**Online Appendix**

This online Appendix, including model solutions, supporting regressions and country classification, data sources.

**1A. Solving the model**

In each period, an adult solves the following utility maximization problem:

Subject to:

Substituting the budget constraint and human capital accumulation into the utility function gives the indirect utility:

So the first order conditions, FOCs, after some rearrangements become:

First, substituting from into budget constraints, after some rearrangements, gives the optimal fertility rate, .

Second, investment in education is obtained by combining the two FOCs:

From the human capital accumulation we can find the steady state level of human capital:. Hence, the steady state level of education is:

And, finally the fertility rate in the steady state is given by:

Comparative statics with respect to wage, , infant survival, , weight attached to education in human capital function,, marginal time cost associated with raising each child, , and weight attached to children in the utility function, , respectively are:

**2A. Supporting regressions**

**Table 1A: Robustness to the Sub-Saharan African Sample**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Dependent Variable:** | | | | |  |
|  | (1)  Panel IV with Fixed Effect | (2)  Panel IV with Fixed Effect | (3)  Panel IV with Fixed Effect | (4)  Panel IV with Fixed Effect | (5)  Fixed Effect OLS | (6)  Panel IV with Fixed Effect |
|  | ***Panel A: Second Stage Regressions*** | | | | |  |
|  | **0.556\*\*\***  **(40.06)** |  |  |  |  | -0.034  (0.95) |
|  |  | **-0.230\*\*\***  **(26.98)** |  |  |  | **-0.133\*\*\***  **(12.22)** |
|  |  |  | **-0.430\*\*\***  **(13.98)** |  |  | -0.007  (0.27) |
|  |  |  |  | **-0.219\*\*\***  **(32.63)** |  | **-0.029\***  **(1.92)** |
|  |  |  |  |  | **-0.362\*\*\***  **(43.43)** | **-0.271\*\*\***  **(14.04)** |
| **Observations** | 1595 | 1210 | 1155 | 1485 | 1485 | 770 |
| **No. of Countries** | 29 | 22 | 21 | 27 | 27 | 14 |
|  | 0.53 | 0.31 | 0.15 | 0.30 | 0.56 | 0.40 |
| **Fixed Effect** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
|  | ***Panel B: First Stage Regressions*** | | |  | | |
| **Instrumented** |  |  |  |  |  | **All Vars** |
|  | **0.005\*\*\***  **(3.97)** |  |  |  |  |  |
|  | **-0.004\*\*\***  **(18.35)** |  |  |  |  |  |
|  | **-0.007\*\*\***  **(29.97)** |  |  |  |  |  |
|  |  | **0.059\*\*\***  **(33.53)** |  |  |  |  |
|  |  | **0.021\*\*\***  **(8.12)** |  |  |  |  |
|  |  |  | **0.006\*\*\***  **(11.27)** |  |  |  |
|  |  |  | **0.014\*\*\***  **(5.97)** |  |  |  |
|  |  |  |  | **0.570\*\*\***  **(48.47)** |  |  |
|  |  |  |  | -0.000  (0.63) |  |  |
| **Sargan-Hansen Test (p-value)** | 0.165 | 0.841 | 0.796 | 0.458 |  |  |
| **-test**  **(P-values)** | (0.000) | (0.000) | (0.000) | (0.000) |  |  |
|  | 0.69 | 0.56 | 0.13 | 0.63 |  |  |

**Notes**: The numbers in parentheses are absolute *t*-ratios based on standard errors robust to serial correlation, heteroscedasticity and within variation. Constants are included in the regressions but not reported. \*\*\*, \*\* and \* denote significance at the 1%, 5% and 10% levels, respectively.

**Table 2A: Identify Potential Threshold Effect**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Dependent Variable:** | | | | | | | |
|  | 1960 | | 1980 | | 2000 | | 2014 | |
|  | (1)  6.06 | (2) | (3) | (4) | (5)  6.88 | (6) | (7) | (8) |
|  | **0.133\***  **(1.66)** | **0.314\*\*\***  **(4.75)** | **0.415\*\*\***  **(4.55)** | **0.356\*\*\***  **(17.28)** | **0.620\*\*\***  **(8.86)** | **0.295\*\*\***  **(4.04)** | **0.543\*\*\***  **(4.11)** | **0.312\*\*\***  **(7.26)** |
|  | -0.003  (0.25) | **-0.585\*\*\* (8.12)** | **-0.003\*\*\***  **(4.87)** | **-0.423\*\*\***  **(6.04)** | **-0.122\*\***  **(2.77)** | **-0.073\***  **(1.89)** | **-0.518\*\*\***  **(9.77)** | **-0.178\***  **(1.80)** |
|  | -0.023  (1.09) | **-0.163\*\*\***  **(2.85)** | **-0.188\*\*\***  **(15.72)** | **-0.153\*\*\***  **(3.06)** | **-0.066\***  **(1.90)** | 0.108  (1.03) | 0.052  (0.46) | 0.090  (1.25) |
|  | 0.017  (1.01) | 0.494  (0.12) | **-0.190\*\*\***  **(11.54)** | 0.031  (0.63) | 0.000  (0.11) | **-0.117\***  **(1.75)** | **-0.280\***  **(1.81)** | 0.003  (0.08) |
|  | -0.015  (0.32) | 0.713  (0.33) | **-0.173\*\*\***  **(12.44)** | **-0.375\*\*\***  **(3.67)** | **-0.241\*\***  **(2.65)** | **-0.078\***  **(1.77)** | **-0.599\*\*\***  **(3.39)** | **-0.474\*\*\***  **(3.81)** |
| **Observations** | 83 | 9 | 68 | 24 | 44 | 48 | 15 | 77 |
| **F-test (p-value)** | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
|  | 0.15 | 0.93 | 0.60 | 0.85 | 0.84 | 0.46 | 0.74 | 0.58 |

**Notes**: is the threshold variable. We follow Furouka (2009, 2013) to show threshold regression (estimated using OLS) results from different years (1960, 1980, 2000 and 2014) across the entire time span for our panel data, since the Hansen (2000)’s threshold method applies to only cross-section model. The results from other years are not qualitatively different. The numbers in parentheses are absolute *t*-ratios based on standard errors robust to serial correlation, heteroscedasticity and within variation. Constants are included in the regressions but not reported. \*\*\*, \*\* and \* denote significance at the 1%, 5% and 10% levels, respectively.

**Table 3A: Panel Cointegration Test and the Long-run Equilibrium**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Pedroni (1999)’s Panel Cointegration Test | | | Pedroni’s PDOLS Estimates | | |
| **(1)** | (2) | (3) | (4) | (5) | (6) |
| **Test Stats** | Panel | Group | Variables | Coefficients | t-stat |
| v | -2.9 | n/a |  | **0.089\*\*\*** | 4.898 |
|  | 5.122 | 7.051 |  | **-0.034\*\*\*** | 9.001 |
| t | 3.819 | 4.861 |  | **-0.279\*\*\*** | 13.1 |
| ADF | 4.283 | 4.066 |  | **-0.310\*\*\*** | 9.29 |
|  |  |  |  | **-0.120\*\*\*** | 3.56 |

**Notes:** We report all seven statistics of the Pedroni (1999) panel cointegration test, i.e. panel v, panel , group , panel t (nonparametric), group t (nonparametric), panel ADF (parametric t) and group ADF (parametric t) in Columns (1) to (3). The null hypothesis is that there’s no panel cointegration. Columns (4) to (6) report the Pedroni’s PDOLS estimates addressing panel cointegration. 2 lags and leads are selected, the number of panel units is 92, number of observations is 4600, data has been time demeaned. The t-stats are in absolute values. \*\*\*, \*\* and \* denote significance at the 1%, 5% and 10% levels, respectively.

**Table 4A: Panel Causality Test**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Average Wald Statistics (average p-value) | Z-bar Stat (p-value) | Z-bar-tilde Stat (p-value) |
|  | 66.8832  (0.000) | 446.8417  (0.000) | 416.5740  (0.000) |
|  | 100.6933  (0.000) | 676.1528  (0.000) | 630.4821  (0.000) |
|  | 88.2417  (0.000) | 591.7017  (0.000) | 551.7037  (0.000) |
|  | 27.7360  (0.000) | 181.3324  (0.000) | 168.8991  (0.000) |
|  | 63.7309  (0.000) | 413.7388  (0.000) | 385.7016  (0.000) |

**Notes:** The panel causality test is conducted using Dumitrescu and Hurlin (2002)’s method. The null hypothesis is that the dependent variables (in rows) does not granger-cause the independent variable (. The (average) p-values for the (average wald stats) Z-bar and Z-bar-tilde stats are in brackets. In all tests, the lag order option is defaulted at one.

**3A. Country classification**

**Table 5A: Country classification and data availability**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **Type** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| **Afghanistan** | low | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X | X |
| **Albania** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Algeria** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Bangladesh** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Barbados** | middle | X | O | X | X | O | X | O | X | X | X | X | X | X | X | X | X |
| **Belize** | middle | X | X | X | X | O | X | O | X | X | X | X | X | X | X | X | X |
| **Benin** | low | X | X | X | X | X | O | X | X | X | X | X | X | X | X | X | X |
| **Bolivia** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Botswana** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Brazil** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Burundi** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | O | X |
| **Cambodia** | low | X | O | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Cameroon** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Central African Rep.** | low | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X | X |
| **Chile** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **China** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Colombia** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Congo, Dem.Rep.** | low | X | X | X | O | X | X | X | X | O | X | X | X | X | X | X | X |
| **Congo, Rep.** | middle | X | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X |
| **Costa Rica** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Cote d'Ivoire** | low | X | X | X | O | O | O | O | X | X | X | X | X | X | X | X | X |
| **Cuba** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Dominican Rep.** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Ecuador** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Egypt** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **El Salvador** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Fiji** | middle | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X | X |
| **Gabon** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Gambia** | low | X | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X |
| **Ghana** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | O | X |
| **Guatemala** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Guyana** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Haiti** | low | X | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X |
| **Honduras** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **India** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Indonesia** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Iran** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Iraq** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Jamaica** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Jordan** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Kazakhstan** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Kenya** | low | X | X | X | X | X | X | X | O | O | X | X | X | X | X | X | X |
| **Kyrgyzstan** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Laos** | low | X | X | X | X | X | X | X | X | O | X | X | X | X | X | O | X |
| **Lesotho** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | O | X |
| **Liberia** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Lithuania** | middle | X | O | X | X | X | X | X | O | X | X | X | X | X | X | X | X |
| **Malawi** | low | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X | X |
| **Malaysia** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Maldives** | low | X | X | X | X | O | X | O | X | X | X | X | X | X | X | X | X |
| **Mali** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Malta** | middle | X | O | X | X | O | X | O | X | X | X | X | X | X | X | O | X |
| **Mauritania** | low | X | X | X | O | X | X | X | X | O | X | X | X | X | X | X | X |
| **Mauritius** | middle | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X | X |
| **Mexico** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Moldova** | low | X | O | X | X | X | O | X | X | X | X | X | X | X | X | X | X |
| **Mongolia** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Morocco** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Mozambique** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Myanmar** | low | X | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X |
| **Namibia** | middle | X | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X |
| **Nepal** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Nicaragua** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Niger** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Pakistan** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Panama** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Papua New Guinea** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Paraguay** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Peru** | middle | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X | X |
| **Philippines** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Rwanda** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Saudi Arabia** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Senegal** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Serbia** | middle | X | O | X | X | O | X | O | X | X | X | X | X | X | X | X | X |
| **Sierra Leone** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **South Africa** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Sri Lanka** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Sudan** | low | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X | X |
| **Swaziland** | middle | X | X | X | O | X | X | O | X | O | X | X | X | X | X | X | X |
| **Syria** | middle | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X | X |
| **Tajikistan** | low | X | X | X | X | O | X | X | X | X | X | X | X | X | X | X | X |
| **Thailand** | middle | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X | X |
| **Togo** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Tonga** | middle | X | X | X | X | O | X | O | X | X | X | X | X | X | X | X | X |
| **Trinidad and Tobago** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Tunisia** | middle | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Uruguay** | middle | X | X | X | X | X | O | X | X | X | X | X | X | X | X | X | X |
| **Venezuela** | middle | X | X | X | X | X | X | O | X | X | X | X | X | X | X | X | X |
| **Vietnam** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Yemen, Rep.** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Zambia** | low | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Zimbabwe** | low | X | X | X | X | X | X | X | X | O | X | X | X | X | X | X | X |

Notes: 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11: 12: 13: 14: 15: 16: X: available. O: not available.