CHAPTER 8: EDUCATION FOR ALL

I. Life Cycle Approach to Human Development

Economic development depends on investment. Countries achieve economic growth when they have the roads, the ports, the rail, the fiber optics, and the power grids that give them the basis for developing industry and expanding the economy. Investments in all these types of infrastructure and industry are crucial. But the most important kind of investment that countries make is in their own people, and especially the investment in their children. Economists have come to use the language of investment when talking about education, health care, nutrition and the other inputs to a healthy productive life. Economists speak about investments in "human capital," just like investments in the physical capital of roads and bridges. And just as a single business or an entire economy can accumulate physical capital, so too can an individual or an entire society accumulate human capital, meaning more education, job skills, improved health and the like.

The concept of human development includes two related ideas. The first is the important fact that the abilities and health of an individual depend on a cumulative process, of good health and access to health care, living in a safe environment, education, building skills, and on-the-job experience. The evidence is quite strong that as individuals accumulate more education, more on-the-job training, and more work experience, their productivity in the labor force (as indicated most directly by earnings) also rises. Similarly, investments in health accumulate. Investments in a child's health help to provide the basis for health as an adult. In this process of accumulating human capital, certain periods of life are most crucial, starting with neonatal survival within the first few weeks of life. Early childhood is extraordinarily important not only because it is the time when we learn many of the necessary social and human skills, but because it is also the time of the formation of the brain itself.

The second important idea of human development is of the individual "lifecycle." We should consider an individual over an entire lifespan. An individual's capacities, health, and productivity at any stage of the lifecycle depend on the choices that are made at earlier stages of that lifecycle. Each stage of the lifecycle sets up the conditions for the stages that follow. Even the health of parents before conception can be important. Bad health and poor nutrition can actually transmit across generations, even in addition to genetic influences, in a phenomenon called "epigenetics." The safety of the mother in pregnancy; a healthy child birth; an infant's good health; proper nutrition and deworming as necessary for young children; are all extraordinarily important not only for an individual's survival through the biological hazards of childhood, but also for a productive and prosperous life as an adult.

A child's cognitive development begins at an early age. Brain development in infancy depends on a loving and low-stress environment, bonding with caregivers, and hearing many words spoken by the caregivers. The formal education process, we now understand, should begin even before the start of primary school. More and more countries are introducing pre-kindergarten classes for young children as a way to bolster early learning and healthy brain development. From there, primary education for all

children is now globally recognized to be a basic need and a basic right of all children, and is enshrined as Millennium Development Goal 2. Yet in the 21st century world economy, universal primary education is surely not enough. All children need at least a secondary education, and beyond a secondary education, some form of vocational (skill) training or tertiary education. It is the very nature of our technological age that young people today will on average require more skills and training than did their parents.

Beyond secondary education there will be many tracks to job skills and further training. These might include vocational schools to learn a specific skill, or higher education in the form of two-year programs (typically called an "associate degree" in the US) or four-year programs (typically called a "bachelor's degree"). With the advent of online education, more and more training may come from downloadable, freely available courses. And online education is likely to promote continuing education through adulthood as a lifelong strategy.

There has been recent significant progress in achieving MDG 2, which calls for universal access to primary education. The data in Figure 8.1 show that as of 2010, the **gross enrollment rate** at the primary level is now above 100%. What does it mean to have a gross enrollment rate of greater than 100%? The gross enrollment rate measures the number of children *of any age* attending primary education divided by the population size of primary-school-age children. Since some older children (outside of the primary school age group) are sometimes enrolled in primary school (because they started late or were held back), there can actually be more children enrolled in primary school than there are children of primary school age. Back in 1970, the gross enrollment rate was around 85%. With the extra push of the MDGs, this has increased to more than 100%.

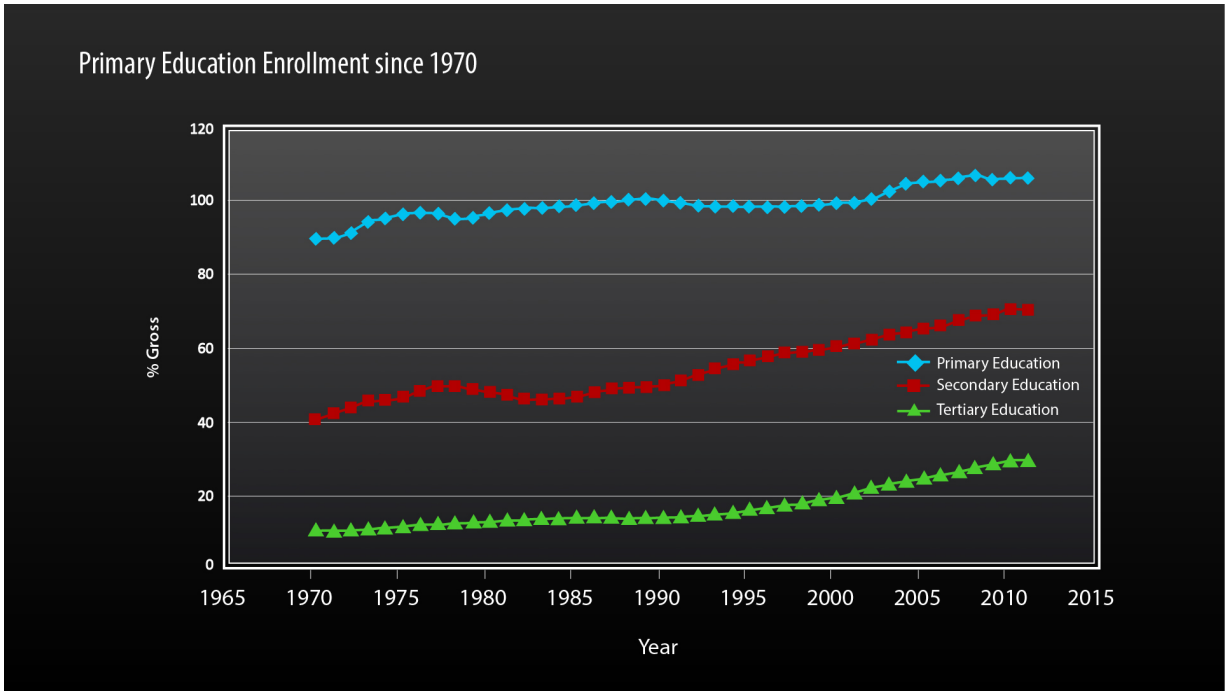

Figure 8.1. Primary School Enrollment Since 1970

This very high primary school enrollment rate is also extremely important in terms of MDG 3, which calls for gender equality for education. Girls throughout the world at the primary school age are now by and large attending primary school. As we see in Figure 8.2, as recently as 1990, the gross enrollment rate for girls was still only around 60%, compared with 90% for boys. As of 2010, the gender gap at the primary level has essentially closed.

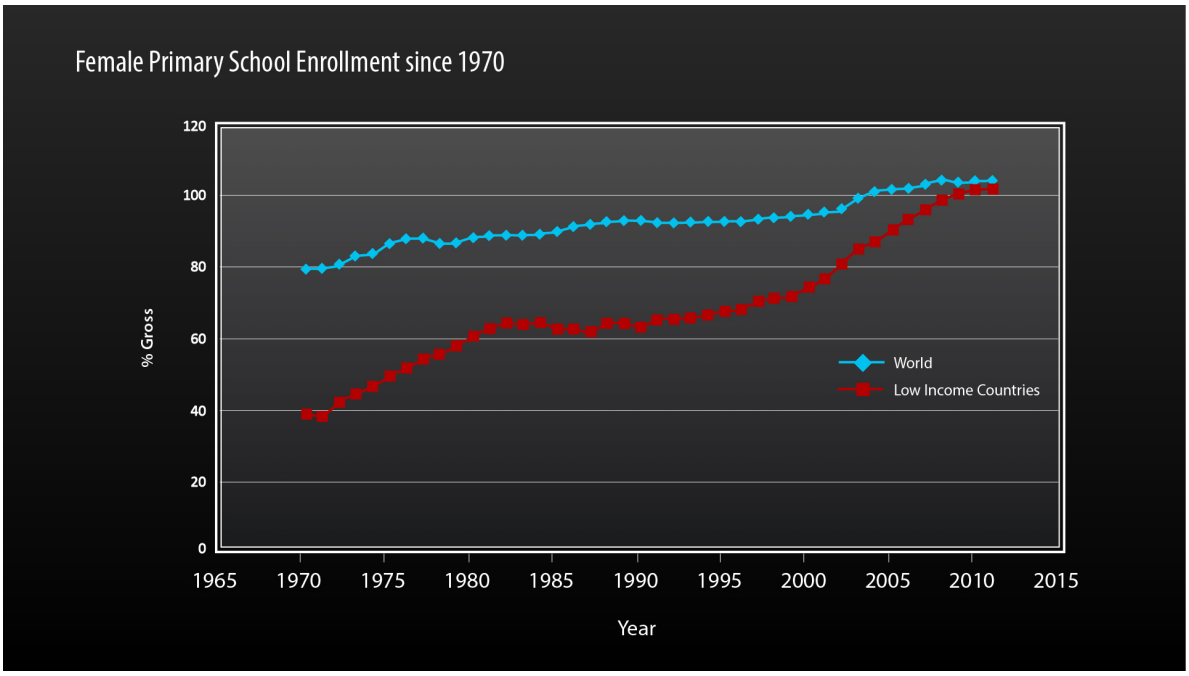

Figure 8.2. Female Primary School Enrollment Since 1970

While there has been great progress made at the primary school level, the progress in educational enrollment and attainment is much less at the secondary level and above. Figure 8.3 shows a world map of secondary education rates. Much of the world now has relatively high secondary school enrollment, but in tropical Africa and in parts of Asia where extreme poverty persists, secondary education levels remain inadequate. The Sustainable Development Goals for the period 2015 to 2030 should focus on ensuring universal secondary education as well as access to job skill training beyond secondary education.

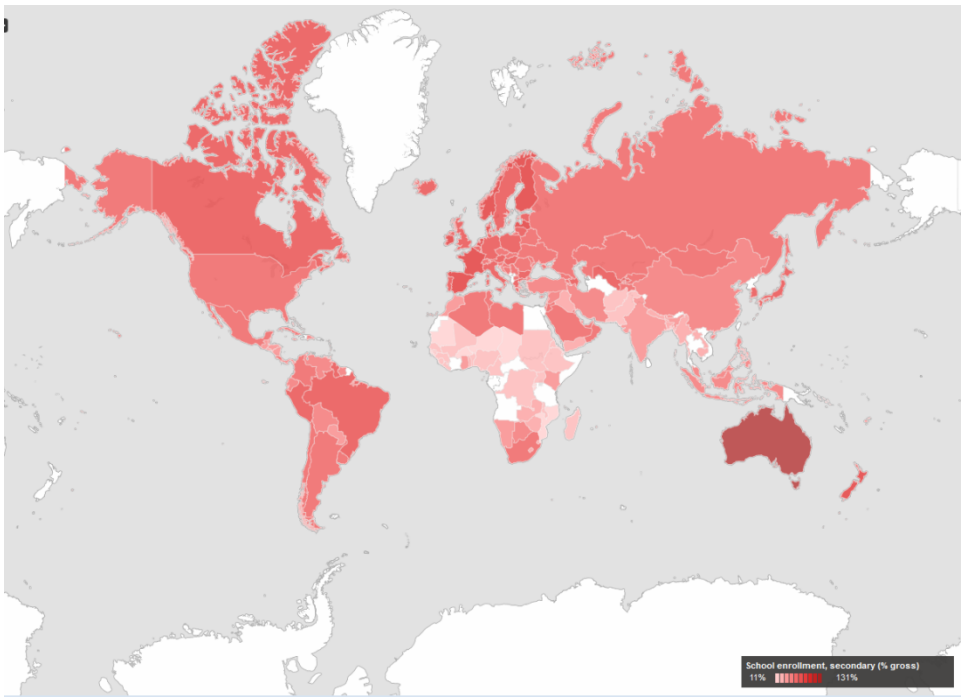

Figure 8.3. Secondary School Gross Enrollment

The situation of higher levels of education is even more varied. The poorest countries in the world still have very low tertiary education levels, often 10% or below, as shown in Figure 8.4. The lack of adequate enrollment in higher education is becoming a major impediment to the economic progress of the low income countries. At this stage of global economic development, every economy, rich or poor, needs a significant cohort of university graduates. The tertiary institutions are necessary to ensure that there are qualified teachers, sufficient numbers of technical workers, and a generation of skilled young people trained in public policy and sustainable development.

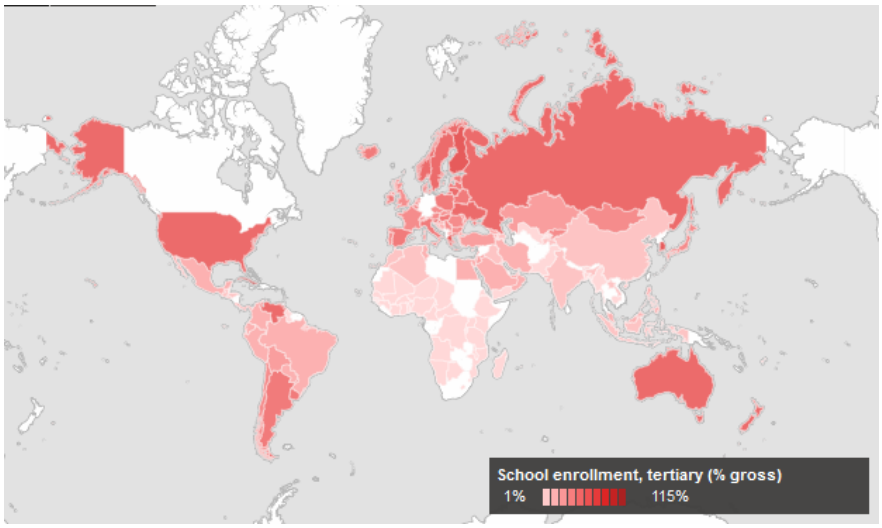

Figure 8.4. Tertiary School Gross Enrollment

II. Early Childhood Development

One of the most significant advances in the understanding of human capital over the lifecycle has been in the area of early childhood development (ECD). Between 20 and 30 years ago, most of the focus was on the formal public education system, with little understanding of the crucial importance of the preschool environment, including the health, nutrition, physical safety, and the preschool preparation of children ages 0-6. Research over the past 20 years has shown the startlingly important effects of early childhood, especially during the first three years, when the brain develops in many dynamic and important ways. If those first three years are a period of excessive environmental stress (e.g. a household marked by violence, noise, and lack of security); repeated illnesses or under-nutrition; or the lack of adequate cognitive stimulus and educational preparation; a young child will likely incur liabilities that may be impossible to overcome during school years or later.

Investing in the early health, wellbeing, safe environment and cognitive development of young children is therefore crucial for the child's subsequent development. This is an area where the concept of cumulative investment is essential. Scientists studying brain development of young children and overall physiological development have come to the conclusion that the cumulative amount of stress that a young child faces will shape the child's cognitive and physical development and conditions as an adult. If there is an over-accumulation of stress, the subsequent changes to the body's biophysical pathways can lead to a lifetime of physical and mental difficulties. This is shown in the Figure 8.5 graphic from the Harvard University Center on the Developing Child, which emphasizes that the biology of health is cumulative over time and embedded during very sensitive periods, especially during brain formation.

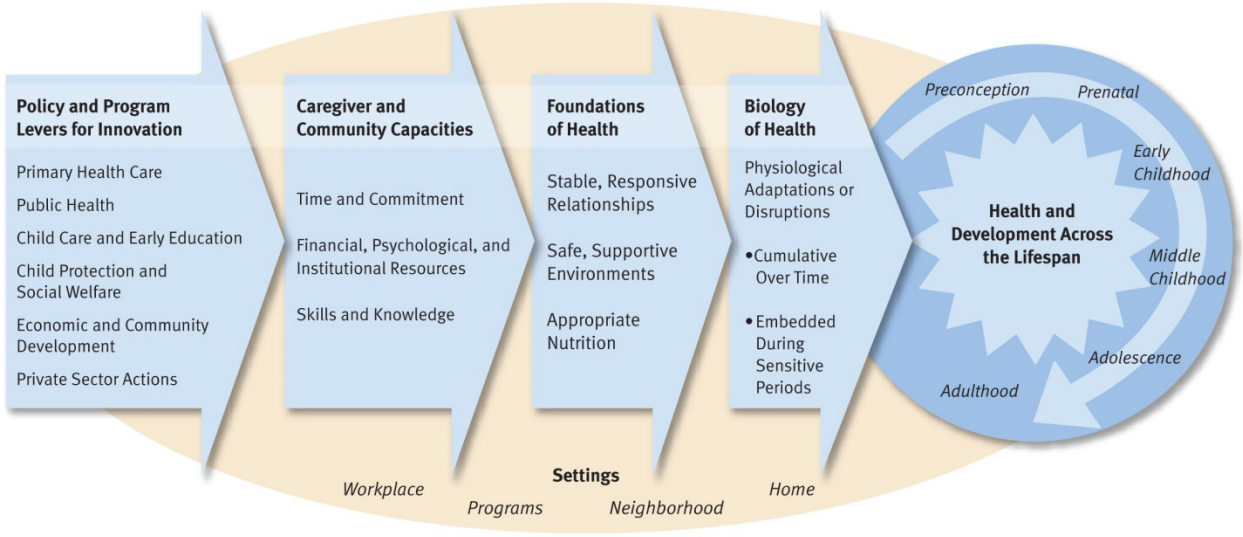

Figure 8.5. Health and Development Across the Lifespan

Several studies have tried to take a look at the overall evidence on what great exposure to risk during this period really means in terms of raising a healthy child. The conclusion summarized in an important

2011 study in the *Lancet*[1] emphasizes that exposure to biological and psychosocial risks, such as being in an unsafe (perhaps violent or noisy) environment, can affect brain development and compromise the subsequent development of the child both cognitively and physically. Inequalities of childhood development start at a very young age. By age six or seven, a child raised in an unsafe environment will already have huge disabilities and liabilities relative to those children fortunate to be raised in a safe and secure environment.

This means that reducing inequalities across children requires integrated and very early interventions, in ensuring a safe environment, in cognitive development, in preschool learning, in proper nutrition and healthcare for young children. The time for those investments is at a very young age, because these investments are very hard to make and much less effective if made as a correction for a child who is already five or six years old. If a child's growth is inhibited early on, the consequences can last for the entire life of that individual, and for future generations to come; the consequences for society can be absolutely enormous.

Making those investments, which requires leadership of government, therefore has tremendous social returns in many ways, including raising national income because of the population's improved productivity. A leading economics scholar, Nobel Laureate Professor James Heckman, has studied this issue of investing in human capital throughout his career and has made a graph of the kind in Figure 8.6. On the horizontal axis is age, and on the vertical axis is the rate of return to investing in human capital. Those returns are absolutely the highest at the preschool age. As age increases, the returns that one can achieve by incremental investments in human capital are lower. Missing a year of investment in human capital when a child is two cannot be made up by that same investment when the child is six. The returns are very high in the formative years of the brain, early socialization and development of personality, cognition and scholastic aptitude, and physical wellbeing; and this cannot simply be replaced by investments later on.

[1] Walker, Susan P. et al., "Inequality in Early Childhood: risk and protective factors for early child development." *Lancet* 378, Issue 9799, 1325-1338.

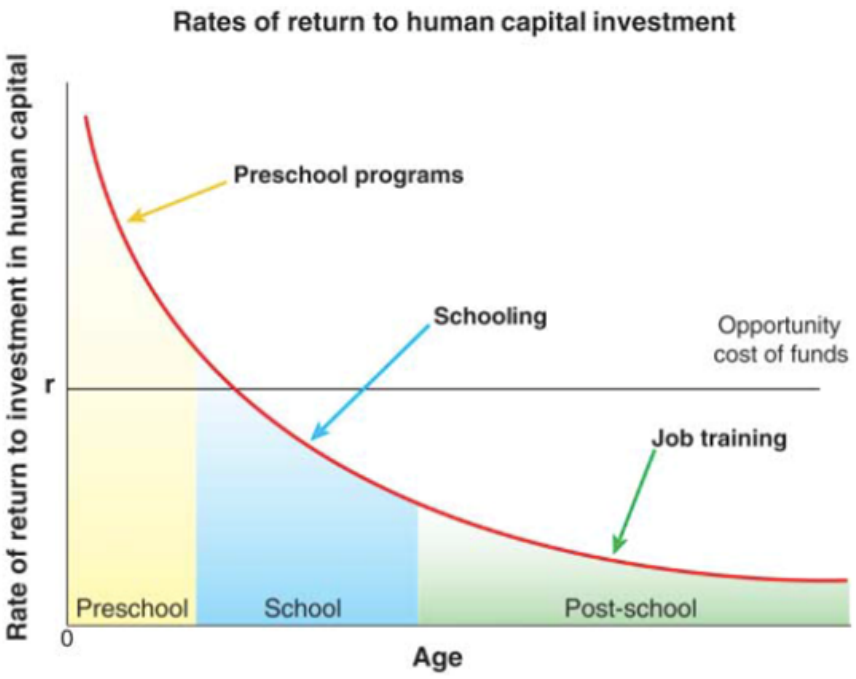

Figure 8.6. Rates of Return to Human Capital Investment

Wealthier families are likely to make the needed investments in the preschool of their young children. They can bear the cost, and they themselves are more likely to be educated and thereby realize the large benefits of preschool. There are likely to be more books, and even more words used, in those households, so that children benefit not only from formal preschool away from the house, but also from a highly supportive learning environment at home. It is the children of poor families that are likely to suffer the deficits of under-investments in preschool. The parents will not be able to afford the market costs of preschool (and will be unable to borrow if necessary to cover those costs). And their children will generally be less well prepared by their home life for learning outside of the home.

This pattern suggests that poverty will repeat itself from one generation to the next. Low-income parents will tend to underinvest in their children, who will then grow up to be low-income parents themselves. High-income parents, by contrast, will invest heavily in their children (both at home and at preschool), thereby preparing their children for economic success as adults. The situation would seem to be grim for intergenerational income mobility.

Yet here is where government can play a crucial role. Government programs and financing can help children of impoverished families to get a decent start. Part of the issue is money: transfers to poor families (as are common in Scandinavia, for example) can ensure that poor households, like richer households, have the financial means to provide adequate healthcare, nutrition, environmental safety, and an enriched cognitive environment (e.g. with books and toys for learning) for the young child. Public financing can ensure access to preschool programs that would be out of financial reach for poor families. And government programs can provide targeted support as well, for example by training parents in parenting skills that can enhance the wellbeing, development, and cognitive enrichment of

the child. When parents have little or no education, they are likely to need guidance and support to create an effective learning environment for their children. In careful studies, good parenting skills have been shown to play the important role we would expect in the child's cognitive development.

The upshot is that societies that make substantial investments in the preschool years, usually with ample public financing, end up with more upward social mobility for poor children, and therefore with more inclusive and productive societies. Societies that fail to invest in preschool are likely to have lower social mobility, and a greater gap in lifetime attainment between children born to high-income and low-income households. If the government does not add its support to low-income families, poverty is likely to be passed from one generation to the next.

Figure 8.7 hints at this pattern. The figure shows the relationship between two key variables. On the horizontal access is the proportion of young children in preschool programs. On the vertical access is the gap in educational attainment of youth aged 15-19 who grow up in the richest 20% of households versus those youth who grew up in the poorest 20% of households. A point that is high on the vertical access, say with a gap of four years, signifies a large difference in the school attainment of affluent youth versus poor youth. The graph depicts a **downward-sloping relationship**. Where there is more access to preschool, there is a smaller gap in educational attainment of rich versus poor youth. This is just as we would expect. Preschool offers upward mobility for poorer children, enabling them to come closer to the educational attainment of richer children. Investing in preschool lowers the extent of inequality and in the right way – not by pulling down any child from the top, but by raising kids from the bottom who otherwise would not have the educational opportunity they need.

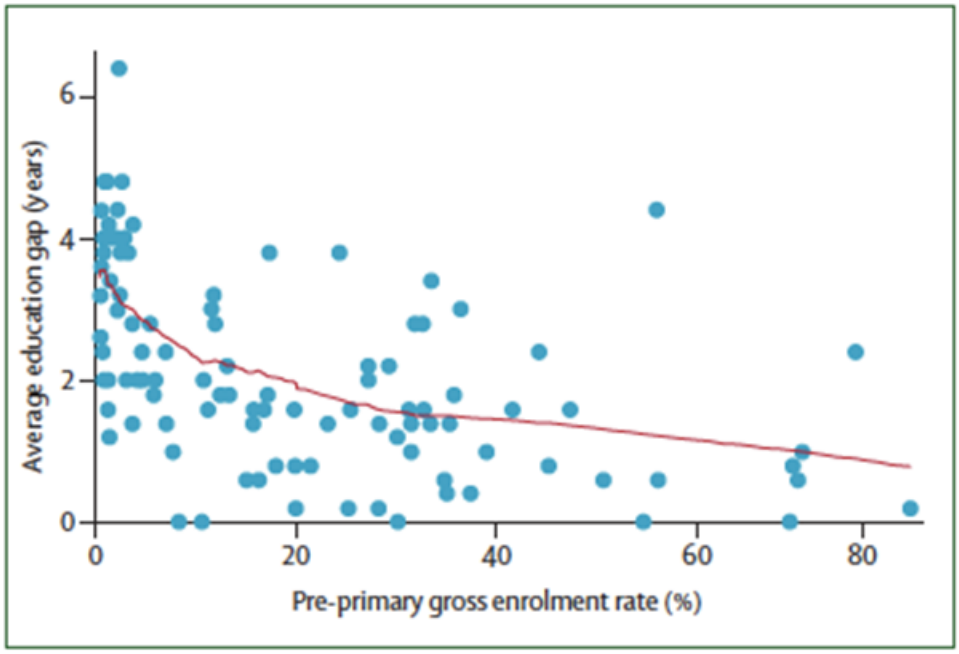

Figure 8.7. Preschool Enrollment and the Schooling Gap

Figure 8.8 offers an example of the estimated economic benefits of a specific preschool program in the United States: the Perry Preschool Program. The Perry Preschool Program offered intensive help to poor children in preschool. The costs and benefits of this program have been measured with great specificity, and demonstrate that the returns to these preschool investments were very high, and in several ways. According to the data, the direct costs of the program per child amounted to $16,514, while the lifetime gains amounted to $127,831 (measured in present value terms, by discounting future benefits according to the rate of interest). Thus the benefit-to-cost ratio is estimated to be 8.74, meaning that the program is enormously justified by the social benefits. And what are those benefits? One part is higher future earnings, estimated to be around $40,000 (not discounted). Yet another major part is less crime, and less cost to the criminal justice system. This is estimated to be a whopping $94,065, even larger than the gain in earnings. The Perry Preschool Program demonstrated lasting benefits in so-called "non-cognitive" personality skills, such as perseverance, motivation, study habits, and sociability.

Table 1. Economic benefits and costs of the Perry Preschool Program (*27*). All values are discounted at 3% and are in 2004 dollars. Earnings, Welfare, and Crime refer to monetized value of adult outcomes (higher earnings, savings in welfare, and reduced costs of crime). K–12 refers to the savings in remedial schooling. College/adult refers to tuition costs.

	Perry Preschool
Child care	$986
Earnings	$40,537
K–12	$9184
College/adult	$–782
Crime	$94,065
Welfare	$355
Abuse/neglect	$0
Total benefits	$144,345
Total costs	$16,514
Net present value	$127,831
Benefits-to-costs ratio	8.74

Figure 8.8. Economic Benefits and Costs of Perry Preschool Program

In the United States, a misguided criminal justice system combined with chronic under-investments in children has led to a tragically large population in prisons, roughly 2.4 million people. Many of those imprisoned are young men from poor families, who received an inadequate education and who grew up in environments of great stress, little support, and little promotion of learning. Not only is poverty thereby passed from one generation to the next. It is passed on through an especially tragic and costly process: criminality and imprisonment. If the US shifted resources from locking up young men to educating young children, it would experience a huge gain in fairness, productivity, and wellbeing of the society. The pure economic gains society-wide would be enormous, as the costs of excessive incarceration run to the tens of billions of dollars per year.

Societies around the world are finally recognizing, based on rigorous evidence across pediatrics, psychology, physiology, and economics, that investments in early childhood development are the best investments they can make. These investments in young children not only lead to efficiency in the sense of high economic returns, but to fairness and social inclusion as well. The children benefit not only with greater cognitive development but also with social (non-cognitive) skills that are highly valuable for lifetime achievement. With a strong investment in early childhood development – combining healthcare, nutrition, environmental safety, and a preschool learning environment – all children rich or poor have a real chance to succeed and to become productive citizens.

III. The Rising Returns of Education and the Supply Response

It is crucial to make investments at all stages of the life cycle. There remains a significant gap between rich and poor countries, and rich and poor households, in the access to secondary education. This also should be eliminated as part of the new Sustainable Development Goals covering 2015 to 2030. For children who are given an adequate start (preschool through secondary) there is also a huge return to completing a college degree. In Figure 7.5 in the previous chapter, we saw the wage premium in the United States enjoyed by college graduates compared with high-school diploma holders. That wage premium has been soaring since 1979, from about 25% in 1979 to around 45% by 2010.

The rising relative earnings of college graduates is a market signal to children to stay in school and obtain a college degree – if they can afford it, and if they are adequately prepared by their experience up to college age. Alas, too many young people are in fact not college-ready when they finish high school, because they have lacked the benefits of an enriching household environment as well as the access to preschool and quality primary and secondary education. Many of these ill-prepared young people start college, take on financial burdens to pay for tuition, and then end up dropping out, with heavy debts and without the benefits of a college degree.

When the market sends a signal that an activity has a high rate of return, we would expect people to pursue that activity, and so we would expect more people in the US to complete a bachelor's degree. While this is happening to a small extent, something odd is also happening. Figure 8.9 shows the percentage of adults in the US who have finished a high-school degree and who have finished a college degree. (There are two lines show for each educational category: one for 25-29 year olds, and the other for all adults over 25 years of age.) As for high-school completion, the rate has risen sharply over time to around 90% today. As for college completion, the curve has also sloped upward over time, but not so dramatically. From 1940 to around 1975, the proportion of 25-29 year olds with a college degree increased significantly, from around 5% to around 20%. Yet starting around 1975 that upward sloping curve has a kink; there is almost a leveling off after 1975, even as the returns to college soared. While a bit over 20% in 1975 have a four-year degree, by 2009-2010 the proportion is only around 30%. The numbers have really stopped increasing at anything like the rate we would expect, despite the strong signal of enormous benefits of a college degree. What is happening?

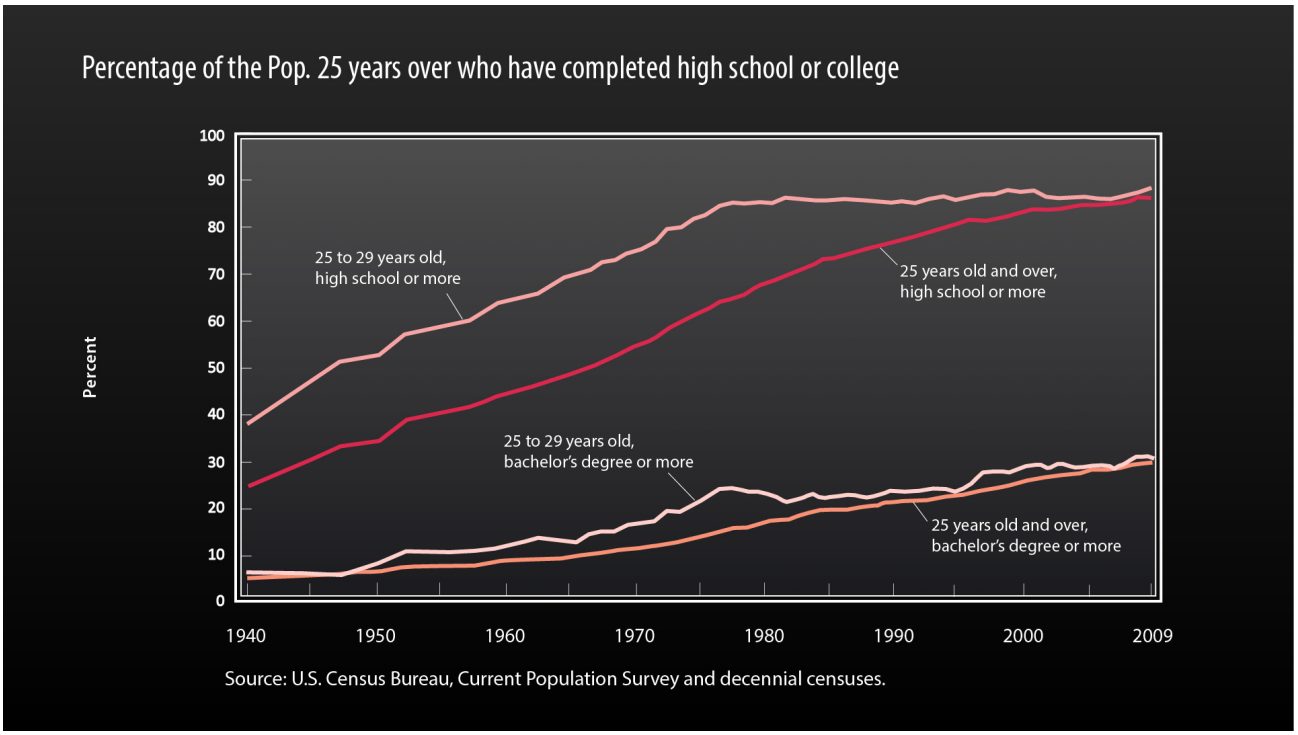

Figure 8.9. Percentage of Population 25 years+ Completing High School or College

There are clearly bottlenecks on the supply side, and Figure 8.10 gives some suggestion of one key bottleneck. Tuition costs are extremely high and continue to rise. Just when society ought to be helping young people to make an investment in higher education, very high tuition costs are holding back the supply response to a clear demand.

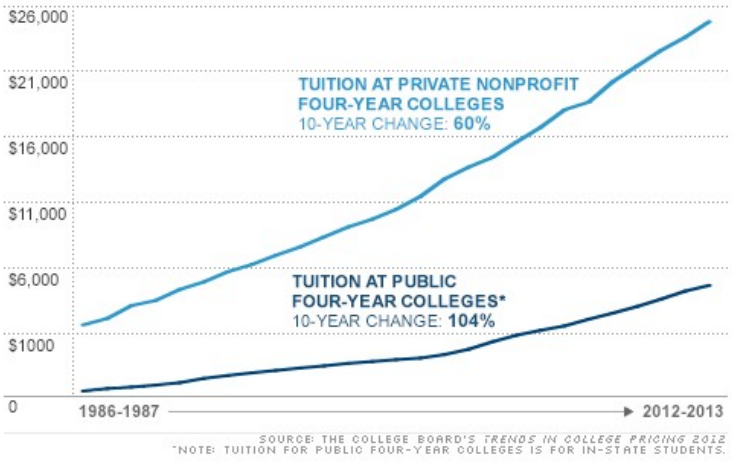

Figure 8.10. US Tuition Costs (1986-2013)

There are two troubling implications of this. One implication is that a very large proportion of US young people, even in a very rich country, are not able to enjoy the benefits of a completed higher education.

Tuition costs are a huge barrier, and those tuition costs have not only soared compared with the past, but also compared with tuition rates in other countries. The second troubling aspect is that college completion is disproportionately by kids from wealthier families. College education is not equalizing incomes across the income distribution, but exacerbating inequalities. Poor kids can't make it through college.

The gaps show up not only by income, but also by race and ethnicity. In 2012 in the US, the percentage of white non-Hispanic people over age 25 with a four-year university degree was 35%; for African-Americans, it was 21%; and for Hispanics, it was only 14.5%. It is poor kids, and especially poor non-white kids, who are not making it. There are no doubt several barriers standing in the way of the poorer kids completing a college degree: a less supportive home environment while growing up (with less educated and lower-income parents, and more single-parent households), less access to preschool, lower quality primary and secondary education, less college readiness upon high-school graduation, and less ability to finance a costly higher education.

The US has not deployed social policies (such as universal preschool or free higher education) to address these vast social inequalities, and the dangerous under-investments in educational attainment. By virtue of its libertarian traditions, the US tends to look to "self-help" market solutions. In the case of higher education, young people are told to borrow money in order to go to university, and so the government has helped to create a rapidly rising and increasingly problematic level of student debt, which now total around $1 trillion dollars. The double irony is, of course, it is the poor kids who take the loans, because the parents of the youth from wealthier families are able to pay tuition from the start.

Figure 8.11 shows how rapidly the student debt has been growing in recent years, from an estimated $250 billion total in 2003 to a four-fold increase in 2013. As I've indicated, young people who will not complete a four-year degree owe much of this debt, and therefore will not earn the extra income necessary to repay what they've borrowed.

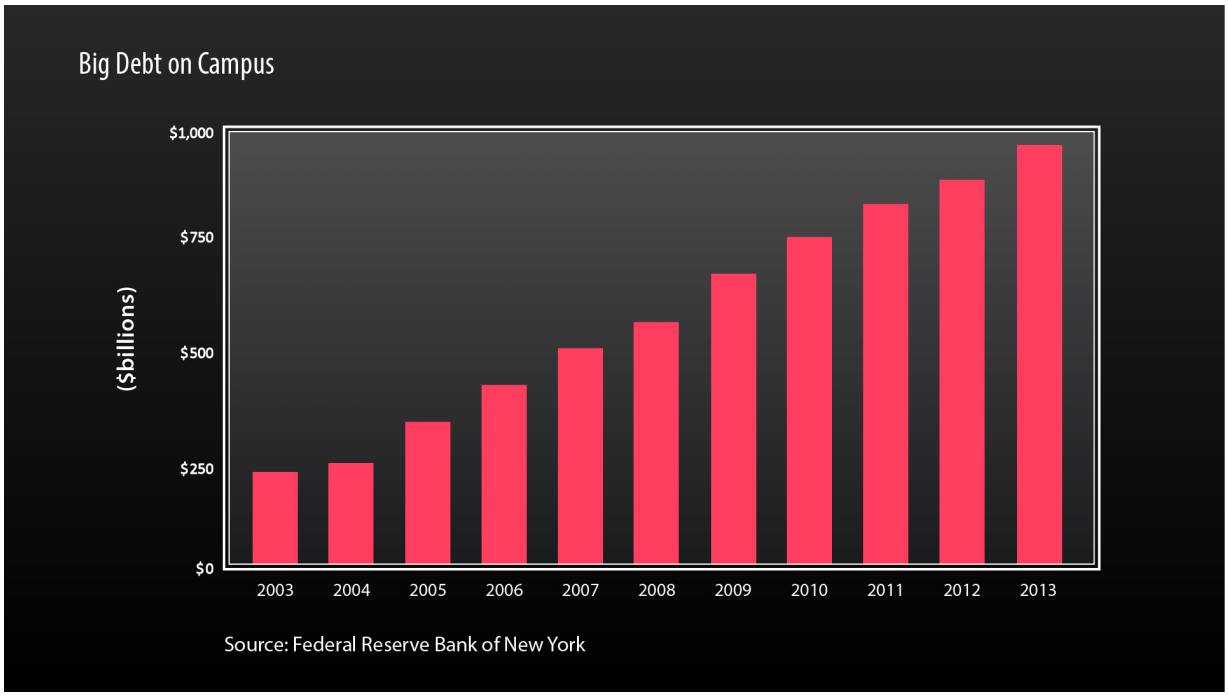

Figure 8.11. Student Debt in the US

The US therefore faces a triple challenge: highly unequal access to higher education; very little increase in the rate of college graduation since the 1970s; and a massive buildup of student debts. One solution in the future would be a decisive lowering of tuition costs, and one important innovation that can help that about would be online education, as exemplified by this course! We can realistically envision a big breakthrough in access to higher education in the future, as well as new ways to learn and to combine online learning and "brick and mortar" campuses. Technological progress therefore offers us some realistic hope that higher education can soon reach a vastly higher proportion of young people in all parts of the world.

IV. Social Mobility

Education is a path to a more productive life as a citizen and an income earner, but we've noted that it can also be an amplifier of social inequality. If higher education is so expensive that only children from affluent families are able to pursue higher degrees, and if the returns to higher degrees are themselves high, then education becomes a bottleneck for the poor and a cause of widening inequalities. This seems to be the case in the US today, a country that once prided itself as "the land of opportunity," but now is a society of high inequality and low social mobility.

Figure 8.12 illustrates the problem. The graph is base on a sample of 8th-grade children in 1988. It divides the children into three categories according to their 1988 household income: the lowest quartile (the poorest 25%) of households; the middle two quartiles (from the 25th to 75th percentile); and the top quartile (from 75th percentile to the richest household). It then examines the educational attainment of these children as of the year 2000. There are four categories of educational attainment:

no post-secondary education (PSE); some PSE but no four-year bachelor's degree; a bachelor's degree; a master's degree or higher.

The results are striking. Of the children in the poorest quartile, 48% had no post-secondary education, and another 45% had some PSE but no bachelor's degree. Only 7% had a bachelor's degree, and none had a master's degree. Compare this with the children in the richest quartile. Now, only 4% had no post-secondary education. 36% had some PSE but no bachelor's degree, while 51% had a bachelor's degree and another 9% had a master's degree or higher. The income inequality these youngsters faced in 8th grade will be replicated when they are adults by virtue of the fact that the children of high-income households have been able to avail themselves of the high returns to higher education while the poorer children have not.

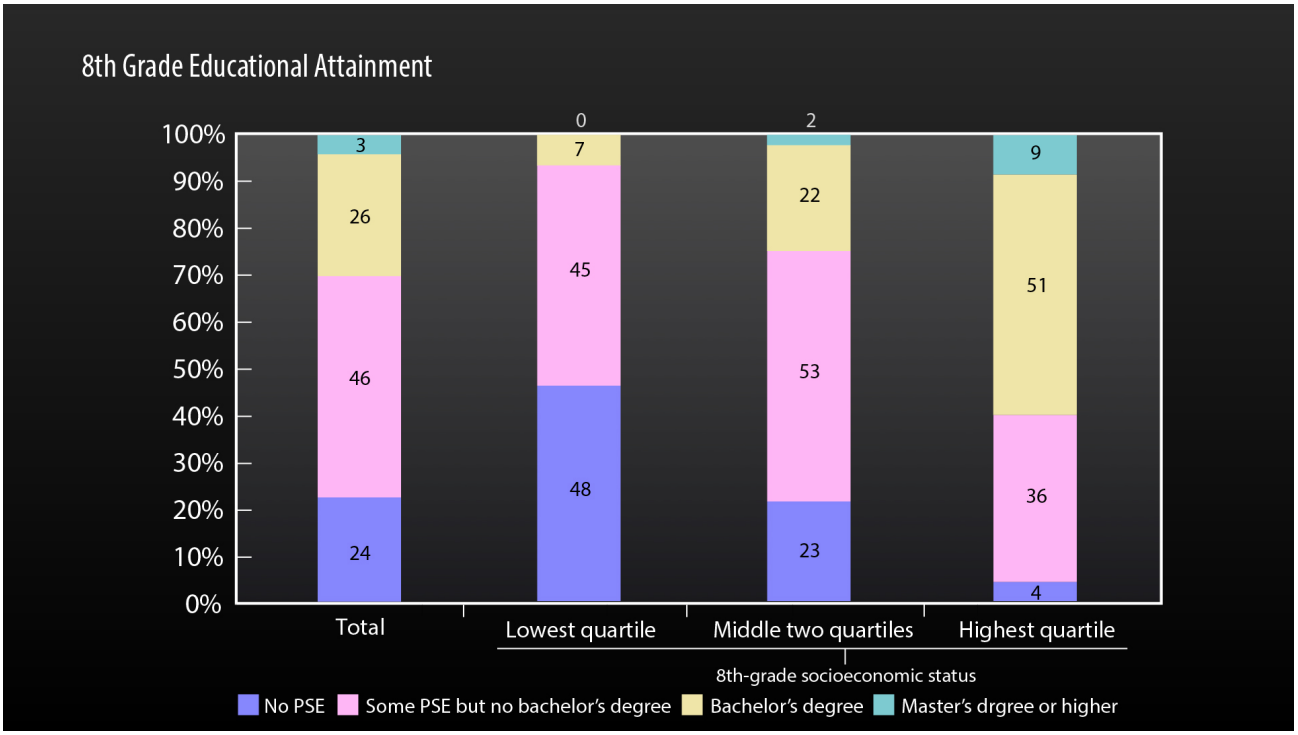

Figure 8.12. Educational Attainment By 8th Grade Socioeconomic Status

Figure 8.13 shows an extremely important and rather sobering relationship that is consistent with this finding. The horizontal axis shows the Gini coefficient (degree of inequality) for 13 high-income countries; the higher the Gini coefficient, the higher the inequality. The lowest inequality countries in this graph are, not surprisingly, the Nordic countries, while the most unequal country is the United States, with the United Kingdom coming in second. The vertical axis shows an indicator of social mobility. For each country, the earnings of current workers are correlated with the earnings of their parents. If the correlation is high, it means that poor kids tend to grow up to be poor adults, and rich kids tend to grow up to be rich adults. In that case, social mobility is low. Alternatively, if there is little correlation in earnings between parents and children (so that a poor child has a reasonable chance to grow up to be a rich adult) then we say that social mobility is high.

We see a strong upward relationship in the graph. Countries (like the Scandinavian countries) that are relatively equal in income distribution have a high social mobility (a low correlation of earnings of parents and children), while countries that are highly unequal (like the United States) tend to have low social mobility. The parent's income is a strong predictor of their children's future income.

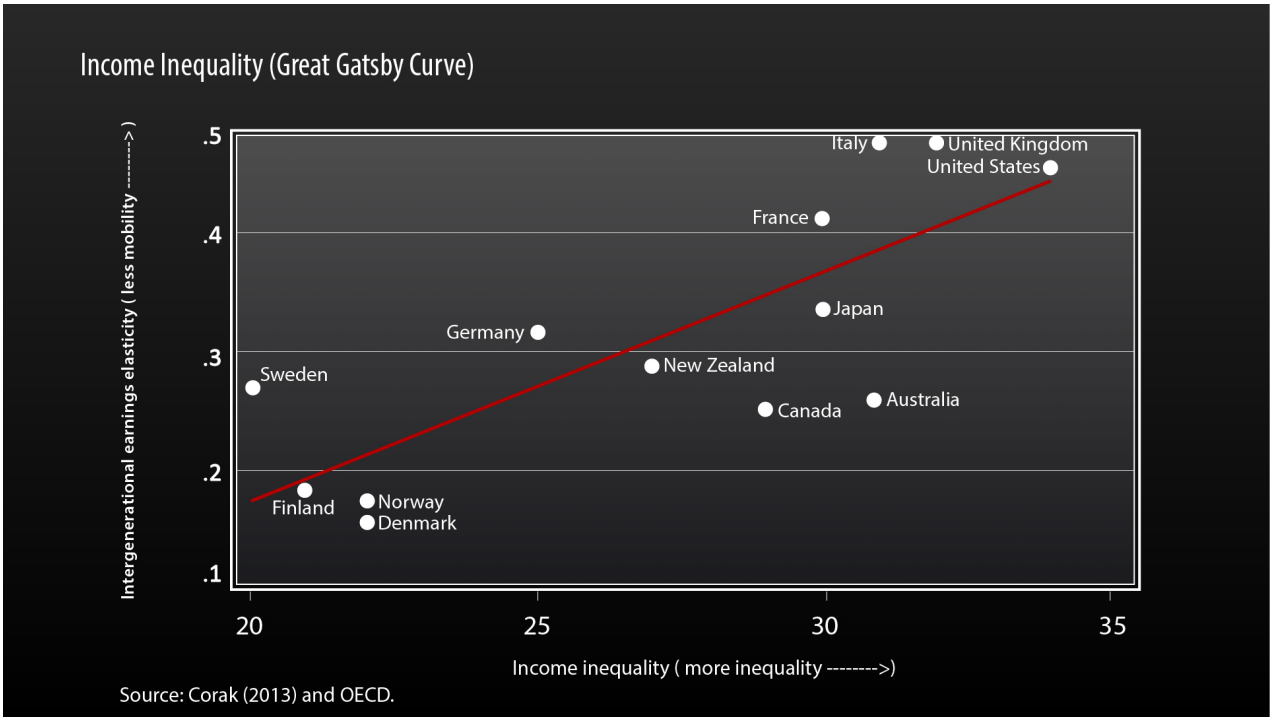

Figure 8.13. Great Gatsby Curve – Inequality and Intergenerational Earnings Mobility

One more chart helps to make the same point. Figure 8.14a shows a comparison of the United States and Canada. It considers poor households where the father is among the lowest 10% of earners (the bottom decile), and asks where the sons end up in the income distribution. For sons born to low-income fathers, 22% also end up in the lowest decile and another 18% end up in the second-lowest decile. Thus, 40% of sons who are born to poor fathers end up in the bottom fifth of the income distribution (the bottom two deciles). In Canada, there is more upward mobility. Only 15% of the sons end up in the lowest decile and 13% in the second lowest, for a total of 28% in the bottom fifth. In Canada, being born poor is still predictive of staying poor, but there is much more upward mobility than in the United States.

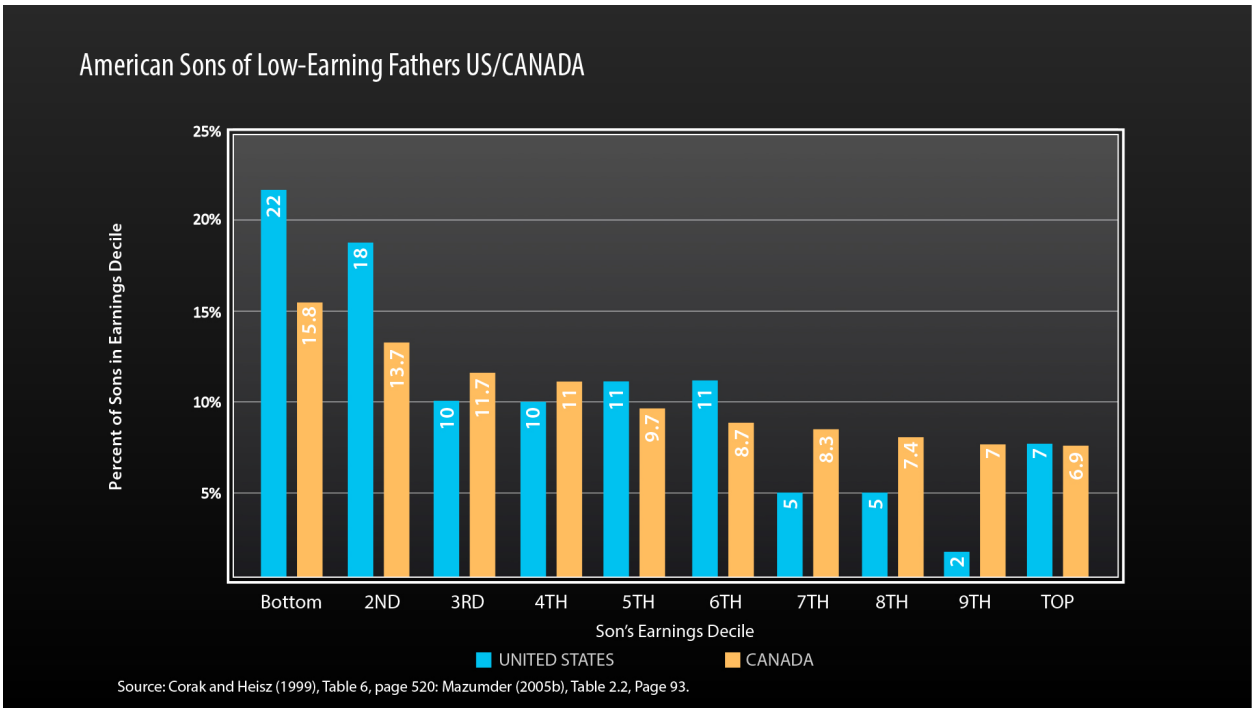

Figure 8.14a. Economic Status of Sons with Low-Earning Fathers

Figure 8.14b shows the outcomes for sons born to rich fathers. In the United States, of sons born to fathers earning in the top 10% (the top decile), 26% also end up in the top decile and another 11% end up in the ninth decile (second from the top), for a total of 37% in the top fifth (the top two deciles). By contrast in Canada, only 18% end up in the top decile and 13% in the second decile, for a total of 31%. The difference is not as stark as with poor households, but the tendency is the same: Canada has higher social mobility than the US.

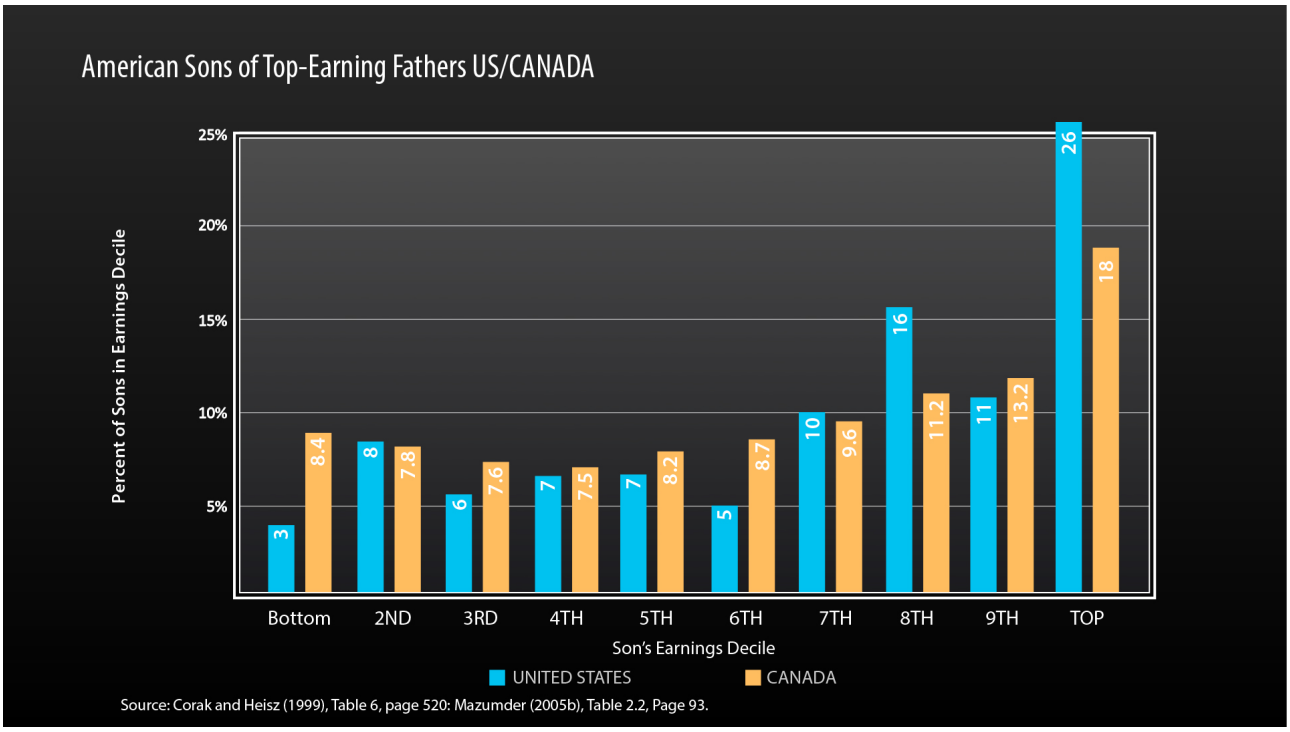

Figure 8.14b. Economic Status of Sons with High-Earning Fathers

More equal societies, which generally also have a strong role of government in providing early childhood development and access to quality education at all levels, end up with greater intergenerational mobility. The social democracies of Scandinavia are thereby the outstanding achievers in social inclusion, promoting widespread prosperity and the highest observed extent of social mobility across generations.

V. The Role of Higher Education in Technological Advance

Higher education plays a key role in the two kinds of growth that we discussed in Chapters 3 and 4: endogenous growth and catching-up growth. Endogenous growth is the economic growth based on new technological breakthroughs, such as the ongoing revolution in information and communications technology. These technological breakthroughs tend to be the result of intensive research and development by highly skilled scientists and engineers with advanced degrees. Just as James Watt invented his steam engine in a workshop of Glasgow University, today's inventors are likely to be employed at universities, or in start-up companies linked to universities, or at high-tech companies in some kind of partnership with academic sciences and engineering. The greatest technological advances in the past 50 years, in computer science and applications, the Internet, fiber optics, genomics, advanced materials sciences, solid-state physics, aerospace, and much more; have been the fruits of universities, national and international laboratories, and high-tech companies, powered by highly trained individuals with advanced degrees in their respective areas of work.

Figure 8.15 shows the share of national income devoted to research and development (R&D) in different parts of the world. We see that R&D is heavily concentrated in the high-income world. This has been true essentially for the two centuries since the start of the Industrial Revolution. A tremendously high share of the new innovations has come from a small subset of countries, including the United States and Canada, Western Europe, Japan, and more recently, Korea, Singapore, and Israel. These countries account for the lion's share of scientific breakthroughs and patented intellectual property that underpins endogenous growth. Recently, China has increased its investments in R&D in a bid to join the group of high-innovation countries.

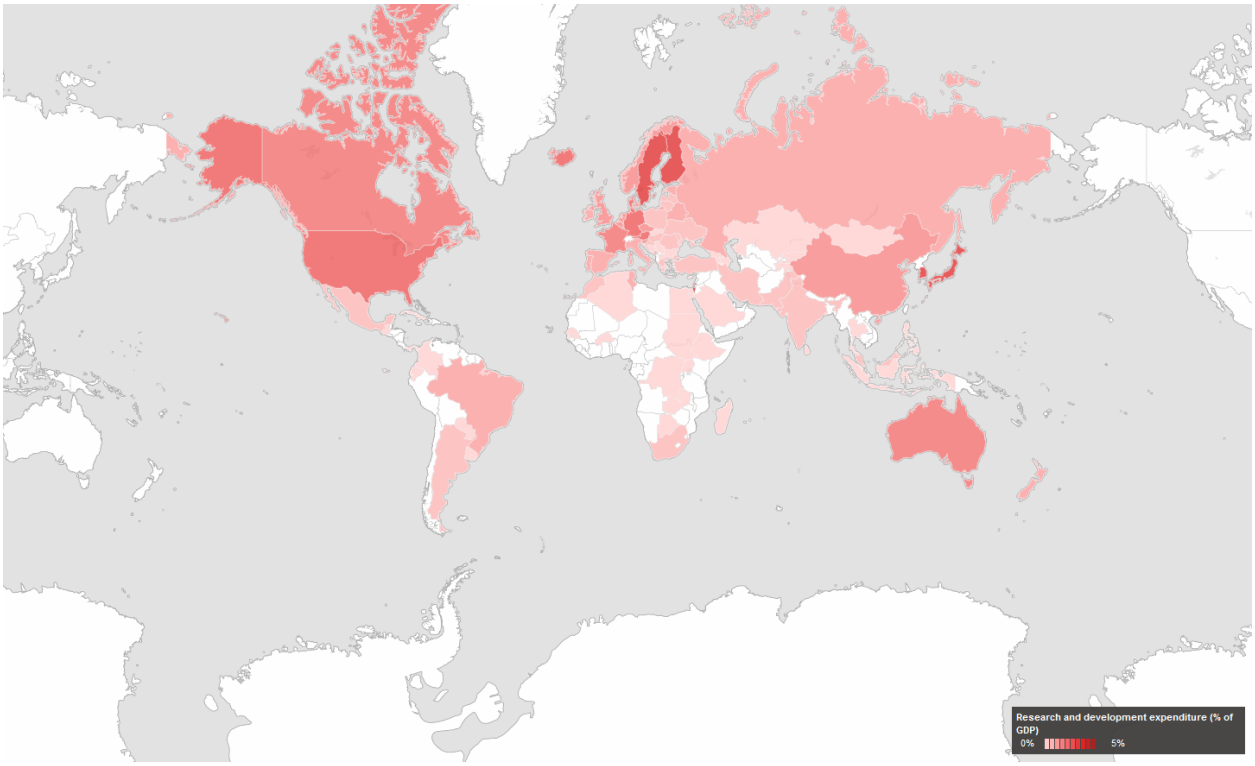

Figure 8.15. R&D Expenditures as Percentage of GDP

R&D is underpinned not by a single institution (like a university) but by a full web of institutions, involving universities, national laboratories, and high-tech businesses. The complex interplay of these institutions in producing technological advances is called the country's "national innovation system." There are many tools to build a strong national innovation system, including public financing of scientific research, tax incentives for new innovations, prizes to honor and encourage scientists and engineers, national laboratories, and public and private philanthropic funding to support universities and other sites of innovative research activities. At the base of all of these institutions, however, is a strong system of higher education in the sciences, engineering, and public policy.

The second kind of growth is the adaptation of technologies from abroad. Sometimes these technologies do not require local skills in the importing country. Only a very few mobile phone users, after all, understand the advanced electronics of their phones. Only a few patients understand the

biochemical mechanisms of their life-saving medicines, and only a few farmers understand the genetic composition of their high-yield seeds. Nonetheless these technologies work wonders.

Yet some technologies cannot simply be used "off the shelf." The technologies have to be adapted to local use. This is almost always true of high-yield seed varieties, for example, which have to be adapted to local pests and pathogens and local climate conditions. Machines imported from abroad don't require the advanced expertise of the original inventors, but do require high skills to use the machinery. We can say that technology transfer from abroad typically requires at least some highly skilled specialists in the importing country. Universities are vital for preparing that skilled workforce. Universities are also vital for training the teachers who will train vast numbers of students to be ready to use the new technologies from abroad.

Universities are also critical for a third basic activity: helping society to identify and solve local problems of sustainable development. Every issue with which we are grappling – poverty, disease, climate change, new information technologies, and so on – requires locally tailored solutions, often based on sophisticated management systems. Suppose that a country must shift its energy system from traditional coal-based power plants to low-carbon alternatives. What is the country's potential to develop wind or solar power; how safe is nuclear power; what about geothermal energy; should the country deploy electric vehicles? These questions may well lie beyond the competency of government institutions. Universities may then be crucial partners in the national problem solving.

America has long promoted its universities for this kind of problem solving. One of the pioneering steps in the US was the Morrill Act, a major piece of legislation passed by the US Congress in 1862 and signed into law by President Abraham Lincoln. This wise legislation created "land-grant universities" in order to foster agricultural and mechanical advances based on science and technology. The US federal government granted land and financing to every state to establish a new institution of higher education in agricultural and engineering studies. The Morrill Act said that this federal support would enable:

> The endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

What makes the Morrill Act so novel and important for America's economic development is that these new institutions of higher education were set up not only to train students, but to work with the local communities in which they are located to solve difficult problems and to develop technical capacities. These land-grant universities established agricultural field stations and outreach programs by university-based scientists. The land-grant universities helped farmers across the US to grapple with the problems of pests, crop productivity, soil nutrients, climate, mechanical innovations, and the other keys to high-productivity agriculture. What a legacy these universities have created, and how wise of Abraham

Lincoln and the US Congress to realize, in the midst of a civil war, the importance of building strong, practically-oriented institutions of higher education.

It is with this history of the crucial role of universities in mind that I am especially honored that UN Secretary General Ban Ki-moon asked me to assist him in his global leadership challenge of promoting solutions to sustainable development, by helping to establish a new knowledge network based on the universities around the world, so that these universities can be effective problem solvers in their respective cities, nations, and regions. The new UN Sustainable Development Solutions Network (SDSN) is an outreach organization under the auspices of the UN Secretary General that aims to link universities, businesses, and other knowledge institutions around the world in the common challenge of finding solutions to sustainable development. Countries and regions around the world are now forming their own chapters of the SDSN, and linking up with the global SDSN. The hope is that the SDSN will effectively support universities around the world to be available for problem solving in the same way that the Morrill Act created effective institutions of problem solving across the US.