Fertility and Education Patterns Across Different Phases of Development

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Abstract

This paper simulates and presents novel empiric evidence supporting the fertility dynamics model's main conclusions from Ohinata and Varvarigos (2020). With three stages, this model proposes that an N-shaped curve can represent the relationship between fertility and human capital. Three facts arise from the birth cohort-cross sectional analysis of this relationship: First, for women born between 1920 and 1970, this relationship changes from positive to negative in Africa and Asia regions. In contrast, in the Latin-America region, it remains negative. Then, these three regions are still in the second stage. Second, for the USA, a new positive relationship arises for women born in cohort 1950. However, this pattern is different depending on the racial group. Third, in four European countries, these two variables exhibit a new positive relationship for cohort 1960. Therefore, these advanced economies are already in the third stage according to the model. Finally, I show that Reher's onset of demographic transition is consistent with the first two stages of the fertility dynamics model. In ten latecomer countries, the onset classification is associated with the change in the coefficient for the relationship between fertility and human capital, while trailer countries show a negative relationship between these two variables after the onset.

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Contents

1 Introduction

Most of the literature about fertility dynamics classifies this process into two stages. The first one, which begins from early industrialization, records that population and fertility rates increased while the second stage indicates a marked decrease in fertility rates. However, in the last decades, some developed countries have experienced a fertility rebound that could be considered the new third stage. Which countries are still in stage two? When the third stage started? Is this pattern maintained over time for advanced economies?

I study the fertility dynamics by focusing on the relationship of fertility and human capital to answer these questions in three steps. First, I present and simulate the fertility dynamics model proposed by Ohinata and Varvarigos (2020)- henceforth, OV -. Second, I empirically demonstrate the evolution of the main variables' relationship for different regions and countries over time. Finally, I show that Reher's onset of demographic transition is consistent with the first two stages of demographic dynamics model.

Section IV presents the fertility dynamics model of OV. This model proposes an N-shaped curve representing the relationship between fertility and human capital, where fertility dynamics face three stages. At the first stage, the return to education is such low that parents decide to spend the amount of income that they do not consume for child-rearing purposes. In the second stage, the return to education spending is high. Therefore, households reduce the number of children to finance the desired amount of education expenditures, so we observe the quantity-quality trade-off. Finally, in stage three, households have enough resources to raise more children and provide a desirable amount of education for each of them.

Section V presents a quantitative version of the model. In section V.A, the model is calibrated to the long-run development patterns of a developed country. The simulated model produces the endogenous evolution of the economy over a long period (1700-2100). This simulation shows that the N-shaped relationship between fertility and human capital where the beginning of the second stage is in $t = 1880$, and the beginning of the third stage is in $t = 2000$. Section V.B shows the evolution of the primary endogenous variables over the period 1750-2050.

In section VI, I look at the relationship of fertility and human capital in micro-data from low-income countries in Africa, Asia, Latin-America, and some advanced economies such as the USA, Austria, France, Portugal, and Switzerland. Three primary sources are used for the cohort cross-section analysis, the Demographic and Health

Survey(DHS) for low-income countries and IPUMS census data for the developed economies. For women born between 1920 and 1970, I document how this relationship changes from positive to negative in Africa and Asia regions in cohorts 1940 and 1950, respectively. In contrast, in the Latin-America region, this relationship remains negative during the analysis period. Besides, for the USA, I found empirical evidence for stages two and three. The positive relationship starts for white women born in cohort 1950. For black women, this relationship is also positive but very close to zero for cohort 1960. Finally, for European countries, I also show that this relationship became positive for women born in cohort 1950 onwards. Switzerland is the country that started earlier this new stage in the cohort 1940.

Section VII, I compare the onset of fertility decline classification proposed by Reher (2004) and the first two stages of fertility dynamics according to Ohinata and Varvarigos (2020). I consider this analysis necessary because some authors have used Reher's classification being a relevant input for their studies(Galor (2012), Cervellati and Sunde (2011), Cervellati et al. (2019)). I confirm that in ten latecomer countries, the onset classification is associated with the change in the coefficient for the relationship between fertility and education. However, I can not test if the onset is in line with the coefficient change for trailer countries because of not data availability. Still, most of them show a negative relationship between these two variables after the onset.

2 Related Literature

2.1 Hump shaped relationship

Most of the literature about fertility dynamics categorizes this process into two stages. The first one, which starts from early industrialization, shows that population and fertility rates increased while the second stage reflects a striking decrease in fertility rates. Given the availability of data, these patterns are easy to check for advanced economies. Several authors have proposed theoretical frameworks that account these patterns of fertility dynamics (Galor and Weil (2000), Lagerlöf (2003), Strulik and Weisdorf (2008) Galor (2011)). While some other mainly focus on the second stage of fertility dynamics (Galor and Weil (1996); Blackburn and Cipriani (2002)).

Empirical studies also focus on the second stage of fertility and have documented that income and fertility are negatively correlated. For low and middle-income countries studies, researchers mainly focus their analysis using WFS and DHS surveys nationally representative. For instance, Vogl (2016) propose that exist a hump-shaped relationship between parental human capital and fertility using data from DHS Survey and conclude this for five different regions in the world [1]. In the same line, Chatterjee and Vogl (2018) found that fertility responds differently to growth occurring over different time horizons, and these responses vary over the life cycle. He argues that fertility is procyclical in the short run, falling during recessions—besides, fertility declines and delays with long-run economic growth.

For the US, Jones and Tertilt (2008) documented the history of the relationship between fertility choice and key economic indicators at the individual level for women born between 1826 and 1960. They found a robust negative relationship between income and fertility for all cohorts and estimate an overall income elasticity of about -0.38 for this period. Some other authors also used cross-sectional studies; although this approach restricts their analysis to a specific point in time, they also find a negative correlation (Docquier (2004),Westoff (1954)).

For Europe, Beaujouan and Berghammer (2019) found that for 19 European countries, women eventually had fewer children than the earlier expectations in their birth cohort (the early 1970s), and more often than intended, they remained childless. Aldieri and Vinci (2013) used data from the European Community Household Panel (2001) for 9 EU countries and showed a postponement effect on fertility, i.e., females would decide to delay motherhood. This motivation entails negative impacts on the fertility rate.

2.2 Positive Relationship

However, in the last decades, some developed countries have faced a new demographic change called a "fertility rebound." Consequently, new literature has emerged, but most of them are empirical studies rather than theoretical frameworks.

For the USA, Hazan and Zoabi (2015) estimate an emerging U-shape in the relationship between women's education and fertility, such that women with advanced degrees have more children than women with just undergraduate degrees, but this is a cross-sectional analysis where he appends all women from ACS from 2001 to 2011.

Some studies used panel methods to show the new positive relationship between fertility and education for developed countries. Myrskylä et al. (2009) applied longitudinal analyses to find the relationship between total fertility and the human development

[1] West Africa, East and South Africa, Caribbean, South, and South East Asia and South America.

index(HDI). They observed that the negative relationship is reversing as the population enters the 21st century among highly developed countries. Dominiak et al. (2015) using 18 countries from 1970-2011 found that there is a U-shaped impact of economic growth on the total fertility rate. Finally, Luci-Greulich and Thévenon (2014) found that the strong negative correlation between GDP per capita and fertility does no longer hold for high levels of per capita economic output; the relation instead seems to turn into positive from a certain threshold level of economic development.

The studies cited above concluded that the relationship is U-shaped. However, their main argument arises from observing a positive coefficient for the quadratic term for the income (education, human capital) variable. This approach's disadvantage implies that they can not find the period or cohort where this change on the coefficient's sign happened.

A recent study from Fox et al. (2019) capture this change on the coefficient. The authors look at trends in the cross-sectional relationship between income and fertility levels across NUTS regions for each sample country (20 European countries) between 1990 and 2012. They did this by performing cross-sectional regressions on a by-country annual basis. They documented a weakening of the negative relationship between fertility and economic development within many countries and the emergence of a positive relationship.

To the best of my knowledge, the only paper that offers a theoretical framework that includes this new rebound on fertility as a process of the dynamics of development is Ohinata and Varvarigos (2020). In the next two sections, I will present the model and their main results and do a numerical simulation.

3 Theoretical Model

Ohinata and Varvarigos (2020) propose a model where the economy is populated by overlapping generations of households that have a lifespan of two periods: childhood and adulthood. In childhood, individuals are rared by their parents and receive education that determines the stock of human capital, that will be available to them when they become adults. In adulthood, they receive a salary by offering their labour to perfectly competitive firms.

The household's budget constraint is

$$c_t = \omega h_t - n_t(q + x_t) \tag{1}$$

where c_t denotes consumption and h_t is the stock of human capital. Besides, ω is the wage per unit of effective labour, and rearing each child entails a fixed cost of $q > 0$. Parents spend resources towards the education of each of their offspring using x_t amount.

Parents can affect each child's human capital by devoting resources towards their education using x_t units, so the human capital will be determined as:

$$h_{t+1} = \varphi h_t^{\eta} + \psi h_t^{\mu} x_t \tag{2}$$

Where $\varphi, \psi > 0$ and $\eta, \mu \in (0,1)$. Note that h_t captures intergenerational externalities that generate dynamics in the formation of human capital [2]. He assumed constant returns to x_t because this is the only way to achieve closed-form solutions in the model [3].

The lifetime utility of the household is given by:

$$u_t = \gamma \ln(c_t) + (1-\gamma)\left[\beta \ln(n_t) + \theta \ln(n_t h_{t+1})\right] \tag{3}$$

or we could also rewrite it as:

$$u_t = \gamma \ln(c_t) + (1-\gamma)[(\beta+\theta)\ln(n_t) + \theta \ln(h_{t+1})] \tag{4}$$

where $\gamma \in (0,1)$ and $\beta, \theta > 0$ are preference parameters [4].

Households make their choices to maximize their lifetime utility in equation (3), subject to the constraints in equations (1) and (2). The first order conditions for n_t and x_t implies :

$$n_t(q + x_t) = \frac{(1-\gamma)(\beta+\theta)}{\gamma + (1-\gamma)(\beta+\theta)} \omega h_t \tag{5}$$

$$x_t = \frac{(1-\gamma)\theta}{\gamma + (1-\gamma)(\beta+\theta)} \frac{\omega h_t}{n_t} - \frac{\varphi}{\psi} h_t^{\eta-\mu} \tag{6}$$

Equation (5) shows that a household will dedicate a fixed fraction of labor income to finance the rearing and education of children. From equation (6) he derives two results. First, the first component of the equation is the fraction of disposable income

[2] Blackburn and Cipriani (2002), De La Croix and Doepke (2003), Varvarigos and Arsenis (2015) use the same specification.

[3] Moav and and Neeman (2012) , Vogl (2016), prove why constant returns is needed.

[4] Equation (4) implies that the utility weight on the number of children born in each household is higher than the utility weight attached to human capital per child

devoted to education expenditures is associated with the relative weight attached to the utility accruing from the number of children when these are measured in effective terms. Second, the inter-generational externality from the current stock of human capital has an ambiguous overall effect on the amount of resources devoted to each child's education [5].

The system of equations in (5) and (6) can be solved simultaneously to

$$x_t = X(h_t) = \max\{0, \frac{1}{\beta}[\theta q - (\theta + \beta)\frac{\varphi}{\psi} h_t^{\eta-\mu}]\} \tag{7}$$

and

$$n_t = N(h_t) = \begin{cases} \frac{(1-\gamma)(\beta+\theta)}{\gamma+(1-\gamma)(\beta+\theta)} \frac{\omega h_t}{q} & \text{if } x_t = 0 \\ \frac{(1-\gamma)\beta}{\gamma+(1-\gamma)(\beta+\theta)} \frac{\omega\psi h_t^{1+\mu-\eta}}{q\psi h_t^{\mu-\eta} - \varphi} & \text{if } x_t > 0 \end{cases} \tag{8}$$

These two results show the joint determination of demographics and economic development.

3.1 Dynamics

Economic Dynamics

Equation (7) reveals that there are circumstances under which parents might find it optimal not to invest any resources towards their offspring's education. That will happen as long as $\varphi > 0$, each child will still be endowed with units of efficient labour, because of the presence of the intergenerational externality, even though parents might not invest any resources towards their education.

Assuming that $\mu > \eta$, when the stock of human capital is relatively low, the utility cost of foregone consumption outweighs the utility benefit of educating children and increasing their efficiency. Nevertheless, when the stock of human capital is relatively high, its complementary effect becomes strong enough to guarantee that the return to investment in education is sufficiently high to compensate parents for the utility loss due to decreased consumption.

[5] The ambiguity comes from the fact that h_t can either substitute or be complementary to x_t. On the one hand, a higher h_t supports a young person's human capital improvements; on the other hand, a higher h_t also increases the return (in terms of human capital improvement) of parental investments towards the offspring's education.

Lemma 1: There exist a threshold which comes when the second element of X functions is equalized to zero :

$$\tilde{h} \equiv \left[\frac{(\theta+\beta)\varphi}{\theta\psi q} \right]^{\frac{1}{\mu-\eta}} \tag{9}$$

such that

$$x_t = X(h_t) = \begin{cases} 0 & \text{if } h_t <= \tilde{h} \\ \frac{1}{\beta}\left[\theta q - (\theta+\beta)\frac{\varphi}{\psi} h_t^{\eta-\mu}\right] & \text{if } h_t > \tilde{h} \end{cases} \tag{10}$$

We can see that $X(\tilde{h}) = 0$ and

$$X'(h_t) = \frac{(\mu-\eta)(\theta+\beta)\varphi}{\beta\psi} h_t^{\eta-\mu-1} > 0 \tag{11}$$

The outcome summarized in (10) and equation (2) allows us to express human capital accumulation as :

$$h_{t+1} = F(h_t) = \begin{cases} \varphi h_t^{\eta} & \text{if } h_t <= \tilde{h} \\ \frac{\theta(\psi q h_t^{\mu} - \varphi h_t^{\eta})}{\beta} & \text{if } h_t > \tilde{h} \end{cases} \tag{12}$$

Fertility Dynamics

From equation (8) we can see how fertility varies with stock of human capital.

Lemma 2: Consider $n_t = N(h_t)$. It is straightforward to establish that (a) when $x_t = 0$ then $N'(h_t) > 0$,

$$N'(h_t) = \frac{(1-\gamma)(\beta+\theta)}{\gamma+(1-\gamma)(\beta+\theta)} \frac{\omega}{q} > 0 \tag{13}$$

(b) when $x_t > 0$ then there exists.

$$\hat{h} \equiv \left[\frac{(1+\mu-\eta)\varphi}{\psi q} \right]^{\frac{1}{\mu-\eta}} \tag{14}$$

such that

$$\begin{aligned} N'(h_t) = & \frac{(1-\gamma)(\beta)}{\gamma+(1-\gamma)(\beta+\theta)q} \omega\psi \\ & X\left[\frac{(1+\mu+\eta)h_t^{\mu-\eta}(q\psi h_t^{\mu-\eta} - \varphi) - h_t^{1+\mu-\eta}(\mu-\eta)(q\psi h_t^{\mu-\eta-1})}{(q\psi h_t^{\mu-\eta} - \varphi)^2} \right] \end{aligned} \tag{15}$$

The sign of the derivative will depend on the sign of the expression inside the square brackets.

$$N'(h_t) = \begin{cases} < 0 & \text{if } h_t <= \hat{h} \\ > 0 & \text{if } h_t > \hat{h} \end{cases} \tag{16}$$

Lemma 3: If $[(1+\mu-\eta)\theta]/(\theta+\beta) > 1$ then $\hat{h} > \tilde{h}$.

To prove that $\hat{h} > \tilde{h}$ is true, this implies

$$\hat{h} = \left[\frac{(1+\mu-\eta)\varphi}{\psi q}\right]^{\frac{1}{\mu-\eta}} > \tilde{h} = \left[\frac{(\theta+\beta)\varphi}{\theta\psi q}\right]^{\frac{1}{\mu-\eta}} \tag{17}$$

And this is only true if $[(1+\mu-\eta)\theta]/(\theta+\beta) > 1$, then $\hat{h} > \tilde{h}$. Therefore, as the stock of human capital grows, the fertility rate increases for $h_t < \tilde{h}$; it declines for $\tilde{h} < h_t < \hat{h}$; and it increases again for $h_t > \hat{h}$. Formally,

$$N'(h_t) = \begin{cases} > 0 & \text{if } h_t < \tilde{h} \\ < 0 & \text{if } \tilde{h} < h_t <= \hat{h} \\ > 0 & \text{if } h_t > \hat{h} \end{cases} \tag{18}$$

From equation (18), we can see that there exist three phases of development. In the first one, the fertility rate increases with h_t at relatively low levels of income; in the second one, it decreases at intermediate income levels. In the third one, it increases again at relatively high levels of income.

Finally, to analyze long-run equilibrium h^*, the author examines an economy that goes through all stages of possible demographic changes. He proposes a scenario where the steady-state equilibrium lies above the two thresholds identified previously.

Lemma 4: Assume that.

$$q\psi > max\left\{\left(\frac{\beta}{\theta}\right)^{(\mu-\eta)/(1-\eta)} \frac{(1+\mu-\eta)\varphi^{(1-\mu)/(1-\eta)}}{(\mu-\eta)^{(\mu-\eta)/(1-\eta)}}; \frac{(\theta+\beta)\varphi^{(1-\mu)/(1-\eta)}}{\theta}\right\} \tag{19}$$

holds. Then $h^* > \hat{h}$

3.2 The full dynamical system

The full dynamics of this model are characterized by a non-linear three dimensional system of difference equations.

$$h_{t+1} = F(h_t) = \begin{cases} \varphi h_t^{\eta} & \text{if } h_t <= \tilde{h} \\ \frac{\theta(\psi q h_t^{\mu} - \varphi h_t^{\eta})}{\beta} & \text{if } h_t > \tilde{h} \end{cases}$$
$$x_t = X(h_t) = \max\{0, \frac{1}{\beta}[\theta q - (\theta+\beta)\frac{\varphi}{\psi} h_t^{\eta-\mu}]\} \tag{20}$$
$$n_t = N(h_t) = \begin{cases} \frac{(1-\gamma)(\beta+\theta)}{\gamma+(1-\gamma)(\beta+\theta)} \frac{\omega h_t}{q} & \text{if } x_t = 0 \\ \frac{(1-\gamma)\beta}{\gamma+(1-\gamma)(\beta+\theta)} \frac{\omega \psi h_t^{1+\mu-\eta}}{q\psi h_t^{\mu-\eta} - \varphi} & \text{if } x_t > 0 \end{cases}$$

Figure 1 shows the dynamics of fertility, and it represents an N-shaped graph. The intuition behind this model is the following. At the first stage (where $h_t < \tilde{h}$), the return in education is so low that parents decide to spend the amount of income that they do not consume for child-rearing purposes. Therefore, as disposable income grows, families can afford to rear more children, as seen in Equation (10). However, as h_t increases, the threshold defined by $\tilde{h}$ will be exceeded, and the return to private education spending will be high enough to motivate households to invest in it. In fact, the return to education spending is so high in the second stage ($\tilde{h} < h_t <= \hat{h}$) so we can observe the quantity-quality trade-off, which means households reduce the number of children they rear in order to finance the desired amount of education expenditures per child. Finally, as the economy keeps growing eventually reaches the third stage ($\hat{h} < h_t$) where disposable income is sufficiently high, and the quantity-quality trade-off is no longer necessary. Hence, households have enough resources to raise more children and provide a desirable amount of education for each of them.

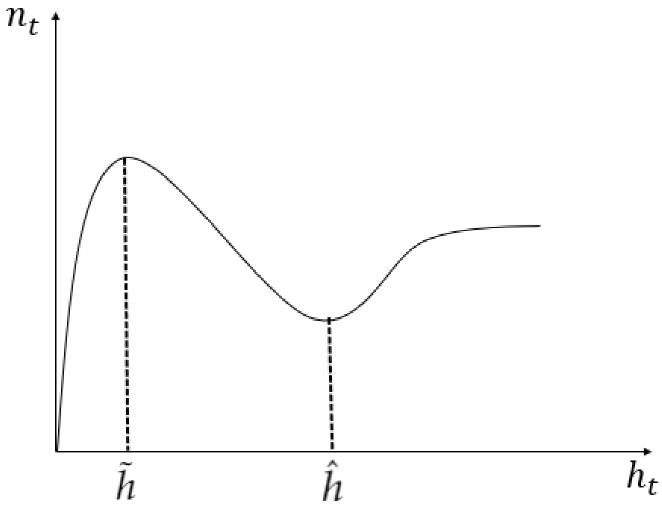


Figure 1: The dynamics of fertility.

4 Simulation

4.1 Benchmark Calibration

The calibration of this model requires setting the time-invariant parameters of a model that produces a dynamic evolution. More specifically, calibrating the model proposed in Section IV requires setting the values of nine parameters that characterize the utility function $\{\beta, \theta, \gamma\}$, the human capital function $\{\eta, \mu, \varphi, \psi\}$, wage $\{\omega\}$ and the cost of raising children $\{q\}$. Finally, the age at reproduction m and the initial condition for human capital h_0 needs to be specified.

For a given set of parameters and initial conditions, the evolution of all variables of interest is determined endogenously by the model for $m = [0, 1, \ldots, \infty)$, and it involves to the balanced growth path.

Parameters Set Exogenously.-

Length of a Generation: The length of a generation is set to $t = 20$ years. Across countries, the average age of women at first birth before the demographic transition is approximately 20 years (Boldrin and Jones (2002)).

Preferences: The parameter γ is set to 0.7 (Lagerlöf (2006) set this value to 0.775, De la Croix and Doepke (2009) to 0.6). The preference over number of children is set to $\beta = 0.2$, and preference over number of educated children, $\theta = 0.8$. This implies that the utility weight on the number of children born in each household is higher than the utility weight attached to human capital per child.

Human Capital: I assume diminishing return to h_t in equation 2. Thus, I set $\mu = 0.8$ and $\eta = 0.2$. The technology parameters are set as $\psi = 2.5$ and $\varphi = 0.1$

The parameter ω is normalized to one. This is neutral in the sense that after calibrating initial conditions, it plays no role.

Parameters Set by Solving the Model.-

The parameters for the threshold that determines whether agents invest or not in education $\tilde{h}$, and the value of $\hat{h}$ which turns from negative to positive the slope of the fertility function $N(h_t)$ are set by solving the model moments. Given the function (17), I set $\tilde{h} = 0.056$ and $\hat{h} = 0.076$.

I finally also need to determine the initial conditions for human capital in the production function, h_0. Given this initial parameter, the dynamic system (20) generates the endogenous evolution of all variables of interest along the development path for $t = [0, 1..., \infty]$. The initial value of h_0 affects the three main functions h_{t+1}, x_t, n_t. Setting $h_0 = 0.00001$, the simulation converges to the balanced growth path in 50 generations. The initial year of simulation is 1700.

4.2 Time Series Results

The dynamic evolution of the model economy is characterized by rapid development in the first 100 years, then a long period of slow development followed by a rapid transition to a sustained growth path.

Figure 1 restricts attention to the period 1750-2050 and shows the simulated data. Panel A shows the main conclusion from the theoretical model: the N shape relationship between fertility and human capital. For values of $h < 0.056$, stage 1, the slope of this relationship is positive and has a linear form, but for values $0.056 < h < 0.076$, stage 2, this relationship becomes negative. Finally, for values $0.076 < h$, stage 3, the relationship is positive again. It is worth noticing that the value h_t reaches the value $\tilde{h}$ in period $t = 1880$, and the value $\hat{h}$ in period $t = 2000$. Furthermore, as we will see later in the empiric analysis part, these breakpoints seem reasonable for advanced economies that have experienced the three fertility dynamics stages.

Panel B reports the evolution of the four endogenous variables. Gross fertility increases in the first 50 years after 1750 and starts declining after 1900, but from 2000 onwards appears what we have called the rebound on fertility. This process reflects the new stage of development in most advanced economies. Human Capital has a similar pattern but in no stage shows any decrease in values, but it reflects the dynamics of average school years in most advanced economies. After 1950 the rate of increase is higher compared to previous periods.

Looking at Gross fertility and Human capital for the period between 1950 and 2000, we can see that these variables move in opposite directions. Panel B also shows the levels of education expenditures per child and consumption. As the model established, the education expenditures are close to zero for periods before 1900, as for households, it is not worth it to invest in children's education. However, we can see that after 1900 the increase in human capital investment is pronounced. Consumption also covers three stages, first an increasing period in the first 50 years, and then stagnation for about 150 years, but from 2000 started to increase again.

5 Data

5.1 WFS - DHS

To measure fertility and parental human capital in low-income countries, I assemble data from WFS and DHS surveys for all childbearing age women (usually 15–49 years). Respondents provided full birth histories, detailing all of their children ever born, information on birth date, and survival status. The advantage of appending WFS and DHS is that I can analyze cohorts back into 1920, compare to studies as Vogl (2016) who only analyze from 1940 afterward and includes women older than 20 years. I construct 10-year cohort data for the countries. I only keep those countries with more than three cohorts information, leading to 23 countries [6].

From this data, I only focus on three groups, countries that belong to Africa, Asia, or Latin-America (See appendix for the list of countries of each region). However, I do not pretend that these groups are representative samples of each continent. Therefore, the analysis works at the group level, and I will refer, i.e., to the Africa group as a group of countries rather than the continent.

The Africa group has twelve countries; Asia has six and finally Latin America five. I select these countries because they have the most extended sample in WFS-DHS surveys. It allows me to analyze women born from 1920 to 1970 and evaluate these countries in different stages of development.

[6] See Figures 18, 19, 17 for detailed list of countries by group and Table 11.1 in appendix for detailed country-survey year.

5.2 USA & Europe - IPUMS

To measure fertility and parental human capital in developed countries, I assemble data from International IPUMS. For European countries, I include censuses from 1960 to 2010. For the US, I include samples from 1850 to 2000 and the American Community Survey (ACS) from 2001 to 2018 [7]. I also construct 10-year cohort data for the principal analysis.

Four sample restrictions are worthy of note in WFS-DHS and IPUMS data. First, I focus on women at least 45 years old and interpret the number of children as completed fertility. Second, throughout this paper, I restrict the data to "marital fertility", the completed fertility of those who indicate they are married. The main reason for this is that the main focus of this paper is on fertility decisions as a function of education, I do not want to mix single-parent household with two-parent households. Besides, only for married women, I can exploit information from husband education. Three, in USA Censuses from 1850-1930, there is no information about years of schooling or education attainment. Hence the only variable related to these measures is literacy. Finally, from IPUMS data, I only include persons who declare themselves as citizens.

6 Basic Trends in Fertility

For countries that I have information in DHS-WFS, a measure close to fertility decisions at the individual household level is the Number of Surviving Children(NSC). From IPUMS, women also responded to the question about how many children they had. Then, I will also use NSC as the primary analysis variable. For both datasets, The respondent's age is also available; this allows me to obtain mean fertility for women by birth cohort.

Figure 2 shows the number of children per women(CPW) over time for women born between 1920-1970. From this figure, there are different patterns across groups. The Africa group increased fertility from 4.5 CPW to 5.4 from 1920 to 1940, and then they seem to decrease the number of children to close to 5 in cohort 1960. The Asia group had the same increasing pattern for the first two cohorts, and after that, CPW decreased to close to 3.5 in 1970. For Latin American countries, the overall fertility decline was substantial, starting with about 5.2 CPW in 1920 to about 3.7 children born in the 1960 cohort. Moreover, surprisingly there is an increase in the last cohort to 4.1 children.

[7] See Table 11.1 in appendix for detailed country-census year.

Figure 15, 16, 17 show in more detail how fertility has changed within countries.

Figure 4 shows NSC for white women born between 1800 and 1970 in the USA. From this figure, three features stand out. First, there is a long-term reduction in overall fertility over the 200 years. The number of CPW was roughly 3.5 for cohorts between 1800 and 1820. Over the next 60 years, the decline was very steep after that: a decline of 1.5 children over the entire period. Second, the increase in fertility from 1910-1930 is because of the baby boom. Finally, From 1950 to 1970 cohorts, there was an increase of 0.6 more children per woman.

Figure 3 shows the number of CPW for women born between 1920 and 1970 for four countries in Europe. Portugal shows a decreasing pattern for the entire period. Fertility was 2 CPW in 1930 and declines in 1960 to roughly 1.4. For Austria, France, and Switzerland, we see a decreasing pattern, but the number of CPW has increased in the last cohort. France shows 1.2 CPW in the 1950 cohort and increases to 1.4 in the 1960 cohort. In Switzerland, this increase started earlier. From having 1.3 CPW in cohort 1940 to 1.4 in 1950.

7 Results

7.1 Fertility and Education

As the first step of the analysis, I look at trends in the cross-sectional relationship between fertility and parental education for each region. I do this by performing cross-sectional regressions on a cohort-region basis.

To capture this association's long-run evolution, I estimate regressions separately by region and 10-year birth cohort (1920–1930 to 1960–1970). For woman i born in country c and cohort t, the regression specification is:

$$CBR_{irt} = \beta_0 + \beta_{1t} * EdH_{irt} + \epsilon_{it} \tag{21}$$

Where CBR_{it} (Crude Birth Rate) is the number of children and EdH_{it} is the years of schooling of the husband.

Figure 1 plot the region-specific cross-sectional correlations for Africa, Asia, and Latin America region. Africa and Asia moved from having a relatively positive correlation to a negative one. In Africa, the highest positive correlation is in the cohort 1920-1930 with a coefficient of 0.157 and is statistically significant, but this coefficient decreases to 0.044 in cohort 1940-1950. Then the coefficient turns to negative values.

For cohort 1950-1960, the coefficient is -0.033 and statistically significant, but this coefficient keeps decreasing to -0.114 for the 1970-1980 cohort, the last cohort of analysis. In Asia, just the first two cohorts show a positive correlation. For cohort 1920-1930, the coefficient is 0.155 and is statistically significant but in the next cohort declines to 0.149. In the cohort 1940-1950, the coefficient is -0.044, but in the last cohort, the negative correlation increases in absolute values to -0.094; all coefficients are statistically significant.

For the Latin America region, the cross-sectional correlation remained consistently negative throughout the study period and became higher in absolute terms in the last cohort of analysis. For cohort 1920-1930, the negative correlation is equal to -0.105 and keeps decreasing until the cohort 1940-1950, where the coefficient is -0.160. In the cohort 1950-1960, the coefficient increases to -0.111. Finally, in the cohort 1970-1980, the coefficient is -0.194, which is the lowest one. Clearly, in the Latin American region, the relationship between fertility and human capital is not decreasing constantly across the analysis period, as do Africa and Asia.

Turning to the USA, I can decompose the analysis for withes and blacks. Figure 5 shows a big change in the fertility-parental education relationship from negative to positive values for withes. Table 11 shows the coefficients from these regressions. For women born in the cohort 1890-1900, the coefficient is -0.101, and it remains negative until 1910-1920, where the coefficient is equal to -0.018. During this period, the coefficients are statistically significant. From 1920 to 1950, the coefficients are statistically significant but close to zero. On average, the coefficient is close to 0.017. Nevertheless, in the cohort 1950 the coefficient is 0.055 and in the last cohort of analysis 1980, this coefficient increases to 0.059. Again, for this period, the coefficients are statistically significant.

Figure 11 shows a significant change in the coefficients from negative to positive values for blacks. Before the cohort 1950 the graph reveals a consistent negative pattern except for cohort 1900, where the coefficient is not significant. For women born in the cohort 1890-1900, the coefficient is -0.049 and it decreases for cohort 1930-1940 to -0.058. The first positive value for the coefficient appears in the cohort 1950-1960, which is 0.023 and increases for the last cohort to 0.032.

Figure 12 displays the evolution of the relationship between fertility and education for countries in the Europe region. From the cohort 1920-130, we can see a clear pattern where this relationship increases for the entire period of analysis for all countries. Given the availability of data in France, we can analyze the 1910-1920 cohort, where the coefficient is -0.008 but decreases to -0.019 in the next cohort. In the cohort 1920-1930, the coefficient is equal to -0.106 in Austria and is the lowest coefficient compared to the other countries in the same cohort. The highest coefficient is located in Switzerland's graph in the cohort 1950-1960 and is equal to 0.052. Portugal shows no significant changes related to the coefficient. For the cohort 1930-1940, the coefficient is -0.048, and the maximum value is in the last cohort, where the value is equal to 0.021.

From all the results presented above, I can determine the cohort where each region and countries change stages according to my fertility dynamics definition.

Developing countries.- The Africa group faced stage 1 between 1920-1950, and then it turned to the second stage from cohort 1950-160 and remained in this stage until now. The Asia group faced stage 1 between 1920-1940, and then it turned to the second stage from the cohort 1940-1950 and remained in this stage until now. Given the data available, we do not observe stage one for America, but we see that it is on stage 2 of fertility dynamics in the entire analysis period.

Advanced countries.- For the USA, we have different transition periods when we split the analysis between whites and blacks. We observe stage two of fertility dynamics for whites from cohorts 1880-1900 to 1910-1920 and stage three, from 1920-30 to 1970-1980. However, the relationship is nearly zero for the first two cohorts of the third stage. For blacks, stage two takes a longer period, from the cohort 1980-1900 to 1940-1950. Stage three is associated with the last three cohorts of analysis. In Europe, the country which enters earlier to the third stage is Switzerland in the cohort 1940-1950. Austria and Portugal were in stage two until cohort 1950-1560, where the coefficients became positive, and stage three begins. Finally, France enters the third stage in the cohort 1950-1960, although the coefficients starting from this period are close to zero.

7.2 Testing Demographic transition: Reher(2004) vs Ohinata and Varvarigos(2020)

Reher (2004) proposed a classification of 145 countries into four groups: The forerunners, countries where the onset of fertility decline began before 1935; the followers, countries where the onset began between 1950 and 1964; the Trailers, countries where the onset began between 1965 and 1979; and finally latecomers who experienced this transition after 1980.

The approach Reher (2004) used to designate the onset involves a certain degree of arbitrariness. In his paper, the onset is set at the beginning of the first quinquennium after a peak, where fertility declines at least 8% over two quinquennia and never increases again to levels approximating the original take-off point. Table A of this paper shows the year of the onset of fertility decline for each country.

Some authors have used this onset year as a relevant input for their studies. First, Galor (2012) created a variable called time elapsed since the demographic transition which is derived from Reher (2004). The author shows that contemporary income per capita and education are significantly associated with this time elapsed variable. Second, Cervellati and Sunde (2011) adopted three criteria to classify countries as post-transitional or pre-transitional, depending on whether it satisfies these by 1940 or not. The second (C2) establishes that demographic transition is identified if fertility or the crude birth rate has exhibited a sustained decline. This is also based on Reher (2004) classification. Third, Cervellati et al. (2019) provides evidence that the time since the onset of the demographic transition affects growth across countries and within countries. They conclude that growth accelerates after the onset of the demographic transition.

Although these authors' main results seem plausible, their estimates are based on an arbitrary classification of onset. However, for OV, onset means a change in the relationship between fertility and education—specifically, the cohort where this relationship changes from positive to negative. Therefore, this part of the study aims to compare both definitions empirically.

Reher did not explain the new rebound on fertility [8]. Therefore, to compare both approaches, I need to use the date of onset and only the first two stages of fertility dynamics according to OV. So, I include countries where we may observe these two stages: mostly middle and low-income countries classified as trailer and latecomer countries by Reher.

Reher's onset definition is in line with the fertility dynamics conclusions if two empirical facts arise. First, there is a positive relationship between fertility and education before the onset. Second, after the onset, a positive relationship should appear. Figure 13 and Figure 14 plot the relationship between fertility and education by country and also plot the year of the onset of dynamic transition according to Reher for latecomers and trailer countries. On the one hand, the latecomer countries' onset definition seems to fit the fertility dynamics theory well. Countries such as Kenya, Nigeria, and Uganda

[8] An interesting approach would be to determine the new onset of the demographic transition for developed countries in this new stage

show that both approaches meet. On the other hand, for trailer countries, given that data is not available before 1920 is not easy to test whether the onset set the change in the association's sign. Nevertheless, we can see that the association between fertility and education after the onset is negative for most countries. To test these approaches empirically, I again use data from WFS-DHS because most trailer and latecomer countries belong to the developing countries group. To capture the association between fertility and education pre-post onset, I estimate regressions separately by country. The equations to estimate are very similar to the one above, but the only change is the timing.

$$CBR_{ict} = \beta_{0ct} + \beta_{ct}^{pre-onset} * EdH_{ict} + \epsilon_{cit} \ , \ \forall \ t <= T^{onset} \tag{22}$$

$$CBR_{ict} = \beta_{0ct} + \beta_{ct}^{post-onset} * EdH_{ict} + \epsilon_{cit} \ , \ \forall \ t > T^{onset} \tag{23}$$

I only present regressions for pre and post-onset for nine latecomer countries and one trailer country because of data restrictions. Table 10.4 shows the results of the separate regressions in (22) and (23). For latecomer countries before the onset, we can see that most countries have positive coefficients before the onset except Cameroon, which has a negative coefficient. Senegal, Kenya, and Mali have the highest positive coefficients. The coefficients are 0.34, 0.34, and 0.17, respectively. After the onset, all the regressions of those countries show negative coefficients. Ghana and Namibia are the countries that have a larger coefficient in absolute terms.

For trailer countries, only Peru is the country with available data for pre and post-onset analysis. Though, both pre and post-onset analyses show negative coefficients. We can also see that all the other countries of this group have negative coefficients after onset, which may not contradict Reher classification. Nevertheless, we can not test when the transition from stage 1 to stage 2 happened.

From these results, we can conclude that in ten latecomer countries, the onset classification is associated with the change in the coefficient for the relationship between fertility and education. Although we can not test if the onset is in line with the change in the coefficient for trailer countries, we see that most of them show a negative relationship after the onset.

8 Conclusions

In this paper I have studied the relationship between fertility and human capital, and how this changes over different stages of fertility dynamics. Besides, I test two different approaches to determine the onset of fertility dynamics.

I presented the model of Ohinata and Varvarigos (2020), which includes a new third stage of fertility dynamics where the relationship between fertility and human capital is positive. In this new stage, households have enough resources to raise more children and provide a desirable amount of education for each of them. This model is calibrated to historical data of an advanced economy. I found that the cut-off points for stages two and three are 1880 and 2000, respectively, which seems reasonable according to the empirical evidence I presented for advanced economies.

From the empirical analysis, I document how the main variables' relationship changes from positive to negative in Africa and Asia groups. In the Latin-America group, this relationship remains negative during the analysis period. Therefore, we can conclude that these three regions are still in the second stage. Besides, for the USA, I found empirical evidence for stages two and three. The positive relationship starts for white women born in cohort 1950. For black women, this relationship is very close to zero but positive from cohort 1960. Finally, all European countries already exhibit a positive relationship for cohort 1960. Although, Switzerland is the country that started earlier this new stage by cohort 1940.

From relating the onset of fertility decline classification proposed by Reher (2004) with the first two stages of fertility dynamics according to OV, I conclude that in ten latecomer countries, the onset classification is associated with the change in the coefficient for the relationship between fertility and education. However, I can not test if the onset is in line with the coefficient change for trailer countries because of not data availability. Still, most of them show a negative relationship between these two variables after the onset.

The results of this paper suggest some directions for further research. First, the theoretical model is mainly determined by the initial condition of human capital. Including new parameters as technological change or by endogenizing the wage would help better understand the economic dynamics. Second, the model assumes all the agents are homogeneous; however, the increase in fertility could be addressed by highly educated groups [9]. Third, we have seen that the coefficients evolve differently in

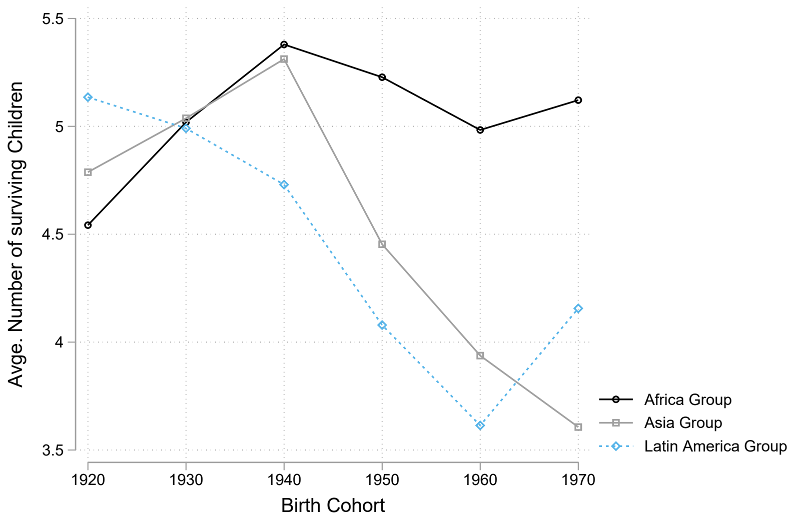
[9]Figures 23, 24, 25, 26 show coefficients of number of children regressed on husband's education

European countries and the USA. For instance, Switzerland started earlier in the third stage and has the highest positive coefficient among advanced economics. Therefore, explaining the main factor behind this difference appears to be a fruitful direction for future research.

9 Figures

9.1 Fertility Trends

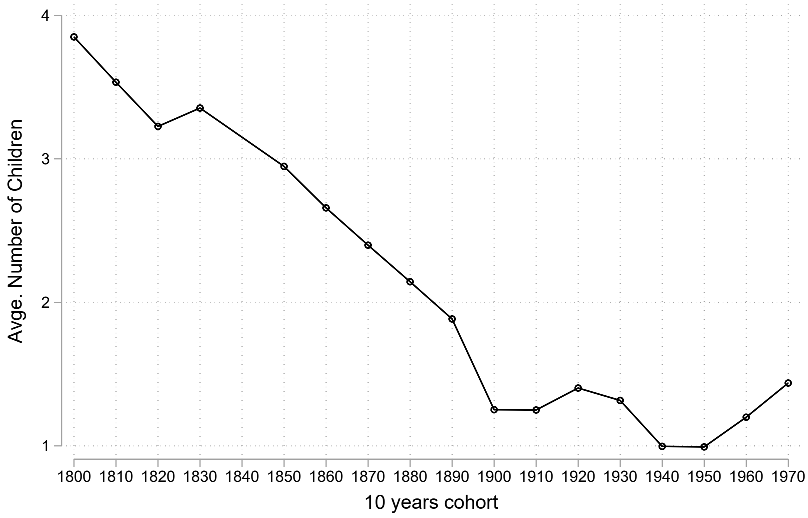
Figure 2: Developing World - Number of children by 10 year birth-cohort



Note: The main variable is the number of surviving children. Africa Group contains thirteen countries, Asia group has six and South America group, four (see appendix for list of countries). I select these countries because they have the longest sample in WFS-DHS and allow us to study the different stages fertility dynamics.I include in this sample women older than 45 years who are married.
Source : WFS-DHS Survey data, 1970-2012.

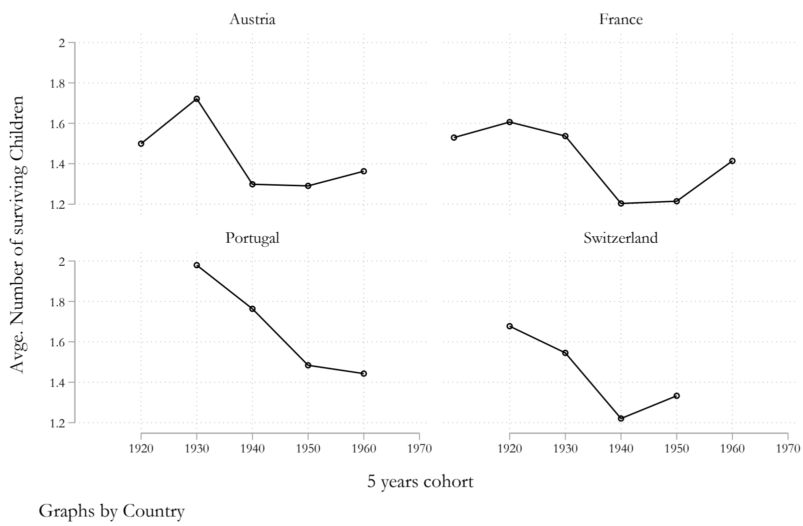
group, baseline group is high school dropout.

Figure 3: USA - Number of children by 10 year birth-cohort



Note: The main variable is the number of surviving children. I include in this sample women older than 45 years, married and who self-declare as citizens.
Source : IPUMS Census 1850-2000 & ACS 2001-2018

Figure 4: Europe - Number of children by 10 year birth-cohort.



Note: The main variable is the number of surviving children. I include in this sample women older than 45 years, married and who self-declare as citizens.
Source : IPUMS International Census. Austria : 1971, 1981, 1991, 2001, 2011. France: 1962, 1968, 1975, 1982, 1990, 1999, 2006, 2011. Portugal: 1981, 1991, 2001, 2011. Switzerland: 1970, 1980, 1990, 2000.

9.2 Simulation

Figure 5: Panel A - Gross Fertility and Human Capital

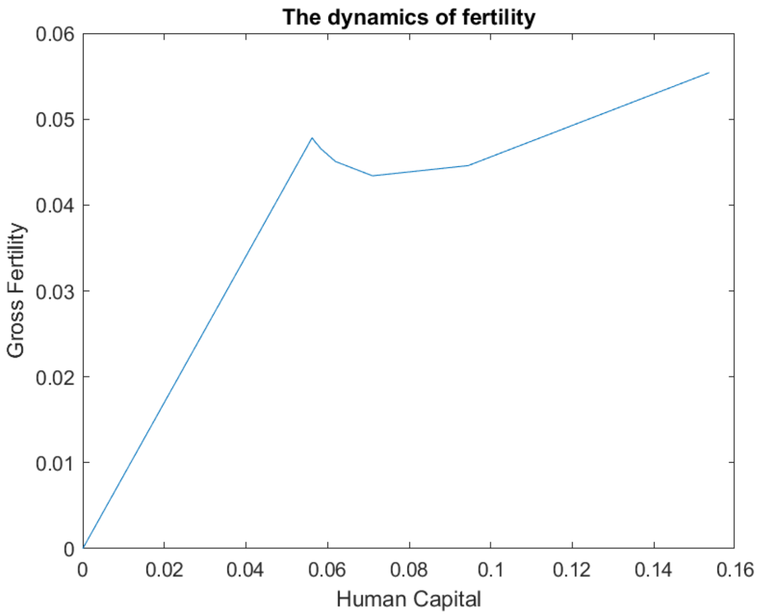
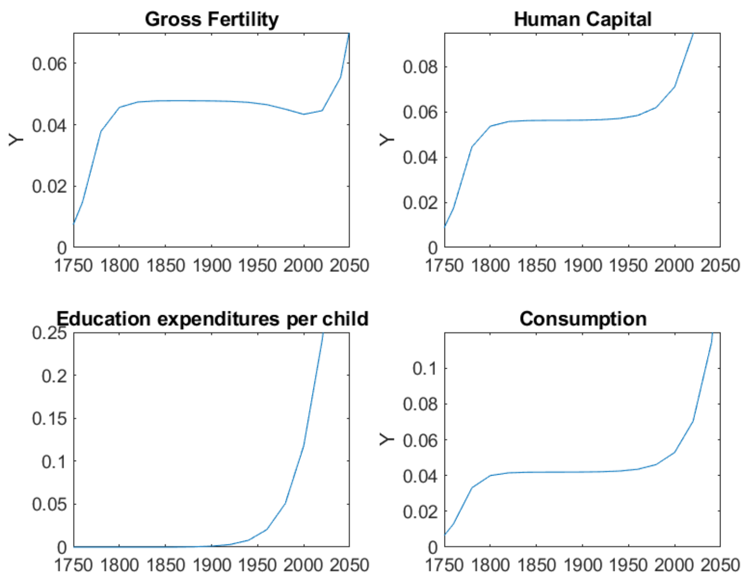
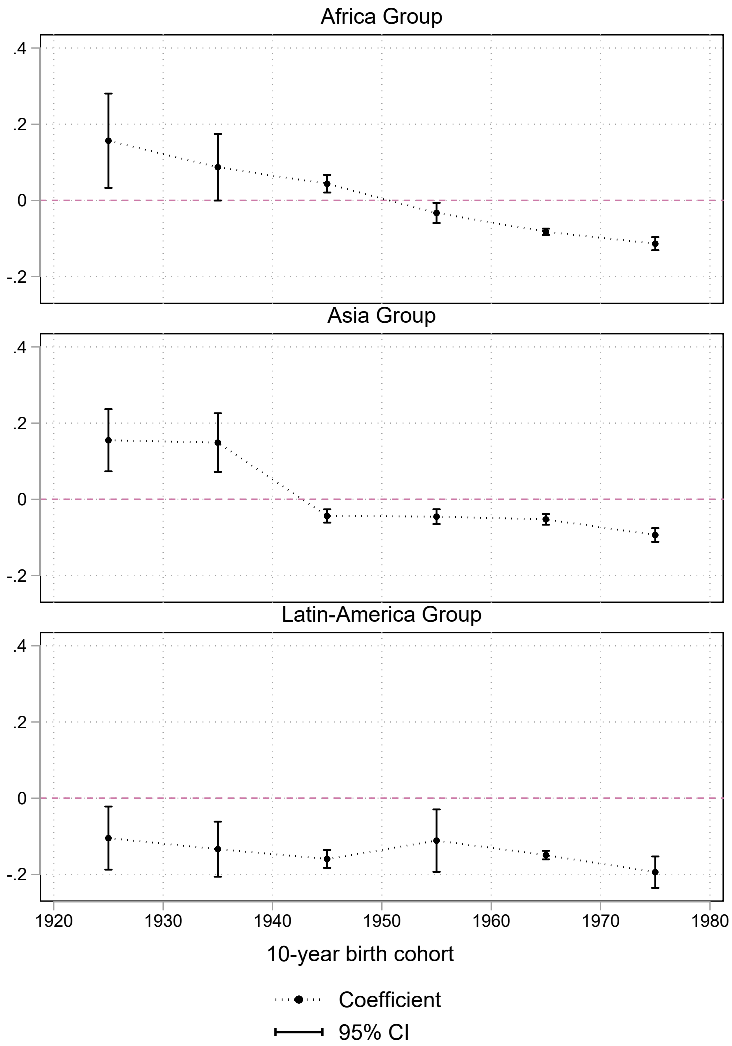


Figure 6: Panel B - Long-Run Development: Simulation of Benchmark Calibration of the Model.



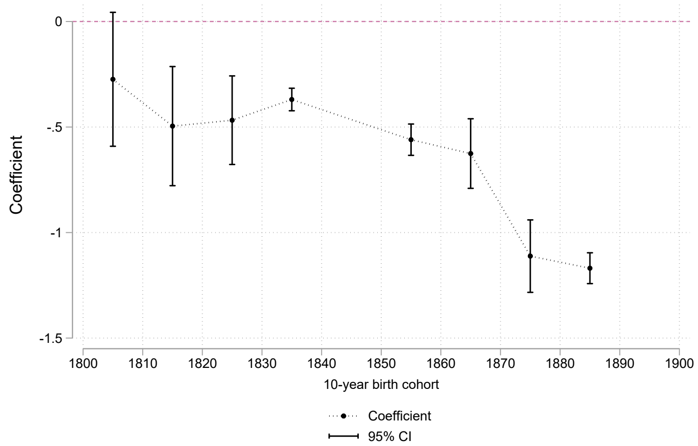
9.3 Cohort Regressions

Figure 7: Association of fertility with education by 10-year birth cohort.



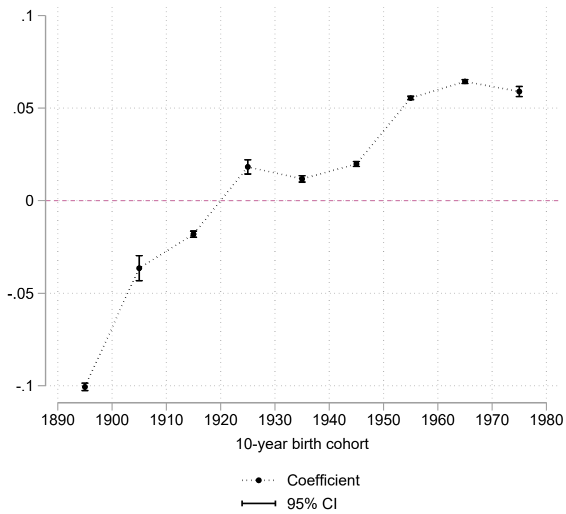
Notes: Each data point represents the coefficient of number of children regressed on the husband´s year of schooling. Coefficients are calculated separately by region and 10-year birth cohort from cross-sectional regressions.Africa Group contains thirteen countries, Asia group has six and South America group, four (see appendix for list of countries).
Source: WFS-DHS Survey, 1970-2012.

Figure 8: USA Whites - Association of fertility with Literacy by 10-year birth cohort.



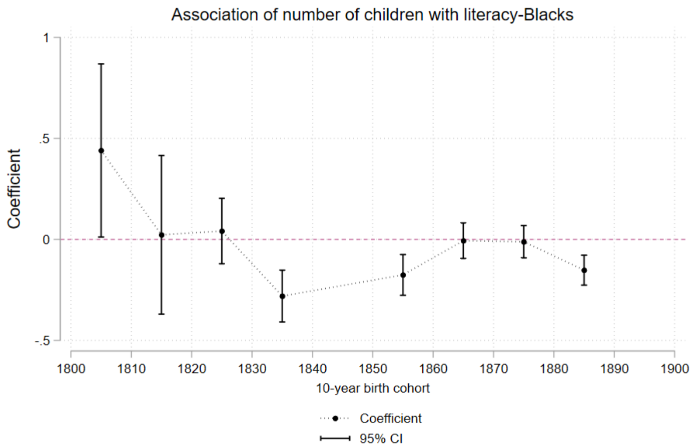
Notes: Each data point represents the coefficient of number of children regressed on husband´s literacy dummy. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. This sample only includes whites. Literacy variable indicates whether the respondent can read and write. Years of schooling is not available for these censuses.
Source: USA Census, 1840-1930

Figure 9: USA Whites - Association of fertility with education by 10-year birth cohort.



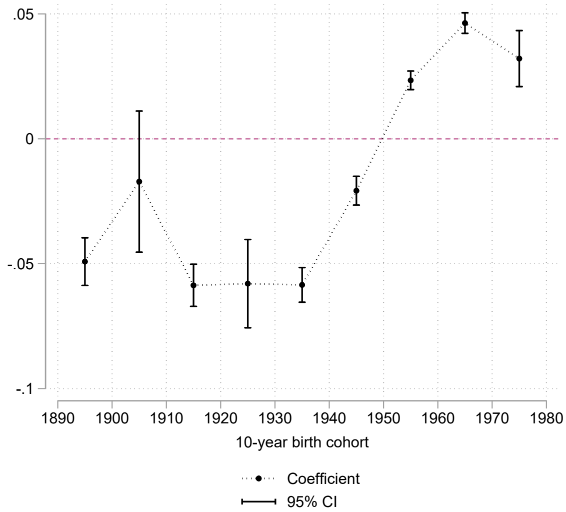
Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. This sample only includes whites. I include in this sample women older than 45 years, married and who self-declare as citizens.
Source: USA Census 1940-2000; ACS 2001-2018

Figure 10: USA Blacks - Association of fertility with Literacy by 10-year birth cohort.



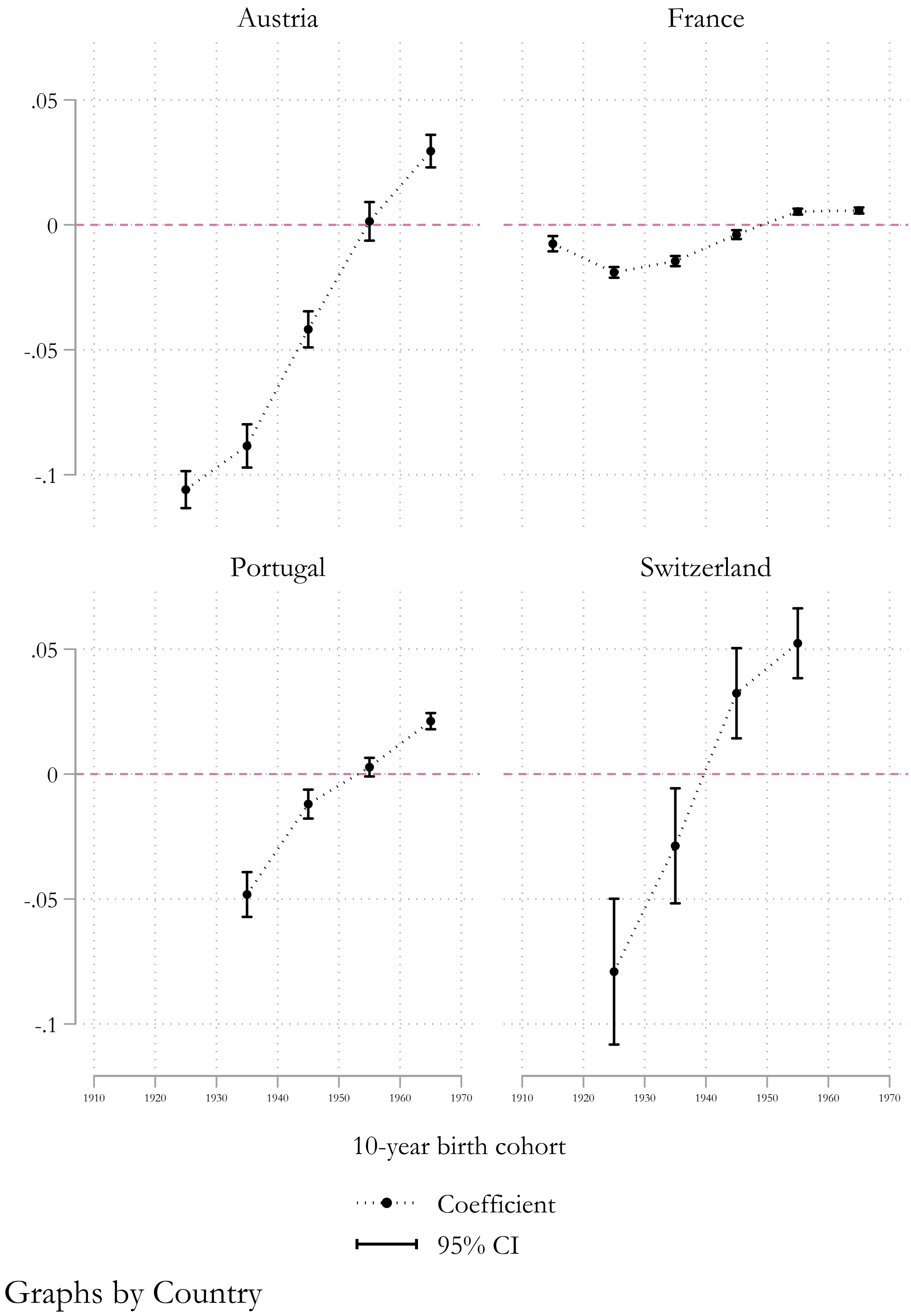
Notes: Each data point represents the coefficient of number of children regressed on husband´s literacy dummy. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. This sample only includes blacks. Literacy variable indicates whether the respondent can read and write. Years of schooling is not available for these censuses.
Source: USA Census, 1840-1930

Figure 11: USA Blacks - Association of fertility with education by 10-year birth cohort.



Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. This sample only includes blacks. I include in this sample women older than 45 years, married and who self-declare as citizens.
Source: USA Census 1940-2000; ACS 2001-2018

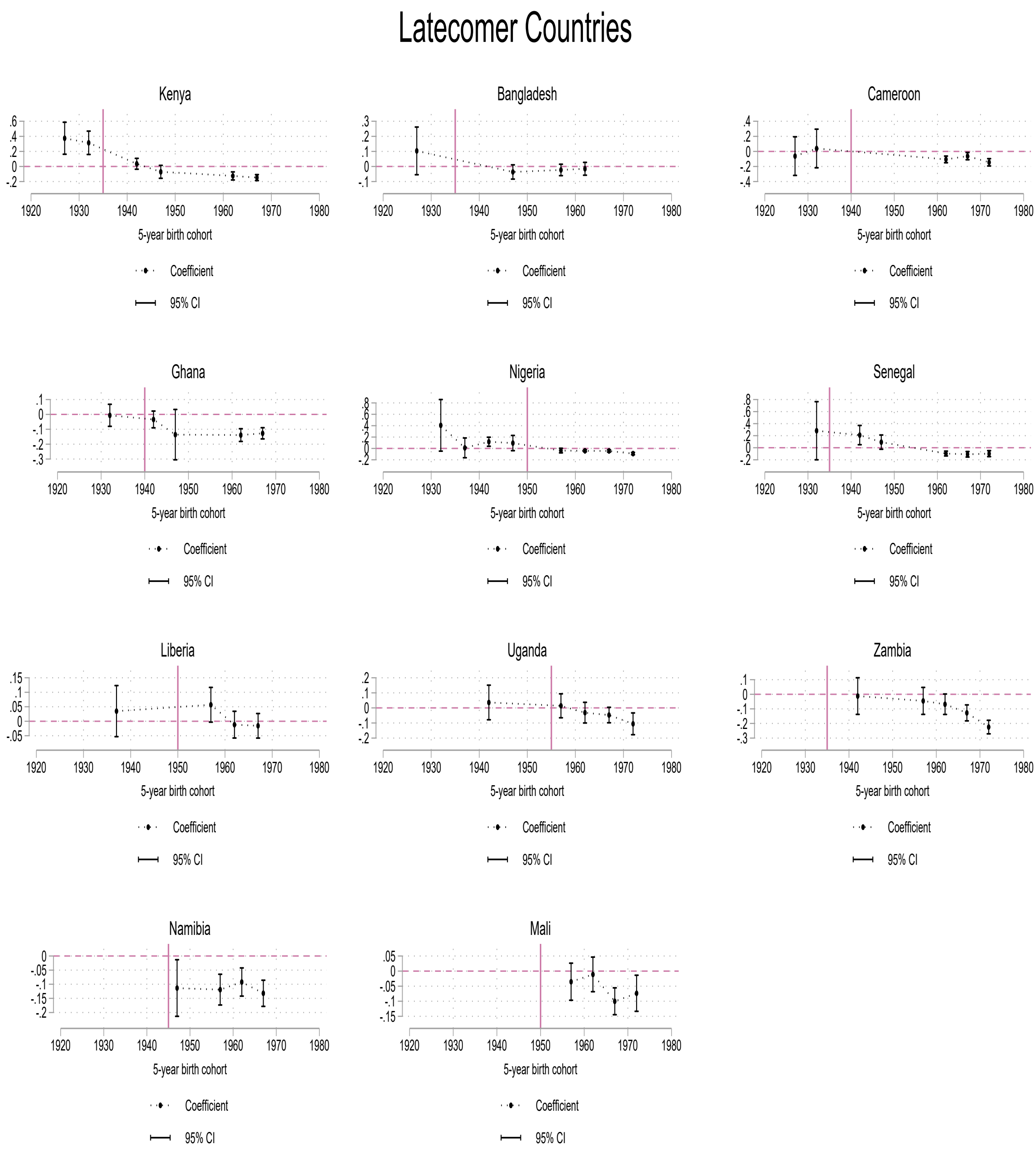
Figure 12: Europe - Association of fertility with education by 10-year birth cohort.



Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. I include in this sample women older than 45 years, married and who self-declare as citizens. **Source:** IPUMS International Census. Austria : 1971, 1981, 1991, 2001, 2011. France: 1962, 1968, 1975, 1982, 1990, 1999, 2006, 2011. Portugal: 1981, 1991, 2001, 2011. Switzerland: 1970, 1980, 1990, 2000.

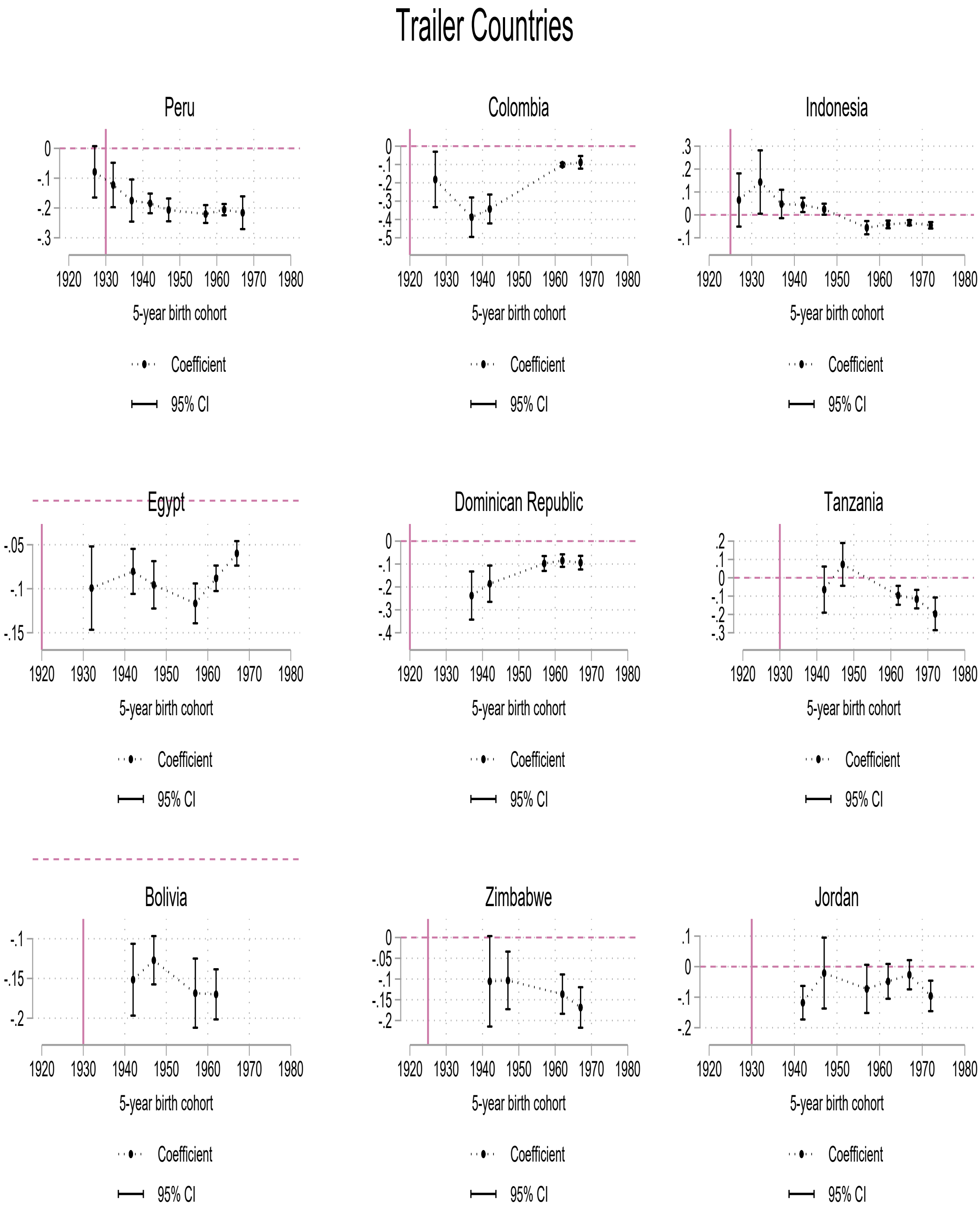
9.4 Testing Demographic Change Onset

Figure 13: Latecomer Countries and Onset of fertility transition.



Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling for latecomer countries. Coefficients are calculated separately by 5-year birth cohort from cross-sectional regressions. These samples includes women older than 45 years, married and who self-declare as citizens. Red line is $T_c = Onset_c - 45$, where Onset demographic transition for each country is according to Reher(2004). **Source:** WFS-DHS Survey, 1970-2012

Figure 14: Trailer Countries and Onset of fertility transition.



Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling for Trailer countries. Coefficients are calculated separately by 5-year birth cohort from cross-sectional regressions. These samples includes women older than 45 years, married and who self-declare as citizens. Red line is $T_c = Onset_c - 45$, where Onset demographic transition for each country is according to Reher(2004).

Source: WFS-DHS Survey, 1970-2012

10 Tables

Table 10.1: Relationship between CEB and Husband's Education by cohorts

	1920–1930	1930–1940	1940–1950	1950–1960	1960–1970	1970–1980
Panel A. ***Africa Group***						
Husband's Education	0.157**	0.087*	0.044***	-0.033**	-0.082***	-0.114***
	(0.063)	(0.045)	(0.012)	(0.013)	(0.004)	(0.009)
N	560	3,878	5,962	2,834	22,757	5,357
Panel B. ***Asia Group***						
Husband's Education	0.155***	0.149***	-0.044***	-0.046***	-0.053***	-0.094***
	(0.042)	(0.039)	(0.009)	(0.010)	(0.007)	(0.009)
N	1,662	1,941	18,403	9,932	32,268	9,992
Panel C. ***Latin America Group***						
Husband's Education	-0.105**	-0.134***	-0.160***	-0.111***	-0.149***	-0.194***
	(0.042)	(0.037)	(0.012)	(0.042)	(0.006)	(0.021)
N	820	1,474	4,022	2,784	12,760	427

Notes: Panel A: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for Africa Group. Panel B: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for Asia Group. Panel C: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for Latin America Group. Observations are drawn from the WFS-DHS Surveys 1970-2012. Fertility is defined as number of surviving children. Husband's education is defined as years of schooling. Africa Group contains twelve countries, Asia group has six and South America group five (see appendix for list of countries). Robust standard errors in parentheses are clustered on country, year, household and survey id.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 10.2: Relationship between CEB and Husband's Education by cohorts

	1890–1900	1900–1910	1910–1920	1920–1930	1930–1940	1940–1950	1950–1960	1960–1970	1970–1980
Panel A. ***USA-Whites***									
Husband's Education	-0.101***	-0.036***	-0.018***	0.018***	0.012***	0.020***	0.055***	0.064***	0.059***
	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
N	285,532	10,199	229,211	51,196	214,479	253,604	629,181	621,663	89,290
Panel B. ***USA-Blacks***									
Husband's Education	-0.049***	-0.017	-0.059***	-0.058***	-0.058***	-0.021***	0.023***	0.046***	0.032***
	(0.005)	(0.014)	(0.004)	(0.009)	(0.004)	(0.003)	(0.002)	(0.002)	(0.006)
N	22,615	914	18,384	4,017	18,201	16,880	43,575	43,916	5,988

Notes: Panel A: Each coefficient is calculated separately by 10-year birthcohort from cross-sectional regressions for whites. Panel B: Each coefficient is calculated separately by 10-year birthcohort from cross-sectional regressions for Blacks. Observations are drawn from the IPUMS USA 1940-2000 and ACS 2001-2018. Fertility is defined as number of surviving children. Husband's education is defined as years of schooling. Robust standard errors in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 10.3: Relationship between CEB and Husband's Education by cohorts

	1910–1920 (1)	1920–1930 (2)	1930–1940 (3)	1940–1950 (4)	1950–1960 (5)	1960–1970 (6)
Panel A. ***Austria***						
Husband's Education		-0.106***	-0.088***	-0.042***	0.001	0.030***
		(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
N		23,835	18,272	20,452	19,412	22,734
Panel B. ***France***						
Husband's Education	-0.008***	-0.019***	-0.015***	-0.004***	0.005***	0.006***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N	69,299	110,371	82,559	65,048	160,781	177,189
Panel C. ***Portugal***						
Husband's Education			-0.048***	-0.012***	0.003	0.021***
			(0.005)	(0.003)	(0.002)	(0.002)
N			15,035	14,534	16,572	15,363
Panel D. ***Switzerland***						
Husband's Education		-0.079***	-0.029**	0.032***	0.052***	
		(0.015)	(0.012)	(0.009)	(0.007)	
N		7,654	7,756	8,254	8,303	

Notes: Panel A: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for Austria. Panel B: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for France. Panel C: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for Portugal. Panel D: Each coefficient is calculated separately by 10-year birth cohort from cross-sectional regressions for Switzerland. Observations are drawn from International IPUMS 1950 - 2011. Fertility is defined as number of surviving children. Husband's education is defined as years of schooling. Robust standard errors in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 10.4: Relationship between CEB and Husband's Education by cohorts

Continent	Country	Onset	Group	Beta Pre	Beta Post
Asia	Burkina Faso	2000	Latecomer	0.06	-0.14
Asia	Ghana	1985	Latecomer	0.03	-0.11
Asia	Cameroon	1985	Latecomer	-0.03	-0.05
Asia	Senegal	1980	Latecomer	0.34	-0.03
Asia	Nigeria	1995	Latecomer	0.12	-0.05
Asia	Kenya	1980	Latecomer	0.34	-0.08
Asia	Mali	1995	Latecomer	0.18	-0.05
Latin America	Haiti	1985	Latecomer	-0.12	-0.17
Asia	Uganda	2000	Latecomer	0.11	-0.03
Africa	Bangladesh	1980	Latecomer	0.09	-0.04
Asia	Rwanda	1995	Latecomer	0.03	-0.05
Asia	Liberia	1995	Latecomer	0.05	0.00
Asia	Tanzania	1975	Trailer	.	-0.07
Latin America	Panama	1970	Trailer	.	-0.25
Latin America	Dominican Republic	1965	Trailer	.	-0.20
Asia	Egypt	1965	Trailer	.	-0.10
Latin America	Bolivia	1975	Trailer	.	-0.13
Asia	Zimbabwe	1970	Trailer	.	-0.21
Africa	Jordan	1975	Trailer	.	-0.16
Latin America	Mexico	1970	Trailer	.	-0.18
Africa	Malaysia	1965	Trailer	.	0.56
Latin America	Colombia	1965	Trailer	.	-0.21
Asia	Tunisia	1965	Trailer	.	0.16
Africa	Indonesia	1970	Trailer	.	-0.04
Latin America	Peru	1975	Trailer	-0.08	-0.21
Latin America	Ecuador	1970	Trailer	.	-0.15
Latin America	Costa Rica	1965	Trailer	.	-0.35

Notes: The onset column is the year of Onset demographic transition, according to Reher(2004). For each country, I create two samples, the first one appending all the surveys before $T = Onset - 45$, and the second one includes all surveys after T. "Beta-Pre" column displays the coefficient of fertility regressed on education for data appended before T. "Beta-Post" column displays the coefficient of fertility regressed on education for data appended after T. Observations are drawn from the WFS-DHS Surveys 1970-2012. Fertility is defined as the number of surviving children. Husband's education is defined as years of schooling. Missing coefficients is because of no data availability.

Table 10.5: Pretrial Release and new criminal activity

	(1)	(2)	(3)
Pretrial release	0.144***	0.158***	0.169***
	(0.005)	(0.006)	(0.005)
Observations	57052	56674	56389
Court FE	x	x	x
Controls		x	x
Offense Type FE			x

Notes: This table reports OLS results of the impact of pre-trial release. The dependent variable is an indicator of new criminal activity after being released pretrial and before their final disposition date. All specifications control for court fixed effects. Column 2 add defendant controls: defendant age, defendant race, defendant sex, and number of prior chargers. Column 3 includes type of offense Fixed effects. Robust standard errors two-way clustered at the individual and judge level are reported in parentheses

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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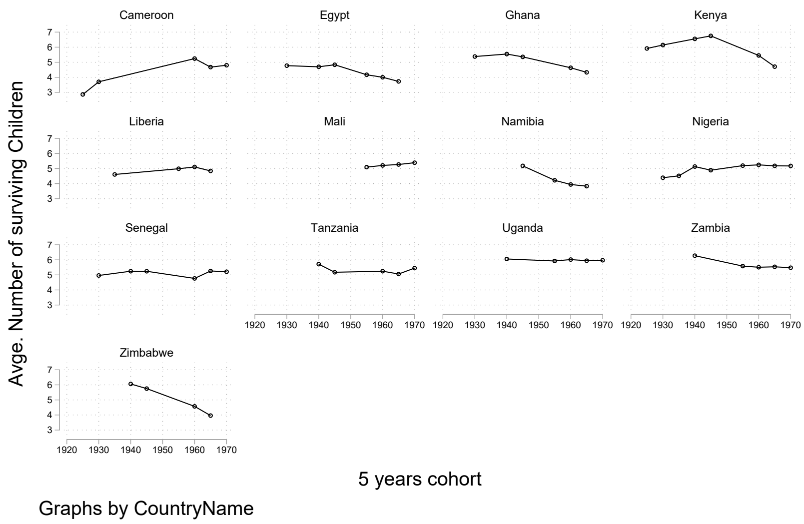
11 Appendix

Table 11.1: Countries and survey years

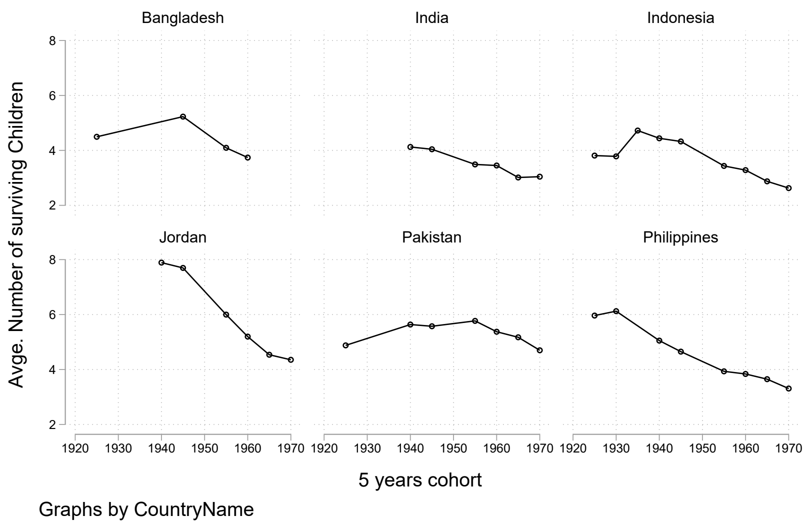
WFS-DHS	IPUMS
Bangladesh 1993, 1976, 1994, 1975, 2007; Bolivia 1989, 1993, 1994, 2008; Burkina Faso 1992, 1993, 2010; Burundi 1987, 2010, 2011, 2016, 2017; Cameroon 1978, 1991, 2011, 2018, 2019; Colombia 1976, 1986, 1990, 2009, 2010; Costa Rica 1976; Cote d' Ivoire 1980, 1981; Dominican Republic 1975, 1986, 1991, 2007, 2013; Ecuador 1979, 1980; Egypt 1980, 1988, 1989, 1992, 1993, 2008, 2014; Fiji 1974; Ghana 1979, 1980, 1988, 1993, 1994, 2008, 2014; Haiti 1977, 1994, 1995, 2016, 2017; India 1992, 1993, 2005, 2006, 2015, 2016; Indonesia 1976, 1987, 1991, 1994, 2007, 2012, 2017; Jordan 1990, 2007, 2012, 2017, 2018; Kenya 1977, 1978, 1988, 1989, 1993, 2008, 2009, 2014; Korea 1974; Liberia 1986, 2006, 2007, 2013; Madagascar 1992, 2008, 2009; Malawi 1992, 2010, 2015, 2016; Malaysia 1974, 1975; Mali 1987, 2006, 2012, 2013, 2018; Mexico 1976, 1977; Namibia 1992, 2006, 2007, 2013; Nepal 1976; Niger 1992, 2006; Nigeria 1981, 1982, 1990, 2008, 2013, 2018; Pakistan 1975, 1990, 1991, 2006, 2007, 2012, 2013, 2017, 2018; Paraguay 1975, 1976; Peru 1992, 1996, 2000, 2003, 2004, 2005, 2006, 2007, 2008, 2010; Philipinas 1978, 1993, 2008, 2013, 2017; Rwanda 1992, 2010, 2011, 2014, 2015; Senegal 1978, 1986, 1992, 1993, 2010, 2011, 2017; Siria 1978; Sri Lanka 1975; Sudan 1978, 1979; Tanzania 1991, 1992, 2009, 2010, 2015, 2016; Tunisia 1978; Uganda 1988, 1989, 2006, 2011, 2016; Zambia 1992, 2007, 2013, 2014, 2018, 2019; Zimbawe 1988, 1989, 1994, 2010, 2011, 2015	USA 1850-2018 Austria 1971, 1981, 1991, 2001, 2011; France 1962, 1968, 1975, 1982, 1990, 1999, 2006, 2011; Portugal 1981, 1991, 2001, 2011; Switzerland 1970, 1980, 1990, 2000.

Figure 15: Africa group - Number of children by 5 year birth-cohort.



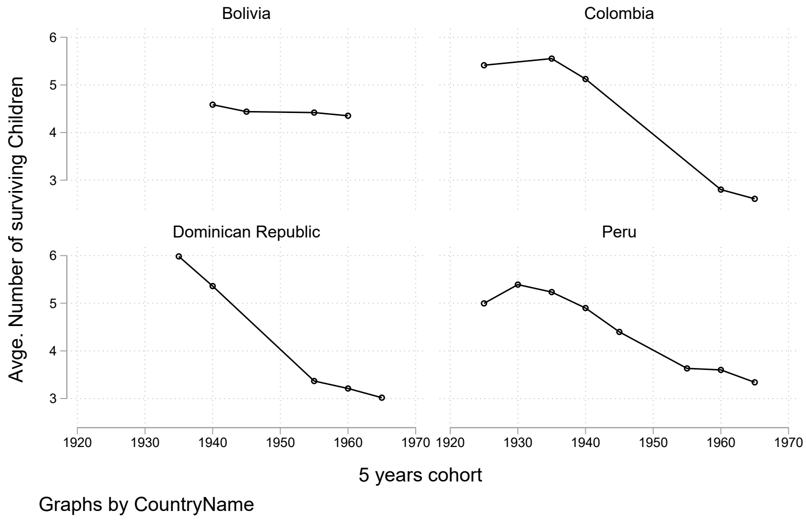
Notes: This graph displays means for countries in the Africa Group. The main variable is the number of surviving children.
Source: WFS-DHS Survey, 1970-2012

Figure 16: Asia group - Number of children by 5 year birth-cohort.



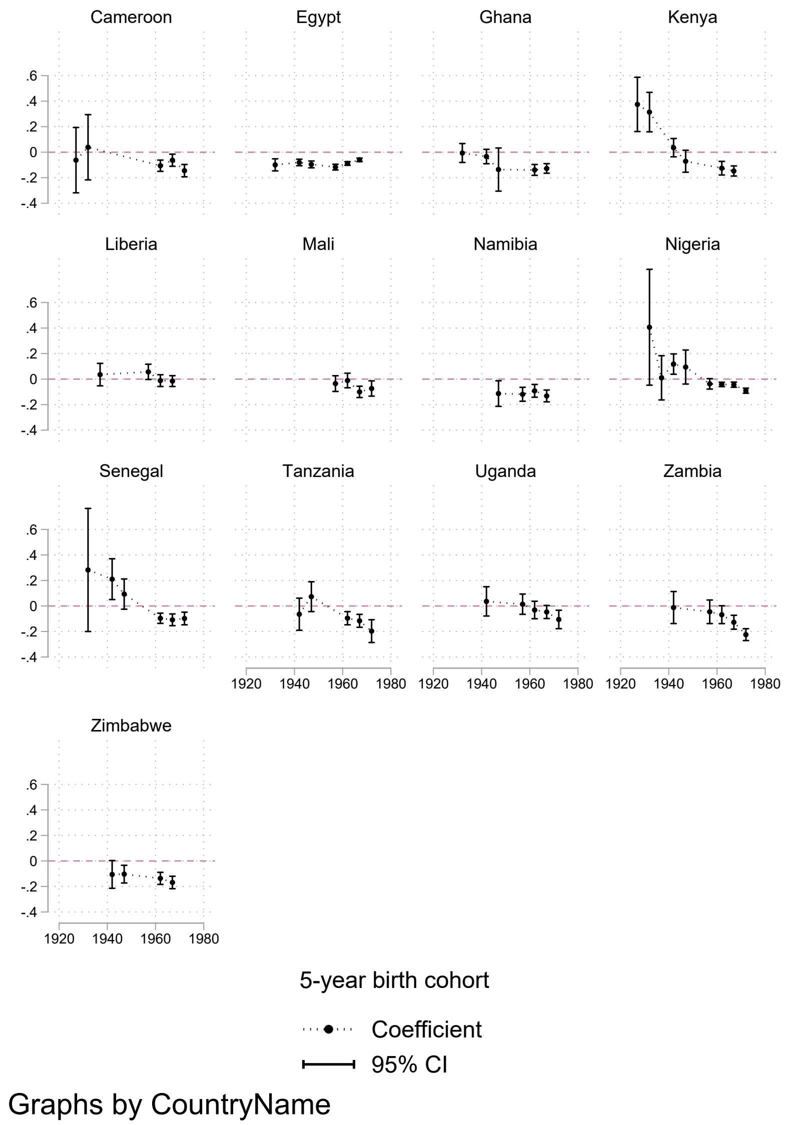
Notes: This graph displays means for countries in the Asia Group. The main variable is the number of surviving children.
Source: WFS-DHS Survey, 1970-2012

Figure 17: Latin America group - Number of children by 5 year birth-cohort.



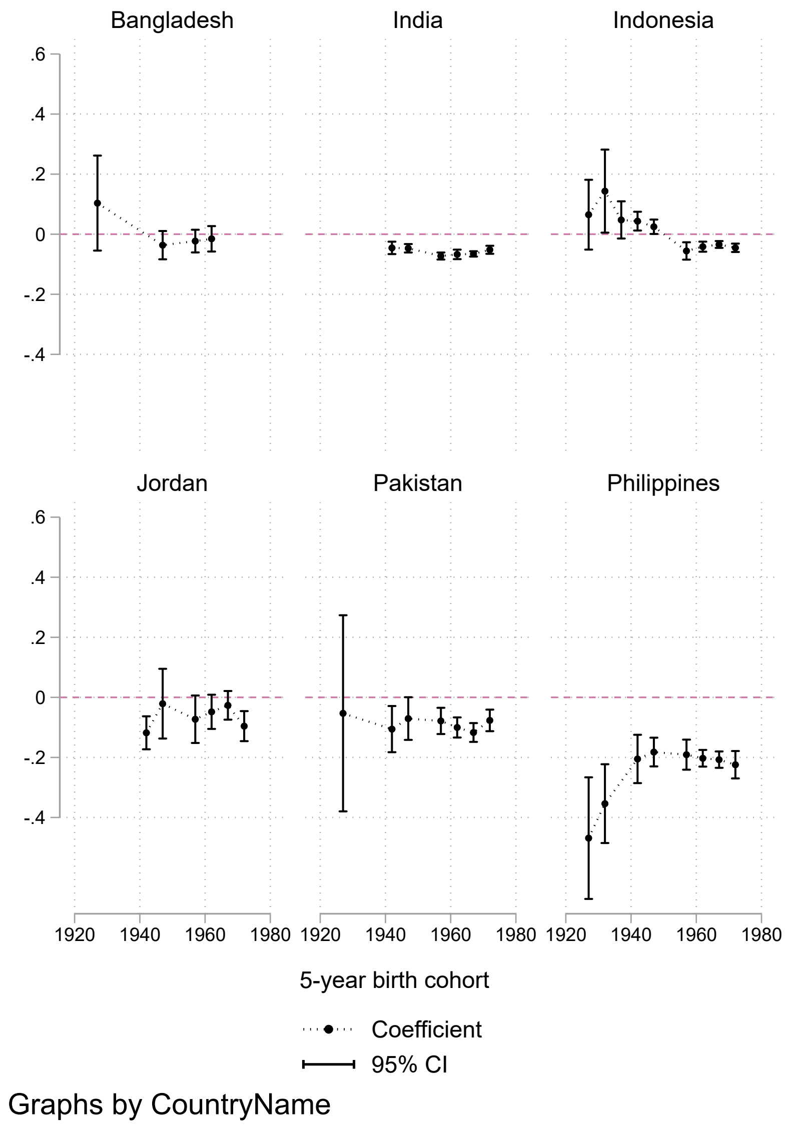
Notes: This graph displays means for countries in the Latin America Group. The main variable is the number of surviving children.
Source: WFS-DHS Survey, 1970-2012

Figure 18: Africa Group - Association of fertility with education by 5-year birth cohort.



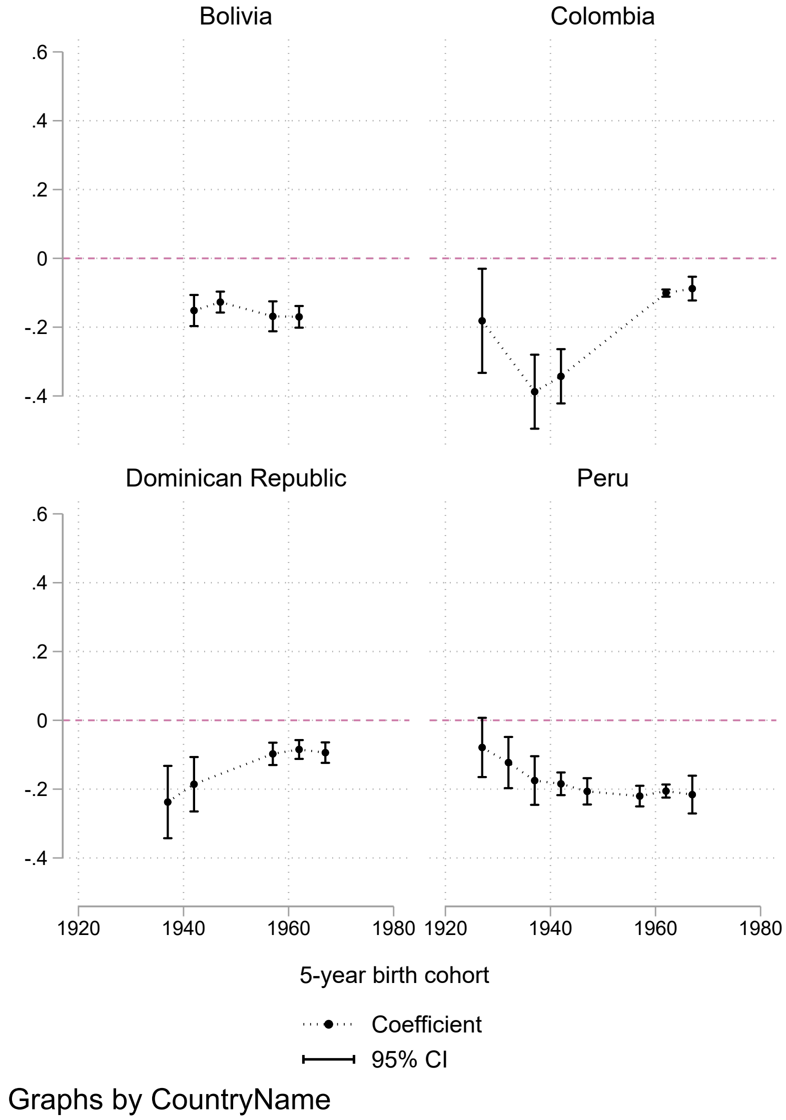
Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling for countries in the Africa Group. Coefficients are calculated separately by 5-year birth cohort from cross-sectional regressions. These samples includes women older than 45 years, married and who self-declare as citizens.
Source: WFS-DHS Survey, 1970-2012

Figure 19: Asia Group - Association of fertility with education by 5-year birth cohort.



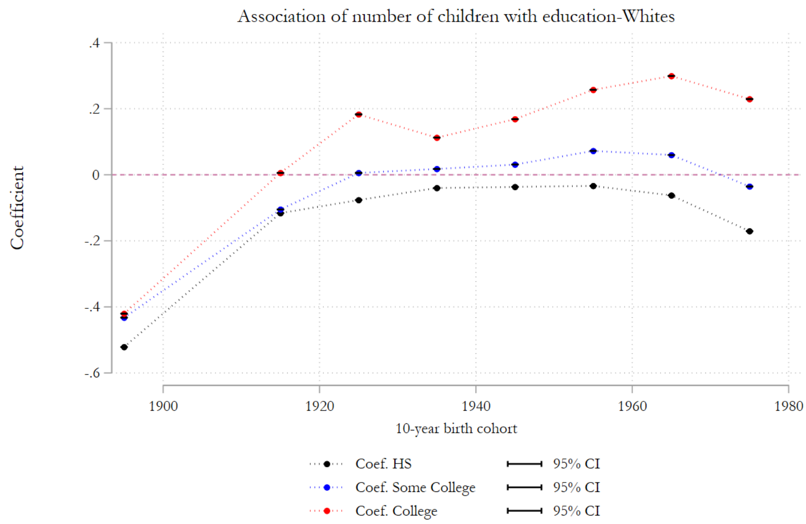
Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling for countries in the Asia Group. Coefficients are calculated separately by 5-year birth cohort from cross-sectional regressions. These samples includes women older than 45 years, married and who self-declare as citizens.
Source: WFS-DHS Survey, 1970-2012

Figure 20: Latin America Group - Association of fertility with education by 5-year birth cohort.



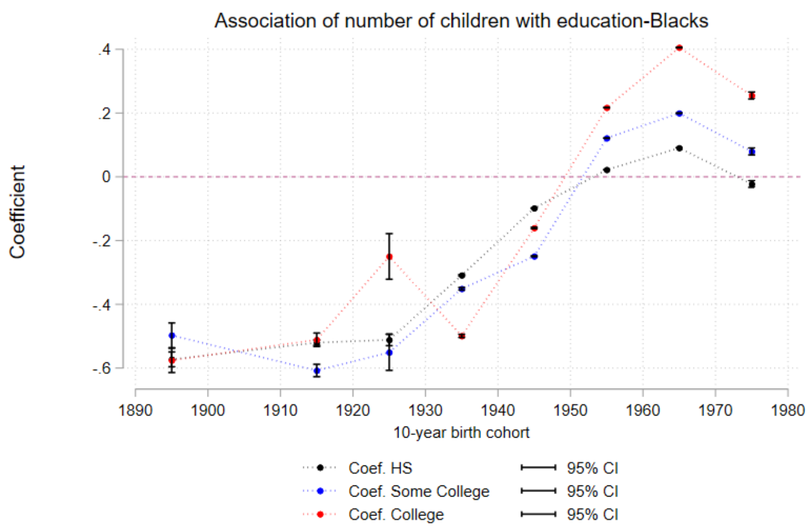
Notes: Each data point represents the coefficient of number of children regressed on husband´s years of schooling for countries in the Latin America Group. Coefficients are calculated separately by 5-year birth cohort from cross-sectional regressions. These samples includes women older than 45 years, married and who self-declare as citizens.
Source: WFS-DHS Survey, 1970-2012

Figure 21: USA Whites - Association of fertility with education group by 10-year birth cohort.



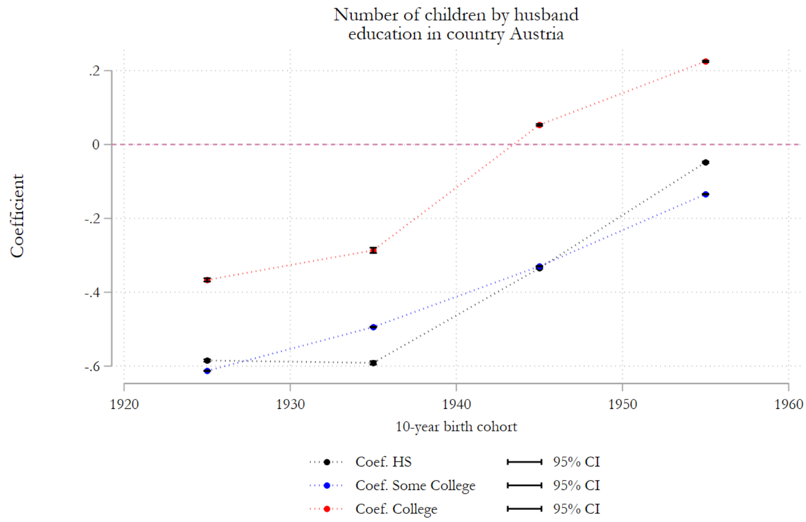
Notes: Each data point represents the coefficient of number of children regressed on husband´s education group, baseline group is high school dropout. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. This sample only includes whites.
Source: USA Census 1940-2000; ACS 2001-2018

Figure 22: USA Blacks - Association of fertility with education group by 10-year birth cohort.



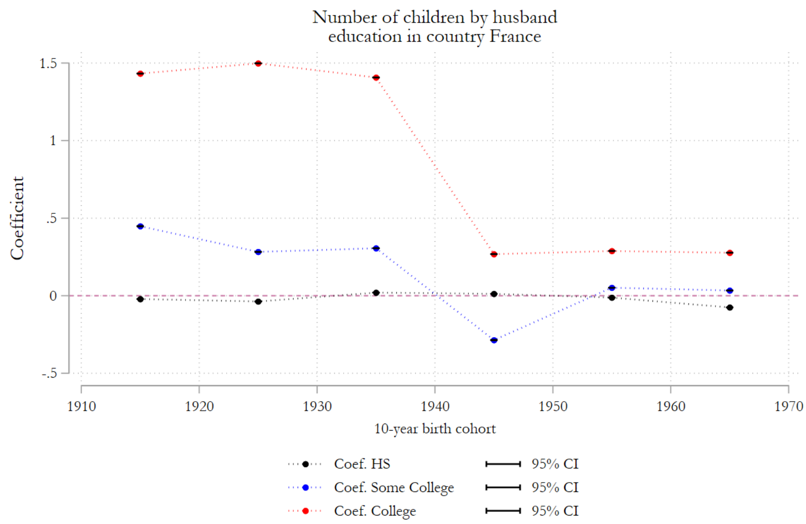
Notes: Each data point represents the coefficient of number of children regressed on husband´s education group, baseline group is high school dropout. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions. This sample only includes blacks.
Source: USA Census 1940-2000; ACS 2001-2018

Figure 23: Austria - Association of fertility with education group by 10-year birth cohort.



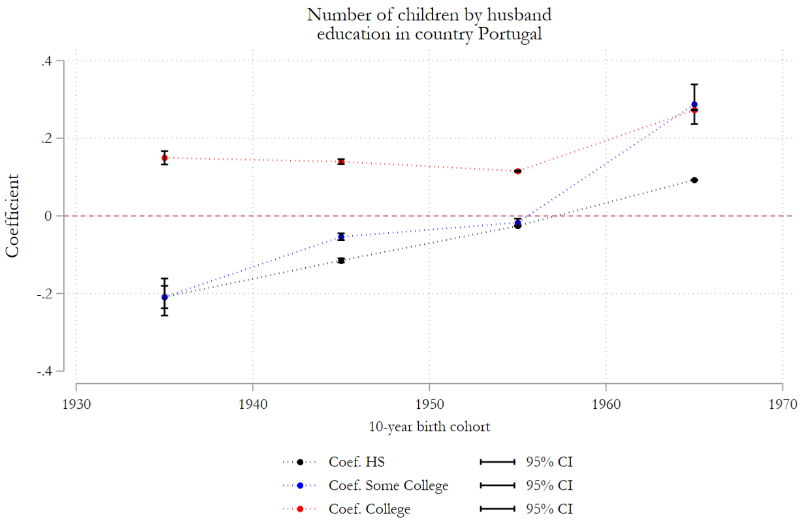
Notes: Each data point represents the coefficient of number of children regressed on husband´s education group, baseline group is high school dropout. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions.
Source: Austria Census 1971, 1981, 1991, 2001, 2011

Figure 24: France - Association of fertility with education group by 10-year birth cohort.



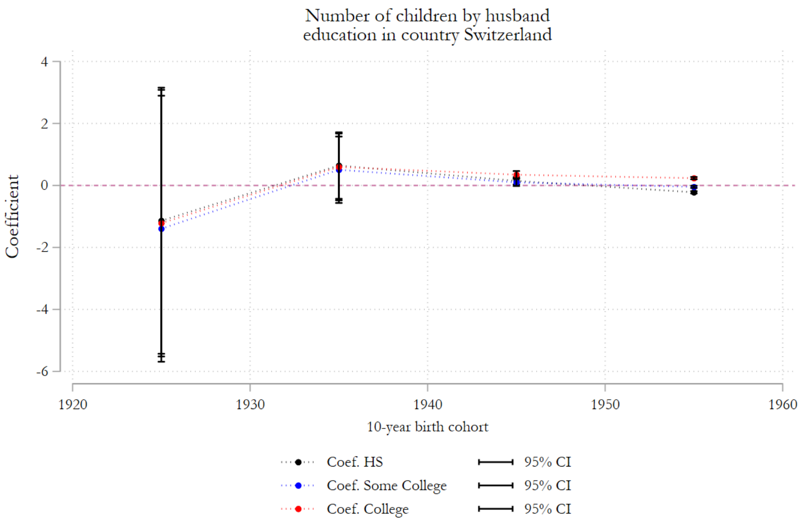
Notes: Each data point represents the coefficient of number of children regressed on husband´s education group, baseline group is high school dropout. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions.
Source: France Census 1962, 1968, 1975, 1982, 1990, 1999, 2006, 2011

Figure 25: Portugal - Association of fertility with education group by 10-year birth cohort.



Notes: Each data point represents the coefficient of number of children regressed on husband´s education group, baseline group is high school dropout. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions.
Source: Portugal Census 1981, 1991, 2001, 2011

Figure 26: Switzerland - Association of fertility with education group by 10-year birth cohort.



Notes: Each data point represents the coefficient of number of children regressed on husband´s education group, baseline group is high school dropout. Coefficients are calculated separately by 10-year birth cohort from cross-sectional regressions.
Source: Switzerland Census 1970, 1980, 1990, 2000

Table 11.2: Mean of Husband's, Wife's Education and Living Children by Cohorts and Continent

	1920–1930	1930–1940	1940–1950	1950–1960	1960–1970	1970–1980
Panel A. ***Africa Group***						
Husband's Education Mean	0.586	1.683	3.081	5.836	5.569	5.030
Wife's Education Mean	1.652	1.625	1.479	3.768	3.913	3.844
Living Children's Mean	4.536	5.075	5.413	5.249	5.086	5.485
N	560	3,878	5,962	2,834	22,757	5,357
Panel B. ***Asia Group***						
Husband's Education Mean	1.053	1.180	4.713	6.593	7.301	8.563
Wife's Education Mean	2.010	1.937	2.745	4.936	6.035	7.748
Living Children's Mean	4.791	5.032	5.375	4.502	4.153	3.890
N	1,662	1,941	18,403	9,932	32,268	9,992
Panel C. ***Latin America Group***						
Husband's Education Mean	2.364	2.817	5.070	7.271	8.023	4.883
Wife's Education Mean	3.223	3.102	3.861	6.518	6.874	3.609
Living Children's Mean	5.135	5.087	4.957	4.184	3.757	4.495
N	820	1,474	4,022	2,784	12,760	427

Notes: The main variables are the mean of the number of surviving children, years of schooling from both husband and wife. Panel A displays means for Africa Group. Panel B displays means for Asia Group. Panel C displays means for Latin America Group. I include in this sample women older than 45 years, married and and who self-declare as citizen. Source: U WFS-DHS Surveys 1970-2012

Table 11.3: Mean of Husband's, Wife's Education and Living Children in USA (1890-1980)

	1890-1910	1910-1920	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970	1970-1980
Panel A. ***White USA***								
Husband's Education Mean	8.281	9.860	11.094	11.858	13.462	14.116	14.207	14.518
Wife's Education Mean	8.501	10.197	11.131	11.762	13.162	13.903	14.195	14.705
Living Children's Mean	1.884	1.250	1.403	1.317	0.997	0.993	1.200	1.438
N	340,115	263,222	60,144	269,185	319,354	817,910	820,840	118,557
Panel B. ***Black USA***								
Husband's Education Mean	4.562	6.362	8.117	9.715	11.784	13.098	13.480	13.835
Wife's Education Mean	5.317	7.612	9.222	10.777	12.417	13.317	13.769	14.311
Living Children's Mean	1.793	1.458	1.776	1.839	1.326	0.978	1.120	1.296
N	33,038	26,054	6,143	32,083	31,502	84,752	85,013	11,432

Notes: The main variables are the mean of the number of surviving children, years of schooling from both husband and wife. Panel A displays means for Whites. Panel B displays means for Blacks. I include in this sample women older than 45 years, married and and who self-declare as citizen. Source: USA Census 1940-2000; ACS 2001-2018

Table 11.4: Mean of Husband's, Wife's Education and Living Children in Europe

	1910–1920	1920–1930	1930–1940	1940–1950	1950–1960	1960–1970
Panel A. ***Austria***						
Husband's Education Mean		11.710	11.977	12.901	13.365	12.822
Wife's Education Mean		10.270	10.501	11.855	12.406	12.204
Living Children's Mean		1.495	1.718	1.298	1.290	1.589
N		24,363	18,776	21,545	20,443	24,340
Panel B. ***France***						
Husband's Education Mean	6.195	6.950	7.415	10.647	11.494	11.921
Wife's Education Mean	5.450	6.108	6.465	9.803	10.910	11.544
Living Children's Mean	1.563	1.591	1.560	1.209	1.240	1.330
N	121,778	140,369	148,238	137,560	232,183	286,818
Panel C. ***Portugal***						
Husband's Education Mean			3.916	5.181	6.377	7.577
Wife's Education Mean			2.997	4.661	6.249	8.141
Living Children's Mean			1.969	1.761	1.484	1.443
N			15,621	14,634	16,963	15,788
Panel D. ***Switzerland***						
Husband's Education Mean		13.607	13.637	14.065	14.142	
Wife's Education Mean		12.881	12.949	13.379	13.518	
Living Children's Mean		1.676	1.545	1.221	1.333	
N		7,771	7,889	8,592	8,840	

Notes: The main variables are the mean of the number of surviving children, years of schooling from both husband and wife. I include in this sample women older than 45 years, married and and who self-declare as citizen. Source: IPUMS International Census. Austria : 1971, 1981, 1991, 2001, 2011. France: 1962,1968, 1975, 1982, 1990, 1999, 2006, 2011. Portugal: 1981, 1991, 2001, 2011. Switzerland: 1970,1980, 1990, 2000.

Hiermit versichere ich, dass ich die vorliegende Arbeit selbständig und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt, noch nicht einer anderen Prüfungsbehörde vorgelegt und noch nicht veröffentlicht habe.

München, den 1 Dezember 2020
(Datum)

(Unterschrift)