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**A Reversal in the Relationship of Human Development with Fertility?**

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# A Reversal in the Relationship of Human Development with Fertility?

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**Abstract**

Myrskylä et al. (2009) found that the relationship of the human development index (HDI) with the total fertility rate (TFR) reverses from negative (increases in HDI are associated with decreases in TFR) to positive (increases in HDI are associated with increases in TFR) at a HDI level of 0.86. In this paper we show that the reversal in the HDI-TFR relationship is neither robust to UNDP's recent revision in the HDI calculation method nor the decomposition of the HDI into its education, standard of living and health sub-indices.

**Key words:** Fertility, human development index, education, health, standard of living.

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# 1 Introduction

Myrskylä , Kohler and Billari (MKB) document a reversal in the relationship between fertility and HDI at advanced levels of human development in a recent paper in *Nature* (Myrskylä et al. 2009). They find that the HDI-TFR relationship reverses from negative (increases in HDI are associated with a decrease in fertility) to positive (increases in HDI are associated with increases in fertility) at a HDI level of 0.86. The analysis of MKB is very rigorous, but it leaves a few open questions which we strive to answer in this paper:[3]

*Data issues.* MKB use annual data from 1975 to 2005 in their longitudinal analysis. However, until the year 2000 the HDI was only measured every five years. Thus, their data set is largely based on constructed data. MKB explain in the online appendix of their paper how they filled in missing observations (basically assuming a linear trend between existing observations) and why they believe that it is ok to do so. We believe that the imputation of parts of the data set biases the result in favor of their hypothesis. It is possible to do the analysis without imputing data: Rather than using one-year intervals from 1975 to 2005 one could use five-year intervals for the same time period in the longitudinal analysis. Since the year 2000 the HDI was measured annually, thus, we can redo the longitudinal analysis with annual data starting in 2000.

Futrher, MKB remove all countries from the longitudinal analysis that don't have a HDI level in 2005 that is above the point of reversal (which they identified descriptively prior to the analysis). It is quite plausible that countries can only show a reversal in

[3]We are aware of two other papers that comment on MKB. Furouka (2009) uses a threshold regression approach and finds a reversal point at a HDI level of 0.78 (in contrast to 0.86 found by MKB). He also finds that the relationship between HDI and TFR is not very strong and concludes that the assumption about a persistently negative relationship between human development and fertility cannot be rejected. Luci and Thevenon (2010) focus on the standard of living dimension and analyze the impact of income on fertility in OECD countries. They argue that GDP per capita is the main determinant that drives the fertility reversal. In particular, they test, whether GDP per capita has an inverted U-shaped relationship with the TFR using data from 1960 through 2007. They also try to identify the factors that lead to this rebound by decomposing GDP per capita in several components. Luci and Thevenon (2010) confirm the main findings of MKB and additionally find that female employment is the main driver of fertility. Further they conclude that the reversal is not sufficient to increase fertility rates above replacement level.

the HDI-TFR relationship, if they have observations below and above the reversal point. However, the exclusion of the remaining countries once again biases the results in favor of MKB's hypothesis.

*HDI calculation.* Recently, UNDP revised the methodology to compute the HDI (c.f. UNDP, 2010). With the old methodology quite a few countries approached the maximum HDI value of one, which made it difficult to make distinctions in this cluster of countries and to measure further progress of these countries. Thus, UNDP revised the levels of education, health and standard of living that are necessary to achieve an index value of one, resulting in lower HDI values for all countries. We discuss this revision in great detail in the next sections.

*Componennts of the HDI.* MKB only do their analysis for the composite HDI index and not for the components of the HDI. Also Luci and Thevenon (2010) only focus on the standard of living component. The components of the HDI are highly correlated, but the remaining variation can still give important insights into the HDI-TFR relationship and its (potential) reversal at high levels of development. This is particularly true, since the relationship reverses as soon as countries jump over a certain threshold (a HDI level of 0.86 in the MKB paper). A HDI level of 0.86 can mean very different things in different countries. Are there thresholds for each HDI component at which the relationship between development and fertility reverses? Which component(s) is/are driving the result for the composite index?

It turns out that the main result of MKB is neither robust to the new calculation method of the HDI nor to the decomposition of the HDI into its sub-indices.

## 2 Data and descriptive statistics

### 2.1 Human Development Index and Total Fertility Rate

The total fertility rate (TFR) represents the number of children that a woman would give birth to if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates (World Bank 2010). Hence, the total TFR assesses the number of children born per year and it is an important parameter for population growth, as well as for population aging. Total fertility rates (TFRs) have declined in most developed countries until the early 2000s. For example, European countries have experienced a decrease between 1980 and 2000 from 1.77 to 1.46 (World Bank 2011). More recently TFRs increased again in some highly developed countries (still being far below the replacement level). For example, between 2000 and 2009 the TFR increased from 1.46 to 1.56 in Europe and from 1.79 to 1.81 in all OECD countries (World Bank 2011). Particularly, family friendly policies facilitating the co-existence of childbearing and work both for women and men seem to be an important explanation for the recent increase of fertility rates (see. e.g. Neyer, and Anderson (2008), Adsera (2004)).

Despite some critique of the TFR as a measure of fertility in a given population, which are is mostly related to its proneness to tempo and compositional influences (Bongaarts and Feeney 1998; Kohler et al. 2002; Kohler and Ortega 2002; Sobotka 2004), the TFR is the most widely used indicator for fertility and available for a large number of countries and years. MKB demonstrate that their main result is robust to using the tempo-adjusted TFR.

The HDI is a composite index that measures the level of development of a country in three basic dimensions: health, education, and standard of living. Before 2010 the HDI was calculated based on life expectancy at birth, GDP per capita, gross school enrollment and the adult literacy rate. Since last year's 20th anniversary of Human Development

Report, the indicators used to calculate the index are the following: life expectancy at birth for health, average years of schooling for adults aged 25 and older and expected years of average schooling for children of the official school age for education, and the log of the PPP-adjusted Gross National Income per capita (UNDP 2010).

Prior to 2010, the HDI was calculated by the arithmetic mean of the three component indices. The new HDI is calculated as the geometric mean of the three sub-indices. Using the geometric mean has an in-built 'inequality aversion' across components, which implies that countries whose achievements differ greatly by components will receive a lower score compared to those with more 'balanced' achievements across components.

The calculation of the HDI is straight forward. Let $g$ denote the geometric mean and $\mu(y)$ denote the arithmetic mean of a given distribution of $y$ (income), $(e)$ (education) and health $(h)$. All three dimensions of the HDI can then simply be represented in a $3 \times k$ matrix $D$ (where $k$ refers to the number of countries in the data). The first row is the vector $y$, followed by $e$ and $h$. The human development index *HDI* can then be defined as a function $F : D \to R$ from the set of D matrices to the real number R and formally expressed as the mean of the means:

$$HDI(D) = g[\mu(y), g(e), \mu(h)], \tag{1}$$

which corresponds to the mean achievement in each dimension of the HDI which is then averaged across dimensions (Alkire and Foster 2011).

The component indices *(y), (h)*, and *(e)* are calculated by standardizing each component based on

$$x_t^{standardized} = \frac{x_t - x_{min}}{x^{max} - x^{min}}. \tag{2}$$

The minimum and maximum values for the standard of living component *(y)* are ln(163) USD PPP and ln(108,211) USD PPP, respectively. The minimum and maximum values for the health component *(h)* are 20 years and 83,2 years, respectively.[4]

For the education component, equation (2) is applied to both sub-components. For the average years of schooling the minimum value is 0 and the maximum value is the observed maximum of the countries at a period *(t)* from the Barro and Lee (2010) data set on years of schooling between 1890 and 2010. The expected years of schooling measure the 'school life expectancy' and are defined as the total number of years of schooling, which a child at a certain age can expect to achieve based on current age specific enrollment ratios. In particular, for each child of age $a$, the expected years of education are calculated as the sum of the age specific enrollment ratios to the reference age range $a$ to $n$. The minimum value for expected years of education is 0 and the maximum value corresponds to the maximum value for a country at time $t$ from the Barro and Lee (2010) data set. In contrast to the former education component, the new education component is calculated not as the arithmetic but as the geometric mean of the two educational subcomponents.

The change in the methodology, in particular, the use of new indicators and the new functional form, leads to substantial changes in the outcomes of the overall HDI, which is important for the comparison of our findings to those of MKB. Especially, employing the geometric mean results in lower values of the HDI compared to the arithmetic mean. However, the change in the methodology has predominantly a level effect on the HDI but only a minor impact on the HDI ranks. This is illustrated in Figure 1, which shows a scatterplot go the HDI values based on the old and new calculation methodology.

For our analysis, we use data for the HDI from the International Human Development Indicators database (UNDP 2011). The database contains the HDI and its components based on the new methodology for all countries for which the HDI is calculated (187 countries in the latest HDR 2011 (UNDP 2011)) for a period between 1980 and 2010. Between

[4] Before 2010, the minimum and maximum values for *(y)* were ln(100) and ln(40,000), and for *(h)* 25 and 85.

1980 and 2000, the data is available for every five years (1980, 1985, 1990, 1995, and 2000). From 2000 onwards the data is available for every year. TFR data come from the World Development indicators (WDI) and are available for every year until 2009. Same as MKB we exclude city-states from the sample in order to avoid misleading distortion of countries with a very low population size and a pure urban structure. [5]. We have a sample of 158 countries with five-year data from 1980 to 2000 and annual data from 2000 to 2009.

## 2.2 Country samples and descriptive statistics

We define six different country samples to check the robustness of MKB's results. First, we use the same sample of countries as MKB, for which we have five-year data from 1980 to 2009 (1980, 1985, 1990, 1995, 2000, 2005, and 2009 to be more precise). Second, we use the same sample of countries as MKB, for which we have annual data from 2000 to 2009. Third, we take a balanced sample of all countries in the data set, for which we have five-year data from 1980 to 2009. Fourth, we take a balanced sample of all countries in the data set, for which we have annual data from 2000 to 2009. Fifth, we use an unbalanced sample of all countries with five year data form 1980 to 2009. Sixth, we use an unbalanced sample of all countries with annual data from 2000 and 2009.

The total balanced sample of countries consists of 87 countries and is presented in Table 1 for the year 2009 and Table 2 for the year 1980. Countries that appear in italic also belong to the balanced sample of MKB (which consists of 29 countries). [6]

In turn, this implies that for 71 countries at least one value for the HDI, its components or the TFR is missing resulting in an unbalanced panel.[7]

[5] We exclude Hong-Kong, Macao, Monaco, and Singapore from the analysis

[6] The country sample is identical to MKB's country sample with the exception of Germany, where no balanced panel is available.The original MKB sample is presented in Table A.1 in the Appendix.

[7] These countries are: Mongolia, Uganda, Mauritania, Tonga, Iran, Kuwait, Uruguay, Albania, Dominican Republic, Romania, Kazakhstan, Tajikistan, Namibia, Lithuania, Poland, Kyrgyzstan, Ukraine, Moldova, Viet Nam, Russian Federation, Swaziland, Armenia, Slovakia, Cambodia, Azerbaijan, Slovenia,

Table 3 shows the mean, minimum, and maximum values of the HDI and its components by the six different samples we use for the longitudinal analysis. We also calculated the correlation coefficient between the HDI and its components for the restricted sample. As expected, the correlation between the HDI and its components is high. All correlation coefficients are in the range of 0.83 and 0.95.[8]

Figures 2 and 3 show the relationship between the HDI, its components and the fertility-rate in 1980 and 2009 based on the total sample of countries. Figure 3 is based on a rescaled HDI similar to the Figure presented by MKB.[9] The upper left part of Figure 3 is the simple reproduction of the figure presented by Myrskylä et al (2009). For the year 2009 (old HDI 2005), Figure 3 seems to confirm that the TFR starts to increase at higher level of human development resulting in an inverted J-shaped relationship. This holds also for the component indices of the HDI. No such relationship can be identified for the year 1980. For lower levels, especially in 1980, the relationship seems to become strongly negative and shows no sign of a inverted J-shape. The observation in Figure 3 is strongly affected by countries from Europe that have experienced increasing rates of fertility in recent years (c.f. Table 2 and 1).

The clear visual pattern is largely driven by the rescaling of the HDI values. Figure 2 shows the same data displayed on the natural scale of the HDI and its components. In Figure 2 no inverted J-shaped relationship between fertility and human development is observable (with the exception of the education component). The new HDI, the health

Gambia, Liberia, Czech Republic, Estonia, Croatia, Qatar, Madagascar, Angola, Bolivia, Chad, Yemen, Ethiopia, Brazil, Maldives, Equatorial Guinea, Cape Verde, Papua New Guinea, Syrian Arab Republic, Sri Lanka, Timor-Leste, Andorra, Belize, Afghanistan, South Africa, Liechtenstein, Bhutan, Germany, Comoros, Haiti, Guinea, Montenegro, Djibouti, Myanmar, Georgia, Suriname, Uzbekistan, Turkmenistan, Burkina Faso, Nigeria, Guinea-Bissau, Sao Tome and Principe, Bosnia and Herzegovina, Serbia, Belarus, Barbados.

[8] The respective spearman's rank coefficients are: HDI - health index: 0.939; HDI - GNI index: 0.944; HDI - education index: 0.942; health index - GNI index: 0.879; health index - education index: 0.838; GNI index - education index: 0.844.

[9] The HDI (also the components) is rescaled as follows: HDI rescaled= $-\log(1 - \text{HDI})$ and TFR rescaled = $\log(0.4886 \cdot \text{TFR})/31$ (see MKB).

component and the standard of living component even seem to show a negative relationship with the TFR in 2009. [10]

## 3 Estimation approach

MKB employ a difference-in-differences estimation approach. We fully adopt their estimation strategy. Specifically we estimate a piecewise linear model with the TFR as dependent variable, in which the coefficient of the HDI (or its components) can differ below or above a pre-determined threshold value of the HDI. [11]

$$\Delta TFR_{it} = \alpha \Delta B_{it}^{post} + \beta^{pre} \Delta X_{it}^{pre} + \beta^{post} \Delta X_{it}^{post} + \Delta \gamma_t + \Delta \epsilon_{it}, \quad (3)$$

$$i = 1, ..., n; t = 1, ..., T.$$

The coefficients $\beta^{pre}$ $\beta^{post}$ measure the effect of human development below or above above a pre-determined threshold value on the total fertility rate. $X_{it}$ is the HDI of country $i$ in year $t$ (or one of the HDI components). The operator $\Delta$ is the difference indicator with $\Delta X_t = X_t - X_{t-1}$ and $\Delta X_{it}^{pre} = B_{it}^{pre}$ and $\Delta X_{it}^{post} = B_{it}^{post}$. $B_{it}^{pre}$ and $B_{it}^{pre}$ are dummy variables indicating whether the HDI(-component) level is below or above the critical value. $\gamma_t$ are time fixed effects.

The specification in equation 3 allows us to test whether the reversal in the relationship of fertility and the HDI (or its component) is statistically significant while controlling for time- and country-fixed effects. MKB find $\beta^{pre} < 0$ and $\beta^{post} > 0$ for their data set.

Because it is possible that changes in the HDI (or its components) affect the total

[10] The respective Figures for MKB's country sample are found in the Appendix. Figure A.1 presents the relationship based on the the rescaled HDI (and its components) and Figure A.2 presents the relationship based on the natural scale.

[11] See the supplementary information of MKB for a more detailed description.

fertility rates with some time lag, we also estimate the model with lagged HDI variables.

$$\Delta TFR_{it} = \alpha \Delta B_{it}^{post} + \beta^{pre} \Delta X_{i(t-1)}^{pre} + \beta^{post} \Delta X_{i(t-1)}^{post} + \Delta\gamma_t + \Delta\epsilon_{it}, \tag{4}$$

$$i = 1, ..., n; t = 1, ..., T.$$

Before we can estimate equations 3 and 4, we first have to determine the threshold value of the HDI(-component). Again, we adopt the empirical strategy of MKB and use maximum likelihood methods to determine the threshold. Specifically, we estimate equation 3 for a broad range of potential threshold value of the HDI(-component).[12] We take the HDI(-component) value for which the log-likelihood function shows its maximum as threshold in equations 3 and 4. The threshold value is also used to define $B_{it}^{pre}$ and $B_{it}^{post}$. The distribution of the log-likelihood function and the threshold values of the HDI for our six different samples is shown in Figure 4. The respective Figures for the old HDI and the components of the new HDI are shown in Figures A.3 -A.6 in the Appendix.

## 4 Estimation results

All tables with regression results include the results for all six different samples organized in six columns. The first sample (first column) includes the countries that MKB use in their longitudinal analysis from 1980 to 2009 (for five-year periods).[13] The second sample includes the same set of countries but for one-year periods from 2000 to 2009. The third and fourth sample include all countries which form a balanced panel for the given period, again for five-year periods from 1980 to 2009 and for one-year periods from 2000 to 2009. The last two columns include all available observations, once again for five-year periods from 1980 to 2009 and for one-year periods from 2000 to 2009. In the text we refer to the

[12] The step size is 0.01 for each index.

[13] See Table 2 and 1 and Table A.1.

different samples as "nature" sample, balanced sample and unbalanced sample. We refer to the different periods as five-year data and annual data.[14]

In the upper part of Table 4 we replicate the results of MKB for the old HDI.[15] We use the difference-in-differences estimation approach described in equation 3 and determine the threshold value between the two linear parts of the equation using the likelihood method described in great detail in the appendix of MKB and briefly sketched in the methods section of this paper.[16] It turns out, that for all samples the likelihood is greatest for a cut-off around 0.85/0.86. The difference-in-differences estimations show that for HDI levels above the cut-off, an increase of the HDI leads to an increase of the TFR. This result is highly significant in all samples. Below the cut-off, an increase of the HDI leads to a decrease of the TFR (with exception of the nature sample, where w do not observe a significant change). The results with the lagged independent variable (equation 4) are shown in Table A.2. They are fully consistent with the results described above. These results show that the main finding of MKB is robust to the data issues that we discussed above.

We now turn to the downward revision of the human development index (new HDI). The results for the difference-in-differences model (equation 3) are shown in lower part of Table 4.[17] The log-likelihood values for various threshold values are shown in Figure 4. For the nature sample we find cut-off values of 0.74 and 0.80 respectively. Those values are consistent with the cut-off values that we found for the old HDI (considering the level differences between old and new HDI). However, the main result that increases of the HDI above the cut-off value lead to increases of the TFR is now insignificant. For the five year data we also find a cut-off value of 0.74, both for the balanced and the unbalanced

[14]For the old HDI we use the data of MKB), which are available from 1975 to 2005.

[15]With one difference: We do not fill in observations if they don't exist. We use a five-year sample from 1975 to 2005 and an annual sample from 2000 to 2005.

[16]The log-likelihood for various cut-off values is shown in Figure A.3 in the Appendix.

[17]The results with the lagged independent variable are shown in Table A.2 in the Appendix.

sample. The relationship between HDI and TFR is again statistically significant and negative below the cut-off and positive above. For the annual data we find an implausibly low cut-off value of 0.56. The relationship is statistically significant and negative below the cut-off and positive above. The results with the lagged independent variable (equation 4) are very similar to the ones discussed above.

The finding that the relationship between development and fertility changes at a HDI level of 0.56 undermines the entire finding that advances in development reverse fertility declines. It shouldn't be seen as a result in its own right but rather as an indicator that something strange is going on. The index composition changed between the old HDI and the new HDI, and this alone made the main result of Myrskylä et al (2009) go away in their own country sample and led to an implausible result in the balanced and unbalanced sample. Arguably, the annual sample from 2000 and 2009 is much more important than the five-year sample from 1980 to 2009, because the increase of fertility rates in rich countries is a rather recent phenomenon.

We now turn to the components of the HDI to understand how changes in the index composition of the HDI have affected the empirical relationship between the HDI and the TFR.[18]. The threshold values for the nature sample are in general larger than the threshold values for the balanced and unbalanced samples. In quite a few cases the threshold values are not very well defined. In other words the graph has multiple peaks of similar height, thus very small differences in the log-likelihood determine which threshold value is used in the analysis. The threshold values for the standard of living component are comparable to the values that we found for the HDI. The threshold values for the education component are generally smaller and the threshold values for the health component are generally larger than those found for the HDI.

[18]The log-likelihood of the various cut-off values of the piecewise linear regressions for the sub-indices of the HDI is shown in Figures A.4, A.6 and A.5 in the Appendix

In Table 5 we present the difference-in-differences results for the three HDI sub-indices. We will start with the education index: We find a very small and implausible cut-off value of 0.45 for the nature sample with five year data. The relationship is negative below the cut-off and insignificant above. For the annual data the cut-off is 0.72, and the relationship is still negative below the cut-off and insignificant above. For the balanced and unbalanced sample the relationship is negative below the cut-off and positive above. However, the cut-off value is very small (between 0.56 and 0.63).

While the cut-off values for the standard of living component are comparable to those of the HDI, the regression results are not. For the nature sample the relationship is insignificant for HDI levels below the cut-off. Above the cut-off the relationship is positive for the five-year data and negative for (the more important) annual data. For the five-year data, both for the balanced and the unbalanced sample, the relationship of HDI with TFR is insignificant below and positive above the cut-off. Only for the annual data we can observe a reversal in the HDI-TFR relationship with a negative coefficient below the cut-off and a positive coefficient above. However, the cut-off value is so small (0.50) that it does not make much sense to conclude that advances in development lead to a reversal in the HDI-TFR relationship. We rather interpret this finding as a statistical artifact.

The results for the health sub-index are closest to the original finding of MKB. Both for the balanced and the unbalanced sample, the relationship of the HDI with the TFR reverses from negative to positive at HDI levels between 0.82 and 0.90 (which is quite high for the new HDI). For the nature sample the picture is less clear: For the five-year data the relationship is negative below the cut-off and insignificant above. For the annual data from 2000 to 2009 it is positive throughout (with a slightly larger slope above the cut-off).[19]

[19]The results of the lagged model for the three sub-indices (equation 4) are reported in Table A.3 in the Appendix.

## 5 Conclusions

We reinvestigated the finding of MKB that the relationship of the human development index (HDI) with the total fertility rate (TFR) reverses from negative (increases in HDI are associated with decreases in TFR) to positive (increases in HDI are associated with increases in TFR) at a HDI level of 0.86. We find that the reversal in the HDI-TFR relationship is neither robust to UNDP's recent revision in the HDI calculation method nor the decomposition of the HDI into its education, standard of living and health sub-indices.

Our analysis does not change the fact that we observe an increase in the TFR in developed countries in recent years. However, we find little support in the data that this increase is causally linked with overall advances in development. Our analysis for the new HDI and its sub-indices shows that the reversal, which MKB correctly documented for the old HDI, was largely a statistical artifact due to clustering of HDI values at high levels and due to the composition of the index.

The recent increases in fertility rates may still have something to do with development, but we find little support for simple answers of the kind that fertility rates will automatically start to increase once a certain level of development is reached. If anything there is mild evidence that improvements in health lead to increases in fertility. [20] Overall, we conclude that the data does not support simple conclusions that link decreases in fertility rates to improvements in development. We believe that it is necessary to investigate the reasons for the recent decline in fertility rates beyond the macroeconomic level. The analysis of family friendly policies in a few developed countries or the fertility behavior of certain population sub-groups seem to be promising starting points for future research.

[20] One should not confuse this finding with the demographic transition theory where decreases in child mortality lead to decreases in fertility. At the levels of development we are talking about, child mortality is close to zero and virtually all improvements in the health index are due to improvements in old age longevity.

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Table 1: Fertility, HDI and its components values in 2009 by country

| Country | TFR | HDI | Edu index | GNP index | Health index | Country | TFR | HDI | Edu index | GNP index | Health index | Country | TFR | HDI | Edu index | GNP index | Health index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Norway* | 1.98 | 0.94 | 0.94 | 0.90 | 0.96 | *Argentina* | 2.23 | 0.77 | 0.76 | 0.69 | 0.88 | Honduras | 3.20 | 0.60 | 0.54 | 0.48 | 0.83 |
| *Australia* | 1.90 | 0.93 | 1.00 | 0.84 | 0.98 | Latvia | 1.31 | 0.77 | 0.80 | 0.68 | 0.84 | Indonesia | 2.15 | 0.59 | 0.53 | 0.48 | 0.81 |
| *New Zealand* | 2.14 | 0.90 | 1.00 | 0.77 | 0.96 | Panama | 2.52 | 0.75 | 0.71 | 0.67 | 0.88 | Morocco | 2.31 | 0.56 | 0.43 | 0.51 | 0.82 |
| *United States* | 2.05 | 0.90 | 0.89 | 0.87 | 0.94 | Saudi Arabia | 2.89 | 0.75 | 0.65 | 0.77 | 0.84 | Nicaragua | 2.67 | 0.56 | 0.49 | 0.42 | 0.85 |
| *Ireland* | 2.07 | 0.89 | 0.92 | 0.82 | 0.95 | Mexico | 2.36 | 0.75 | 0.68 | 0.68 | 0.89 | Guatemala | 4.05 | 0.56 | 0.42 | 0.52 | 0.80 |
| *Netherlands* | 1.79 | 0.89 | 0.87 | 0.85 | 0.95 | Bulgaria | 1.57 | 0.74 | 0.74 | 0.65 | 0.85 | India | 2.66 | 0.51 | 0.42 | 0.45 | 0.70 |
| *Canada* | 1.67 | 0.89 | 0.86 | 0.84 | 0.96 | Malaysia | 2.67 | 0.74 | 0.69 | 0.68 | 0.86 | Pakistan | 3.50 | 0.49 | 0.36 | 0.43 | 0.74 |
| *Sweden* | 1.94 | 0.88 | 0.86 | 0.83 | 0.97 | Trinidad and T. | 1.64 | 0.73 | 0.65 | 0.77 | 0.79 | Congo | 5.90 | 0.48 | 0.47 | 0.45 | 0.53 |
| *Japan* | 1.37 | 0.88 | 0.84 | 0.82 | 1.00 | Costa Rica | 1.88 | 0.72 | 0.63 | 0.64 | 0.93 | Kenya | 4.76 | 0.46 | 0.52 | 0.35 | 0.55 |
| *Switzerland* | 1.50 | 0.87 | 0.80 | 0.84 | 0.98 | Peru | 2.54 | 0.72 | 0.73 | 0.60 | 0.85 | Bangladesh | 2.30 | 0.46 | 0.39 | 0.34 | 0.74 |
| *Israel* | 2.96 | 0.87 | 0.87 | 0.79 | 0.97 | Mauritius | 1.50 | 0.70 | 0.61 | 0.67 | 0.82 | Ghana | 4.24 | 0.46 | 0.52 | 0.33 | 0.58 |
| *Finland* | 1.86 | 0.87 | 0.84 | 0.82 | 0.95 | Venezuela | 2.52 | 0.70 | 0.59 | 0.67 | 0.85 | Cameroon | 4.56 | 0.46 | 0.48 | 0.40 | 0.50 |
| *France* | 2.00 | 0.87 | 0.82 | 0.82 | 0.97 | Ecuador | 2.52 | 0.69 | 0.64 | 0.60 | 0.87 | Benin | 5.37 | 0.43 | 0.36 | 0.34 | 0.66 |
| *Iceland* | 2.23 | 0.87 | 0.87 | 0.77 | 0.98 | Jamaica | 2.36 | 0.69 | 0.67 | 0.58 | 0.82 | Togo | 4.16 | 0.42 | 0.45 | 0.25 | 0.68 |
| *Belgium* | 1.84 | 0.86 | 0.83 | 0.82 | 0.95 | Colombia | 2.40 | 0.68 | 0.63 | 0.61 | 0.84 | Nepal | 2.81 | 0.42 | 0.34 | 0.30 | 0.75 |
| *Denmark* | 1.84 | 0.86 | 0.84 | 0.83 | 0.93 | Tunisia | 2.05 | 0.68 | 0.61 | 0.59 | 0.86 | Lesotho | 3.27 | 0.42 | 0.49 | 0.38 | 0.40 |
| *Spain* | 1.40 | 0.86 | 0.82 | 0.80 | 0.97 | Jordan | 3.80 | 0.68 | 0.67 | 0.55 | 0.84 | Senegal | 4.90 | 0.41 | 0.32 | 0.37 | 0.57 |
| *Greece* | 1.52 | 0.85 | 0.83 | 0.79 | 0.94 | Turkey | 2.11 | 0.67 | 0.55 | 0.67 | 0.82 | Cote d'Ivoire | 4.52 | 0.39 | 0.29 | 0.35 | 0.60 |
| *Italy* | 1.41 | 0.85 | 0.79 | 0.80 | 0.97 | Algeria | 2.31 | 0.67 | 0.61 | 0.60 | 0.83 | Zambia | 6.23 | 0.39 | 0.43 | 0.32 | 0.42 |
| *Luxembourg* | 1.59 | 0.85 | 0.74 | 0.88 | 0.95 | Fiji | 2.70 | 0.67 | 0.76 | 0.50 | 0.78 | Rwanda | 5.40 | 0.38 | 0.37 | 0.30 | 0.49 |
| *Austria* | 1.39 | 0.85 | 0.77 | 0.83 | 0.95 | China | 1.61 | 0.66 | 0.59 | 0.57 | 0.84 | Malawi | 5.99 | 0.38 | 0.38 | 0.26 | 0.54 |
| *United King.* | 2.00 | 0.85 | 0.78 | 0.82 | 0.94 | El Salvador | 2.28 | 0.65 | 0.61 | 0.57 | 0.82 | Sudan | 4.48 | 0.38 | 0.23 | 0.38 | 0.61 |
| *Malta* | 1.44 | 0.81 | 0.76 | 0.75 | 0.95 | Thailand | 1.60 | 0.65 | 0.59 | 0.59 | 0.78 | Sierra Leone | 5.08 | 0.31 | 0.29 | 0.24 | 0.44 |
| *United A. E.* | 1.79 | 0.81 | 0.65 | 0.91 | 0.91 | Gabon | 3.29 | 0.64 | 0.61 | 0.66 | 0.65 | CAR | 4.72 | 0.31 | 0.30 | 0.23 | 0.43 |
| *Cyprus* | 1.49 | 0.81 | 0.74 | 0.76 | 0.95 | Philippines | 3.19 | 0.63 | 0.63 | 0.49 | 0.82 | Mali | 6.36 | 0.30 | 0.21 | 0.30 | 0.46 |
| *Hungary* | 1.32 | 0.80 | 0.85 | 0.72 | 0.85 | Paraguay | 3.00 | 0.63 | 0.61 | 0.51 | 0.82 | Mozambique | 4.99 | 0.28 | 0.20 | 0.25 | 0.45 |
| Bahrain | 2.57 | 0.80 | 0.74 | 0.78 | 0.88 | Botswana | 2.80 | 0.63 | 0.66 | 0.67 | 0.56 | Burundi | 4.47 | 0.28 | 0.32 | 0.13 | 0.49 |
| *Portugal* | 1.32 | 0.79 | 0.70 | 0.75 | 0.93 | Egypt | 2.78 | 0.61 | 0.53 | 0.55 | 0.80 | Niger | 7.12 | 0.26 | 0.16 | 0.22 | 0.51 |
| *Chile* | 1.88 | 0.78 | 0.75 | 0.67 | 0.93 | Guyana | 2.29 | 0.60 | 0.65 | 0.46 | 0.75 | Zimbabwe | 3.36 | 0.12 | 0.52 | 0.01 | 0.41 |

*Note:* Countries are sorted by HDI. The sample includes all countries for which data from 1980 to 2009 are available. Countries in italic are countries used by Myrskylä et al (2009) for their longitudinal analysis. *Source:* International Human Development Indicators 2011, Word Development Indicators 2011; calculations by the authors.

Table 2: Fertility, HDI and its components values in 1980 by country

| Country | TFR | HDI | Edu index | GNP index | Health index | Country | TFR | HDI | Edu index | GNP index | Health index | Country | TFR | HDI | Edu index | GNP index | Health index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *United States* | 1.84 | 0.81 | 0.79 | 0.79 | 0.85 | *United A. E.* | 5.42 | 0.63 | 0.33 | 1.00 | 0.75 | Botswana | 6.22 | 0.43 | 0.26 | 0.48 | 0.64 |
| *Switzerland* | 1.55 | 0.80 | 0.71 | 0.82 | 0.88 | *Portugal* | 2.19 | 0.62 | 0.45 | 0.67 | 0.81 | Guatemala | 6.18 | 0.41 | 0.23 | 0.50 | 0.59 |
| *Australia* | 1.89 | 0.79 | 0.76 | 0.76 | 0.86 | Bahrain | 4.92 | 0.61 | 0.41 | 0.76 | 0.75 | Kenya | 7.46 | 0.40 | 0.33 | 0.34 | 0.60 |
| *Canada* | 1.74 | 0.79 | 0.73 | 0.77 | 0.87 | Panama | 3.74 | 0.61 | 0.52 | 0.56 | 0.79 | Lesotho | 5.59 | 0.40 | 0.35 | 0.33 | 0.53 |
| *Norway* | 1.72 | 0.79 | 0.69 | 0.80 | 0.88 | Venezuela | 4.20 | 0.61 | 0.45 | 0.67 | 0.76 | Egypt | 5.37 | 0.39 | 0.25 | 0.42 | 0.58 |
| *New Zealand* | 2.03 | 0.79 | 0.80 | 0.72 | 0.84 | *Chile* | 2.68 | 0.61 | 0.53 | 0.54 | 0.78 | Indonesia | 4.43 | 0.39 | 0.33 | 0.33 | 0.54 |
| *Netherlands* | 1.60 | 0.78 | 0.70 | 0.77 | 0.88 | Costa Rica | 3.62 | 0.60 | 0.45 | 0.57 | 0.83 | Zambia | 7.18 | 0.38 | 0.32 | 0.34 | 0.51 |
| *Sweden* | 1.68 | 0.77 | 0.69 | 0.76 | 0.88 | Jamaica | 3.73 | 0.59 | 0.49 | 0.53 | 0.80 | China | 2.63 | 0.37 | 0.36 | 0.19 | 0.73 |
| *Denmark* | 1.55 | 0.77 | 0.70 | 0.76 | 0.86 | Mexico | 4.71 | 0.58 | 0.41 | 0.65 | 0.74 | Ghana | 6.54 | 0.36 | 0.32 | 0.29 | 0.52 |
| *Japan* | 1.75 | 0.77 | 0.69 | 0.74 | 0.89 | Ecuador | 5.06 | 0.58 | 0.51 | 0.56 | 0.68 | Cameroon | 6.43 | 0.35 | 0.24 | 0.37 | 0.49 |
| *Israel* | 3.24 | 0.75 | 0.70 | 0.70 | 0.85 | Peru | 5.01 | 0.56 | 0.49 | 0.56 | 0.63 | Morocco | 5.65 | 0.35 | 0.17 | 0.42 | 0.60 |
| *Iceland* | 2.48 | 0.75 | 0.62 | 0.75 | 0.90 | Saudi Arabia | 7.21 | 0.56 | 0.32 | 0.84 | 0.65 | Cote d'Ivoire | 7.61 | 0.35 | 0.18 | 0.43 | 0.56 |
| *Finland* | 1.63 | 0.74 | 0.67 | 0.74 | 0.84 | Fiji | 3.91 | 0.55 | 0.51 | 0.48 | 0.69 | Togo | 7.21 | 0.35 | 0.25 | 0.30 | 0.55 |
| B *Belgium* | 1.67 | 0.74 | 0.65 | 0.75 | 0.84 | Malaysia | 3.79 | 0.54 | 0.40 | 0.53 | 0.74 | India | 4.68 | 0.32 | 0.22 | 0.27 | 0.56 |
| *United King.* | 1.89 | 0.74 | 0.65 | 0.73 | 0.84 | Colombia | 3.99 | 0.54 | 0.39 | 0.54 | 0.72 | Pakistan | 6.54 | 0.31 | 0.15 | 0.33 | 0.60 |
| *Austria* | 1.62 | 0.73 | 0.61 | 0.76 | 0.83 | Paraguay | 5.22 | 0.53 | 0.39 | 0.51 | 0.74 | Senegal | 7.43 | 0.29 | 0.16 | 0.35 | 0.43 |
| *Ireland* | 3.23 | 0.72 | 0.66 | 0.68 | 0.83 | Mauritius | 2.67 | 0.52 | 0.41 | 0.49 | 0.72 | CAR | 5.95 | 0.26 | 0.14 | 0.29 | 0.45 |
| *Luxembourg* | 1.50 | 0.72 | 0.58 | 0.78 | 0.83 | Philippines | 5.18 | 0.52 | 0.50 | 0.44 | 0.65 | Benin | 7.03 | 0.26 | 0.12 | 0.31 | 0.48 |
| *France* | 1.85 | 0.71 | 0.55 | 0.76 | 0.86 | Gabon | 5.17 | 0.51 | 0.34 | 0.71 | 0.54 | Bangladesh | 6.37 | 0.26 | 0.19 | 0.21 | 0.44 |
| *Greece* | 2.23 | 0.71 | 0.56 | 0.73 | 0.86 | Jordan | 7.23 | 0.51 | 0.39 | 0.50 | 0.67 | Malawi | 7.43 | 0.26 | 0.19 | 0.24 | 0.39 |
| *Italy* | 1.64 | 0.70 | 0.54 | 0.75 | 0.86 | Guyana | 3.57 | 0.50 | 0.49 | 0.39 | 0.65 | Sudan | 6.44 | 0.25 | 0.11 | 0.29 | 0.47 |
| *Hungary* | 1.91 | 0.69 | 0.64 | 0.66 | 0.78 | Thailand | 3.39 | 0.48 | 0.37 | 0.41 | 0.73 | Rwanda | 8.29 | 0.25 | 0.15 | 0.26 | 0.41 |
| *Malta* | 1.99 | 0.68 | 0.61 | 0.63 | 0.84 | Turkey | 4.45 | 0.47 | 0.28 | 0.56 | 0.64 | Zimbabwe | 7.10 | 0.24 | 0.30 | 0.07 | 0.62 |
| *Spain* | 2.22 | 0.68 | 0.51 | 0.71 | 0.87 | Congo | 6.59 | 0.46 | 0.36 | 0.44 | 0.63 | Sierra Leone | 5.56 | 0.23 | 0.14 | 0.25 | 0.34 |
| *Cyprus* | 2.35 | 0.66 | 0.54 | 0.63 | 0.86 | El Salvador | 5.14 | 0.46 | 0.32 | 0.52 | 0.57 | Nepal | 5.83 | 0.21 | 0.10 | 0.21 | 0.44 |
| *Argentina* | 3.33 | 0.66 | 0.56 | 0.65 | 0.78 | Algeria | 6.91 | 0.44 | 0.24 | 0.57 | 0.63 | Mozambique | 6.49 | 0.20 | 0.12 | 0.17 | 0.36 |
| Trinidad and T. | 3.34 | 0.66 | 0.54 | 0.70 | 0.75 | Nicaragua | 6.13 | 0.44 | 0.32 | 0.44 | 0.61 | Burundi | 6.65 | 0.18 | 0.09 | 0.16 | 0.42 |
| Latvia | 1.86 | 0.65 | 0.58 | 0.61 | 0.78 | Tunisia | 5.33 | 0.44 | 0.26 | 0.48 | 0.67 | Niger | 7.70 | 0.17 | 0.05 | 0.27 | 0.31 |
| Bulgaria | 2.05 | 0.65 | 0.61 | 0.56 | 0.81 | Honduras | 6.31 | 0.44 | 0.30 | 0.44 | 0.62 | Mali | 7.05 | 0.16 | 0.06 | 0.25 | 0.32 |

*Note:* Countries are sorted by HDI. The sample includes all countries for which data from 1980 to 2009 are available. Countries in italic are countries used by Myrskylä et al (2009) for their longitudinal analysis. *Source:* International Human Development Indicators 2011, Word Development Indicators 2011; calculations by the authors.

Table 3: Summary statistics

| | (1) Nature sample 5 year int. (balanced) 1980-2009 | (2) Nature sample annual (balanced) 2000-2009 | (3) Total sample 5 year int. (balanced) 1980-2009 | (4) Total sample annual (balanced) 2000-2009 | (5) Total sample 5 year int. (unbalanced) 1980-2009 | (6) Total sample annual (unbalanced) 2000-2009 |
|---|---|---|---|---|---|---|
| *HDI old* | | | | | | |
| Mean | 0.87 | 0.87 | 0.68 | 0.67 | 0.67 | 0.67 |
| Min | 0.71 | 0.71 | 0.25 | 0.25 | 0.25 | 0.25 |
| Max | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 |
| *HDI new* | | | | | | |
| Mean | 0.80 | 0.84 | 0.59 | 0.63 | 0.59 | 0.62 |
| Min | 0.61 | 0.73 | 0.12 | 0.21 | 0.12 | 0.12 |
| Max | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| *Education component* | | | | | | |
| Mean | 0.74 | 0.81 | 0.53 | 0.59 | 0.53 | 0.58 |
| Min | 0.33 | 0.55 | 0.05 | 0.11 | 0.05 | 0.08 |
| Max | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| *Standard of living component* | | | | | | |
| Mean | 0.77 | 0.79 | 0.55 | 0.56 | 0.54 | 0.55 |
| Min | 0.52 | 0.61 | 0.01 | 0.07 | 0.01 | 0.01 |
| Max | 1.00 | 0.93 | 1.00 | 0.94 | 1.00 | 0.95 |
| *Health component* | | | | | | |
| Mean | 0.89 | 0.92 | 0.74 | 0.76 | 0.73 | 0.75 |
| Min | 0.75 | 0.80 | 0.14 | 0.34 | 0.14 | 0.34 |
| Max | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| *Total fertility rate* | | | | | | |
| Mean | 1.87 | 1.70 | 3.51 | 2.99 | 3.44 | 3.03 |
| Min | 1.14 | 1.14 | 1.18 | 1.10 | 1.10 | 1.10 |
| Max | 5.55 | 2.96 | 8.29 | 7.50 | 8.29 | 7.50 |

*Source:* International Human Development Indicators 2011, Word Development Indicators 2011, Myrskylä et al (2009); calculations by the authors.

Table 4: Regression results - Differences in Differences

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Old HDI** | | | | | | |
| | Nature sample 5 year interval (balanced) 1975-2005 | Nature sample annual (balanced) 2000-2005 | Total sample 5 year interval (balanced) 1975-2005 | Total sample annual (balanced) 2000-2005 | Total sample 5 year interval (unbalanced) 1975-2005 | Total sample annual (unbalanced) 2000-2005 |
| Pre | -1.722 | -1.586** | -1.691*** | -1.682*** | -0.971* | -0.589** |
| | (1.879) | (0.780) | (0.646) | (0.308) | (0.548) | (0.258) |
| Post | 7.495*** | 4.073*** | 14.88*** | 10.64*** | 14.90*** | 10.86*** |
| | (2.082) | (0.931) | (1.539) | (0.783) | (1.478) | (0.772) |
| Observations | 210 | 1051 | 630 | 3120 | 774 | 3913 |
| R-squared | 0.383 | 0.244 | 0.603 | 0.450 | 0.598 | 0.435 |
| Cut-off | 0.850 | 0.860 | 0.850 | 0.860 | 0.851 | 0.860 |
| **New HDI** | | | | | | |
| | Nature sample 5 year int. (balanced) 1980-2009 | Nature sample annual (balanced) 2000-2009 | Total sample 5 year int. (balanced) 1980-2009 | Total sample annual (balanced) 2000-2009 | Total sample 5 year int. (unbalanced) 1980-2009 | Total sample annual (unbalanced) 2000-2009 |
| Pre | -10.44*** | -2.842*** | -2.375*** | -4.489*** | -1.526*** | -4.765*** |
| | (1.609) | (0.878) | (0.634) | (0.447) | (0.539) | (0.390) |
| Post | 0.561 | 1.052 | 9.387*** | 2.354*** | 10.23*** | 2.659*** |
| | (1.166) | (0.686) | (1.074) | (0.425) | (1.020) | (0.417) |
| Observations | 196 | 319 | 522 | 1143 | 703 | 1283 |
| R-squared | 0.444 | 0.287 | 0.604 | 0.399 | 0.583 | 0.417 |
| Cut-off | 0.74 | 0.80 | 0.74 | 0.56 | 0.74 | 0.56 |

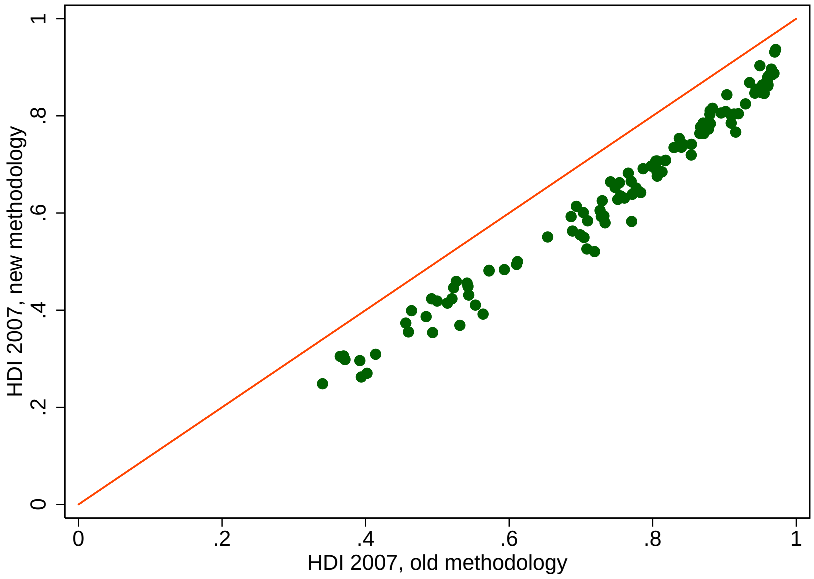
*Note:* Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
*Source:* Myrskylä et al (2009); calculations by the authors; International Human Development Indicators 2011, Word Development Indicators 2011; calculations by the authors.

Table 5: Regression results - Differences in Differences (HDI Components)

| | (1) Nature sample 5 year int. (balanced) 1980-2009 | (2) Nature sample annual (balanced) 2000-2009 | (3) Total sample 5 year int. (balanced) 1980-2009 | (4) Total sample annual (balanced) 2000-2009 | (5) Total sample 5 year int. (unbalanced) 1980-2009 | (6) Total sample annual (unbalanced) 2000-2009 |
|---|---|---|---|---|---|---|
| | | | Education component | | | |
| Pre | -7.688*** | -3.172*** | -4.655*** | -3.252*** | -3.839*** | -3.143*** |
| | (2.665) | (0.673) | (0.469) | (0.299) | (0.466) | (0.299) |
| Post | 0.145 | 0.136 | 2.640*** | 1.600*** | 2.759*** | 1.620*** |
| | (0.549) | (0.273) | (0.523) | (0.279) | (0.445) | (0.275) |
| Observations | 209 | 319 | 522 | 1143 | 764 | 1317 |
| R-squared | 0.372 | 0.302 | 0.638 | 0.399 | 0.580 | 0.386 |
| Cut-off | 0.45 | 0.72 | 0.63 | 0.64 | 0.56 | 0.64 |
| | | | Standard of living component | | | |
| Pre | 1.004 | 0.484 | 0.798 | -1.436*** | 0.441 | -1.970*** |
| | (0.944) | (0.409) | (0.545) | (0.334) | (0.362) | (0.254) |
| Post | 7.483*** | -1.868* | 10.58*** | 1.170*** | 10.74*** | 1.149*** |
| | (1.118) | (1.042) | (1.407) | (0.276) | (1.400) | (0.247) |
| Observations | 202 | 324 | 522 | 1143 | 848 | 1451 |
| R-squared | 0.392 | 0.254 | 0.558 | 0.319 | 0.537 | 0.361 |
| Cut-off | 0.77 | 0.89 | 0.77 | 0.50 | 0.77 | 0.50 |
| | | | Health component | | | |
| Pre | -10.48*** | 7.841*** | -0.867** | -1.911*** | -0.954*** | -2.286*** |
| | (2.184) | (2.401) | (0.391) | (0.412) | (0.361) | (0.363) |
| Post | -0.660 | 10.81*** | 15.12*** | 9.933*** | 14.54*** | 12.39*** |
| | (2.635) | (2.657) | (1.507) | (0.976) | (1.570) | (1.100) |
| Observations | 216 | 324 | 522 | 1143 | 984 | 1488 |
| R-squared | 0.341 | 0.278 | 0.604 | 0.408 | 0.527 | 0.423 |
| Cut-off | 0.87 | 0.94 | 0.87 | 0.82 | 0.87 | 0.90 |

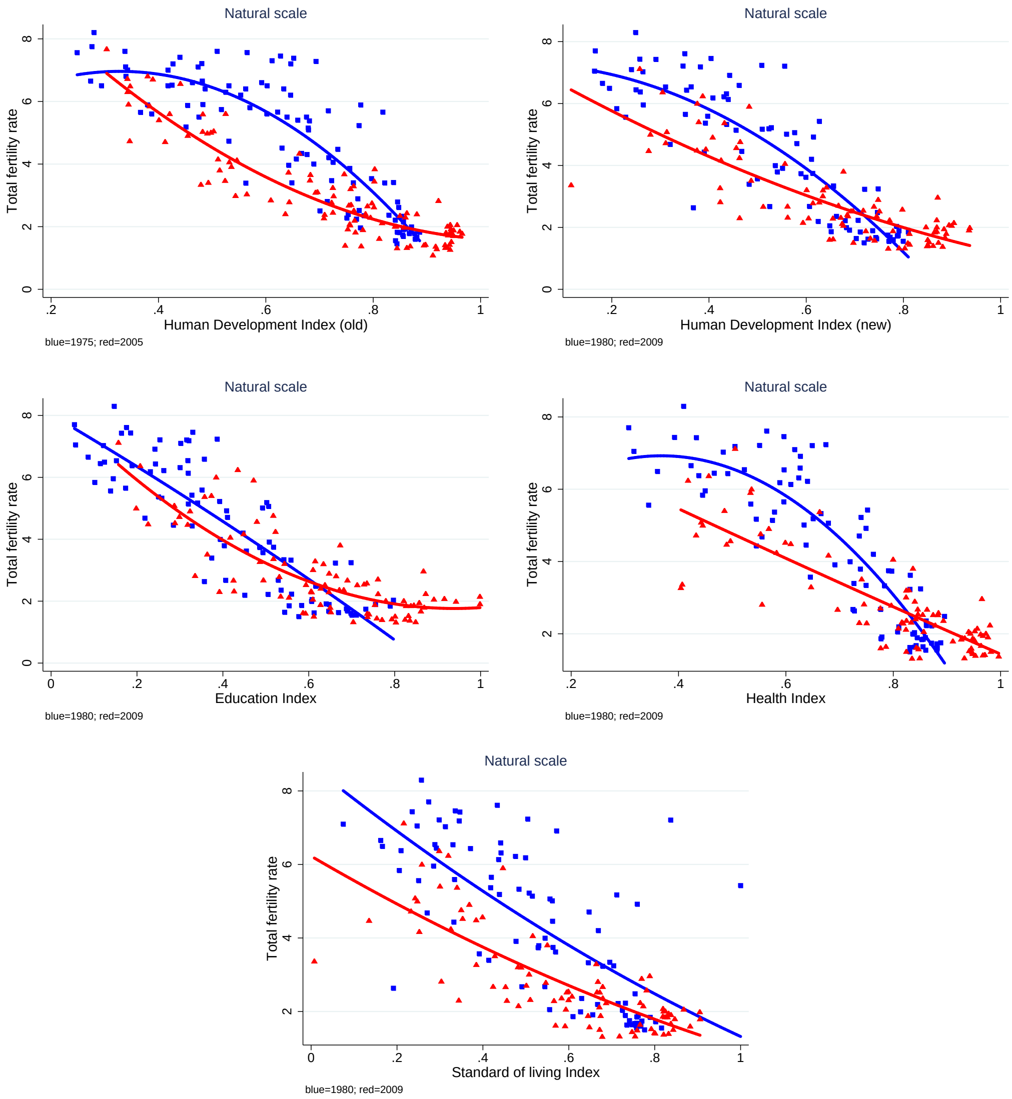
*Note:* Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
*Source:* International Human Development Indicators 2011, Word Development Indicators 2011; calculations by the authors.

Figure 1: Relationship between old and new HDI calculation methodology



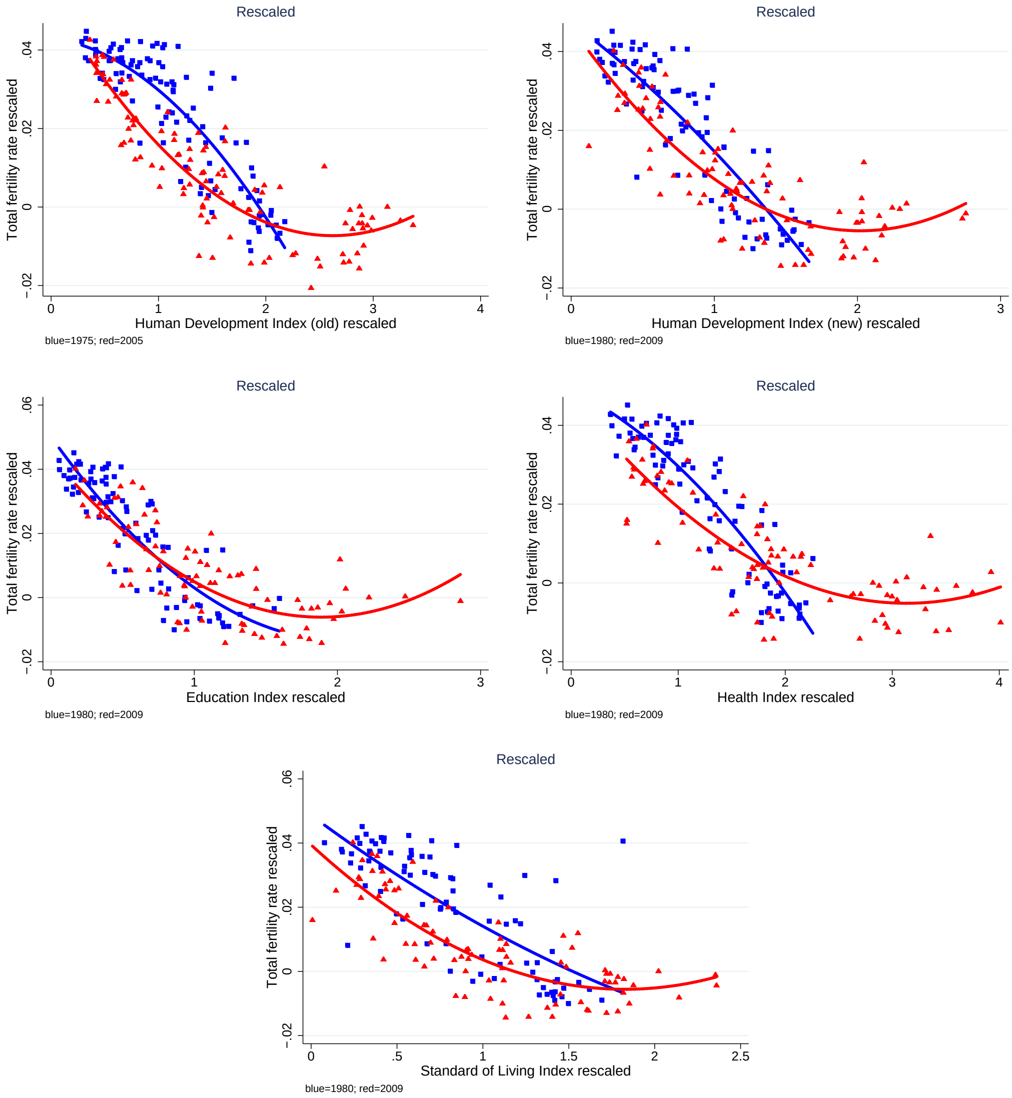

*Source:* International human Development Indicators 2011, Word Development Indicators 2011;

Figure 2: Relationship between HDI, its components and fertility



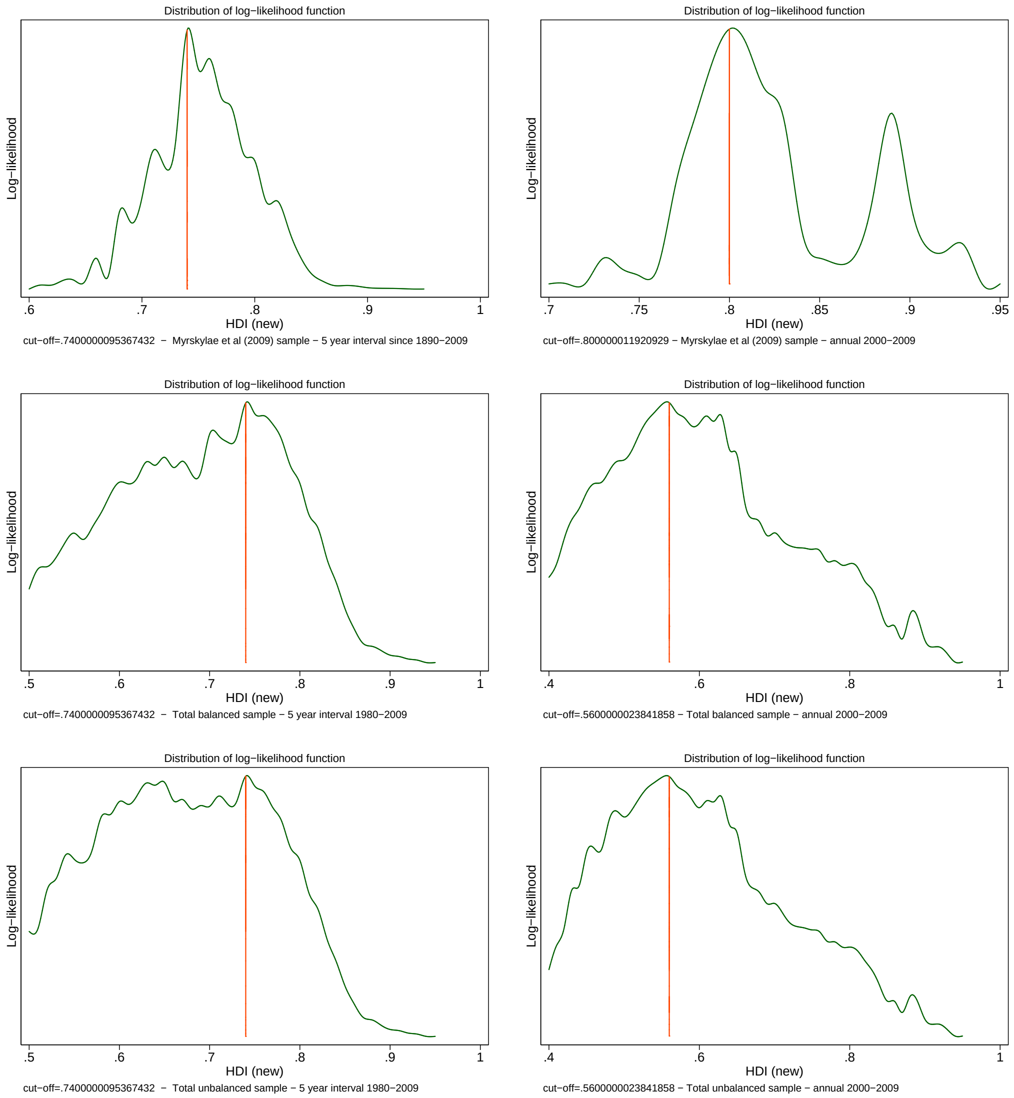

*Source:* International human Development Indicators 2011, Word Development Indicators 2011;

Figure 3: Relationship between HDI, its components and fertility (Rescaled)




*Note:* HDI rescaled $= -\log(1 - \text{HDI})$ and TFR rescaled $= \log(0.4886 \cdot \text{TFR})/31$. Education index: Australia 2009 (0.999), New Zealand 2009 (0.998). Health index: Japan 2009 (0.996).
*Source:* International human Development Indicators 2011, Word Development Indicators 2011;

Figure 4: Log-likelihood function for Difference in Difference Model - New HDI




*Source:* International human Development Indicators 2011, Word Development Indicators 2011;

# Online Appendix

Table A.1: Myrskylä et al (2009) countries used for the longitudinal analysis of the old HDI

| | 1975 | | 2005 | |
|---|---|---|---|---|
| Country | TFR | HDI (old) | TFR | HDI (old) |
| Argentina | 3.53 | 0.80 | 2.29 | 0.86 |
| Australia | 2.15 | 0.86 | 1.77 | 0.97 |
| Austria | 1.82 | 0.84 | 1.41 | 0.93 |
| Belgium | 1.74 | 0.85 | 1.72 | 0.94 |
| Canada | 1.82 | 0.89 | 1.51 | 0.95 |
| Chile | 2.80 | 0.71 | 1.97 | 0.86 |
| Cyprus | 2.24 | 0.77 | 1.42 | 0.90 |
| Denmark | 1.92 | 0.87 | 1.80 | 0.94 |
| Finland | 1.69 | 0.86 | 1.80 | 0.94 |
| France | 1.93 | 0.86 | 1.92 | 0.94 |
| Germany | 1.45 | 0.84 | 1.36 | 0.92 |
| Greece | 2.37 | 0.83 | 1.28 | 0.92 |
| Hungary | 2.35 | 0.78 | 1.32 | 0.86 |
| Iceland | 2.61 | 0.85 | 2.05 | 0.96 |
| Ireland | 3.40 | 0.82 | 1.88 | 0.95 |
| Israel | 3.41 | 0.84 | 2.82 | 0.92 |
| Italy | 2.21 | 0.84 | 1.32 | 0.93 |
| Japan | 1.91 | 0.86 | 1.26 | 0.94 |
| Kuwait | 5.89 | 0.78 | 2.39 | 0.88 |
| Luxembourg | 1.55 | 0.84 | 1.70 | 0.95 |
| Malta | 2.27 | 0.75 | 1.37 | 0.87 |
| New Zealand | 2.33 | 0.85 | 2.00 | 0.94 |
| Norway | 1.99 | 0.87 | 1.84 | 0.96 |
| Portugal | 2.52 | 0.77 | 1.40 | 0.89 |
| S. Korea | 3.47 | 0.72 | 1.08 | 0.91 |
| Spain | 2.79 | 0.85 | 1.33 | 0.94 |
| Sweden | 1.78 | 0.87 | 1.77 | 0.95 |
| Switzerland | 1.60 | 0.88 | 1.42 | 0.94 |
| United Arab Emirates | 5.66 | 0.82 | 2.43 | 0.86 |
| United Kingdom | 1.81 | 0.85 | 1.80 | 0.94 |
| Average | 2.50 | 0.83 | 1.71 | 0.92 |

*Note:* Countries were sorted by the HDI value in 2005. The base sample includes all countries used in Myrskylä et al (2009) for which data from 1980 to 2005 are available. Myrskylä et al (2009) restrict their total sample of countries to countries that had a HDI value 0.85 or higher.
*Source:* Myrskylä et al (2009); calculations by the authors.

Table A.2: Regression results - Differences in Differences (lagged)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Old HDI** | | | | | | |
| | Nature sample 5 year int. (balanced) 1975-2005 | Nature sample annual (balanced) 2000-2005 | Total sample 5 year int. (balanced) 1975-2005 | Total sample annual (balanced) 2000-2005 | Total sample 5 year int. (unbalanced) 1975-2005 | Total sample annual (unbalanced) 2000-2005 |
| Pre | -0.487 | -1.069 | -2.119*** | -1.628*** | -1.452** | -0.601** |
| | (2.476) | (0.791) | (0.722) | (0.310) | (0.611) | (0.260) |
| Post | 8.781*** | 4.172*** | 14.81*** | 10.66*** | 14.40*** | 10.72*** |
| | (2.320) | (0.919) | (1.626) | (0.778) | (1.553) | (0.740) |
| Observations | 173 | 1014 | 525 | 3016 | 631 | 3770 |
| R-squared | 0.344 | 0.235 | 0.614 | 0.458 | 0.604 | 0.447 |
| Cut-off | 0.85 | 0.86 | 0.850 | 0.860 | 0.85 | 0.86 |
| **New HDI** | | | | | | |
| | Nature sample 5 year int. (balanced) 1980-2009 | Nature sample annual (balanced) 2000-2009 | Total sample 5 year int. (balanced) 1980-2009 | Total sample annual (balanced) 2000-2009 | Total sample 5 year int. (unbalanced) 1980-2009 | Total sample annual (unbalanced) 2000-2009 |
| Pre | -10.17*** | -2.525*** | -2.816*** | -3.992*** | -1.585*** | -3.931*** |
| | (2.292) | (0.892) | (0.645) | (0.458) | (0.569) | (0.406) |
| Post | 1.133 | 0.731 | 8.288*** | 3.340*** | 8.571*** | 3.741*** |
| | (1.288) | (0.650) | (0.975) | (0.434) | (0.926) | (0.432) |
| Observations | 160 | 283 | 435 | 1016 | 547 | 1127 |
| R-squared | 0.368 | 0.242 | 0.617 | 0.380 | 0.566 | 0.390 |
| Cut-off | 0.74 | 0.80 | 0.74 | 0.56 | 0.74 | 0.56 |

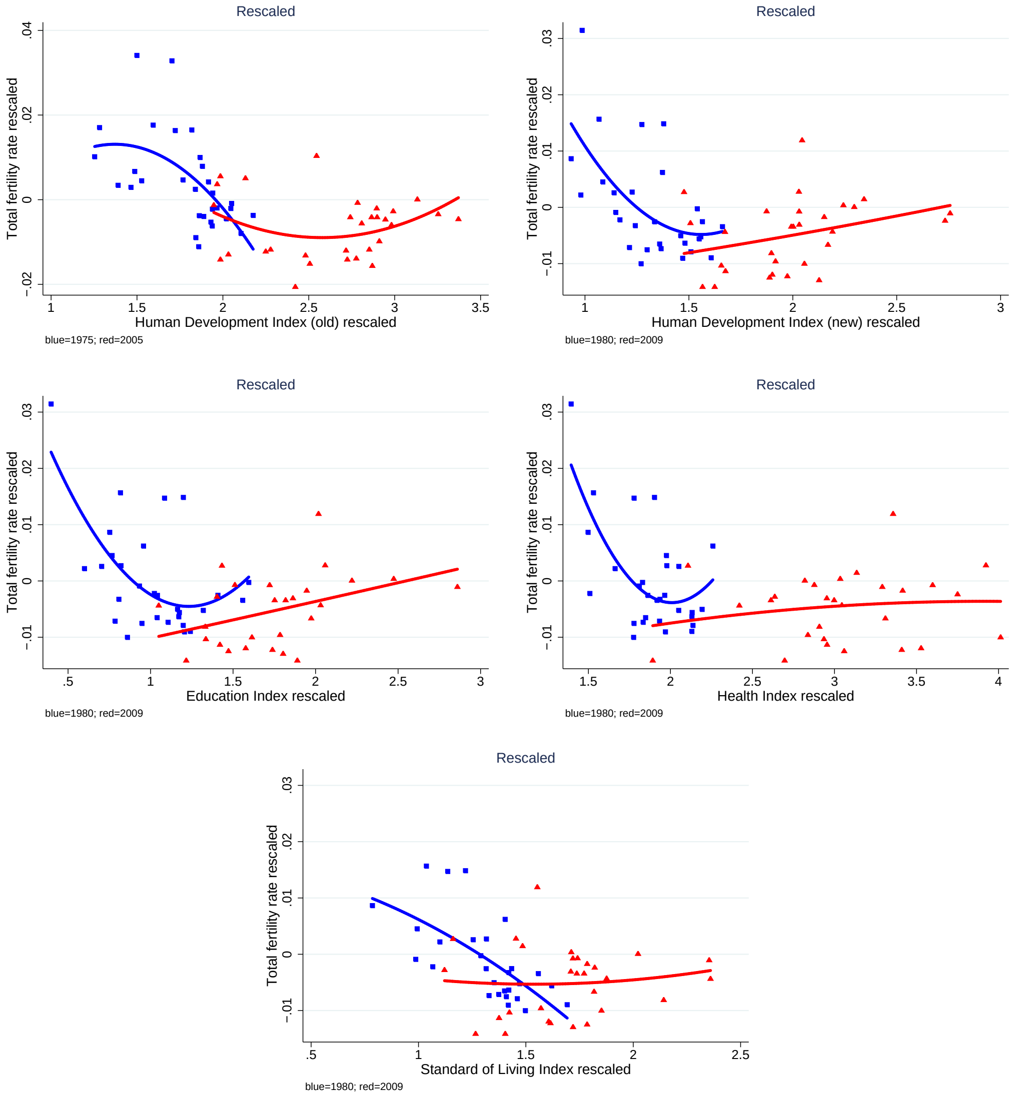
*Note:* Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
*Source:* Myrskylä et al (2009); calculations by the authors; International Human Development Indicators 2011, Word Development Indicators 2011; calculations by the authors.

Table A.3: Regression results - Differences in Differences (HDI Components) (lagged)

| | (1) Nature sample 5 year int. (balanced) 1980-2009 | (2) Nature sample annual (balanced) 2000-2009 | (3) Total sample 5 year int. (balanced) 1980-2009 | (4) Total sample annual (balanced) 2000-2009 | (5) Total sample 5 year int. (unbalanced) 1980-2009 | (6) Total sample annual (unbalanced) 2000-2009 |
|---|---|---|---|---|---|---|
| Education component | | | | | | |
| Pre | -13.73*** | -3.207*** | -4.799*** | -3.128*** | -4.309*** | -2.999*** |
| | (4.739) | (0.673) | (0.485) | (0.303) | (0.497) | (0.304) |
| Post | -0.187 | 0.0781 | 2.142*** | 1.976*** | 1.986*** | 1.993*** |
| | (0.560) | (0.260) | (0.475) | (0.275) | (0.414) | (0.272) |
| Observations | 173 | 283 | 435 | 1016 | 606 | 1158 |
| R-squared | 0.273 | 0.260 | 0.648 | 0.378 | 0.592 | 0.365 |
| Cut-off | 0.44 | 0.72 | 0.63 | 0.64 | 0.56 | 0.64 |
| Standard of living component | | | | | | |
| Pre | 2.962*** | 0.437 | 1.464*** | -1.073*** | 0.603 | -1.536*** |
| | (0.989) | (0.398) | (0.546) | (0.349) | (0.380) | (0.280) |
| Post | 11.05*** | -2.272** | 12.43*** | 1.696*** | 11.46*** | 1.478*** |
| | (1.022) | (1.106) | (1.330) | (0.292) | (1.258) | (0.251) |
| Observations | 166 | 288 | 435 | 1016 | 686 | 1288 |
| R-squared | 0.516 | 0.214 | 0.586 | 0.282 | 0.540 | 0.321 |
| Cut-off | 0.77 | 0.89 | 0.77 | 0.50 | 0.77 | 0.50 |
| Health component | | | | | | |
| Pre | -12.68*** | 7.309*** | -1.304*** | -1.578*** | -2.048*** | -2.000*** |
| | (2.263) | (2.354) | (0.388) | (0.422) | (0.357) | (0.372) |
| Post | -2.164 | 10.45*** | 13.01*** | 10.59*** | 11.63*** | 13.19*** |
| | (2.346) | (2.519) | (1.415) | (0.986) | (1.427) | (1.109) |
| Observations | 180 | 288 | 435 | 1016 | 821 | 1323 |
| R-squared | 0.345 | 0.242 | 0.607 | 0.374 | 0.557 | 0.399 |
| Cut-off | 0.87 | 0.94 | 0.87 | 0.82 | 0.87 | 0.90 |

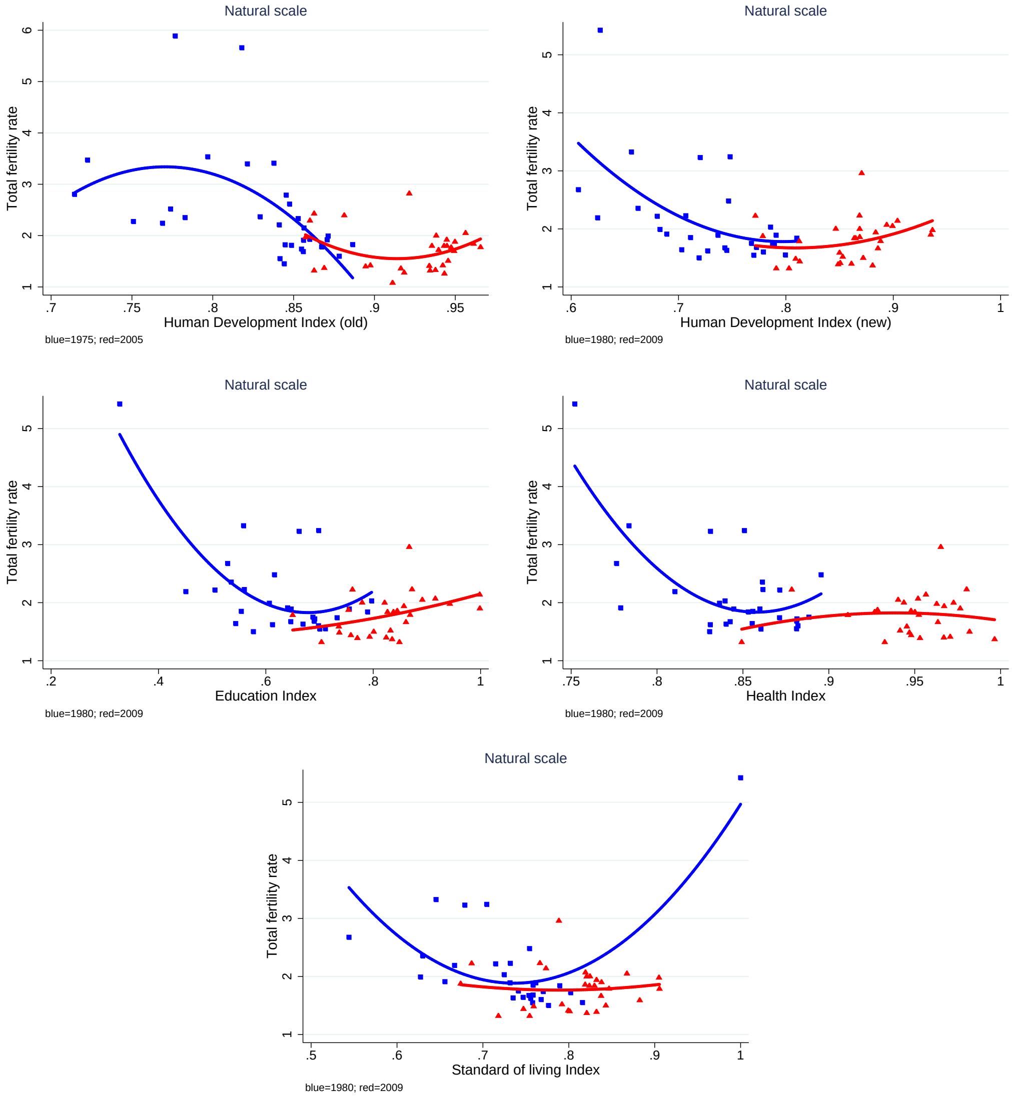
*Note:* Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
*Source:* International Human Development Indicators 2011, Word Development Indicators 2011; calculations by the authors.

Figure A.1: Relationship between HDI, its components and fertility - Myrskylä et al (2009) country sample (Rescaled)



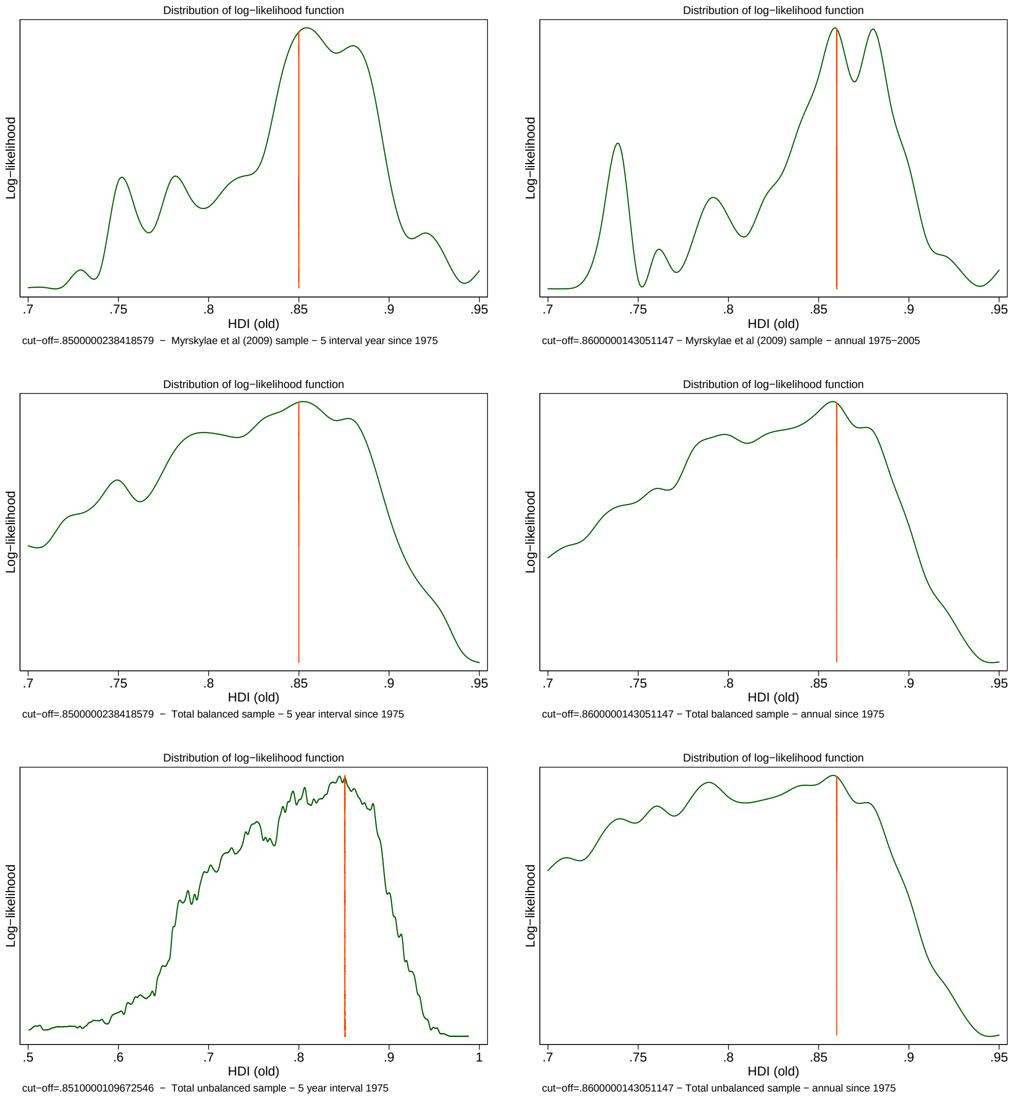

*Note:* HDI rescaled $= -\log(1 - \text{HDI})$ and TFR rescaled $= \log(0.4886 \cdot \text{TFR})/31$. Education index: Australia 2009 (0.999), New Zealand 2009 (0.998). Health index: Japan 2009 (0.996). *Source:* International human Development Indicators 2011, Word Development Indicators 2011.

Figure A.2: Relationship between HDI, its components and fertility - Myrskylä et al (2009) country sample



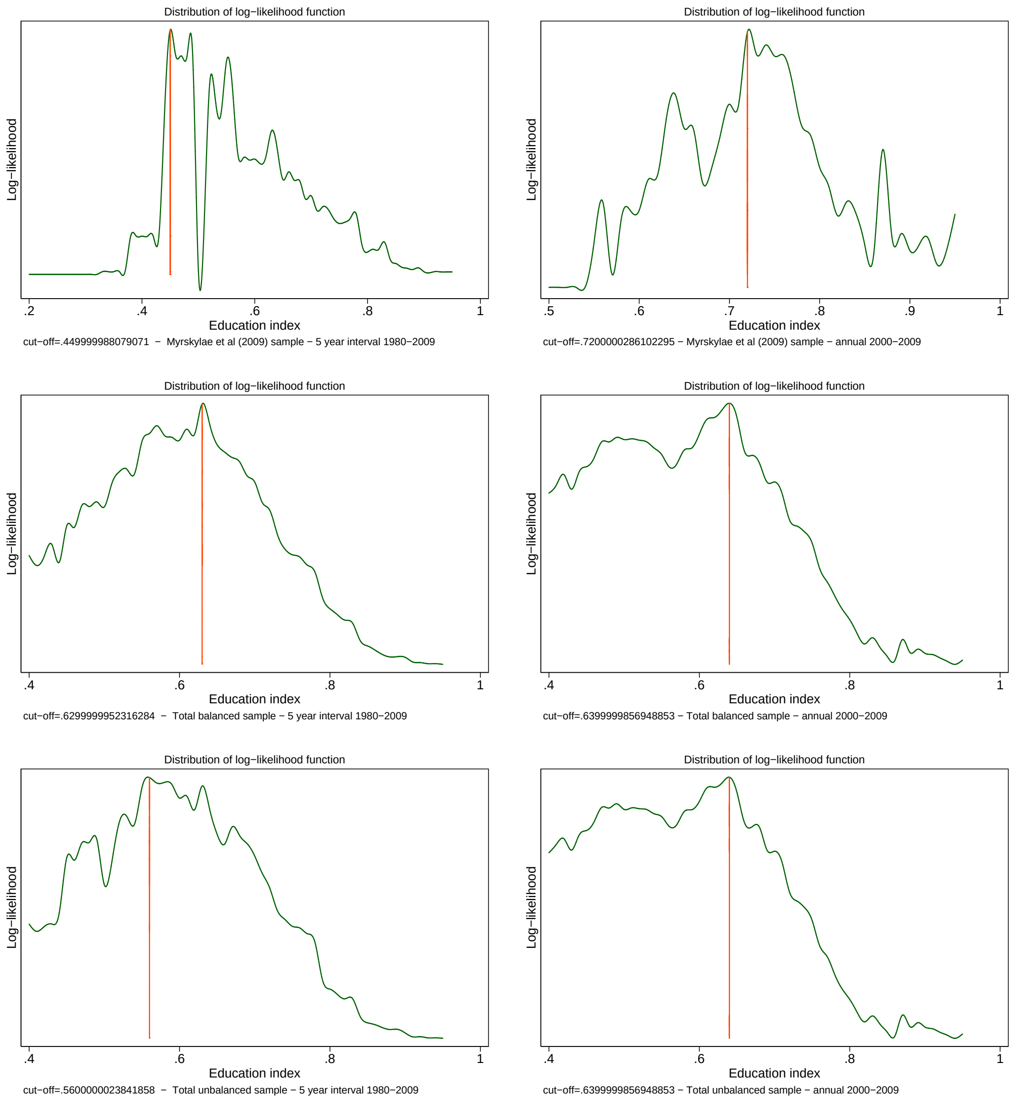

*Source:* International human Development Indicators 2010, Word Development Indicators 2010.

Figure A.3: Log-likelihood function for Difference in Difference Model - Old HDI



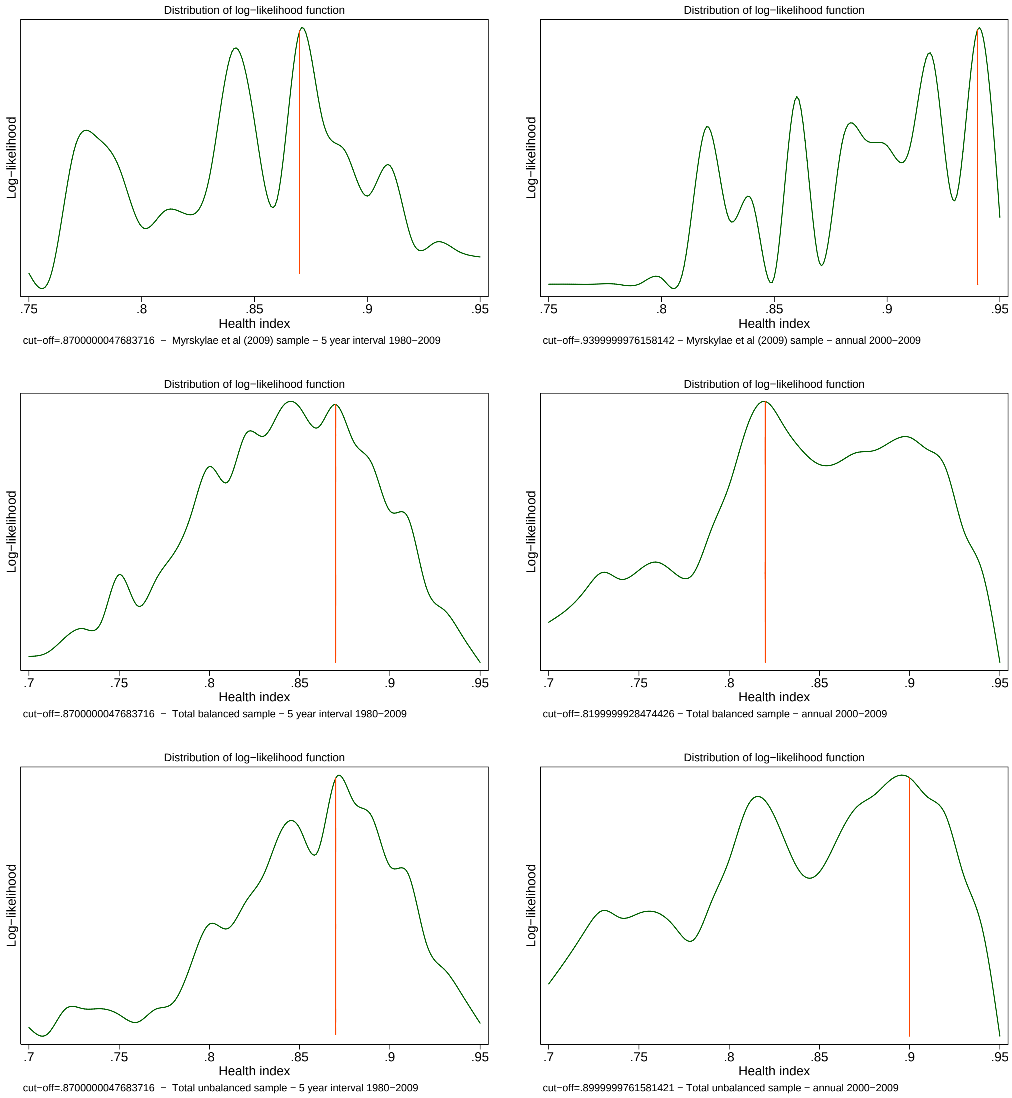

*Source:* International human Development Indicators 2011, Word Development Indicators 2011.

Figure A.4: Log-likelihood function for Difference in Difference Model - Education Component



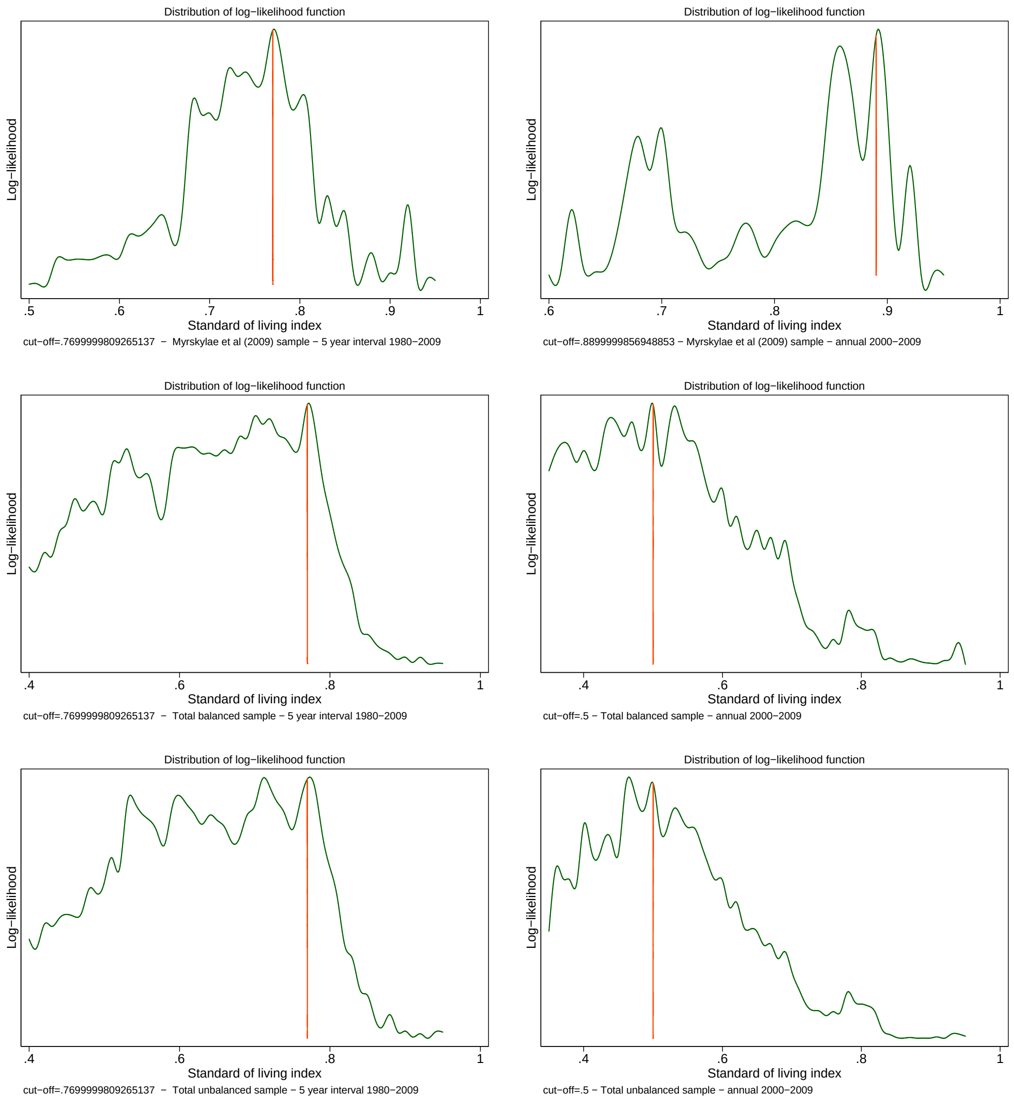

*Source:* International human Development Indicators 2011, Word Development Indicators 2011.

Figure A.5: Log-likelihood function for Difference in Difference Model - Health Component




*Source:* International human Development Indicators 2011, Word Development Indicators 2011;

Figure A.6: Log-likelihood function for Difference in Difference Model - Standard of Living Component




*Source:* International human Development Indicators 2011, Word Development Indicators 2011;