Education and Human Development

Patterns of Potential Human Progress

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Janet R. Dickson, University of Denver
(Corresponding Author: jdickson@du.edu)
Mohammod T. Irfan, University of Denver
Barry B. Hughes, University of Denver

Graduate School
of International Studies
University of Denver
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IFs

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Abstract

This paper reports on the development and early use of a forecasting system for exploring the future of global education and its relationships to broader human development. The paper uses the International Futures (IFs) with Pardee modeling system as the primary tool for the analysis, focusing on its fully integrated education module. International Futures (IFs) is a large-scale integrated global modeling system, the broad purpose of which is to serve as a thinking tool for the analysis of near through long-term country-specific, regional, and global futures across multiple, interacting issue areas. The education study is part of a larger project called Patterns of Potential Human Progress, a project that will produce a series of annual volumes that each investigates one key global issue. The second volume will be devoted to global education.

The paper summarizes the conceptual foundations for understanding education systems and also briefly sketches some dynamic connections of those systems to broader economic and social ones. That mapping produces a general schematic for a desirable system with which to analyze the future of education and human development. The paper then reviews existing forecasting projects and extracts insights from them, before turning to a summary discussion of the model structure used in this project.

Although the central purpose of the broader project is to explore global educational and human development paths and to investigate human leverage to affect those paths, the primary purpose of this paper is to introduce the tool under development. Provision and consideration of its early results in historic context and relative to other forecasts helps us evaluate its strengths and weaknesses and determine the next steps for the project.

Thus a significant portion of the paper reviews early results from the current analysis. In particular it looks at forecasts of student flows through the formal educational system, especially considering net primary enrollment (the central focus of the Millennium Development Goals) and primary completion. It looks at the future of gender parity in education. The paper then turns to an exploration of the costs of achieving universal primary education. Finally, it provides forecasts of the growth in educational stocks within the larger population (often called human capital).

This early analysis joins others in showing that the MDG of universal primary education by 2015 will not be met, but this study also offers some support for anticipating a rapid pace towards that goal in the longer run and provides some specific forecasts through mid-century. The analysis also suggests that substantial progress towards gender parity is probable across the century and that it may be achieved at the primary level by 2050. The study further shows, in support of other studies, that the costs of universal primary education are not a primary barrier to its achievement. Finally, the study provides forecasts of the global build-up of educational stock. Throughout, the paper draws lessons for next steps in the larger development and analysis project.

1. Education and Human Development – An Introduction

1.1 Statement of the Problem

Education perhaps has a unique relationship to human development. It is something that, once acquired by an individual, cannot be taken away (see Birdsall, Levine, and Ibrahim, 2005:25). In this sense, it is at the core of Sen's concept of development as the expansion of human capabilities, freedoms, and choices. It is also related to human development through the contributions of educated people ("human capital") to social and economic development. As stated by ul Haq (2003:21) in explaining the human development framework:

> None of the economic issues is ignored, but they all are related to the ultimate objective of development: people. And people are analysed not merely as the beneficiaries of economic growth but as the real agents of every change in society whether economic, political, social or cultural. To establish the supremacy of people in the process of development – as the classical writers always did – is not to denigrate economic growth but to rediscover its real purpose.

Even while widely recognized as fundamentally important, the educational attainment of peoples proves inadequate almost everywhere, especially across the developing world. At the beginning of the twenty-first century, just 88 percent of the world's children completed primary education, and in Middle Africa only 40 percent did so. In the same year, only 66 percent of children enrolled in secondary education globally, and the portion in Eastern Africa barely reached 20 percent. At the tertiary level, 21 percent of those of age enrolled world-wide, and the level was at or below 2 percent in countries as disparate as Afghanistan, Bhutan, Papua New Guinea, and Yemen. The gap between education for women and men remains stubbornly large – in South Asia, 55 percent of males enrolled in secondary education, but only 43 percent of females did so.

World-wide in 2000, the average years of education attained by those 25-years of age and older reached only 6.6 years for men and 5.1 years for women. Although these numbers have increased by nearly 2 years since 1960, it is appalling that the average education of global adults remains essentially at the level of primary completion and that it is so unequally distributed.

Within an environment with so many areas of need and of constrained resources, how can the governments of developing countries best advance human development through education? How much emphasis should societies place on education relative to basic health care, housing, or infrastructure? What relative emphases on primary, secondary, and tertiary education, over varying time frames, most increase people's capabilities and the opportunities for these capabilities to be expressed? The answers to these and other questions about education within a human development framework are not necessarily intuitive.

1.2 Purpose and Organization of this Paper

This paper is about the development of, and initial results from, an educational component within a global large-scale long-range structural model called International Futures with Pardee (IFs).[1] The education subsystem being developed in IFs extends across all levels of formal education so that it can explore the kinds of questions raised above. So far as we know, IFs offers a unique modeling system by virtue of dynamic connections between education, demography, and the economy that are built into the model.

The paper is organized in the following sections: (1) the current emphases in the pursuit of global education; (2) a consideration of key concepts and relationships for analyzing education, including consideration of education as part of a broader development system; (3) a discussion of the purposes of global forecasting tools and an introduction to five recently developed approaches to education forecasting; (4) an introduction to the International Futures with Pardee structural model and the education module being developed with it; (5) IFs preliminary Base Case education forecasts, including comparisons with other models; and (6) planned applications to broader integrated forecasting.

[1] Frederick S. Pardee is generously sponsoring a series of volumes that explore the global human development system. The first volume in the series on Patterns of Potential Human Progress will address global poverty, the second volume will turn to education, and the third will move to health. Each will provide both analysis of alternative futures and substantial series of country-specific forecasts through mid century.

2. Pursuit of Global Education: The Current Emphasis

The long-term advancement of human education and of broader human development motivates the work of this study. The advance has accelerated in recent decades. For example, global adult literacy increased from about 54 percent in 1970 (which at the time was a remarkable benchmark to attain) to more than 80 percent today.

Yet progress can seem painfully slow. It is no surprise that global leaders wish to accelerate the pace still further, in part by setting ambitious goals. The most recent and best-known of those are the Millennium Development Goals (MDGs), which set specific targets for primary education and for gender parity through 2015. Before turning to the longer-term, to levels of education beyond primary, and to the broader context of education, it is important to recognize the contemporary importance of the MDGs.

2.1 The Millennium Development Goals

In September of 2000, the Millennium Summit of UN members issued the Millennium Declaration, a pledge signed by over 180 heads of state and other participants to 'do our utmost to free our fellow men, women and children from abject and dehumanizing conditions of extreme poverty.' The Millennium Declaration elaborated eight Millennium Development Goals (MDGs) in areas related to poverty reduction, education, gender equality, health, environmental sustainability, and a global partnership for development. Concrete targets substantiate each goal, as do quantifiable indicators for all but MDG 8 (global partnership), and a target date of 2015.[2]

Rooted in a view of basic education as a human right, MDG Goal 2 is universal primary education. Its target statement is "Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling." MDG Goal 3 is gender equality and women's empowerment, and its target statement is "Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015."[3]

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[2] The United Nations Development Program defines all goals, targets, and indictors at www.undp.org/mdg/goallist.shtml.

[3] Both of these goals were among six education goals (collectively referred to as Education for All) articulated earlier in 2000 in the Dakar Framework for Action resulting from the World Education Forum in Dakar in April of 2000. The other Dakar Framework goals relate to early childhood care and education, learning and life skills programs for young people and adults, improvement in adult literacy, and the achievement of recognized and measurable learning outcomes indicative of quality, especially with respect to literacy, numeracy and essential life skills. (Dakar Framework for Action, http://www.unesco.org/eduction/efa/ed_for_all/dakfram_eng.shtml)

2.2 Mandated Monitoring of Progress Toward Goals

The Millennium Declaration importantly mandated annual monitoring of progress toward the goals, including assignment of responsibility for data gathering and dissemination [4] The broad commitment of developed and developing countries and international organizations (the United Nations, the World Bank, the International Monetary Fund and others) embodied in the articulation of the Millennium Development Goals, in combination with mandated and assigned responsibility for monitoring progress, is stimulating extraordinary levels of activity toward achieving the goals. It is also stimulating critically important discussions about the goals and strategies for achieving them, as well as the development of tools for measuring, reporting, analyzing, and projecting the extent to which the goals will be attained and/or the extent to which the education profile of countries' populations has changed and will change over time.

There are enormous benefits of clearly articulated measurable goals and mandated reporting, the first of course being that they focus attention and activity. This same focusing, however, can pose a challenge when a goal is pursued or examined in relative isolation from other components of the system in which it is a part (for example, primary education in isolation from secondary and tertiary education). Similarly, as articulated in the report of the UN Millennium Project Task Force on Education and Gender Equality (Birdsall et al. 2005:32-33), ". . . global goals that represent a uniform vision of where countries should be headed have obscured the tremendous heterogeneity across countries and regions." The same report also notes that goal-setting in education has tended to focus almost exclusively on expanding access, and that attention to demand side factors has been lacking (Birdsall et al. 2005:33). Finally, contemporary educational goal-setting and pursuit simply must look well beyond 2015, at least to mid-century. These are issues that we will return to in later sections of this paper.

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[4]The UNESCO Institute for Statistics is the agency mandated with responsibility to monitor and report progress on the education targets of MDG Goal 2 and MDG Goal 3.

3. Concepts and Relationships for Analyzing Education

The study of the present and possible futures for global education requires conceptualization, measurement and theory. The purpose of this section is to introduce each of these.

3.1 Education System Components

3.1.1 The Concept of Education Stocks and Flows

Educational attainment is a time-lagged phenomenon. Measuring progress *toward* an educational goal begins with measuring the participation or *flows* of individuals into and across components of educational systems (e.g., into school and then from grade to grade, or from the primary to the secondary level or the secondary to the tertiary level). It continues by tracking students' progress *to* an indicator of attainment - the point at which they join the *stock* of individuals who have achieved a given level of education (e.g., completed primary, secondary or tertiary education). Flow indicators describe patterns of participation, and are frequently referred to as indicators of access, while attainment indicators – frequently referred to as indicators of the efficiency and/or quality of a school system – represent outcomes (e.g., human capabilities). Figure 1 represents education system stocks and flows at a high-level

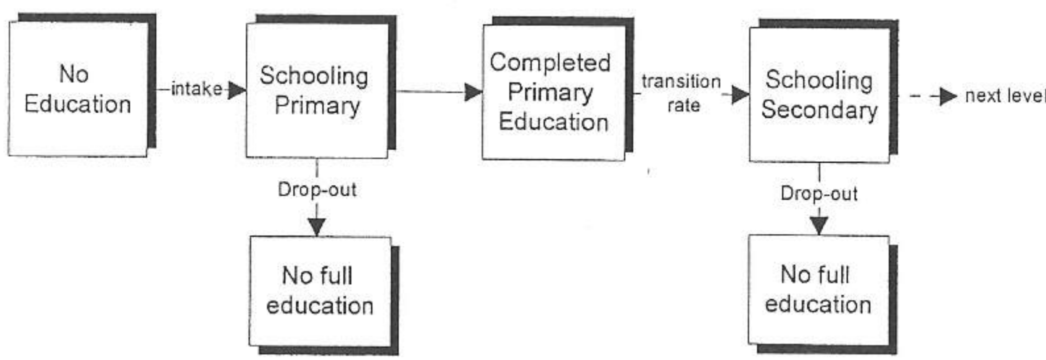

Figure 1. Representation of Education Stocks and Flows.
Source: Henk Hilderink (2005:3)

The formally adopted indicators for the MDG education targets are examples of stock and flow concepts. This section discusses them both as background for later sections of this paper that will explore progress toward universal primary education and gender parity and as examples of stock and flow concepts that can be applied within and across all levels of education systems.

3.1.2 MDG Education Stock and Flow Indicators

UNESCO uses four indicators to track progress toward universal primary education: (1) the *net enrollment ratio* in primary education (a flow indicator); (2) the proportion of pupils starting grade 1 who reach grade 5 (often called the *survival rate*, and usually referred to as a measure of education system efficiency); (3) the *primary completion rate* (variously referred to as an indicator of efficiency, quality, and capital stock formation); and (4) the *literacy rate of 15-24 year-olds* (regarded as a quality indicator). Of four indicators adopted to track progress toward gender parity, two specifically relate to education: (1) the *ratio of girls to boys in primary, secondary, and tertiary education;* and (2) the *ratio of literate women to men*, 15-24 years old. Box 1 defines these widely-used concepts and indicators.[5]

Net enrollment rate: the ratio of the number of official school-age children enrolled in primary school to the total population of children of official primary school age, as defined by the national education system.

Survival rate: the percentage of a cohort of pupils enrolled in first grade of primary school in a given school year who are expected to be enrolled in year 5.

Primary completion rate: the ratio of the number of students successfully completing the last year of primary school in a given year to the total number of children of official graduation age in the population.

Literacy rate of 15-24 year olds: the percentage of the population age 15-24 years old who can both read and write with understanding a short, simple statement on his or her everyday life. The definition sometimes extends to basic arithmetic and other life skills.

Ratio of girls to boys in primary, secondary, and tertiary education: the ratio of the number of female students enrolled at primary, secondary, and tertiary levels to the number of enrolled male students.[6]

Ratio of literate women to men, 15-24 years old: the ratio of the female literacy rate to the male literacy rate for the age group 15-24.

Box 1. Important Educational Concepts and Indicators
Source: *Indicators for Monitoring the Millennium Development Goals* (UN, 2003:16-27)

Additional important flow indicators include the *apparent intake rate*, the *net intake rate*, and the *gross enrollment rate.* The *gross (or apparent) intake rate* represents the number of new entrants in the first grade of primary education, regardless of age, as a

[5] The USAID's *Indicator Handbook for Primary Education* (Cameron, 2004) is an especially valuable tool for understanding and selecting indicators. It describes 14 indicators, using the following dimensions for each: definition, purpose or use, method of computation, data sources and periodicity, data trends, and comments and limitations. It summarizes trends for regional groupings of low and middle income countries provided by the World Bank, and identifies rate of change "benchmarks" that countries and agencies might consider in goal-setting and assessment of progress.

[6] Cameron (2004: 11) notes that a gender parity index, computed as the ratio of girls' gross or net enrollment rate to boys' gross or net enrollment rate, better measures equality in participation rates because it takes the population size of girls and boys into account.

percentage of the population at the official primary school entrance age, whereas the *net intake rate* is the number of new entrants who are of the official primary school entrance age as a percentage of the population of that age.

The *gross enrollment rate* is the total enrollment in primary school, regardless of age, expressed as a percentage of the official school-age population. The gross enrollment rate captures the participation or flows of students outside the typical primary school age range in addition to those of typical primary school age. It includes the enrollment of "overage" students, the enrollment of students who repeat grades, and the enrollment of students who re-enter the system after a period of absence (which in turn are themselves flow indicators). A gross enrollment rate over 100% (and sometimes well over) is not unusual, and can indicate factors as diverse as a high level of students repeating grades – often referred to as low efficiency in the system - or a large proportion of children entering school at a late age as the result of the elimination of a substantial barrier to entry – regarded as an indicator of increased access (Cameron, 2004:7). One frequently articulated goal is to reach the condition where gross and net intake and enrollment rates converge at 100% as children enroll at the intended starting age and persist to completion without interruption or repetition.

With respect to attainment indicators, *survival rate* and *primary completion* differ conceptually. Survival to grade 4 or 5 originated as a proxy measure for the minimum level of education necessary for sustainable literacy, but monitors student progression *only for those students who have entered the system.* Completion rate measures attainment of the total age-appropriate population of both school attenders and school non-attenders.[7]

3.1.3 A Comment on Indicator Patterns

Clearly, reaching universal primary education is a complex process. It requires both universal intake into the system at the front end of the process (access) and then persistence to completion some years later in order to add to the stock of educated people in a population. The demands on a developing country with limited resources are great. Does it focus on expanding access? If so, can quality be maintained (or improved) simultaneously? If not, it is possible to envision an outcome – as has indeed occurred in some countries – where access increases dramatically but persistence and completion decrease, both relatively and perhaps even in absolute numbers of completers.

Until a country achieves universal primary education, the time lag from access or entry to survival or completion requires the tracking of multiple indicators to assess a country's progress. The following table from the Millennium Project Task Force on Education and Gender Equality report (Birdsall et al. 2005:153) shows measures on three indicators for three different countries to illustrate how any single indicator fails to reflect the status of progress on all important dimensions of movement toward universal primary education.

[7] Cameron (2005:10) notes that either indicator of educational attainment may go up while the other goes down

Table A4.1	Country	Gross enrollment ratio (%)	Net enrollment ratio (%)	Primary completion rate (%)
Net enrollment ratios, gross enrollment ratios, and primary completion rates do not necessarily vary in parallel	El Salvador	111	81	80
	Mongolia	92	81	66
Source: Bruns, Mingat, and Rakotomalala 2003.	Togo	115	81	68

Table 1. The Importance of Multiple Indicators to Describe Education
Source: Birdsall et al. 2005: 153

3.1.4 Measurement and Data Issues

Analysts gather education data in two ways: (1) through country-level administrative data that education ministries and other governmental bodies provide from school records; and (2) through household survey data. UNESCO compiles and disseminates the most comprehensive database, primarily using country-level administrative data. With respect to household survey data, the primary sources are USAID's Demographic and Health Surveys, UNICEF's Multiple Indicator Cluster Surveys, and the World Bank's Living Standards Measurement Surveys.

Several data issues complicate measuring progress toward the goals (Birdsall, 2005:73). With respect to administrative data, the issues include *missing or inaccurate data* (some data elements are available on the UNESCO website for fewer than half the low and middle income countries), *varying educational systems* (such as the number of years of schooling that constitute primary education), *differing reporting elements and definitions* across countries, *time lags* before data are processed and made available, and the *use of proxies* for qualitative outcomes. Household surveys present their own issues; for example, they generally occur only once every three to five years, they are not standardized across agencies, and they do not provide global coverage. However, they provide coverage in important areas beyond those typically provided in administrative data, such as the characteristics and circumstances of children who are not in school in specific regions or subpopulations within a country.

In committing to the MDG education goals, countries committed to developing country-level education plans. As they do so, and with assistance from UNESCO and other agencies to develop more robust reporting systems, more data gradually become available. In addition, greater congruity in the use of terms has occurred through an International Standard Classification of Education (ISCED) that UNESCO established for compiling and reporting comparable cross-national statistics on education.[8] Significant gaps in data and many incongruent measures remain.

[8] For example, ISCED 1 – defined as beginning usually between the ages of five and seven, typically lasting six years, and marking the start of systematic studies in reading, writing, and mathematics – is used first to discriminate and then to aggregate data on primary education.

Perhaps the most significant issue is that proxy measures do not guarantee literacy as a functional concept. No standardized assessment of literacy accompanies survival to fifth grade or primary completion. Schools vary widely in quality, and many have automatic year-to-year promotion policies.

3.2 Education as Part of a Broader Development System

Education, as a human development goal, exists within a broader – and more complex - development context. In this section we present our view of, and raise questions about, a number of critical components of that context. We do not suggest that the components we identify are the only critical components. However, we do believe they provide a framework of variables and relationships essential to thinking comprehensively about long-term global education models and forecasts, the topic we will turn to in the next section of this paper.

One such set of relationships is the linkage between human development and economic development. This linkage is complex, and includes both private (personal or micro) and public (social or macro) components. As might be expected, there is a large body of literature that presents widely varying perspectives about the direction, magnitude, and value of the relationships. We share the perspective of Ranis, Stewart, and Ramirez:

> We view HD as the central objective of human activity and economic growth as potentially a very important instrument for advancing it. At the same time, achievements in HD themselves can make a critical contribution to economic growth. There are thus two distinct causal chains to be examined: one runs from EG to HD, as the resources from national income are allocated to activities contributing to HD; the other runs from HD to EG, indicating how, in addition to being an end in itself, HD helps increase national income (Ranis et al. 2003:61).

Ranis et al. go on to make the following case for the ways education affects economic growth (2003:65):

> Specifically, (i) health, primary and secondary education and nutrition raise the productivity of workers, rural and urban; (ii) secondary education, including vocational, facilitates the acquisition of skills and managerial capacity; (iii) tertiary education supports the development of basic science, the appropriate selection of technology imports and the domestic adaptation and development of technologies; (iv) secondary and tertiary education also represent critical elements in the development of key institutions, of government, the law, the financial system, among others, all essential for economic growth.

After citing evidence supporting this relationship at both individual (micro) and societal (macro) levels, Ranis et al. (2003:66) acknowledge limits on education's impact:

> Education alone, of course, cannot transform an economy. The quantity and quality of investment, domestic and foreign, together with the overall policy environment, form other important determinants of economic performance. Yet the level of human development has a bearing on these factors too.

At the same time, the structure of a country's economy, its level of economic development, and its public sector expenditure choices and policies impact the human development of its population. This happens first through the supply and availability of health, education, and other resources. There are a number of salient questions: (1) What percentage of GDP does a country commit to education? (2) How are public expenditures allocated across primary, secondary, and tertiary education? (3) What will it cost to provide universal primary education to a country's children? (4) Is there capacity in the educational system to make an affordable primary education available to all children? (5) What impact will that have on the availability and quality of secondary and tertiary education? (6) Is the country's GDP adequate to fund universal primary education or does it need to be (and is it) augmented with external aid? These are supply side questions, and they – or at least those that focus on primary education – have been the most frequently raised questions among individuals, organizations, and agencies tracking and attempting to project the outcome of the MDG education targets.

There is a second way in which a country's economy and level of economic development affect participation in the educational system, and this is with respect to demand. What are the factors that parents take into account when deciding whether to send their children to school? Parents must be able to envision a future benefit for the opportunity costs incurred if their children attend school rather than work at or outside the home. Will there be improved employment opportunities for children who pursue and complete a primary education? Clemens, in a paper prepared for the Millennium Project Task Force on Education and Gender Equality refers to a "take-off" point in rates of primary enrollment that occurs when GDP per capita reaches a level signaling likely returns for education (2004:18). An additional factor that comes into play on the demand side is the availability of secondary education. Because a secondary education is often perceived and/or required as a prerequisite to an individual's participating in and benefiting from a growing economy, parents may decide whether or not to send their children to primary school in the context of their perceived opportunities to pursue a secondary education (Birdsall et al. 2005:65).

Figure 2 illustrates connections among the variables discussed above: education supply, education demand, critical economic and financial variables, and the level of education of a population (education stock). The schematic introduces three additional concepts: (1) demography, (2) human capabilities or human development, and (3) broader socio-political development.

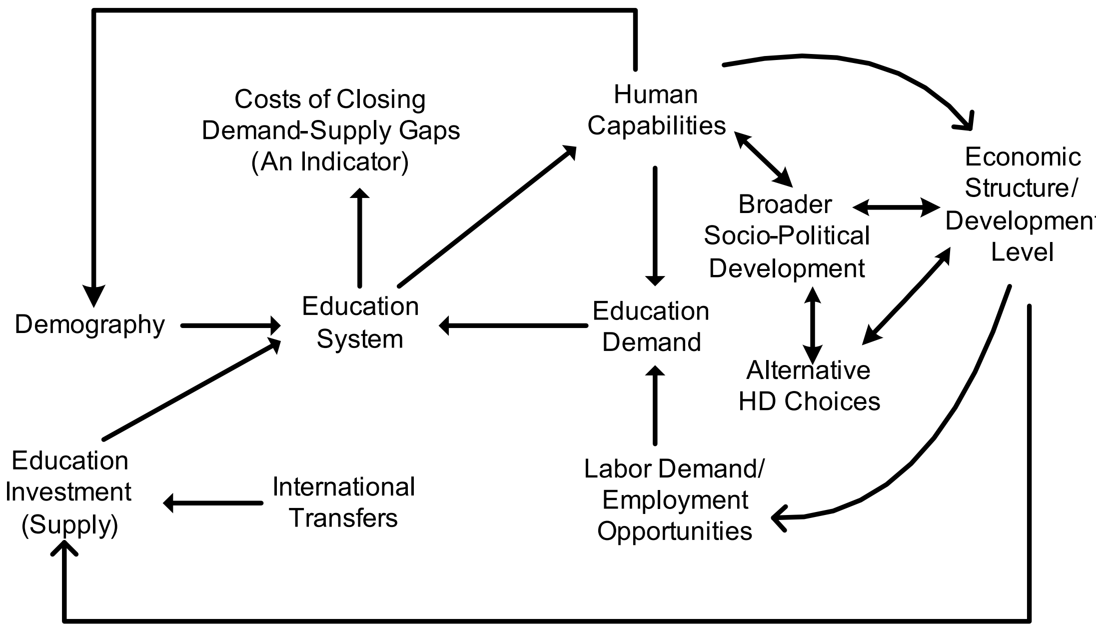

Figure 2. Education and the Human Development System

The diagram includes an arrow from human capabilities to education demand in part because a more educated population has greater educational expectations for the next generation. This is particularly true when women have attended school; for each additional year women have attended, their children are more likely to enroll and persist in school than with additional years fathers have attended. Women's education also affects the birth rate, represented by the arrow from human capabilities to demography. Fertility rates decline as women's enrollment and years of education increase, and their children's health increases with a consequent reduction in child mortality. Other things being equal, the combined effect of these influences is increased demand for education within a healthier population of fewer school-age children. In turn, the reduction in population growth rates – again, other things being equal – reduces the cost requirements of education system supply. The relationship between demography and education is further reflected in a comparison of the number, characteristics, and proportion of school-aged girls and boys in the population with those in school.

Up until this point we have been discussing variables for which there are at least relatively agreed-upon direct measures or measurement proxies. When we turn to human capabilities or human development we're in new territory. This variable represents the constellation of outcomes and benefits to the individual that are only partially captured in measures like the Human Development Index, outcomes that are perhaps best captured in the concepts of agency, freedom, and choice. While these concepts have forward linkages to instrumental social benefits, they have the additional quality of being the embodiment of human development at the experiential level. Education is widely considered an avenue to these personal benefits. Alternative human development investments are also.

This brings us to the question of how the outcomes of the investment of scarce resources in education compare, at a given point in time, with investment of those same resources in other sectors that might also advance human development (represented in the diagram by "alternative HD choices"). These alternative choices might advance human development directly by enhancing a different human capability (e.g., health) or by creating a more hospitable environment (e.g., infrastructure or a fair and just legal system) within which people are enabled to exercise more fully their exiting capabilities. This question has particular relevance because of the extended period required to increase the average educational level of the adult population as the result of increases in primary enrollment rates. The citation from Rains et al. (2003:65) earlier in this section about the impacts of education refers in all but one case to at least secondary education, extending even further the time frame before impacts might be readily apparent. It also makes clear the importance of coordinated educational planning across educational levels.

In summary, this section has introduced briefly, within a broader human development context, major variables affecting education and affected by education. As we turn to the topic of tools to help in the analysis and forecasting of educational paths in developing countries, including consideration of policy choices and interventions, we need to keep in mind these variables and their dynamic interactions.

4. Tools for Analyzing and Forecasting Education

The preceding section sketched understandings of education flows and stocks. It also laid out the broader human development context for the pursuit of higher levels of educational attainment. In many respects that discussion identified the characteristics of what we might label an ideal educational forecasting system. This section uses that contextual discussion as a backdrop for reviewing existing educational models and forecasts and for outlining the International Futures (IFs) system.

4.1 What Do We Want?

Although the Millennium Development Goals are important, the modelling and forecasting tools we desire look well beyond those goals both temporally and in scope. We want a system that helps us with: (1) understanding where we are and where we are headed with respect to the educational system and the human development system more generally; (2) assessing the degree of uncertainly around where we are headed; (3) identifying possible policy levers for interventions to speed or guide the process towards our goals; and (4) exploring the relative costs and benefits of a given goal or goal set in comparison with other possible choices. In summary, such tools are aids in planning – not by predicting specific outcomes within certain confidence intervals, but rather by suggesting likely patterns of human development under certain sets of assumptions and with and without various interventions.

4.2 Recent Modeling Approaches

Models should reflect the purposes they mean to serve. We can generally classify educational models according to their purposes. Some, that we can call "flow models," forecast educational participation and attainment via focus on intake, progression through, and completion of one or more levels of education. Others, that we can call "costing models," seek to understand the financial costs of pursuing specific goals, whether those be achievement of the MDGs or the improvement of educational quality. Still others, that we can call "human capital models," calculate the educational stock of a society as a result of flows and probably will seek to feed forward that stock to demographic variables and economic growth and possibly to other socio-political variables. Still others will be hybrids that pursue more than one of these objectives.

Another dimension on which models will vary is geographic scope. Some might serve the needs of individual countries, for instance in support of the development of Poverty Reduction Strategy Plans (PRSPs). Others will have regional or even global scope, sometimes losing country detail to attain it. Educational models also differ on whether they rely primarily on administrative or survey data. And, of course, they differ greatly on the general methodologies they use and the formulations they introduce, including linkages, if any, to population or GDP per capita growth, and in the way they endogenize other variables or make exogenous assumptions about them.

It should be clear from the discussion of the last section that our own desire is to create a hybrid model that, in order to consider education in a broad human development context, essentially pursues all of the above purposes in a modelling system with a high level of endogenous specification of broader linkages. We also seek global scope with country-level detail. As a general rule, of course, the more extensive the set of purposes a model seeks to satisfy, the less detail it will provide it support of any one, so we recognize trade-offs.

We will consider five other tools or models before turning to an introduction of the International Futures (IFs) with Pardee model. The principal developers and some important institutional connections are:

- Delamonica, Mehrotra, and Vandemoortele (published by UNICEF in 2001)
- Bruns, Mingat, and Rakotomalala (published by the World Bank in 2003)
- Clemens (published by the Center for Global Development in March 2004 as a working paper for the Millennium Project Task Force on Education and Gender Equality)
- Wils, O'Connor, and Somerville (reported in a paper by Wils, Carrol, and Barrow published by the Education Policy and Data Center, an organization funded by USAID and affiliated with the Academy of Educational Development, in 2005)
- Lutz, Goujon, and Wils (developed in a project at the International Institute for Applied Systems Analysis and presented in a paper published by the Education Policy and Data Center in 2005)

4.2.1 Delamonica, Mehrotra, and Vandemoortele

Delamonica, Mehrotra, and Vandemortele (2001) project the costs of achieving universal primary education by 2015. Their purpose was to provide estimates based on the status of enrollment coverage in 2000 (and gaps to 100%), and thereby to update global and regional cost estimates for the remaining period in distinction from cost estimates based on enrollment patterns in the early to mid 1990s (2001:2).

Their analysis includes all 128 developing countries, and focuses on changes in costs associated with linear increases in the net enrollment ratio to bring each country's net enrollment rate to 100% by 2015. They do not include new costs from population trends at constant enrollment rates. They assume constant GDP per capita for the period from 2000 to 2015, and express their cost estimates in 1998 US dollars. UNESCO is the source of their enrollment data and their population projections are from the UN Population Division.

Delamonica et al. estimate costs in four categories: (1) recurrent expenditures related to net enrollment rate increases; (2) quality improvements associated with non-wage inputs (by adjusting unit costs to make provision for 15% of recurrent costs for non-wage items without reducing teacher salaries); (3) reducing pupil-teacher ratios to an average of 40; and (4) capital costs for those countries where the increase in students from the expanded net enrollment ratio will be greater than the decrease in the school population from trends in the decline of expected births. Items (1) and (4) are added to the costs as increases in the net enrollment ratio bring new students into the school system, whereas items (2) and (3) are added across the school population in the first year of estimated costs (2001:12-13). Delamonica et al. comment that reaching and educating disadvantaged and marginalized children (who will be the last to be brought into school) is likely to cost more per child than current per unit costs. They also expect gains in efficiency, such as a reduction in repetition rates, from quality improvements. Their model implicitly treats these two trends as offsetting one another (2001:4-5).

Delamonica et al. estimate a total annual average cost of $9.1 billion dollars for all 128 developing countries as follows: $6.9 billion for recurrent expenditures, $1.4 billion for quality improvements in non-wage inputs; $0.5 billion for reducing the pupil-teacher ratio; and $0.6 billion for increased capital requirements (2001:v).

4.2.2 Bruns, Mingat, and Rakotomalala

Bruns, Mingat, and Rakotomalala (2003) authored a seminal study entitled *Achieving Universal Primary Education by 2015: A Chance for Every Child*. The study utilizes a simulation model developed by Rakotomalala and subsequently adopted for use by the countries selected to participate in the Education for All Fast-Track Partnership sponsored by the World Bank, UNESCO, UNICEF, and the regional development banks.

The study focused on a detailed analysis of the 47 low-income countries furthest from the MDG education goals in 2000, with an estimate added for Afghanistan (2002:20). A large component of the study focused on estimating what it would cost to achieve the goals in terms of incremental funding between 2000 and 2015, the portion of that funding that developing countries could afford, and where and how much international assistance would be needed under the assumption of a 5% economic growth rate applied across all countries.

World Bank task teams collected enrollment data for the then most-recent year (usually 2000) directly from the education ministries of the 47 low-income countries included in the study. UNESCO published data (usually for 1997) were used when more recent data were not available from the education ministries. Population data were from the United Nations/World Bank population database used by the World Bank (2003:39,41).

The study included analysis of the characteristics of the low-income countries that were making accelerated progress toward the goals in 2000 compared to countries that were not (2003:8). Most countries fell into one of three stylized groupings:

- Countries with gross enrollment ratios at 85% or above and primary completion rates at 70% or above were considered as "relatively successful," and were characterized by healthy spending; reasonable unit costs, teacher salaries, and class size; and low repetition (2003:8,63).
- Countries with gross enrollment ratios at 80% or above but primary completion ratios at 60% or below were considered as "high inefficiency" countries and were characterized by inadequate spending on quality and excessive repetition (2003:8,64).
- Countries with both gross enrollment ratios and primary completion ratios at 60% or lower were considered as "low coverage countries" and were characterized by

> low spending, high unit costs driven by extremely high teacher salaries, and relatively poor efficiency (2003:8,64).

From this analysis, a "best practices" framework was created to provide guidelines for policy levers to achieve universal primary completion at "minimum adequate cost" (2003:109). The framework includes benchmarks for quality improvements, efficiency improvements, and domestic resource mobilization (2003:82). The financing benchmarks include a cap on the portion of educational expenditures from government revenues going to primary education in order to avoid stripping resources from secondary and tertiary education.

In a variety of scenarios the authors present estimates of incremental costs, including estimated gaps in domestic funding capacities. A summary average annual incremental cost for all low-income countries, using the best practices framework, is recurring and classroom expansion capital costs of $8.2 billion, infrastructure rehabilitation costs of $0.8 billion, and infrastructure expansion of $0.3 billion, for a total of $9.7 billion, of which the average annual domestic financing gap is estimated at $3.7 billion. Bruns et al. estimate average annual incremental costs for middle-income countries (not the focus of the study) at an additional $23-28 billion, of which $1-3 billion is estimated to be a domestic financing gap (2003:110-11).

4.2.3 Clemens

Clemens (2004) is concerned primarily with understanding if there is a typical transition pathway from low to high primary schooling for most developing countries, and to what degree the transition can be accelerated by government policies. He raises these questions in the context of exploring the feasibility of meeting the MDG goal of universal primary education by 2015.

To explore these questions, Clemens developed a flow model that focuses on transition speeds as measured by net primary enrollment. Using administrative data compiled by UNESCO field offices from school registers for the years from 1960-2000 for over 100 developing countries, he finds evidence of a typical transition speed (57.7 years) at which a developing country goes from 50% net enrollment (which he posits as a "take-off" point) to 90% net enrollment (2004:15). By applying this typical transition speed to UNESCO pre-revision 2000 country level data on net primary enrollment rates,[9] Clemens produces S-curve extrapolations of the number of years, based on the typical developing country experience between 1960 and 2000, it will take individual countries and multi-country regions to reach 90% net primary enrollment (2004:42, 52). Clemens uses the same UNESCO data to model a typical "gender transition speed" in primary and

[9] Clemens (2005:64) points out that in 2003 the UNESCO Institute of Statistics revised its estimates of net primary enrollment for the period 1998-2001 as part of an effort to correct errors in reported statistics. The revision process included some changes in methodology. Clemens chose not to replace the previous 2000 estimates, based on the likelihood they were more congruent with the historical data he used in his time series analyses. Using a regression analysis, he demonstrated that the divergence between pre- and post-revision estimates was small for most countries. However, this should be kept in mind as a possible confounding factor in a comparison with IFs, where post-revision data are used.

secondary enrollment, and finds that for a country to go from a girls-to-boys gender ratio of 80% to 95% typically takes 28 years in primary education and 29 years in secondary education (2004:20).

Clemens explores three other dimensions in his effort to evaluate the feasibility of achieving universal primary education by 2015: (1) he compares the 1960-2000 transition rates in developing countries with the rates of today's rich countries during their transition to universal primary education; (2) he estimates the necessary transition speeds if today's developing countries are to meet the 2015 goal of universal primary education (2004:55); and (3) he uses cross-country data to explore relationships between education transition rates and a number of social, economic and education policy variables for one point in time (1980) (2004:45). From all three analyses, he concludes that while today's developing countries are moving at "blistering speed" compared to earlier transitions, the goals will not and cannot be met by 2015. Clemens also concludes that education policies (supply side interventions) are limited in their impact on speeding transition rates compared to the impacts from economic conditions and a slowly-growing more educated population (demand side factors). He argues that a common goal for all countries, irrespective of where they were and are on the transition curve, is to condemn them with failure despite, in many cases, extraordinary gains by historical standards.

4.2.4 Wils, O'Connor, and Somerville

The model developed by Wils, O'Connor, and Somerville (reported in Wils, Carrol, and Barrow 2005) focuses on the concept of growth paths toward universal primary education, and includes a consideration of how inequality is associated with the speed of growth. The context again is an exploration of the feasibility of meeting the MDG goal of universal primary education by 2015.

While this, too, is a flow model, it differs from Clemens' approach in several ways. First, Wils et al. use and compare two measures of primary education coverage - entry and completion (not net enrollment). Second, they estimate individual average growth patterns for each of 70 mostly poor International Development Assistance countries (rather than an across-country average) for a historical period from 1950-2000, and then apply the country-specific growth patterns in S-shaped extrapolations. Their descriptor for the paths is the number of years it will take each country to go from a primary completion rate of 10% to a primary completion rate of 90%, represented as T10-90 (2005:10). Considerable variability in growth patterns is demonstrated by their approach. Countries are classified as fast, average, or slow depending on the projected number of years in their T10-90 growth paths. Fast countries (N=7) have T10-90 values of 48-58 years; average countries (N=55) have T10-90 values of 62-116 years; and slow countries (N=8) have T10-90 values of 117-216 years. They do not find that the global focus on education in recent decades has coincided with a noticeable acceleration in long-term growth rates (2005:28-31).

A significant difference between this and earlier models is its use of household surveys rather than administrative data (2005:7). The authors divided the population of 15-65 year olds participating in the then most recent household surveys (1999-2001) into one-year age cohorts. They used the percentage of each 14 year-old cohort that took part in at least some primary schooling to estimate primary entry rates for the period from 1950 to 2000. They applied a similar methodology with 19 year-olds to estimate historical trends in primary completion rates. The use of household data also allowed identification of out-of-school children on a variety of dimensions as well as analyses of inequality, such as attendance gaps between urban males and rural females (2005:39). Wils, O'Connor, and Somerville find a far greater gap in education participation between rural and urban children than between girls and boys. They also find inequality associated with slower growth rates.

As does Clemens, they conclude that universal primary education will not occur by 2015. Their model suggests: (1) with present trends, most of the countries studied will reach 80% primary completion by 2025; (2) some countries would take until 2035 to reach 80% completion even at the fastest country growth rate; and (3) at current individual country trends, a small number of countries will not reach the goal even by 2070 (2005:20).

4.2.5 Lutz, Goujon, and Wils

The paper by Lutz, Goujon, and Wils describes a multi-state population projection model that demonstrates that the ". . .effects of specific near-term education efforts on longer-term changes in human capital can be accurately and comprehensively described and under certain assumptions predicted, using demographic methods" (2005:1).

This model, developed at IIASA, differs from the previous models in a number of ways. Its focus is not education system flows but rather the stock of human capital as reflected by the educational attainments of a population by age and sex across four categories: no education, primary education, secondary education, and tertiary education.[10] The developers initialized the model with UN population data by age and sex extending back to 1937. They created population pyramids, displaying the current population of three pilot countries (Guinea, Zambia, and Nicaragua) by age and sex in five year intervals, upon which they superimposed educational attainment levels from USAID Demographic and Health Surveys**.** They estimated fertility levels and infant and child mortality levels by mother's education from the Demographic and Health Surveys. Moving forward, the population projections reflect impacts of changes in educational attainment, with both fertility and child mortality decreasing as education increases; this is the first example of which we are aware of a model with an endogenous feedback loop between education and demography. However, transition rates are not endogenized; instead Lutz et al. advance the pyramids to 2030 using three sets of stylized assumptions about transition rates between one level of education and the next: (1) constant (current) rates; (2) trend rates; and (3) MDG goal fulfilling rates. Rather than forecasting whether the MDG goals

[10] The definition of levels of education attainment used by Lutz et al. (2005:16) differ from the usual definitions. They define "no education" as never having gone to school or completing less than one year of primary education. They consider people as having primary education if they complete at least one year of primary school; as having secondary education if they ever entered secondary school, and as having attained higher education if they ever entered tertiary education after completion of secondary school. The use of these definitions produces a higher profile of education attainment than the use of completion measures would, and needs to be taken into account when comparing their results.

will be met by 2015, the analysis focuses on the impacts of the differential paths. For example, the authors note that the return for reaching the MDG primary completion goals is the increase that would occur relatively soon after in the proportion of the adult population with secondary schooling, assuming constant primary to secondary transition rates (2005:32).

The IIASA model and its pyramidal displays clearly illustrate that education is a long-term investment by displaying the time lag between increases in educational attainment among young members of a population and increases in the overall structure and pattern of "human capital stock" in the total population. Further, the authors point out that by using the distribution of educational attainment (rather than mean years of schooling) as an indicator of human capital, it becomes possible to explore relationships between age, sex, levels of education, and other variables (e.g., health, poverty, and economic growth). They also point to the possibility of sub-national forecasts, as the methodology can be applied to any population that is clearly defined and for which there is the necessary information by age, sex, and level of education (2005:33). Continuing work is underway at IIASA to extend the model to a large number of countries (2005:37) and to explore relationships between age, sex, levels of education, and other variables.

4.3 International Futures (IFs) with Pardee

International Futures (IFs) is a large-scale, long-term, integrated global modeling system. The first version appeared in 1980 for educational use on mainframe computers and development has continued over the intervening years. The central purpose of IFs is to facilitate exploration of alternative global futures. The model is integrated with a large database containing values for all key series since 1960. IFs is now available to users (www.ifs.du.edu) both for on-line use and in downloadable form.

IFs is a structure-based, agent-class driven, dynamic modeling system. The current version represents demographic, economic, energy, agricultural, socio-political, and environmental subsystems for 182 countries interacting in the global system. The demographic module uses a standard cohort-component representation. The 6-sector economic module structure is general equilibrium. The socio-political module represents life conditions, traces basic value/cultural information, and portrays various elements of formal and informal socio-political structures and processes.

Among several other modules, education and health are the two most recently developed. The demographic and economic modules in particular are integral to the education model and a number of two-way linkages exist (some described below). In addition, linkages of education to broader socio-political processes such as democratization have begun to emerge, but this paper does not discuss them.

IFs use has grown steadily. It was a core component of a project exploring the New Economy sponsored by the European Commission. Forecasts from IFs supported Project 2020 of the U.S. National Intelligence Council. IFs provided demographic and economic driver forecasts for the fourth Global Environment Outlook of the United Nations Environment Program.

Documentation of IFs is extensive. Hughes and Hillebrand (2006) provide a basic introduction. Many project reports are available on the web site (www.ifs.du.edu). The Help system of the model contains primary documentation via causal diagrams, equations, and even model code.

4.4 The Education Module of IFs

The education model simulates educational flows and resultant human capital stock in 182 countries over a long time horizon under alternative assumptions about uncertainties and interventions. Its purpose is to serve as a generalized thinking and analysis tool for educational futures within a broader development context.

The model structurally represents a three-level formal education system. The major agents in the system are households, especially parents whose decisions help determine the boys and girls who enter and progress through the system, at gender specific rates, and governments that direct resources into and across the educational system. The major flows within the model are student and budgetary flows, while the major stock is that of educational attainment embedded in a population. Other than the budgetary variables, all the flows and stocks are gender disaggregated.

The level of economic development of countries is a major underlying driver that affects, but certainly does not wholly determine both the supply of education and the demand for it. On the supply side, the level of GDP per capita significantly shapes the access of governments to resources. In addition there are typical global patterns of expenditure allocations across various demands (education, health, the military, and other) that provide a context for the actions of particular governments. On the demand side, the level of economic development of societies significantly influence sectoral structures and labor markets in ways that affect the demand by households for education. In addition, economic development levels affect teacher salaries and other expenses that collectively determine costs per student in a relationship with GDP per capita that is fairly strong across countries. At this stage in the model's development, the relationships between economic development level and educational supply and demand are quite fully represented, while other factors that will also influence supply and demand (for instance, the educational attainment of parents as a driver of household demand) are not.

The relationship between education and the economy is bi-directional in the model. The availability of human capital and the current spending on education are among the forces that determine change in economic productivity via a model formulation that endogenizes the forecasting of multifactor productivity.

The education module also interacts bi-directionally with the demographic module in IFs. During each year of simulation, the cohort-specific demographic model provides the school age population to the education module. The demographic and education modules maintain single-year cohorts for calculation and five-year cohorts for display. In turn, the education sub-model feeds its calculations of educational attainment to the population module's determination of women's fertility.[11] In the future, it may be possible to use age-sex differentiated human capital acquisition for that purpose.

Although not elaborated in this paper, there are additional linkages of the educational module to the representations in IFs of the broader socio-political system. For instance, a calculation of government effectiveness relies upon the stock of human capital. So, too, does a calculation of the prospects for political instability and state failure. As the educational module develops further, such linkages will increasingly allow much more sophisticated considerations of the costs and benefits associated with investment in education.

4.4.1 Conceptualization of the IFs Education Module

The education sub-model has two major components. The first, a flow component, models the dynamics of the educational system itself. It forecasts the demand for schooling, the flows of students through the system, and the resource requirements to sustain the flow. The second, a stock component, models the levels of human capital stock in the society as a result of educational attainment.

The flow part of the education model is simulated in two stages. During the first stage, three things are forecast: (1) demand for education (manifested by rates of entry); (2) system efficiency (or student progress); (3) per-student cost or price of education. Per capita income levels drive the first and the third, while the second is a function of the economic development of the country. The entry and progress rates are applied to the forecasts of single year age-sex cohorts obtained from the IFs demographic module to calculate an initial enrollment figure at each level of education. These enrollment estimates times level-specific unit cost forecasts provide estimated budget demands at each level of education.

The second stage of the flow model begins with budget balancing, whereby the total government allocation in education, obtained from the IFs economic module, is distributed among the three levels of education by a demand-proportionate normalization algorithm. Any surplus or shortfall in budget as a result of this allocation adjusts the student flow rates by raising them with a surplus and lowering them, somewhat slowly, with a shortfall. The new flow rates are used to recalculate the forecast numbers of enrolled students and graduates. Final enrollments are used to readjust the per student costs.

In the stock part of the model, the number of annual graduates from the three levels of education are added to the appropriate single-year age-sex cohorts of the population, and the five-year cohorts of human capital stock displayed in population pyramids are adjusted by inflows from the cohort below and outflows to the cohort above. Both completed and partial years of different levels of education are then aggregated to calculate average years of education for men and women over the age of 25.

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[11] In the emerging health module, educational stock is a key driver of mortality from 11 specific causes. At this point, those specific mortality calculations are not tied back to forecasts of total mortality.

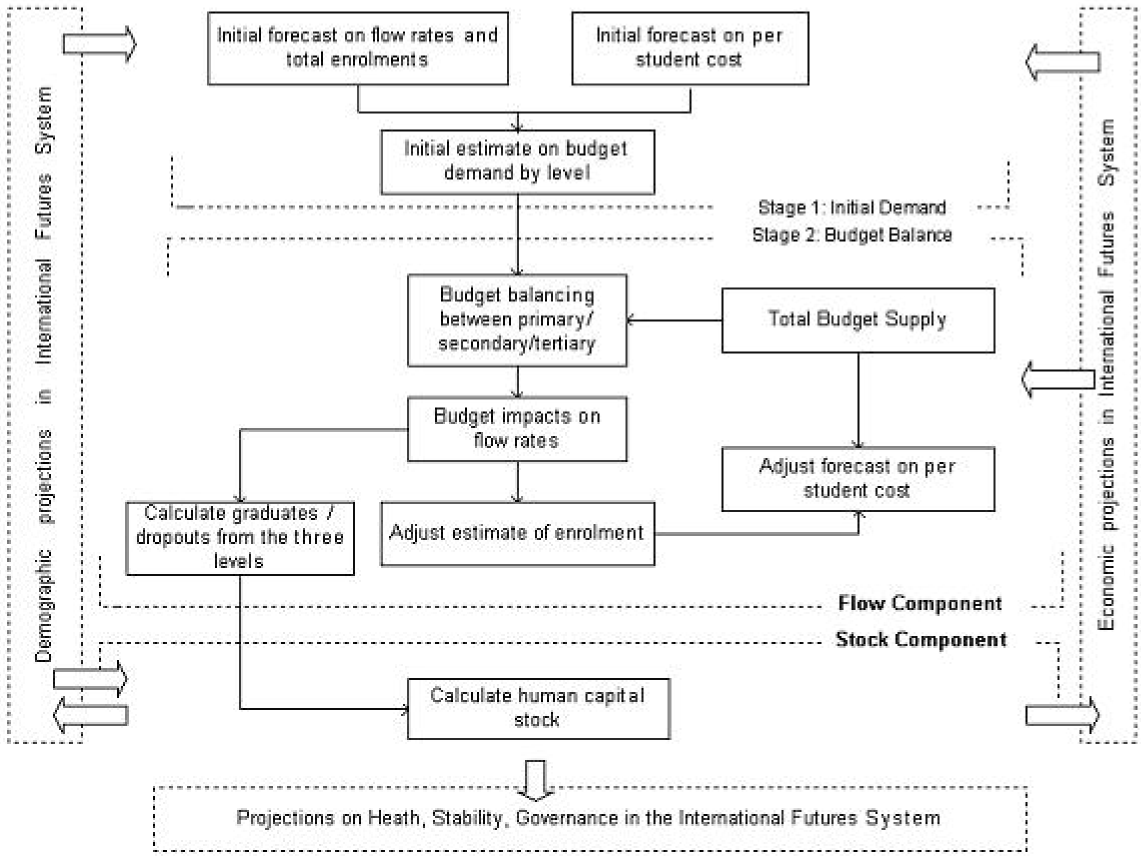


Figure 3. IFs Education Module Conceptualization

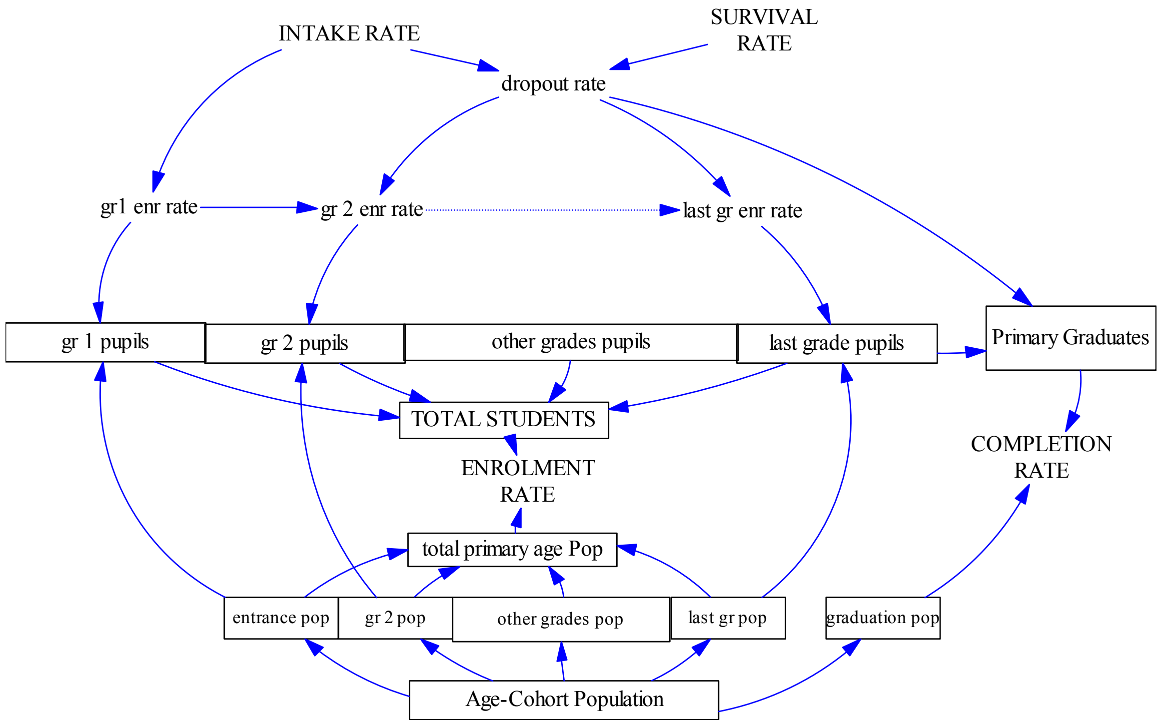
4.4.2 Implementation Detail: Student Flow

Because of a defined entrance age and schooling length in each country, projections of grade-wise flow rates can be applied to population projections of single-year age cohorts to obtain the absolute number of students. We shall use student flows in primary education to demonstrate how students move through an educational system.

Because of early or late entry and repetition, there can be students who are older than their contemporaries. To tackle this situation, the modelling of primary flow rates differentiates gross and net enrollment ratios, tracking both above- and appropriate-age students to do so. In the primary education representation of the IFs education module, gross rates will gradually converge towards the net as the schools become more efficient and the pool of potential late entrants is exhausted.

A gendered (gross or net) intake rate applied to the total number of entrance age children determines the number of students entering the first grade of primary school. Figure 4 represents the flows of students through the grades of primary school. Students proceed from one grade to the next, repeat a grade, or drop out of the system. Currently, a single number is calculated to represent the net effects of dropout and grade repetition. This is because we have initialized our data with the survival rate, which is defined as the percentage of entrants who reach the final grade and thus captures the dual inefficiencies of grade repetition and school dropout. Each year students who do not dropout or repeat proceed to the next grade continuing thus until the completion of primary education.

One of the strengths of our model is the exact representation of the entrance age and the duration of the primary cycle for each country. This is useful in educational planning as well as the measurement of average years of education.



gr = grade, enr = enrollment, pop=population

Figure 4. Flows of Primary Students

4.4.3 Implementation Detail: Budget Flow

Figure 5 displays the budgetary flows in the IFs education module. GDP per capita is used as a principal driver of both education demand and education supply. On the demand side, the percentage of parents sending their children to school varies positively with levels of per capita income. The demand projection of enrollment is multiplied by a projection of unit cost, which also varies positively with per capita income, to obtain the total budget demand. On the supply side, the economic and socio-political modules of the International Futures system determine overall resource mobilization and spending and the total educational budget's share of government consumption (subject to scenario intervention by the model user). Higher public spending is associated with an increase in entry rates and persistence. In the current version of the model, for want of sufficient data, we use a total educational expenditure rather than disaggregating into recurrent and capital expenditure or further components of recurrent expenditure like teacher salary and non-salary expenditures.

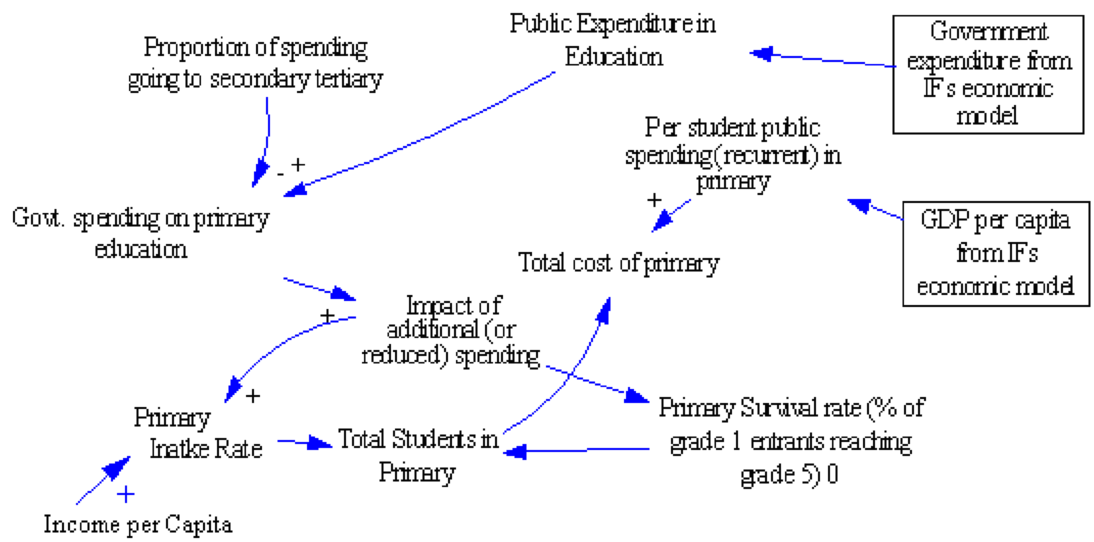


Figure 5. Financing Demand and Supply in Primary Education

4.4.4 Implementation Detail: Human Capital Stock

The flow concepts and patterns described earlier with respect to primary education are also applied to secondary and tertiary education. Children enter primary school, and at the end of each year enrolled students either proceed to the next grade, repeat in the same grade or dropout of the system altogether. A portion of the students completing primary education proceed to secondary education, and a portion of the students completing secondary education in turn proceed to tertiary education. A change in the levels of participation at secondary levels can result either from larger number of students completing primary education who then continue into secondary education at a similar rate as in previous years, or by an increase in the rate of primary graduates going on to secondary school, or both. A similar algorithm applies to tertiary education.

As students age they join the adult population of the country with an embedded level of educational attainment. During the IFs dynamic simulation process, the bottommost of the adult cohorts (15-19) are fed with the graduates of appropriate age coming out of the education system. The cohorts above (20+ in five-year intervals) are also updated by an inward flow from the younger (generally more educated) cohorts and an outward flow to the older (generally less educated) cohorts. Over time the overall population profile will be changed by changes in the educational attainments of young people and by mortality across the age distribution. Following a period of increased educational flows, we see a gradual enrichment of human capital. As track and forecast human capital, we maintain the detailed age-sex-education distribution of the population, which can be viewed as population-education pyramids (Figure 21 shows examples). We also calculate aggregated indicators, such as the average years of education of adults and the percentages of adults with primary, secondary or tertiary education.

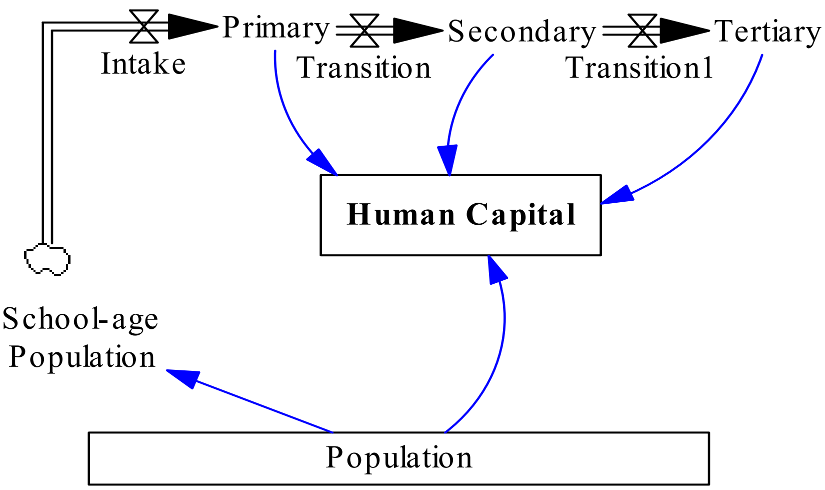


Figure 6. Flows from Education System to Human Capital Stock

4.4.5 Current Status of the Education within IFs

Figure 2 sketched our general conceptualization of education and the broader human development system. It should be obvious from the above discussion that the conceptualization has framed our approach to the development of the IFs educational module and its linkages to the other modules of the system. Figure 7 summarizes the current status of the model structure and it clearly looks much like Figure 2.

One difference between the figures is that GDP per capita (or income per capita) from the economic model is now the principal driver of educational demand. As Figure 2 indicated, a more appropriate driver conceptually would be the educational requirements of the labor force, taking into account, for instance the sectoral structure of it and the perceived returns from employment. The model does not have that detail of specification. Nor does it currently include the demand that current human capabilities of the population generate for education – more educated parents, especially women, will want their children to attend school. The model does, however, include a representation of a demand force that we call "systemic shift," an observable global increase in educational demand independent of income but related to a variety of factors, including transformations of economic structures towards knowledge economies and growing education of adult populations. That systemic shift, which is also implemented on the supply side to drive education system quality, is currently something of a proxy for factors not captured by income per capita.

On the supply side, the congruence of the two figures is substantial. The Base Case of the model does not represent a pre-emptively changing pattern of allocation of educational investment across educational levels that would capture governmental action to strengthen the competitive position of their work forces. Instead, the expenditure allocation, as noted earlier, responds currently to the demand side. The larger IFs model does, however, represent international aid flows, so the augmentation of governmental revenues so as to support investment in education is present.

With respect to the feedback of human capabilities to demography, we have noted earlier that there is a general but not yet gender-specific linkage of educational levels in the population to fertility. And the earlier discussion also briefly noted, but did not elaborate the more general linkages of education to economic productivity and broader social systems.

In short, the causal structure of the current model increasingly represents our conceptual image of a system that we believe will strongly support the analysis of education and human development. There is, of course, always more that can be done.

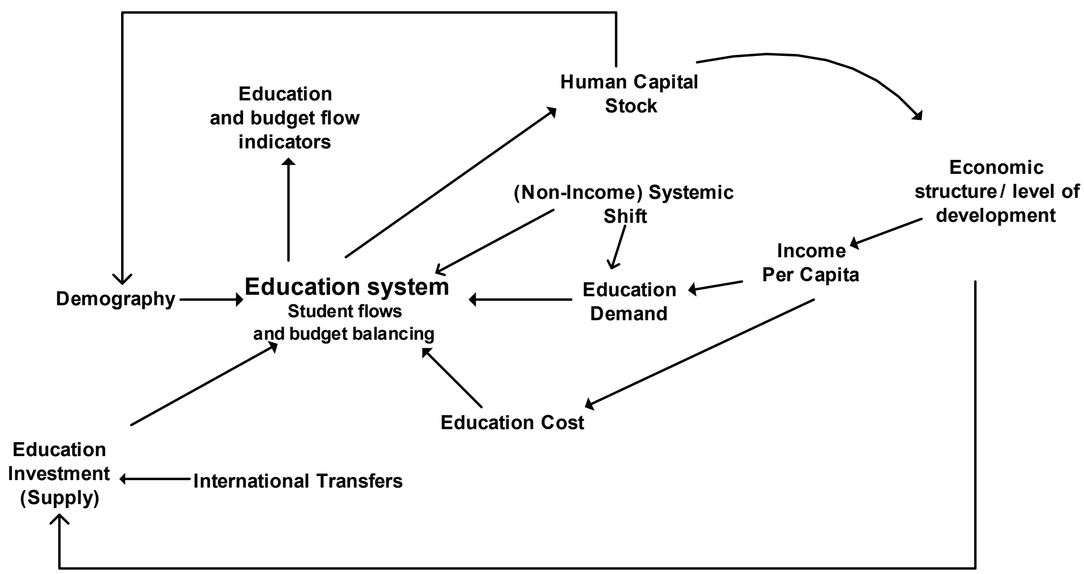


Figure 7. Causal Structure of the Current IFs Educational Module

4.4.6 Data, Initialization (Pre-Processor) and Calibration

UNESCO has the most extensive and direct data on both student-related and budget-related education system variables. Even so, data on key primary rate variables is missing for a number of developing countries, and the data for selected cross-sectional analyses, much less longitudinal ones, become increasingly weak as we move to secondary and especially to tertiary education. Sometimes, World Bank World Development Indicators (WDI) have better longitudinal coverage than the readily available published UNESCO sources[12]. In those cases we combined the data from UNESCO and the World

[12] WDI cites UNESCO as their sources.

Development Indicators, which cite UNESCO as their source. UNESCO data are usually collected by their field offices from administrative sources, i.e., school registers. UNESCO has revised its historical numbers several times in the recent past to correct inconsistent data or to ensure comparability among the national education systems. This adds to the difficulty of comparing results from different education models using different versions of data.

A data pre-processor in the education module populates the model with the initial values of flow rates from UNESCO or WDI data for the appropriate or nearest year whenever such data are available. If UNESCO or WDI data are not available for a specific variable for a given county or countries, the pre-processor populates that country by using cross-sectional or trend extrapolation techniques. Figure 8 illustrates one such cross-sectional relationship, namely a relationship between GDP per capita and net primary enrollment (such relationships are also used in the dynamics of the model). More generally, the pre-processor is an important tool for filling holes and also for reconciling flow data that are incompatible (via a variety of algorithms for data cleaning).

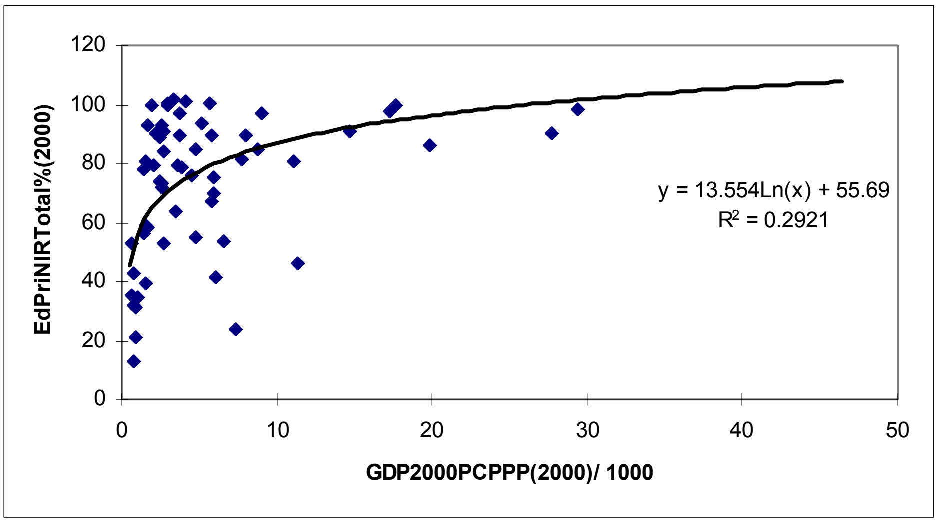


Figure 8. Cross-sectional Function of Net Primary Intake Rate over GDP per Capita at Purchasing Power Parity (thousands of constant 2000 dollars), year 2000

For human capital data, the IFs education model uses the Barro-Lee (2000) education data set to initialize the age-sex structure of country-specific populations by four different levels of educational attainment (no education, primary graduates, secondary graduates and tertiary graduates). Barro and Lee built a historic time series going back to 1950. We used a spread algorithm[13] to distribute the levels of educational attainment from the single combined age group of 25 and above in the Barro-Lee data set into five-year cohorts.

[13] Developed by Weishang Qu at the Millennium Institute and shared with us via e-mail communication

5. IFs Base Case Forecasts and Comparison with Other Models

The discussion to this point (see especially Figure 2) has made clear that forecasting of education and human development ideally addresses several sets of issues, each related to important human values and goals. The first set concerns the increase of educational attainment towards universal primary (and ideally secondary) education and the achievement of gender equality at all levels. The second set concerns the financing of education, especially for those countries in which the level of financial resources poses a constraint upon the accomplishment of attainment goals. The third set of issues surrounds the integration of education into the larger human development system, including the development and successful deployment of what economists often call human capital so as to improve economic growth and, more generally, help achieve a broad range of human development and social objectives.

This section explores each of these sets of issues. In each case, it provides initial forecasts from IFs with Pardee, compares those forecasts with ones made by others when available, and sketches briefly the agenda for future analyses.

5.1 Increasing Enrollment and Completion toward Universality

5.1.1 IFs Forecasts in Historical Context

As a general rule, analysis with IFs begins by examining a Base Case scenario, a dynamic forecast based on the unfolding of the integrated systems that the model represents. The Base Case is not necessarily a high-probability portrait of the future, much less a prediction of it, but constitutes a reasonable story around which others can be explored. Because the Base Case is very much path dependent with respect to historical patterns, analysis with IFs also generally attempts to place forecasts in historic context. Examination of forecasts as an extension of history and comparison of forecasts with those of others are standard techniques in processes of the verification, validation, and accreditation for a model. This report on IFs results therefore uses both of these techniques throughout the discussion.[14]

With respect to educational enrollment patterns, that is not a simple matter. As discussed earlier, historic data, especially administrative data, but also survey data, are often limited or tap somewhat different dimensions than those of direct interest to us. For example, Figure 9 shows the historic trends and IFs Base Case forecast of net primary enrollment rates in several regions of the world. Because the data points for constituent countries are limited and inconsistent temporally, the historic mapping of continental averages (weighted by country population) is at best a rough guide to historic patterns.

[14] Hughes (2006) uses these and other techniques for looking at forecasts of IFs more broadly.

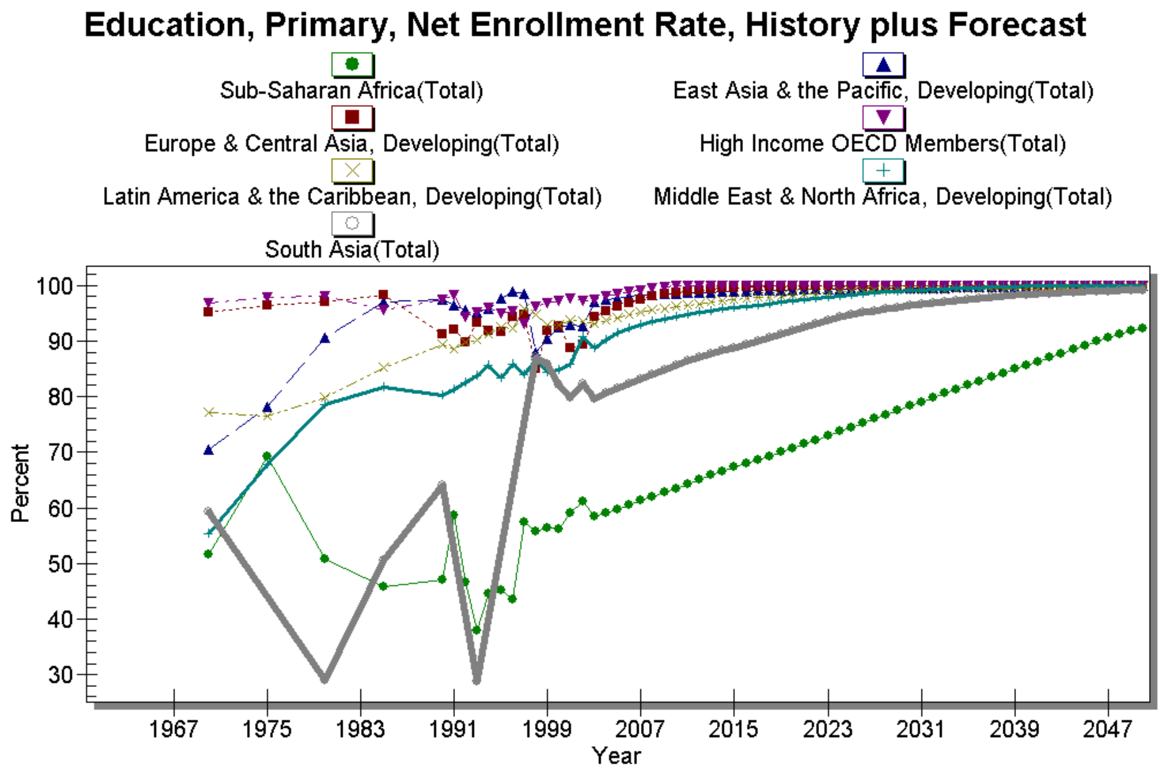


Figure 9. Primary Net Enrollment Rates Across Continental Regions
Source: IFs with Pardee, version 5.40.

Nonetheless, we see in Figure 9 a general pattern of increased education across all the regions except Sub-Saharan Africa, where there has been no clear increase in recent decades. In the Base Case, regional growth in net primary enrollment continues (also in Africa), albeit at different speeds, before saturating towards the upper limit of 100 percent. At least two groups of countries, namely the rich OECD countries and the emerging economies of East Asia and the Pacific, were already within five percent of the maximum enrollment at the dawn of the millennium. All other regions but two follow the leading regions towards a near universal primary enrollment by the year 2020. Enrollment rates in South Asia and Sub-Saharan Africa, despite the rapid convergence evident in the slope of the curves, fail to catch up with those of the other regions because the initial shortfalls in enrollment rates are so large. The IFs Base Case suggests that South Asia will be within five percentage points of universal enrollment by 2025 and at universal enrollment by mid-century. Sub-Saharan Africa, in spite of having increased enrollment rates by more than sixty percent by mid-century, still falls somewhat shy of universal primary enrollment by mid-century in the IFs Base Case.

Figure 10 delves more deeply into the pattern of Sub-Saharan Africa. Focusing on countries of the continent with relatively more extensive historic data, it shows net primary enrollment rates and primary completion rates from the Base Case of IFs as an extension of history. Two insights may be especially important.

First, as a general result, the forecasts of IFs appear somewhat optimistic relative to historic performance. Many countries may have experienced reversals historically, for reasons of civil conflict, economic crises, the ravages of disease or other reasons. (It is also important to note, however, that data series historically are not strictly comparable and that what sometimes appear to be reversals can simply be artefacts of changes in data series) In general, the figure suggests that there was something close to stagnation in enrollment rates across the entire historic period in a handful of countries (see Lesotho, Mozambique and Zambia), while others (note Malawi and The Gambia) have demonstrated substantial bur irregular advance. Only a few (namely Niger, Burkina Faso, and Mali) have exhibited a pattern of fairly regular, steady growth.

Second, very roughly speaking, a general S-curve shape characterizes patterns of transitions from low to high enrollments (that is more apparent in the longer-term, so the figure extends the horizon to 2100). This will be important when we compare the forecasts of IFs with others, because the S-curve can help in the forecasting process itself.

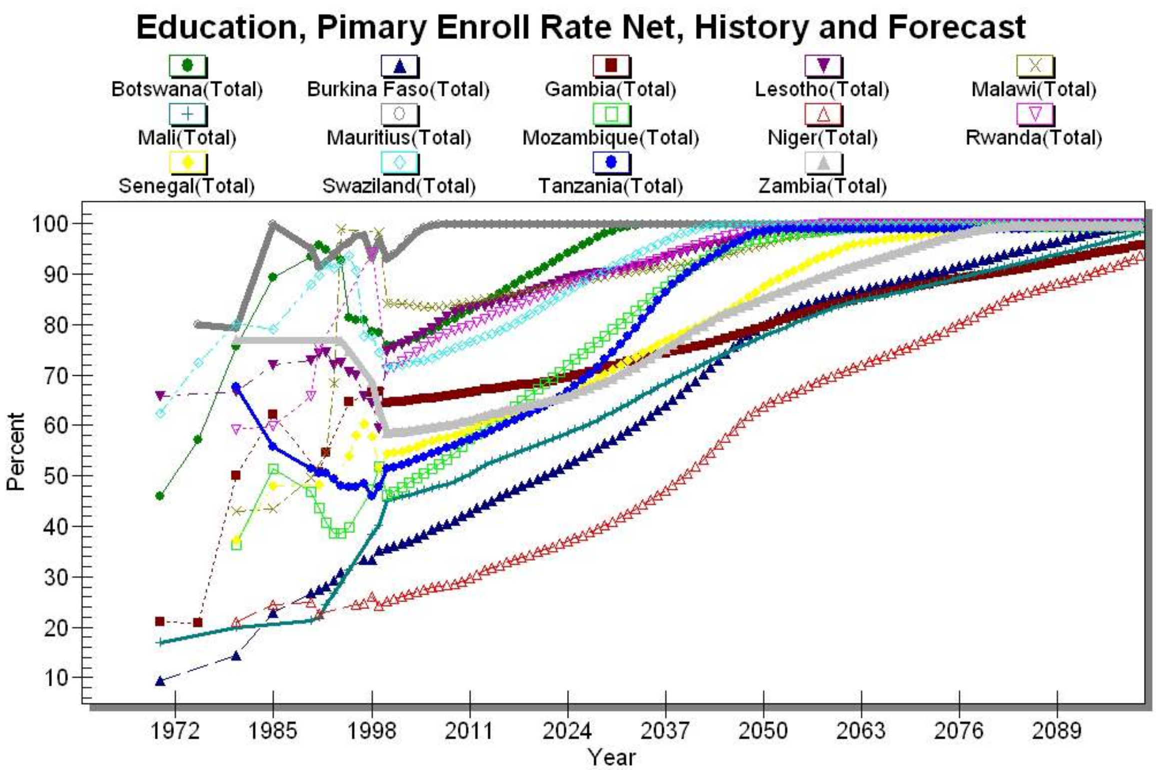


Figure 10. Primary Net Enrollment Rates across Selected African Countries
Source: IFs with Pardee, version 5.40.

Because of the way the Millennium Development Goal on education is phrased,[15] some experts, for example Bruns (2003), have interpreted Universal Primary Education as Universal Primary Completion (UPC), not merely Universal Primary Enrollment (UPE). Figure 11 shows the IFs Base case forecasts on the primary completion rates for the same set of Sub-Saharan countries that we discussed above. Again, we observe a failure to

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[15] Ensure that all boys and girls complete a full course of primary schooling.

achieve UPC even at mid-century. That does not seem surprising considering our findings on enrollment.

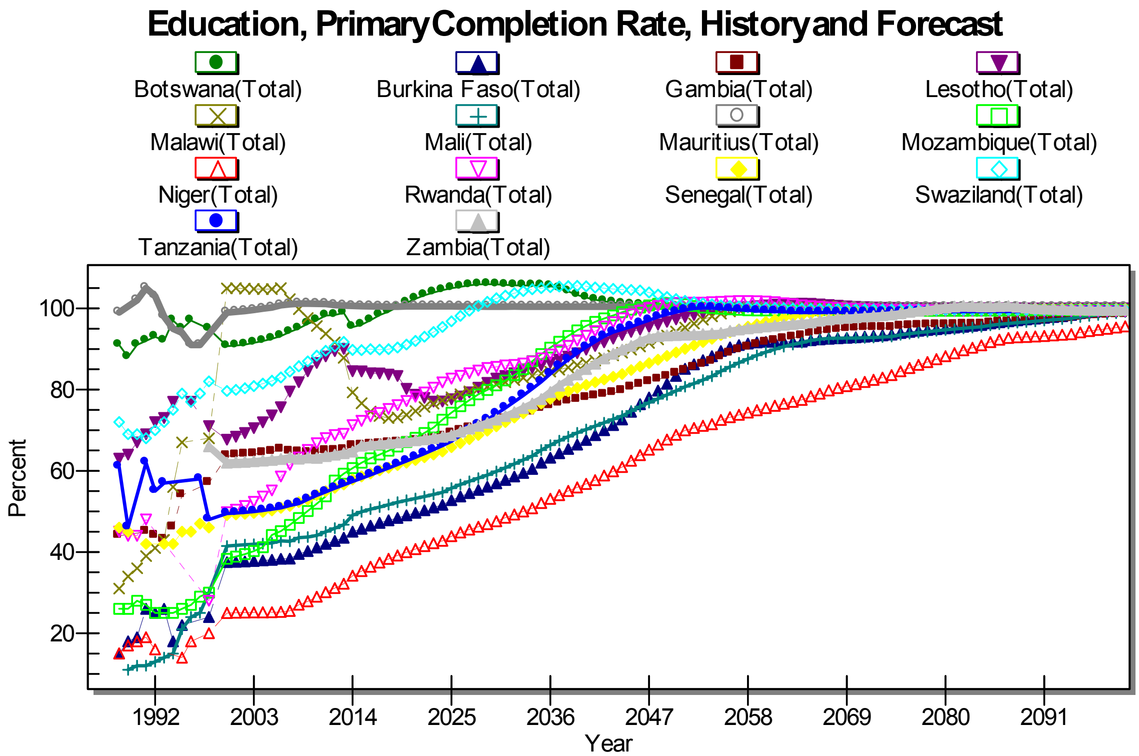


Figure 11. Primary Completion Rates across Selected African Countries
Source: IFs with Pardee, version 5.40.

Clearly, Figures 9-11 all suggest that the Millennium Development Goal of universal primary education was essentially unattainable, at least for some countries and regions, from the day it was adopted. Again, the IFs forecasts are, if anything, optimistic extensions of history. There are two primary reasons for optimism. One is that the goals themselves have mobilized very great efforts to achieve them, if not by 2015 then in the more mid-term future. Second, there appears to have been, even before the MDGs, an acceleration of enrollment rate increases at all levels of country income. The discussion will return to this.

Table 2, however, shows the Base Case level of enrollment that might be expected by 2015 in the first 10 alphabetically of the relatively data-rich Sub-Saharan African countries that Figure 10 identified. Burkina Faso and Niger may be at or below, respectively, 50 percent net primary enrollment. Only Mauritius, a small island country with a much higher than regional average income, will likely be within the reach of universal primary enrollment by the year 2015. And, as indicated earlier, South Asia is also likely to fall short of the goal, although by a much more manageable distance.

Primary Net Enrollment Rates, Total, Percent									
Year	Burkina Faso	Gambia	Lesotho	Malawi	Mali	Mauritius	Mozambique	Niger	Senegal
2000	35.77	66.04	81.07	89.15	46.5	92.89	50.05	25.26	54.36
2001	36.22	66.29	81.5	89.28	47.03	94.01	50.81	25.8	54.79
2002	36.87	66.6	81.99	89.26	47.6	95.25	51.74	26.37	55.15
2003	37.67	66.97	82.61	89.28	48.1	96.81	52.75	27.01	55.82
2004	38.58	67.44	83.25	89.37	48.68	98.17	53.88	27.61	56.56
2005	39.56	67.91	83.88	89.57	49.38	99.09	55.11	28.19	57.31
2006	40.64	68.45	84.54	89.8	50.23	99.57	56.25	28.85	58.1
2007	41.59	68.94	85.57	89.99	50.94	99.79	57.33	29.48	58.9
2008	42.49	69.41	86.41	90.29	51.57	99.83	58.56	29.7	59.31
2009	43.5	69.98	87.09	90.62	52.43	99.83	59.92	30.2	59.99
2010	44.54	70.55	87.59	90.96	53.42	99.83	61.38	30.87	60.9
2011	45.63	71.17	87.94	91.29	54.5	99.83	62.93	31.67	61.88
2012	46.75	71.8	88.17	91.59	55.65	99.83	64.26	32.61	62.94
2013	47.9	72.46	88.3	91.84	56.86	99.83	65.58	33.74	64.08
2014	48.96	73.02	88.71	92.05	57.84	99.83	66.91	34.5	64.84
2015	50.02	73.55	89.13	92.23	58.77	99.83	68.25	35.26	65.58

Table 2. Primary Net Enrollment Rates Across Selected African Countries
Source: IFs with Pardee, version 5.40.

5.1.2 Comparison of IFs Results with Others

How do the results from the IFs Base Case compare with those from other forecasting efforts? Among the education models discussed in this paper, Clemens (2004) and Wils et al. (2005) identify patterns of enrollment growth and use the pace of historic growth as an extrapolative basis for their forecasts. Both projects fit S-shaped logistic growth curves to historic data. Meyers et al. (1977, 1992) previously identified such sigmoidal patterns of diffusion of mass education throughout the world for a very long period of 1870-1980.

Results from Clemens (2004) and Wils et al. (2005) are not directly comparable, either with each other or with the IFs education model, because of differences in the dependent variable and/or the data series that they use. For example, Clemens (2004) uses administrative data on net enrollment rate obtained from UNESCO for the post-World War II period. IFs does as well, but Clemens' use of the pre-2003 revision data make his results not strictly comparable to those from IFs, which is based on post-2003 revision data.

For approximately the same historic period, Wils et al. (2005) tap DHS and MICS[16] survey data on current educational attainment to reconstruct past educational flow rates like entry or completion. These rates, as defined by Wils et al. (2005), represent the proportion of any single-year age cohort that entered (or completed) primary school, either at an appropriate age or later[17]. While this definition sounds close to the gross

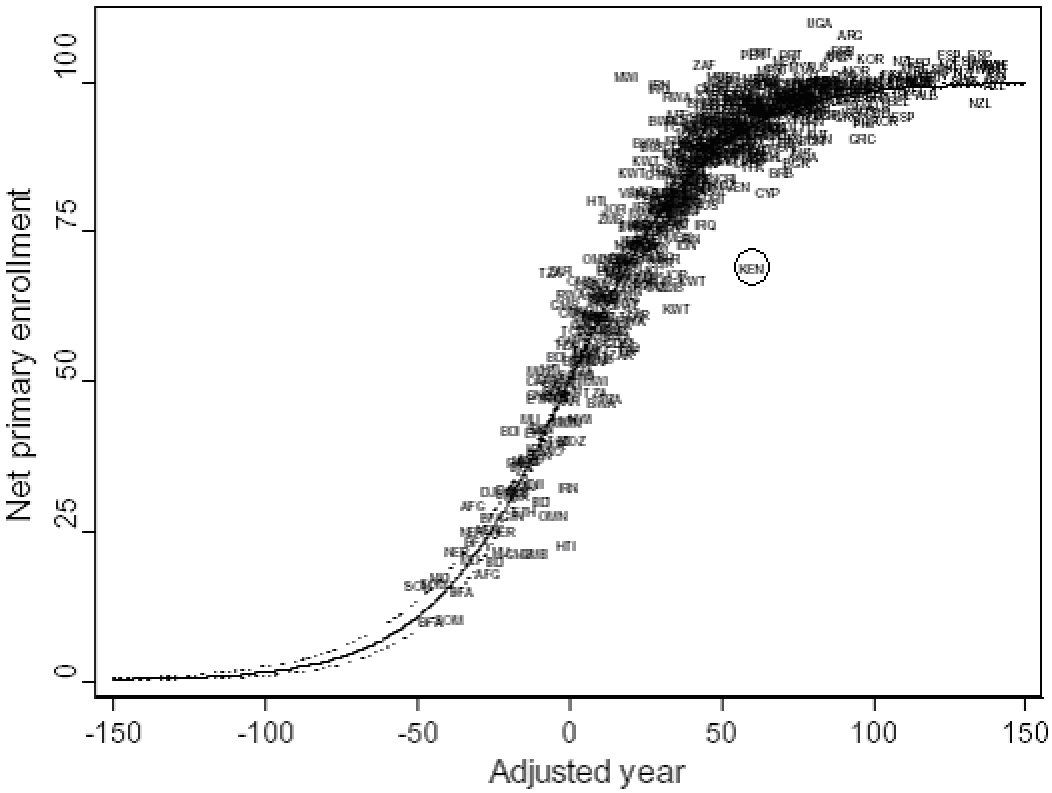
[16] USAID-sponsored Demographic and Health Surveys (DHS) and UNICEF-sponsored Multiple Indicators Cluster Surveys (MICS).

[17] Wils et. al. (2005) included entrance up to the age of 14 and completion up to the age of 19 in their entry and completion rate calculations.

enrollment rates defined by UNESCO, they cannot exceed one hundred percent by definition and, thus, are not exactly the gross intake or completion rates. The flow rates used by Wils et al. are thus quite different from the similarly titled rates used and forecast by Clemens and IFs.

These dissimilarities in operationalizing basic educational concepts, however, do not preclude us from comparing the *pace* of growth in the education sector flows forecast across these different models. For instance, Clemens (2004:15) reports that "…the typical transition occurs at a measured pace. . . in the postwar 20th century the typical country – rich or poor – would have risen [from 50%] to 70% after 22.3 years, 80% after 36.4 years, and 90% after 57.7 years." He also reported (2004:16) that "the typical country after 1960 took about 28 years to get from 75% of the worldwide maximum level of that enrollment statistic to 90% of the maximum."

Figure 12 shows Clemens' (2004) historic basis for this analysis. He mapped more than 100 countries at five-year intervals from 1960-2000. Each point represents the net primary enrollment for a country-year related to the number of years it took to move up to or beyond 50 percent enrollment. For instance, the outlier Kenya (Ken, circled by the authors) below and to the right of the curve appears to have taken about 60 years (reading from the X-axis) to move from 50 to 70 percent enrollment (reading the 70 percent from the Y-axis), compared to the roughly 22 years that the more typical country on the curve would have needed (see that 22 on the X-axis corresponds with 70 on the Y-axis using Clemens' fitted S-curve, and those numbers correspond to what he reported above). Note how steep the ascent of countries is from 50 percent to about 90 percent – it is the last 5-10 percent that countries have the most trouble completing.



"Adjusted years" are the elapsed time since 50% enrollment. Datapoints show country-years, spaced quinquennially. Solid line shows fitted line from first column of Table 4, dotted lines show 95% confidence interval on parameter α from the same table.

Figure 12. The Transition in Net Primary Enrollment
Source: Clemens (2004: 42).

How do the transition speeds in the IFs Base Case forecasts compare with those from the historical analysis of Clemens? Table 3 shows a striking similarity during the early stages of educational transition. At the later stages of the transition, however, for instance from 50% to 80% enrollment, Clemens calculates an historically slower pace of transition than those forecast by the International Futures (IFs) model.

Transition in Net Enrollment Rate	Clemens' transition time	IFs transition time (average)
50%-70%	22.3 years	20.3 years
50%-80%	36.4 years	29.8 years
50%-90%	57.7 years	40.5 years
75%-90%	28 years	18.1 years
90%-99%	-	19.8 years

Table 3. Comparing the Speed of Transition in Primary Net Enrollment
Source: Clemens (2004:15-16); IFs with Pardee, Version 5.40

The Wils et al. (2005) analysis also allows this sort of comparison. That study, however, computed individual transition speeds for seventy low income countries, rather than using the pooled, cross-sectional approach that Clemens (2004) applied to a larger sample of countries, rich and poor. Because of this country specific analysis, Wils et al (2005), unlike Clemens (2004), reported a range of transition speeds rather than a typical speed. Wils et al. chose to report the speed for the transition from 10% to 90%, probably because that is the span of an S-curve where there is most variation. In any case, because they picked different variables for analyses, the range reported in Wils' 2005 paper is not comparable directly to the speed reported in Clemens (2004). Clemens, however, in a footnote (2004:15) cautiously compares his 10%-90% enrollment transition speed of 115 years with a 35-80 years range for a 10%-90% "hypothetical" enrollment transition reported by Wils et al. in another 2003 paper.

For the purpose of comparison with IFs we calculated an average of the transition speeds[18] reported by Wils' et al. (2005) for 80%-90% and 90% -95% transitions in primary completion rates. The figures in Table 4 compared Wils' completion transitions with that for the same set of countries from IFs. Keeping in mind the subtle differences between the ways these two models define the completion rate, the results are comparable.

Transition in Completion Rate	Wils' transition time	IFs transition time (average)
80%-90%	14.68 years	13.63 years
90%-95%	13.2 years	11.3 years

Table 4. Comparing the Speed of Transition in Primary Enrollment
Source: Wils et al. (2005:22); IFs with Pardee, Version 5.40.

The earlier analysis already suggested a reason why the Base Case forecasts of IFs are somewhat optimistic relative to historic experience, namely the substantially increased

[18] We estimated the data from the bar graph showing 80%, 90% and 95% completion dates.

attention now given to increasing educational enrollments around the world. We sometimes refer to this as an example of "systemic shift." That is, there has been a tendency world-wide for change on many social variables to accelerate independent of income levels (Hughes 2001). It is particularly striking in some instances, such as fertility rates, where cross-sectional functions of fertility related to GDP per capita (at PPP, constant dollars) shifted downward about 1.5 children per woman from 1970 to 2000. The shift has been surprisingly consistent across different levels of GDP per capita. Some of the shift has a material basis, namely improved birth-control technology, but almost certainly some has an ideational basis.

Figure 13 shows that the same phenomenon has occurred globally on primary survival rates. Although the shift has been more pronounced for Middle-Income and to a lesser extent High-Income countries, even Low-Income countries, on average, exhibit an improvement in primary survival rates of about 5 percent from 1970 to 2000 at any given level of per capita income. Interestingly, Clemens (2004) noted exactly this same effect when comparing the experience of the currently developed countries early in the twentieth century with the currently less developed countries in 1960-2000. According to Clemens' (2004, p16): "the typical country after 1960 took about 28 years to get from 75% of the worldwide maximum level of that enrollment statistic to 90% of the maximum....before 1914 it took about 41 years to get from 75% of the worldwide maximum value of net primary enrollment to 90% of the maximum."

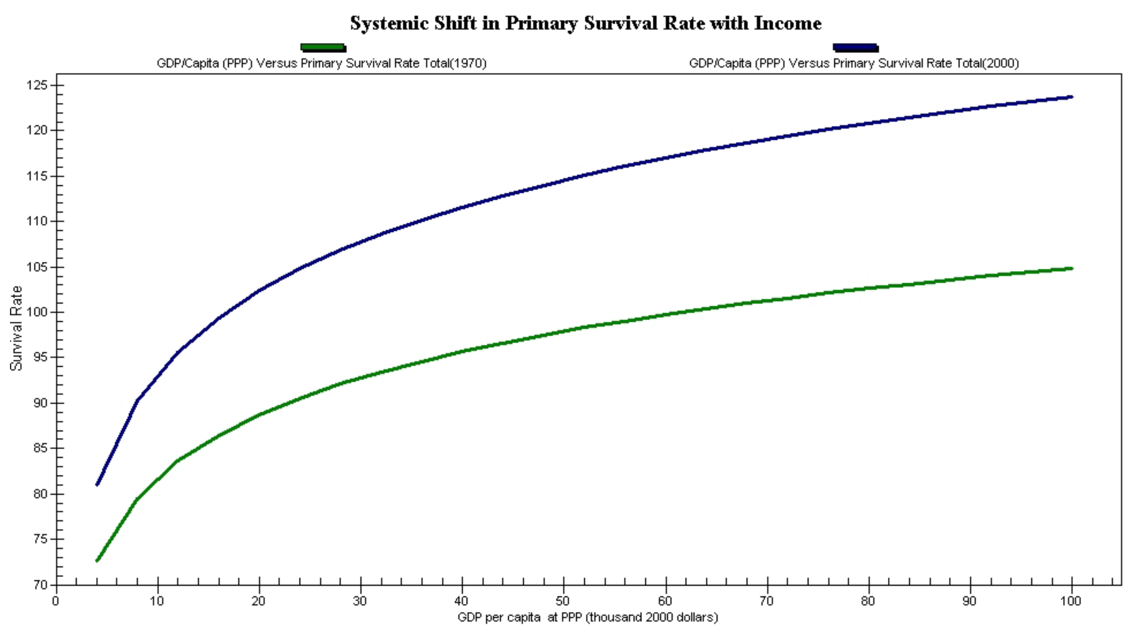


Figure 13. Comparative Cross-Sectional Analyses of Primary Survival with GDP per Capita
Source: IFs with Pardee, Version 5.40.

We must be careful not to make too much of Figure 13. First, data have not been very good or consistent across this period. Second, there is obviously a ceiling effect with respect to such a shift and it is possible that the world has reached it or will very soon.

Still another reason for the relatively greater optimism of forecasts in IFs, however, is that the S-curve does not completely capture the rapidity of transition up to the last 5-10 percent of enrollment. In some ways, the phenomenon is more of a Z-Curve, with rather sharp transitions (see again the points shown by Clemens on Figure 12 above). Our examination, for instance, of historic data for Indonesia, Portugal, and Norway, which have completed the transition to at least 95 percent enrollment, show essentially linear rises to that level rather than slowly decreasing slopes.

As the IFs forecasting efforts continue, several activities will unfold:

- Further study of the transition speed issues discussed here.
- Analysis of secondary and tertiary transitions (the IFs model contains representations of these similar to its representation of primary education, but this paper has focused on primary education).

5.2 Achieving Gender Equality

Indicators for MDG 3 call for gender parity in education at primary and secondary levels by 2005 and at the tertiary level by 2015. The official indicator is numerical parity between females and males. Populations can differ substantially, however, in the ratio of females to males at any given age; for instance, male preference in China and India create substantial differences. Hence, as mentioned in an earlier section, it is preferable to use the ratio of enrollment rates – the gender parity index – rather than the ratio of enrolled numbers.

Figure 14 shows the historical trends and IFs Base Case forecasts for gender parity in primary education for continental regions. Specifically, it displays the ratios of the net primary enrollment rate for girls to that for boys.

Looking beyond the irregularities in the historical pattern for South Asia because of missing data, we see a general pattern of progress towards gender parity in enrollment in all regions except those that had already reached parity by the early seventies. The two regions that are still some distance from primary enrollment parity are Sub-Saharan African and South Asia, and both are showing impressive narrowing of the gap. Perhaps surprisingly, Sub-Saharan African which is well behind South Asia in terms of achieving the UPE goal, is ahead in the case of gender parity. The IFs Base Case forecast suggests that girls in Sub-Saharan Africa will be enrolled at a higher rate than the boys in the region by mid-century, before it attains UPE.

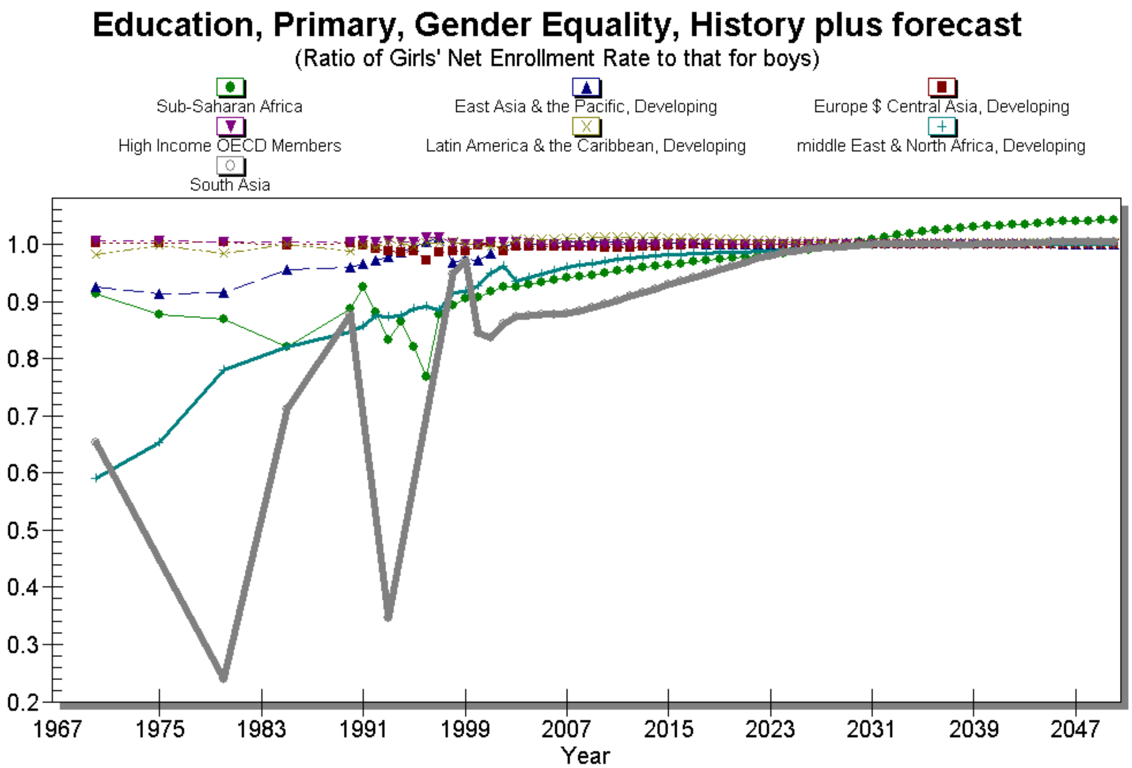


Figure 14. Primary Gender Ratio (Ratio of Girl-to-Boy Enrollment)
Source: IFs with Pardee, Version 5.40.

Figure 15 extends the analysis to a forecast at the secondary level, using the global regionalization preferred by the United Nations and Population Reference Bureau (PRB). Again, Africa and Asia are the regions of interest. At the same time, however, a reverse gender gap in Latin America becomes apparent (and is true for net enrollments, not only gross enrollments). An extension of the analysis to the tertiary level would show also an emerging reverse gender gap in North America. In fact, the 2007 EFA Global Monitoring Report notes (2006:44):

> Patterns of gender disparities are more complex in secondary education than in primary. In primary education they are nearly always at the expense of girls. At secondary level, however, there are as many countries with disparities at the expense of boys as there are countries where girls are at a disadvantage. Countries with low overall secondary enrolment ratios tend to be those where disparities are at the expense of girls, while disparities at the expense of boys are observed in developed countries as well as in several Latin American and Caribbean countries. Overall, gender disparities in favour of boys [at the secondary level] tend to be more pronounced than those in favour of girls.

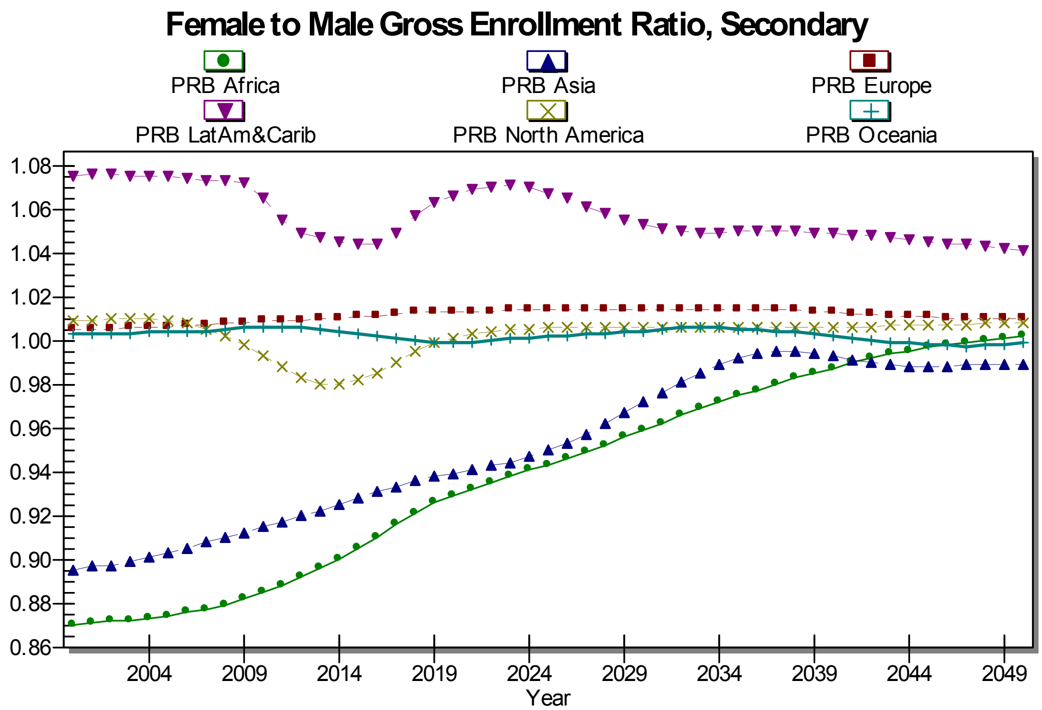


Figure 15. Secondary Gender Ratio (Ratio of Girl-to-Boy Enrollment)
Source: IFs with Pardee, Version 5.40.

There are limited other forecasts of gender parity in education with which to compare those of IFs. We hypothesize two reasons for this: (1) the goal of parity in primary and secondary education by 2005 was so close to the date the MDGs were established that outcomes for those two indicators could be projected reasonably without developing complex forecasting systems; and (2) the bulk of attention to date has been on UPE, not on secondary and tertiary education, so there has been less attention to the context within which examinations of gender parity at those levels would "naturally" occur.

Clemens, however, did undertake an analysis of the closing of gaps in terms of typical primary and secondary gender transition rate speeds. He found that "a country whose ratio of girls' gross primary enrollment to boys' is 0.8 typically takes 28 years to reach a ratio of 0.95. In secondary education, the transition from 0.8 to 0.95 has typically taken 29 years." (Clemens 2004:20, see also 46-49 for analysis of some of the determinants of transition speed). An examination of Figure 15 suggests that the forecast pattern for closing the primary gender gap in South Asia is similar to this expectation. An examination of Figure 15 further suggests that the forecast patterns for the primary gender gaps in Africa and Asia as a whole are closing somewhat more slowly than the Clemens pattern. Those regions are, however, moving into the range of the gap where fundamental cultural patterns may tend to retard completion of the transition.

In a 2004 study, Abu-Gaida and Klasen used 1999 data to project which countries were not on track to meet the 2005 parity goals as a basis for projecting associated human and financial costs for those countries. Although they looked with 1999 data to the near-term and now historic 2005 date rather than exploring the longer horizons of this study, Abu-

Gaida and Klasen (2004) did provide some forecasts of relevance for comparison with IFs. They concluded:

> Not only virtually all transition countries (with the exception of Tajikistan and Lithuania), but also almost all countries of Latin America and the Caribbean, in East Asia and the Pacific, the majority of countries in the Middle East and North Africa, half the countries in South Asia, and one-third of countries in Sub-Saharan Africa are projected to reach the goal. Within South Asia, Bangladesh and Sri Lanka are projected to reach the goal, as is China in East Asia and Egypt and Saudi Arabia in the Middle East (2004:11-12).

As Abu-Gaida and Klasen (2004) suggest, it is the countries of South Asia and Sub-Saharan Africa that have lagged, and for them we must move our analysis horizon considerably further out.[19]

The more extended analysis of gender in the future of education will be complex and interesting. As the IFs forecasting efforts continue, several activities will unfold, including:

- Further analysis of country-specific gender gaps at all levels of education.
- Devoting particular attention to the countries and regions furthest from gender parity.
- Elaborating and exploring the (forward) linkages of gender gaps and their closing to fertility, social stability, and economic growth (a la Abu-Ghaida and Klasen 2004) and other human and social development variables.

5.3 Meeting the Needs for Education Financing

The case for public investment in basic education on a global level is well established by now both because of the consensus that education, at least basic education, is a human right and the relatively high magnitude of the social return from that level of education. In the literature insufficient public finance is posed as a major obstacle towards progress in primary education.

IFs and its education model attempt to capture both the demand side and the supply side of public financing in education with a dynamic representation of variables like per-student cost on the demand side and resource mobilization and allocation on the supply side.[20] After providing some basic information about these financial foundations, this section will turn to one of the key questions raised in recent discussion of educational

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20 As discussed earlier, the education model balances demand and supply via allocation mechanisms that, in general, proportionally allocate available funds to primary, secondary, and tertiary levels relative to demand patterns.

financing: what might it cost to move the global system to universal primary education (UPE)?

5.3.1 IFs Analysis of Financing Demand and Supply

Demand for public investment in education can be obtained from the total number of students (actual enrollments, or more appropriately, desired enrollments) multiplied by the per student cost. The bulk, up to around 90% (Delamonica 2001:11-12), of the per-student cost goes to teacher salaries; the share generally goes down somewhat with per capita income in a country.

On the demand side, the IFs education model has a dynamic representation of the per student cost whereby the cost relative to GDP per capita at purchasing power goes up with the latter. The figure below shows the historical trend and IFs base case forecast on per student costs as a percentage of GDP per capita for several regions of the world. We see a general trend of increasing per student expenditure in primary education as the countries get richer.

An interesting finding is the lower relative costs for the two recent high achievers East Asia and the Pacific (developing countries in the region only, Japan excluded) and Latin America and the Caribbean. Considering the fact that East Asia and the Pacific is already at 100 percent enrollment, the forecast doubling of relative per student cost by mid-century bears the potential of increasing the quality of basic education. By mid-century, the relative per student cost in all but one region is forecast to be in the range of one-fifth to one-fourth of per capita income. For Sub-Saharan Africa, ignoring the few jumps in the historic period coming either from skimpy or irregular data, we see a forecast of general stagnation in the relative cost per student. We have previously seen the significant relative or absolute shortfall in this region in net enrollment rates. The region clearly faces complicated challenges in addressing both desires to sharply increase net enrollment and also to increase per student spending enough to enhance quality.

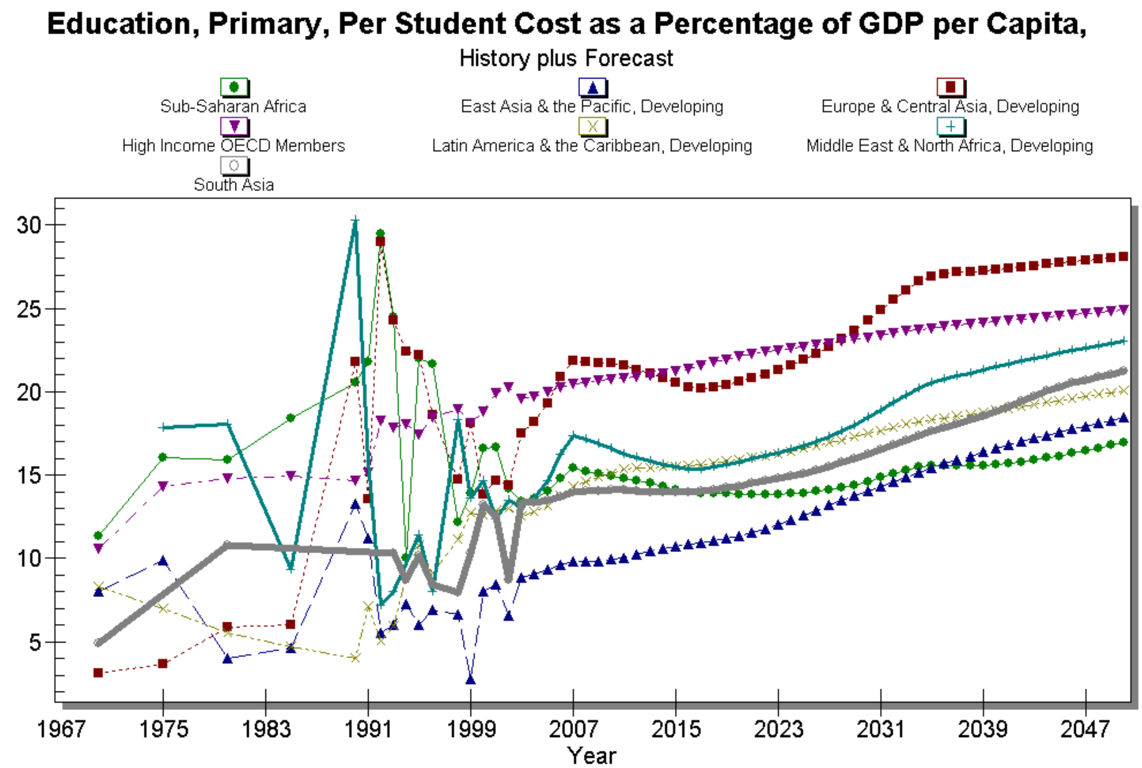

Figure 16. Primary Per-Student Spending as a Percent of GDP per Capita
Source: IFs with Pardee, Version 5.40.

Turning to the supply side, high income countries spend about 4.5 percent of their economic product on education. Many of the developing regions of the world (see Figure 17) fall considerably below this educational spending rate. Because of the dominance of China in the grouping of developing countries in East Asia and the Pacific, and the common perception that Chinese investment in human capital is high, the low level of spending on education in that region might be surprising. In fact, China spent less than 2.5 percent of GDP on education for most of the 1990s, and 3.4 percent in 2002, with a near term goal of 4 percent[21] The recent gains in education in China despite education's low share of GDP perhaps reinforces the conclusion in much of the education literature than per capita spending and quality are not necessarily highly correlated.

[21] China Daily story at http://www.chinadaily.com.cn/english/doc/2006-03/06/content_527242.htm The education data for China in Figure 7.6 are somewhat out of date. (taken from Hughes et al, 2007)

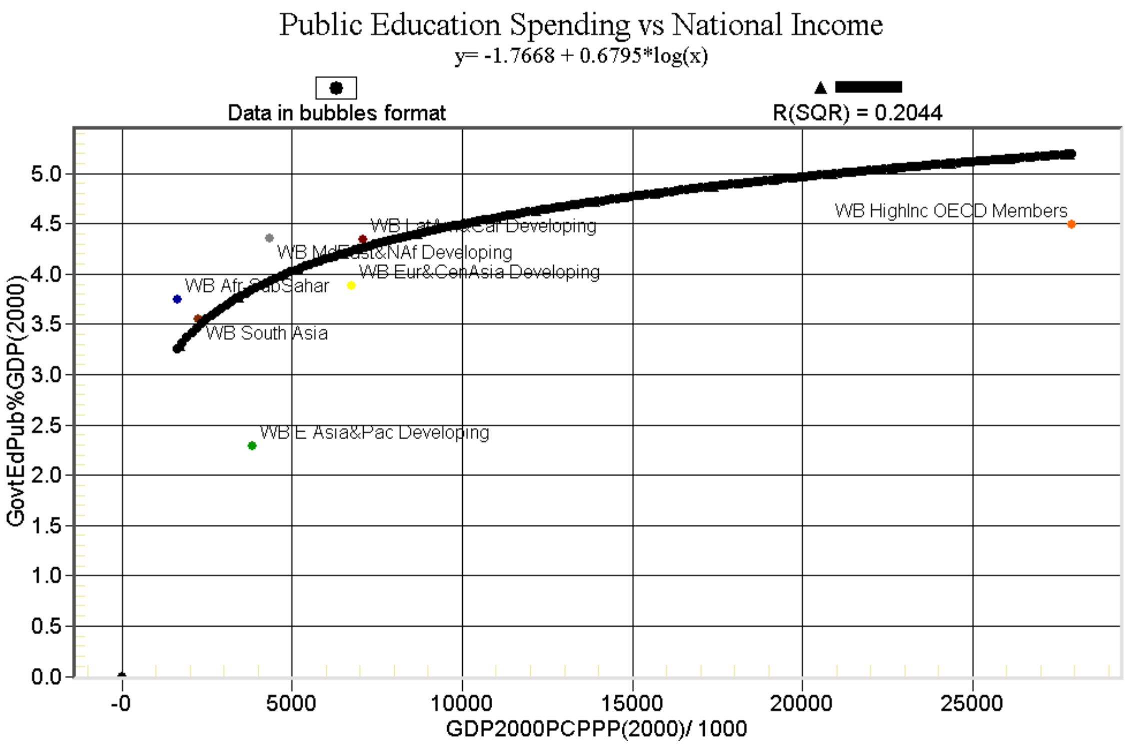

Figure 17. Public Education Spending in 2000 as Portion of GDP Related to GDP/Capita
Source: IFs with Pardee, Version 5.40.

On the supply side, governments struggle not just with the total amount of education spending, but its pattern of allocation across levels of education. Figure 18 portrays the global pattern for all countries combined in the year 2000. It conveys a snapshot at that point in time of how countries start to shift their allocation proportions from primary to secondary levels as they proceed towards universal enrollment in primary. At higher levels of income there tends to be another shift in proportions, as countries with very high incomes increase their emphasis and spending on tertiary education. Interestingly, the longitudinal pattern for South Asia in the Base Case of IFs looks almost identical to this cross-sectional pattern – secondary spending in that region passes their primary expenditure before 2015 and tertiary spending exceeds primary in about 2040.

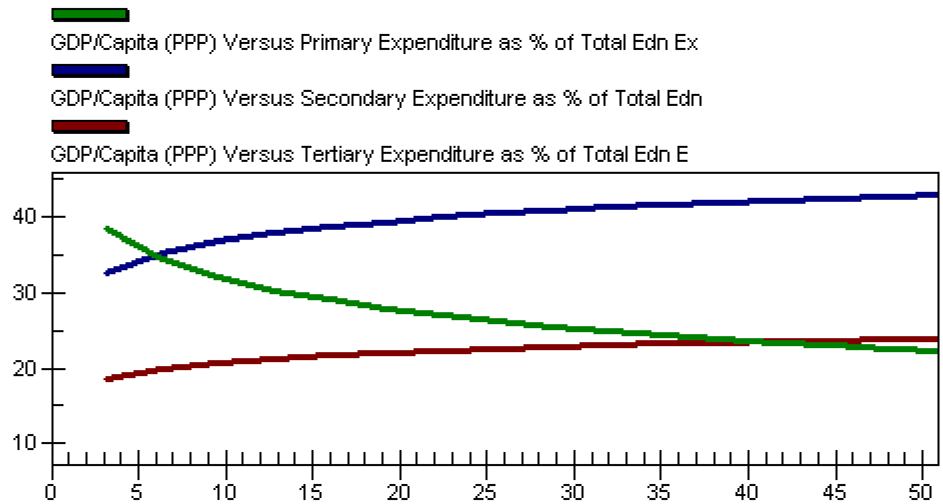

Figure 18. Public Education Spending at Different Levels as GDP per Capita Increases
Source: IFs with Pardee, Version 5.40.

5.3.2 The Costs of UPE: Comparison of IFs Analyses with Others

Among the education forecasting models discussed earlier, only the cost calculation models of Delamonica et al. (2001) and Bruns et al. (2003) represent education financing. Both seek to calculate the incremental cost of moving from current enrollment rates to universal primary education. Obviously, that incremental cost has policy relevance, because it may be very difficult for poorer countries to pay such costs.

What are the incremental costs of moving to universal education? One component is presumably a rate element. Over time, as we saw above, expenditures per student tend to rise as GDP per capita increases; in developing countries they also tend to increase as a portion of GDP. If so, the calculation of incremental costs would ideally take into account this rising cost rate. The second component is a volume element, which in turn has two subcomponents. The first is tied to potential student numbers, the size of the of-age population, typically still rising in most developing countries. The second is the portion of students enrolled, which in cost calculations is normally assumed to rise from the current portion (say 40 percent) to UPE or 100 percent.

Thus it is relatively simple to calculate the total annual cost of universal education at a future point as the anticipated of-age population times the anticipated per-student cost. It is considerably harder to calculate the incremental costs, because the reference point is less clear. Incremental to what?

Because of limitations related to data and supporting model structure, incremental cost calculations of Delamonica et al. (2001) make important simplifying assumptions about two of the three drivers of costs indicated above (the portion educated, and the cost-per student). In particular, the study assumes that the per-student cost stays constant at the last available data value throughout their forecast horizon both in their base calculation and in their UPE forecast. In short, rate changes play no role – the initial per-student rate is applied to their baseline volume forecast (based on generally increasing of-age student numbers) and their UPE forecast. Although a constant per-student rate certainly was not ideal, the study was calculating incremental costs on a country-specific basis, thereby advancing beyond earlier studies that made region-wide assumptions. They also recognized that GDP per capita increases, also not represented explicitly, could likely pay many such costs.[22]

With respect to volume, Delamonica et al. (2001) uses UN population forecasts to estimate a changing of-age population. Yet the baseline cost estimate uses the initial enrollment rate (e.g. 40 percent) and multiplies that times the changing (normally growing) number of of-age population, multiplied again times the constant per-student rate – thus this, too, is a simplifying assumption because we know that enrollment rates are naturally growing around the world. The UPE cost estimate ramps the initial enrollment rate up to 100 percent over time, again multiplying that times the of-age population and the constant per-student rate. The incremental cost is, of course, the simple difference summed over time of the UPE cost estimate and the constant enrollment rate calculation.

Because of these simplifying assumptions of constant per-student costs and constant enrollment rates in the base cost specification, calculations of Delamonica et al. (2001) are not directly comparable with IFs. As we have seen, the Base Case of IFs forecasts is generally rising per-student costs and enrollment rates, quite naturally covered by (1) the growth of GDP per capita and (2) the typical spending of higher portions of GDP on education as GDP per capita rises.

In order to provide a basic check on our own calculation of incremental costs for UPE, however, we decided to compute them in two basic ways (see Table 5). First, we calculated them using the simplifying assumptions of Delamonica et al. (2001). Second, we calculated them *relative* to the IFs Base Case, with its typically rising per-student costs and enrollment rates. We did the IFs calculations for exactly the same 128 countries studied by Delamonica et al. (2001), and we also did the two IFs calculations for each of the continental regions they defined. Delamonica et al. (2001) present the incremental costs as an annual average over his time horizon and we have done the same.

Providing some assurance to us, the estimate of incremental average annual costs for the 128 countries by IFs using constant costs and base enrollment rates was quite close to that of Delamonica et al. (2001). Part of even the small difference can be explained by our use of 2000 dollars and Delamonica's (2001) use of 1998 dollars. In contrast, the incremental cost calculation in the IFs Base Case, without the simplifying assumptions, is considerably lower. Because these numbers are inputs to the policy process, the difference is significant. It is important to note, however, that Delamonica et al. did an

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[22] For part of his analysis Delamonica (2001:11-13) adjusts his cost estimates with various quality and capital adjustments that he says in total add some 20 percent to recurrent expenditures. Such adjustments are not in the IFs forecasts and they are also not in the estimations by Delamonica presented here.

extended analysis of additional, quality-related expenses that should be added to their base calculation for policy purposes. That moved their global value up to $9.1 billion.

Similarly, and in spite of somewhat different regional definitions by Delamonica and IFs, we see comfortably close estimations of Delamonica and simplified IFs assumptions for all but one region. The IFs constant enrollment and constant cost estimation for the Middle East and North Africa is much higher than that for the same region from Delamonica. A closer examination has revealed that the difference in estimation is coming mostly from Saudi Arabia, where the year 2000 data used by IFs for net primary enrollment (from latest UIS web data) is lower than the value used by Delamonica (about 58% as opposed to 70%). The difference is widened by a higher per-student cost in IFs -- 31% of GDP per capita (as obtained from WDI, 2006) compared to the 10% value used by Delamonica et al. (2001).

Model/Case	Additional Average Annual Cost for meeting the MDG, billion dollar		
	Delamonica	IFs Analysis with Constant Enrollment and Cost	IFs Base Case
Global (128 Countries)	6.9	7.4	4.053
Sub Saharan Africa	1.741	1.248	1.051
South Asia	1.611	1.061	.803
East Asia and Pacific	.306	.498	.136
Middle East and N Africa (MENA)	1.885	3.3	1.834
Latin America and the Caribbean	.782	.847	.2
Eastern Europe and Central Asia	.604	.411	.028

Table 5. Comparing Incremental UPE Cost Calculations of Delamonica and IFs
Source: UNICEF-Delamonica (2001: 26-27); IFs with Pardee, Version 5.40.

Turning to the second model used for forecasting cost calculations, Bruns et al. (2003) added substantial sophistication both on the demand and supply side of the budgetary analysis. To begin, the project's base line, as a foundation for estimating incremental UPE costs is dynamic. For instance, it assumes 5% economic growth for all of their 47 low income economies. As we know, growing GDP will affect per-student costs (demand for expenditures, such as teacher salaries).[23] Growing GDP will also affect government revenues and therefore expenditure potential.

The study added complexity also via the development of alternative scenarios. Its rough equivalent to the IFs Base Case is called Status Quo, and it involves increasing costs and

[23] Bruns (2003) even divides costs into teacher salary and non-salary components.

revenues (see Table 6 and their estimate of about $2.2 billion). The authors understand, however, that reaching UPE without quality improvements is both unlikely, because the demand would not emerge, and undesirable, because quality levels are often low and should improve. They thus prepare a second scenario, Quality Only, in which substantial elements of quality enhancement are added.[24] This is the beginning stage of a "Best Practice"-based analysis.

They further understand, however, that the resource requirements of moving to UPE and high quality (see the $7.5 billion in Table 6) are unreasonable to request of either local populations or donors in the absence of simultaneous efficiency improvements. The third scenario is thus Quality plus Efficiency and brings incremental costs down.

Still further, they recognize that before any appeal can be made to external donors, countries need also to implement best practices with respect to resource mobilization, e.g., increasing their own expenditure rates on education, taking into account their development levels.[25] Doing so reduces the incremental costs still further in their Resource Mobilization scenario. Given that the scenario posits a combination of movement to UPE, best practices in quality enhancement, best practices in efficiency improvement, and best practices in resource mobilization, they put forward this last number as a reasonable one to put in front of external donors.

To make it possible to compare results of IFs with Bruns et al., we designed a custom group of countries with the 47 EFA countries analyzed by the study. Table 6 outlines results from Bruns et al. and compares those with the IFs Base Case estimation. As indicated, the IFs Base Case analysis of incremental costs, which does not implicitly represent best practices on quality, efficiency, or resource mobilization, is probably most nearly comparable to the Status Quo scenario.

We must, however, be very wary of direct comparisons of results from Bruns et al. and IFs. Clearly, they take very different approaches to representing many dynamic elements. For instance, the GDP forecasts of IFs are endogenous and highly variable across countries and over time. In addition, the target variables of the two studies differ. IFs looks at incremental costs associated with linearly moving the net enrollment rate to universal primary education in 2015. In contrast, Bruns et al. calculates the cost differentials around gross enrollment rates with assumptions of climb in the intake rate and the completion rate to one hundred percent by 2010 and 2015 respectively[26].

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[24] It appears that this scenario posited higher teacher salaries and other expenses from the very first year, however, as opposed to ramping them up over time. That would seem to make it a high-side calculation of quality improvements costs.

[25] This analysis relied on exogenous specification of total resource mobilization and rates of expenditures on education, which were constant in the Status Quo scenario. IFs endogenously calculates those values for its Base Case in the economic and socio-political modules (making it less comparable to the Status Quo of Bruns et al.), and IFs also allows exogenous intervention for scenario analysis.

[26] Bruns' enrollment rates are simple averages of completion and intake rates.

Model/Case	Additional Average Annual Cost for meeting the MDG for 47 EFA countries
Bruns-Status Quo	2.24 billion
Bruns- Quality Only	7.49 billion
Bruns-Quality plus Efficiency	4.34 billion
Bruns-Resource Mobilization	2.0 to 1.5 billion
IFs-Base Case with NER	1.81 billion

Table 6. Comparing Incremental UPE Cost Calculations of Delamonica and IFs
Source: Bruns et al. (2003), accompanying CD-ROM, FinalmodelMarch12.xls:AllCountries, Table C.1; IFs with Pardee, Version 5.40.
Note: Numbers for the Bruns et al. (2003) scenarios on page 102 differ somewhat from those in the table on the CD-ROM; for instance, the Resource Mobilization range is $1.6-2.2 billion.

Bruns et al. take their analysis still further, beyond that shown in Table 6. For instance, they recognize that such ramping gearing up towards UPE would likely involve additional costs, including some system rehabilitation and expansion of infrastructure. They also note that Afghanistan is not among the 47 countries analyzed. When these expenditures are added, the number needed in the Resource Mobilization scenario rises to $3.7 billion.

Even though we should be careful in comparing the various cost estimates across Delamonica, Bruns et al. and IFs, because of the disparities in source data and dissimilarities in the variables selected, it is worth mentioning some insights from the analysis. One, evident from Table 5 comparing IFs and Delamonica results, relates to the changes in incremental cost across the constant cost and dynamic Base Case forecasts of IFs. Specifically, the incremental cost does not decline much for the two most problematic regions, namely Sub-Saharan Africa and South Asia. For all other regions, we see a substantial downward shift in the estimate of the costs required to meet the MDG, as we move from the constant-cost to the dynamic scenario. This is a result, in part, of relatively slow change in regional cost structures in the Base Case. The result suggests that the incremental cost estimates for those regions are relatively robust across methodologies.

A second insight relates to the Middle East and North Africa, where the per-student cost is highest among all the developing regions. There the incremental cost of UPE remains absolutely and somewhat surprisingly high, even after the reduction in the dynamic situation of IFs base case. This is in part because of the rapid demographic growth of the region. Current oil prices facilitate the payment of such costs. Lower prices could, however, create real difficulties.

Most of all, the analysis reinforces the financial burden faced by Sub-Saharan Africa and South Asia as they pursue UPE. These are the regions that continue to deserve analytic attention.

5.3.3 Putting Financing Costs in Context

Where might the incremental financial resources to achieve universal primary education come from? With the many demands on the public resources of low-income developing countries, there is widespread agreement that some countries will not be able to assume the full incremental costs. In an attempt to put the resource needs in context, both for the developing countries and for donor countries, Table 7 from the IFs Base Case shows both education and military spending, in billions of dollars, of the two poorest regions and of the high income OECD countries as a group.

The table shows two things. First, if Sub-Saharan Africa and South Asia were to freeze their military expenditures at 2000 levels, they would have more than enough to meet the goal of UPE even at the highest estimate computed above. Second, we see an average projected annual increase of 16.7 billion dollars in the military expenditures of OECD countries between 2000 and 2015. This amount, again, is considerably more than enough to meet 100% of the highest estimates for incremental financing to accomplish universal primary education; in fact, it is a multiple of the amount the low-income countries need.

Government Expenditures in Billion 2000 $						
	Sub-Saharan Africa		South Asia		High-Income OECD Members	
Year	Education	Military	Education	Military	Education	Military
2000	12.55	6.249	21.3	15.28	1100	536
2001	12.91	6.471	22.53	16.05	1115	542.8
2002	13.33	6.683	23.44	16.67	1135	551.8
2003	13.69	6.88	25.43	17.94	1162	562.9
2004	14.29	7.209	27.26	19.12	1208	580.7
2005	15.14	7.675	29.08	20.29	1247	595.6
2006	16.44	8.359	31.23	21.66	1290	612.3
2007	17.58	8.957	33.54	23.11	1330	627.3
2008	17.91	9.161	35.7	24.44	1363	638
2009	18.31	9.429	38.03	25.87	1408	653.5
2010	18.77	9.723	40.48	27.36	1451	669.6
2011	19.29	10.07	43.13	28.95	1492	685.6
2012	19.85	10.44	45.96	30.64	1535	701.6
2013	20.45	10.83	48.98	32.43	1577	717.5
2014	21.01	11.18	52.21	34.32	1620	733.4
2015	21.57	11.55	55.65	36.32	1663	749.2

Table 7. Base Case Forecast of Education and Military Spending
Source: IFs with Pardee, Version 5.40

Resource availability is not, however, the only and quite possibly not the most important constraint on achieving UPE. The demand for education is at least as important as its availability. If good jobs do not exist for graduates, if the opportunity costs of going to school outweigh the longer-reward for doing so, if constraints imposed by poor infrastructure, school fees, or other demand-reducing forces simply do not permit school attendance, spending more money will not necessarily move education towards universality.

Thus some of the major conclusions concerning next steps in the IFs forecasting analysis have little to do with this line of analysis:

- Cost estimates are important, but they are also significantly artificial as barriers, because the goal of universal primary education over very short time horizons is unrealistic.

- The demand for education by children and their parents is a critical variable not well treated in many costing calculations, but one that requires and will receive close attention in our future analyses.

- We wish to explore the specifics of interventions around costs, including the implications of pursuit of best practice to address quality and efficiency.

5.4 Building and Using Human Capital

Education and the universalization of it are ends in and of themselves. Or are they? In Sen's (1999) conceptualization of capabilities and functionings, education makes possible human functionings including understanding their environment and interacting successfully with others. More broadly, the earlier discussion around Figure 2 noted the links between education and many broader aspects of human development. Educational attainment affects demography through both the increase of longevity and the general decrease of fertility. It affects economic growth through the enhancement of productivity. It shapes the ability of societies to pursue fairness and justice, thus enhancing social stability. It even helps those societies understand and pursue the foundations of long-term environmental sustainability.

The characterization of the stock of educational attainment within a population as **human capita**l may sound overly economistic. It may even predispose those studying it to focus on the relationship of a society's stock of education and economic productivity, downplaying the stock's relationship to a broader set of ends. Yet the term enjoys wide-spread use and is understood to represent the accumulation by a population of not just formal education, but of life-long and experiential learning. This study uses it in this spirit, even though at this stage of work our use captures only formal education and its distribution across the age-sex cohorts of the population. Earlier discussion of the IFs educational model explained the manner in which the model tracks the educational attainment level of populations over time with aging and mortality.

5.4.1 IFs Forecasts in Historic Context

Figure 19 shows the average years of formal education attained by people 25-years of age or older for global regions. That is a standard indicator of capital stock. Other important indicators include the percentage of the adult population that have completed primary, secondary, and tertiary education. IFs forecast all of these, differentiated by sex, to provide a richer portrayal of the stock of education in societies.

Figure 19 tells two stories. The first is of gradual increase in the human capital stock across all regions of the world. This finding is consistent with our previous analysis of growing educational attainment around the world. The second is of a remarkable persistence in the magnitude of gaps across regions. There are, of course, changes in global position. For instance, the Middle East and North Africa rose from the bottom of the hierarchy between 1960 and 2000; the Base Case forecasts significant continued positional rise. One could interpret this second story optimistically (the ratio of education years in advantaged regions to those in disadvantaged regions has been declining) or more pessimistically (the educationally poor are not catching up). And the statistics say nothing about the character and quality of education.

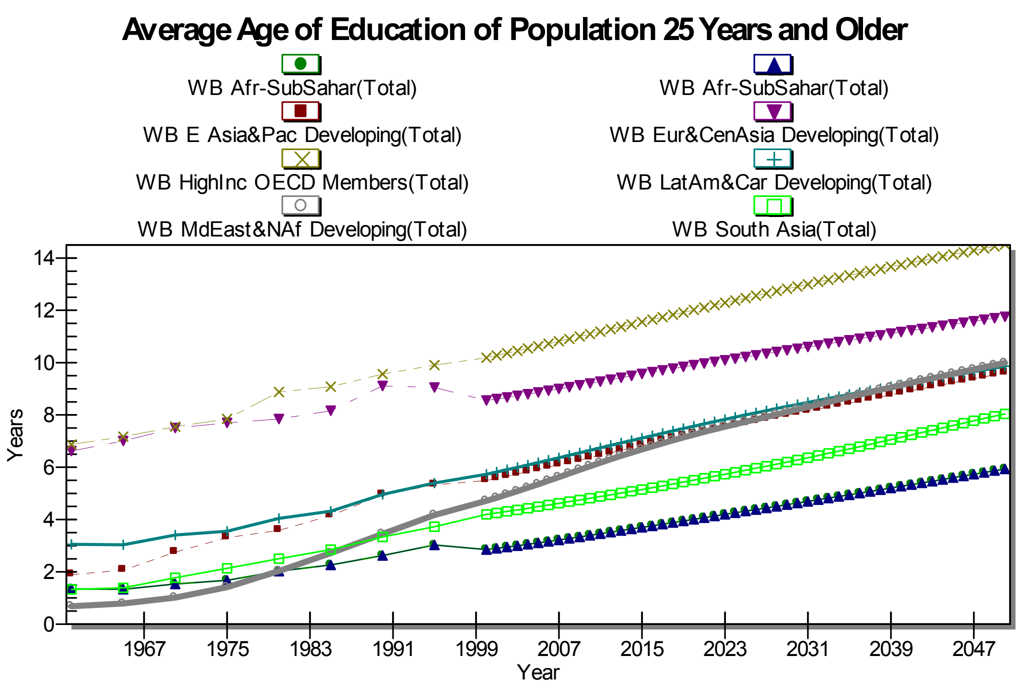

Figure 19. Average Years of Formal Education at 25-Years of Age and Older
Source: Barro and Lee (2000); IFs with Pardee, Version 5.40.

Figure 20 compares the average years of education across the sexes for the richer OECD and the poorer non-OECD economies. Women in OECD countries trailed men by about ½-1 year in those countries across the period since 1960. Women in non-OECD countries lagged 1-2 years behind men during that time. It is interesting to note the brief widening of the gap between sexes in the non-OECD region during the 1990s. This is likely to have been the result of increased emphasis on education late in the twentieth century, the benefit of which the privileged gender initially reaped.

The ongoing convergence of women to men in enrollment and completion rates underlies the IFs forecasts that women will gradually catch up with men by mid-century, possibly even creating a society-wide (not just in-school) reverse gap. This phenomenon of increased women's education will, of course, have great effects on fertility, economic productivity, and broader societal change.

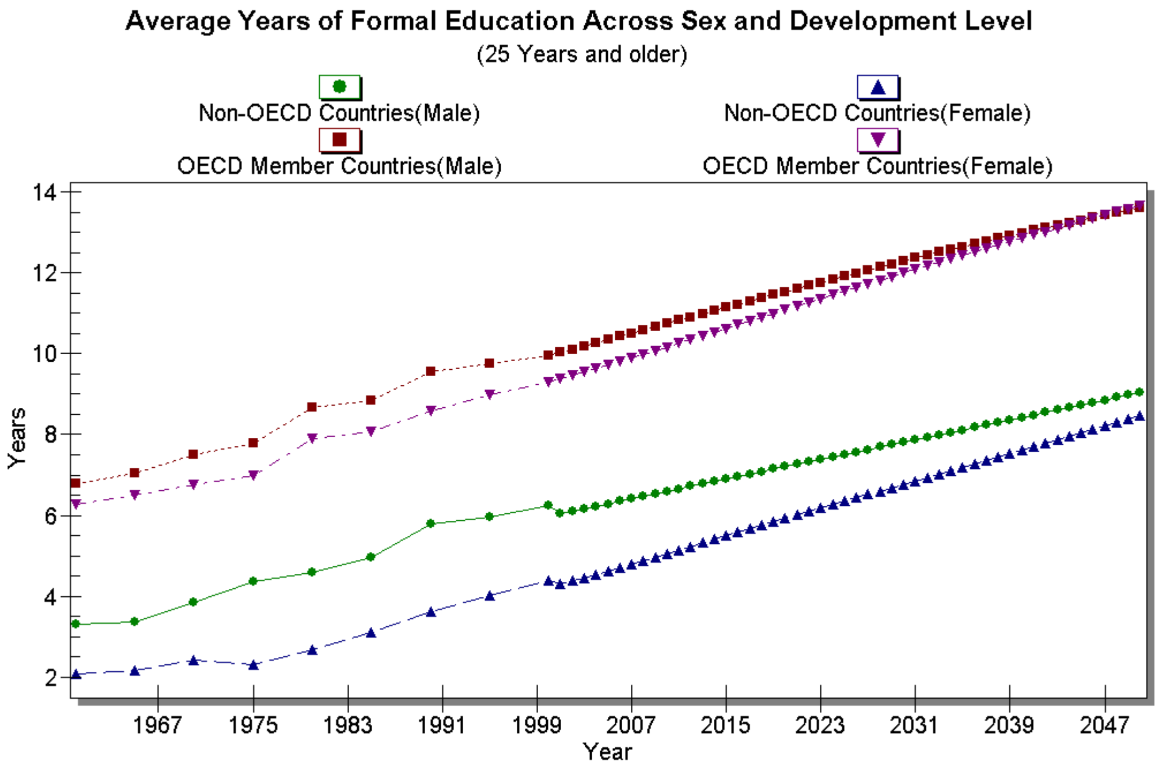

Figure 20. Average Years of Formal Education Across Sex and Development Level
Source: Barro and Lee (2001); IFs with Pardee, Version 5.40

Aggregate indicators of educational attainment in societies, although useful, benefit from the elaboration of the educational distributions that underlie them (and from which they are, in fact computed). Figure 21 shows age-sex pyramids of educational achievement for two countries, the United States and China. Although only 30 years separate the two pyramids for each country, that proves enough time for substantial human capital reshaping to take place. In the percentage of population with tertiary education (the blue part of the bar) the United States is well ahead of China in 2000 and augments its lead by 2030. People in China, on the other hand, have proportionately little tertiary education, but relatively greater secondary education at present, supporting perhaps their current edge in low-wage manufacturing exports. By 2030, tertiary-educated Chinese adults will be quite visible in the pyramid. And with a Chinese population more than four times as great, the absolute number of Chinese tertiary graduates will approach US numbers. From a US- or EU-centric, pessimistic perspective, the competition that US and EU workers face today from their Chinese counterparts may emerge across the wage continuum within the next few decades. From a more human-centric or nonzero-sum perspective, the Chinese contributions to knowledge development and use will likely rise sharply. The figure suggests a tremendous number of ways in which basic demographics and educational patterns will reshape China and the world.

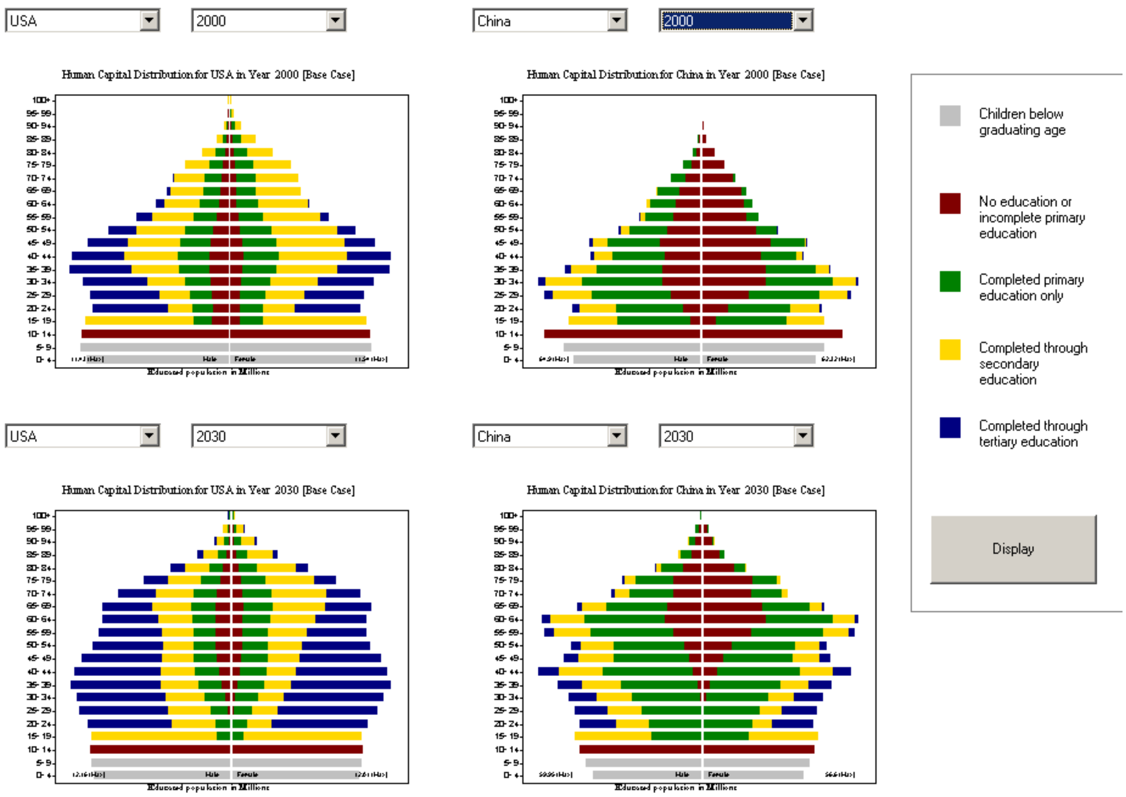

Figure 21. Average Years of Formal Education Across Sex and Development Level
Source: Barro and Lee (2001); IFs with Pardee, Version 5.40,

5.4.2 <u>Comparison of IFs Results with Others</u>

IIASA (Lutz 2005) is creating the only other model of which we know with detailed representation of age-sex differentiated educational stocks. There are important similarities in the two projects. Both use fully-developed age-sex cohort population models to provide the demographic foundations needed. Both are seeking to represent educational stocks within populations so as to explore the impact of those stocks on demographics, economic productivity and other variables.

There are also important differences between the IIASA and IFs approaches. Whereas the IFs model computes changing rates of intake and completion of education at different levels as endogenous functions of other variables in the model (especially economic level and educational spending), allowing the user also to introduce generally policy-based exogenous interventions, the IIASA approach uses educational attainment surveys to estimate the "transition rates" into and across educational levels. As discussed earlier, these survey-based transition rates are similar to but not the same as the UNESCO-provided flow-rate data that IFs the education model uses. In their basic exploratory forecasts, IIASA extrapolates those transition rates. In more normative scenarios, they explore what-if questions about the acceleration of those transition rates.

More specifically, in a 2004 book Lutz and Sanderson outlined a human capital model for thirteen world regions. In that analysis they developed three education (flow) transition scenarios – a constant transition scenario, a goal-seeking scenario (to a different goal) and a convergence scenario, in which the transition rates of all other regions converge to the current North American rate by 2025-2030.[27]

In more recent work (Lutz 2005) the project has moved to a country-specific representation and plans to extend that globally (presumably somewhat comparably to the 182 countries that IFs represents). In Lutz (2005) they talked about their work in progress on a global database on human capital and reported forecasts through 2030 for three countries, namely Guinea, Nicaragua and Zambia.

In comparing the forecast results of the two projects, it would be useful to directly compare average years of education as a summary measure. Lutz (2005) recognized the limitations of such measures and did not report them, instead showing only the detailed pyramids of educational attainment for the three countries. We have undertaken a comparative analysis of the pyramids for Zambia in 2030 from the two projects and drawn the following conclusions:

- Overall, the pyramids are similar in immediate appearance, but rather different in detail.

- The Lutz pyramids display categories of education in terms of those who have entered each level (e.g. even one year of primary education is displayed as primary education). In contrast, IFs builds on a structure of flow-representations in each years of each educational category and displays those who complete any given category. The consequence of the difference in approach is that it is not really possible to compare the values in the pyramids.

- The Lutz pyramid for Zambia in 2030 also differs in basic underlying population distribution, showing relative stabilization of cohort size in the cohorts below 30

[27] Because those North Amercan rates are anticipated to be 100% for some primary, 98% for some secondary and 55% for some tertiary), regions like Sub-Saharan Africa or South Asia are extremely unlikely to attain them by 2030.

years of age. Given a total fertility rate for Zambia in 2006 of 5.7, the IFs model shows continued substantial growth in cohort size through 2030.

Among the next steps desired in the IFs project around educational stock/human capital are:

- Representing non-formal educational elements of educational stock, including the acquisition of life-long learning

- Elaborating the forward linkages of educational stock to other elements of the IFs system, including

    - Revising the IFs linkage from education to fertility so as to better represent the special role understood for secondary education of women; probably to make the linkage of educational stock to fertility responsive to the age distribution of that stock
    - Reviewing the newly-developed linkage in IFs of education to mortality by specific cause of death, currently implemented using formulations from the World Health Organization's Global Burden of Disease.
    - Reviewing the existing IFs linkage of educational stock and spending to economic productivity; considering the implications of age distribution of that stock for productivity
    - Reviewing the currently existing IFs linkages of educational attainment to broader social variables such as democratization, social stability, and international conflict

6. Using IFs to Extend the Analysis

Although it is not possible to do it within the scope of this paper, it is important to explain some of the next steps in analysis with IFs. They will include:

- Exploring uncertainty concerning the forecasts of the Base Case. For instance, there is a range of reasonable uncertainty around both the demographic and economic forecasts of the Base Case. Because these are important drivers of educational transitions and human development, scenarios representing the range of that uncertainty will help us map the implications of it.

- Interventions with respect to educational policy levers. What if African or South Asian countries, using their own resources or in partnership with outside actors, substantially increased their spending on education? What if the balance of educational spending in any region were shifted to emphasize primary education (or secondary)? What if completion of primary education were emphasized relative to intake? There are a very large number of what-if questions that we wish to analyze with IFs (the acronym of the model is IFs for that reason).

- As an extension of the last point, we wish to explore the broad benefits that societies gain as a return on the expenditures and other policy interventions they make. Cost-benefit analysis is an important element of policy analysis.

7. Conclusions

The purpose of this paper has been to advance forecasting of global educational futures as an aid to advancing the quality of those futures and broader human development. Toward that end, the paper first reviewed foundational concepts of educational systems and discussed education in the broader developmental context, so as to identify some of the basic elements that such a forecasting tool would ideally have. It then surveyed existing forecasting tools to better understand the manner in which they have contributed to educational forecasting. Because of the careful attention that many of the forecasting studies have paid to data and to the broad education and development literatures, garnering the insights from those studies has been very important to our effort.

The paper turned next to a presentation of the educational module of the International Futures (IFs) with Pardee system and its role within that larger system. The sometimes implicit comparisons of the evolving IFs system with other forecasting efforts and what we have come to see as the ideal forecasting tool have been helpful in understanding our particular strengths and weaknesses.

Our strengths include having created a country-specific global system (with flexible aggregation of countries into groupings used for analysis by others), the representation of year-by-year flows through and across primary, secondary and tertiary educational levels with clear differentiation by sex at all levels, the differentiation of demand and supply aspects of the flows system with strong ties to the economy, the separate but integrated treatment of net and gross enrollment at the primary level, the seamless integration of student flows with society-wide educational stocks, and the already significant two-way integration of the educational module with full demographic, economic, and broader socio-political modules in the IFs system. Additional strengths are the treatment of education in a modeling system that is fully integrated with its database, contains an easy-to-use interface, and is freely available for anyone else to use.

Our weaknesses include some limitations of data coverage (primarily administrative), attention only to the formal educational system, current omission of any explicit representation of repeaters and re-entering students, lack of structural consistency between gross and net enrollment at the secondary level, a budgetary system that is highly aggregated and simultaneously complicated in its allocation processes, and the simplicity of the current linkages of education to other systems. In addition, there is overly heavy reliance currently on GDP per capita alone (as a proxy for income) as the driver of demand and supply features. Perhaps finally, there is no urban-rural or within country representation of educational differences.

The largest portion of this paper has examined early forecasting results of IFs. Because these results are early, a primary reason for attention to them has been to analyze the forecasting behavior of the model. When possible, we have shown results as an extension of history, so as to place them in context and consider whether their extension of past patterns has credibility. Also, whenever possible we have compared the early results of IFs with those of other forecasting projects. Similarities in forecasts, especially when methods and even databases are different, further add credibility to our own approach. Differences in forecasts point to areas in which (1) our forecasts may provide new insights or (2) our formulations and approach may require additional attention. Obviously, our hope has been, even at this early stage, to add some new insights and understandings, as well as to strengthen our approach.

What then are the substantive insights, if any, that this analysis has generated? What are the next steps it suggests for the larger project? The analysis focused on (1) the forecasting of student flows (with special attention to enrollment and completion patterns); (2) forecasting of gender equity in education; (3) computation of the costs of reaching universal primary education (because of the attention literature has given costing, especially because of the MDG); and (4) forecasting of the growth of the educational capacity or human capital of societies.

With respect to future enrollment and completion patterns, it was not a surprise that we found that attainment of the second Millennium Development Goal, universal primary education, was not only impossible at this late date but probably impossible at the time of its enunciation. The challenge of the goal for Africa is well known. More interestingly, we found that, in general, our forecasts were somewhat more optimistic about the rates of likely progress towards that goal than other forecasting projects have been. Why?

Prominent among the reasons are two. First, the economic growth forecasts of IFs tend to be higher for Sub-Saharan Africa than forecasts by others including the World Bank. Our formulations do drive educational demand and supply by economic growth in a manner quite different from more extrapolative techniques based on S-curve analysis. In the future we want to add additional drivers to the demand for education, including the education of parents. In general, our desire is to establish a forecasting system that facilitates policy-oriented interventions with dynamic feedbacks; such analysis is somewhat more difficult in extrapolation-based systems. Second, our preliminary analysis of the S-curve indicates a pattern that is perhaps more of a Z-curve, in which the rise of intake and survival rates towards maximum levels is quite sharp and steady. This is consistent also with our investigation of the possibility of systemic shift, the increase over time of key educational flows independently of income levels.

As we proceed, our analysis will explore transition speeds on enrollment and other variables even more carefully. We will also extend the analysis to secondary and tertiary levels, representing as well the connections across those levels.

With respect to the future of gender equality, our early analysis suggests that, for aggregate global regions, enrollment parity may be largely attained by about 2030 at the primary level and 2050 at the secondary level. Obviously, there will be individual countries and sub-regions that lag well behind that pattern. We also see the possible spread of reverse gender-gap issues.

At this point, we have been surprised to find a very small amount of forecasting of gender parity (wider examination of studies focused directly on the gender goal may uncover others). We will, nonetheless, continue to attempt improvement in our own efforts. Some incorporation of household data should facilitate analysis of sub-regions with countries and sub-groups such as poor, urban girls. At least as important as we proceed, we will elaborate the implications of gender parity or lack thereof on a wide range of variables including demographics (fertility and health), economic growth, and social stability.

With respect to the costs of achieving universal primary education, especially the "incremental" costs, we have made our own estimates and found them to be well within the range of alternative forecasts. At the same time, however, we found that approaches to the calculation of such costs differ significantly, making comparison very difficult.

In addition, we find that the incremental costs are not extraordinarily large and that, using growth in military spending as a context for analysis, resources for meeting those costs are often potentially available even locally, and certainly internationally. This finding reinforces, however, the broader arguments of the education literature that failure to increase enrollment rates rapidly to UPE is at least as much a matter of the demand for education as for the supply.   Some next steps might productively refine cost calculations, including distinguishing operating and capital costs and dividing operating costs into salaries and other items. Yet our activity might even more productively attend to the issues that affect the demand side.

With respect to the tracing and use of educational stocks (or human capital), the only other known set of forecasts is not truly comparable because it conceptualizes educational levels differently. Whereas the IIASA project reports, via age-sex-education distributions like ours, any acquisition of education at each formal level, our reporting presents completion at each level (we do have the year-by-year flow data that could allow reporting of any acquisition).

We also report the average years of education for adults above 25 years of age, a standard measure used in economic analysis. Our forecasts appear to be very smooth extensions of the historic record, giving us considerable confidence in them. Among the interesting substantive results is a forecast of roughly parallel continued patterns of increase in average years of education in the adult populations of major global regions (excepting continued catch-up by North Africa and the Middle East with developed countries).

Because the forecasts of educational stock only require demographic accounting added to a flow model of educational acquisition, the project needs do little more with respect to such forecasts themselves and should turn instead to the enhancement of forward linkages of human capital to demographics, economics, and social systems.

Overall, the project has already created a powerful tool with broad coverage of education and its linkages to human development. The next stages in the project ought to considerably enhance our ability to explore not just the educational path on which humanity finds itself, but the leverage we have to shape that path and the dynamic consequences of doing so.

Bibliography

Abu-Ghaida, Dina and Stephan Klasen. 2004 (February). *The Costs of Missing the Millennium Development Goal on Gender Equity.* Discussion Paper No. 1031. Bonn: The Institute for the Study of Labor (IZA). Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=515945

Barro, Robert J. 1999b. *Determinants of Economic Growth: A Cross-Country Empirical Study*, 2nd edition Cambridge: MIT Press. First edition 1997.

Barro, Robert J. and Xavier Sala-i-Martin. 1999. *Economic Growth*. Cambridge: MIT Press. Originally McGraw Hill, 1995.

Barro, Robert J., and Jong-Wha Lee. 2000. "International Data on Educational Attainment Updates and Implications." NBER Working Paper 7911. National Bureau of Economic Research, Cambridge, MA.

Birdsall Nancy, Ruth Levine, and Amina Ibrahim, lead authors. 2005. *Toward Universal Primary Education: Investments, Incentives, and Institutions.* Report of the UN Millennium Project Task Force on Education and Gender Equality. Earthscan: London and Sterling, Va. Available at http://www.unmillenniumproject.org/documents/Education-part3.pdf

Bosworth, Barry and Susan M. Collins. 2003 (September draft). "The Empirics of Growth: An Update," Economics of Developing Countries Paper, The Brookings Institution.

Bruns, Barbara, Alain Mingat, and Ramahatra Rakotomalala. 2003. *Achieving Universal Primary Education by 2015: A Chance for Every Child.* Washington, DC: The International Bank for Reconstruction and Development/The World Bank.

Cameron, Laurie. 2004 (December). *Indicator Handbook for Primary Education: Abridged.* Publication of EQUIP2, Educational Quality Improvement Program, funded by USAID. Available at http://www.epdc.org/static/MissionHandbookV1_FINAL.pdf

Cameron, Laurie. 2005 (September). *Primary Completion Rates.* Technical Paper WP-09-01. Education Policy and Data Center, Washington, DC (Academy for Educational Development). Available at http://www.epdc.org/static/CompletionRates.pdf

Chen, Derek H.C. and Carl J. Dahlman. 2004 (August). "Knowledge and Development: Global Trends and a Literature Survey," forthcoming.

Chenery, Hollis, and Moises Syrquin, 1975. *Patterns of Development, 1950-70*. Oxford: Oxford University Press.

Clemens, Michael A. 2004 (March). *The Long Walk to School: International educational goals in historical perspective.* Center for Global Development. Working Paper Number 37. Originally prepared as a background paper for the Millennium Project Task Force on Education and Gender Equality. Available at http://ideas.repec.org/p/wpa/wuwpdc/0403007.html

Delamonica, Enrique, Santosh Mehrotra, and Jan Vandemoortele. 2001 (August). *Is EFA Affordable? Estimating the Global Minimum Cost of 'Education for All'.* Innocenti Working Paper No. 87. Florence: UNICEF Innocenti Research Centre. Available at http://ideas.repec.org/p/wpa/wuwpdc/0403007.html

Easterly, William. 2001. *The Elusive Quest for Growth*. Cambridge, Mass: MIT Press.

Fukuda-Parr, Sakiko. 2006. "The Human Poverty Index: A multidimensional measure." International Poverty Centre *Poverty in Focus*, December, 7-9.

Gurria, Martin and Alec Ian Gershberg. Undated. *Costing the Education MDGs: A Review of the Leading Methodologies.* Paper commissioned by the World Bank on behalf of the Finance Working Group of the Education for All Fast Track Initiative. Available at http://www1.worldbank.org/education/efafti/documents/CostingeducationMDG.pdf

Hilderink, Henk. 2000. *World Population in Transition: An Integrated Regional Modellling Framework.* Amsterdam: Thela Thesis.

Hilderink, Henk. 2005 (November 2). "Modeling Education Dynamics,' Unpublished manuscript.

Hughes, Barry B. 2001. "Global Social Transformation: The Sweet Spot, the Steady Slog, and the Systemic Shift," *Economic Development and Cultural Change* 49, No. 2 (January): 423-458

Hughes, Barry B. 2004b (July). "Scenario Analysis with International Futures (IFs), unpublished IFs working paper on the IFs website

Hughes, Barry B. 2004d (March). "International Futures (IFs): An Overview of Structural Design," unpublished IFs working paper on the IFs website

Hughes, Barry B. 2005a (May). "Forecasting Productivity and Growth with International Futures (IFs)," unpublished IFs working paper on the IFs website.

Hughes, Barry B. 2006. "Assessing the Credibility of Forecasts Using International Futures (IFs): Verification and Validation. Graduate School of International Studies, University of Denver (June)

Hughes, Barry B. and Evan E. Hillebrand. 2006. *Exploring and Shaping International Futures*. Boulder, Co: Paradigm Publishers.

Hughes, Barry B. with Anwar Hossain and Mohammod T. Irfan. 2004 (May). "The Structure of IFs," Unpublished IFs working paper on the IFs website.

Kravis, I.B., A. Heston and R. Summers. 1978a. "Real GDP per Capita for More than One Hundred Countries," *Economic Journal* 88 (June): 215-242.

Kravis, I.B., A. Heston and R. Summers. 1978b. *International Comparisons of Real Product and Purchasing Powe*r, Phase II of the U.N. International Comparison Project. Baltimore, MD: Johns Hopkins University Press.

Lutz, Wolfgang and Warren Sanderson, eds. 2004. *The End of World Population Growth: Human Capital and Sustainable Development in the 21st Century*. London: Earthscan.

Lutz, Wolfgang, Anne Goujon, and Annababette Wils. 2005. Forecasting Human Capital: *Using Demographic Multi-State Methods by Age, Sex, and Education to Show the Long-Term Effects of Investments in Education*. Working Paper WP-07-03. Education Policy and Data Center, Washington, DC (Academy for Educational Development). Available at http://www.epdc.org/static/ForecastingHumanCapital.pdf

Meyer, John W., Francisco O. Ramirez; Richard Rubinson; John Boli-Bennett. 1977. The World Educational Revolution, 1950-1970. Sociology of Education, Vol. 50, No. 4. (Oct., 1977), pp. 242-258.

Meyer, John W., Francisco O. Ramirez; Yasemin Nuhoglu Soysal. 1992. World Expansion of Mass Education, 1870-1980. Sociology of Education, Vol. 65, No. 2. (Apr., 1992), pp. 128-149.

Millennium Project. 2005. *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals.* London: Earthscan. Project Director: Jeffrey D. Sachs.

Nussbaum, Martha C. 2000. *Women and Human Development: A Study in Human Capabilities*. Cambridge: Cambridge University Press.

Rawls, John. 1971. *A Theory of Justice*. Cambridge, MA: Harvard University Press.

Ranis, Gustav, Frances Stewart, and Alejandro Ramirez. 2003. "Economic Growth and Human Development" in Sakiko Fukada-Parr and A.K. Shiva Kumar, eds, *Readings in Human Development*, Second Edition. United Nations Development Programme Human Development Report Office. New York: Oxford University Press, 61-84.

Sen, Amartya Kumar. 1999. *Development as Freedom*. New York: Alfred Knopf.

ul Haq, Mahbub. 2003. "The Human Development Paradigm" in Sakiko Fukada-Parr and A.K. Shiva Kumar, eds, *Readings in Human Development*, Second Edition.

United Nations Development Programme Human Development Report Office. New York: Oxford University Press, 17-34.

United Nations. 2003. Human Development Report 2003. New York.

United Nations Development Group. 2003 (September). Indicators for Monitoring the Millennium Development Goals: Definitions, Rationale, Concepts and Sources. New York: United Nations. Available at http://mdgs.un.org/unsd/mdg/Resources/Attach/Indicators/HandbookEnglish.pdf

UNESCO. 1997. *International Standard Classification of Education: ISCED 1997*. Available at http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

UNESCO. 2000. *Dakar Framework for Action.* Text adopted by the World Education Forum, Dakar, Senegal, 26-28 April 2000. Available at http://www.unesco.org/education/wef/en-conf/dakframeng.shtm

Wils, Annababette and Raymond O'Connor. 2003. The causes and dynamics of the global education transition, Working Paper, Academy of Educational Development, Washington, DC.

Wils, Annababette, Bidemi Carrol, and Karima Barrow. 2005. *Educating the World's Children: Patterns of Growth and Inequality.* Education Policy and Data Center, Washington, DC (Academy for Educational Development). Available at http://www.aed.org/ToolsandPublications/upload/EducatingTheWorldsChildren.pdf