Human Development and Low Fertility

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Abstract[1]

The most developed countries led both the first and second demographic transitions. During these transitions, development indicators were inversely correlated with fertility levels. Results from data on 100 countries for the period 1975-2005 suggest that countries with highest development are again leading the transition by showing signs of fertility recovery from low and lowest-low levels to closer to replacement levels, and that among the most developed countries, the association between fertility and development has changed from negative to positive. The overall change is driven by changes in the fertility–education and fertility–health associations; the association between wealth and fertility has been positive over the whole observation period.

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1 Introduction

Fertility and mortality started declining in the western world in the 19th century, and by now almost all other countries are following suit. In the last quarter of the 20th century this first demographic transition was followed by a second transition, where the role of family started to change rapidly – cohabitation became more common, marriage rates declined, and out-of-wedlock childbearing rose. In conjunction with these changes, fertility rates fell below replacement levels.

The countries with highest development were the first to experience both the first and second transitions, and less developed countries lagged behind. For many countries with high development, fertility continued to decline during and after the second transition in the 1980s and 1990s. The inverse link between fertility and development raises the question whether continuing development – rising standard of living, improving education, and increasing longevity – always means declining fertility.

In this paper we study the association between development and fertility with a focus on the contemporary developed world. There is little new in studying the link between development and fertility from a historical perspective at a worldwide level, or in the contemporary world among developing countries (e.g. Bongaarts and Watkins 1996; Bryant 2007). This line of research has confirmed a strong negative association between development and fertility. Development levels, however, tend to be pushed even higher and higher, so we are always finding ourselves in an uncharted territory where the associations found at lower levels of development may not hold. The results of this study, obtained using annual data for 100 countries from 1975 to 2005, suggest that among the most developed countries the picture is indeed changing: the countries with highest level of development are again leading the transition by entering a new of regime where development and fertility are positively correlated.

2 Background

In most developed countries fertility is below replacement. In 2002 there were already 17 European countries with TFR below 1.3, and over half of the European population lived in countries with TFR below 1.5, and low fertility has been spreading fast to developing countries (Kohler et al. 2006). There is no evidence that once fertility starts to decline, it would converge to replacement levels. In fact, when fertility rates plummeted below replacement, there was little if any resistance at TFR=2.1.

Countries with very high development, measured by any conventional development index, were the first to experience below replacement fertility. In Europe, Denmark, Netherlands, and United Kingdom fell below replacement regime as early as the late 1960s or early 1970s. Most other developed countries followed suit, and now the lowest fertility levels among developed countries are in the Eastern Europe and Mediterranean countries (Kohler et al. 2006).

In both Eastern and Western Europe the fall of fertility has been accompanied by a progressive postponement of childbearing (Andersson and Neyer 2004). Therefore part of the low contemporary fertility may be attributable to postponement of fertility, which can depress period levels of fertility even if the average number of births per woman remains constant. This is known as a “tempo effect”, and it has been shown that adjusting for the tempo effect may have a significant effect on the estimated level (Bongaarts & Feeney 1998). However, in many countries, for example in the Scandinavian and Mediterranean countries, low fertility has persisted so long that there is not doubt about the fact that also the level of fertility is below replacement.

The historical fertility decline, which occurred during the first demographic transition, was associated with increasing levels of development. The first demographic transition first started in the Western World, and less developed countries lagged behind. Recent research has also established a strong inverse link between fertility and development in contemporary developing countries (Bryant 2007). The exact mechanisms through which development decreases fertility are not known, but potential candidates such as decreasing infant mortality rates, quality-quantity tradeoff of children, and governments' increasing role in providing care for the elderly all fall under the broad umbrella of socioeconomic theory of fertility decline.

The inverse link between development and fertility raises the question of what will happen to fertility in the long run. If the inverse link holds everywhere, the answer is obvious. However, prior research has shown that that the association between fertility and many societal variables has changed signs during the last 10-15 years. These include the correlations between fertility and female labor force participation (Ahn and Mira 2002; Brewster and Rindfuss 2000), mean age at first birth, mean age at first marriage, and total divorce rate (Prskawetz et al. 2006). Few studies, however, have considered the association between development and fertility in the developed world. Prior research has, however, shown that the desired fertility has remained close to 2 even in countries where the observed fertility has long been well below replacement. This suggests that there might be room for a turnaround in the association between development and fertility. And if development works as a proxy for the ability of people to reach the goals they set themselves, the turnaround should take place at high levels of development.

3 Data

We use data on total fertility rate TFR, *absolute* human development index aHDI, and components of aHDI. These data come from the World Bank World Development Indicators Online Database (World Bank 2008). The data is annual, covering the period 1975-2005 for 100 countries.

Both TFR and *standard* human development index HDI are readily available in the World Development Indicators Database. The period total fertility rate TFR, which is the sum of age-specific fertility rates in a given period, is well suited for the purposes of this paper: it is a simple, easy-to-interpret measure of the quantum of fertility, describing in a single figure the average number of children women would have if they lived through the reproductive years and experienced the prevailing fertility schedule.

Our development measure is absolute HDI (aHDI), a modified measure of the standard human development index HDI. We use the non-standard aHDI because the standard HDI is not consistently comparable over time. The standard HDI measures the average achievements in a country in three basic dimensions of human development: i) mortality conditions, as measured by life expectancy at birth, ii) knowledge, as measured by adult literacy rate (with two-thirds weight) and the combined primary, secondary, and tertiary gross enrolment ratio (with one-third weight), and iii) standard of living, as measured by gross domestic product (GDP) per capita at purchasing power parity (PPP) in USD. For each year these indicators are standardized between 0 and 1 with the formula $s(x) = [x - \min(x)]/[\max(x) - \min(x)]$, where $s(x)$ is the standardized value of component x and max(x) and min(x) are the maximum and minimum of component x in all countries in that year. HDI is then calculated as the arithmetic mean of the three standardized components.

Because of the definition of HDI, individual country's HDI level and HDI ranking depend both on the country itself and on the minimum and maximum values of all countries. Therefore country's development index and development ranking may change even if there are no changes in any of the HDI components. Moreover, an individual country's HDI may increase (decrease) even if all the components of HDI decrease (increase). To overcome this problem we calculate an absolute human development index aHDI. In the standard HDI, the scaling values (minimum and maximum of HDI components) change from year to year, but in aHDI they are fixed. We use the minimum and maximum values of year 2000 in the sample of 100 countries as the scaling values.

To calculate the absolute human development index aHDI, data on individual components of HDI are required. For many countries, however, data on all components are not available on an annual basis. The data is almost complete for TFR, life expectancy and GDP per capita at purchasing power parity. Unobserved GDP and TFR values were left as missing (no imputation was done) because these variables are subject to unpredictable fluctuation. Life expectancy, on the other hand, evolves relatively slowly, so we used linear interpolation to impute missing values. The same linear imputation was used for enrollment ratios and literacy rates. It is unlikely that the imputation has any large effect on the results, since both enrollment ratios and literacy rates evolve slowly in a cohort manner and are not subject to large period variation, unlike GDP per capita or TFR.

Originally, there were 226 countries or country groups in the World Development Indicators database. For some countries the total amount of missing data was so large that these countries could not be included in the analyses. Specifically, a country was not included in the analyses if missingness for any of the aHDI components was more than 30. This reduced the number of countries to 100.

To summarize, the data was subject to missingness. Some countries were discarded from the data because of large proportion of missing data. For those countries that were included in the analyses, linear interpolation was used to impute the data for some variables. The imputation method reduces variation and imposes structure on the data, so imputation may affect the results and conclusions. The data was, however, most complete for developed countries and for time period 1990-2005. The focus of this paper is in these observations. Therefore it is unlikely that imputation would have a large effect on the findings. The same reasoning applies also for potential bias arising from country selection: the focus of this study is in developed countries, and no developed countries were discarded because of large proportion of missing data.

Figure 1 shows the distribution of countries by fertility level and year. One can see that that the number of countries with TFR above 3 has been decreasing fast, and the number of countries with low fertility (TFR<2) has been steadily increasing. The number of countries with TFR below 1.5 started increasing since early 1990s. These trends are discussed by Bongaarts and Watkins (1996) for the developing world, and by Billari and Kohler (2004) for the developed world.

FIGURE 1 ABOUT HERE

Figure 2 shows the distribution of absolute human development index aHDI in the sample of 100 countries for years 1975, 1990 and 2004. The figure shows that during the 30 years this study covers, the distribution of development has shifted to the right, with mean of aHDI increasing from .478 in 1975 to .545 in 1990 and .603 in 2004, but the pace of development has not been equal for all countries. This can be seen from the emerging second mode in the distribution. Already in 1975 there are some signs of two modes, one close to sHD1=.40 and another close to aHDI=.70. In 2004 the second mode is evident at about aHDI=0.90.

FIGURE 2 ABOUT HERE

4 Results

4.1 Graphical and non-parametric analyses

Figure 3 shows absolute human development index aHDI and total fertility rate TFR for 1975 and 2005. The scale of aHDI has been stretched by using transformation aHDI → -log(1-aHDI). This transformation makes changes in the association between development and fertility more visible but does not change the ranking of observations and preserves all the patterns. A non-parametric smoothed spline has also been fitted to the graph for years 1975 and 2005 separately.

The Figure 3 shows that for every level of development observed in 1975, fertility was lower in 2005 than in 1975. Thus it is clear that development is not the only force affecting fertility. Second, in 1975, the statistical association between development and fertility was inverse and close to linear. Third, the association has changed dramatically during the period 1975 – 2005: in 1975, countries with highest development had lowest fertility, but in 2005, countries with highest development (aHDI>0.90) had higher fertility than countries with aHDI between 0.75 and 0.85.

FIGURE 3 ABOUT HERE

Figure 4 shows how the positive association between aHDI and TFR emerges. The figure shows that until about aHDI=0.80, fertility level is inversely and linearly associated with development (1975-1985). But when aHDI further increases, fertility does not systematically decrease, but first stays approximately on the same level and then starts to increase (1985-1995). Starting from year 1997, there is a clear positive relationship between aHDI above 0.80 and total fertility rate.

FIGURE 4 ABOUT HERE

Figures 3 and 4 showed the changing relationship between development and fertility from a cross-sectional perspective. Figure 5 shows the within-country time-path of aHDI-TFR for selected countries. The figure focuses on the developed countries that attain an aHDI of at least 0.85 at the end of the observation period. The figure then depicts the TFR in 1975 and 2005 *relative* to the lowest TFR that was observed while a country's aHDI was within the window that typically signals a "turning point" – 0.78—0.82. The (first) year in which this TFR is observed is denoted *reference year*. The figure then draws for all countries that attain an aHDI of at least 0.85 the line connecting the aHDI—TFR combinations for the three years 1975, reference year, and 2005. For four particularly interesting and relevant countries – the United States, Norway, the Netherlands and Japan – the graph shows not only the aHDI—TFR combination for 1975, the reference year and 2005, but the full path of the aHDI—TFR development during 1975—2005 (plotting the time path for all countries would have unnecessarily cluttered the graph).

FIGURE 5 ABOUT HERE

The motivation for comparing the 1975 and 2005 TFR values to the TFR of the reference year (the lowest TFR observed while a country's aHDI was within the window 0.78—0.82) is the hypothesis that at aHDI around .8 there is a "turning point" for the long-term trends in TFR. If this was true, the lines connecting the aHDI—TFR combinations for 1975, the reference year and 2005 should exhibit a "kink": both the 1975 and 2005 aHDI—TFR points for a specific countries should be above the aHDI-TFR point for the reference year, which for all countries is within the grey circle (by definition, aHDI for the reference year is within the 0.78—0.82 range, and the relative TFR equals 1). Country paths supporting the hypothesis should then begin in the top-left quadrant of Figure 5, pass through the grey circle, and end in the top right quadrant of the figure.

The most important insight of Figure 5 is that for the vast majority of countries, the lines connecting aHDI—TFR combinations for the three years 1975, the reference year and 2005 (or the full time paths in the case of the US, Norway, the Netherlands and Japan) do indeed exhibit a kink. In particular, the lines for 14 countries – the United States, Norway, the Netherlands, Austria (line #2 in Figure 5), Belgium (line #3), Denmark (line #5), Finland (line #6), France (line #7), Germany (line #8), Iceland (line #9), Ireland (line #10), Italy (line #11), Spain (line #12) and the United Kingdom (line #15) – all begin the top left quadrant as fertility was higher in 1975, and aHDI lower than in the reference year; and consistent with our hypothesis of a TFR reversal around an aHDI level of 0.80, the lines for these countries end in the top right quadrant as *both* the aHDI and the TFR were higher than in the reference year. Only the lines for five countries in Figure 5 – Japan, Australia (line #1), Canada (line #4), Sweden (line #13) and Switzerland (line #14) – however, do not confirm with the hypothesis of a TFR reversal around an aHDI level of 0.80: in these five countries, the final year of our observation period, 2005, is characterized by a higher aHDI as compared to the reference year, but a *lower* TFR.

4.2 Parametric statistical analyses

We use difference-in-differences models with time fixed effects and a spline restriction (e.g. Wooldridge 2002) to test whether the flip in the development – fertility association stays after adjusting for potentially confounding factors[1]. The model controls for country-specific time invariant factors and time-specific factors that do not vary across countries. The country-level fixed effects are taken into account by differencing, and time-fixed effects are explicitly incorporated in the model. The model equation is

$$(1) \qquad \Delta TFR_{it} = \Delta[(\beta_0^{pre} + \beta_1^{pre} aHDI_{it})B_{it}] + \Delta[(\beta_0^{post} + \beta_1^{post} aHDI_{it})B_{it}] + \Delta\gamma_t + \Delta\varepsilon_{it},,$$

where Δ is the difference operator, TFR_{it} and $aHDI_{it}$ are total fertility rate and absolute human development index for country *i*, time *t*, B_{it} is the breakpoint indicator for country *i*, time *t*, and γ_t is the time fixed effect. Note that because of differencing the country fixed effect vanishes, but the model still controls for these effects. The models are estimated using OLS.

We use three criteria to define the breakpoint in the aHDI – TFR association. The first criteria is based on aHDI, the second is based on changes in TFR, and the third one uses time as the criterion for change. The

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[1] We estimate the model in differences because preliminary analyses indicated that there is an unit root in the residual. We use spline restriction to guarantee that the pre- and post-break lines $\beta_0^{pre} + \beta_1^{pre} aHDI_{it}$ and $\beta_0^{post} + \beta_1^{post} aHDI_{it}$ match at the defined breakpoint level.

aHDI based breakpoint rule defines the breakpoint B so that B=1 for $aHDI \geq 0.80$, otherwise B=0.[1] The TFR based breakpoint rule defines the breakpoint so that B changes from 0 to 1 if TFR is below 3 and rises for three consecutive years.[2] The time base breakpoint rule finds a common year B for all countries such that mean squared error is minimized. Year 1990 turned out to provide best fit.

Table 1 shows parameter estimates for the coefficients of interest, β_1^{pre} and β_1^{post}. Negative values for β_1^{pre} and positive values for β_1^{post} would support the hypothesis that the statistical association between development and fertility has broken down and changed signs.

TABLE 1 ABOUT HERE

Table 1 indicates that there has indeed been a change in the aHDI-fertility association, and the results are in line with the graphical analyses. When the breakpoint is based on $aHDI \geq .80$, there is statistically strong evidence that the association between fertility and development has changed signs. The coefficient -1.62 for aHDI below 0.80 implies that an increase in development from, say, 0.70 to 0.75 is associated with $0.05 \cdot 1.63 = 0.08$ unit *decrease* in TFR, and the coefficient 4.62 for aHDI above 0.80 implies that a change in aHDI from 0.80 to 0.85 is associated with a $0.05 \cdot 4.62 = 0.23$ unit *increase* in TFR.

If the breakpoint is defined using changes in TFR, we observe the same statistically significant change in the sign of aHDI. However, the magnitude of the coefficients drops markedly compared to what was observed when breakpoint was defined using aHDI. This indicates that the aHDI based rule captures the moment of change better than TFR based rule. When the breakpoint is defined using only time, the estimate for β_1^{post} is not significantly positive. This indicates that changes in the aHDI-TFR association are more likely driven by development, not by time.

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[1] This threshold was chosen because it maximizes the fit of the model in terms of minimizing the mean squared error MSE. The results were not sensitive to small changes in the threshold.

[2] The results were robust to the TFR based breakpoint definition: none of the estimates of interest changed sign or lost significance if the rule i) was discarded and breakpoint was defined using 1, 2, 3, 4, or 5 years of consecutive TFR increase.

Overall, the estimates in Table 1 indicate that once countries reach a sufficiently high level of development, the association between development and fertility turns from negative to positive. Results were robust to the definition of breakpoint: the signs of coefficients stayed the same and significance was lost when breakpoint values 0.70, 0.71, 0.72, …, 0.89, 0.90 were used. Results were also robust to outlying countries. The three countries with highest aHDI in 2005 are Norway, the United States and Ireland, and they are partly responsible for the positive association in the smoothed spline regression in Figure 3. If these countries are excluded, the results in table 1 stayed practically the same.

To study the relative contributions of various aHDI components, we the effect of development on fertility by components of development. The breakpoint rule is aHDI>=0.80. The model is as follows:

$$\begin{aligned}(2)\quad TFR_{it} = {} & [\beta_0^{pre} + \beta_1^{pre} e_{it}^0 + \beta_2^{pre} Know_{it} + \beta_3^{pre} GDP_{it}]Br_{it} + \\ & [\beta_0^{post} + \beta_1^{post} e_{it}^0 + \beta_2^{post} Know_{it} + \beta_3^{post} GDP_{it}]Br_{it} + \alpha_i + \gamma_t + \varepsilon_{it},\end{aligned}$$

where e^0 is the standardized life expectancy, $Know$ is the standardized knowledge measure (combining enrollment and literacy rates), and GDP is standardized gross domestic product per capita at purchasing power parity. We estimated the model (2) first with AR(1) residuals, but the results indicated the presence of a unit root (the autocorrelation parameter was 0.98). Therefore we transformed the equation (2) into differences, and used OLS to estimate the model in differences. This does not change the interpretation of the parameters. Table 2 shows the parameter estimates for this model.

TABLE 2 ABOUT HERE

Results for model (2) indicate that wealth, as measured by GDP per capita at purchasing power parity, has been positively associated with fertility during the whole study period. The effect of wealth on fertility has, however, increased over time. In the association between fertility and health, as measured by life expectancy, and association between fertility and education, there have been changes both in the signs and in the magnitudes of the coefficients: the fertility-health association has changed from negative to positive, and the fertility-knowledge association has changed from strong negative to a weak, potentially positive association. These results seem plausible, especially in light of Beckerian theory where children are considered as goods and the demand of children should increase with income. Microeconomic theory says less about the relationship between fertility and education or fertility and health, but it seems reasonable to think that fertility preferences might depend on education level and/or health.

5 Discussion

In this paper we analyzed the fertility-development relationship at the highest levels of development to investigate whether the relationship changes when countries reach high enough levels of development. Previous studies, focusing on developing world, have established a strong link between fertility and development: the higher the development level, the lower the fertility. Studies on low fertility in developed countries have also shown that many variables that just a couple of decades ago were inversely associated with low fertility, such as female labor force participation (Ahn and Mira 2002) and divorce rates (Prskawetz 2006), are now positively associated with fertility. But studies on the association between development and fertility in developed world are rare or out of date, analyzing era when countries had not reached the levels of development where the fertility-development association starts to change.

Data on 100 countries from 1975 to 2005 suggest that the association between fertility and development is not constant across observed levels of development. Until 1980, observed aHDI levels ranged from .25 to 0.80, and with aHDI values within this range, fertility was linearly and negatively associated with aHDI. But as countries cross the aHDI threshold 0.80, the inverse association between development and fertility breaks down: once countries cross this threshold, fertility and development are no longer negatively correlated, and the association seems to change sign from negative to positive.

The finding that development and fertility are positively correlated among most developed countries was supported by visual graphical analyses and formal statistical analyses which employed both non-parametric regressions and parametric difference-in-differences fixed-effects regressions. Various breakpoint rules were used to define when the association changes from negative to positive and results were robust to the definition of breakpoint. The strongest results, however, were obtained when the breakpoint rule was based on absolute human development index crossing the threshold 0.80. This indicates that the aHDI based rule captures the moment of change better than TFR or calendar year based rules. The results were also robust to excluding outlier countries.

There are at least three different explanations for the fact that development and fertility are positively correlated among countries with highest development. First, the observed positive correlation may be an artifact caused by tempo effects: During the last two decades mean age at childbirth for most parities has increased markedly in developed countries. But it is unlikely that results as robust as ones obtained in this study would be driven only by tempo changes. However in future studies it would be important to take changes in timing into account.

Second, the observed positive association between fertility and development may be caused by rapid fertility declines in countries whose development level is close to most developed countries. For example in many eastern European countries fertility has recently plummeted below the levels observed in most developed countries. These countries could be responsible for turning cross country correlation from negative to positive by creating a fertility dip at moderate levels of development, but the within-country correlation could still be negative. However both graphical analyses and regression results suggest that there has been a change in the development – fertility association also within countries.

Third, development itself, or changes closely associated with development, such as institutional and value changes, may be either changing fertility preferences or making it easier for individuals to realize their fertility desires. If this is true, it would be important to study more the mechanisms through which these changes might happen.

To summarize, this study suggests that the statistical association between development and fertility turns from negative to positive once countries reach a sufficiently high level of development. The most developed countries led also the first and second demographic transitions, so it might not be very surprising that they are again leading the transition by entering a new of regime where development and fertility are positively correlated.

This study did not answer two important questions: First, which exactly is the mechanism through which development feeds fertility, and second, which dimensions of development contribute most to the positive association and/or timing of the change in the association. One potential explanation for the change in the development-fertility association might be the following. At high levels of development, the development indicators mirror societal changes which may make childbearing more feasible (e.g. by introducing institutions which make it easier to combine parenthood and career). This is important, since one of the many explanations for modern fertility decline is that women entering the labor market find it difficult to find time to raise children. Also, there is increasing pressure for men to participate in childrearing, and countries with highest development are the first to introduce policies which make it possible for men to combine career and involved parenthood. Countries with high development also have relatively high supply of child care services, and relatively inexpensive high school and college education. These factors effectively reduce the costs of having children and may thus be increasing fertility.

References

Andersson G; Neyer GR (2004) Contemporary research on European fertility: perspectives and developments. Max Planck Institute for Demographic Research, Rostock

Ahn N, Mira P (2002) A note on the changing relationship between fertility and female employment rates in developed countries, Journal of Population Economics, vol. 15, pp.667-682

Billari F, Kohler HP (2004) "Patterns of Low and Lowest-Low Fertility in Europe." Population Studies 58(2), 161-176

Bongaarts J, Feeney G (1998) On the Quantum and Tempo of Fertility. Population and Development Review 24:271–91.

Bongaarts J, Watkins SC (1996) Social interactions and contemporary fertility transitions. Population and Development Review 22:639–682

Brewster, K. and Rindfuss, R. (2000). Fertility and women's employment in industrialised nations. Annual Review of Sociology, pp. 271-296

Bryant J (2007) Theories of Fertility Decline and the Evidence from Development Indicators. Population and Development Review 33:101–127

Kohler HP, Billari F, Ortega JA (2006) Low Fertility in Europe: Causes, Implications and Policy Options. In F. R. Harris (Ed.), The Baby Bust: Who will do the Work? Who Will Pay the Taxes? Lanham, MD: Rowman & Littlefield Publishers, 48-109

Prskawetz A, Mamolo M, Engelhardt H (2006) Reconsidering the Relation between Fertility and Key Fertility-Related Demographic Behaviour across Space and Time. Vienna Institute of Demography Working Papers 09/2006

Wooldridge, JM (2002) Econometric Analysis of Cross Section and Panel Data. MIT press, Cambridge

World Bank (2007) http://devdata.worldbank.org/dataonline/old-default.htm (Date used 01/29/2008)

Tables

Table 1. Pre- and post-break estimates for aHDI from the fixed effects Model (1) by breakpoint rule.

Breakpoint rule based on	***Coefficient***	***Parameter estimate***	***P-value (two-tailed hypothesis)***
aHDI	β_1^{pre}	-1.62	<0.001
	β_1^{post}	+4.62	<0.001
TFR	β_1^{pre}	-0.34	<0.001
	β_1^{post}	+0.98	<0.001
Time	β_1^{pre}	-0.40	<0.001
	β_1^{post}	+0.11	0.118

Table 2. Pre- and post-break estimates for the components of aHDI from the fixed effects Model (2). Breakpoint rule: aHDI>=0.80.

	Coefficient	
Variable (index)	***aHDI<0.80***	***aHDI>0.80***
Life expectancy	-0.25 ($p = 0.04$)	+1.82 ($p < 0.01$)
Knowledge	-2.09 ($p < 0.01$)	+0.03 ($p = 0.96$)
GDP/Capita	+0.15 ($p = 0.29$)	+1.54 ($p < 0.01$)

Figures

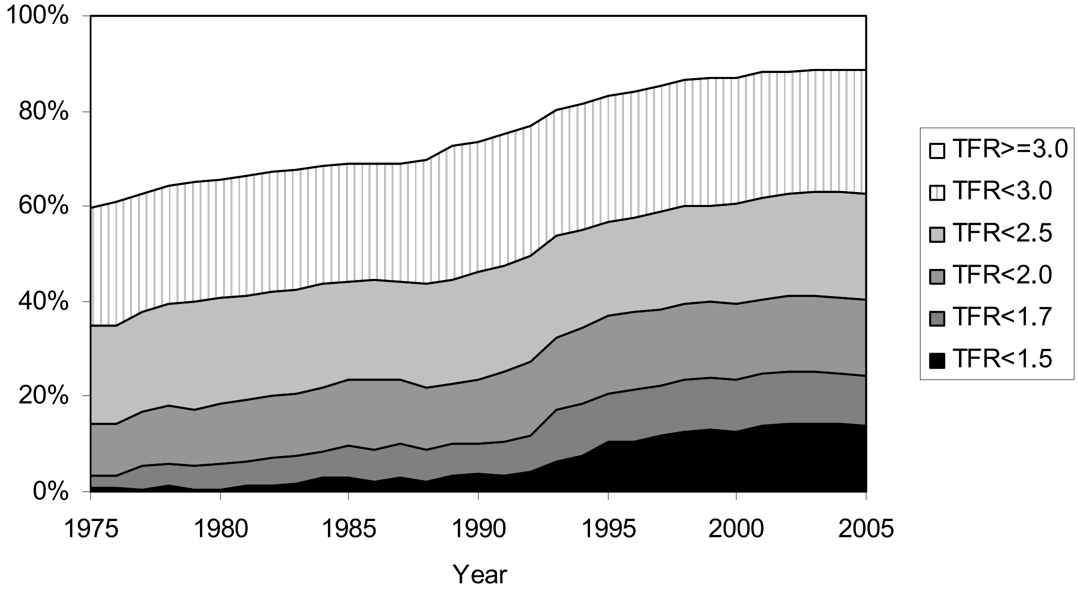

Figure 1. Proportion of countries with TFR in the specified range by year.

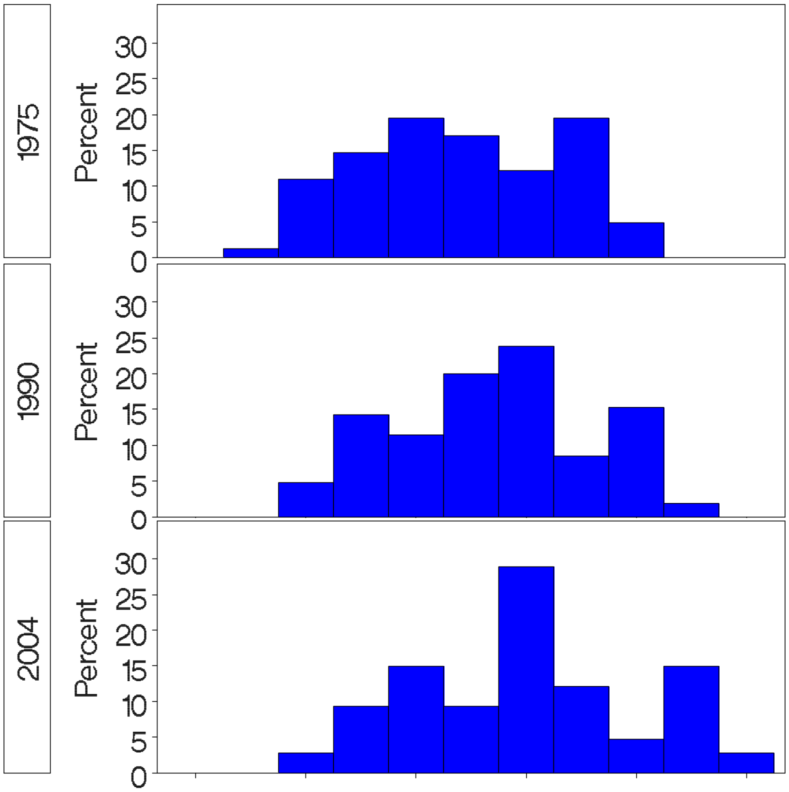

Figure 2. Distribution of absolute human development index aHDI in the sample of 100 countries for years 1975, 1990 and 2004.

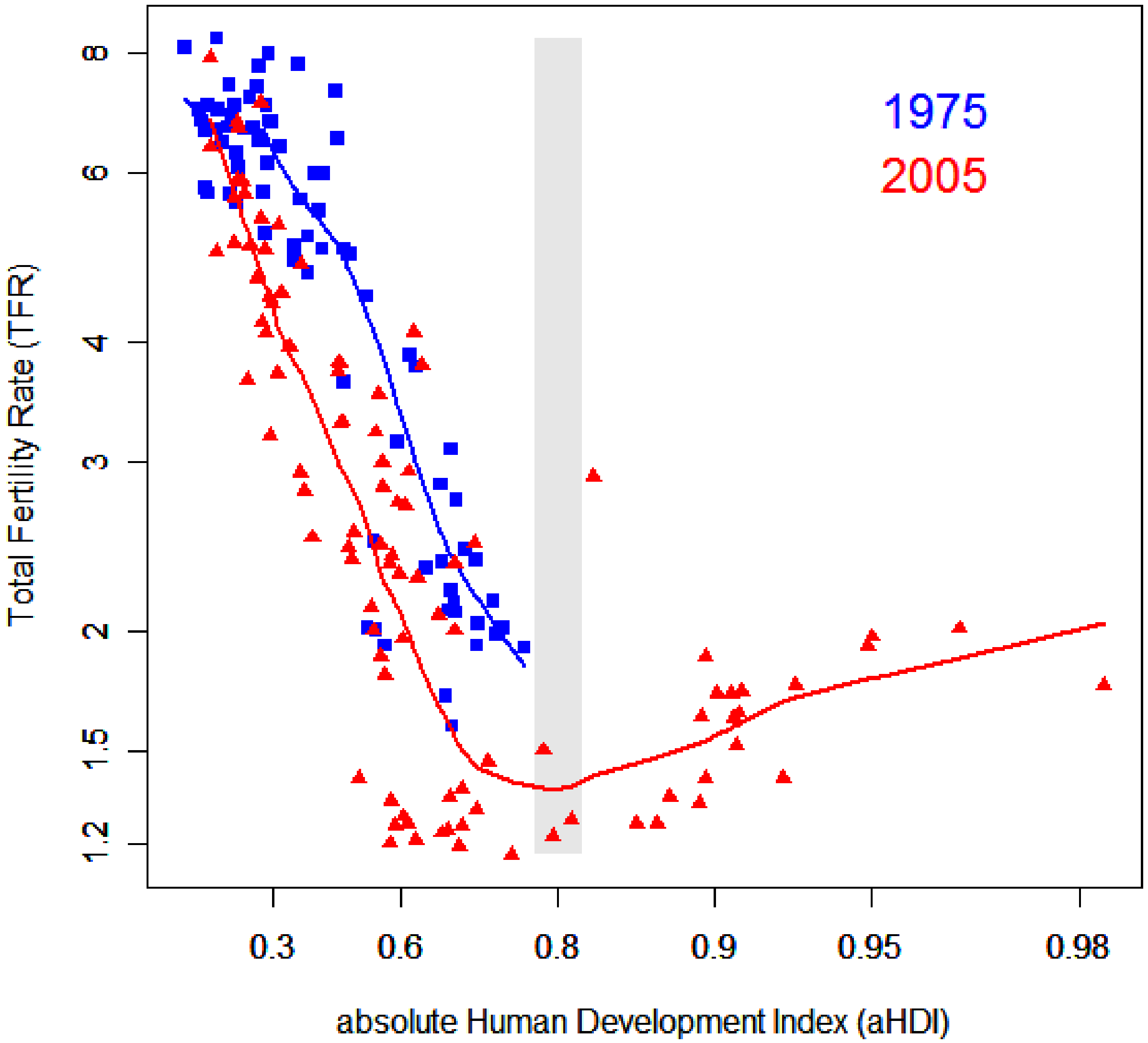

Figure 3. Absolute human development index aHDI and total fertility rate TFR in 1975 and 2005 with a non-parametric smoothed spline regression.

Squares = 1975, Triangles = 2005

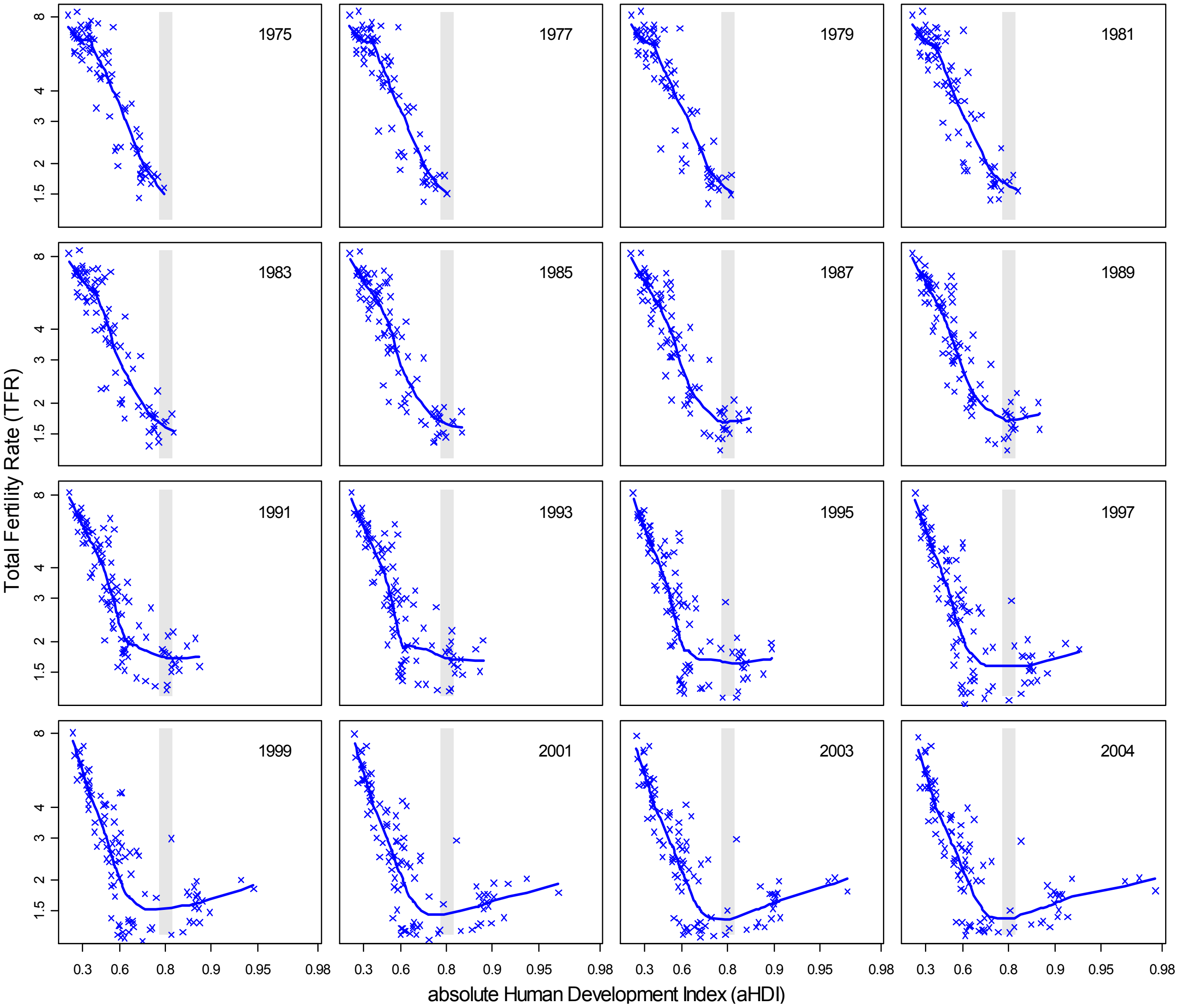

Figure 4. Absolute human development index aHDI and total fertility rate TFR and a non-parametric smoothed spline regression for selected years.

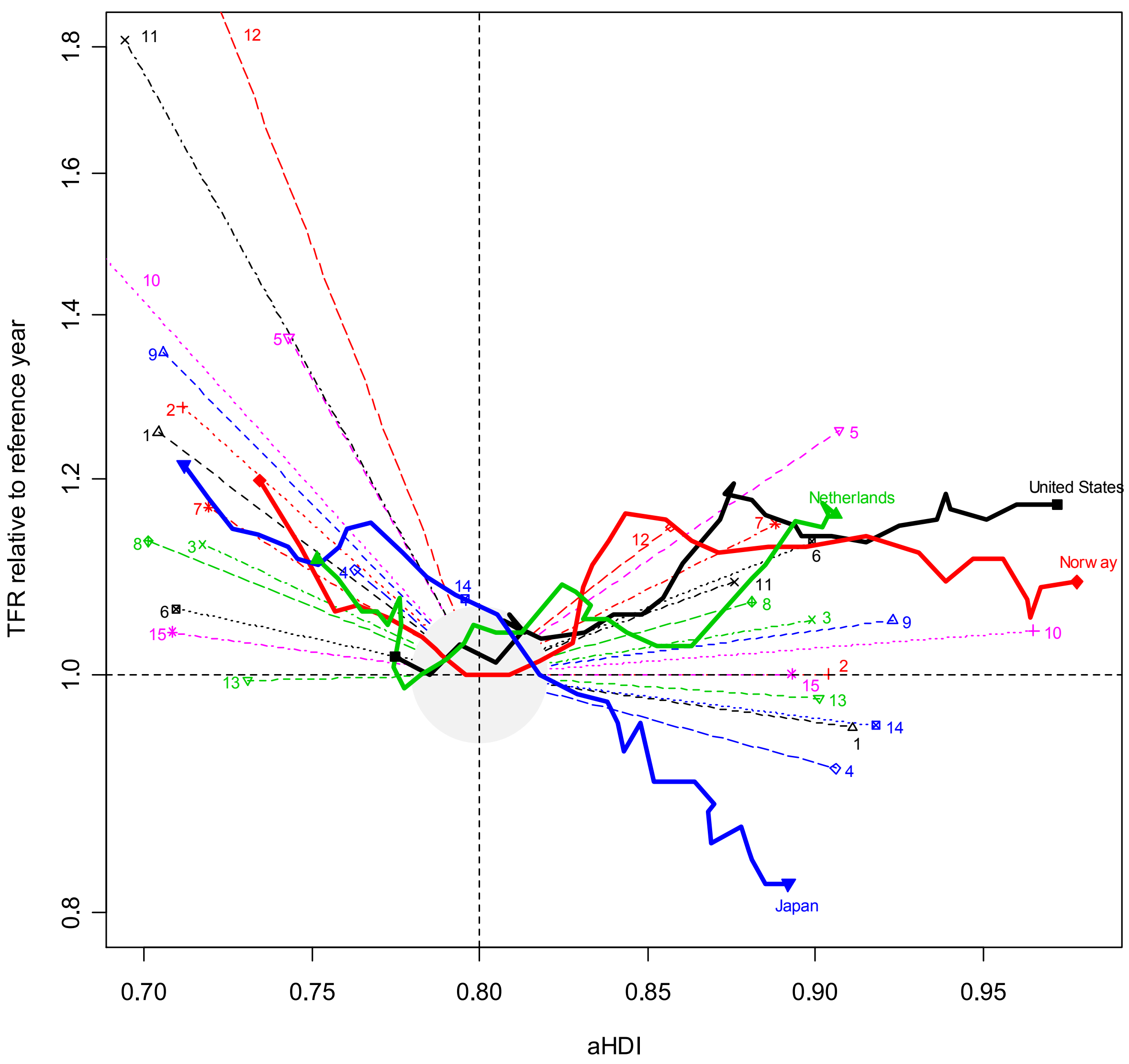

Figure 5. TFR relative to reference year (year with lowest TFR while a countries aHDI was within the range 0.78—0.82)