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Future Education Trends

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Abstract

In projecting educational expansion at different levels of schooling into the future for the world's countries, this chapter weighs numerous theoretical perspectives against each other in terms of their predictive implications. The explanations for the global expansion of formal schooling since the mid-20th century derived from these different perspectives emphasize different social, political, and economic factors as well as different characterizations of the growth logic intrinsic to the education system itself. This analysis implies a projection model that assumes continued diffusion, with country-specific variation around a typical path of expansion from low shares of population attainment at a given level of schooling to its near universalization. Such a model is estimated on reconstructed attainment data and projected into the future to provide a baseline scenario. This is complemented by additional scenarios formalizing more rapid or stagnant educational growth.

Acknowledgments

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Future Education Trends

Bilal F. Barakat and Rachel E. Durham

1 Introduction

Education is an inherently long-term endeavor. Not only in the sense that formal schooling alone may last a significant part of a life-time, but also because part of the reason for spending this time in school is the promise of benefits for decades to come. This is true at both the individual and societal levels.

For the underlying educational systems, the long-term nature of education is felt more keenly than at the individual level. Schools are built to serve multiple generations of students, and teachers are often hired for life as civil servants. A newly trained teacher of today will, towards the end of her career, teach students who, in turn, may well still be in the active labor force a hundred years from now.

Educators themselves also hold expectations about the long-term future. Part of why we care whether a Dalit boy gets some form of early childhood education is because we expect that as a consequence, his increased chances to complete school will benefit him not only for the next 10 or 15 years, to the end of our program intervention or planning horizon, but for the rest of his life. His own education may even make it more likely that he will send his own children to school. If he sends a daughter to school, her education will possibly lead her to wait until she is in her late 20s to bear her first child, when she is better able to provide care. That "delayed benefit" of the Dalit boy going to school now might not occur until sometime in the 2050s.

To insist that we "learn for life, not for school" is a cliché, yet there are strikingly few attempts to look ahead—much less project quantitatively—how today's students will contribute to the educational composition of tomorrow's population, and the implications for their personal life course and the challenges of their generation. Some of the key contemporary policy debates concern very long-term issues. Among these are the sustainability of pensions, the provision of health care, and responding to environmental degradation. For all of these, the education of the concerned populations matters. Conversely, these debates have serious consequences for education today, such as public funding cuts motivated by the aspiration to reduce future public debt.

Informing these debates from a perspective of educational futures requires an attempt to abstract away the vagaries of never-ending educational policy reforms that, at first glance, appear to render any concrete attempts to look into the future an exercise in speculation. Yet, given the proven difficulty of achieving set objectives through deliberate policy changes, it is all too easy to overstate the problem they cause for projection. Even less successful than long-term forecasts of education have been predictions of its imminent radical change.

On a different level, tremendous differences exist in what nominally equivalent school qualifications in different settings actually mean, either in terms of knowledge and skills or in terms of societal reward. On educational grounds, we have no reason to expect nominal attainment levels to distinguish groups of people with identifiably distinct, and generalizable, demographic behaviors; yet mark such distinctions they do, as the empirical evidence presented in Lutz et al. (2013) demonstrates. For marking such distinctions, and as a characteristic that is stable over the life course, taking an interest in the educational attainment profile of future populations is prudent. Not least, the demographic consequences of educational expansion are relatively predictable compared to projections of economic and poverty impacts (Hannum and Buchmann 2005).

Forecasting in the sense of predicting is certainly impossible. And there is no possibility of conducting meaningful planning over such a generational time horizon. Not because this would necessarily require predictions as inputs—it does not—but because in any case there can be no credible commitments that far into the future. What is possible is to place explicit bounds on what we can and do know about the future; within those bounds we can form reasonable expectations, even if the expectations remain open to further revision. Indeed, some of the potential benefits of thinking systematically about the future of educational attainment lie not in the results, but in potentially highlighting contradictions in our thinking. The education development community generally asserts that a "GDP growth first" development strategy cannot substitute for an active education policy. From such a position, it would be inconsistent to deny the relevance of long-term projections of education by arguing that schooling will anyhow become virtually universal within our lifetime due to increasing wealth.

Such ambivalence reflects long-standing, and unresolved, debates among educationalists between the poles of seeing structural "periodicity and process" (Archer 1982, p. 3) in educational expansion, and calling such generalizations into question with reminders of the importance of accounting for contextual and historical specificity when assessing a concrete educational policy challenge. We believe the latter perspective is essential for well-grounded educational action. Nevertheless, we do not think it invalidates the effort to seek "stabilities and governing principles" in the "emergence and development of educational systems" (Ericson 1982, p. 300). Indeed, the international consensus surrounding the quintessential elements of a public school system appears to be shifting from being almost universal, to being truly so.

Today, of the 199 countries on which UNESCO reports, 98 percent require children to attend school (UNESCO 2012, pp. 18–19), up from 90 percent in 2002 (Benavot et al. 2006).This fact reflects a widespread belief that formal education should be, at least up to a basic level, provided or supported by the State. The motivations for formalizing education and developing state-sponsored systems of mass education have varied by context. Widely different pressures, goals, and priorities have supported public education development across time and place. Yet despite such differences, the pattern and structures of educational development exhibit remarkable similarity in many societies.

Education by the most liberal definition is at least as old as civilization, but here we are not addressing informal learning occurring in the home, provided by families or the immediate community, or even learning occurring in the workplace after

matriculation. While these forms of education are fundamental to individual development, the current discussion refers only to formal, systematized schooling. Thus, the following sections will briefly examine the history of educational expansion with respect to formal schooling, focusing on commonalities and differences in its structures and progress across time and place, as well as theories regarding the motivations and processes of educational development in different contexts. In a novel step, we then derive the predictive content of these empirical patterns and theoretical frameworks. Part II presents a specific statistical projection model based on these insights.
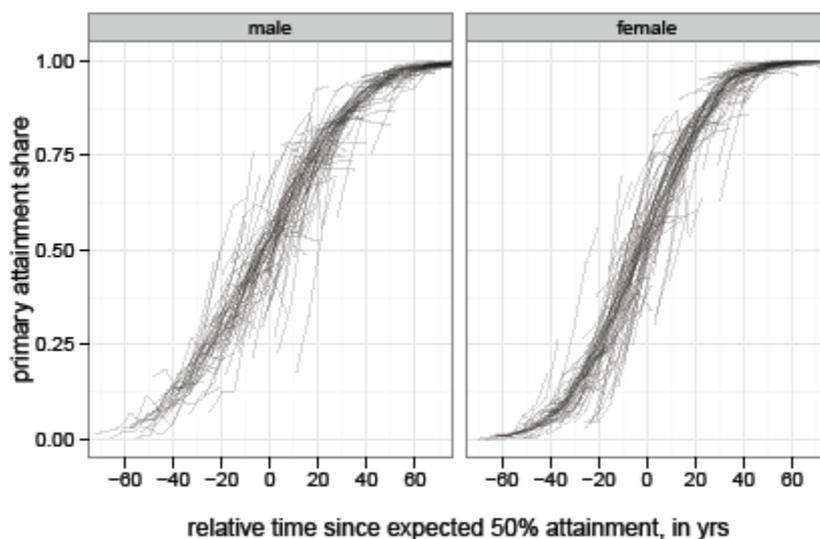

Figure 1. Empirical country trajectories of expanding primary education attainment in the 30-34 age group, arranged around global average time since reaching 50% attainment share (c.f. Section 3).

2 Dynamics of Educational Expansion

2.1. Historical Overview

Similarities across time and place in educational structures, as well as the motivations for educational expansion, have long been noted. Until modern times, formal education was—in practice and intention—a privilege of only the elite classes of society, e.g., those serving as civil or religious authorities. Trades and skills were passed down over generations within families or through apprenticeships. While a handful of ancient societies supported systems of formal education, mass literacy—especially with any sense of gender parity—was a rare occurrence until relatively recently. Literacy education was traditionally linked to social privilege, and there are numerous instances in history where the withholding of literacy education was a means of oppression.

However, over the past two centuries, a level of expansion in mass schooling has occurred that indicates the emergence of an alternative paradigm. Societies worldwide appear to recognize that providing basic education—fundamental skills in literacy and numeracy—improves quality of life for persons of disparate social and economic backgrounds and, by eliminating inequality, benefits the whole of society. The historic motivations to offer formal basic education have varied widely and signified local

social, economic, and political concerns (Benavot et al. 2006). In the West, the Reformation brought forward the belief that all individuals must have the capability to read and interpret scripture for themselves, and as a result, basic education came to be seen as a fundamental requirement. This is one reason why churches were often the initial stewards of educational instruction across Europe. In part this was because monasteries had been the only providers of schooling and literate material for centuries (Cordasco 1976).and Literacy for religious purposes is still a motivating factor in the organization of formal education in areas like Northern Africa, where Qur'anic schools, in addition to instruction in local languages, teach Arabic literacy for scriptural understanding, as has been done for centuries.

During the 18th and 19th centuries, education was also seen as a means to provide moral instruction to emergent citizenries, as the role of the church as moral leader declined during this period of rapid secularization and modernization. Because the formalization of mass education systems coincided with industrialization, some analysts have theorized that education systems were created to provide the necessary skills for a productive workforce and create a rational sorting mechanism for employers. We also see evidence that nation-states elect to formulate mass education systems as a means of generating legitimacy on the world stage, often adopting the formal structures of other nations' educational systems and creating identical systems of symbolic links between the individual and society (Meyer 1992). This motivation is plausible, since in many cases, the formal education system appeared at the same time that the nation-state emerged.

In the contemporary era, the initiation of a formal, mass educational system typically involves several signals of commitment (Boli et al. 1985). Although in some cases a formal education system predates an official statute (and in some cases a system predates the nation-state), nation-states have commonly begun by adopting laws regarding compulsory education, which often mandate an age at which education must begin and the years of duration to reach a required minimum level of schooling. Ministries of education are also commonly authorized, whose function is to implement programs, set benchmarks, develop curricula, and to monitor and report progress. Education entities also tend to adopt uniform, hierarchical systems, i.e., primary education that leads to secondary education, which in turn is required for entry to tertiary education. This is enabled by standardization, which tends to coincide with centralization of the educational system.

Importantly, educational expansion has followed rather typical patterns across all world regions (Wils and Goujon 1998). Initially, there is a focus on primary or "basic" education that provides fundamental skills such as literacy and numeracy. Once a stable level of primary educational participation is achieved, expansion into secondary schooling occurs, where the curriculum is characterized by greater skill specificity. However, expansion of secondary education does not necessarily follow universal primary enrolment. In some cases, e.g., in Africa and Latin America, secondary education has developed even in the midst of high levels of illiteracy and low levels of primary completion. In such contexts where primary educational expansion is growing slowly, secondary education enrolment is confined to the more economically advantaged echelons of society. For instance, prior to World War II secondary education in Europe was relatively selective and was considered to serve primarily as preparation for university. After World War II, however, a new political climate in

Europe led to increased inclusiveness and longer periods of free, compulsory education, resulting in virtually universal secondary participation.

Then, as nations mature and secondary enrolment levels rise, tertiary enrolment expands. Although university education is at least 1,000 years old, this stage of educational development is still underway, and the final shape that global tertiary expansion will take is still being determined. For many centuries, tertiary education served only a very small minority such as clerical, medical, or legal specialists, but over the past century, enrolments have grown tremendously. During the 20th century tertiary enrolments increased by a factor of 200, from around half a million people of college age, to more than 100 million (UNESCO 2004, cited in Schofer and Meyer 2005), and between 1950 and 1970, enrolments in higher education grew faster than in any other level (Meyer et al. 1977). Schofer and Meyer (2005) found that higher education enrolments grew rapidly in conjunction with global democratization, scientization, growth in human rights, and involvement in development planning. These variables proved more important than secondary enrolments, inequality, research and development levels, or economic development at the country level (although country-level secondary enrolments were positively related to tertiary enrolments). Moreover, higher education institutions tend to be similar world-wide, both in what is taught and how the curriculum is delivered. This suggests that the recent expansion of higher education is the result of global cultural and symbolic forces emphasizing the value of advanced forms of knowledge and its potential to generate capital in many forms—economic, social, and intellectual. Countries invest in higher education to meaningfully participate in, and integrate into, the global discourse of progress and human development.

2.2. Theoretical Perspectives

The body of research examining educational expansion has considered the timing and pace of formal education's development along with antecedents of historical context and socio-political conditions. The different themes in the historical overview—social privilege, nationalism, industrialization—have served as organizing principles for different theories to explain the diverse conditions under which educational expansion has taken place. While points of overlap exist, to date these theories largely remain as competing explanations, and a "grand theory" of educational growth that would reconcile the different explanatory paradigms remains elusive.

The main theories range from functional-structural perspectives that emphasize the development of education as a response to society's social needs, or to maintain existing power relationships, to systemic theories that frame educational expansion as a feature of an emergent, self-reinforcing world culture.

2.2.1 Technological Progress and Economic Transformations

Within the Functionalist paradigm, formal education serves an important function in the labor market, where mass schooling systems lead to credentials that allow employers to differentiate potential workers in a systematic and objective manner. Credentials may legitimate claims of skills learned, but importantly, education provides a skills-differentiated workforce for the industrial labor force. As a result, economic transformations, beginning with the industrial revolution but including more recent

shifts towards a service economy, create a demand for the output of the education system. In many cases, this pressure has been expansionary and spurred an upgrading of qualifications. But while economic development has been considered a prerequisite to the emergence of mass schooling, its relationship to educational expansion is certainly not straightforward, especially since this relationship is not limited to the labor market. For one, the distribution of wealth weighs on the demand for education, because demand seems to be proportionally related to household income. Population growth (or decline) also affects enrolment rates, since educational infrastructure must be able to keep pace with the size of entering cohorts (Colclough and Al-Samarrai 2000). Secondary and tertiary educational expansion may be especially affected by economic development, for reasons related to both supply and demand. When increased industrialization and development of technical infrastructure occur, employers seek out workers with more highly specialized skills, such as those provided in secondary or tertiary programs (Meyer et al. 1977). At the same time, development can provide resources to be invested in the educational infrastructure, creating openings for more enrolments.

While research has examined the extent to which economic development has spurred the growth in educational enrolments, to a large extent the motivation behind external aid efforts for developing countries' education sectors historically has revolved around the belief that increasing educational enrolments itself leads to economic growth (Corrales 2006; Resnik 2006). Recent discourse has additionally emphasized the power of education to eliminate poverty and promote sustainable development (Hannum and Buchmann 2003). The process whereby education leads to improved economic conditions, however, is not well understood and is widely debated, not least because empirical verification of the causal relationship is challenging (see the discussion of causality between education and selected outcomes in Lutz and Skirbekk 2013). To some extent the relationship is one of mutual feedback mechanisms.

Increasing amounts of education within a population might seem clearly related to a country's economic growth potential, but there are many correlates of both higher enrolment rates and economic development. For example, higher levels of female primary enrolment are associated with lower fertility rates, and lower fertility rates are positively correlated with economic growth. Economic growth is also strongly correlated with the openness of the economy and stability, which also likely relate strongly to educational investment. Moreover, countries with low initial levels of both human capital and GDP tend to grow faster than more developed countries, as a result of their lower starting place, which gives the impression that education enrolment growth, per se, causes economic development (Barro and Lee 2001). And educational quality, as measured by cognitive ability on internationally normed tests in reading, math, and science, may matter for economic growth as much as enrolment or attainment shares. Studies indicate that aggregate cognitive ability affects economic development via a better trained labor force, higher individual incomes, and a more equitable distribution of wealth (Barro and Lee 2001; Hanushek and Kimko 2000; Hanushek and Woessmann 2008). In effect, 12 years of schooling in one country is not necessarily the same as 12 years in another country in terms of actual learning. Learning is also not only the purview of the school, as it occurs in the home, the community and among peers, the features of which also vary across countries. Furthermore, internal efficiency (i.e., school quality) may not coincide with expansion, nor may enrolment growth

necessarily lead to appreciable increases in attainment shares. Rapid expansion in enrolment is sometimes characterized by an initial decrease in school quality, as stocks of qualified teachers must accumulate and funds must be properly allocated in response to where needs are greatest. Poor quality can in turn depress overall attainment and cognitive ability. Finally, improvements in schooling change the existing population stock of human capital only slowly, the contribution of educational expansion to economic development, taking age structural effects into account, has been analyzed only recently (Lutz et al. 2008)

2.2.2 Nation States and the Imperatives of Nationalism

Despite the strong linkages between educational expansion and industrial development, the observation that mass educational systems pre-date industrialization, e.g., in Europe and the United States (Boli et al. 1985; Meyer 1992; Meyer et al. 1977), and that mass educational systems arose only after the appearance of the nation-state, point to a dominant role of the latter. Indeed, the earliest modern instances of state-sponsored mass education systems explicitly served the purpose of creating citizens for the emergent nation-states. In this way, mass formal education is viewed as necessary for the development of a coherent, nationalistic, and unifying identity. For instance, in Prussia, which in the late 1700s was characterized by geographically isolated city-states, a unifying curriculum was perceived as particularly useful for national security and consensus building (for a good review of European national education systems, see Ramirez and Boli (1987). Even before being legally instituted, some societies provided formal education because of normative beliefs about its value as a socializing agent for children (Benavot et al. 2006) Over time, as labor markets diversified and populations became increasingly diverse in terms of language, norms and religious belief, the home as a primary learning environment came to be seen as inadequate. Public schools were instituted to offer not just basic skills, but also an orientation to normative civically and socially responsible behavior and abilities. Furthermore, public schools were viewed as a way to equalize learning opportunities across populations of disparate socioeconomic and cultural backgrounds. In some countries, state-run systems of mass schooling were legally established to enhance the power of the state, and in many cases to simultaneously diminish the historical power of the Church (Archer 1982).

However, neither a strong centralized effort by a nation-state to define its educational system, nor nation-wide standardization (of credential and curricula) is necessary. England, the United States, Switzerland and Belgium have fairly de-centralized national education systems (Benavot et al. 2006). Green (1980) significantly notes that the structure of an educational system tends to reflect the philosophy and exigencies of the country. Systems in Southeast Asia, for instance, educate vastly diverse linguistic and ethnic groups, which necessitates a higher degree of centralization. However, other nations with diverse populations place a higher value on autonomy than unification. The United States, for example, has a long tradition of federalism (i.e., states' rights) that is reflected in its widely-varying state education agencies.

The dominant role of the state in the effective supply of schooling is uncontested, even if the question of whose interests it serves is. In addition, however, at all but the most advanced levels of educational development, the state apparatus likewise influences the demand. In European countries well into the 1970s, the labor

market for tertiary graduates was essentially limited to the public sector and publicly-regulated professions. Similar patterns can be observed in many developing countries, where the prospect of a public sector civil service job may be a dominant motivation for seeking formal schooling.
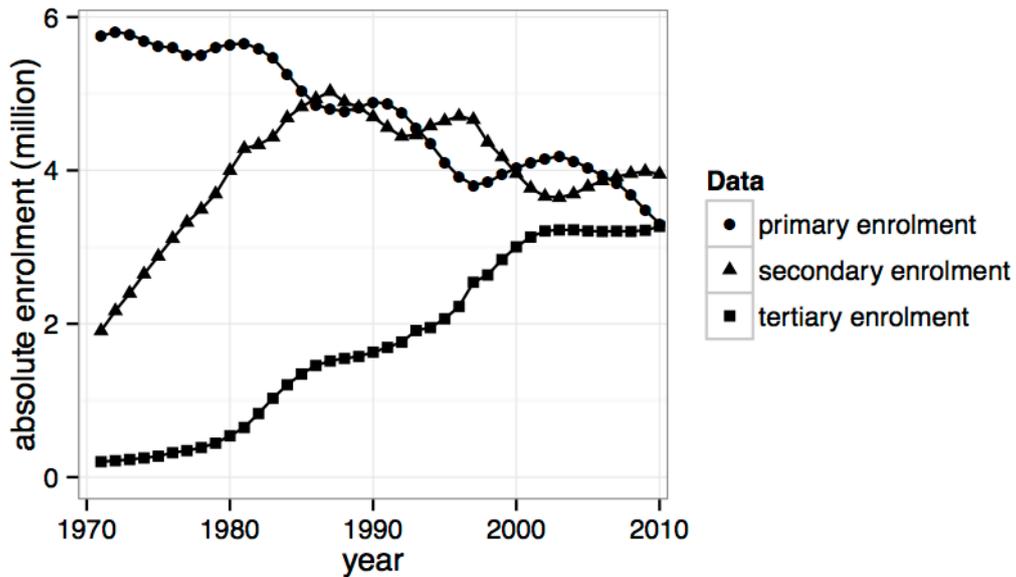

Box 1: The example of the Republic of Korea

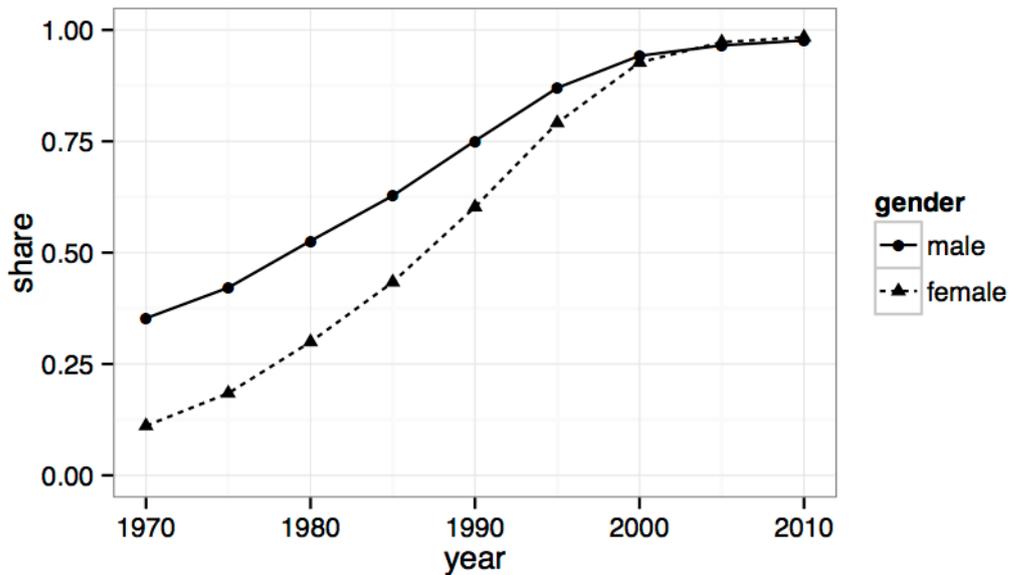Figure 2. Absolute enrolments over time

Figure 3. Upper Secondary Attainment at Age 30-34

The education system in Korea expanded greatly over the course of the second half of the twentieth century. As can be seen in Figure 2, while absolute enrolments in primary schooling, which was virtually universal, started declining in the 1970s due to shrinking cohort size, secondary enrolments more than doubled in 15 years. In relative terms (Figure 3), this was the result of extending the secondary franchise from a minority of children to virtual universality. The overall shape of the expansion of secondary attainment also provides an excellent example of the theoretical sigmoid pattern (i.e., an s-shape). Increasing public and private investments in education grow even more, with the education sector as a whole increasing more than 100-fold in real GDP between 1960 and 1980 (Kim 2012, p. 3).

While such dynamics appear to point to a determined "all-out" effort to maximize educational attainment, these figures must be interpreted in context. After decades of a slowly increasing share, Korea's Ministry of Education's budget only reached 20% of the total government budget in 1985, an unremarkable percentage in international comparison. The state's development strategy was not fully based on rational human capital planning to the extent that is often assumed. On the contrary, Jeong and Armer argue that the state's shift in economic policy "from light manufacturing to heavy, chemical, and high-tech industries [...] spurred a transformation of the South Korean economy, [but] it largely ignored the nation's comparative advantage in skilled labour" (Jeong and Armer 1994, p. 535).

While tertiary enrolments grew more than tenfold between 1970 and 2010, Figure 2 clearly shows that this growth occurred in distinct spurts, reflecting the policy-driven process of expansion, and an education system that lacked autonomy. Indeed, up until the late 1970s, the tertiary sector was rather small, as the military junta was concerned about over-education and actively limited growth at the higher level (Jeong and Armer 1994). Indeed, most of the higher education in the early 1970s was private rather than public (Kim 2012). When tertiary expansion did eventually take off, it was "in response to political and class forces rather than economic needs" (Jeong and Armer 1994, p. 539).

Indeed, the argument has been made that educational expansion at the secondary and higher level in Korea occurred as an unintended consequence of a bipolar dynamic between government policy and society. It was precisely the state's earlier efforts to contain expansion at the post-primary level that "intensified entrance examination competitions, stimulated demand for education, [...] and mobilized private resources for education" (Kim 2012, p. 14). Ironically, when the state did react to popular demand during a political legitimacy crisis by taking over funding responsibilities for private secondary schools, it "laid [the] foundation for universal secondary education and, as such, [...] reached far beyond what the public had demanded" (Kim 2012 p. 13). This observation provides an example of a "self-propelled" dynamic in educational expansion that is elaborated further below.

2.2.3 Social Privilege, Status and Conflict

Functionalist accounts, whether explicitly applied to a global pattern or to a country-level trend towards modernization, are sharply contradicted by theories locating the driving force behind school expansion in social conflict. This view posits that schooling expands "to legitimate present inequalities, allowing advantaged classes to retain their jobs and cultural forms through a seemingly fair, meritocratic system. Here, the central state does not functionally expand mass schooling to pursue society's 'common good.' Instead, political actors, captured by elites, serve to reinforce and reproduce economic and cultural differences" (Fuller and Rubinson 1992, p. x). More specifically, some argue that mass educational systems are organized to reproduce existing inequalities over generations and serve the priorities of the elite by creating a skilled and obedient working class capable of performing the labor that keeps those with the means of production wealthy (Bernstein 1971; Bowles and Gintis 1976; Collins 1971). In a related vein, cultural theories argue that educational credentials offered by formal mass educational systems offer a way for individuals to signal their privileged status within social realms (e.g., social class membership, eligibility for marriage) or the field of labor (e.g., entitlement to authority) (Bourdieu 1986).

Support for this perspective comes from the fact that one of the most important predictors of an individual's educational attainment continues to be his or her parents' educational attainment (Clemens 2004). Parents' education is an essential determinant of family socio-economic status (SES), and home and community SES in turn determines a child's educational and occupational aspirations (Sewell and Hauser 1980). Countless studies emphasize how important family background is to academic performance, as well. Not only does the home environment created by more educated parents stimulate higher cognitive ability, it also conditions children's attitudes toward schooling and beliefs about the inherent value of education. Thus, parents with relatively high educational attainment tend to raise more educated children.

Despite the fact that these patterns suggest a great deal of intergenerational transfer of status, an inherent amount of individual competition leads at the same time to self-sustaining levels of education within a population: as one generation becomes more educated, the higher the probability that the next generation will be at least as highly educated. Higher levels of participation can create an intrinsic, self-reinforcing demand. This is not just true of industrialized societies. A body of research aimed towards understanding the reasons for educational expansion grew rapidly during the 1970s, when the world was witnessing tremendous expansion in mass schooling systems in developing nations across Latin America, Southeast Asia and Sub-Saharan Africa. These studies explored a number of contextual differences in economic development, political and social modernization, and economic dependencies. The contexts examined also varied according to ethnic and linguistic diversity, governmental authority (e.g., democracy versus authoritarianism), and degree of centralization. The results suggested that educational development within a country is often a self-generating process, whereby underlying levels of education create increasing demand over cohorts as higher levels of educational attainment become normative.

At the same time, different dimensions or stages of educational growth respond to different processes of social negotiation. Archer (1982), for example, suggests that "external transactions" result in increased provision of schooling (e.g., private

universities in Latin America), while "internal initiation" results in longer schooling for the privileged (e.g., when teachers press for greater differentiation to reflect rising professionalization), in contrast to "political manipulation" of the system leading to wider access (e.g., the movement towards desegregation of schools in the U.S.). "The fact which accounts for the extremely high growth rate is that these three processes of negotiation take place conjointly and their effects reinforce each other" (Archer 1982, p. 25).

Furthermore, processes of "political manipulation" do not necessarily move directly from inequality toward greater equality. As a case in point, we can consider the unintended consequences of school desegregation efforts in the U.S. During the 1960s and 1970s, after the decision of Brown v. Board of Education led to efforts to better balance the racial composition of public schools in recognition of the fact that minority concentration was associated with inherently unequal school outcomes, families of more affluent backgrounds reacted in ways that ultimately countered such efforts (Massey 1990). In some cases, parents withdrew their children from the local public schools and re-enrolled them in private schools. In other cases, parents left inner cities in search of more favorable residential areas where minorities were far less concentrated. In fact, this de facto segregation is still a major factor in educational inequality (Kozol 1991). Schools are primarily funded from local property taxes, and local property tax revenue reflects the local tax base, resulting in vast disparities in revenue across locales. Children are most often assigned to the school district closest to their homes, and neighborhood segregation is a phenomenon not so easily legislated away. But again in response, "school choice" initiatives have been implemented in an attempt to allow families in less affluent neighborhood to select schools in more prosperous areas; however, it is often the case that families from the most disadvantaged backgrounds have been the least likely to exercise this choice, or "choice schools" in segregated areas have failed to attract a diverse student population, both of which have resulted in further concentration of disadvantage in schools (Frankenberg et al. 2010).
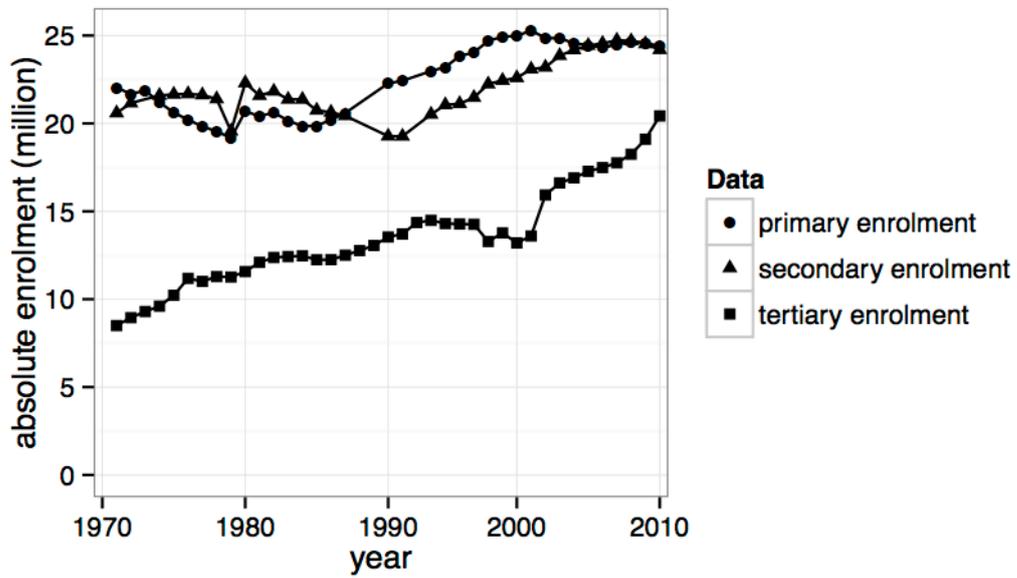
Box 2: The example of the United States

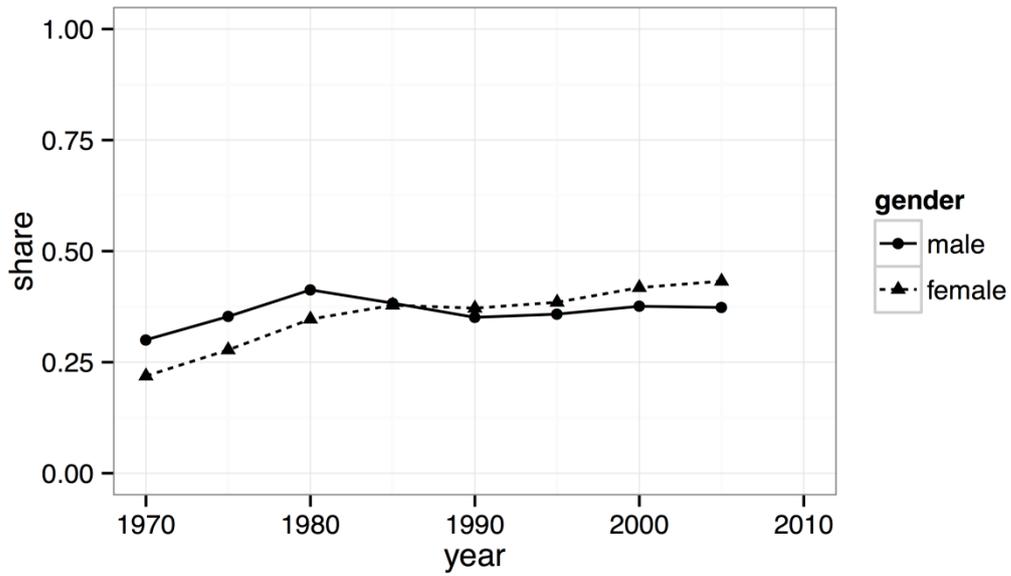

Figure 4. Absolute enrolments over time

Figure 5. Post-secondary Attainment at Age 30-34

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With a focus on the latter part of the twentieth century when primary education was universal and high school completion stable at a relatively high level in the U.S., the main dynamic in the education sector, in addition to overall growth to keep pace with population growth, has been at the post-secondary and tertiary levels. Figure 4 shows how tertiary enrolments, while undergoing sometimes decade-long periods of stagnation, more than doubled in total between 1970 and 2010. This dynamic is not immediately evident in the attainment distribution at age 30-34, though (Figure 5). Partly, this is because the latter is lagged relative to enrolments, and does not yet fully reflect the enrolment expansion that occurred since 2000.

Enrolments only translate into attainment if students successfully complete their courses. In this context, parts of the enrolment growth driven by community colleges that enjoy lower completion rates than academic 4-year colleges, contribute proportionally less to attainment growth. Another reason that growth in tertiary completion rates in the U.S. may slow somewhat is that, compared to other developed countries, the financial cost of a college education in the U.S. is substantial and growing rapidly. In 2007-08, the average full-time 4-year college enrollee spent $19,100 a year (including room, board, tuition, materials). This figure represented a 22% increase over the cost just 8 years prior in 1999-00. More recent estimates suggest that tuition in some places has nearly doubled in 10 years. While this trend may in fact stratify options across different socioeconomic groups (e.g., poor minorities less likely to enroll), innovative means by which to pay for college are growing.

In addition, composition effects depress the expansion of U.S. post-secondary and tertiary attainment, as a result of population heterogeneity. Growth in college completion rates over the past 30 years has not occurred uniformly across demographic groups. Between 1971 and 2009, white students' bachelor degree completion share increased from 19% to 37%. For Blacks, it increased from 7% to 19%; for Hispanics from 5% to only 12%. Thus, although college completion is increasing for all three groups, minority groups' college completion has not increased as fast as for white students. At the same time, this supports the view that in the long run, further expansion can be expected, since college completion is increasing for all subgroups.

Labor market dynamics continue to encourage further upgrading of qualifications, as income differentials by educational attainment remain high. In 2010, an employee with a college education earns on average 66% more in weekly earnings than an employee with only a high school diploma (Bureau of Labor Statistics 2012a). In the next decade, occupations requiring some postsecondary education are projected to grow the most (i.e., management, scientific, technical consulting, and computer systems design), while those requiring secondary or less will decline the most (i.e., manufacturing and retail trade) (Bureau of Labor Statistics 2012b).

2.2.4 Emerging Global Norms

In the contemporary, globally-connected world, the needs of nation-states are not limited to creating favorable conditions within their own borders, but include successful participation in international systems of political and economic cooperation. The state's engagement in education, therefore, is guided not just by the considerations outlined in the preceding sections, of achieving specific outcomes in the form of well-educated citizens and productive workers. It is also guided by the desire to signal its adherence to emerging global norms. In other words: "mass schooling spreads like a social movement, allowing the state to signal that it is modern and efficacious" (Fuller and Rubinson 1992, p. x). Systemic theories (i.e., World Culture theories) positing the emergence or existence of a world system, a world society, or a world culture, as they refer to educational development, all point to the inherent desire of nation-states to legitimize themselves on the world stage via the adoption of common ideologies, institutions, and organizational systems. This "isomorphization" is seen as a way for countries to signal their validity to proximate nation-states, as they adopt the same symbolic systems of legitimation as their peers (DiMaggio and Powell 1983; Meyer 1992). A system of mass schooling is an essential institution that can communicate a country's position in the world order. Problems with these theories have been discussed elsewhere (Fuller and Rubinson 1992), but perhaps the biggest problem is that they lack specificity as to whether development results from actions of individuals, interest groups, or states, though it is likely that they are interactive (Jónasson 2003). For instance, states may invest in educational infrastructure based on ideals promoted by power elites, but individuals or their families must act to enroll.

Furthermore, it is undeniable that international organizations have played a major role in the expansion of mass educational systems worldwide. One of the most important milestones in global educational expansion was the establishment in 1946 of the United Nations Educational Scientific and Cultural Organization (UNESCO), which was granted the authority to make policy recommendations and provide technical assistance concerning educational progress in specific countries, and to inform efforts undertaken by other international economic organizations (Chabbott 1998). The sustained commitment of groups like UNESCO, the United Nations Children's Education Fund (UNICEF), the World Bank, United Nations Development Programme (UNDP), and other country-specific aid organizations (e.g., USAID, Canadian International Development Agency) have given rise to an enormous field of research and associated professional communities devoted to educational development. These organizations have initiated several international conferences intended to advance a framework for universal literacy, universal primary enrolment (UPE), and gender equality within education (i.e., Education for All), or the Millennium Development Goals (MDGs). Such efforts have built off other initiatives, such as Health for All, and infer authority from the Universal Declaration of Human Rights and the Rights of Children.

The fundamental tension between World Culture Theory and conflict-based accounts of educational dynamics becomes evident when the former is characterized as being predicated on two assumptions: "the existence of significant commonality across societies (convergence) and, by implication, the view of change as primarily a derivative of consensual cultural processes (consensus)" (Carney et al. 2012, p. 373). World Culture Theory emphasizes that "the fact that the system may originally have

been pieced together by elites is no longer the salient point. Now everyone accepts the credibility of modern schools, states, and workplaces: These provide understood rules for achievement, common paths towards higher status, and seemingly just ways of distributing material goods" (Fuller and Rubinson 1992, p. x). However, while at some level, the occurrence of convergence is an empirical question, it cannot be fully decided by empirical observation alone, because superficial convergence in form does not necessarily entail "deep" normative convergence.

However, identifying global processes as driving educational growth does not imply that such processes are necessarily consensus-driven. At their best, the efforts of international aid organizations reflect a sincere belief in promoting better outcomes in people's lives globally. But others argue that these efforts reflect pre-WWII colonial dependencies and Western biases, create unintentional structural problems, and lack necessary oversight and accountability (Corrales 2006; de Moura Castro 2002; Heyneman 2003). Indeed, there is evidence that supply-side interventions ill-adapted to local conditions have not had the desired impact, particularly when demand has been assumed to be universal but if in fact insufficient. In other words, externally-led efforts are unlikely to achievement their desired results when they fail to account for barriers to quality schooling or attendance, or fail to account for labor market characteristics, local cultural characteristics, or the dynamics that shape demand for education within the population.

Among the most important determinants of increased educational demand are labor market demand and household economic factors, which are often more influential than supply-side inputs, such as school availability or distance to school (for an interesting review, see (Clemens 2004). Developing countries seeking external aid for various educational efforts have generally been in a vulnerable position. Given the appeal of the loans on offer, and the desire for recognition in the world community, such countries face strong incentives to commit to any number of externally-mandated reforms (e.g., the decentralization of education systems and devolution of authority to local community-centered education agencies), despite the social, economic or demographic realities these countries confront (McNeely 1995). As a result, oft-stated commitments to certain principles may not translate into actual results. Further, the structural reforms to which countries conditionally agree have sometimes had unintended and unfortunate consequences. These conditions are otherwise known as 'Structural Adjustment Programs' that typically require countries to cut expenditures on sectors seen by outside organizations as inefficient, such as public health or public employment. Countries may also be required to privatize certain public-good industries. Geo-Jaja and Mangum (2001) note the irony in expecting that de-funding public services would have a positive effect on development, since previous international aid programs that actually improved economic conditions heavily funded the social service sectors (e.g., the Marshal Plan, the New Deal, etc.). In any case, the purposes of these loans provided are arguably too broad. Often, goals are non-specific or poorly matched to local conditions. Geo-Jaja and Mangum (suggest that educational development plans should be better aligned with actual labor market needs and should take into account the changes to the market occurring in a re-structured economy.

2.2.5 Autonomous Systemic Dynamics of the Education Sector

In contrast to functional-structural explanations, a different explanatory framework focuses on, "the internal laws of the system [in order] to ask from a fresh perspective whether its behavior is controlled or guided by its relation to the surrounding society or whether it is in fact the other way—that the relation of the system to its society is determined by its own internal necessities" (Green 1980, p. 112). This approach does not deny the ties between the education system and other social structures, but notes that the larger the education system, itself, the greater its autonomy (Ericson 1982, p. 306)., The positive feedback relation through parents' ambitions for their children, for example, becomes merely one in a number of feedback relations, most of which are considered to be intrinsic to the education system itself. This is based not least on the observation that frequently, and particularly at early stages of development, the education sector tends to be the largest single employer of its own graduates, and thereby increasingly able to tailor the system to its own needs.

Based on empirical analysis, Müller-Benedict (1991) affirms the latter interpretation and concludes that the autonomous dynamics of the education system are logically prior to functional relationships with other social systems. Evidence in favor of this claim is his analysis of university enrolment time series for Germany. Disregarding the long-term growth and looking only at fluctuations around the overall trend, internal dynamics in terms of two kinds of cycles explain 75 percent of the remaining variance in this case. The first type of cycle is characterized by a wavelength (a period between peaks) that corresponds roughly to the length of a professional working life, namely in the range of 25–40 years. This can intuitively be recognized as fluctuations in replacement demand resulting from an uneven age structure within a profession and the resulting regular occurrence of large retirement waves. The second regular fluctuation is shorter and reflects the anti-cyclical entry behavior into training. In other words, a peak (trough) in graduates in a given field entering the labor market encourages a corresponding trough (peak) in entrants into training, through the feedback mechanism of observed career chances. Since the distance between neighboring peaks and troughs is the approximate duration of the relevant training, the wavelength of this fluctuation is approximately twice the training duration, namely 8 to 15 years. From a slightly different perspective, these can be interpreted as the response of entry flows to observed changes in the stock on the one hand, and to changes in the flows of the profession being trained for on the other. While the existence of "long" cycles in educational growth is controversial, the explanatory power with respect to short-term fluctuations actually provides a stronger rationale for considering educational dynamics as being largely autonomous. Moreover, under certain conditions the short cycles of twice the duration of study experience a destabilizing feedback. Mathematically this leads to an arbitrarily increasing amplitude. In practice, of course, this will not occur, because pressure on the labor market will result in an increase in the number of skilled positions (Müller-Benedict 1991).

The tight feedback between past and future output of an education system naturally hinges on the availability of qualified teachers. Despite external funding efforts, one of the most difficult internal constraints on educational expansion is the lack of a qualified teaching force. Without an infusion of foreign personnel, a native population must build its teaching corps from the underlying stock of qualified persons, and in countries with historically low enrolment and fast population growth, this is

particularly challenging. In a systematic analysis of teacher shortages, Wils and O'Connor (2004) examined the links between gross primary enrolment and a number of country-level characteristics, including adult educational attainment, GNP per capita, and percent of GNP spent on education. They found that the single largest correlate of primary enrolment was the proportion of adults with secondary education. Moreover, in countries with a relatively low proportion of adults with secondary education, a very large share worked as teachers, implying that a serious impediment to enrolment was low educational attainment among the adult population. The authors point out, however, that increasing enrolment is a "chicken versus egg" problem (p. 8) , in the sense that an increased share of adults qualified to teach primary and secondary education is necessary to increase enrolment, while at the same time increasing adult education levels requires earlier sustained success with primary and secondary enrolment. In Sub-Saharan Africa the problem of teacher shortage is particularly stark. Children in such education systems may have teachers with barely more education than they have themselves. This may either result from efforts to avoid large classes at the expense of low teacher qualifications, or occur in addition to large classes. In this sense, poor teacher quality could be a self-reinforcing process.

An emphasis on feedback relations and autonomous behavior driven by systemic logic than by external factors does not mean that the behavior of the education system is in any way "automatic". What it does mean is that to a large extent it is the result of the behavior of actors within the system applying "practical arguments" (Green 1980) which are rational with respect to their situation within the education sector, not necessarily with respect to the education sector's functional relationship with other social systems.

2.2.6 A Tentative Synthesis

"Mono-causal factors [such] as status-group conflict, the social reproduction of the class structure, or the homogenizing characteristics of an evolving world system [are] superficially appealing, but inadequate" (Craig and Spear 1982, p. 154). Instead, the different general theories "can be seen as simultaneous oscillating processes, each operating within a given society but with varying strength over long stretches of time" (Fuller and Rubinson 1992, p. 12). With a slightly different focus, Archer cautioned that "the possibility/probability that different theories (or theoretical modifications) may be needed for different stages of socio-educational development is never even considered" (Archer 1982, p. 5).

Overall, the debate has not advanced significantly in elaborating the conditions under which different effects are operative or how their relative importance varies either over time or at different levels of development. Instead, the debate has become stuck in disagreements about fundamental premises underlying different explanations, and the meaning and causal attribution of expansion. At the same time, the different theoretical approaches do not necessarily stand in conflict. For example, while not focusing on the political aspects of social competition, Green's systems perspective serves to further explicate why educational expansion does not resolve class conflict. This perspective implies that as an attainment level is universalized, the last to reach it, "will be disappointed because as they attain their target … they will not gain the relative benefits that others have secured. They will only have avoided a disaster that is uniquely their own" (Green 1980, p. 111). This is both empirically confirmed and conceptually echoed

more recently by Raftery and Hout and their notion of "maximally maintained inequality" (1993).

We argue that the different accounts of educational dynamics are not mutually contradictory, but could be interpreted as focusing on, respectively: the demand for entry (sociological), demand for the product (economic), supply (nation state), and the self-interested internal logic of the education sector. Undoubtedly, all these processes are at work. For the purpose of educational projection, which is the central program of Lutz et al. 2013, the key question is not which of them dominates, but which has stable long-term implications, and which result in fluctuations that may be characterized as statistical noise.

A unified perspective, at least on the macro-dynamics, appears possible if the hints are taken seriously as to conditions under which each theory applies. For example, individualistic status competition for attainment may not be keenly felt in a setting where educational participation is extremely low and does not differentiate members of the vast majority. It seems likely that "take-off" is driven by an economic need for more skilled manpower, and the ensuing rapid expansion to levels over and beyond societal needs is driven by status competition, while universalization to the last marginalized groups can only be achieved through state intervention under normative pressure.

This perspective is not pursued any further here. Rather than arbitrating between competing explanations, of greatest interest for present purposes is to identify overlaps in their implications for future developments, especially in what they identify as deep underlying trends, as opposed to fluctuating actions. The different explanations need not stand in conflict in terms of their qualitative implications for future expansion. The next section attempts to extract such insights.

2.3. Predictive Content of the Theoretical Models

The theories outlined above have been formulated by their proponents as explanations of observed patterns of expansion, not as vehicles for generating predictions. Nevertheless, examining their statements about conditions conducive to educational expansion and considering conditions we may expect to prevail in the future provide some basis to expect overall sustained expansion in the long run.

Indeed, one implication of Green's framework is that "there are reasons to believe that the system will expand, even when there is a decline in resources for it and a decline in the demand for its services", termed the "Principle of Uniform Growth" (Green 1980, p. 17). One of the reasons is the upgrading of qualification requirements within the education system, itself, in response to either an undersupply or an oversupply of graduates. This leads to the expectation that, in the long run, everyone within the system will have the highest credentials. A consequence of the systemic nature of the education sector is that growth at one level tends to stimulate growth at another. This applies both in "upstream" and "downstream" directions. An upgrading of early-childhood education, for example, leads to an expansion in post-secondary or even tertiary training of early-childhood specialists and teachers. Conversely, high targets for tertiary attainment stimulate expansion at lower levels in order to supply the pool of candidates so selectivity can be maintained at the tertiary stage. Importantly, "this principle is not a prediction that the system is always, in fact, expanding or that

qualifications for positions within it are always, in fact, increasing" (Green 1980, p. 74), but that other behaviors can only occur in response to outside influence.

Even where internal system dynamics do not provide the propulsion for expansion, they can create an upward drift by acting as an expansion "valve" (Müller-Benedict 1991, p. 144). Several factors serve to ensure that the system has a tendency to react only to growth pressures, but not to contract when demand falls. On the face of it, a difference between a constant expansionary drift on the one hand, and such a one-way "valve" effect on the other, is that the latter only leads to increasing size of the education system in terms of its capacity, not necessarily its output. However in practice, non-decreasing capacity means that eventual demand increases can always be accommodated, so an upward drift in output still follows.

It is important to note that projections of continued expansion are intended as descriptive, not prescriptive accounts of future developments. Indeed, Green and colleagues describe how system momentum drives attainment at any level towards universality, but explicitly argue that from an equity point of view, a more appropriate policy target would be 55–60% high school attainment (which they argue would force the labor market to offer valid opportunities to those without a high-school diploma, whose number would be too large to ignore). The same applies not to only the final level, but also the pace of expansion. Descriptively, we can assert that expansion slows down at high levels, while in terms of social equity, it would be desirable to reach between 75-100 percent participation as quickly as possible "in order to minimize the hardships that will have to be endured by the decreasing percentage of non-attainers" (Seidman 1982, p. 285); at the intermediate stage, non-attainment is already a liability. Archer likewise diagnoses "unguided growth" of the system as "an unintended consequence, sought by no-one and welcomed nowhere" (Archer 1982, p. 55).

For projections to be meaningful, we need neither an unfounded belief that the spread of formal attainment is necessarily "effective, efficient, and equitable" (Carney et al. 2012, p. 383), nor an assumed inevitability of continued attainment expansion in a way that is consistent with past patterns. Indeed, the partial disagreement Archer expressed with Green's model was not about the regularity in expansion it describes, but about whether this regularity reflects an "ineluctable logic" or whether there are merely "good reasons, founded in social interactions, why these conditions [leading to expansion] are approximated to in reality" (Archer 1982, p. 53)

We recognize the contingency of expansion on these conditions (hierarchical organization of attainment levels and educational credentials as sorting mechanisms), but we also note that their persistence is likely, or at least provides a defensible baseline hypothesis. It seems more likely that our projections will be falsified because the very meaning, or modality, of "formal schooling" changes, than because formal attainment growth radically changes its dynamic. It would be misguided to deny the meaningfulness of projections by pointing out that policy represents a deliberate and purposeful attempt to direct the educational process, and that projections cannot account for such future policy changes. We may think of policy and crises as "non-deterministic deviations" from a deterministic expectation. Here, "deterministic expectation" does not mean that we expect a deterministic trajectory, but that, whatever our expectation is, we do not form it by tossing coins

This hypothesis of sustained expansion does not contradict the fact that when development advocates have attempted to "scale up" successful interventions from one place to others, they have found that the contingencies of the context matter tremendously. This suggests that interactions between population growth, social demand, economic development and the existing stock of human capital are complex and do not necessarily allow the imposition of one particular policy of schooling expansion onto any setting (Mennerick and Najafizadeh 1987). However, locating the driver of expansion in conditions the education systems is likely to endogenously create in the long run, explains rather than contradicts the difficulty of bringing about change through external policy stimulus. Historical evidence supports this. "In Europe, since the late eighteenth century … prior enrollment levels predict subsequent school expansion more strongly than the appearance of novel forces, such as rapid commercial growth, industrial job demand, and the modern state's rise and penetration into the hinterlands" (Fuller and Rubinson 1992, pp. 23–24). In any case, since changes in the external input- and output relations with other systems do not create corresponding changes in the education system directly, but only by triggering an autonomous response within the system, they are transformed into internal dynamics. The implication is that it is sufficient to study only the dynamics of the education system itself, without explicit consideration of external factors such as economic development, because the consequences of relevant impacts have already been absorbed (Müller-Benedict 1991, p. 255).

In summary, in terms of their implications for future developments, there is overlap among different theories seeking to explain past attainment growth. This overlap points to: continued expansion in the long term; a trend towards (not necessarily complete) global convergence; the qualitatively similar expansionary behavior at higher education levels now and lower levels before (to the extent that expansion is driven by competition and not the substantive benefits directly linked to the educational content); and accelerating expansion as a given level of attainment becomes more common. This final point occurs because the "cycles of positive reinforcement operating between supply and demand, context and environment, and microscopic and macroscopic action" are, in general, speeding up (Archer 1982, p. 42). The systems-theoretical accounts specifically, as well as the empirical evidence, justify a model seeking to project educational attainment endogenously based only on past and current attainment levels.
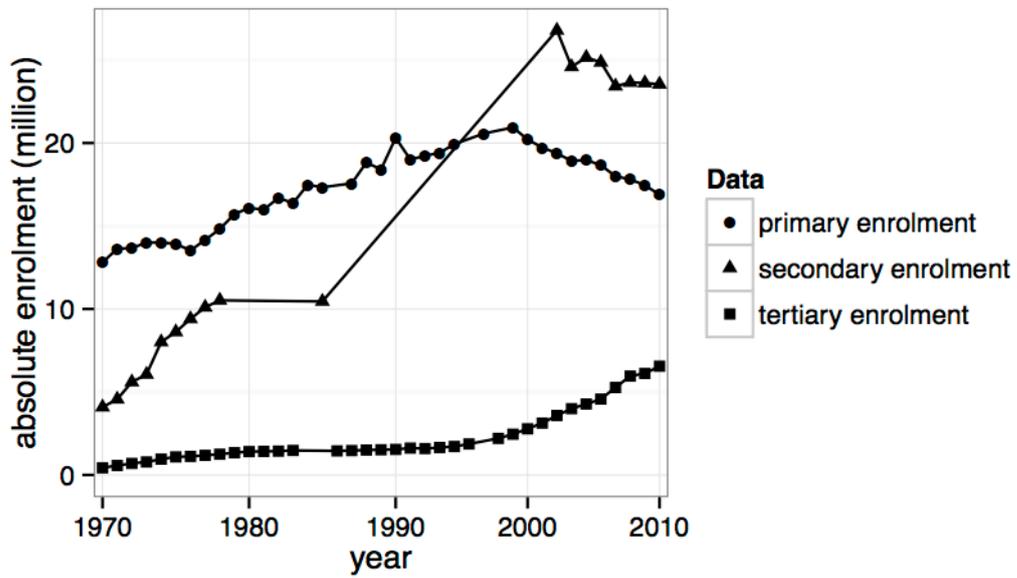
Box 3: The example of Brazil

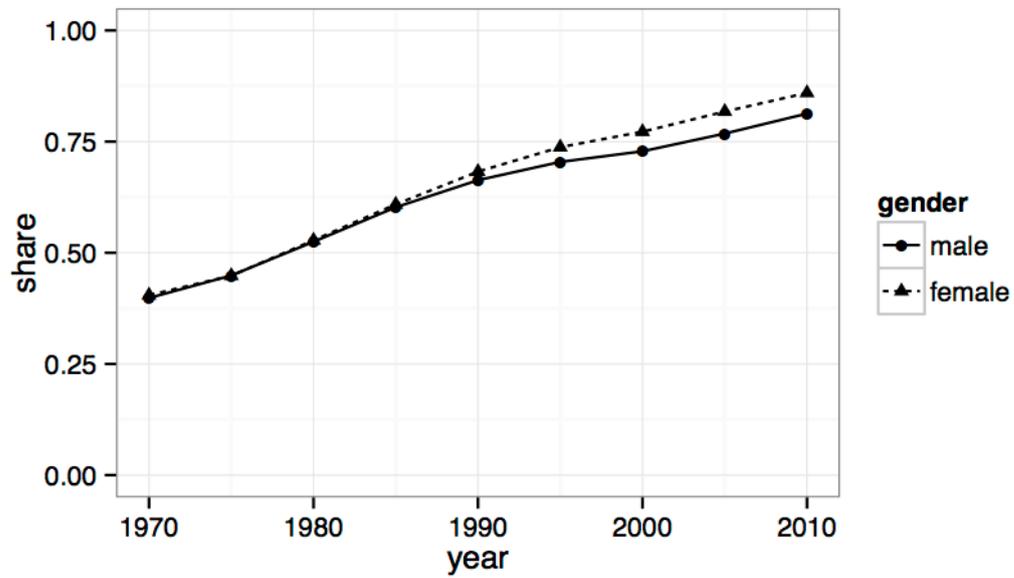
Figure 6. Absolute enrolments over time

Figure 7. Upper Secondary Attainment at Age 30-34

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While the relative stability in primary enrolments over the past decades (Figure 6) already reflects the Brazilian fertility transition, the education system as a whole expanded greatly during that time, with secondary and tertiary enrolments increasing five-fold despite the presence of a "lost decade" from the mid-1980s to mid-1990s (Burton 2011). Even at the primary level, the relatively recent successes in expanding participation can still be observed in the attainment of the 30-34 age group. While only a minority of both men and women of this age had completed primary school in 1970, this share is steadily approaching universality (Figure 7).

Brazil has shown a strong reduction in inequality in educational participation as a result of policies and programs intended to increase both the supply and demand for education. At the starting point, the 1970s were characterized by top-down supply-driven programs, such as the implementation of a law that made school mandatory for all children aged 7-14 (the previous law only required schooling for children aged 7-10), and a corresponding investment in construction of new schools in order to support new entrants. By the 1980s, investments in education stalled, and a number of studies have shown evidence of a close relationship between the deep economic crisis (faced by Brazil and other countries in Latin America) and poor educational outcomes (Duryea et al. 2007; Marteleto et al. 2012; Torche 2010). Indeed, Figure 5 demonstrates a slow pace of expansion during that decade. From the point of view of social justice, the 1980s were actually a success, as the most disadvantaged children were catching up faster with the most advantaged children. This indicates that the convergence toward a more balanced attainment distribution between groups occurred at the expense of a reduction in the aggregate level of education.

From the mid-1990's onward, sustained educational policies, which were maintained and expanded especially after the Brazilian government transition in 2003, extended schooling to even the poorest and most geographically remote children. Among the most influential programs were FUNDEF (Fund for the Maintenance and Development of Basic Education and Teacher Appreciation), the education finance equalization strategy that increased expenditures in the poorest Brazilian regions (North and Northeast), and Conditional Cash Transfer Programs that tied the payment of benefits to households to the school attendance of their children.

3 A Projection Model for Global Educational Attainment

Our overall approach consists of two parts: fitting a model of educational development trajectories to the empirical development of attainment over the course of recent decades; and projecting attainment by extending these trajectories into the future.

The specifics of both parts are interdependent. Estimating the model is logically prior, since it is meaningful without attempting a projection but the converse is not true, and the feasible characteristics of the model constrain the form of the projection. Examples of such constraints are discussed below. Conversely, the intended primary purpose of the model as a projection input determines the requirements. On the one hand, the model must be of a kind that can be extrapolated in a meaningful and consistent way; on the other hand, it need only capture temporally robust associations,

not causal explanations. The model is fit to reconstructed educational attainment data for 178 countries for the period 1970–2010.

3.1 Fitting Past Expansion

The first question is which measure(s) to model directly, and which to derive. In the present context, educational growth could conceivably be modeled by projecting the number of people attaining each level, or the shares of different attainment groups among each cohort, or transitions between levels. There are arguments in favor of each choice. Modeling absolute numbers accounts for some of the absolute constraints on capacity expansion in the education sector, and might suggest a view that educational development is supply-driven. Transition rates between attainment levels arise naturally from the common approach to modeling within-school flows in terms of entry, promotion, repetition, and drop-out rates. We choose to focus on attainment shares among (five year) cohorts as the measure to be modeled directly. The distinct advantages are three-fold: firstly, in a world of declining fertility, supply-side constraints are expected to lose importance relative to social demand, especially at levels below tertiary, and normalizing the education model by population size makes it possible to specify it independently from the overall population growth model and its fertility assumptions. This breaks a potentially troublesome feedback loop in the projection method. Secondly, in contrast to transitions, attainment is directly a property of persons, and represents the outcome of the education model required for inclusion in the overall population projection (this also serves as an argument against examining enrolments, which are indeed a person characteristic, but not a stable one). Moreover, shares at different levels can be interpreted independently, whereas transitions are cumulative and their implications for attainment can only be understood as an ensemble.

Having settled on attainment shares as the principal measure, the question arises whose attainment to model directly, or more specifically, which age group to focus on. It would be possible, of course, to separately model the attainment at different ages, but the possibility of contradictory results makes it an unattractive approach. Using a single reference age group, however, calls for a balancing act: younger ages reflect more closely the recent developments in the education system, while at older ages there is a greater chance of accurately capturing the maximal lifetime attainment. Here, we use the attainment share at ages 30–34 as the benchmark, in a compromise between these two concerns.

An additional question concerns the levels to model explicitly. Separate models for different attainment levels risk creating inconsistent results, where the share of those with upper secondary or higher attainment is projected to be greater than the share with lower secondary or higher attainment, for example. This risk is greater the closer the levels in question are to each other. Instead of attempting a complex joint model that imposes ordering constraints, we estimate independent models for the sufficiently separated levels of completed primary, upper secondary, and tertiary education, which results in projections without inconsistent crossovers. We then interpolate the intermediary levels of lower secondary and incomplete primary education, with no education calculated as the residual. Specifically, the share of these intermediary levels among those with completed primary, but less than completed upper secondary schooling (in the case of lower secondary), and among those with less than completed

primary schooling (in the case of incomplete primary), respectively, is held constant at the most recent value observed.

Based on the discussion in Section 2.3, the model is designed to capture the intrinsic dynamics of the education sector, rather than the effect of external predictors (such as economic growth), that would then, in turn, need to be projected, raisinging additional questions of data reliability and endogeneity.

The model assumed here effectively relates the growth over time in the share of 30–34 year olds having reached a given attainment level or higher to the current level of said share. The relationship is such that growth is slowest for both very low and very high shares and fastest at middle levels, resulting in a sigmoid, trajectory over time. In the present case, this shape is parameterized as an (inverse) probit curve. The probit curvature was found during exploratory investigations to match the empirical patterns more closely than a logistic specification.

Concretely, the observed data on the highest attainment are transformed into reversely-cumulated attainment shares such as "percentage with upper secondary or higher" and correspondingly for other attainment levels. These figures in the interval [0,1] are probit-transformed into unbounded numbers. An exact inverse-probit sigmoid-curve would be perfectly linearized as a result, turned in other words into a straight line. Accordingly, a linear fit to the transformed data corresponds to an inverse-probit sigmoid-curve fitted to the original data. The linear predictor is taken to consist of an overall global component g, as well as region-specific and country-specific elements (r and c), all time-invariant, as well as random residuals epsilon at the level of country-year dyads. Formally:

$$\text{participation}_{it} = \Phi(x_{it})$$

$$x_{it} = x_{i(t-1)} + g + r_i + c_i + \epsilon_{it}$$

Because we are not interested in lateral shifts in time, the data can be centered so that participation is 50 percent at time t0 for estimation purposes. In order to obtain distributional results to aid scenario creation, the above specification is estimated within a Bayesian framework. The priors for all parameters are normally distributed with zero means and half-Cauchy priors for the variances. The outcomes of the estimation are posterior probability distributions for the overall global, regional, and country-specific rates of educational growth.

For the post-secondary education level, the attainment share is re-scaled so that complete saturation corresponds to 90% of a cohort attaining post-secondary education. This reflects the fact that, unlike lower levels of schooling, universalizing post-secondary education is nowhere a policy target, and, on the contrary, the current frontrunners such as Singapore are debating whether to actively limit post-secondary expansion.

Figure 8 shows the empirical pattern of attainment growth by level. The dashed line is a locally weighted scatterplot smoother (LOESS). The solid line displays the predicted growth based on only the global average term g in Formula 1. In other words, this represents the global average inverse-probit shaped expansion path. In terms of implied trajectories of educational growth over time, Figure 1 displays the observed country paths at the original scale, arranged around the hypothetical global average

trajectory. As is evident, even this simple, purely endogenous, model does a credible job of approximating the pattern in the data.
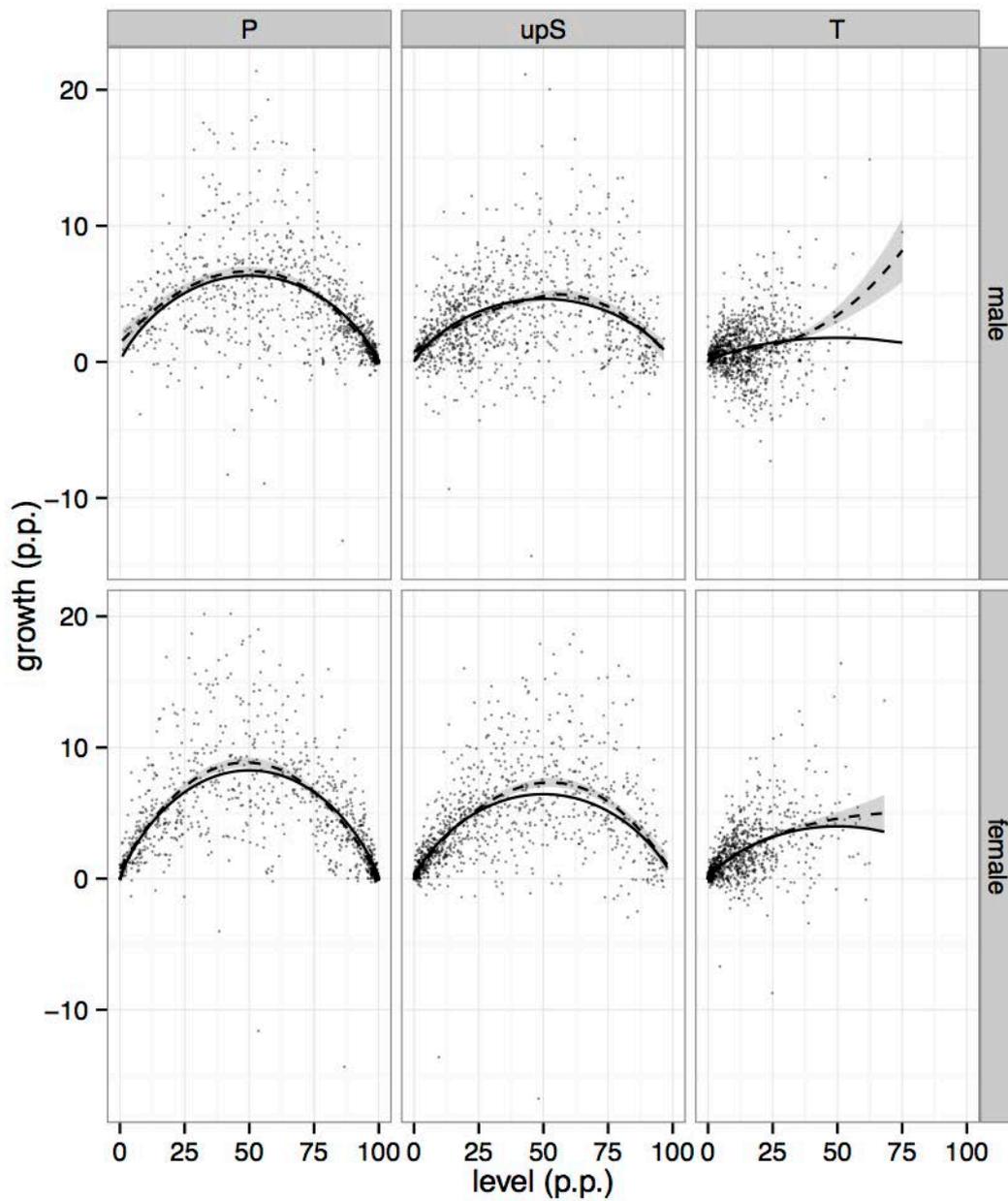

Figure 8. Observed (dots), smoothed (dashed), and predicted (solid) 5-year attainment growth (in percentage points) as a function of attainment share already achieved.]

3.2 Projected Diffusion

Our aim is to obtain projected attainment levels for all age groups for the period 2010-2060. Extrapolating the above model in the first instance provides these only for the age group 30–34.

Given the simplifying assumption that educational attainment is mostly complete by age 30-34, changes in the attainment shares at higher ages result from differential mortality and migration behavior between different education groups, rather than attainment transitions. Accordingly, the shares at higher ages derive from the general multi-state population projection and require no further input from the education projection itself and.
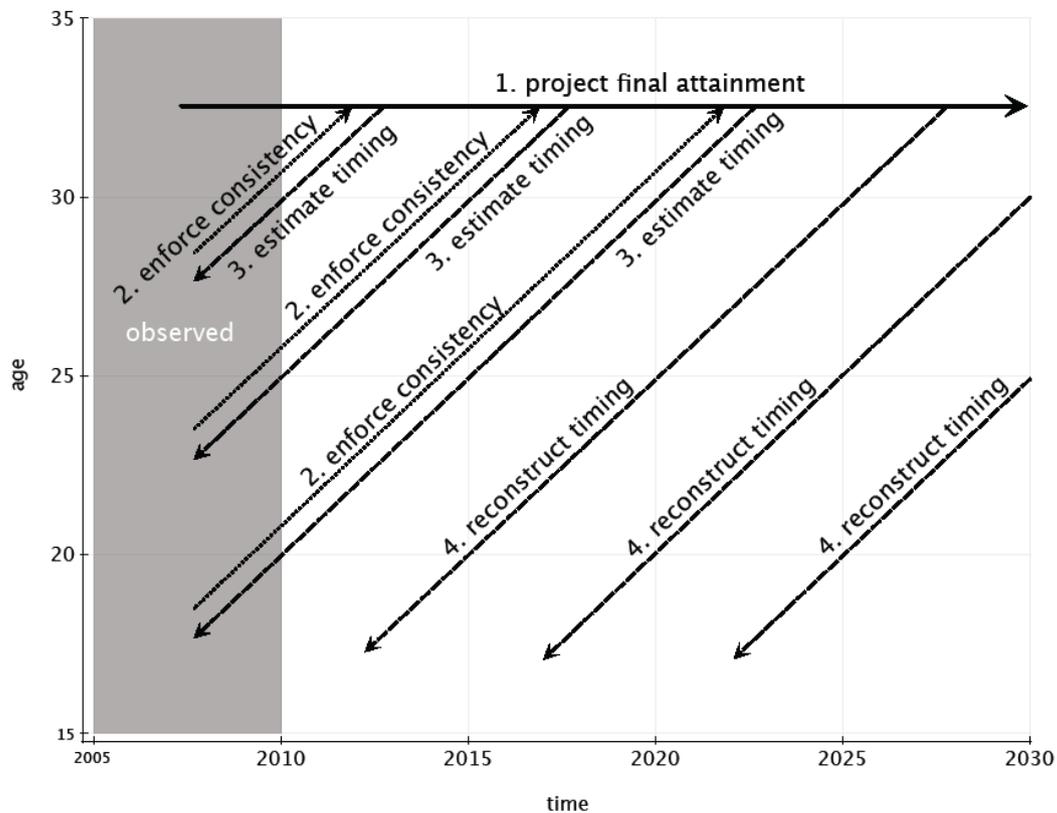
Figure 9. Short-term reconciliation between projected attainment at age 30-34 and observed attainment at younger ages

3.2.1 Reconciliation of Observations and Projections During Transition Phase

Because it is time series of attainment at age 30-34 that is explicitly modeled and projected into the future, there is potential for disagreement with the observations of attainment at younger age groups. In principle, it is possible that the cohort 25-29 in the base year already has higher levels of attainment than the simple projection implies for the age group 30-34 five years later.

This affects only the first three projection steps, as the individuals who in the base year are located in the age groups 25-29, 20-24, and 15-19 have observed attainment shares that might be inconsistent with their projected attainment at age 30-34 based on the simple projection. Beginning with the cohort that is aged 10-14 in the base year, there are no observations that could be at odds with the projected attainment at later ages.

A two-step process ensures consistency along two directions. The first is along cohort lines. Since the highest level of education attained is non-decreasing with age, this is a logical requirement. It is achieved by adjusting the projection so that the share having achieved a given education level in a cohort is at all ages at least as high as the share observed in the base year.

The second step ensures that the application of the first step does not result in fluctuations over time in attainment at a given age. While this is not a logical necessity since educational stagnation and even decline across cohorts are certainly possible in reality, this is done in the interest of coherence. Fluctuations around the central trend are possible, but the entire model is set up to project the long-term central trend, not short-term fluctuations. Accordingly, the maximum is taken of the values resulting from a) the simple projection of attainment at age 30–34 over time, starting in the base year, and b) the attainment of younger age groups observed in the base year, brought forward along cohort lines.

In effect, the local maximization approach to the first step corresponds to the assumption that, as far as possible, inconsistencies should be reconciled by adjusting the assumed timing of attainment, rather than the final level. Consider, for example, a situation in which the observed attainment at age 20–24 is higher than the projected attainment at this age, but lower than the projected final attainment at age 30–34. Our approach reconciles this by adjusting the timing of attainment so that sufficiently many attainment transitions are assumed to have occurred earlier than initially assumed, but without changing the overall number of transitions to higher levels. In principle, it would be equally possible to fix the timing schedule, in other words the assumed relationship between attainment at age 20–24 and final attainment at age 30–34, but to adjust the assumed final level so that the back-projected attainment at the younger age no longer falls below the observed level. The choice between the two approaches (and against a mixture of them) was dictated by the principle that the least certain parts of the model should be the first to be adjusted to accommodate contradictory information. In the present case, the timing schedules are reasonable a priori assumptions, while by contrast the projected final attainment levels at age 30–34 also incorporate modeling assumptions, and hence are also data-driven.

3.2.2 Transition Schedules Below Age 30

Attainment projections for age groups younger than 30 depend on the timing of attainment at different levels. If it were the case that all those who complete upper secondary school do so by the age of 24 at the oldest, then the share of those with completed secondary schooling among 25–29 year olds is equal to their projected share as 30–34 year olds five years later. These relations are only strict in the absence of educational mortality differentials. The error induced by ignoring mortality is marginal, however, since overall mortality at young adult ages is low.

The aggregation into five-year age groups complicates matters: even in the simplest case where everyone completes the upper secondary level at the nominally standard age of 18, for example, the age group 15–19 would include both individuals between the ages 15 and 17 who will complete the level but only in the future, and those aged 18 and 19 who have already graduated. The specification of attainment timing in terms of five-year age groups should take this into account.

Here, the system of attainment age schedules is conditioned on the highest level attained by the age of 30–34. This means the schedules specify which attainment group those with post-secondary degrees by age 30–34 were in at ages 25–29, 20–24, and 15–19, and similarly for those with upper secondary attainment and other levels at age 30–34. Conditional on the shares at age 30–34, these schedules could, in principle, be converted into matrices of transition rates between education categories, one matrix per age group. The age-schedule characterization allows for a specification of assumptions that is more natural from an educational development point of view. The implied transition matrices are effectively parameterized by five parameters with a natural interpretation (the ultimate attainment shares). Many entries are either logically predetermined or straightforward to specify: the monotonicity of highest attainment over the life course implies a number of structural zeroes.

The transition schedules are estimated for each country by taking the short-term projections for the age group 30-34 as given, and comparing them to the observed attainment at ages 25-29, 20-24, and 15-19 in the baseline year. Specifically, if 30 percent are projected to have completed post-secondary attainment or higher by age 30-34 in 2015, and 20 percent are observed to do so among 25-29 year olds in 2010, then the implied schedule is that, of those completing post-secondary, two-thirds do so between the ages of 25-29 and 30-34. A similar comparison is made for the age group 30-34 in 2020 and the age group 20-24 in 2010, and for the age group 30-34 in 2025 and the age group 15-19 in 2010.

These schedules are not guaranteed to be consistent from a cohort perspective. In a second step, schedules are determined through optimization techniques that satisfy logical consistency constraints and are closest in absolute difference (over the entries) to the raw schedules found above. More precisely, a weighted average distance is minimized between the raw country-specific schedules and a standard set of schedules described below, with weights of 0.7 on the country-specific schedule and 0.3 on the standard schedules. This regularization step avoids some undesirable transition behavior that can occur in the raw schedules in countries whose baseline population attainment at younger ages is highly irregular due to rapid educational change, declining attainment, or possibly migration.

The assumed schedules are designed to correspond to nominal graduation ages based on school entry at age six, with a stylized school system of 6+3+3 for primary, lower, and upper secondary schooling, and three years for a first post-secondary degree, while taking into account the age spread within five-year age groups. At the same time, it must be recognized that at the post-secondary level, there is no consensus that a "regular" education career requires higher education studies to immediately follow the completion of upper secondary schooling. Indeed, "late" post-secondary attainment, even above the age of 35 is substantial in some countries, including the USA.

The sensitivity of the population projections with respect to the assumptions concerning attainment timing is expected to be greater in the case of fertility than for mortality. Overall mortality is generally lowest at the young adult ages at which the assumptions apply. The greatest impact is expected to be on fertility and migration. However, this impact is moderated by the fact that absolute educational fertility differentials are smallest in the countries with high levels of post-secondary attainment and largest in those countries where the share of post-secondary graduates, and therefore the share of those whose attainment timing is most difficult to estimate, is relatively low. In general, the specification of assumptions in terms of age schedules conditional on ultimate attainment means that, in contrast to the alternative of specifying transition rates, specification errors do not cumulate.

3.2.3 Convergence

Due to the specification of the model, where countries' expansion parameters are estimated as coming from a shared statistical distribution (by gender and education level), the basic country estimates and, by implication, their projected trajectories, are not independent. Some "shrinkage" towards the overall mean occurs, reflecting the fact that a country with an exceptionally fast/slow historical expansion path may be assumed to have experienced a particularly fast/slow incidental spell in addition to having a fast/slow intrinsic momentum.

However, the estimation model does not assume that countries become more similar over time. This is, nonetheless, something that may be assumed as a projection assumption. Here, it is the rates of change in probit-transformed attainment that undergo convergence, not the attainment levels directly. In other words, even if complete convergence were assumed, countries would still differ in attainment, and--due to the non-linear sigmoid expansion model--would still expand at different rates on the original scale of attainment shares, because even with identical rates on the transformed scale, countries at middle levels of attainment would increase their attainment share more rapidly than countries close to saturation.

The case for assuming a weak convergence over a very long time horizon is different from the case for assuming relatively rapid complete convergence (within a few decades). The first is a "regularization" of the projection rather than a reflection of a strong assumption of mechanisms leading to convergence. In the absence of any convergence, countries that have undergone a recent decline in educational attainment would be projected to undergo an educational collapse if the decline were extrapolated without a corrective. Assuming a slight level of convergence to the global median ensures that such countries' trajectories are merely stagnant. Accordingly, a slow convergence in rates, namely complete convergence by 2100, is assumed for all scenarios. By contrast, the central scenario is one where globalization trends in educational development result in a convergence in rates by 2060.

A separate issue is that of convergence of educational attainment of males and females within a given country. The initial estimates of the trajectories are independent for each gender. Indeed, historical patterns show that large gender differences in attainment can occur and remain for decades at all education levels. Gender difference in primary school attendance in countries with low educational development in sub-Saharan Africa, South Asia, and elsewhere are systematically highlighted by international development agencies. But large gaps at the post-compulsory stage can

also be observed in industrialized countries. Nevertheless, for projection purposes, it is appropriate to include some degree of linkage between female and male attainment levels in a given country to avoid a situation where gaps are projected that fall outside the range of precedent. Here, male and female attainment, in terms of the share attaining or exceeding each level of education, are projected to converge to the gender-averaged attainment by the end of the projection horizon in 2060.

3.3 Scenario Definition

Basing the projection on the median estimates of the country slopes corresponds to a "business as usual" setting. One of the aims of the exercise is to investigate the possible consequences of more rapid, or on the contrary more laggard, educational growth.

3.3.1 Central Scenario: Global Education Trend (GET)

In the GET scenario, the attainment profile of future cohorts is based on the median parameter estimates of the model estimated above. In that sense, while not interpretable as the "most likely" scenario in a probabilistic sense, it can be interpreted as the scenario that reality is equally likely to exceed or fall short of.

In policy terms, this may be interpreted as "business as usual". This does not, however, imply a static perspective. On the contrary, even if the pace of educational expansion statistically depends on the level already attained in an endogenous fashion, the theoretical discussion in Section 2 makes it clear that this expansion, though statistically unsurprising, nevertheless has to be actively produced by the actors involved. It is therefore a scenario of sustained effort. At the same time, being based on the average performance of the most recent decades, including at the country-specific level, this scenario does factor in the inevitable setbacks and mismatches between ambitious policy targets and actual change "on the ground".

Accordingly, the assumed and implied overall development will continue to have both light and shade. Steady progress may be achieved in terms of overall education participation, but some groups will not benefit as much economic and less tangible rewards from the schooling they receive as they could, due to low quality of education. As a result, increasing educational aspirations from generation to generation cannot be taken as a given. Technological progress and social innovation will continue to be made, but their diffusion is uneven.

3.3.2 High Scenario: Fast Benchmark

In this scenario, the most rapid country-specific expansion parameters are applied to all countries throughout the projection period. In other words, all countries follow the educational development paths taken in the past by the frontrunners in East and South-East Asia.

Note that due to the nonlinearity in the expansion paths, this does not mean that all countries proceed at the same pace on the original scale of attainment shares, much less that all countries have identical attainment profiles at the end of the projection.

In policy terms, this corresponds to a scenario where there is an immediate and concerted global effort to supply a sufficient number of schools, expand teacher training, and pursue the enrolment and retention of marginalized and disadvantaged

subpopulations. At the global level, assuming that all countries simultaneously and successfully replicate the educational growth of the Republic of Korea or Singapore is, of course, implausible. This scenario therefore purely serves the function of supplying an upper bound on the effect educational expansion could possibly exert on overall projection outcomes.

Since educational development is locked into a tight relationship of mutual feedback with overall socio-economic change, such a scenario of rapid educational expansion can only be meaningfully interpreted in an assumed context of substantial transformation of global society, partly as a prerequisite and partly as an effect of explosive educational growth. It may therefore be assumed, in the context of the Fast Benchmark scenario, that a focused global effort is made not only to finally achieve the "Education For All" aims initially set by the international community for 2015 in terms of universalizing primary education, but that similar schemes follow at the secondary level. The unconditional success of such schemes on a global level would facilitate the achievement of other development goals relating to poverty reduction and global health. In particular, the scenario implies the essential disappearance of female disadvantage in education, with significant implications for female empowerment and possibly the ease of diffusion for social innovation. This scenario also assumes a substantial reduction in the occurrence of man-made crises and conflict that have set back educational development in the past.

3.3.3 Low Scenarios

Constant Enrolment Rates (CER)

For the CER scenario, the attainment shares at age 30-34 of future cohorts are fixed at the levels observed in the base year (but adjusted where necessary if younger age groups in the base year already exhibit higher than predicted attainment).

While in general terms, this is a lower bound scenario that is likely to be exceeded in most places, it is not necessarily a "worst case" scenario. Indeed, in countries where cohort-on-cohort population growth remains high, schooling even a constant proportion of increasing successive cohorts may require substantial investments in capacity expansion. It is quite possible for an actual country trajectory to fall behind even the CER scenario if the education system is under pressure from population growth, disasters, emergencies, or conflict. Nevertheless, constant rates at the global level would correspond to an unprecedented period of stagnation.

Constant Enrolment Numbers (CEN)

Under the CEN scenario, the absolute numbers of individuals in each 5-year age cohort that complete a given level of schooling by age 30-34 remains constant.

To give it a substantive interpretation, such a scenario may be approximated if educational growth is limited by capacity constraints. A given number of university places for example, coupled with an underdeveloped private sector to cater to potential excess demand for them, means student numbers may be stable regardless of the size of school-leaving cohorts. In contrast to the CER scenario, where fixed participation rates imply that absolute enrolments fluctuate as a function of cohort size, under CEN the reverse is true: absolute numbers are fixed, and together with cohort sizes they determine the rates.

Structurally, CEN is a pessimistic scenario in that the education category that is not subject to the constancy constraint, and that therefore expands or contracts to accommodate changing cohort sizes, is the category of "no education". However, in some circumstances, this case may lead to greater educational growth than the CER scenario, specifically when birth cohorts are becoming successively smaller. However, because the educationally least developed countries are at the same time among those with the highest fertility, however, the CEN scenario is particularly negative at the low end. In these countries, the implied participation rates amount to a deterioration of current conditions.

An actual path close to either the CER or CEN scenarios would likely represent a major obstacle to socio-economic development. A parent generation with a stagnant or even increasing share of poorly-educated would not help the further diffusion of improving child health, for example. And an increasing supply of unskilled labor would at the same time provide little incentive for a modernization of the national economy and also depress wages at the low end.

4 Implications

At the country level, there is no lack of policy questions that can benefit from an informed estimate of future educational attainment. A few examples among many will suffice here. The question of how many older persons there will be relative to the number of school children and students in higher education will be a crucial part of the political economy context for education spending in the future. Anticipating when and where public support is likely to shift away from public education as a spending priority towards public provision of services for the elderly is a crucial strategic parameter for educators. The education profile of the senior majority itself is also likely to matter, as will their family relationships, i.e. whether the higher education students are still disproportionately members of families that contain the most politically active and sophisticated seniors, or whether, due to a combination of demography (the poor have more children) and educational progress, the student body does not seem like kin to these seniors.

The future education profile of the population will also matter in terms of how, through ageing of the generations that benefited from the rapid expansion in higher education, the average "vintage" of degrees and qualifications in the population will increase. In partially predictable ways, the importance of life-long learning vis-a-vis formal schooling for the young will increase almost automatically, simply because there will be relatively more older adults, and more of them than today will be in knowledge industries and qualified by degrees that have a shorter "half-life".

Teacher recruitment is another case in point. To base recruitment on present (or worse: recent!) teacher shortages is to lag eternally behind. Matters are worse regarding recruiting students into teacher training. Ideally, human resource planning for the teaching force would take into account demand in the coming 40 years (as well as estimates of retirement, attrition and so on). Even ignoring the students, aligning teacher recruitment purely with current needs rather than taking a sufficiently long-term view would risk creating problems that are both foreseeable and avoidable. For example, if an unbalanced age structure among the teaching force is created, the situation may arise where there is a shortage of head teachers (because the pool of potential candidates who

are neither too old nor too inexperienced is small) even if there is an oversupply of teachers overall.

There are also theoretical implications at the aggregate level. On average, educational expansion tends to follow a sigmoid diffusion pattern. Taken at face value, this implies that a cluster of countries with similarly, but not exactly equally, low levels of educational attainment, will, by this measure, move apart before moving closer again, as one passes the "take-off" point before the other. In other words, it is not unreasonable to expect that inequality between countries that are only beginning to embark on a path towards universalizing schooling will initially increase, even if all of them are on (the same) track. This has implications for the direction of international support.

Moreover, extreme cases illustrate the benefit of projecting long term scenarios even if they are purely hypothetical and not intended as reasonable forecasts, because they provide bounds on what can be achieved. Even if Niger stepped up to the extraordinary pace of South Korea, given its current stocks, it would still be far behind the international average even two generations from now.
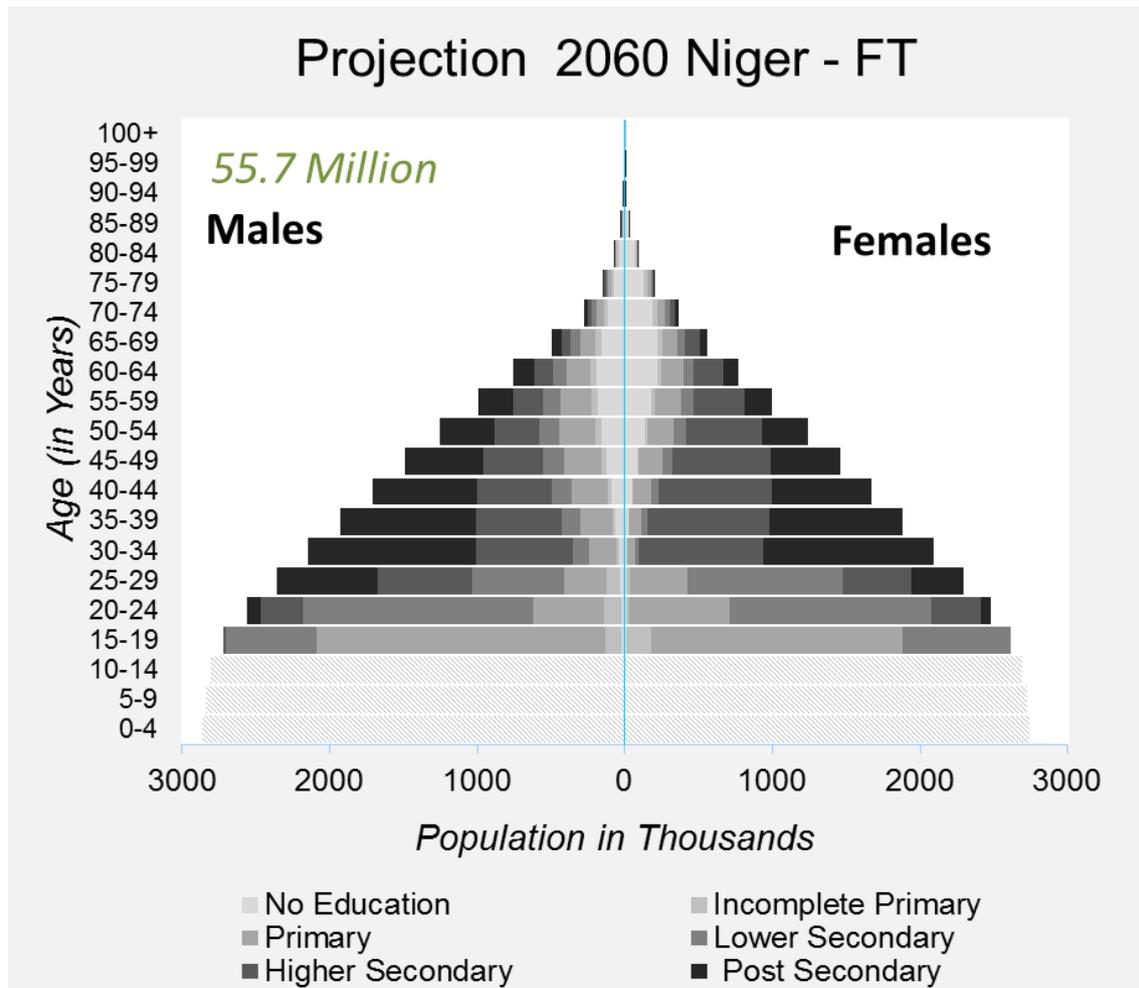

Figure 10. Projected education composition of Niger in 2060 under the Fast Benchmark scenario.

In fact, together with only a handful of other countries, in relative terms Niger would be even further behind than it is now, because the global benchmark may well move faster than the late-comers. This means we have to acknowledge what it means to be "in it for the long haul." This example also raises the question of how much momentum is likely to remain behind international support for educational expansion once it has become a minority problem of a few marginalized nations. It also means that eventually, adult education will have to become a bigger part of educational development work than initial schooling.

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