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DISCUSSION PAPER SERIES

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ABSTRACT

Spurring Economic Growth through Human Development: Research Results and Guidance for Policymakers[1]

Education, general health, and reproductive health are key indicators of human development. Investments in these domains can also promote economic growth. This paper argues for the importance of human development related investments based on i) a theoretical economic growth model with poverty traps, ii) a literature review of evidence that different human development related investments can promote growth, and iii) own empirical analyses that aim at estimating the relative contribution of different human development indicators to economic growth across heterogeneous growth regimes. Our results suggest the following associations: (i) a one-child decrease in the total fertility rate corresponds to a 2 percentage point (pp) increase in annual per capita GDP growth in the short run (5 years) and 0.5 pp higher annual growth in the mid to long run (35 years), (ii) a 10% increase in life expectancy at birth corresponds to a 1 pp increase in annual GDP per capita growth in the short run and 0.4 pp higher growth in the mid to long run, and (iii) a one-year increase in average educational attainment corresponds to a 0.7 pp increase in annual growth in the short run and 0.3 pp higher growth in the mid to long run. By contrast, infrastructure proxies are not significantly associated with subsequent growth in any of the models estimated.

JEL Classification: I15, I25, J11, O15, O20
Keywords: human development, economic development

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1. Introduction

Most countries classified as low or middle income in the mid-20th century experienced substantial economic growth over the last 70 years, but average incomes improved considerably more in some countries than in others. Corresponding differences in human development trajectories accompanied cross-country differences in rates of income growth (see Table A1 in the appendix). The positive association between economic growth and human development outcomes, especially in education, life expectancy, and fertility, is consistent with economic theory and presumably reflects a bicausal relationship: (i) the extent to which increased income allows individuals and governments to invest more heavily in human development and (ii) the impact of improvements in general health, reproductive health, and education on economic growth.

Investments in the domains of education, health, and fertility can promote economic growth by enhancing worker productivity and labor supply and by inducing higher rates of saving, capital accumulation, and technological progress (Barro, 2001; Hanushek, 2013; Bloom and Canning, 2000; Malecki, 1997; Bloom et al., 2000; Lee and Mason, 2010). While substantial evidence supports the impact of human development on economic growth, the literature does not clearly indicate which aspects of human development have the most potent influence on economic growth. The literature also fails to clearly compare human development and its components with other drivers of growth, such as those related to institutional quality or the nature and density of infrastructure.

In this paper we aim to contribute to the literature by assessing the relative extent to which education, health, and fertility can promote economic growth. In addition, we show that other domains that are often mentioned as important for investments, such as infrastructure, are less potent in promoting economic development. This is done i) by a theoretical argument based on an economic growth model with poverty traps, ii) by a comparative review of the literature that analyzes the growth effects of education, health, and fertility separately, and iii) by an empirical analysis in which we assess the relative importance of the different associations between education, health, and fertility on the one hand, and economic growth on the other.

Identification and inference with respect to these effects is performed using cross-country and dynamic panel threshold growth regressions, which allow for heterogeneous growth regimes. Whereas literature on cross-country threshold growth regressions exists (see Hansen, 2000), it does not sufficiently address dynamic threshold panel data growth regressions. This is an important point, because the magnitudes and significance of the effects plausibly differ across growth regimes in a dynamic setting as well. Heterogeneity of economic growth regimes, and thus differences in the effects of growth determinants, poses a new challenge for policymakers, because measures applied in one regime may yield different returns when applied under other conditions.

Bearing in mind the challenges related to reverse causality, we separate the dependent and independent variables in time of their measurement and obtain the following findings: (i) a one-child decrease in the TFR corresponds to a 2 percentage point (pp) increase in annual GDP per capita growth in the short run (5 years) and 0.5 pp higher annual growth in the mid to long run

(35 years), (ii) a 10% increase in life expectancy at birth corresponds to a 1 pp increase in annual GDP per capita growth in the short run and 0.4 pp higher growth in the mid to long run, and (3) a one-year increase in average educational attainment, measured in years of schooling, corresponds to a 0.7 pp increase in annual growth in the short run and 0.3 pp higher growth in the mid to long run. By contrast, infrastructure proxies are not significantly associated with subsequent growth in any of the models estimated.

While we acknowledge that all different approaches in the paper are susceptible to idiosyncratic criticisms, we find that the overall picture is remarkably consistent. Human development focused policies might therefore be the most successful in promoting economic growth.

The paper is organized as follows: Section 2 describes a theoretical framework motivating the importance of investment in human development to escaping national poverty traps. Section 3 reviews the literature on the causal pathways from health, education, and fertility to economic growth and the evidence supporting these mechanisms. Section 4 describes this paper's methodological approach in assessing the associations between health, education, and demographic variables and economic growth and presents the results of these analyses. Section 5 concludes.

2. Theoretical Analysis

The purpose of this chapter is to introduce the basic model of economic growth and to show how poverty traps can emerge and be sustained in such a setting. This allows to isolate the channels by which improvements in education, health, and infrastructure and changes in fertility can exert a causal impact on economic development. The literature review on empirical results and our own analyses in later sections are consistent with the presence of these channels. However, we acknowledge that definitive causal macroeconomic evidence is difficult to establish because all methods that we apply to address issues such as reverse causality can be criticized for different reasons.

To differentiate the effects of investments in infrastructure, health, education, and fertility reduction from a qualitative point of view, we consider an economy in which time $t = 1,2 \dots$ evolves discretely. Aggregate output Y_t depends on the stocks of physical capital K_t and human capital H_t employed in the production process. These two accumulable production factors can be combined to produce aggregate output according to the overall productivity level A_t. The production function that translates factor inputs and productivity into output has the general form

$$Y_t = F(A_t, K_t, H_t),$$

where $F(\dots)$ has positive first partial derivatives and negative second partial derivatives with respect to the accumulable production factors K_t and H_t. Physical capital comprises private production capital, such as machines, production halls, and office buildings, and public capital, such as railroads, highways, electricity grids, and ports. In contrast to physical capital, human capital is embodied in an economy's workers and is mainly determined by the workforce's average health status and education level. Productivity A_t consists of two parts: the economy's technological state, which determines the location of the production possibility frontier, and the efficiency of input use, which determines whether the economy produces at its production possibility frontier (is efficient) or below its production possibility frontier (is inefficient).

2.1 The case of a unique steady-state equilibrium

In a perfectly competitive economy with full information, no externalities, and no over-accumulation of physical capital all agents' investment decisions are efficient. The private and social rates of return coincide for each investment such that the equilibrium outcome is optimal and does not require governmental intervention. In this case, the economy develops according to the well-known dynamics of standard economic growth models with exogenously increasing technology (cf. Solow, 1956; Diamond, 1965). Figure 1 illustrates the development process of such an economy. The horizontal axis depicts the physical capital stock at time t, while the vertical axis refers to the physical capital stock at time $t + 1$. The capital stock in each period carries over from the previous period net of the depreciation of old capital, as given by $\delta * K_t$ (where δ is the depreciation rate). The capital stock rises because of gross investment $I_t = s * F(A_t, K_t, H_t)$, where s is the saving rate. These facts are summarized in the capital accumulation equation of the form

$$K_{t+1} = s * F(A_t, K_t, H_t) + (1 - \delta)K_t$$

that pins down the physical capital stock of the next period as a function of, *inter alia*, saving/investment decisions, s, and past levels of human capital, H_t. For the illustration in the figure, we assume that productivity and human capital stay constant at levels $\bar{A}$ and $\bar{H}$ and that the function $F(\bar{A}, K_t, \bar{H})$ is concave in K_t because the marginal product of physical capital is diminishing. Thus, at some point, capital accumulation stops because additional gross investment is only sufficient to replace additional depreciation. When this is the case, the capital stock at time t and the capital stock at time $t + 1$ coincide and the economy reaches its steady state. In Figure 1, this point is the intersection of the K_{t+1} curve and the 45° line at the corresponding steady-state capital stock K^*. At this steady state, the economy is comparatively rich. Output growth at the long-run steady state depends mainly on technological progress that shifts the production possibility frontier outward (Romer, 1990). In empirical analyses of long-run growth processes in developed countries, the determinants of technological progress are the main regressors of interest, and the specifications of the growth regressions are typically standard linear models of either a cross-country or panel data structure.

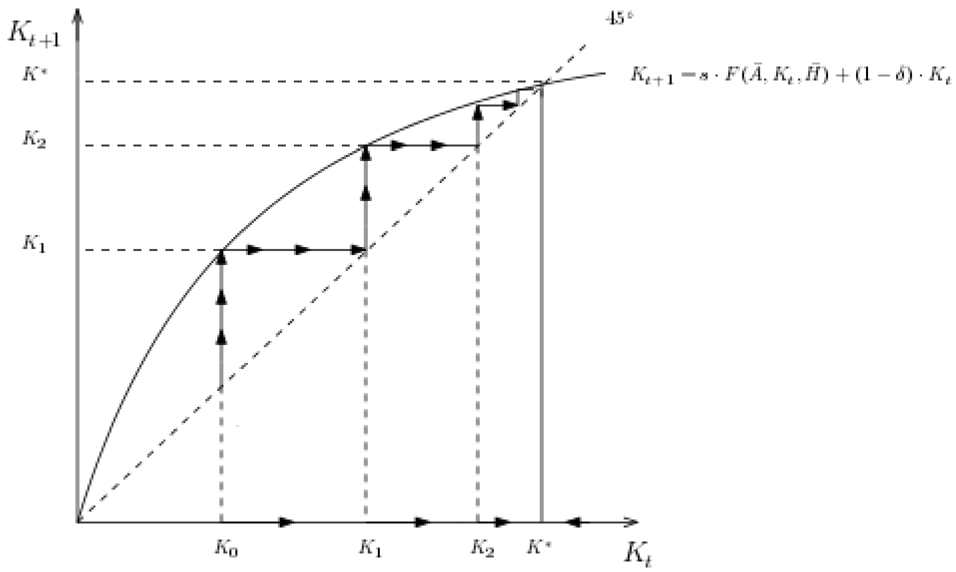

Figure 1. Economic development based on capital accumulation without a poverty trap. The figure illustrates the growth process as described by a discrete-time version of the Solow (1956) model with a constant human capital stock and constant technology.

2.2 The case of multiple equilibria and poverty traps

In contrast to the case of a unique steady-state equilibrium in high-income countries, market imperfections, externalities, and coordination failures among agents can lead to the presence of multiple steady-state equilibria in low-income countries. The multiplicity of equilibria means that some economies will be caught in a poverty trap. In such a poverty trap, income is much lower than it could be at the high-income steady state (described in the previous subsection) because endogenous forces push the economy back into a low-income equilibrium.

Three potential forces that could sustain these poverty traps are

(i) **Poor health status of the population:** The population's general health status could be very low, e.g., due to widespread infectious diseases. Consequently, life expectancy might be so low that private investments in education do not pay off (Ben-Porath, 1967; Cervellati and Sunde, 2005, 2013). Poor population health and its negative consequences for education limit the country's potential for growth, inducing a poverty trap. In this situation, building schools might not be an effective development strategy because the individual return on education and thus education demand are very low.

(ii) **Population growth:** In a country where the majority of the population lives close to the subsistence level, an increase in income (e.g., by a technological improvement or by foreign aid inflows) primarily leads to a higher net rate of reproduction over the subsequent periods. The associated faster population growth additionally strains private and public investments, resulting in declines of physical and human capital whereby the economy remains trapped in the low-income equilibrium.

(iii) **Unaffordable or low-quality education:** If attending schools or universities incurs high fees, or if these institutions do not broadly provide quality education, then some segments of the population will fall short of their educational and human capital potential. Children in these circumstances are likely to be less productive and earn less, impeding the prospects for educational investment in their own children. This could perpetuate poverty across generations and reduce the economy's growth potential (Galor and Zeira, 1993).

For an overview of mechanisms that lead to the emergence of poverty traps see, for example, Galor and Weil (2000), Bloom et al. (2003b), Azariadis and Stachursky (2005), Galor (2005, 2011), Strulik et al. (2013), and Bloom et al. (2017a).

Straightforward extensions of Solow (1956) and Diamond (1965) allow for a qualitative analysis of the dynamics of poverty traps. This analysis clarifies why physical capital accumulation alone might not lift an economy out of poverty and why investments in human capital and fertility reduction are more promising (which is consistent with our empirical findings below). Figure 2 shows the canonical case of the dynamics of economic development in the presence of a poverty trap. Three intersections are present between the K_{t+1} curve and the 45° line such that three qualitatively different steady-state equilibria emerge. One steady-state equilibrium is at the origin, where the capital stock K'^{*} is low and the economy is poor. Another equilibrium is at the capital stock K^{*}, which corresponds to the prosperity equilibrium shown in Figure 1. In between these two equilibria is an unstable steady-state equilibrium, where the vertical red line intersects the K_{t+1} curve. If the economy starts with a capital stock that is lower than that corresponding to the level indicated by the vertical red line, the economy is caught in the poverty trap's basin of attraction and converges to the low-income steady state (as indicated by the arrows in the diagram). Any policy that fails to raise the capital stock to a value above the vertical red line is insufficient to catalyze sustained growth.

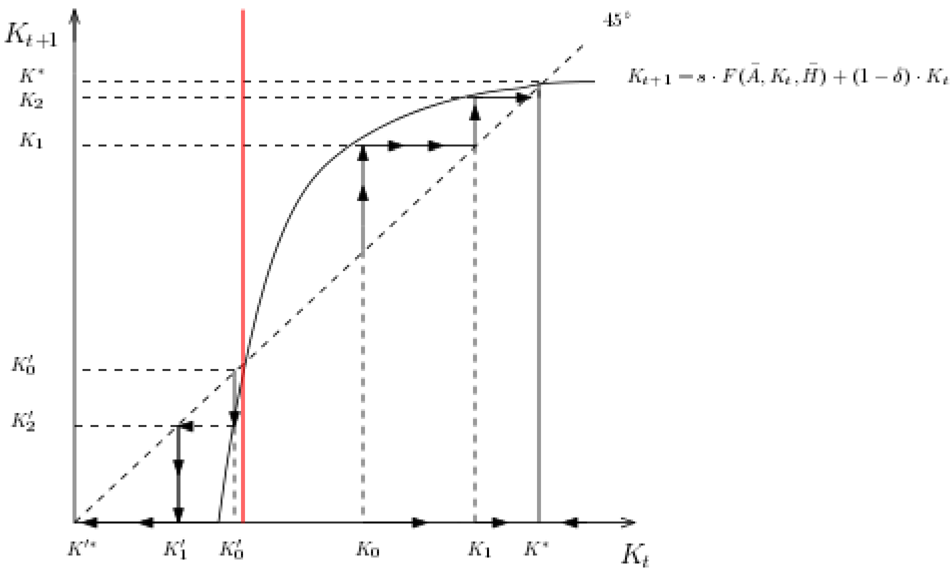

Figure 2. Illustration of a possible poverty trap. If the initial capital stock is located to the left of the vertical red line, the capital stock decreases over time and the economy shrinks toward the origin that represents the poverty trap.

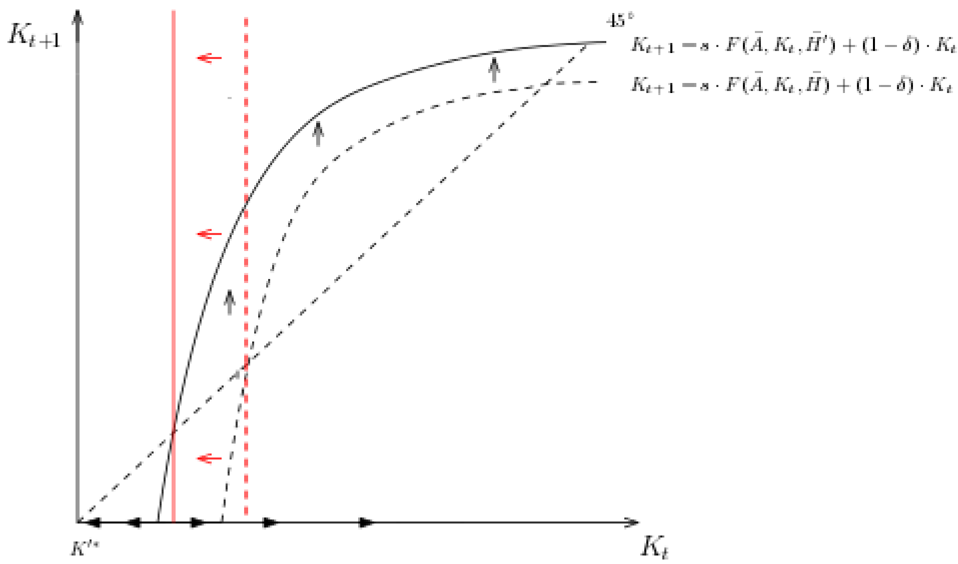

Figure 3. Illustration of the effects of a policy that raises $\overline{H}$ in the case of a poverty trap. The K_{t+1} curve shifts upward such that the poverty trap's basin of attraction shrinks as compared with Figure 2.

Two fundamentally different approaches to escaping such a poverty trap exist. The first is to invest massively in accumulating physical capital, whereby the economy ends up with a capital stock to the right of the vertical red line and in the basin of attraction of the high-income steady state. This "big push" strategy has been used as an argument in favor of immense foreign aid packages and expenditures on large infrastructure projects (cf. Murphy et al., 1989).

The second way to overcome the poverty trap is represented by policies targeted at increasing productivity $\bar{A}$ and/or human capital $\overline{H}$ to shift the K_{t+1} curve upward. This shift shrinks the poverty trap's basin of attraction, as Figure 3 illustrates, in which $\overline{H}$ increases to $\overline{H'}$. Investments in education, health, or fertility reduction could cause such an upward shift. The next section discusses the particular pathways by which enhancing human capital may foster economic growth and reviews the empirical evidence in support of these mechanisms.

3. Literature Overview on the Qualitative and Quantitative Results of Different Investments

2.3 Pathways and qualitative findings

The literature suggests the following pathways as explanations of the growth effects of education investments: better educated individuals (i) are more productive and therefore contribute more to aggregate output (Psacharopoulos, 1994; Hall and Jones, 1999; Bils and Klenow, 2000; Psacharopoulos and Patrinos, 2004, Patrinos and Psacharopoulos, 2011), (ii) more readily adopt productivity-enhancing technologies from abroad (Nelson and Phelps, 1966; Bloom et al., 2015), (iii) are more likely to establish successful and productive firms (Cabral and Mata, 2003; Bhattacharya et al., 2013; Gennaioli et al., 2013), and (iv) increase their team members' productivity through spillover effects (Lucas, 1988; Battu et al., 2003). Overall, a substantial body of macroeconomic literature finds education to be a key determinant of economic growth, suggesting that education's impacts on individual productivity lead to greater total productivity at the country level (see, for example, Barro, 1991; Sala-i-Martin, 1997; Hanushek and Kimko, 2000; Krueger and Lindahl, 2001; Sala-i-Martin et al., 2004; de la Fuente and Domenech, 2006; Cohen and Soto, 2007; Hanushek and Woessmann, 2012, 2015).
Similar pathways suggest that health investments pay off over and above the increases in longevity and reductions in morbidity that are beneficial at the individual level. The literature focuses especially on the following channels: (i) healthier workers are more productive and contribute more to aggregate output (Fogel, 1994, 1997; Shastry and Weil, 2003; Weil, 2007; Kuhn and Prettner, 2016; Bloom et al., 2019); (ii) healthier children tend to perform better in school, which enhances their potential for human capital accumulation (Miguel and Kremer, 2004; Bleakley and Lange, 2009; Field et al., 2009; Bleakley, 2010, 2011; Bloom et al., 2017b; Baldanzi et al., 2019); (iii) healthier individuals are more inclined to educate themselves and to invest (Ben-Porath, 1967; Kalemli-Ozcan et al., 2000; Bloom et al., 2003a, 2007, 2014b; Cervellati and Sunde, 2005, 2013; Prettner, 2013); and (iv) health investments (such as vaccination) that cure or prevent infectious diseases have positive spillovers to other individuals (Luca et al., 2018). Here, too, the positive effect found in micro-based studies is consistent with the macro-based evidence that health is an important determinant of economic growth (Barro, 1991; Sala-i-Martin, 1997; Sala-i-Martin et al., 2004; Lorentzen et al., 2008; Suhrcke and Urban, 2010; Aghion et al., 2011; Cervellati and Sunde, 2011; Bloom et al., 2014a; Bloom et al., 2019).

In addition to enhancing productivity, education and health investments facilitate the escape from fertility-induced poverty traps. Poor countries tend to have much higher youth dependency rates than wealthier countries. Supporting the basic needs of a relatively large child population imposes a substantial resource burden, necessitating the diversion of resources from other productive investments and ultimately impeding economic growth. While this high youth dependency partly reflects high infant and child mortality, it is primarily driven by the high fertility rates in these settings. As women become healthier, more educated, and more empowered, and as their expectations regarding child mortality improve, they tend to have fewer children, which helps to escape fertility-induced poverty traps and to converge onto a development path with low fertility and sustained economic growth (see Becker et al., 1990; Galor and Weil, 2000; Galor, 2005, 2011; Diebolt and Perrin, 2013a, 2013b; Bloom et al., 2015; Prettner and Strulik, 2017a, for the theoretical mechanisms and Brander and Dowrick, 1994; Ahituv, 2001; Li and Zhang, 2007; Herzer et al., 2012; Crespo Cuaresma et al., 2014, for empirical evidence). The economic gains from lowering fertility (known as the "demographic dividend") can be sizable (Bloom and Williamson, 1998; Bloom et al., 2003c, 2017a; Golley and Tyers, 2012; Misra, 2015). In addition, published research has revealed a second demographic dividend due to ageing (Mason and Lee, 2006), wherein persons expecting to live longer accumulate more assets to smooth consumption in old age.

3.1. Quantitative results from the literature

Quantitative assessments of the return on investment (ROI) from health, education, and fertility show that their impacts on productivity are sizeable. Psacharopoulos (1994), Hall and Jones (1999), Bils and Klenow (2000), and Montenegro and Patrinos (2014) demonstrate that, on average, income is about 10% higher for each additional year of schooling. Psacharopoulos and Patrinos (2018) estimate even higher returns for low-income countries. In particular, average private rates of return to schooling are highest in Latin America and the Caribbean and for sub-Saharan Africa and lowest for Europe, the Middle East, and Northern Africa. Table 1 presents the findings of four prominent studies on education and growth of per capita GDP. The relation between schooling and growth is positive and ranges from 0.2% to 12.5% per each additional year of schooling with most of the estimates clustering in the range of 0.5% to 1.2%. A 25-point improvement in Programme for International Student Assessment (PISA) score, a measure of educational quality, is similarly associated with a 0.5 pp increase in annual GDP per capita growth. These improvements in education may have a positive spillover effect on health as well (Pradhan et al., 2017, p. 424; Lutz and Kebede, 2018).

Table 1. Selected prominent studies on the relation between one-year increases in schooling and per capita GDP growth in percentage points

Sources	Relation to per capita GDP growth	Time frame	Coverage
de la Fuente and Domenech (2006, p. 28)	0.574–1.151% per schooling year	1960–1990	World
Cohen and Soto (2007)	1.05–1.26% per schooling year	1960–1990	World
Lutz et al. (2008, Fig. S1, Supplements)	0.2–12.5% per schooling year	1970–2000	World
Hanushek and Woessmann (2012)	0.5% per 25 PISA test score points	1960–1990	World

Fogel (1997), Weil (2007), and Shastry and Weil (2003) quantify the effects of health improvements on economic growth. Fogel (1997) provides historical evidence that improved nutrition (as observed over the period 1780–1980 in Great Britain) raised the productivity of the workforce by 95%. Weil (2007) estimates that a 10% increase in the adult survival rate leads to a 6.7% increase in productivity per worker and a 4.4% increase in GDP per worker. Shastry and Weil's (2003) results imply that differences in adult survival rates can explain as much as one-third of cross-country variation in GDP per worker. Bloom et al.'s (2019) macroeconomic estimates lie in between the results derived by Shastry and Weil (2003) and Weil (2007) based on the aggregation of microeconomic effects. Bloom et al.'s results indicate that a 10% increase in the adult survival rate leads to a 9.1% higher productivity per worker. Table 2 includes the results of selected studies that address these problems.

Table 2. Selected prominent studies on the relation between increases in life expectancy and GDP per capita (or income) growth

Sources	Effect on growth	Time frame	Region
Bloom et al. (2014a, p. 1364)	A 1-year increase in life expectancy raises per capita income between 5% and 15% over a 60-year period	1940–2000	World
Bloom et al. (2004)	A 1-year increase in life expectancy is associated with a 4% increase in long-run per capita output	1960–1990	World
Aghion et al. (2011, Table 5)	A 1% increase in life expectancy at birth is associated with 2.88%–9.46% higher growth	1960–2000	OECD
Cervellati and Sunde (2011, p. 130)	A 1% increase in life expectancy at birth in post–demographic transition countries is associated with a 1.94%–4.14% higher growth rate	1940–2000	World
Bloom et al. (2018a, p. 16)	A 10% increase in adult survival rates is associated with an increase in labor productivity of 9.1%	1960–2010	World
Weil (2007, p. 1291)	A 10% increase in adult survival rates is associated with an increase in labor productivity of 6.7% and thus GDP per worker of 4.4%	-	Australia, Denmark, Finland, France, Italy, Japan, the Netherlands, Norway, Sweden, and the UK
Shastry and Weil (2003, p. 394)	Changes in health can explain 19% of cross-country	-	World

	differences in per capita income		

Note: OECD = Organisation for Economic Co-operation and Development. Studies with a – under time period are cross-sectional.

Ashraf et al. (2013) simulate output trajectories for different demographic scenarios and show that reducing the total fertility rate (TFR) by 0.5 children per woman raises per capita GDP by 11.9% after 50 years. Assuming linearity in the dependence between economic growth and fertility reduction, this implies that reducing the TFR by one child leads to an economic growth rate that is 0.45 pp higher (see also Bloom et al., 2017a). For Asian countries, the results of Bloom and Williamson (1998) and Bloom and Finlay (2009) suggest that one-third of East Asia's "growth miracle" is due to the demographic dividend that followed the strong decline in fertility in these countries. This corresponds to an increase in GDP per capita growth of about 0.66% for each one-child reduction in the TFR. Even small changes in infant mortality, wherein lower fertility rates follow increased survival rates, may lead to a substantial rise in growth (see effects from the selected studies in Table 3).

Table 3. Estimates for demographic dividends

Sources	Effects found	Time frame	Region
Bloom and Williamson (1998, p. 435–437)	A 1% higher growth rate of the working-age population is associated with an increase of 1.37%–1.46% in the growth rate of GDP per capita	1960–1990	East and Southeast Asia
Bloom and Finlay (2009, p. 58)	A 1% higher growth rate of the labor force is associated with an increase of 1.665% in the growth rate of GDP per capita	1965–2005	World

We also analyzed literature that studied the relationship between infrastructure spending and economic growth. Influential works by Barro (1990) and Canning and Pedroni (2008) suggest that government spending—and infrastructure spending in particular—may enhance economic development and growth. Other findings (Crafts, 2009) suggest that the effect is heterogeneous and that other countereffects may outweigh the positive ones.

4. Empirical Analysis

The previous section's estimates are drawn from various sources that use different country samples, time frames, controls, and datasets (of varying quality). Furthermore, these studies utilize different econometric methods and account for different types of costs and benefits. Most importantly, these studies typically focus only on one aspect such as education or health and not on different aspects together. As such, these results are helpful for discerning the general impacts of different types of expenditures but do not lend themselves easily to straightforward comparisons of the relative ROI across sectors.

One main virtue of the original empirical analyses presented in this paper is that they estimate the impact of health, fertility, education, and infrastructure on GDP per capita simultaneously and under an internally consistent methodological framework. These analyses can better isolate the different relationships of interest and estimate their magnitudes in a fully comparable manner. Our empirical strategy[2] is based on growth regressions in both cross-country and panel data settings. Cross-sectional analyses are used to capture cumulative relationships over a relatively long time horizon. Here we use initial levels of explanatory variables to explain economic growth over the following time period as a means of addressing issues of reverse causality. However, this does not control for confounding factors that may influence both initial levels of explanatory variables and subsequent growth and thus does not fully address endogeneity concerns. As such, dynamic panel data methods are used to make better inferences about the effects over a five-year interval. Our dynamic panel data specification treats all explanatory variables as endogenous ones thus instrument these by their lagged levels and differences – this way we try to tackle endogeneity at least in the time dimension.

The data for the cross-country and subsequent panel data analysis is taken from different sources and the number of country observations is restricted by the size of the full set of the explanatory variables. The cross-country regressions explain annual per capita GDP growth rates between 1980 and 2015 as a function of initial income (two time points selected as in Barro, 1991, p. 410), the share of equipment investments, the initial level of life expectancy, mean years of schooling, the total fertility rate, electricity usage per capita (a proxy for infrastructure), the share of the population that is of working age (i.e., age 15–64) to control for the initial demographic structure, and political rights (a proxy for institutions).[3] As for the data sources, per capita GDP, life expectancy, the total fertility rate, electricity usage per capita, and the share of the population that is of working age are taken from the World Development Indicators (World Bank, 2018), whereas the share of equipment investments is taken from DeLong and Summers (1991), the political rights index from Gastil (1987) and Barro (1991) and mean years of schooling from Barro and Lee (2013). The same sources were used for the panel data analysis with the exception of the data on political rights, which were taken from the Freedom House (2018).

To be consistent with the presence of poverty traps based on the theoretical analysis, our data should exhibit multiple equilibria. As such, before we proceed to formulating the empirical strategy, we test the income data for the presence of multiple equilibria, or thresholds. The first step in testing for the presence of multiple growth regimes is to conduct a univariate analysis of distributions for the countries in our sample, similar to the one of Quah (1996). Three well-established modality tests are applied using 1960, 1980, and 2015 GDP per capita data for the

[2] An alternative strategy is a micro-simulation using a general equilibrium model as in Kabajulizi et al. (2017) and Mohammed (2018), where the causal impact of expenditures is modeled for Uganda and Algeria, respectively. However, due to calibration issues, these simulations are generally better suited for specific countries, rather than for large cross-country samples. Thus, to provide a broader analysis we base our empirical approach on the well-established growth regression framework.

[3] One could assume nonlinearities in these relationships (e.g., the diminishing returns to education) and interaction terms between variables (e.g., that investments in education may increase productivity to a greater extent when a population is healthy). However, inclusion of these extra terms did not improve the predictive power of the models developed in this paper, possibly due to the relatively small sample of countries.

countries involved in our further analysis: the original Silverman (1981) test; the improved Hall and York (2001) test, specifically tuned for unimodality testing; and the Fisher and Marron (2001) test, which is superior in handling outliers. These tests reveal mixed evidence in favor of unimodality for GDP per capita analyses of 1960 data: the Hall and York (2001) test does not reject unimodality, whereas the Fisher and Marron test does (see Table 4). However, both tests reject unimodality in favor of bimodality for 1980 and 2015 numbers. Figure 4 indicates that the 1980 modes are located near 8.02 (3,041 International Dollar adjusted for purchasing power (INT-$)) and 10.2 (26,903 INT-$), corresponding to the low- and high-income equilibria, respectively. The antimode of 8.8 (6,634 INT-$) for 1980 serves as a virtual borderline between these two regimes. For 2015, the modes are located near 8.21 (3,679 INT-$) and 10.71 (44,802 INT-$). This indicates that the income distribution shifted higher, but maintained bimodality, making the threshold analysis valid throughout the period.

While bimodality was maintained throughout the period, dispersion increased among low-and-middle-income countries (LMICs), reflecting the fact that countries like China, Indonesia, and South Korea moved to upper quartiles within the LMIC group, while other countries experienced very little growth. Strikingly, only South Korea managed the transition from the low-income equilibrium in 1980 to the high-income equilibrium in 2015. Understanding the modality and the implications of the presence of different income regimes is crucial for the estimation strategy, because the effects may have different magnitudes for different regimes (and may even offset one another).

Table 4. Testing income modality

log GDP p.c.	Hall and York (2001) / Silverman (1981)	Fisher and Marron (2001)
	H0: Unimodality	
1960	0.08	0.044
1980	0.042	0.039
2015	0.043	0.028
	H0: Bimodality	
1980	0.96	0.662
2015	0.486	0.243

Note: for all tests 1,000 bootstrapping rounds are conducted; support is derived from the range of the sample; p.c. = per capita

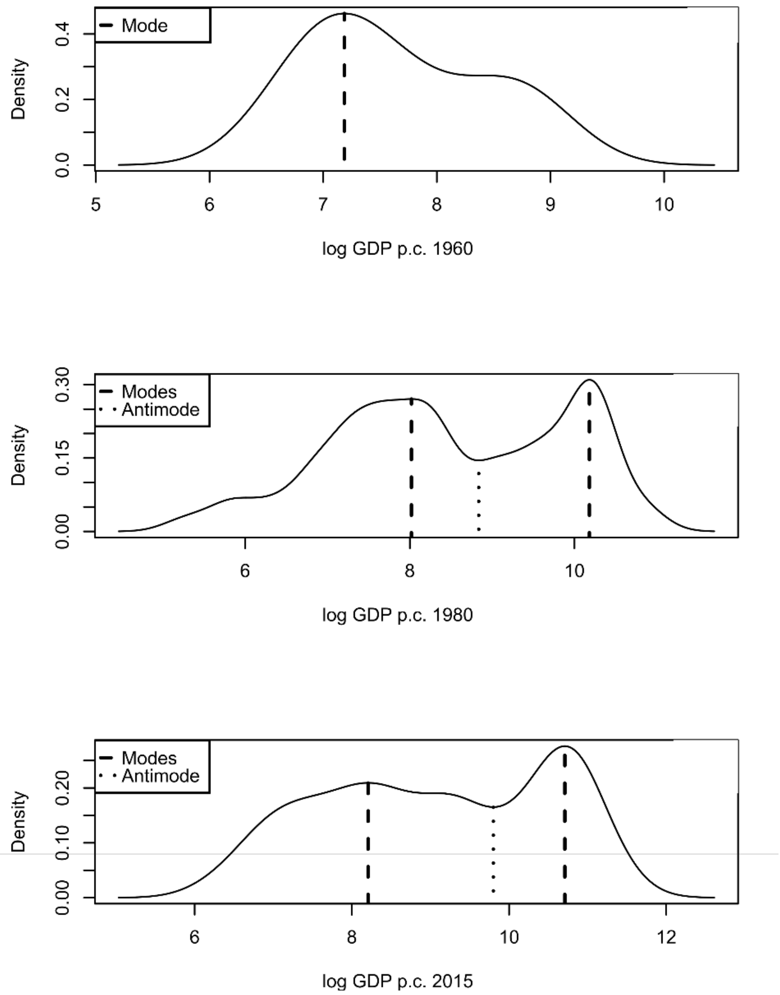

Figure 4. Evolution of the log of GDP per capita distribution from 1960 to 2015. The same sample of 69 countries is used for the estimation. Critical bandwidths used from 1960, 1980, and 2015 are 0.41, 0.26, and 0.4.

To address the problem of poverty traps, we apply single and multiple equilibria empirical strategies. The equation for the single equilibrium approach allows for one single set of coefficients,

$$\bar{y}_{i,T-t_0} = \beta_0 + \beta_1 y_{i,t_0} + \beta_x X_{i,t_0} + u_{i,T-t_0} \ , \tag{1}$$

whereas the multiple equilibria approach, as in Hansen (2000), allows for two sets of coefficients:

$$\bar{y}_{i,T-t_0} = \begin{cases} \theta_{10} + \theta_{11} y_{i,t_0} + \theta_{1x} X_{i,t_0} + u_{i,T-t_0} \ q_i \leq \gamma \\ \theta_{20} + \theta_{21} y_{i,t_0} + \theta_{2x} X_{i,t_0} + u_{i,T-t_0} \ q_i > \gamma \end{cases} \tag{2}$$

where $\bar{y}$ is the annual growth rate of GDP per capita between time t_0 and T, y is income at time t_0, X is a matrix of growth determinants at time t_0, u is the error term, i is the country subscript, and β and θ denote the coefficients of interest, whereas γ and q_i denote the threshold and the threshold variable. We use the initial levels of the selected growth determinants (i.e., their values at t_0) to limit the influence of endogeneity and reverse causality on the estimated coefficients. For the threshold variable, we use the logarithm of initial income to distinguish between countries around the low- and high-income equilibria.

In the single equilibrium estimations (Table 5, column 1), fertility was the most powerful predictor of growth. In this specification, the only other significant effects were the convergence effects and the share of equipment investments. However, the single equilibrium approach may be problematic because effects may vary in magnitude and sign across different segments of the data; the multiple equilibria analysis in Table 5 (columns 2 and 3) separately estimates effect magnitudes for low- and high-income countries (for the list of countries, see Table A3 in the appendix). The threshold between low- and high-income countries, γ, is determined during the estimation.[4] This reflects bimodality of income that was persistent during the period of our analysis (as shown previously).[5] For the countries in the low-income equilibrium, the following variables were significant: initial income, the share of equipment investments, life expectancy, fertility, the working-age population share, and the share of the rural population. It follows that low-income countries exhibit a higher speed of convergence than high-income countries. A 10% increase in life expectancy for the low-income countries is linked to a 0.39 pp increase in average annual per capita GDP growth over the following 35 years. Increasing mean years of schooling by one year is in turn linked to a 0.27 pp increase in annual growth. Decreasing TFR by one child per female is associated with a 0.5 pp and 1 pp increase in growth for low- and high-income countries, respectively. No empirical evidence of heteroscedasticity was found, and standard errors were used for both estimation strategies.

Table 6 points out the absence of an omitted variable bias according to the Ramsey test. The inclusion of regional dummies improves the results of the given test slighty. Therefore, we additionally conduct a robustness check with regional dummies for Sub-Saharan Africa and South-East Asia validating our results (see Table A2).

Initial income is an intuitive variable for determining thresholds in the multiple equilibria analysis. However, other variables can be used to delineate thresholds as well: for example, Bloom and Canning (2007) focus on mortality traps and distinguish equilibria using life expectancy data. The state of the country with respect to the demographic transition can also be used to differentiate equilibria. Although correlated with income, the timing of a country's demographic transition can provide additional perspective on variation in economic growth determinants among demographic transition forerunners, followers, trailers, and latecomers (Reher, 2004). Bimodality of fertility transitions is plausible (see Figure 5), and the Hall and York (2001) and Fisher and Marron (2001) tests both reject unimodality, with p-values of 0.022

[4] The multiple equilibria analysis presented in Table 5 assumes two regimes, reflecting the bimodal income distribution evidenced previously.

[5] Implementing these analyses assuming a larger number of regimes would be problematic due to the sample size.

and 0.0002, respectively. According to the threshold analysis, forerunners and followers belong to one regime, whereas trailers and latecomers belong to the other. Table 6 shows that using thresholds based on the timing of the demographic transition produces effect estimates that correspond reasonably well to those produced using initial income: for trailers and latecomers, life expectancy is significant and positive, and for forerunners and followers, mean years of schooling is the most significant determinant. Once again, fertility is significant and negative for both regimes, whereas life expectancy shows a negative effect for forerunners and followers. The latter could be explained by the fact that increases in life expectancy in forerunners and followers are mainly due to reductions in mortality beyond the retirement age such that the positive effects of increasing life expectancy on economic growth that would occur through increases in labor productivity of workers cannot play out for this group (Bloom et al., 2019). Another interesting finding is that forerunners of the demographic transition exhibit a lower speed of convergence, whereas the followers exhibit a higher speed of convergence: this finding is intuitive, since many of the followers are countries with relatively low income. Controlling for regional dummies, Sub-Saharan Africa and South-East Asia did not change our results substantially (see Table A2).

Table 5. Single (1) and multiple equilibria (2 and 3) analysis; annual GDP per capita growth rates in 1980–2015

		Low income	High income
	(1)	(2)	(3)
Variables	Overall	$q_i \leq \gamma$	$q_i > \gamma$
log of GDP p.c., 1980	-0.0128***	-0.0169***	-0.0143**
	(0.00285)	(0.00424)	(0.00600)
log of GDP p.c., 1960	-0.00435	-0.00268	-0.00832
	(0.00318)	(0.00487)	(0.00525)
equipment investment share (DeLong and Summers, 1991)	0.101*	0.184*	0.108
	(0.0505)	(0.0992)	(0.0693)
log of life expectancy, 1980	0.00927	0.0390**	-0.0470
	(0.0176)	(0.0193)	(0.0470)
mean years of schooling, 1980	0.00105	-0.000953	0.00273***
	(0.000744)	(0.00115)	(0.00105)
fertility, 1980	-0.00992***	-0.00521*	-0.0103**
	(0.00229)	(0.00304)	(0.00511)
log of electricity usage p.c., 1980	0.000483	0.00144	0.00359
	(0.00178)	(0.00185)	(0.00442)
working-age population share, 1980	-0.000412	0.00203**	-0.00106
	(0.000564)	(0.000934)	(0.000916)
rural population share, 1980	-2.60e-05	-0.000292*	2.78e-05
	(7.72e-05)	(0.000169)	(9.68e-05)
political rights (Gastil, 1987; Barro, 1991)	0.00123	0.00177	0.00145
	(0.000990)	(0.00118)	(0.00186)
constant	0.168*	-0.0752	0.458*
	(0.0992)	(0.129)	(0.249)
countries	69	35	34
R-squared	0.679		
R-squared adj.	0.624		
Breusch-Pagan test (p value)	0.884		

Threshold (log of GDP p.c., 1980)	8.38

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: p.c. = per capita

Table 6. Specification test for the omitted variable bias

Equation	Ramsey RESET test (p value)
(1)	0.1435
(9)	0.2105

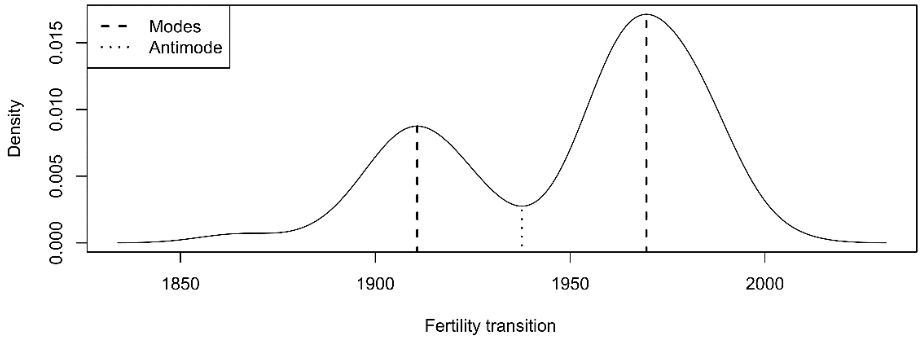

Figure 5. Fertility transition years as in Reher (2004); sample of 58 countries; critical bandwidth: 10.35.

Table 6. Multiple equilibria analysis; annual GDP per capita growth rates in 1980–2015

	Forerunners and followers	Trailers and latecomers
	(4)	(5)
Variables	$q_i \leq \gamma$	$q_i > \gamma$
log of GDP p.c., 1980	-0.0125***	-0.0176***
	(0.00473)	(0.00362)
log of GDP p.c., 1960	-0.00788*	0.00217
	(0.00464)	(0.00381)
equipment investments share (DeLong and Summers, 1991)	0.0825	0.186**
	(0.0598)	(0.0886)
log of life expectancy, 1980	-0.123***	0.0379**
	(0.0410)	(0.0175)
mean years of schooling, 1980	0.00287***	0.000251
	(0.000804)	(0.00103)
fertility, 1980	-0.0192***	-0.00822***
	(0.00466)	(0.00245)
log of electricity p.c. usage, 1980	0.00113	-4.28e-05
	(0.00327)	(0.00172)
working-age population share, 1980	-0.000851	0.000436
	(0.000764)	(0.000799)

rural population share, 1980	-6.42e-05	-0.000152
	(0.000108)	(9.46e-05)
political rights (Gastil, 1987; Barro, 1991)	0.00222	0.00126
	(0.00145)	(0.00101)
constant	0.788***	-0.00114
	(0.199)	(0.109)
countries	28	30
threshold (fertility transition)	1960	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: p.c. = per capita

To further minimize endogeneity bias and overcome other problems typical to cross-country growth regressions, we also construct a strongly balanced panel dataset encompassing 55 countries for 1990–2015. In this estimation, we include the lag of GDP per capita to control for the convergence process and use five-year averages of the explanatory variables to smooth out business-cycle fluctuations,[6] alleviate measurement errors, and focus on short-run effects. Panel data growth equations are estimated using the system-generalized method of moments (SGMM) estimator (Blundell and Bond, 1998) and treating all explanatory variables as endogenous. Explanatory variables are all lagged by one five-year time period, and time fixed effects are included.[7] The dynamic threshold panel model from Dang et al. (2012) is used to apply the single and multiple equilibria approach to the panel data. This model is superior to nondynamic threshold panel models, such as Hansen (1999), because it enables the use of dynamic instruments for potentially endogenous variables, including the autoregressive term (which is a crucial control for the convergence effect). We use the same set of variables as in the cross-country regressions, with the exception of the fixed capital investments share, which is not available for the given time span and country sample. Controlling for lagged income should at least partly account for the stock of physical capital and therefore the absence of the latter control should not pose a major issue. The dynamic threshold panel model from Dang et al. (2012) takes the following form:

$$y_{i,t} = (\rho_1 y_{i,t-1} + \pi_1 X_{i,t-1}) I_{\{q_{i,t} \le c\}} + (\rho_2 y_{i,t-1} + \pi_2 X_{i,t-1}) I_{\{q_{i,t} > c\}} + v_{i,t}, \quad (3)$$

where i and t are country and time indices with five-year periods, y is the log of GDP per capita, X is a matrix of determinants and controls, I is the indicator function for the regime attribution below or above the threshold, c is a country indicator variable (1 for low income and 2 for high income), ρ and π are coefficients, and $v_{i,t}$ is the composite error term. The data for the dynamic panel data analysis were taken from the World Bank (2018), Barro and Lee (2013) and Freedom House (2018). In the given specification the explanatory variables are instrumented by their lagged levels and differences to address the temporal endogeneity. This approach raises the number of instruments, but is necessary to disentangle the temporal

[6] As Durlauf et al. (2005) note, five-year aggregation is a well-established practice in dynamic panel data estimation of growth regressions.
[7] Due to collinearity, controlling for the 2010–2015 period was possible for both estimation models.

interdependencies between the variables. The over-identification tests[8] in Table 7 suggest that the instruments used are valid.

One has to note that since the dependent variable, GDP per capita, are given in logarithms, the marginal effects represent the change of income in percentage points (pp). In the single equilibrium dynamic panel data estimation (see Table 7), fertility is the only significant predictor of economic growth: a one-unit decrease in the TFR in the current five-year period is associated with a 4.46% increase in GDP per capita in the next. Thus, the annualized effect of fertility is to increase per capita GDP growth by roughly 0.89 pp. Under the multiple equilibria specification, the dynamic threshold panel model estimates significant effects for multiple variables: for the low-income equilibrium, the annualized effects of TFR, schooling, and life expectancy are all significant. A one-child decrease in the TFR is associated with a 2.1 pp increase in GDP per capita growth, an additional year of schooling with a 0.7 pp increase, and a 10% increase in life expectancy with a 1.1 pp increase. Notably, the threshold for the given estimation lies close to 7.142 (1,264 INT-$),[9] which is lower than in the cross-section threshold growth regressions, and therefore these effects can be interpreted as best applying to very low-income cases.[10] In general, the short-run effects using the dynamic threshold panel model confirm the importance of fertility, education, and health in these settings.[11]

Table 7. Single (6) and multiple (7 and 8) equilibria SGMM estimation; five-year log GDP per capita levels, 1990–2015

Variables	(6) Overall	(7) $q_{i,t} \leq c$	(8) $q_{i,t} > c$
log GDP p.c. (t-1)	0.939***	0.913***	0.860***
	(0.0329)	(0.230)	(0.0629)
log life expectancy (t-1)	0.111	0.583*	0.125
	(0.107)	(0.317)	(0.120)
mean years of schooling (t-1)	0.00337	0.0360**	-0.00257
	(0.00503)	(0.0179)	(0.0105)
fertility (t-1)	-0.0446*	-0.103***	-0.0312
	(0.0250)	(0.0369)	(0.0345)
working-age population share (t-1)	0.00764	0.000382	0.00786
	(0.00634)	(0.0154)	(0.00740)
log of electricity p.c. usage (t-1)	-0.0203	-0.199	0.0647
	(0.0371)	(0.235)	(0.0813)
rural population share (t-1)	-0.000134	-0.00697	0.000413
	(0.00136)	(0.00474)	(0.00124)
political rights (t-1)	-0.0100	-0.0205	-0.0164
	(0.00880)	(0.0229)	(0.0186)

[8] Please note that the Hansen test for over-identifying restrictions may be weakened by the amount of instruments.

[9] The Hansen (1999) model estimates similar threshold values, validating these results.

[10] At least 12 countries from our sample would fall in this category at different time periods: Bangladesh, Benin, Cameroon, China, Congo (Dem. Rep.), Côte d'Ivoire, Ghana, India, Kenya, Myanmar, Nicaragua, and Nigeria. For the list of countries see Table A2 in the appendix.

[11] In addition, we conducted an impulse-response analysis (see Figure A1) using panel vector autoregressions based on three-year periods to cross-validate the effects in the short run and explicitly address the impact of health and education expenditures on economic growth. The orthogonal cumulative impulse-response functions suggest that after 15 periods (45 years) the impact of health expenditures would prevail.

time dummies	x	x
observations	275	275
countries	55	55
Arellano-Bond test for AR(2)	0.117	0.838
Hansen test p-value	0.999	0.999
threshold (log of GDP p.c.)		7.142
Difference-in-Hansen tests		
GMM levels, exclusion	0.978	0.997
GMM levels, difference	0.999	0.888
IV instruments, exclusion	0.999	0.999
IV instruments, difference	0.999	0.188

Robust two-step corrected errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: p.c. = per capita

To summarize, health and demography are again the most powerful predictors of economic growth and thus should be considered priorities in policymaking. Schooling follows in terms of magnitude and robustness. Altogether, these results are consistent with the theoretical model suggesting that policies to reduce fertility, increase health, and bolster education are effective in helping an economy to escape from a poverty trap. The results are also consistent with the literature discussed in Section 3.

5. Conclusions

During the last 70 years, many LMICs underwent transformational economic growth, while others experienced moderate to nonexistent development gains. Governments of developing countries that made substantial progress can take advantage of the resource expansion that accompanied their past growth experiences and invest in health, education, and fertility reduction to promote further economic growth. Countries that made only modest improvements can draw lessons from these disparate growth outcomes to improve their growth trajectory going forward.

Using an intuitively accessible growth model in discrete time with multiple equilibria, we show that (i) investments in physical capital (e.g., infrastructure investments) could help a country escape a poverty trap and develop along a balanced growth trajectory only in the case of a “big push” scenario, while (ii) investments in health and human capital would change the dynamic system and lift the balanced growth trajectory upward, reducing the poverty trap’s basin of attraction and easing the transition to sustained growth.

Our empirical analysis is based on cross-sectional and dynamic panel data threshold regressions of data from 1980 to 2015. While conducting cross-sectional and panel analysis we addressed the issue of temporal reverse causality by separating the measurement of the dependent and independent variables in the cross section framework and instrumenting the dependent variables with their lagged levels and differences in the panel data framework. Empirical analyses across multiple datasets, time frames, controls, and econometric estimators yield four main associations relevant to policymakers in LMIC settings:[12]

(1) A one-child decrease in the TFR corresponds to a 2 pp increase in annual GDP per capita growth in the short run (5 years) and 0.5 pp higher annual growth in the mid to long run (35 years).

(2) A 10% increase in life expectancy at birth corresponds to a 1 pp increase in annual GDP per capita growth in the short run and 0.4 pp higher growth in the mid to long run.

(3) A one-year increase in average educational attainment, measured in years of schooling, corresponds to a 0.7 pp increase in annual growth in the short run and 0.3 pp higher growth in the mid to long run.

(4) Infrastructure proxies were not significantly associated with subsequent growth in any of the models estimated.

Given that per capita GDP growth in LMICs generally averages between 2% and 4%, these estimated changes in annual growth are appreciable.[13] The findings of these analyses are generally consistent with the theoretical and empirical literature.

In prioritizing governmental expenditures for economic growth, decision makers should consider several factors alongside the average effects of the outcome variables on growth: the effectiveness of spending in improving the outcome variables, the timeline over which the spending effects will be realized, and validation using context-specific findings. Applying these metrics, reproductive health and fertility reduction tend to predominate as growth determinants. Policy measures related to this area are most effective in the short- and medium-term time domains (5–15 years). Improving general health can be particularly effective in the medium term as well;[14] however, most of the returns would be expected in the long run. Education features a longer maturity horizon, although for low-income countries, some effects are evident even in the medium term. Infrastructure projects have the broadest range in terms of findings and time domain. Our analyses suggest that this category has less transformative potential than the others, but this does not suggest that a positive relationship between infrastructure spending and economic growth should be ruled out entirely.

Priority setting within sectors is equally important. The Copenhagen Consensus Center's Post-2015 Consensus informs this task for developing countries by ranking more than 100 development targets proposed by the United Nations' Open Working Group according to the

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[12] The relationships among these variables likely vary with contextual factors. As such, the results presented should be understood as average, at-the-margin estimates. Additionally, as discussed previously, different methodologies are used to estimate short-run and mid- to long-run effects, so conclusions about the timeline of the return on benefits should be made cautiously.

[13] In interpreting these results, considering the compounding effect of a persistent change in growth over several years is important. For example, a 1 pp increase in average annual economic growth from 3% to 4% accumulates to GDP per capita that is 3.9 times higher after a period of 35 years rather than 2.8 times higher.

[14] See Table 7 for the panel data results and the related medium term effects.

social returns to each dollar spent meeting each goal. The results of this aggregated research suggest that investments in decreasing the burden of diseases, HIV and AIDS treatment and prevention, and preschool and primary education (especially for low-income countries) have the most potential for promoting growth (Lomborg, 2018). Other meta-analyses show that investments in primary education tend to offer higher social returns than such investments in secondary education, which, in turn, are higher than returns from tertiary education (Psacharopoulos and Patrinos, 2018). Furthermore, investments in improving gender equality across various domains also promote sustained economic growth very effectively by reducing fertility, increasing the stock of human capital, and improving women's and children's health (Klasen, 2002, 2018; Abu-Ghaida and Klasen, 2004; Bhalotra and Rawlings, 2011; Bloom et al., 2015; Albanesi and Olivetti, 2016; Prettner and Strulik, 2017a).

Recognizing that the results presented in this manuscript represent the average benefits of different interventions and improvements in outcomes across countries, with the original empirical results excluding costs altogether, is important. In reality, both the costs and benefits of achieving improvements in outcomes will vary substantially across settings and within the context of different programs. For example, a program to expand access to birth control may be highly successful in reducing fertility in a locality where unmet need for contraceptives is high, but completely ineffective in another environment where individuals desire more offspring (Prettner and Strulik, 2017b). As such, policymakers must consider the specific constraints to development in their settings and the relative cost of the options available for achieving improvements in health, education, fertility, and infrastructure to make sound assessments of their relative ROIs. Ultimately, determining which interventions will best promote economic growth remains highly contextual, but well-informed decision makers should benchmark their expectations relative to the cross-country development experience of the last several decades.

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Appendix

Table A1. Income and human development indicators by current income grouping

Variable	1990 Value	2017 Value	Change (%)
Low-Income Countries			
Income p.c. (in 2010 US$)	567	720	27
Life Expectancy at Birth	51	63	24
Literacy Rate (Age 15+)	46	61	33
Total Fertility Rate	6.3	4.6	-27
Lower-Middle-Income Countries			
Income p.c. (in 2010 US$)	944	2,189	132
Life Expectancy at Birth	59	68	15
Literacy Rate (Age 15+)	58	76	31
Total Fertility Rate	4.9	2.8	-33
Upper-Middle-Income Countries			
Income p.c. (in 2010 US$)	3,148	8,225	161
Life Expectancy at Birth	69	75	9
Literacy Rate (Age 15+)	82	95	16
Total Fertility Rate	2.6	1.8	-31

Source: World Bank (2018)

Note: p.c. = per capita

Table A2. Threshold regressions with regional controls

		Low income	High income	Forerunners and followers	Trailers and latecomers
	(9)	(10)	(11)	(12)	(13)
Variables	Overall	$q_i \leq \gamma$	$q_i > \gamma$	$q_i \leq \gamma$	$q_i > \gamma$
log of GDP p.c., 1980	-0.0128***	-0.0175***	-0.0176**	-0.0122**	-0.0170***
	(0.00290)	(0.00422)	(0.00771)	(0.00475)	(0.00359)
log of GDP p.c., 1960	-0.00381	-0.00247	-0.00902*	-0.00780*	0.00318
	(0.00318)	(0.00495)	(0.00533)	(0.00465)	(0.00392)
equipment investment share (DeLong and Summers, 1991)	0.0970*	0.169*	0.0913	0.0603	0.158*
	(0.0518)	(0.101)	(0.0718)	(0.0610)	(0.0908)
log of life expectancy, 1980	0.00160	0.0349*	-0.0391	-0.127***	0.0330*
	(0.0182)	(0.0201)	(0.0497)	(0.0405)	(0.0181)
mean years of schooling, 1980	0.00116	-0.000762	0.00281***	0.00304***	0.000376
	(0.000745)	(0.00117)	(0.00106)	(0.000801)	(0.00102)
fertility, 1980	-0.00930***	-0.00525*	-0.0108**	-0.0195***	-0.00710***
	(0.00234)	(0.00292)	(0.00518)	(0.00472)	(0.00254)
log of electricity usage p.c., 1980	0.000984	0.00127	0.00424	0.00130	7.46e-05
	(0.00183)	(0.00196)	(0.00453)	(0.00324)	(0.00187)
working-age population share, 1980	-0.000289	0.00188**	-0.00116	-0.00101	0.000475
	(0.000568)	(0.000873)	(0.000926)	(0.000765)	(0.000795)
rural population share, 1980	-4.35e-06	-0.000334*	2.18e-05	-4.50e-05	-0.000160
	(7.84e-05)	(0.000178)	(9.78e-05)	(0.000107)	(0.000101)
political rights (Gastil, 1987; Barro, 1991)	0.00156	0.00199	0.000186	0.00198	0.00121
	(0.00104)	(0.00122)	(0.00234)	(0.00144)	(0.00102)
constant	0.181*	-0.0455	0.468*	0.810***	-0.00118
	(0.0991)	(0.120)	(0.252)	(0.197)	(0.108)
regional controls	x	x		x	
countries	69	36	33	28	30
Threshold		8.51		1960	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: p.c. = per capita

Table A3. List of countries for Table 5

Cross-section	
Low-income equilibria	High-income equilibria
Algeria	Argentina
Bangladesh	Australia
Benin	Austria
Bolivia	Belgium
Cameroon	Brazil
Colombia	Canada
Congo, Rep.	Chile
Côte d'Ivoire	Costa Rica
Dominican Republic	Cyprus
Ecuador	Denmark
El Salvador	Finland
Ghana	France
Guatemala	Germany
Honduras	Greece
India	Hong Kong
Jamaica	Ireland
Jordan	Israel
Kenya	Italy
Korea, Rep.	Japan
Malaysia	Mexico
Mauritius	Netherlands
Morocco	Norway
Mozambique	Panama
Nepal	Portugal
Nicaragua	Singapore
Pakistan	Spain
Paraguay	Sweden
Peru	Switzerland
Philippines	Trinidad and Tobago
Senegal	Turkey
Sri Lanka	United Kingdom
Thailand	United States
Tunisia	Uruguay
Zambia	Venezuela
Zimbabwe	

Table A4. List of countries for Table 7

Panel data	
Low-income equilibria	High-income equilibria
Bangladesh	Algeria
Benin	Argentina
Cameroon	Australia
China	Austria
Congo (Dem. Rep.)	Belgium
Côte d'Ivoire	Bolivia
Ghana	Brazil
India	Canada
Kenya	Chile
Myanmar	Colombia
Nicaragua	Congo, Rep.
Nigeria	Costa Rica
	Cuba
	Cyprus
	Denmark
	Dominican Republic
	Ecuador
	Egypt
	El Salvador
	Finland
	France
	Gabon
	Germany
	Guatemala
	Honduras
	Hong Kong
	Iceland
	Indonesia
	Iraq
	Ireland
	Israel
	Italy
	Jamaica
	Japan
	Jordan
	Korea, Rep.
	Luxembourg

Malaysia
Malta
Mexico
Morocco
Netherlands
New Zealand

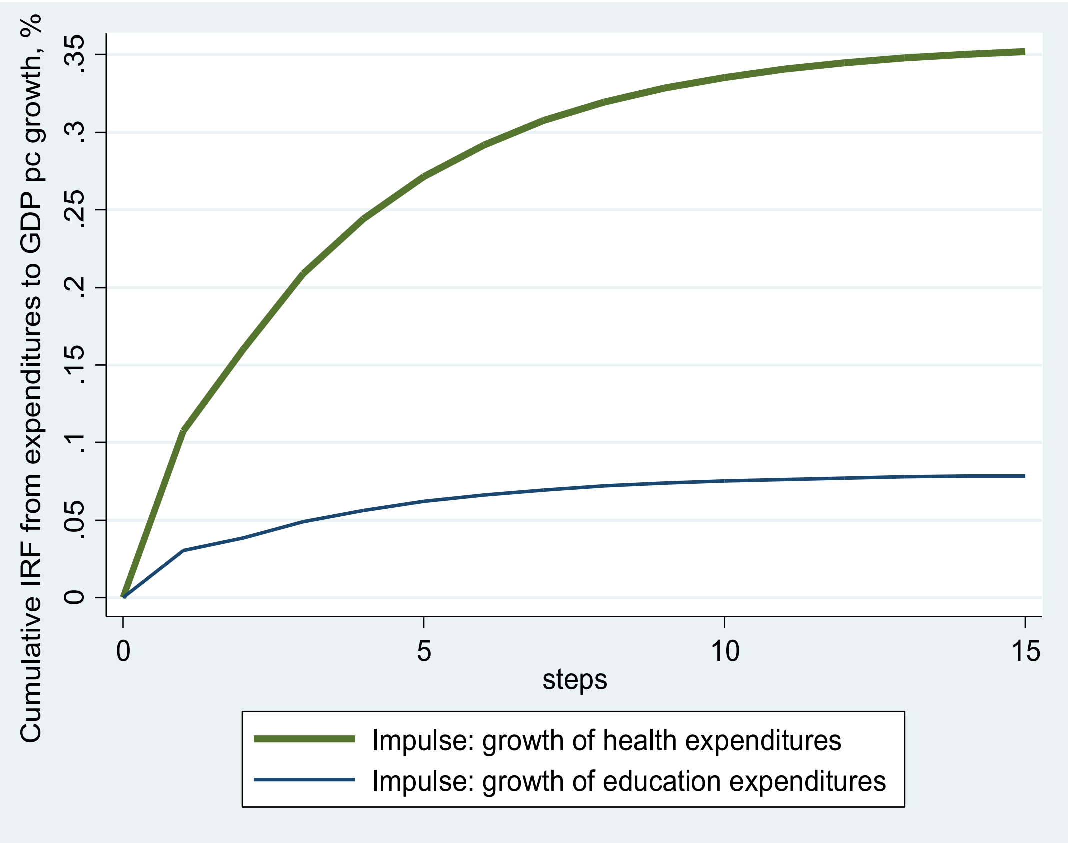

Figure A1. Panel VAR cumulative impulse-response functions for health and education expenditures using three-year periods.

Note: IRF = impulse response function; p.c. = per capita