01	.00	.00	II	II		.00	.00	.00	.49	.00	I	I	
Microneso.	.00	.00	.00	.00	.00	II	II		.00	.07	.55	.00	.00	III	III	
Gabon	.01	.00	.00	.00	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.
UK	.00	.00	.00	.00	.00	I	I		.00	.00	.24	.00	.00	I	I	
Georgia	.00	.45	.00	.00	.99	III	V	CDR at low, relatively steady levels.	.24	.00	.00	.00	.00	II	II	
Ghana	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Guinea	.00	.39	.38	.00	.00	V	III		.00	.00	.00	.00	.00	V	III	
Gambia	.27	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Guinea-B.	.00	.19	.18	.00	.00	V	IV	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.00	.00	.00	V	III	
Eq. Guinea	.00	.01	.00	.00	.00	II	IV		.00	.00	.00	.00	.00	V	V	CBR at relatively steady, high levels.
Greece	.00	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	I	I	
Grenada	.00	.00	.00	.00	.00	II	II		.00	.02	.10	.01	.00	I	III	
Guatem.	.00	.00	.00	.25	.00	I	I		.00	.00	.00	.00	.00	V	III	
Guam	.00	.00	.00	.16	.99	II	V	CDR at low, relatively steady levels.	.06	.70	.98	.06	.00	V	IV	
Guyana	.00	.00	.00	.93	.00	I	I		.00	.82	.00	.00	.00	V	III	
Hong Kong	.00	.00	.00	.00	.00	I	II	Initial CDR not stable enough to be pre-transition.	.00	.00	.00	.00	.00	I	I	
Honduras	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Croatia	.01	.00	.00	.01	.00	V	V	CDR at low, relatively steady levels.	.00	.00	.00	.00	.00	II	II	
Haiti	.00	.00	.00	.00	.00	II	II		.00	.18	.00	.00	.00	V	III	
Hungary	.00	.00	.00	.48	.00	I	I		.00	.00	.00	.00	.00	I	I	
Indones.	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.06	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
India	.00	.15	.84	.00	.00	V	II	Final CDR levels are low and stable enough.	.00	.87	.00	.00	.00	V	III	
Ireland	.00	.73	.00	.00	.00	V	I	Final CDR levels are low and stable enough.	.00	.01	.00	.00	.00	I	I	
Iran	.00	.00	.00	.00	.00	II	II		.00	.00	.28	.00	.00	I	I	
Iraq	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	II	IV	
Iceland	.00	.14	.13	.00	.00	V	V	CDR at low, relatively steady levels.	.00	.40	.00	.00	.00	V	III	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Israel	.15	.00	.00	.00	.00	II	II		.00	.05	.05	.00	.00	II	IV	
Italy	.01	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	I	I	
Jamaica	.00	.00	.00	.02	.00	I	I		.00	.15	.00	.00	.00	V	III	
Jordan	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Japan	.00	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	I	I	
Kazakhstan	.00	.00	.00	.00	.00	II	II		.64	.00	.00	.00	.00	II	II	
Kenya	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.
Kyrgyz Republic	.00	.00	.00	.00	.00	II	II		.08	.00	.00	.42	.00	II	IV	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Cambodia	.00	.00	.91	.00	.00	I	I		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Kiribati	.00	.00	.00	.00	.00	II	II		.02	.00	.00	.01	.00	V	IV	
Korea, Rep.	.00	.00	.00	.00	.00	II	II		.02	.00	.00	.34	.00	I	I	
Kuwait	.00	.00	.00	.00	.00	II	II		.00	.00	.01	.00	.00	I	I	
Lao PDR	.00	.12	.11	.00	.00	V	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Lebanon	.00	.00	.00	.00	.00	II	II		.24	.00	.00	.65	.00	II	IV	
Liberia	.00	.00	.00	.00	.00	V	III		.00	.00	.00	.00	.00	V	III	
Libya	.00	.00	.00	.00	.00	I	II		.00	.00	.00	.00	.00	I	I	
St. Lucia	.00	.00	.00	.00	.00	II	II		.00	.06	.00	.00	.00	V	I	
Sri Lanka	.00	.00	.00	.00	.00	I	I		.00	.10	.00	.00	.00	III	I	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Lesotho	.00	.00	.00	.00	.00	II	II		.00	.00	.59	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Lithuania	.00	.00	.00	.00	.00	V	V	CDR at low, relatively steady levels.	.58	.00	.00	.00	.00	II	II	
Luxemb.	.00	.46	.00	.00	.00	V	V	CDR at low, relatively steady levels.	.00	.00	.00	.22	.00	I	V	CBR at low, relatively steady levels.
Latvia	.00	.00	.00	.11	.00	I	V	CDR at low, relatively steady levels.	.00	.00	.01	.75	.00	I	V	CBR at low, relatively steady levels.
Macao	.00	.00	.00	.00	.00	II	II		.24	.00	.00	.00	.00	II	II	
Morocco	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.18	.00	I	III	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Moldova	.05	.00	.00	.00	.99	III	V	CDR at low, relatively steady levels.	.00	.07	.07	.00	.00	V	II	Final CBR level is low and stable enough for transition to be complete.
Madagas.	.43	.00	.00	.63	.00	II	IV	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.00	.00	.00	V	III	
Maldives	.00	.00	.00	.22	.00	I	I		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Mexico	.00	.00	.00	.44	.00	I	I		.00	.21	.00	.00	.00	V	III	
Macedonia, FYR	.00	.78	.00	.00	.00	III	II		.00	.00	.00	.00	.00	II	II	
Mali	.00	.49	.86	.00	.00	V	III		.00	.00	.00	.00	.00	V	III	
Malta	.00	.00	.05	.00	.00	I	V	CDR at low, relatively steady levels.	.00	.00	.00	.00	.00	II	II	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Myanmar	.00	.00	.00	.00	.00	II	II		.02	.15	.29	.03	.00	III	III	Final CBR level too high, not stable enough to call transition complete.
Mongolia	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.01	.00	I	I	
Mozambiq.	.22	.00	.00	.22	.00	V	IV		.00	.00	.00	.00	.00	V	III	
Mauritan.	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	
Maurit.	.00	.00	.00	.00	.00	I	I		.00	.30	.00	.00	.00	V	III	
Malawi	.00	.00	.00	.00	.00	V	IV		.00	.00	.00	.00	.00	V	III	
Malaysia	.01	.00	.00	.00	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.11	.00	.00	.00	V	III	
Namibia	.00	.00	.00	.00	.00	II	II		.00	.00	.73	.00	.00	I	III	
New Cal.	.20	.00	.00	.00	.00	II	II		.00	.01	.60	.00	.00	I	III	
Niger	.00	.87	.00	.00	.00	V	III		.00	.00	.00	.00	.00	V	III	
Nigeria	.00	.00	.00	.00	.00	V	IV		.00	.00	.00	.00	.00	V	III	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Nicaragua	.00	.00	.00	.00	.00	II	II		.00	.00	.90	.00	.00	I	III	
Netherld.	.00	.00	.00	.43	.00	I	I		.00	.00	.97	.00	.00	I	I	
Norway	.13	.00	.00	.24	.00	II	II		.00	.00	.00	.00	.00	I	I	
Nepal	.00	.00	.00	.20	.00	I	II		.00	.76	.00	.00	.00	V	III	
N. Zealand	.14	.00	.00	.14	.00	V	IV		.00	.00	.00	.00	.00	I	I	
Oman	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Pakistan	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Panama	.00	.00	.00	.00	.00	II	II		.00	.02	.00	.00	.00	I	III	
Peru	.00	.00	.00	.00	.00	II	II		.00	.00	.23	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Philipp.	.00	.00	.00	.00	.00	II	II		.00	.92	.00	.00	.00	V	III	
Papua NG	.00	.00	.00	.00	.00	II	II		.02	.00	.00	.01	.00	V	III	
Poland	.00	.00	.00	.00	.00	II	II		.76	.02	.02	.81	.00	II	II	Final CBR level is low and stable enough for transition to be complete.
Puerto R.	.00	.00	.00	.00	.00	I	I		.00	.09	.00	.00	.00	V	I	Final CBR level is low and stable enough for transition to be complete.
N. Korea	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.55	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Portugal	.00	.00	.00	.54	.00	I	I		.00	.25	.00	.00	.00	V	I	Final CBR level is low and stable enough for transition to be complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Paraguay	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	IV	
Fr. Polynes.	.00	.00	.00	.00	.00	II	II		.00	.07	.43	.00	.00	III	III	Final CBR level is low and stable enough for transition to be complete.
Qatar	.00	.00	.00	.00	.00	II	II		.36	.24	.26	.41	.00	V	IV	
Romania	.00	.00	.00	.00	.00	I	I		.00	.01	.41	.00	.00	I	I	
Russia	.00	.00	.00	.64	.00	I	I		.00	.00	.00	.00	.00	I	I	
Rwanda	.00	.19	.00	.00	.00	V	III		.00	.89	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.
S. Arabia	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Sudan	.00	.44	.43	.00	.00	V	II	Final CDR levels are low and stable enough.	.00	.00	.00	.00	.00	V	III	

(continued on next page)

Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Senegal	.00	.00	.00	.47	.00	I	II	Initial CDR too low and not stable enough to be pre-transition. Final CDR too low for transition to be ongoing.	.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Singap.	.00	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	I	I	
Solom. I.	.00	.70	.70	.00	.00	V	IV		.00	.00	.00	.00	.00	V	III	
Si. Leone	.74	.00	.00	.73	.00	V	IV		.00	.00	.00	.00	.00	V	IV	
El Salv.	.00	.00	.00	.00	.00	II	II		.00	.14	.00	.00	.00	V	III	
Somalia	.00	.00	.00	.00	.00	V	IV		.06	.00	.00	.00	.87	III	III	Final CBR level too high, not stable enough to call transition complete.
Suriname	.00	.00	.00	.00	.00	I	V	CDR at low, relatively steady levels.	.00	.15	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Slovak.	.00	.00	.00	.18	.00	I	V	CDR at low, relatively steady levels.	.00	.00	.00	.00	.00	I	II	Initial CBR levels not stable enough to call pre-transition.
Sloven.	.00	.14	.72	.00	.00	III	V	CDR at low, relatively steady levels.	.00	.00	.00	.00	.00	II	II	
Sweden	.01	.00	.00	.74	.00	I	I		.00	.00	.73	.00	.00	I	I	
Swazil.	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Seychel.	.00	.00	.00	.00	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.28	.00	.00	I	I	
Syria	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	Final CBR level too high, not stable enough to call transition complete.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Chad	.00	.00	.00	.00	.00	V	II		.17	.04	.00	.00	.92	III	V	CBR at high, relatively stable level.
Togo	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	
Thail.	.00	.00	.00	.00	.00	II	II		.02	.00	.00	.00	.00	I	I	
Tajik.	.00	.12	.30	.00	.00	III	II	Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.18	.04	.00	I	IV	Final CBR level too high, not stable enough to call transition complete.
Turkmen.	.94	.00	.00	.00	.00	II	II		.03	.00	.00	.18	.00	I	IV	
Tonga	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	V	III	
Taiwan	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	I	III	CBR clearly still declining.
Tr. & Tob.	.01	.00	.00	.00	.00	I	I		.00	.00	.00	.00	.00	I	I	
Tunisia	.00	.00	.10	.00	.00	I	I		.00	.00	.42	.00	.00	I	I	
Turkey	.15	.00	.00	.00	.00	II	II		.00	.00	.97	.00	.00	I	III	CBR clearly still declining.

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Tanzan.	.93	.00	.00	.93	.00	V	IV		.01	.00	.00	.00	.00	V	V	CBR at high, relatively stable level.
Uganda	.00	.12	.00	.00	.00	V	II		.00	.00	.00	.00	.00	V	III	
Ukraine	.00	.00	.00	.00	.00	I	V	CDR at low, relatively steady levels.	.00	.00	.00	.00	.00	II	II	
Uruguay	.08	.00	.00	.00	.00	II	II		.00	.00	.00	.00	.00	II	II	
USA	.00	.00	.00	.00	.00	I	II	Initial CDR too low and not stable enough to be pre-transition.	.54	.00	.00	.00	.00	II	II	
Uzbek.	.23	.00	.00	.00	.00	II	II		.02	.00	.01	.19	.00	I	IV	
St. V. & Gr.	.00	.00	.00	.00	.00	I	I		.00	.00	.07	.00	.00	I	III	Final CBR level too high, not stable enough to call transition complete.
Venezu.	.01	.00	.00	.00	.00	I	I		.00	.82	.00	.00	.00	V	III	
US Virg. I.	.20	.00	.00	.00	.00	II	II		.00	.00	.35	.00	.00	I	III	

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Model Testing and Selection (continued)

	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Vietnam	.00	.00	.00	.00	.00	II	II		.00	.00	.00	.06	.00	I	III	Final CBR level too high to call transition complete.
Vanuatu	.00	.00	.00	.00	.00	II	II		.00	.83	.83	.00	.00	V	IV	
Samoa	.00	.00	.00	.00	.00	II	II		.00	.33	.32	.00	.00	V	IV	
Yemen	.00	.00	.00	.00	.00	I	II		.00	.00	.00	.00	.00	I	III	
Serb./Yug.	.04	.00	.00	.00	.00	I	I		.00	.03	.00	.00	.00	I	III	
S. Africa	.00	.00	.00	.00	.99	II	II		.11	.00	.00	.48	.00	II	I	
Congo, DR	.00	.00	.00	.00	.00	V	IV	Final CDR not stable enough to call transition complete.	.00	.00	.00	.00	.00	V	III	
Zambia	.00	.50	.00	.00	.00	V	II	Final CDR not stable enough to call transition complete. Initial CDR too low and not stable enough to be pre-transition.	.00	.00	.00	.00	.00	V	V	CBR at high, relatively stable level.

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Model Testing and Selection (continued)																
	CDR								CBR							
Country	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes	p, I v II	p, I v III	p, II v IV	p, III v IV	p, IV v V	R	C	Notes
Zimbab.	.00	.00	.00	.05	.99	II	II		.00	.00	.00	.74	.00	I	III	Final CBR level too high, not stable enough to call transition complete.

Table C2 summarizes the model selection overrides that are made for CDR and CBR.

Table C2: Model selection overrides

from	to	CDR	CBR
I	II	11	1
I	III	0	45
I	IV	1	0
I	V	8	5
II	I	0	0
II	III	0	1
II	II	0	2
II	V	2	1
III	I	1	5
III	II	2	0
III	III	1	0
III	V	5	1
IV	I	0	0
IV	II	3	4
IV	III	0	1
IV	V	1	0
V	I	0	0
V	II	0	0
V	III	0	0
V	IV	0	0
Total		35	66
Remove start or end ate		30	56
Add start date		0	2
Add end date		6	9