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Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs

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Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs

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Abstract

Using panel data from 120 developing countries from 1975 to 2000, this paper explores the direct and indirect channels linking social spending, human capital, and growth in a system of equations. The paper finds that both education and health spending have a positive and significant direct impact on the accumulation of education and health capital, and thus can lead to higher economic growth. The paper also finds that other policy interventions, such as improving governance, reducing excessive budget deficits, and taming inflation, can also be helpful in moving countries toward the Millennium Development Goals (MDGs). As such, higher spending alone is not sufficient to achieve the MDGs.

JEL Classification Numbers: I1, I2, O2, O4

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Contents Page

I. Introduction

The role of human capital in fostering economic development is well recognized in the growth literature. Following Romer (1986) and Lucas (1988), human capital has been identified not only as a key determinant of growth and poverty alleviation, but as critical for human development more generally (Squire (1993), Ravallion and Chen (1997), Sen (1999), and Schultz (1999)). The growing focus on the Millennium Development Goals (MDGs) has further highlighted the importance of making tangible progress in indicators of human capital measured on the basis of key education and health indicators.

A crucial issue in this regard is the role of public policy in helping countries meet the MDGs. In most countries, the public sector plays a dominant role in providing the educational and health services necessary to build human capital. As such, the impact of this spending on social indicators, and the impact of higher spending versus other policy interventions (such as improvements in fiscal sustainability or improvements in governance) that might also help countries meet the MDGs (via their salutary effects on economic growth) are of great interest. While positive externalities or market failures may justify the involvement of the public sector in these areas, this does not, in itself, indicate that higher spending per se is the most effective or the only policy intervention for helping meet the MDGs.[2]

This paper seeks to contribute to this debate by providing an integrated assessment of the role of social spending and other policy interventions on human capital, economic growth, and social indicators. Building upon earlier studies, we analyze the dynamic direct and indirect effects of social spending on human capital and growth, while taking into account the interaction between education and health interventions. The empirical estimates are based on a panel dataset covering 120 developing countries from 1975 to 2000. The model examines the impact of different policy interventions on growth and social indicators, with a view to evaluate their implications for the MDGs.

The remainder of the paper is structured as follows. In Section II, a review of the existing literature is provided. In Section III, an explanation of the data and model is given. Section IV provides the empirical results, including robustness tests. Section V summarizes the simulated effects of different policy interventions on growth and social indicators. Section VI discusses policy implications and concludes the paper.

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[2] On market failures and the rationale for public sector involvement in education and health, see World Bank (1993, 1995), Psacharopoulos (1994), and Sachs and others (2003).

II. Literature Review

Despite the interlinkages between human capital and growth, most empirical studies have employed reduced-form equations that do not capture feedback effects. The literature often focuses on only one segment of the social spending-social indicators-growth nexus. That is, it either analyzes the growth effects of improving education or health indicators, or the impact of public spending on these indicators. Furthermore, research on the first stream has concentrated essentially on education capital, and has often focused on the impact of the initial stock of education capital on growth. Among these studies, Levine and Renelt (1992), Mankiw and others (1992), Barro and Sala-i-Martin (1995), Barro (1996a and 1996b), and Sala-i-Martin (1997) find a positive relationship between enrollment and/or schooling and growth. Also, using a more refined measure on skills, Coulombe and others (2004) find that a country with literacy scores 1 percent higher than the average experiences an increase in per capita GDP growth of 1.5 percentage points. Benhabib and Spiegel (1994) and Pritchett and Summers (1996), however, find that some macroeconomic evidence conflicts with the findings at the microeconomic level on the returns to education and conclude that the positive link from education attainment to output growth is, at best, weak.

The empirical literature on the effects of health capital on growth is relatively thin. Conceptually, a healthy person can not only work more effectively and efficiently but also devote more time to productive activities. Based on microeconomic evidences, Strauss and Thomas (1998) argue that health explains the variations in wages at least as much as education. Research at the macro level can better capture the potential externalities of health sector interventions, and the existing studies are supportive of the positive contribution of health capital to growth. Bloom and Canning (2003), Bloom and Canning (2004), and Gyimah-Brempong and Wilson (2004) find that health capital indicators positively influence aggregate output. They find that about 22 to 30 percent of the growth rate is attributed to health capital, and improvements in health conditions equivalent to one more year of life expectancy are associated with higher GDP growth of up to 4 percentage points per year.

Studies examining the impact of social spending on social indicators have produced mixed results. For example, based on cross-sectional data for developing countries, Baldacci and others (2003) and Gupta and others (2002b) find that social spending is an important determinant of education and health outcomes.[3] They also find that education spending has a greater effect on social indicators than health outlays. The positive effect of social spending on social indicators is also supported by Anand and Ravallion (1993),

[3] These studies find that the effect of social spending on human development indicators is stronger in cross-sectional samples than when the time dimension is also added.

Psacharopoulos (1994), Hojman (1996), Bidani and Ravallion (1997), and Psacharopoulos and Patrinos (2002). At the same time, a number of studies have found insignificant or very weak linkages between public education outlays and education indicators (Noss (1991), Mingat and Tan (1992 and 1998), and Flug, Spilimbergo, and Wachtenheim (1998)). Similarly, a number of studies find that the contribution of health spending to health status—as measured by infant mortality or child mortality—is either small or statistically insignificant (Kim and Moody (1992), McGuire and others (1993), Musgrove (1996), Pritchett (1996), Filmer and Pritchett (1997), and Filmer and others (1998)). In contrast, Gupta and others (2003) find a positive relationship between public spending on health care and the health status of the poor.

As key pillars in forming human capital, education and health are interlinked in their contribution to growth. Higher levels of education increase public awareness and the capacity of families to address their own health needs. At the same time, better health enhances the effective and sustained use of the knowledge and skills that individuals acquire through education (Schultz (1999)). Barro (1996b) further argues that better health can reduce the depreciation of education capital, and thus increases the favorable effect of education on growth. Few studies, however, have examined social spending, social indicators, and growth in an intergrated system. One exception is Arjona and others (2001), which studies the impact of social spending on growth in OECD countries. They find that although there is no clear impact of social spending on growth at the aggregate level, there exists a positive association between certain types of social spending (albeit excluding many forms of education and health outlays) and growth. A more recent study by Gyimah-Brempong and Wilson (2004) finds a positive and robust link between investment in health and growth in both sub-Saharan African and OECD countries.

Recent research has also highlighted the important role of institutions and governance in mediating the nexus between social spending, indicators, and growth. Poor governance has been identified as a key cause of ineffective social spending (e.g., Mauro (1998), Abed and Gupta (2002), Gupta and others (2002a), and Rajkumar and Swaroop (2002)). Therefore, the lack of control for governance could account for the weak relationship between spending, social indicators, and growth found in some previous studies. By explicitly incorporating governance into the model, our paper helps overcome this problem.

III. Data and Model

A. Methodology

The econometric approach is based on panel data regressions in a system of four equations for (1) real per capita income growth, (2) total investment, (3) education attainment, and

(4) health status. The specification of this system is consistent with the literature and allows for the identification of the channels through which social spending and other policy interventions affect growth, as well as the full effects of higher spending over time. The model specification results in a recursive system.[4] Under the assumption that the disturbances are not correlated across equations, standard least square techniques can produce unbiased and efficient estimates for each equation.[5]

1. Growth equation

Drawing upon Mankiw and others (1992), Barro (1996a and 1996b), Bassanini and Scarpetta (2001), Bloom and Sevilla (2004), and Gyimah-Brempong and Wilson (2004), the growth equation is based on a neoclassical growth framework augmented by both education capital and health capital. The per capita output equation is assumed to take the following form:

$$y = f(s_k, he, ed, \Omega),$$

where y is real per capita GDP; s_k is the investment ratio; *he* denotes health capital; *ed* represents education capital; and Ω denotes the set of macro and institutional control variables, such as the fiscal balance, inflation rate, trade openness, and governance that augment the baseline specification of the model.

In addition, we assume there is a relationship between both the initial stock and increment in human capital with per capita GDP growth.[6] As such, the growth of real per capita GDP g is given by:

$$g = f(s_k, he, \Delta he, ed, \Delta ed, \Omega).$$

Therefore, we consider the baseline growth equation as the following:

[4] The preferred model results in a system of four equations where the coefficient matrix is triangular (see footnote 15). See also Duncan (1975) on the advantage of using a recursive system of equations.

[5] The assumption can be tested, for example, by assessing whether results differ using the seemingly unrelated regression (SUR) technique. The results of this test are discussed further under the robustness checks.

[6] A detailed derivation of the growth model, based on Bassanini and Scarpetta (2001), is provided in Appendix I.

$$g_{it} = \alpha_{1i} + \eta_{1it} + \beta_{11} \cdot \ln(y_{it-1}) + \beta_{12} \cdot n_{i,t} + \beta_{13} \cdot s_{k\,i,t} + \beta_{14} \cdot Ed_{i,t-1} + \beta_{15} \cdot He_{it-1} + \beta_{16} \cdot \Delta Ed_{it} + \beta_{17} \cdot \Delta He_{i,t} + \sum_{m=8}^{n} \beta_{1m} \left(\Omega^{m}{}_{it}\right) + u_{it} \quad [1]$$

where

- g_{it} is real per capita GDP growth;
- α_i and η_t denote the country-specific effect and period-specific effect, respectively;
- $\log(y_{it-1})$ is the lagged logarithm of per capita income to control for the expected reduction in growth rates as per capita incomes rise;
- $s_{k\,it}$ denotes the investment ratio, measured in terms of gross capital formation (both private and public) in percent of GDP. As an increase in the investment ratio captures an increase in the stock of physical capital, its coefficient is expected to be positive;
- Ed_{it} refers to the stock of education capital, proxied by the composite primary and secondary enrollment rate.[7] ΔEd refers to changes in education capital. While the stock of human capital affects productivity growth, changes in education capital reflect an adjustment in the level of a productive input (i.e., educated labor). On the relationship between human capital and growth, Lucas (1988) emphasized that changes in human capital promote growth, whereas Romer (1986 and 1990) argued that the stock of human capital drives growth mainly via innovation. The derivation of the growth equation also leads to the inclusion of both the stocks and changes in human capital variables.[8] Therefore, both variables are included.
- He_{it} refers to the stock of health capital, and Δhe refers to changes in health capital. The health condition of the population affects output growth. While it is desirable to

[7] Woszmann (2003) has shown that the correlation between the enrollment rate and other measures (such as years of schooling) is very high, and, therefore, enrollment is a good proxy for a broader measure of education capital. Furthermore, enrollment data are widely available and are closely linked with the indicator targets in the MDGs. While the enrollment rate mixes together stocks and flows, it can nevertheless capture the overall effects of education capital on growth (Gemmel, 1996). In addition, enrollment rate data are largely based on actual country outturns, rather than projected or estimated data often used for other indicators. Finally, following Barro (1996a and 1996b), we adopt a logarithmic functional form for education capital, which allows for the declining impact of higher enrollment rates on growth.

[8] See Appendix I for details.

account for both mortality and morbidity as a full measure of health capital, such data are not available. Instead, the logarithm of under-5 child mortality is used to proxy the stock of health capital.[9] Following the derivation of the growth equation, as well as Bloom and Sevilla (2004) and Gyimah-Brempong and Wilson (2004), both stock and changes in health capital are included.

- n_{it} is the rate of growth of the total population.

- $\Omega^{m}{}_{it}$ consists of control variables. Trade openness (*open*), changes in terms of trade (*dtot*), fiscal balance (*Balance*), and inflation (*p*) were included, as they have been frequently identified as key determinants of growth (Levine and Renelt, 1992; Barro, 1996a; and Baldacci and others, 2004). Trade openness is expressed as the sum of total imports and exports in relation to GDP. Inflation rate is the logarithm of 1 plus the change in CPI. Following Fischer (1993) and Baldacci and others (2004), the high inflation dummy refers to cases where the inflation rate exceeds 20 percent per year. An interaction variable of low deficit fiscal balance (countries with deficits below 3 percent of GDP), *LowdefBalance*, is also created by multiplying fiscal balance with a low-deficit dummy[10] to account for possible non-linear effect of fiscal policy. A dummy for poor governance (*Lowgov*) was also included, based on the anticorruption and democratic accountability index from International Country Risk Guide (ICRG) compiled by the Political Risk Services group. Including both indexes gives a more complete measure of governance. The dummy takes the value of one (zero otherwise) when the index value is lower than the mean. Also, we include both the level of the annual inflation rate (*p*) and the high-inflation dummy (*Highp*) to measure the possible nonlinear effects of inflation on growth.

- u_{it} is the error term.

2. Investment equation

Investment appears in the growth equation as a direct input to growth. It is also assumed to be influenced by education and health human capital, as well as the quality of governance, fiscal balance, and inflation. We estimate the following equation, building on the models used by Fischer (1993), Benhabib and Spiegel (1994), and Mauro (1996):

[9] Gyimah-Brempong and Wilson (2004) use health spending instead of the actual changes in health capital. This approach is problematic, however, as it assumes a positive relationship between health spending and health outcomes, without empirically testing for it.

[10] The dummy takes the value of one if the deficit (fiscal balance) is lower (higher) than the sample mean, or zero if otherwise.

$$I_{it} = \alpha_{2i} + \eta_{2it} + \beta_{21}\log(y_{t-1}) + \beta_{22}n_{it} + \beta_{23}Edu_{it} + \beta_{24}Hea_{it} + \beta_{25}Balance_{it} + \beta_{26}LowdefBalance_{it} + \beta_{27}p_{it} + \beta_{28}Highp_{it} + \beta_{29}Lowgov_{it} + u_{it} \qquad [2]$$

where all macro variables are defined as in the growth equation but only the levels of the education and health indicators are included.

3. Education equation

$$Edu_{it} = \alpha_{3i} + \eta_{3it} + \beta_{31}\ln(y_{it}) + \beta_{32}\cdot Popu15_{it} + \beta_{33}\cdot Hea_{it} + \beta_{34}\cdot Urban_{it} + \beta_{35}Quality_{it} + \beta_{36}EduSpending_{it} + \beta_{37}EduSpending_{it-1} + \beta_{38}EduSpending_{it} * Lowgov_{it} + \beta_{39}EduSpending_{it-1} * Lowgov_{it-1} + \beta_{310}Female_{it} + u_{it} \qquad [3]$$

This equation examines the direct impact of education spending on education capital, as proxied by the composite primary and secondary school enrollment rate.

- School age population (*Popu*15). The age structure of the population can affect school enrollment (Mingat and Tan, 1992). Age structure is captured by the share of population below 15 years old.
- Income level (*y*). Higher per capital income raises the demand for education. This variable is measured as the logarithm of real per capita GDP in PPP dollar terms.
- Health capital. A healthier population is more likely to be able to afford to invest in education. The under-5 child mortality rate is used to proxy the stock of health capital.
- Quality indicator (*Quality*). Following Gupta and others (2003), the quality of education is proxied by the school repetition rate. A higher repetition rate corresponds to a lower quality of education.
- Education spending (*EduSpending*). Both the current five-year average and lagged five-year average of education spending, in percent of GDP, were used.[11] A logarithmic functional form was used to achieve the best fit and control for diminishing returns to spending.

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[11] The appropriate lag structure was selected by comparing Schwartz Information Criteria (SIC) values with different lags in a distributed lag model, and one lag was chosen. This implies that the impact of education spending on social indicators, during a given five-year period, will take additional time (that is, another five years) to be fully realized.

- Poor governance (*Lowgov*). As shown in Abed and Gupta (2002), Baldacci and others (2003), and Gupta and others (2002b), poor governance has a strong adverse impact on the effect of public spending on social indicators.

- Gender equality (*Female*) in education also affects aggregate education capital. As shown in Summers (1992), women are often the primary educators and nurturers of children, and therefore investing in girls' education can reap significantly greater returns than investing in boys' education. This is especially the case in developing countries, where gender inequality is more acute. This effect is captured by the share of female students in primary and secondary schools.

4. Health equation

$$Hea_{it} = \alpha_{4i} + \eta_{4t} + \beta_{41} \cdot \ln(y_{i,t}) + \beta_{42} Fertility_{it} + \beta_{43} Urban_{it} + \beta_{44} HeaSpending_{it} + \beta_{45} HeaSpending_{it} * Lowgov_{it} + \beta_{46} Female_{it} + u_{4it} \qquad [4]$$

- Income level. Past studies indicate that this variable is a crucial determinant of health status (Carrin and Politi, 1996, and Filmer and Pritchett, 1997).

- Gender equality. A number of studies have identified female education as an important determinant of the health status of infants and children, as well as the population in general (e.g., Schultz, 1993, and the World Bank, 1993).[12] For example, in developing countries, women play a more important role in family health and sanitation. Furthermore, female education is positively associated with infants' health and negatively associated with fertility rates. While it would be desirable to measure gender equality for society as a whole, such data are not available. Instead, the share of female students is used as a proxy.

- Urbanization. Schultz (1993) finds that the mortality rate is higher for rural, low-income, agricultural households, and therefore urbanization can be an important determinant of the health status of the population. This effect is captured by including the share of the urban population in the regression.

- Poor governance. This is measured in the same way as in the education equation.

[12] The composite enrollment rate, as a proxy of the aggregate education level of the population, was not found to have any significant impact on health. This variable was thus dropped from the health equation. This allows the four equations on growth, investment, education, and health to be estimated in a recursive system, since the coefficient matrix is triangular. Further support for this specification is given in the section on robustness checks.

- Current health spending. The five-year average of health spending as a percent of GDP was used. A logarithmic functional form was adopted to achieve the best fit and control for decreasing returns to spending. This is consistent with Deaton (2004), which finds that the benefits from investment in health are stronger in countries at the initial stages of development.

5. Decomposition of short-run effects

In many cases, the variables in the system have both direct and indirect effects, and these effects can be separately identified in the following recursive system:

$$\mathbf{y} = \mathbf{B}\mathbf{y} + \boldsymbol{\Gamma}\mathbf{x} + \boldsymbol{\xi}, \text{ or in a reduced form } \mathbf{y} = \boldsymbol{\Pi}\mathbf{x} + \boldsymbol{\xi}$$

where $\mathbf{y}$ is a vector of endogenous variables; $\mathbf{x}$ is a vector of exogenous variables; $\mathbf{B}$ is a lower triangular matrix containing coefficients for direct effects of each pair of endogenous variables *i* and *j* with elements $\beta_{ij} \neq 0$ and $\beta_{ji} = 0$; $\boldsymbol{\Gamma}$ is a matrix of direct effects of the exogenous variables on the endogenous variables, and ξ is a vector of the equations' error terms. The total effect of $\mathbf{x}$ on $\mathbf{y}$ can be calculated by $\boldsymbol{\Pi} = (\mathbf{I} - \mathbf{B})^{-1}\boldsymbol{\Gamma}$, and the indirect effect of $\mathbf{x}$ on $\mathbf{y}$ is then given by $\boldsymbol{\Theta} = (\mathbf{I} - \mathbf{B})^{-1} - \mathbf{I}$.[13]

B. Data

A panel dataset for 120 developing countries from 1975 to 2000 was compiled for the purposes of the paper (see Table 1 for a description of the data and Appendix II for the list of countries). Five-year averages are used to smooth short-term fluctuations and minimize the measurement errors that can be present in annual observations. All macroeconomic variables are from the IMF's *World Economic Outlook* 2003 database, while social indicators and social spending data are from the latest Barro-Lee dataset,[14] the *World Development Indicators* 2003 database and a social spending database compiled from IMF

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[13] The indirect effects can be calculated by subtracting the direct-effect matrices **B** and **Γ** from the respective total-effect matrix **Π.** This decomposition is based on the assumption that current and lagged spending increases are independent and lagged education and health capital are predetermined. Also, the decomposition focuses on the short-run relationship between the current stock and current growth through the recursive system. Long-run effects that fully incorporate lagged effects and interactions of the key variables are analyzed in the simulations discussed in Section V.

[14] See Barro and Lee (2003).

staff reports and the IMF's *Government Financial Statistics*. Data on governance are taken from ICRG index of corruption and democratic accountability.[15]

In this paper, output growth is measured by the five-year averages of the annual growth rate of real per capita GDP; education and health capital are proxied by education and health indicators; and social spending data are expressed as a percent of GDP.

We adopt a fixed-effect model (LSDV) as the baseline specification. This estimator is chosen in light of the fact that it provides consistent estimates in the context of a recursive system of equations. Nevertheless, to assess the robustness of the results for individual equations, we also provide results from alternative estimators to control for outliers, measurement error, autocorrelation, and endogeneity. These include a robust estimator,[16] a Feasible Generalized Least Squares (FGLS) estimator,[17] an error component two-stage least squares estimator (EC2SLS),[18] and a fixed-effect instrumental variable estimator (2SLS).[19] Moreover, as shown by Bond and others (2001), problems associated with endogeneity, measurement error, and omitted variables in dynamic growth models can be best addressed by a system GMM estimator. Therefore, in equations that involve lagged variables, results from a system GMM estimator are also provided as a further robustness check.[20] Finally, we provide results from overidentification tests to show the validity of the instruments used.

[15] For a fuller description of the data, see Appendix II.

[16] This estimator controls for outliers by giving more weight to better-fitting observations. See Hamilton (1991) for details.

[17] The FGLS estimator also controls for heteroskedasticity and first-order autocorrelation in the error term.

[18] The two-stage least square estimator with random effects, small sample correction, and error-correction follows Baltagi (2001). Both EC2SLS and 2SLS are used to control for endogeneity and reverse causality.

[19] Refers to a two-stage least square estimator with fixed effects and small sample correction.

[20] The system GMM estimator combines a first-difference equation and a level equation that uses lags of levels and first differences, respectively, as instruments to correct for endogeneity and obtain additional efficiency gains from exploiting extra moment restrictions. In addition to its general merits, the estimator is also a good robustness check for this paper because the dataset has a large cross-sectional dimension but limited time periods. See Bond and others (2001) and Blundell and Bond (1998) for details.

Table 1. Summary Descriptive Statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Real per capita GDP growth (in percent)	831	1.3	4.0	-20.6	30.9
Investment ratio (in percent of GDP)	883	22.8	8.8	0.3	50.2
Composite enrollment rate (in percent)	792	130.6	49.8	3.0	238.5
Primary school enrollment rate (in percent)	801	88.5	26.9	3.0	174.7
Secondary school enrollment rate (in percent)	798	42.1	29.5	0.0	126.6
Under-5 child mortality (per 1000 live births)	897	111.0	78.9	7.0	345.0
Education spending (in percent of GDP)	689	3.6	1.7	0.6	10.0
Health spending (in percent of GDP)	354	2.2	1.5	0.3	8.7
Population growth (in percent)	831	2.0	1.3	-3.3	8.2
Trade openness (in percent of GDP)	838	81.8	89.1	0.1	1120.5
Changes in terms of trade [1/]	821	2.1	15.5	-21.2	365.9
Fiscal balance (in percent of GDP)	713	-4.9	6.0	-29.8	18.3
Fiscal balance in low-deficit countries (deficit lower than sample mean)	713	0.0	1.9	-3.0	18.3
Income level (log of real per capita GDP in PPP$)	968	9.4	3.2	-10.7	16.9
Inflation rate (log of changes in CPI)	884	0.2	0.4	-0.1	3.4
High inflation dummy (inflation >20 percent)	884	0.2	0.4	0.0	1.0
Governance index (1-12; higher value equals better governance)	364	5.9	1.9	1.0	11.0
Poor governance dummy (1 for countries below the average governance index)	987	0.2	0.4	0.0	1.0
Fertility rate (per 1000 people per year)	951	4.7	1.8	1.1	10.0
Share of under-15 population (in percent)	931	39.3	8.1	16.6	51.2
Urbanization (share of urban population)	980	39.1	20.1	2.4	91.4
School repetition rate (in percent)	512	12.5	9.8	0.1	38.6

Sources: Various databases (see Appendix II for details).
1/ The terms of trade variable compares the relative price of a country's exports and imports. A positive change denotes an improvement in the terms of trade.

Measurement errors are considered an important factor in empirical studies on human capital and growth. Temple (1999) and Krueger and Lindahl (2001) highlight the prevalence of such errors in human capital indicators and the significant impact they may have on the empirical estimates of the human capital-growth relationship. In this paper, measurement errors are minimized by using five-year averages of the data. The robustness of the results is also checked by using alternative indicators of health and education.

IV. Empirical Results

A. Main Results

The results for the growth, investment, education, and health equations are presented in Tables 2–5.[21] In most cases the coefficients are statistically significant, and all equations have a good fit. Among the most salient results from the baseline (LSDV) model are the following:

- **Both education capital and health capital positively contribute to output growth, but through slightly different routes** (Table 2). Both the stock and flow of education capital affect growth. The effects from the two channels are of similar magnitude. In contrast, the only direct effect of health capital on growth is through flows. The stock of health capital does, however, affect growth indirectly via investment (Table 3). Furthermore, the regressions in the education and health equations (Tables 4 and 5) show that education and health spending affects indicators on education and health capital. Thus, social spending also helps boost growth via its effects on human capital.[22]

- **Education spending has both an immediate and a lagged effect on education capital**. About two-thirds of the direct effect are realized in the first five years, with the remainder realized over the next five-year span. For example, the direct effect of an increase in education spending of 1 percentage point of GDP is associated with an increase in the composite enrollment rate of 6 percentage points within five years and of another 3 percentage points in the following period.[23] Furthermore, the higher income brought by growth can generate additional improvement in education capital. The aggregate growth effect is further analyzed in Section V to illustrate the role of lagged effects and interactions between the key variables.

- **Health spending has a positive and significant contemporaneous impact on health capital**. An increase in health spending of 1 percentage point of GDP is associated with a rise in the under-5 child survival rate of 0.2 percentage points, on average, in developing countries. However, lagged health spending has no further

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[21] The results from alternative specifications (used for the robustness tests) are also reported in the tables. These are discussed in Section IV B.

[22] An assessment of the direct and indirect effects is given in Tables 8 and 9.

[23] Following Bils and Klenow (2000), an increase of 6 percentage points in the composite enrollment is equivalent to one more year of schooling.

effect on health indicators, indicating that the impact of health spending is only contemporaneous.[24]

- **Education and health capital have strong interlinkages**. Health capital contributes to the accumulation of education capital, with an elasticity of about 1.3. Moreover, education is also associated with health capital through the variable on gender equality.

- **Governance has significant direct effects on the nexus between social spending and social indicators, with health spending being particularly sensitive to governance**. As shown in Tables 4 and 5, health spending has no effect on health indicators in countries suffering from poor governance. Similarly, the impact of education spending is also much reduced in such countries. The important role of governance—which has not always been incorporated in previous research—could help explain why some earlier studies have found a generally weak relationship between social spending and social indicators.

- **Gender equality influences both education and health indicators**. The share of female students in primary and secondary schools is positively and significantly associated with education capital and negatively and significantly associated with child mortality. A 1 percentage point increase (e.g., from 40 percent to 41 percent) in the female share of enrolled students is associated with an increase of 2 percentage points in the composite enrollment rate, and a reduction of 0.3 percentage point in the child mortality rate. This strongly supports the view that in developing countries, gender equality is important in both education and health sector interventions.

- **Income levels matter for social indicators**. GDP per capita is robustly and positively correlated with both education and health capital. This indicates that higher income levels and greater human capital reinforce each other and contribute to a virtuous circle of growth and higher human capital.

- **Poor governance reduces growth mainly through its impact on human capital and investment**. Countries with poor governance, other things being equal, have growth of about 1.6 percentage points lower per year than other countries.[25]

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[24] The lagged value of health spending (measured in terms of the average spending over the previous five years) has no effect on the current health indicator. This is consistent with previous research, which concludes that health spending has an immediate effect (e.g., Castro and Musgrove (2001)).
[25] The effect captures the impact of a discrete change in governance from lower-than-average to higher-than-average.

Similarly, poor governance is associated with a rate of investment to GDP that is 2 percentage points lower. As shown in Annex Table 9, the effect of governance on growth is transmitted through indirect channels via social indicators and investment.

- **The impact of education and health capital on growth varies in different income and regional country groups** (Table 6). The impact of education capital on growth is more pronounced in low-income countries, where an increase of 1 percentage point in the composite enrollment rate is associated with 0.1 percentage point increase in per capita GDP growth. This effect is 1.5 times that in middle-income countries. Geographically, the impact is highest in sub-Saharan Africa and lowest in Eastern Europe and Central Asia. As for the impact of health capital on growth, the impact of a unit reduction in the under-5 child mortality rate is smaller in low-income countries than middle-income countries. However, this masks the fact that in terms of the elasticities, the impact of reducing child mortality is about 4 times as large when compared to middle-income countries, owing to high initial levels of mortality in the poorest countries.

Table 2. Growth Equation-Dependent Variable:

Average Real Per Capita GDP Growth

	LSDV 1/	Robust Reg.	FGLS	2SLS	EC2SLS	System GMM
Investment	0.160	0.143	0.164	0.155	0.111	0.104
	(7.65)***	(7.69)***	(13.79)***	(1.56)	(2.26)**	(20.61)***
Population growth	-0.040	-0.043	-0.009	-0.030	-0.020	-0.070
	(3.11)***	(3.78)***	(2.16)**	(1.72)*	(1.73)*	(15.16)***
Catch-up variable	-0.159	-0.229	-0.001	-0.233	-0.003	-0.145
	(5.44)***	(8.84)***	(1.11)	(6.79)***	(0.59)	(15.18)***
Education capital (*t-1*)	0.127	0.143	0.029	0.143	0.002	0.087
	(3.08)***	(3.93)***	(2.39)**	(1.53)	(0.05)	(9.33)***
Health capital (*t-1*)	-0.203	-0.001	0.021	-0.423	0.189	-0.050
	(0.81)	(0.00)	(0.28)	(0.77)	(0.66)	(0.70)
Changes in education capital	0.118	0.148	0.072	0.200	0.107	0.082
	(2.48)**	(3.51)***	(3.04)***	(1.70)*	(1.18)	(7.97)***
Changes in health capital	1.099	0.984	0.947	-0.416	2.147	1.531
	(1.82)*	(1.83)*	(3.33)***	(0.22)	(1.69)*	(8.31)***
Trade openness	0.001	0.001	-0.001	0.001	-0.000	0.002
	(2.25)**	(2.07)**	(7.88)***	(2.76)***	(0.33)	(10.68)***
Changes in terms of trade	0.001	0.000	0.000	0.002	0.002	0.000
	(1.32)	(0.42)	(0.48)	(1.52)	(1.67)*	(2.84)***
Fiscal balance	0.005	0.005	0.005	0.004	0.005	0.009
	(3.67)***	(3.95)***	(6.39)***	(2.08)**	(3.29)***	(22.43)***
Low-deficit fiscal balance	0.002	0.002	-0.000	-0.002	-0.009	0.004
	(0.62)	(0.61)	(0.16)	(0.35)	(2.12)**	(3.52)***
Inflation rate	-0.053	-0.048	-0.072	-0.033	-0.079	-0.128
	(2.73)***	(2.78)***	(5.18)***	(1.31)	(3.28)***	(14.95)***
High-inflation dummy	-0.058	-0.048	-0.035	-0.059	-0.045	-0.061
	(3.49)***	(3.27)***	(3.73)***	(2.79)***	(2.17)**	(12.31)***
Low-governance dummy	-0.018	-0.015	-0.023	-0.013	-0.034	-0.048
	(1.23)	(1.15)	(3.34)***	(0.67)	(2.03)**	(7.66)***
Constant	2.107	1.447	-0.633	3.991	-1.519	0.016
	(1.30)	(1.01)	(1.35)	(1.15)	(0.86)	(10.04)***
Observations	435	434	429	339	339	435
R-squared	0.74	0.80		0.42	0.28	
P-value for overidentification				0.16		0.96

Absolute value of *t* statistics in parentheses.
* significant at 10 percent;
** significant at 5 percent;
*** significant at 1 percent.

1/ Baseline regression.

Table 3. Investment Equation-Dependent Variable:
Average Annual Investment Ratio

	LSDV 1/	Robust	FGLS	EC2SLS	2SLS	Sys GMM
Population growth	0.496	0.834	-0.024	0.187	0.374	-0.462
	(1.26)	(2.49)**	(0.10)	(0.49)	(0.78)	(1.59)
Gross enrollment rate	-0.025	0.000	0.027	0.015	-0.210	-0.029
	(1.29)	(0.01)	(3.04)***	(0.26)	(1.55)	(2.74)***
Under-5 child mortality	-0.028	-0.045	-0.028	-0.067	-0.136	-0.058
	(1.69)*	(3.23)***	(4.63)***	(1.91)*	(1.53)	(5.99)***
Catch-up variable	-0.939	-1.688	-1.193	-2.771	-0.620	-0.942
	(1.58)	(3.34)***	(4.33)***	(3.22)***	(0.65)	(2.81)***
Changes in terms of trade	-0.057	0.001	-0.024	-0.046	-0.069	-0.049
	(1.96)*	(0.03)	(1.10)	(1.53)	(1.95)**	(1.58)
Trade openness	0.070	0.123	0.064	0.048	0.043	0.027
	(5.34)***	(11.11)***	(8.35)***	(4.30)***	(2.10)**	(2.56)**
Inflation	-0.961	-0.268	0.139	0.175	-1.571	-5.524
	(1.00)	(0.33)	(0.24)	(0.17)	(1.13)	(8.52)***
High-inflation dummy	-2.198	-1.127	-1.082	-1.801	-2.551	-2.611
	(2.55)**	(1.54)	(2.22)**	(2.09)**	(2.47)**	(4.11)***
Fiscal balance	-0.079	-0.209	-0.094	-0.128	-0.131	0.063
	(1.14)	(3.53)***	(2.01)**	(1.97)**	(1.40)	(1.10)
Low-deficit fiscal balance	0.056	-0.078	0.263	0.263	0.330	-0.083
	(0.27)	(0.45)	(2.00)**	(1.22)	(1.18)	(0.54)
Low-governance dummy	-1.607	-2.038	-0.897	-1.000	-2.273	-2.111
	(2.09)**	(3.13)***	(1.95)*	(1.27)	(1.88)*	(3.76)***
Constant	32.397	38.690	24.553	41.215	65.745	-20.145
	(5.42)***	(7.62)***	(9.07)***	(3.35)***	(2.36)**	(44.42)***
Observations	494	494	487	455	455	473
R-squared	0.67	0.79				
P-value for Overidentification					0.19	0.13

Absolute value of *t* statistics in parentheses.
* significant at 10 percent;
** significant at 5 percent;
*** significant at 1 percent.

1/ Baseline regression.

Table 4. Education Equation-Dependent Variable: Average Gross Composite School Enrollment Rate

	LSDV 1/	Robust Reg.	FGLS	EC2SLS	2SLS	System GMM
Under-5 child mortality	-0.188	-0.130	-0.362	-0.319	-0.125	-0.065
	(3.13)***	(3.01)***	(32.88)***	(3.42)***	(0.82)	(3.97)***
Current per capita income	8.228	6.867	0.465	-1.613	9.316	6.247
	(3.01)***	(3.50)***	(0.44)	(0.42)	(2.08)**	(25.64)***
Share of under-15 population	-0.815	-0.214	-0.977	-1.318	-0.618	-0.144
	(1.79)*	(0.65)	(16.59)***	(3.33)***	(0.84)	(1.30)
Urbanization	0.109	0.101	0.028	0.089	0.647	0.836
	(0.45)	(0.58)	(1.24)	(0.57)	(2.05)**	(13.83)***
Repetition rate	0.024	-0.337	0.189	-0.067	0.191	0.133
	(0.07)	(1.47)	(3.87)***	(0.25)	(0.46)	(2.49)**
Share of female students	1.417	2.349	0.969	0.669	1.645	2.090
	(2.84)***	(6.53)***	(15.96)***	(1.12)	(1.93)*	(26.75)***
Current education spending (in logs)	21.598	17.499	6.906	9.407	11.958	15.514
	(4.00)***	(4.51)***	(3.99)***	(1.85)*	(2.03)**	(13.61)***
Lagged education spending (in logs)	9.776	7.516	5.053	7.756	19.018	15.930
	(1.92)*	(2.05)**	(3.38)***	(1.44)	(2.81)***	(34.80)***
Low-governance * current education spending	-5.262	-1.377	0.420	-0.738	-2.455	-0.780
	(2.32)**	(0.84)	(0.46)	(0.34)	(1.00)	(5.37)***
Low-governance * lagged education spending	-3.529	-4.872	-4.735	-3.331	-3.538	-6.225
	(1.43)	(2.74)***	(12.55)***	(1.54)	(1.48)	(15.25)***
Constant	-144.388	-133.695	-217.794	-140.594	-156.380	-0.233
	(2.69)***	(3.47)***	(27.93)***	(2.09)**	(1.24)	(1.76)*
Observations	300	294	254	232	232	193
R-squared	0.95	0.98				
P-value for overidentification					0.20	0.92

Absolute value of *t* statistics in parentheses.
* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.
1/ Baseline regression.

Table 5. Health Equation-Dependent Variable: Average Annual Under-5 Child Mortality Rate

	LSDV 1/	Robust Reg.	FGLS	EC2SLS	2SLS
Current per capita income	-9.425	-6.027	-16.422	-22.949	-8.576
	(3.47)***	(5.18)***	(9.28)***	(5.38)***	(2.00)**
Urbanization	0.457	-0.219	-0.116	0.118	0.960
	(1.38)	(1.55)	(1.55)	(0.40)	(1.56)
Share of female students	-3.287	-1.308	-3.054	-5.468	-4.151
	(7.13)***	(6.63)***	(11.59)***	(5.42)***	(4.67)***
Current health spending (in logs)	-5.182	-6.471	0.853	-26.504	-27.200
	(1.68)*	(4.89)***	(0.50)	(2.30)**	(1.64)
Low-governance * current health spending	5.157	3.399	-0.092	14.308	12.592
	(1.69)*	(2.60)**	(0.05)	(2.34)**	(1.88)*
Fertility rate	12.160	8.644	17.024	7.582	11.787
	(5.49)***	(9.11)***	(17.07)***	(2.65)***	(3.06)***
Constant	208.100	126.973	275.175	474.587	253.142
	(6.13)***	(8.74)***	(16.70)***	(7.30)***	(4.11)***
Observations	267	258	230	188	188
R-squared	0.99	1.00			
P-Value for overidentification					0.52

Absolute value of *t* statistics in parentheses.
* significant at 10 percent;
** significant at 5 percent;
*** significant at 1 percent.

1/ Baseline regression.

Table 6. Summary of Total Effect Coefficients by Country Group[1/]

	Independent Variable (x)				
	Composite primary and secondary enrollment	Under-5 child survival rate 2/	Current education spending	Current health spending	Lagged education spending
Dependent variable (y)	(in percent of the school age group)	(per thousand live births)	(one percent of GDP)		
All developing countries					
Real per capita GDP growth	0.09	0.17	0.54	0.39	0.25
Composite enrollment rate	0.00	0.19	6.00	0.44	2.72
Under-5 child survival 2/	0.00	0.00	0.00	2.36	0.00
Low-income countries					
Real per capita GDP growth	0.12	0.11	0.59	0.48	0.27
Composite enrollment rate	0.00	0.19	6.54	0.54	2.96
Under-5 child survival 2/	0.00	0.00	0.00	2.88	0.00
Middle-income countries					
Real per capita GDP growth	0.08	0.29	0.50	0.34	0.23
Composite enrollment rate	0.00	0.19	5.54	0.39	2.51
Under-5 child survival 2/	0.00	0.00	0.00	2.07	0.00
Asia					
Real per capita GDP growth	0.08	0.24	0.53	0.48	0.24
Composite enrollment rate	0.00	0.19	5.84	0.54	2.64
Under-5 child survival 2/	0.00	0.00	0.00	2.88	0.00
Eastern Europe & Central Asia					
Real per capita GDP growth	0.06	0.46	0.44	0.24	0.20
Composite enrollment rate	0.00	0.19	4.80	0.27	2.17
Under-5 child survival	0.00	0.00	0.00	1.44	0.00
Latin America & the Caribbean					
Real per capita GDP growth	0.08	0.27	0.56	0.34	0.25
Composite enrollment rate	0.00	0.19	6.17	0.39	2.79
Under-5 child survival 2/	0.00	0.00	0.00	2.07	0.00
Middle East & North Africa					
Real per capita GDP growth	0.08	0.22	0.47	0.48	0.21
Composite enrollment rate	0.00	0.19	5.17	0.54	2.34
Under-5 child survival 2/	0.00	0.00	0.00	2.88	0.00
Sub-Saharan Africa					
Real per capita GDP growth	0.13	0.10	0.55	0.48	0.25
Composite enrollment rate	0.00	0.19	6.02	0.54	2.72
Under-5 child survival 2/	0.00	0.00	0.00	2.88	0.00

Source: Authors' calculation.

1/ The coefficient measures dy/dx, i.e. , the impact of one percentage point change in column variables on row variables. These coefficients are calculated using estimates from the baseline model. If the original coefficients in the regressions are in y/lnx form, they are transformed into linear coefficients of dy/dx derived from the equation dy/dlnx=dy/(dx/x)=(dy/dx)/x.
2/ Under-5 child survival rate is used to facilitate the interpretation of a positive effect, and the increase in the under-5 child survival rate matches exactly the reduction in the under-5 child mortality rate.

B. Robustness Checks

Our estimates generate elasticities that are similar to those found in earlier research. The econometric results imply that the elasticity of education indicators with respect to education spending is 0.25.[26] This is close to the upper range of similar estimates on the returns to primary and secondary education in the literature (Psacharopoulos (1994), Psacharopoulos and Patrinos (2002), and Baldacci and others (2003)). The elasticity of health indicators with respect to changes in public health outlays is about 0.05, which is also consistent with the literature (Schultz (1999) and Gupta and others (2002b)).

The coefficients linking human capital indicators and growth are also consistent with the literature. On health capital and growth, Bloom and Canning (2003) and Bloom and Sevilla (2004) find elasticities of 1.3 and 1.9 respectively, compared with our estimates ranging from 1.4 to 3.2 for different country groups.[27] On education capital and growth, Levine and Renelt (1992), Barro (1996a), Bassanini and Scarpetta (2001), Bils and Klenow (2000), and Sianesi and Van Reenen (2003) estimate that an additional year of schooling raises the growth rate by 0.3 to 3 percentage points per year. Our estimates, based on the composite enrollment rate, indicate that one year of additional primary and secondary schooling is associated with an increase in growth ranging between 0.4 and 0.8 percentage points per year, depending on the country group.[28] Low-income countries and sub-Saharan African countries are on the high end, while Eastern Europe and Central Asia countries are on the low end.

The results are broadly consistent under a number of different estimators controlling for outliers (robust regression) and endogeneity (two-stage least squares and system GMM).[29]

Moreover, solving the growth, investment, education, and health equations simultaneously in a Seemingly Unrelated Regression framework does not lead to qualitatively different results. The Breusch-Pagan test fails to reject the independence of the residuals from the four equations. We also compared the recursive system with other specifications, including

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[26] This figure accounts only for the direct impact of a rise in education spending in two periods. If the intertemporal effects are fully taken into account, the estimated elasticity is 45 percent.

[27] Assuming the average real per capita growth rate to be 1.3 percent per year and the average life expectancy to be 63 in calculating elasticities e=(dg/g)/(dx/x).

[28] Following Bils and Klenow (2000), we consider six times the effect on the average enrollment ratio as equivalent to one more year of average schooling to obtain this estimate.

[29] The model is also tested by using alternative education and health indicators, such as infant mortality and primary schooling, and the results are found to be qualitatively consistent.

a full-fledged system of equations, and find that our model dominates other specifications based on the SIC.

Furthermore, the estimates on governance, inflation, and deficit are also broadly consistent with the literature. For example, Mauro (1996) finds that reducing corruption by one standard deviation is associated with a rise in the growth rate of 0.5 percentage point, while our results indicate that a discrete jump from a low-governance to a high-governance country is associated with an increase in the growth rate of 1.6 percentage points.[30] Fischer (1993) and Burdekin and others (2000) find that lowering inflation by 10 percentage points raises growth by 0.4 and 0.8[31] percentage points respectively, while our results indicate the same inflation reduction is associated with higher growth of 0.5 percentage point. Baldacci and others (2004) find that lowering the deficit by 1 percentage point of GDP is associated with an increase in per capita GDP growth of 0.4 percentage point, while this paper shows an increase in per capita growth of 0.5 percentage point, also similar to that in Fischer (1993), Bleaney (1996), and Gupta and others (2004).

V. Simulation[32] of the Impact of Policy Interventions and Implications for the MDGs

As shown in previous sections, social indicators and growth are affected by many interrelated factors. On the basis of the empirical estimates presented above, simulations can be conducted to assess the impact of different policy interventions for improving social indicators, economic growth, and the poverty headcount. As such, these simulations can provide input into the debate over the effectiveness of different policies in helping countries reach the MDGs. The simulations assess the impact of the following policy interventions: (1) an increase in education spending of one percent of GDP; (2) an increase in health spending of one percent of GDP; (3) an improvement in governance; (4) a reduction in the budget deficit of one percent of GDP; and (5) a reduction in inflation of 10 percentage points.

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[30] We did not find alternative governance indicators that had sufficient time-series data for use in our model. Using alternative corruption measures would most likely generate similar results, given the high degree of cross-country correlation we found (0.6–0.8) between the ICRG index and other corruption indices (i.e., the index of Transparency International and the World Bank governance indicator (see Kaufmann and others (2003)). The difference between the means of the high-governance countries and the low-governance countries are about three times of the standard deviations in each subsample, and therefore the point estimate of 1.6 is consistent with Mauro (1996).

[31] This is a point estimate for the impact of inflation on growth in a developing country when the inflation rate is between 3 and 50 percent.

[32] The simulation is a partial equilibrium analysis focusing on the interaction of key variables. It assumes that elasticities obtained by the recursive system persist over time. See the notes in Table 7 for details.

Each of the simulations assumes that the policy environment remains unchanged. This implies, for example, that increases in public spending do not result in an increase in the budget deficit or a deterioration in governance. As noted in the results below, the macroeconomic environment and governance are important determinants of growth and human development. As such, the effectiveness of spending initiatives would be greatly diminished if not accompanied by a deterioration of performance in these areas.

Increase education spending by 1 percent of GDP [33]

Simulation results for raising education spending, and other interventions, are reported in Table 7. They suggest that raising average education spending by 1 percent of developing country GDP (and maintaining it at that higher level) would increase the sum of the primary and secondary enrollment rates (the composite rate) from an average of 154 to 173 over 15 years (Table 7).[34] This implies that the net enrollment rate can increase from 90 to 100 percent. Thus, increases in spending of this magnitude would be greatly helpful in moving countries toward the MDG target for education, although not necessarily sufficient to achieve it in all regions. Increasing education spending could also contribute to health capital by lowering the child mortality rate from 76 per thousand in 2000 to 65 per thousand in 2015. In addition, the strengthening of human capital would have a beneficial effect on growth, and the per capita growth rate would rise by about 0.5 percentage point per year on average over the simulation period. Such an improvement in growth could reduce the initial poverty headcount by about 17 percent over a 15-year period.[35]

Increase health spending by 1 percent of GDP

Raising average health spending by 1 percent of GDP would reduce the under-5 child mortality rate by 0.6 percentage point, that is from an average of 76 deaths per thousand live births in 2000 to 70 deaths per thousand in 2015. The simulations suggest that the MDG target—lowering the child mortality rate to 62 deaths per 1,000 live births (one-third

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[33] We assume the rise in spending is achieved in time *t* and then maintained at the new level. The increase in spending is assumed to come from sources that do not increase the budget deficit (e.g., external grants, domestic revenues, or reductions in other public spending).

[34] This is equivalent to an average increase in schooling of three years.

[35] See notes in Table 7 for details on the projection method.

Table 7. Simulation on the Impact on Growth and Social Indicators from Various Policy Interventions 1/

	Baseline	T+1	T+2	T+3	T+1	T+2	T+3
			End of period value			Absolute change	
Increase education spending by 1 percent of GDP 2/							
Composite enrollment	154.0	160.0	167.2	172.5	6.0	7.2	5.4
Implied net primary enrollment 3/	89.7	93.2	97.5	100	3.5	4.3	1.0
Per capita GDP growth (in percent)	1.3	1.8	2.0	2.7	0.5	0.2	0.7
Implied headcount ratio 4/	100.0	95.2	89.9	82.9	-4.8	-5.3	-7.0
Under-5 child mortality (per 1000 live births)	76.0	76.0	70.9	64.7	0.0	-5.1	-6.2
Increase health spending by 1 percent of GDP 2/							
Under-5 child mortality (per 1000 live births)	76.0	73.6	69.9	69.9	-2.4	-3.7	0.0
Composite enrollment	154.0	154.4	157.7	157.7	0.4	3.3	0.0
Implied net primary enrollment 3/	89.7	90.0	91.8	91.9	0.3	1.9	0.0
Per capita GDP growth (in percent)	1.3	1.7	1.7	1.7	0.4	0.0	0.1
Implied headcount ratio 4/	100.0	95.6	91.2	86.7	-4.4	-4.4	-4.5
Improving governance to be above the world average							
Under-5 child mortality (per 1000 live births)	76.0	70.8	70.8	69.7	-5.2	0.0	-1.2
Composite enrollment	154.0	159.3	172.4	173.5	5.3	13.2	1.0
Implied net primary enrollment 3/	89.7	92.8	100	100	3.1	7.7	0.6
Per capita GDP growth (in percent)	1.3	2.9	2.7	2.8	1.6	-0.2	0.1
Implied headcount ratio 4/	100.0	92.5	85.5	78.2	-7.5	-7.0	-7.3
Reduce inflation by 10 percentage points (e.g., from 40 percent to 30 percent)							
Per capita GDP growth (in percent)	1.3	1.8	1.8	1.8	0.5	0.0	0.0
Implied headcount ratio 4/	100.0	95.2	90.5	85.7	-4.8	-4.8	-4.8
Marginal change from high inflation to below 20 percent							
Per capita GDP growth (in percent)	1.3	1.4	1.4	1.4	0.1	0.0	0.0
Implied headcount ratio 4/	100.0	96.4	92.9	89.3	-3.6	-3.6	-3.6
Reduce fiscal deficit by 1 percent of GDP 5/							
Per capita GDP growth (in percent)	1.3	1.8	1.8	1.8	0.5	0	0
Implied headcount ratio 4/	100.0	95.3	90.6	86.0	-4.7	-4.7	-4.7

Sources: *World Development Indicators database* 2003, *World Economic Outlook* database 2003, country authorities and authors' calculations.

1/ Simulations are based on coefficients obtained from the baseline model. The initial baseline values are averages for developing countries in the sample, and the policy interventions are assumed to take place at the end of baseline year. In addition, the increased social spending is assumed to be maintained over the simulation period. Furthermore, the elasticity estimates from the recursive model are assumed to hold for the period covered by the simulation while other variables stay at the same level. The effects of higher incomes on education and health capital are also captured.
2/ The value of 1 percent of GDP of all developing countries was about $60 billion in 2000. The rise in spending is assumed to be deficit-neutral, and may be achieved through grants, increased revenue collection, and/or shifting of funding from unproductive outlays.
3/ The implied net primary enrollment rate is calculated under the assumption that the ratio of the net primary enrollment rate over the composite enrollment rate remains what it was in 2000.
4/ The initial value of the headcount ratio is standardized to be 100, and the implied headcount ratios are the projected end-of-period values after incorporating the incremental poverty reduction due to growth acceleration. The impact on the poverty headcount ratio is calculated by the growth elasticity of poverty of -2.6, an average based on estimates from Ravallion and Chen (1997), Bruno, Ravallion, and Squire (1998), and Adams (2003).
5/ The impact on growth is estimated at the sample mean for deficit at 4 percent of GDP, and the reduction is assumed to be achieved through grants, increased revenue collection or cut in unproductive spending without affecting social spending.

of the 1990 level)—cannot be met under this scenario.[36] In addition, there are also small but positive effects from health spending on school enrollment and growth. On average, the net enrollment rate in developing countries would rise by about 2 percentage points (i.e., from 90 to 92), and the growth rate would rise by a total of 0.5 percentage points over 15 years.

Improve governance to a level above the sample average

Enhancing governance is a powerful instrument to improve social indicators and growth. A change in the governance index from lower- to higher-than-average is associated with an immediate reduction of 0.5 percentage point in the child mortality rate, an increase of 6 percentage points in the composite enrollment rate, and a rise of 1.6 percentage points in per capita GDP growth. Through the reinforcing impact of higher income on human capital, this measure can lead to even better social indicators. For example, it can increase net primary enrollment by 10 percentage points in 10 years without additional resources. The positive impact from elevating a country from a below- to a higher-than-average level, therefore, is comparable to an increase in education spending of 1 percent of GDP.

Reduce inflation

The growth effects of lower inflation (and hence its effects on poverty) are substantial. Cutting the rate of inflation by 10 percentage points (e.g., from 40 percent to 30 percent) is associated with a 0.5 percentage point increase in annual growth. Moreover, countries that reduce their rate of inflation to below 20 percent would also experience an additional fillip to growth of 0.1 percentage point per year. The magnitude of this effect is consistent with the literature.

Reduce fiscal deficit

As discussed in previous sections, budget deficits have an adverse effect on growth. Improving the fiscal balance by 1 percentage point of GDP is associated with an increase in per capita GDP growth by 0.5 percentage point.[37] However, while the initial impact on growth is comparable to that achieved with increased social spending, it does not bring additional lagged positive effects, as in the case of social spending. Furthermore, as shown in Table 2, the effects from increasing the fiscal balance in a low-deficit environment is no longer significant. This result is consistent with Gupta and others (2004), which finds no relationship between further deficit reduction and growth in low-income countries that have already achieved a modicum of macroeconomic stability.

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[36] Based on the sample average of the dataset used in this paper.

[37] We assume the cut is achieved through grants, increased revenue collection or reduction of unproductive spending, with social spending on education and health unchanged.

VI. Conclusion and Policy Implications

The paper finds that a number of policy interventions could be effective in moving countries toward the MDGs. Both education and health spending have a positive and significant direct impact on the accumulation of education and health capital, and a positive and significant indirect impact on growth. An increase in education spending of 1 percentage point of GDP is associated with 3 more years of schooling on average and a total increase in growth of 1.4 percentage points in 15 years. Similarly, an increase in health spending of 1 percentage point of GDP is associated with an increase of 0.6 percentage points in the under-5 child survival rate and a rise of 0.5 percentage point in annual per capita GDP growth.

There is a significant time lag between increases in education spending and the realization of their full effects on social indicators and growth. Two-thirds of the direct impact of education spending is felt within five years, but the full impact materializes with a significant time lag of 10 to 15 years. Such a lag needs to be kept in mind when designing policy interventions. The impact of health spending, however, is immediate. The positive effects of both education and health spending are strongly influenced by the quality of governance. In countries suffering from poor governance, the positive effects of increased spending on education is reduced, and those of higher health spending can be completely negated.

There are substantial differences in the effects of social spending on social indicators and growth among different country groups. The positive effects are the highest in low-income countries and sub-Saharan Africa. This supports the view that social spending can be more effective in such countries in achieving MDGs, as the marginal returns to social spending tend to decline for countries with high levels of social outlays.

Other policy interventions may also achieve improvement of a similar size in social indicators and growth. In particular, strengthening governance can have a strong payoff for social indicators as well as for growth. Therefore, reducing corruption and increasing accountability for public spending are no less important than increasing spending. In addition, macroeconomic policies, such as reducing inflation and improving fiscal balances, also have a positive effect on growth and, in turn, on the poverty headcount.

The results have a number of implications for poverty reduction strategies aimed at meeting the MDGs. Given the importance of different policy interventions, efforts to meet the MDGs will need to be wide-ranging and include strengthening the macroeconomic environment and governance. Relative to the significant cost of raising spending, the moderate effects of social spending on indicators also confirm the important role of reforms aimed at improving the efficiency and targeting of these outlays. Furthermore, while improving human capital will have a salutary effect on growth, it will be far from a panacea for unlocking the more robust expansion in economic activity needed to achieve the MDGs. As such, additional research is needed to address the key policy interventions needed to achieve rapid economic growth.

Derivation of the Growth Equation with Human Capital [38]

In a neoclassical growth model enhanced by human capital:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \left(A(t)L(t)\right)^{1-\alpha-\beta}$$

where *Y* is output, *K* and *H* are physical and human capital respectively, *A* is technology, *L* is population, and α and β are the partial elasticities of output with respect to physical and human capital. The right-hand side variables are assumed to take the following time paths:

$$\begin{aligned}
\dot{k}(t) &= s_k(t)A(t)^{1-\alpha-\beta}k(t)^{\alpha}h(t)^{\beta} - (n(t)+d)k(t) \\
\dot{h}(t) &= s_h(t)A(t)^{1-\alpha-\beta}k(t)^{\alpha}h(t)^{\beta} - (n(t)+d)h(t) \\
\dot{A}(t) &= g(t)A(t) \\
\dot{L}(t) &= n(t)L(t)
\end{aligned} \qquad [2]$$

where *y* = *Y/L* and *k* = *K/L* are output and physical capital in per capita terms, *h* = *H/L* represents average human capital, s_k and s_h are the investment rate in physical and human capital, *n* is population growth, *g* is the rate of technological change and *d* is the time-invariant depreciation rate.

Under the assumption of decreasing returns to scale ($\alpha+\beta < 1$), this system of equations can be solved to obtain steady-state values of *k** and *h** defined by:

$$\begin{aligned}
\ln k^{*}(t) &= \ln A(t) + \frac{1-\beta}{1-\alpha-\beta}\ln s_k(t) + \frac{\beta}{1-\alpha-\beta}\ln s_h(t) - \frac{1}{1-\alpha-\beta}\ln(g(t)+n(t)+d) \\
\ln h^{*}(t) &= \ln A(t) + \frac{\alpha}{1-\alpha-\beta}\ln s_k(t) + \frac{1-\alpha}{1-\alpha-\beta}\ln s_h(t) - \frac{1}{1-\alpha-\beta}\ln(g(t)+n(t)+d)
\end{aligned} \qquad [3]$$

Substituting these two equations into the production function and taking logs yields the expression for the steady-state output in per capita terms. The human capital component can be expressed either as a function of s_h and the other variables or as a function of *h** and the other variables (see Mankiw and others, 1992). In this paper, the human capital component is expressed in terms of human capital stock, proxied by the gross enrollment rate. Therefore, the steady-state path of output can be written as:

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[38] The section is adapted mainly from the derivation used in Bassanini and Scarpetta (2001), but we further introduce education capital and health capital as two components of the human capital variable so that their interactions and effects on growth can be better identified.

$$\ln y^*(t) = \ln A(t) + \frac{\alpha}{1-\alpha}\ln s_k(t) + \frac{\beta}{1-\alpha}\ln h^*(t) - \frac{\alpha}{1-\alpha}\ln(g(t)+n(t)+d) \qquad [4]$$

$h*$ is unobservable, but a relationship between $h*$ and the actual level of human capital can be established by solving the system of differential equations in [2] and substituting out the respective investment rates by means of the equations in [3]:[39]

$$\frac{d\ln\frac{k}{A}}{dt} = (n+g+d)e^{-(1-\alpha)\ln\frac{k}{k*}}e^{\beta\ln\frac{h}{h*}}$$
$$\frac{d\ln\frac{h}{A}}{dt} = (n+g+d)e^{\alpha\ln\frac{k}{k*}}e^{-(1-\beta)\ln\frac{h}{h*}} \qquad [5]$$

The linearized solution for *ln h* is the following:

$$\ln(h(t)/A(t)) = \psi(\ln(h^*(t)/A(t)) + (1-\psi)\ln(h(t-1)/A(t-1)) \qquad [6]$$

where ψ is a function of (α, β) and the term $(n+g+d)$. Rearranging equation [6] yields an expression for $\ln h^*$:

$$\ln h^*(t) = \ln h(t) + \frac{1-\psi}{\psi}\Delta\ln(h(t)/A(t)) \qquad [7]$$

By replacing the term $\ln h*$ with its expression [7] into equation [4], we obtain an expression for the steady state output as a function of the investment rate and the actual human capital stock. Assuming countries are in their steady-states or their deviations from the steady states were independent and identically distributed, the transitional growth dynamics can be expressed as follows (Mankiw and others, 1992):

$$\frac{d\ln(y(t)/A(t))}{dt} = \lambda(\ln(y^*(t)/A(t)) - \ln(y(t)/A(t))) \qquad [8]$$

where $\lambda = (1-\alpha-\beta)(g(t)+n(t)+d)$.

Substituting the expression for y^* and h^* into the solution of this differential equation yields the following:[40]

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[39] To simplify the notation, the suffix *t* has been dropped.

[40] The equation has been simplified by assuming a constant rate of technological change. Its version with non-constant technological change can be easily derived as well.

$$\Delta \ln y(t) = -\phi(\lambda)\ln(y(t-1)) + \phi(\lambda)\frac{\alpha}{1-\alpha}\ln s_k(t) + \phi(\lambda)\frac{\beta}{1-\alpha}\ln h(t)$$
$$+\frac{1-\psi}{\psi}\frac{\beta}{1-\alpha}\Delta \ln h(t) - \phi(\lambda)\frac{\alpha}{1-\alpha}\ln(g+n(t)+d) + \left(1-\frac{\phi(\lambda)}{\psi}\right)g + \phi(\lambda)\ln A(0) + \phi(\lambda)gt \qquad [9]$$

Since g is not observable and therefore cannot be distinguished from the constant term empirically, the estimated baseline growth equation can be expressed as follows:

$$\Delta \ln y(t) = a_0 - \phi \ln y(t-1) + a_1 \ln s_k(t) + a_2 \ln h(t) - a_3 n(t) + a_4 t + b\Delta \ln h(t) + \varepsilon(t) \qquad [10]$$

In this paper, we separate human capital further into two components: education capital—*ed*, and health capital—*he*, and assume human capital *h(t)* takes the following form:

$h(t) = ed(t)^{\gamma} * he(t)^{\eta}$ *or* $\ln h(t) = \gamma \ln ed(t) + \eta \ln he(t)$.

We also assume that the time paths for education capital, e, and health capital, h, are as follows:

$$ed_t = ed_{t-1} + \Delta ed_t$$

$$he_t = he_{t-1} + \Delta he_t$$

Hence, [10] becomes [11]

$$\Delta \ln y(t) = a_0 - \phi \ln y(t-1) + a_1 \ln s_k(t) + a_2 \ln he(t) + a_3 \ln ed(t) - a_4 n(t) + a_{54} t + b_1 \Delta \ln he(t) + b_2 \Delta \ln ed(t) + \varepsilon(t) \qquad [11]$$

Or, in a simplified representation after adding a matrix of control variables, Ω,

$$g \ = f(s_k, he, \Delta he, ed, \Delta ed, \Omega) \qquad [12]$$

List of Countries Included in the Sample and Data Sources

The countries included in the study are Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Barbados, Belarus, Belize, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Democratic Republic of Congo, Republic of Congo, Costa Rica, Côte d'Ivoire, Croatia, Czech Republic, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Estonia, Ethiopia, Fiji, The Gambia, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Islamic Republic of Iran, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyz Republic, Lao People's Democratic Republic, Latvia, Lebanon, Lesotho, Libya, Lithuania, FYR Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Slovak Republic, Solomon Islands, South Africa, Sri Lanka, Sudan, Swaziland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, Uruguay, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

All data series are five-year averages of annual data. Data on real per capita GDP, inflation, investment, terms of trade, trade openness, total government expenditure, and fiscal balance are based on the *World Economic Outlook* (WEO) database. In particular, real GDP growth rates are calculated by the change of GDP in constant prices; the rate of inflation is calculated by the rate of increase in CPI index; investment, government expenditure, and fiscal balances are calculated as a ratio to GDP at current prices; and trade openness is calculated by the value of total exports and imports of goods and services as a share of GDP. Data on child mortality, the school repetition rate, ratio of female students in school, population growth, the shares of the under-15 population and urban population, and fertility rates are taken from the World Bank's *World Development Indicators* (WDI) database; data on the enrollment rate is taken from the 2003 Barro-Lee dataset; and the composite enrollment rate is the sum of primary and secondary enrollment rates. Child mortality and enrollment rates are not available for all years, but five-year averages allow the construction of a consistent panel dataset nonetheless. Data on education spending as a share of GDP is taken from the WDI database, but health spending as a share of GDP is taken from an IMF database that has better country coverage. Data in the IMF database is compiled from IMF staff reports and the IMF's *Government Financial Statistics*. Data on governance are calculated as the sum of the simple annual averages of two indices on corruption and democratic accountability, which are two components of the ICRG rating produced by the Political Risk Service Group.

Appendix Table 8. Short-Run Total Effects Decomposition: Selected Endogenous Variables

	Real Per capita GDP growth	Investment ratio	Gross enrollment rate	Under-5 child survival rate
Total effects				
Real per capita GDP growth	0.000	0.702	0.091	0.165
Investment ratio	0.000	0.000	0.000	0.035
Gross enrollment rate	0.000	0.000	0.000	0.188
Under-5 Child survival rate	0.000	0.000	0.000	0.000
Direct effects				
Real per capita GDP growth	0.000	0.702	0.091	0.124
Investment ratio	0.000	0.000	0.000	0.035
Gross enrollment rate	0.000	0.000	0.000	0.188
Under-5 Child survival rate	0.000	0.000	0.000	0.000
Indirect effects				
Real per capita GDP growth	0.000	0.000	0.000	0.042
Investment ratio	0.000	0.000	0.000	0.000
Gross enrollment rate	0.000	0.000	0.000	0.000
Under-5 Child survival rate	0.000	0.000	0.000	0.000

Appendix Table 9. Short-Run Total Effects Decomposition: Selected Exogenous Variables

	Population growth	Catch-up variable	Trade Openness	Changes in Terms of Trade	Fiscal balance	Low-deficit fiscal balance	High inflation dummy	Inflation rate	Low governance dummy	Current income	Gender equality	Current education spending	Lagged Education spending	Health spending
Total effects														
Real per capita GDP growth	-1.93	-15.90	0.15	-0.04	0.50	0.00	-0.07	-0.05	-1.65	2.30	0.67	0.54	0.25	0.39
Investment ratio	0.00	0.00	0.07	-0.06	0.00	0.00	-2.20	0.00	-1.69	0.33	0.12	0.00	0.00	0.08
Composite enrollment rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.90	10.00	2.03	6.00	2.72	0.44
Under-5 child survival rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.34	9.43	3.29	0.00	0.00	2.36
Direct effects														
Real per capita GDP growth	-1.93	-15.90	0.10	0.00	0.50	0.00	-0.06	-0.05	0.00	0.00	0.00	0.00	0.00	0.00
Investment ratio	0.00	0.00	0.07	-0.06	0.00	0.00	-2.20	0.00	-1.61	0.00	0.00	0.00	0.00	0.00
Composite enrollment rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.46	8.23	1.42	6.00	2.72	0.00
Under-5 child survival rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.34	9.43	3.29	0.00	0.00	2.36
Indirect effects														
Real per capita GDP growth	0.00	0.00	0.05	-0.04	0.00	0.00	-0.02	0.00	-1.65	2.30	0.67	0.54	0.25	0.39
Investment ratio	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.08	0.33	0.12	0.00	0.00	0.08
Composite enrollment rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.44	1.77	0.62	0.00	0.00	0.44
Under-5 child survival rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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