
High-Skilled Workers: Stagnating in the United States, Rising Fast in Other Countries?

It's not what we don't know that gives us trouble. It's what we know that ain't so.

—Will Rogers

The US labor force is highly diverse and dynamic. Yet, intuitively, its long-term average skill level is principally determined by the relative magnitudes of labor-market entries by young workers upon finishing their initial education and exits by retiring older workers.¹ The United States led the world in education throughout the 20th century and benefited greatly from it. It is well known that a country reaps a demographic dividend from quantitatively large young population cohorts entering the workforce.² Similarly, in countries like the United States, a positive economic effect has also been felt from the long-term qualitative improvement in the US labor force with less-skilled workers retiring and more high-skilled workers entering the workforce.

1. The long-term trend is the focus of the first section. Therefore, among many things, it ignores the compositional effects of cyclical changes in hours worked among different groups of workers, as well as the “effective skill effects” from rising levels of experience and continuous lifelong work-related training. Some of these data (in the form of the labor composition index) are compiled annually by the Bureau of Labor Statistics (BLS 2007) for use in computing private business-sector multifactor productivity (MFP). Such “effective skill effects” arise when firms in economic trouble, for instance, lay off workers with least seniority first or blue collar workers ahead of white collar professionals. See also OECD (2007a, 62ff) for a review of the productivity effects of lifelong learning programs in the OECD countries.

2. For a recent overview of this literature, see International Monetary Fund's *Finance and Development*, September 2006.

Many researchers have empirically found such gains to long-term US economic growth from rising skill levels using different methodologies. J. Bradford DeLong, Claudia Goldin, and Lawrence F. Katz (2003) estimate that the combined direct and indirect effects (via research and development and multifactor productivity [MFP]) of rising skill levels in the labor force were the single largest contributor to US economic growth in the 20th century. Other researchers find that an additional year of schooling raises GDP per capita by up to 5 percent and MFP by up to 0.9 percent.³

However, this era of broadly rising skill levels in the US labor force is drawing to a close here early in the 21st century. A frequently overlooked side-effect of the imminent retirement of the generally well-educated baby boomer generation is that their retirement will soon take as many high-skilled people out of the US labor force as will simultaneously enter it. This novel development is illustrated in figure 1.1.⁴

Size and Educational Attainment of Resident US Population

Figure 1.1 shows the detailed educational attainment of the resident US population⁵ by five-year age cohort, starting from the age group when people will usually have completed their bachelor's degree (25–29 years) to the age group when they are deep into retirement (age 75+).⁶ It is important to

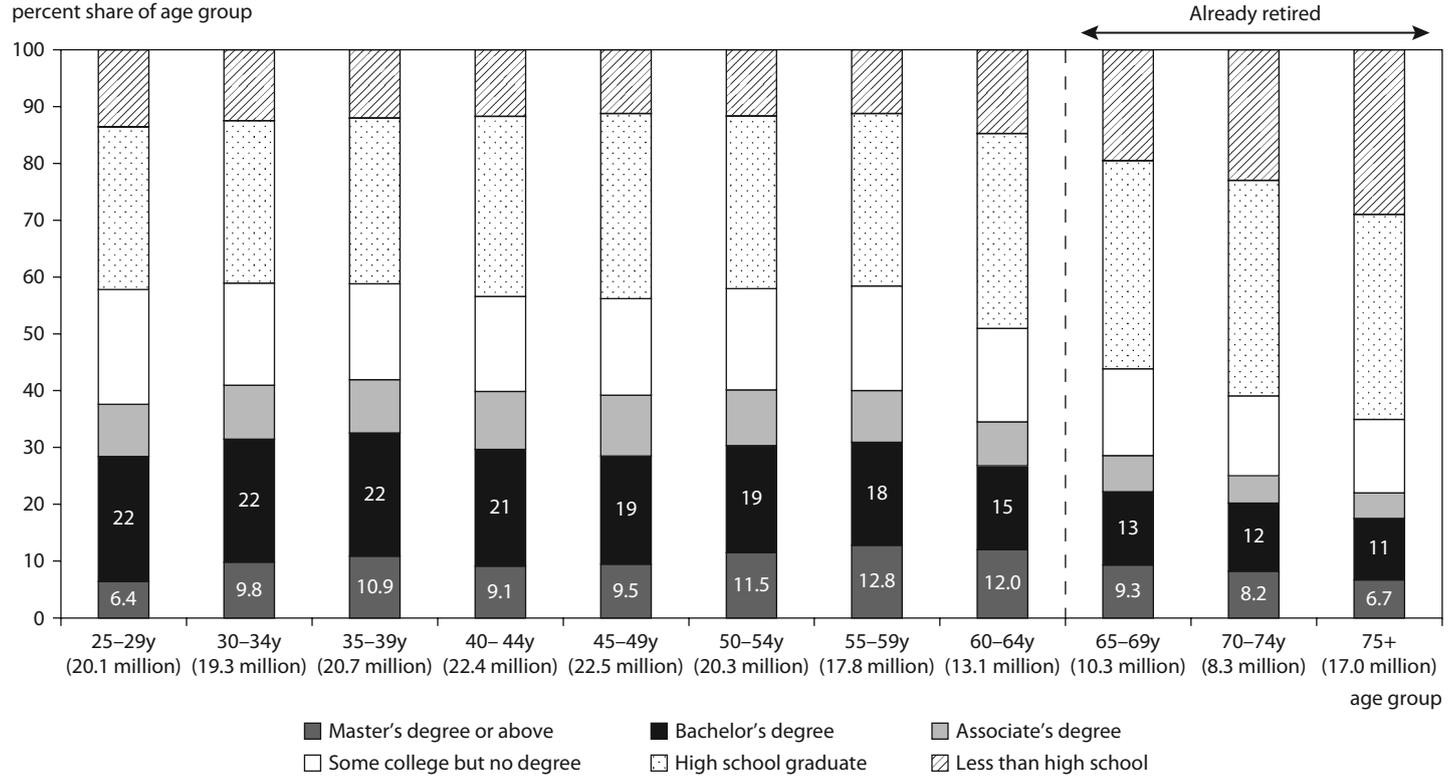
3. OECD (2007a). See also Bassanini and Scarpetta (2001), Cohen and Soto (2007), de la Fuente and Ciccone (2003), and Splitz-Oener (2007).

4. The underlying data for figure 1.1 are presented in more detail in table A.1 in the statistical appendix.

5. These data are from the Bureau of Labor Statistics and the Census Bureau's Current Population Survey, which samples random US households and makes no distinction between US citizens and resident aliens.

6. These data are a snapshot in time and when used here as a "de facto time-series" incorporate the combined share effects of at least four effects active over time: domestic US education (highest level of education attained by Americans in different age groups), immigration (are new immigrants of all ages high or low skilled? For most of the answer, see figure 1.5), lifelong learning (people may choose to go back to school at an older age), and mortality differentials (highly educated people generally live longer than less-educated people). Disentangling these individual effects in detail is, however, beyond the scope of this policy analysis. But these effects work in different directions and therefore do not materially impact the conclusions drawn here. It must be emphasized, though, that lifelong learning is likely less of an uncertainty than many people think, when considering whether people "jump" to one of the higher educational attainment meta-groups depicted in figure 1.1. Usually, lifelong skill acquisition entails acquiring more hands-on skills directly needed to perform a particular job and does not lead to the crossing of educational thresholds into one of the other meta-groups listed in figure 1.1. Most people who do acquire another degree later in life already have a bachelor's or master's degree and therefore do not add to the headcount of the highly skilled by going back to school. Conversation with Barbara Ischinger, director of the OECD Education Directorate, September 18, 2007, at the launch of the *Education at a Glance 2007*:

Figure 1.1 US educational attainment (highest level attained), 2006



Source: Bureau of Labor Statistics and Census Bureau, Current Population Survey, 2006 Annual Social and Economic Supplement, available at www.bls.gov/cps.

note that figure 1.1 implicitly assumes “fixed thresholds” for entering each category. Hence it assumes, for instance, that a 25–29 year old required the same skill level to get a high school degree as did a 75+ year old.⁷

Figure 1.1 conveys at least two important points: First, the average skill level of the US workforce saw continued improvements up until the time those now aged 55–59 entered the workforce—i.e., until the mid- to late 1970s. The share of unskilled workers (i.e., those with less than a high school degree) declined rapidly, while the number of university graduates rose dramatically. Second, however, American residents aged 25–54 are generally not better educated than their immediately older fellow residents aged 55–59, indicating that the “demographic skills dividend” in the US workforce came to an end in the late 1970s.

Fortunately, the full economic impact of this approximately 30-year stagnation in the average skill level of the US population—covering the resident population from age 25–29 years to 55–59 years—has been delayed until now,⁸ as the average skill levels of retiring cohorts aged 65+ have hitherto been below those of younger generations entering the labor force.⁹ However, within the next decade, this trend will by and large cease because the 55–59 year olds are just as well educated as today’s labor-market entering “fully educated cohort” aged 30–34.¹⁰ Indeed, as of 2006, there are more holders of master’s, professional, and doctoral degrees among resident 55–59 year olds in America than there are among the 30–34 year olds.¹¹ In other words, unless the 30-year stagnation among advanced-de-

OECD Indicators publication at the National Education Association in Washington.

7. Some numeracy tests indicate that this assumption may be questionable, as they find evidence that the required level to graduate has declined over time. See, for instance, the 2003 *Trends in International Mathematics and Science Study* (NCES 2004) or the adult literacy survey in OECD/Statistics Canada (2005).

8. Indeed the National Science Foundation in 2005 almost triumphantly announced that the total number of individuals in the United States with at least a college degree rose more than 40 percent from 1993 to 2003—from 29 million to 41 million. This number, however, fails to take into account the rising US total population (up 13 percent from 1993 to 2003) and the rising average age of US degree holders. See National Science Foundation (2005).

9. US labor force participation for the age group 60–64 in 2006 was 52.5 percent but only 29 percent for the age group 65–69, 17 percent for the age group 70–74, and 6.4 percent for the 75+ group. Total labor force participation for the 16+ age group was 66.2 percent. Despite gradually rising Social Security retirement ages, it thus remains accurate to state that Americans on average retire around age 65. The OECD estimates the effective (i.e., taking into account all early retirement programs) age of withdrawal from the US labor force at about 64 years (Bureau of Labor Statistics and Census Bureau, Current Population Survey; and OECD 2006a).

10. “Fully educated” indicates that people usually will not have finished their master’s, professional, or doctoral degrees until reaching the age cohort of 30–34. As such, an educational improvement in the 25–29 age cohort of bachelor’s degree holders should be expected.

11. In 2006 there were 1.61 million master’s degree holders, 305,000 professional degree hold-

gree holders in the resident American population is quickly reversed, a depletion of the graduate degree–holding US workforce seems both imminent and unavoidable.

Given the fundamental economic relationship between supply, demand, and prices, such a scenario will invariably cause earnings inequality between those with high levels (at least a college degree) and those with low levels of education in America to start rising again in the near future.¹² However, as has been the case so far, any additional widening of the wage distribution will not be due to the fact that the US labor force is simply not adjusting fast enough to rising demand for high-skilled workers from technological innovation and international trade. It will be because the US labor force will soon have largely stopped adjusting at all!

The stagnating skills acquisition in the US workforce shown in figure 1.1 can also be described by projecting the share of the total population that can be expected to have acquired tertiary education in the coming decades, given the skill level of those already above age 25 in 2006. This exercise allows for reasonable projections for at least as long as the age groups surveyed in 2006 remain in the population.¹³ The US Census Bureau has since 1940 regularly estimated the share of the US population aged 25 and above with at least a four-year college education. These data for select years from 1940 to 2006, as well as projections until 2035, are presented in figure 1.2.¹⁴ However, given that high-skilled people also can be expected to live considerable parts of their lives in retirement, it is useful to consider the share of the “US workforce” that through time has attained tertiary education. Figure 1.2 illustrates this point with the age group 25–64. US

ers, and 349,000 doctoral degree holders aged 55–59 in America, while there were 1.4 million master’s degree holders, 281,000 professional degree holders, and 199,000 doctoral degree holders aged 30–34. See table A.1 in the statistical appendix. Auriol (2007) also presents data showing that of six out of seven surveyed countries—Canada, Argentina, Germany, Australia, and Switzerland—the United States has the oldest PhD population on average, with doctoral degree holders from Portugal being older.

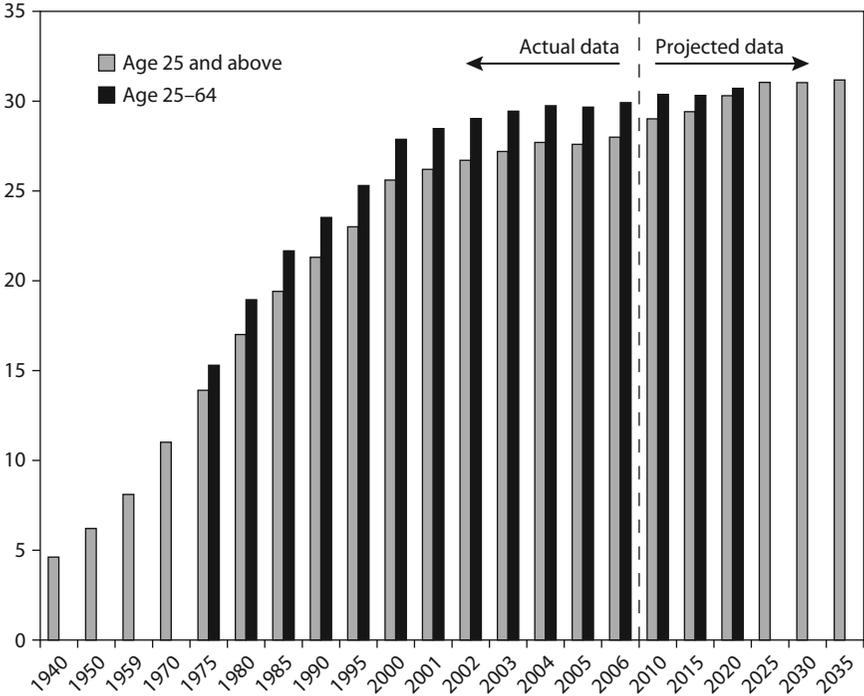
12. The Economic Policy Institute (EPI) estimates that the wage premium for college relative to high school graduates reached 47.1 percent in 2005. This wage premium, however, has been essentially stagnant since 1995, when it reached 46.7 percent, which was preceded by an increase from less than 30 percent in the late 1970s. See EPI datazone at www.epi.org/datazone/06. See also Lawrence (forthcoming).

13. The projection methodology used here assumes that the educational attainment of age groups 25–29 and 30–34 will be retained throughout the projection period, such that the 2006 share of the 30–34 age group will be held constant into the future as older age groups surveyed in 2006 exit the relevant age group. Individual age groups are then weighted by their share of the total relevant age group population total. Note that no adjustment is made for differences in mortality rates among people of different educational attainment, immigration, or lifelong learning in these projections.

14. By 2035 the age group 30–34 surveyed in 2006 will have passed into the oldest 75+ age group, and the projections become flat by assumption thereafter.

Figure 1.2 Share of the US workforce with at least tertiary education, 1940–2035

percent share of total population
in age group



Sources: Bureau of Labor Statistics and Census Bureau, Current Population Survey, available at www.bls.gov/cps; author's calculations.

Census data at this level of age detail go back only to the mid-1970s, so there is not enough information to project this age group beyond 2020.

Two distinct trends are visible in figure 1.2: First, the rapid rise in the share of the US population aged 25 and above that had attained tertiary education started slowing dramatically just after 2000 and will slow even further going forward. Second, part of this continued slower rise after 2006 comes from the continued rise in the share of highly skilled people over 65. By about 2020, Americans 65 years and above—the overwhelming majority of whom will be in retirement—will be about as well educated as the US workforce in the 25–64 age group, the usual workforce age range. To retain this group of elderly high-skilled Americans in the workforce in coming decades poses a significant challenge.¹⁵

15. For the labor-market challenge of aging high-skilled populations, see also Baily and Kirkegaard (forthcoming).

If one takes “equal opportunity for all” in America seriously and believes that every American truly has access to as much education as he or she demands and desires, then this observed stagnation in skill levels at late 1970s levels would point to a “revealed preference” and likely to a resulting maximum skills capacity of the resident US population. This stagnation would again indicate that it occurred near the pinnacle of what a large population like America’s can realistically achieve, assuming that everyone finishes as much education as he or she individually desires. After all, not everyone can possibly graduate from university.

If this indeed were the case, then one would not need to lose too much sleep over this stagnation, as there would be no compelling reason to believe that populations in other rich countries would be able to do any better than potentially catch up with the overall US skill levels reached in the late 1970s. Alas, a look at internationally comparable statistics from the Organization for Economic Cooperation and Development (OECD) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) quickly dispels such notions.

Figure 1.3 presents a different calibration of internationally comparable “de facto time-series data” similar to those presented in figure 1.1 for the United States. The way to interpret figure 1.3 is to look at the difference (i.e., vertical distance) between the age groups. The larger the difference, the bigger the improvement in educational attainment among different age groups in the resident population—the 30-year time-series chronology in figure 1.3 goes “big square-circle-small square-big triangle.” The countries are ranked by the educational attainment of age group 25–34.

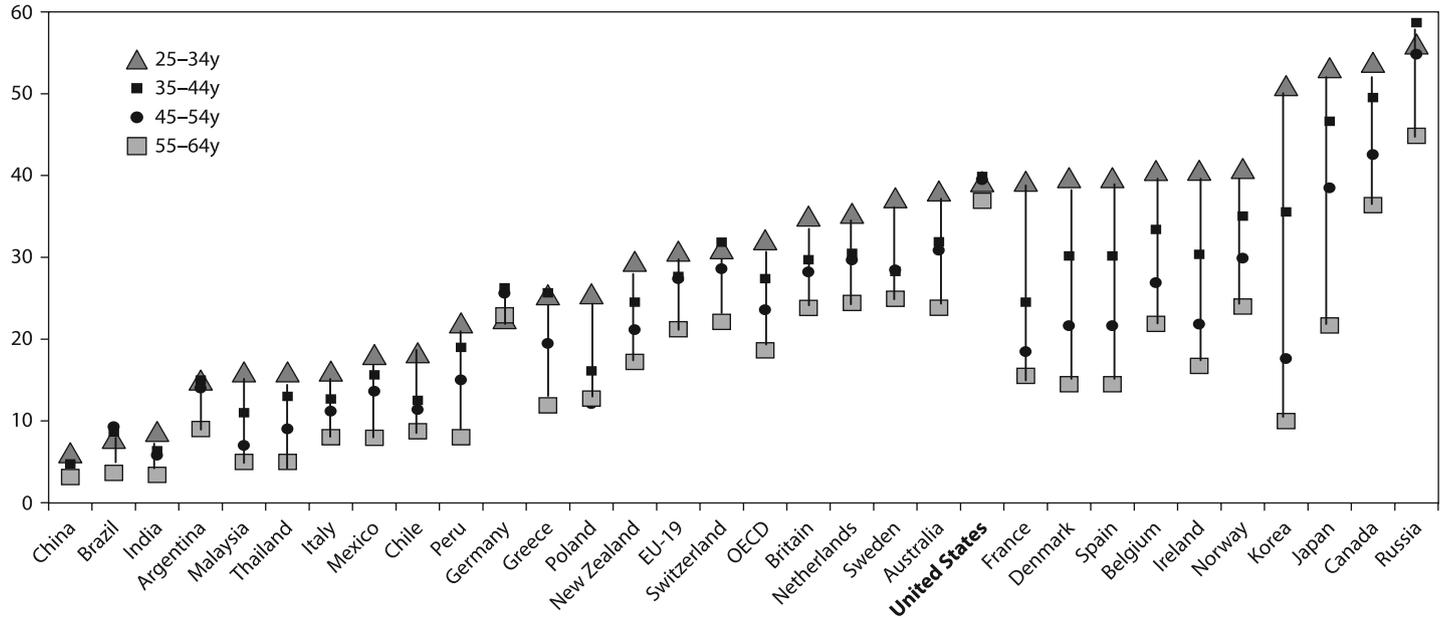
It is important to note that no attempt is made in figure 1.3 to “adjust for quality differences” in tertiary educational experiences between countries. Of course, not every university around the globe is a Harvard, Stanford, Cambridge, or Indian Institute of Technology, so invariably considerable “skill aspects” are not included in figure 1.3. Such comparisons are significantly beyond the scope of this policy analysis. However, following the axiom that tertiary training is what principally enables individuals to quickly grasp new complex subjects and therefore makes it easier to train them on the (especially services-sector) job, it seems evident that in terms of describing the overall level of high-skilled workers in different countries’ workforces, any impact of quality differences among universities will be swamped by the quantitative differences in tertiary skill uptake depicted in figure 1.3.¹⁶

Several things are clear from figure 1.3: First, Americans aged 55–64 by and large were the most highly skilled “free-market generation” of

16. See also data (presented later) on the share of foreign students at US universities. Their rising numbers further hamper any attempt to “adjust for quality differences” in university experiences between countries.

12 **Figure 1.3 Share of population with tertiary education, by age, 2005**

percent of age group



Note: Tertiary education means at least a college degree. Data are for 2005 or latest available from 2003–04. The way to interpret this figure is to look at the difference (i.e., vertical distance) between the age groups. The larger the difference, the bigger the improvement in educational attainment among different age groups in the resident population—the 30-year time-series goes “big square-circle-small square-big triangle.” The countries are ranked by educational attainment of age group 25–34.

Sources: UNESCO/OECD World Education Indicators; OECD (2007d); for China: National Bureau of Statistics of China (2005); for India: Ministry of Statistics and Programme Implementation (2005).

their time, beaten only by their Russian counterparts, who until 1991, from the perspective of competing workers, were “securely” imprisoned by the absurdities of communism and a centrally planned economy.¹⁷ As such, no group in the world would have been in a better position to take advantage of trade liberalization and the opening up of global markets in the latter part of the 20th century than this group of Americans. There is little doubt that this erstwhile skill superiority of the US population has been the backbone of US political support for free trade in the 20th century (Scheve and Slaughter 2001). Stated in another way, up until and including the time when Americans aged 55–64 entered the labor force, America had, in Heckscher-Ohlin terms, abundant skilled labor among resident labor-market entrants relative to the rest of the world.¹⁸

Second, it is evident from figure 1.3 that the skill level expressed in terms of university education that America achieved in the late 1970s and has barely maintained since is not particularly impressive in the 21st century when compared with other countries. While the United States and Germany¹⁹ are unique among OECD countries in having seen stagnating or declining average skill levels by this broad measure over all four age groups presented in figure 1.3, the educational attainment in many countries has continued from generational cohort to generational cohort in recent decades to soar past the levels achieved in the United States. Most impressive is South Korea, which has seen the share of university graduates among labor-market entrants rise from 10 to 50 percent in the approximately 30-year period captured in figure 1.3. Many other countries have also seen dramatic improvements—Japan, Canada, France, Spain, the Scandinavians, and Ireland are all at or significantly above the skill level found among US residents aged 25–34.

Moreover, it is noteworthy that while the average skill levels in Russia have stagnated in the last 20 years—which is not too surprising given the economic turmoil and crisis in the country—this stagnation has occurred at a much higher average skill level than in the United States (or Germany). As such, while their parents may have been “the brightest kids on the global trading block” when they entered the workforce, younger

17. On the other hand, the ability of a Soviet-style planned economy to “order” the production of a large number of university graduates should clearly not be underestimated.

18. The United States led the industrialized world in educational attainment from early in the 20th century; see Goldin (2001) and Goldin and Katz (2003). This supremacy was achieved by an education system that in the words of Goldin (2001, 3) was characterized by “public funding, openness, gender neutrality, local (and also state) control, separation of church and state, and an academic curriculum.” See also Leamer (1984).

19. For a description of the dismal state of German university education, see, for instance, Burda (2006a, 2006b).

Americans today barely make the global top 10.²⁰ Simply put, America in the 21st century is no longer a skill-abundant country relative to an increasing share of the rest of the world.

Third, with the best-educated 55–64 year olds in the world, America faces an imminent disproportionately larger skills drain into retirement than other industrialized countries. Even if the skill levels of the resident workforce in, say, Canada or other countries with continuous improvements started stagnating today as they did in America in the late 1970s, it would still be about 30 years before they faced the same relative skill drain into retirement that America presently confronts. Should these countries find themselves in a similar situation (ignored so far by policymakers in Washington), they will have ample time for long-term reforms of their education system.

At least three issues emerge from the two trends in workforces described so far in this chapter—i.e., stagnating US university-degree skill levels since the late 1970s and accelerating relative decline versus other industrialized nations.²¹ First, a relatively broad-based skills shortage in the United States extending significantly beyond the “usual suspect” fields of science and technology (see below) seems probable in the medium term. This shortage seems likely to accelerate already high US wage differentials between high- and low-skilled workers. The data in figure 1.1 thus should serve to allay many broader concerns about the labor-market situation facing high-skilled Americans in the coming decades.²²

Second, the economics literature is fairly clear that skill levels overwhelmingly determine the attitudes of rich-world populations toward free trade²³: High-skilled workers broadly favor free trade and vice versa. In light of the stagnation seen in US skill levels in the last 30 years, it is not surprising that age generally has little discernible effect on perceptions toward international trade.²⁴ However, one may speculate that the relative decline in skill levels among younger Americans versus their counterparts in other industrialized nations and developing economies like China

20. This is also reflected in the fact that in the late 1970s, 30 percent of the world's university students were in America; today that share has declined to 14 percent (NCEE 2007).

21. This accelerating decline arises from both a lower share of university degree holders among labor-market-entering cohorts and relatively higher numbers of university-trained retirees.

22. The US Census Bureau (2007, table 613) shows that the unemployment rate among college graduates has since 1992 consistently been more than 1 percent below that among non-graduates and always about or below 3 percent or essentially full employment.

23. See, for instance, Scheve and Slaughter (2001).

24. See, for instance, Scheve and Slaughter (2001) or the German Marshall Fund (2006, question 3.2) for another recent survey showing virtually similar views toward international trade among Americans of different age groups.

and India²⁵ may start eroding support for international trade among this group.

Third, and of most direct interest to this analysis, America will feel the full impact of the 30-year stagnation in skill levels in the US workforce when many baby boomers begin retiring, which makes expeditious reform of US high-skilled immigration policies imperative. Urgent reforms of the broader US education system²⁶—even if immediately and successfully implemented—will produce more young American graduates only in the long term. However, in the short term—say at least over the next decade—only high-skilled immigration can provide American employers with the skilled workforce they need to continue to compete and expand in a global skills-biased economy.

Size and Educational Characteristics of Foreign-Born Populations in Rich Countries

The broader US debate on immigration is occasionally framed within the perception of “American exceptionalism” (Lipset 1996)—that America is the number one destination of immigrants in the world and that US borders are far more open to immigrants than almost anywhere else in the world. This perception is partly rooted in US history—that America was a “New World immigrant nation.” Numerically, the United States does take in far more immigrants than any other country today, but it is important to distinguish between simple “immigration size effects”—the United States welcomes more immigrants than other countries because it is a bigger country and has a larger population—and “large-scale immigration.” While the United States continues to welcome many immigrants today, it probably welcomes fewer immigrants relative to other rich countries than many Americans believe. This section provides recent comparative data for the OECD countries to illuminate this issue.

One must first carefully and coherently define “immigrants” across different countries. This superficially simple task is severely inhibited by axiomatic dissimilarities in the way different countries organize their

25. It is clear that economic liberalization in both India and China in recent decades has brought millions of new highly skilled workers into the global labor force. This, however, is a one-off stock effect almost exclusively the result of trade policy liberalizations and not directly related to longer-term improvements in the average skill levels of the Chinese or Indian populations. Moreover, it can be seen in figure 1.3 that both countries are rapidly expanding the number of university graduates each produces, albeit from a very low base. It is less clear that many of these graduates are all truly available to the global economy. See, for instance, McKinsey Global Institute (2005) for estimates that perhaps only as few as 10 percent of Chinese graduates are truly part of the global workforce.

26. See NCEE (2007) or OECD (2007b) for a list of required reforms.

population censuses. Some define immigrants as foreign nationals—i.e., current residents with foreign citizenship. Given the very large differences among OECD countries in access to citizenship—for instance, it has been traditionally relatively easy to acquire citizenship in most Anglo-Saxon countries while extremely difficult, if not outright impossible, in “blood-line oriented” countries like Germany or Japan—such methodological issues may completely invalidate cross-country comparative data.²⁷

Instead, one can use the concept of “foreign-born” from the OECD’s Database on Foreign-born and Expatriates²⁸—i.e., a resident person born outside the country in question—as a possible intuitively valid definition of “an immigrant.”²⁹ The “foreign-born” definition eliminates any differences in countries’ rules for granting citizenship, and valid cross-country data may thus be presented. The “foreign-born” definition, however, ignores cultural or ethnic differences among people born in a given country. The OECD database further relies exclusively on national census data and therefore to the degree that these data are included in the database, it also covers estimates for illegal immigration. Illegal immigrants are thus included in the “foreign-born” data for the United States.

Figure 1.4 shows that while the share of foreign-born in the US population was relatively high in 2005, it was by no means among the highest in the OECD. Other traditional Anglo-Saxon destination countries like Canada and New Zealand, for instance, had shares of foreign-born population fully 50 percent higher than that of the United States, while Australia’s was almost double that of the United States. Alpine countries such as Switzerland and Austria also had a higher foreign-born population share than the United States.³⁰ It is thus erroneous to assume that US borders have been much more open than many other countries or that in relative numeric terms the United States is more of a destination country than many other countries.

The fact that the foreign-born population shares in several continental European countries like Germany, Sweden, Belgium, the Netherlands, and Greece are more than 10 percent—quite similar to, if slightly below, the US level—further underlines the fact that the levels in the United States are far from unusual and certainly not exceptional.

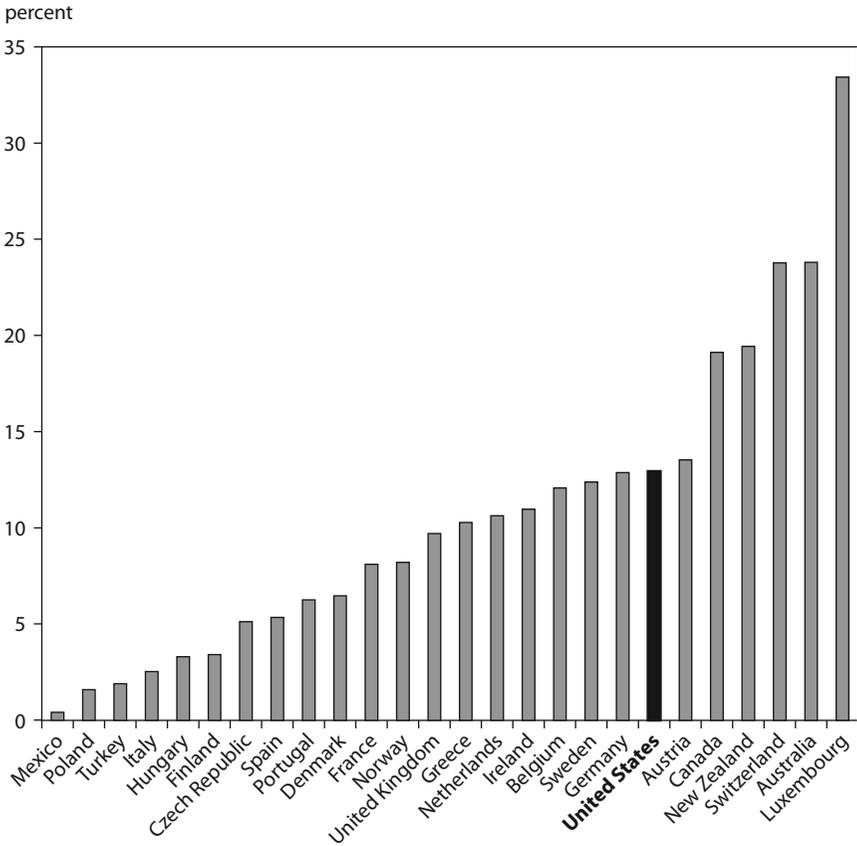
27. See Dumont and Lemaitre (2005) for details.

28. The database covers all aged 15 and above. It is available at www.oecd.org.

29. For US data, foreign-born is defined as anyone who is not a US citizen at birth. They include naturalized US citizens, lawful permanent residents (immigrants), temporary migrants (such as students), humanitarian migrants (such as refugees), and persons illegally present in the United States. The latter—illegals—is an important inclusion in US data. See the Census Bureau’s website at www.census.gov.

30. See also Lowell (2007) for immigration data for the 1975–2005 period, which show a significant rise in immigrant populations across the developed world.

Figure 1.4 Foreign-born population as share of total population, 2005 or latest available

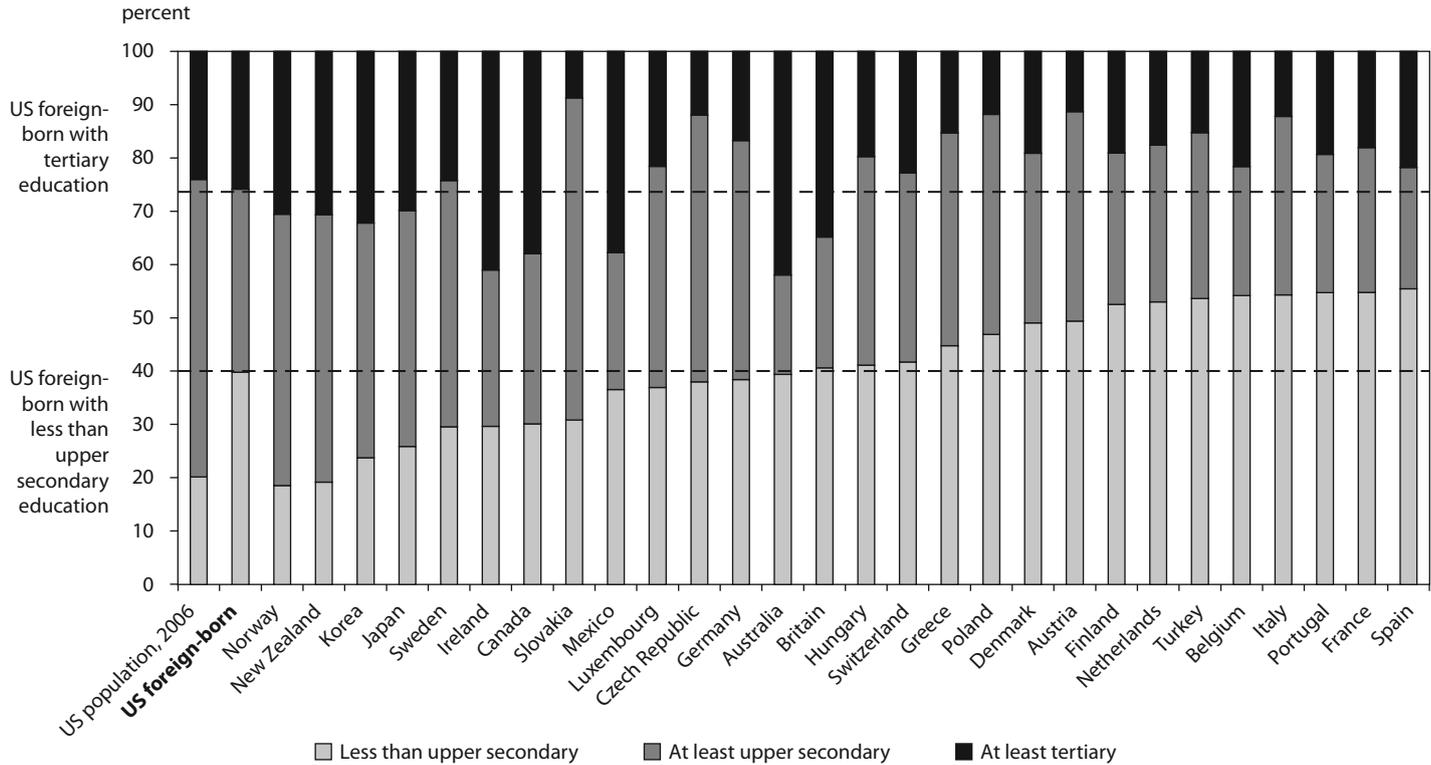


Source: OECD (2007c).

In addition, some commentary on US immigration is rooted in the belief that the immigrant population here is disproportionately low skilled. The most recent data on the educational attainment of foreign-born populations in the OECD are presented in figure 1.5.³¹

The figure illustrates several points: The first bar shows the educational attainment of the entire US population 15 years and older in 2006

31. All foreign-born whose educational attainment could be ascertained are included. In some countries, though not the United States, some foreign-born were coded as “unknown” in the OECD database. Generally, the “unknowns” represented a small share (less than 20 percent) of the total number of foreign-born. As there is no immediate reason to believe that the “unknowns” category is systematically biased toward any particular educational category, its exclusion from the data in table A.1 will not impact the conclusions drawn.

Figure 1.5 Educational attainment of foreign-born population, 15 years and above, circa 2000

Sources: Bureau of Labor Statistics and Census Bureau, Current Population Survey, available at www.bls.gov/cps; OECD Foreign-born and Expatriates Database.

from the same data source in figure 1.1. The second bar shows the latest available data on the educational attainment of the US foreign-born population. The foreign-born population has slightly more high-skilled people (those with tertiary education) than does the entire US population. By this metric, therefore, the immigrant population is as skilled as the US population at large and decisively not low-skilled relative to the total US population.

However, figure 1.5 shows that the share of foreign-born population with less than secondary education is twice as large (40 percent) as that for the US population as a whole (20 percent). This difference may sound quite dramatic. However, recall that the demarcating feature between having attained at least upper secondary education and not having done so is whether an individual has graduated from high school or not. What figure 1.5 ultimately translates into is that, if one more out of every ten immigrants who have come to the United States had graduated from high school, the foreign-born population would in terms of educational attainment essentially have mirrored the US population as a whole.³² This difference is definitely not trivial, but it hardly constitutes a flood of relatively low-skilled workers either. Indeed, figure 1.5 seems to validate descriptions of the US immigrant population as being “hourglass shaped” with many high-skilled and many low-skilled individuals.³³

Equally important, figure 1.5 shows that the overall educational attainment of the US foreign-born population circa 2000 was far from unusual. Several countries have far larger shares of high-skilled foreign-born residents than the United States. The same is true for shares of low-skilled immigrants: A majority of European countries have significantly higher shares of foreign-born residents with less than upper secondary education than does the United States.

The bottom line: The United States is certainly big in immigration terms, but there are few traces of exceptionalism.

High-Skilled Workers in Science and Engineering

A frequently voiced concern about the economic future of the United States is the declining interest among younger Americans in the “hard sci-

32. Note further that the relative similarity between the foreign-born population and the US population as a whole enhances the validity of the “time-series use” of the Census Bureau data in figure 1.1. It seems unlikely that any of the particular age cohorts will have been systematically affected in a biased manner by inflows of immigrants.

33. Passell (2007) shows that a higher share of legal immigrants in the United States had at least a college degree than did the US native population in 2005. Smith (2006) shows that the disparity in the number of school years completed between foreign-born aged 25+ and all native-born aged 25+ declined from 2.1 years in 1940 to just 1.3 years in 2002.

ences” of science and engineering (S&E) and the subsequent acute shortage of workers in these fields. It is beyond the scope of this policy analysis to explore this concern in depth,³⁴ but figure 1.6 on total number of US graduates and share of S&E graduates illustrates a few key points.

First, the relative stagnation in US education since the late 1970s can also be noticed in figure 1.6. While the total number of US graduates at all levels may have continued to rise every year, only up until the mid-1970s did it rise sufficiently fast to also increase as a share of the rising total US population.³⁵ Figure 1.6 shows that the relative interest in S&E—measured as a share of total graduates at the undergraduate, graduate, and doctoral levels—has hardly declined since at least the mid-1970s. As such, the issue is rather a decline in interest in general educational improvement, as opposed to a relative decline in interest in S&E.

Some might say that these S&E numbers are relatively stable only because today—unlike in earlier decades—many S&E students at America’s universities are foreigners rather than American citizens. This is definitely true but not as true as many think when one looks at recent data.

Figure 1.7 shows that the share of foreign graduate S&E students on temporary visas—i.e., neither US-born nor permanent residents—has increased substantially in the last 25 years, even though a recent 9/11-related decline can clearly be identified.³⁶ However, it is noteworthy that this gradual 25-year increase came from an already relatively high level as early as 1980.³⁷ At no point since at least 1980 has the foreign share of total engineering graduate students in the United States been below 40 percent. The same has been true for mathematical, physical, and computer sciences since the mid-1980s. In other words, the heavy reliance on foreign S&E students is not a novelty at US universities but has been the state of affairs for at least a generation.

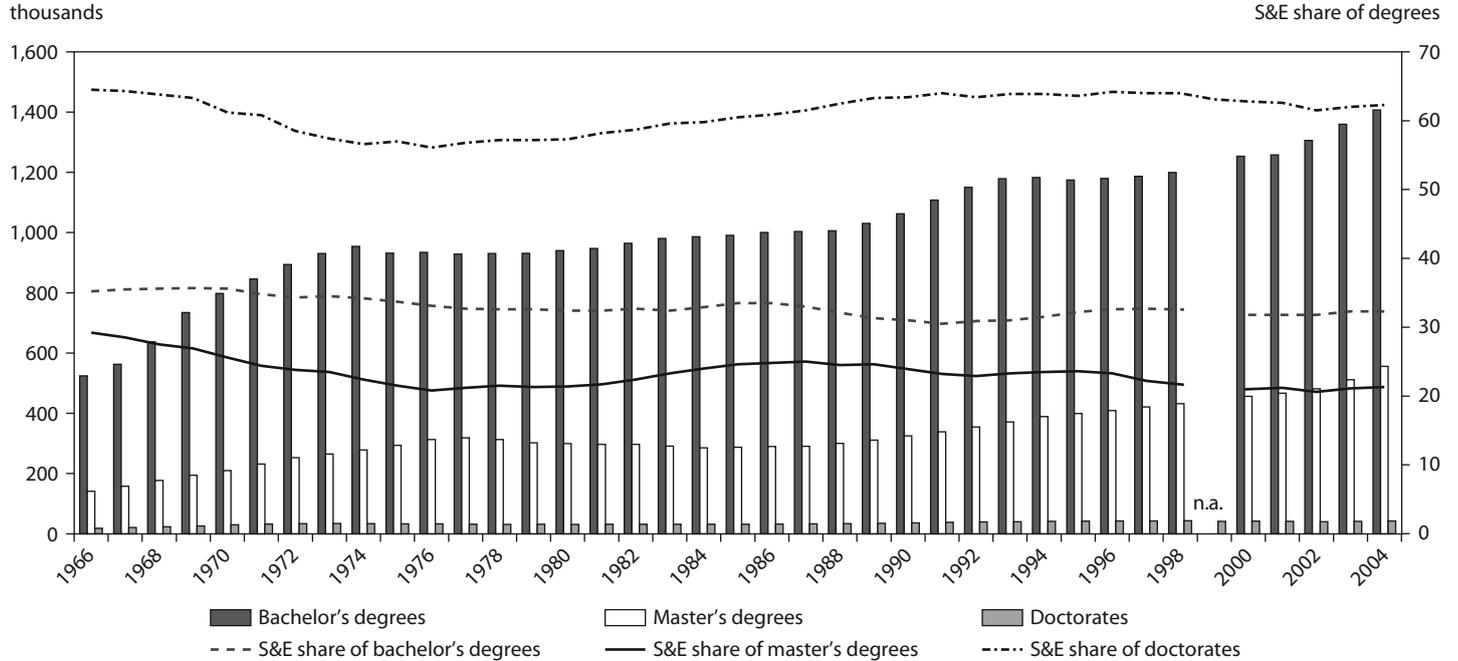
34. See, however, National Science Foundation, *Science and Engineering Indicators 2006*, available at www.nsf.gov.

35. This excludes the four effects from footnote 6, namely immigration, lifelong learning, demographics, and mortality.

36. The effects of 9/11 arise from several issues: tightened US visa requirements, the perception among foreign students that “getting a US visa is hopeless” and their subsequent pursuit of graduate education elsewhere, and aggressive marketing by other destination countries positioning themselves as post-9/11 alternatives to the United States for prospective graduate students from third countries. Note, however, that more recent data from the Institute for International Education (2006) for total foreign student intake by US universities show a rebound in 2005–06.

37. Data from the Institute for International Education (2006, table on International Students by Academic Level, Selected Years 1954/55–2005/06) covering the period from the mid-1950s for the total number of foreign students among US bachelor’s, master’s, and doctoral students indicate that their numbers swelled dramatically during the 1970s from earlier relatively low levels.

Figure 1.6 Annual number of degrees awarded at US universities and S&E share of degrees, 1966–2004



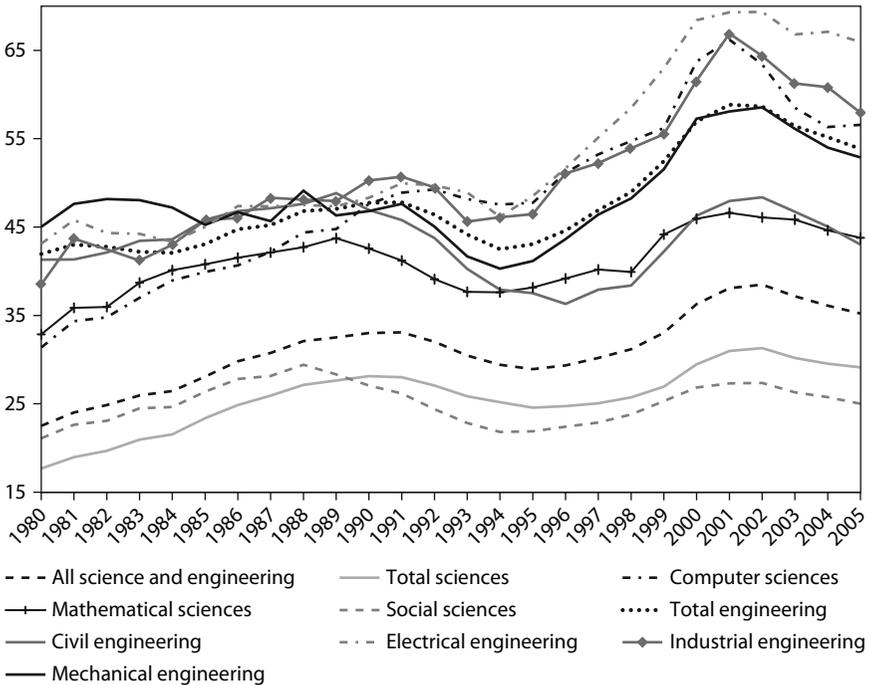
S&E = science and engineering

Note: Data for bachelor's and master's degree holders not available (n.a.) for 1999.

Source: National Science Foundation (2007).

Figure 1.7 Foreign science and engineering students at US universities, 1980–2005

percent share of full-time graduate students on temporary visas



Source: National Science Foundation (2007).

The real issue at present is therefore not that more foreigners are studying S&E in America (they clearly are) but whether or not the United States can maintain its traditionally very high retention rate among highly skilled foreign S&E students. A significant number of these students have historically remained and taken jobs in America upon graduation instead of returning to their countries of origin. Slightly old data from the National Science Foundation (1998) indicate that from 1988 to 1996, approximately two-thirds of foreign S&E doctoral recipients planned to stay in the United States, with the share rising to 79 percent for Indians and 86 percent for Chinese recipients.³⁸ On the other hand, only 36 percent

38. Slightly more recent data in Finn (2005) show that 61 percent of all foreign S&E doctoral

of Korean and 48 percent of Taiwanese recipients intended to stay. As citizens from these four Asian countries accounted for almost 80 percent of all foreign recipients, their intentions mattered. It is noteworthy that the US retention rate among Asian recipients from the more developed economies of South Korea and Taiwan was significantly lower than for China and India. This raises the issue of whether, as China and India gradually achieve developed-economy status and other countries accelerate their intake of Chinese and Indian immigrants,³⁹ the United States will be able to continue to hold on to the vast majority of S&E graduate students from these two countries or whether Chinese and Indian students will become as likely as South Koreans and Taiwanese to return, as economic opportunities in their home countries and elsewhere improve.

More recent, but less geographically detailed, data from Auriol (2007) indicate that in 2003, fully 40 percent of all recent foreign doctoral degree recipients in the United States intended to leave, indicating that the US labor market may not be quite as attractive as it was in earlier decades. Should this trend of departing foreign graduate and doctoral S&E students accelerate, it would pose a substantial threat to the supply of S&E skills to the US workforce.⁴⁰ (See box 1.1.)

At the same time, however, Auriol (2007) also shows that recent doctoral degree recipients who are US citizens are very immobile compared with their noncitizen counterparts, with only 5 percent intending to leave the United States. This indicates that the United States does not suffer any significant hemorrhage of domestic doctoral students and that expeditiously granting foreign students US citizenship could be an effective way of keeping them in the United States after graduation (see also chapter 3).

The age profile of the exiting S&E workforce further accentuates the need to continue to retain a very high level of foreign students in the US workforce. Figure 1.8 shows that, while the age profile of the degree-holding S&E workforce is perhaps slightly younger than the overall university-educated US workforce,⁴¹ a substantial number of S&E degree holders

degree recipients in 1998 worked in the United States five years after graduation—i.e., in 2003.

39. Data from OECD (2007c, figure I.8) show that the 2005 share of inflows of Chinese and Indians to all OECD countries with available data (including the United States), except Spain, Italy, Hungary, and the Czech Republic, were significantly above the share of Chinese and Indians in the countries' total stock of foreign immigrants, indicating a relative acceleration in intake from these two countries.

40. This threat is highlighted by the American Electronics Association (2005, 2007).

41. This is not surprising, because computer sciences as a field of study, for instance, has existed in scale only for about 25 years; it hardly existed when the 55–59 year olds entered the workforce.

Box 1.1 The high-skilled immigrant entrepreneur—shut out at America’s increasing peril

The entrepreneurial zeal of many immigrants in America is well known and can be witnessed when walking on the streets of any American city today: A number of restaurants, grocery shops, convenience stores, or dry cleaning businesses are very likely to have been started by recently arrived immigrants. Undoubtedly, this constant inflow of entrepreneurial zeal—and the possibilities to utilize it in a lightly regulated economy—represents one of the biggest economic advantages America has over other countries in the 21st century. This advantage is also captured in the 2006 Kauffman Index of Entrepreneurial Activity, which shows that the incidence of entrepreneurship among immigrants as a whole was on average 25 percent above that of native-born Americans in the decade from 1996 to 2005.¹

Immigrants are also increasingly becoming a very important component of America’s treasured high-tech entrepreneurs. A survey by Duke University and University of California–Berkeley (2007) shows that fully one-quarter of all newly founded engineering and technology firms in America between 1995 and 2005 had at least one foreign-born founder, while in the Silicon Valley area, this share rose to more than half (52 percent). In software, computer/communications technology, and semiconductors, the shares of foreign founders were all over one-quarter the national US average. By 2006, these US engineering and technology companies, fully or partly founded by immigrants in 1995–2005, employed a total of 450,000 Americans and had annual sales of \$52 billion.

Another survey carried out by the National Venture Capital Association (2007) of all publicly traded venture capital–backed companies founded since 1970—the vast majority of which can be assumed to have been founded by high-skilled individuals—showed similar results. The survey found a substantial rise in the share of immigrant-founded venture capital–backed companies in America. The share rose from just 7 percent in 1970–80 to 20 percent in 1980–89. This corresponds closely with the finding in this chapter that starting as early as 1980, a large share of science and engineering (S&E) graduate students at US universities were foreign nationals. The share of immigrant-founded venture capital–backed publicly traded companies in America rose to 25 percent between 1990 and 2005. In other words, as all immigrant-founded venture capital–backed companies have been in “S&E type” sectors,² it is clear that the large and increasing share of foreign S&E students in America is being directly reflected in America’s population of high-skilled entrepreneurs.

Certainly, some successful high-tech firms will be founded by Bill Gates–like college dropouts³ or others with irrepressible new ideas, but the overwhelming majority of them have been and will continue to be founded by highly skilled people with

(box continues next page)

Box 1.1 The high-skilled immigrant entrepreneur—shut out at America’s increasing peril (*continued*)

university degrees in S&E fields. If America wishes to benefit from new eBays, Yahoo!s, or Googles⁴ in the future, it must not only maintain its flexible business startup-friendly economy but also ensure that tomorrow’s high-skilled technology entrepreneurs gain access into the country in the first place.

1. This index measures the percent of individuals (aged 20–64) who do not own a business in the first survey month but start a business the following month, working 15 or more hours per week (Kauffman Foundation 2006).
2. The sectors involved were high-tech manufacturing; information technology; life sciences; professional, scientific, and technical services; other services; other manufacturing; finance and insurance; and e-commerce (National Venture Capital Association 2007).
3. Incidentally, Harvard University still considers Bill Gates a member of its Class of 1977, despite the fact that he himself claims to have left Cambridge of his own volition in 1975 before graduating. See *FT Observer*, June 5, 2007.
4. eBay’s cofounder Pierre Omidyar is French, Yahoo!’s cofounder Jerry Yang is from Taiwan, and Google’s cofounder Sergey Brin was born in Russia.

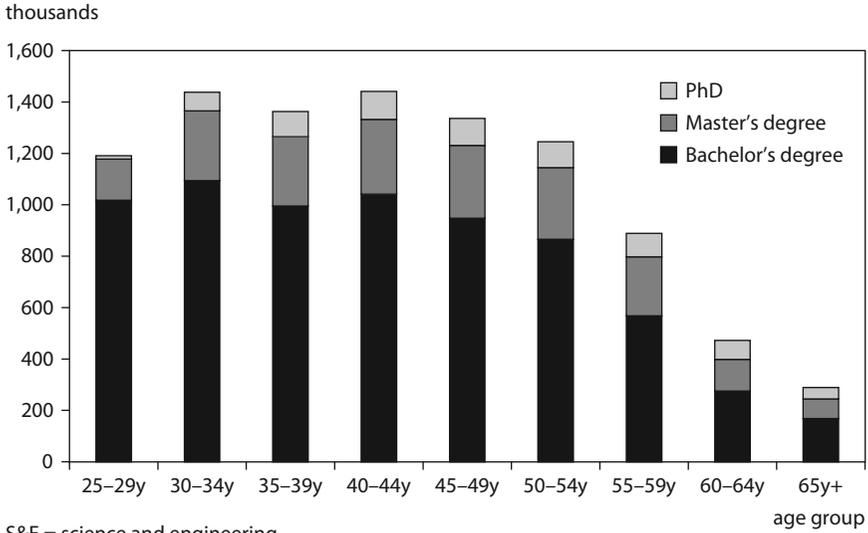
will nonetheless in the coming decade pass into some form of retirement.⁴² Moreover, as is the case with the degree-holding US population, younger cohorts aged 30–34 with S&E degrees are not substantially more numerous than their colleagues 20 years older. Unequivocally, therefore, America will (continue to) become ever more reliant on retaining US-trained foreign high-skilled S&E talent in the workforce, both because their share of supply is rising and because the existing stock will increasingly be retiring.

It is beyond the scope of this policy analysis to discuss required reforms of the broader US S&E education system,⁴³ but the data in this section raise at least two S&E immigration-related issues: US high-skilled im-

42. Figure 1.8 shows that more than 300,000 individuals aged 65+ remained in the US labor force in 2003. However, as pointed out in chapter 3 of the National Science Foundation, Science and Engineering (NSF S&E) Indicators 2006, exact retirement age is a complex matter, with part-time jobs frequently replacing previous full-time employment. Table 3.16 in NSF S&E Indicators 2006 shows that by age 62, more than half of all S&E bachelor’s and master’s degree holders had retired from all types of employment in 2003, while half of the doctoral degree recipients had retired by age 65. The same publication’s annex table 3.14 shows that by age 65, just 31 percent of S&E bachelor’s and master’s degree holders worked full time, while 53 percent of the PhDs did so. This figure corresponds to a total US labor force participation for the 60–64 year olds in 2003 of 51 percent (and rising), 27 percent for 65–69 (and rising), 15 percent for the 70–74, and 6 percent for the 75+ group (Current Population Survey data). Hence the effective retirement age of the US S&E workforce is not that different from the US workforce as a whole.

43. See, however, National Academy of Sciences (2007) for an excellent blueprint on these much-needed reforms.

Figure 1.8 Individuals in US labor force with S&E or S&E-related highest degrees, 2003



S&E = science and engineering

Source: National Science Foundation, Science and Technology Indicators, 2006, table 3.13.

migration policies must increasingly focus on retaining US-trained S&E talent in the US workforce and must also remain generally open for continued inflows of foreign-trained S&E workers.

Global High-Skilled Talent: An Increasingly Sought After Resource

International migration can be roughly split into six groups: (1) family-related (through reunions and marriages), (2) humanitarian (typically refugees from United Nations quotas or asylum seekers), (3) employment-related (permanent), (4) employment-related (temporary), (5) student, and (6) illegal. The categories of family-related, humanitarian, and illegal immigrants are of limited interest here, as their high-skilled component is usually limited.⁴⁴ The student category is almost exclusively by definition

44. As a clear trend exists for the highly skilled to marry highly skilled, there is a possible high-skilled component here, but for the purposes of this analysis, it can be ignored. Passell (2007, table 2) presents data showing that 17 percent of unauthorized immigrants, or 1.3 million, in the United States in 2005 had achieved at least a bachelor's degree. Many in this group likely are individuals admitted on a high-skilled temporary visa like the H-1B or F-1 student visa who have remained in the United States after their visa expiration. This is a significant number, but many of these unauthorized but high-skilled immigrants

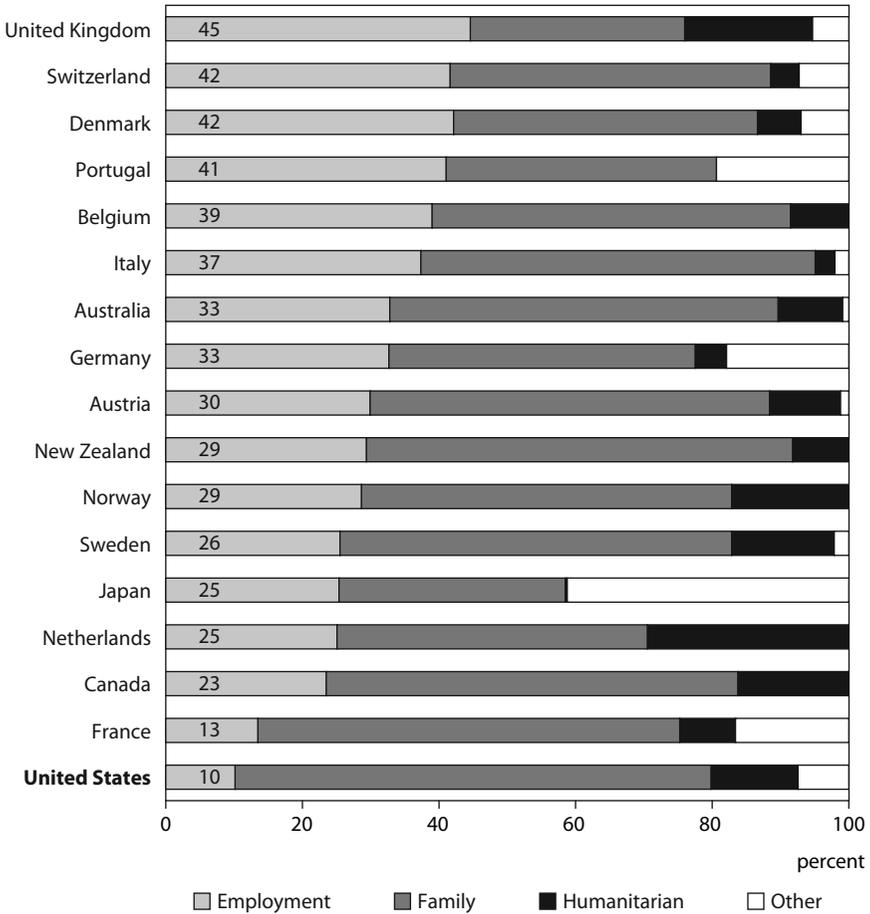
made up of high-skilled immigrants, while both permanent and temporary employment migration have high- and low-skilled components. As can be seen in figure 1.9 (which, however, does not include data on illegal immigrants), in 2005 US permanent immigration policy was far less oriented toward employment than those of other OECD countries. Only one-tenth of new permanent immigrants in the United States in 2005 arrived directly for employment-related reasons, compared with more than twice that in Canada, three times that in Australia and New Zealand, and more than four times that share in the United Kingdom and several other European countries.

Rather, the overwhelming majority of permanent US immigration is—as explicitly stipulated by US immigration law—family-oriented. Given this overwhelming dominance of family-related immigration in total US immigration numbers, it is striking that the National Science Foundation (2007) finds that of all US immigrants with an S&E education (about 3.4 million) in 2003, only 37 percent arrived for family reasons; the number declines to 27.5 percent for S&E immigrants who arrived after 1994. Moreover, these numbers are skewed by the arrival of immigrants younger than 18 years at the time of first entry who subsequently went on to pursue S&E education in the United States. Among S&E-related immigrants with a master’s degree, the share of family-related immigration drops to 30 percent, while among S&E doctoral degree holders, it is merely 16 percent. In other words, despite dominating total US immigration, family is a far less important issue when it comes to attracting S&E-educated foreigners. As other OECD countries increasingly move toward policies of “managed”—i.e., employment-oriented—immigration, this continued focus of US immigration policy on family seems likely to increasingly put the country at a disadvantage relative to other rich countries in attracting high-skilled workers from third countries, because high-skilled workers are less numerous among family-based immigrant groups.

Training foreign high-skilled workers locally is the easiest way to attract them into a country’s workforce. Among international students, the United States remains by a substantial margin the largest destination country, although its share of global foreign students dropped from 25.3 percent in 2000 to 21.6 percent in 2004 (Balatova 2007). Other Anglo-Saxon countries have long competed with US universities for foreign students, but today many non-English-speaking countries, particularly in northern Europe, also offer most S&E courses in English—the globally dominant academic language today—to attract more nonnative students.

seem unlikely to take up jobs in occupations where they can fully utilize their high-skilled capabilities. As such, they seem far more likely to take up lower-skilled jobs for which they are therefore likely significantly overqualified. Their number notwithstanding, it remains pertinent to not take them into account in this analysis.

Figure 1.9 International permanent migration by category of entry, selected OECD countries, 2005 (percent of total inflows)



OECD = Organization for Economic Cooperation and Development

Source: OECD (2007c).

Equally important, more countries are now emulating the US policy of offering foreign students an optional one-year work permit upon graduation⁴⁵ to entice them to stay. Australia has since 1999 made it relatively easier for foreigners with local degrees to obtain permanent residency via its points-based system, while in 2006 Canada eased the restriction of

45. In the United States, this system is known as optional practical training (OPT) and is available once to all foreign graduates from US universities. See, for instance, the page on Applying for F-1 Optional Practical Training at www.oiss.yale.edu for more information.

off-campus work for graduate students and in 2005 made it possible for them to stay for up to two years after graduation.⁴⁶ In May 2007 the United Kingdom expanded its year-long optional work visa program for graduates from just S&E fields (since 2004) to cover all bachelor's and graduate degree recipients.⁴⁷ In 2007 France introduced its new "first professional experience option," which grants foreign students in degree/diploma tracks the option of a six-month renewable visa to search for and accept employment in France (Murphy 2006). Even the usually highly immigration-resistant German government announced in August 2007 that foreign students who finished their degree in Germany (of which many are in science, technology, and engineering) would be eligible for a three-year work permit upon receiving a job offer.⁴⁸ Similar initiatives have also recently been implemented in other EU countries, so the United States as the "market leader" is clearly facing rapidly intensifying competition for foreign students as workforce entrants.⁴⁹

The traditional Anglo-Saxon immigration destination countries of Australia, Canada, New Zealand, and the United Kingdom for a long time have had explicitly skills-oriented immigration policies in place, focusing on granting access to foreigners possessing an adequate number of "skills points."⁵⁰ However, as laid out in OECD (2006b and 2007c), and illustrated in figure 1.10, more OECD countries are putting in place immigration systems intended to "actively manage" national immigration, rather than letting it be driven by family-related and humanitarian considerations. Figure 1.10 shows that traditionally other Anglo-Saxon countries have had a higher share of highly educated immigrants than the United States (about 25 percent). In recent years, however, more European countries have surpassed the US share. Even notoriously immigration-resistant Japan in 2006 changed its Immigration Control and Refugee Recognition Act to facilitate immigration of researchers and engineers (OECD 2007c, 98f).

46. See Citizenship and Immigration Canada press release, Canada's New Government to Extend Off-Campus Work Program to More International Students, December 14, 2006, available at www.cic.gc.ca; see also the web page on "Studying in Canada: Work Permits for Students" on the same website.

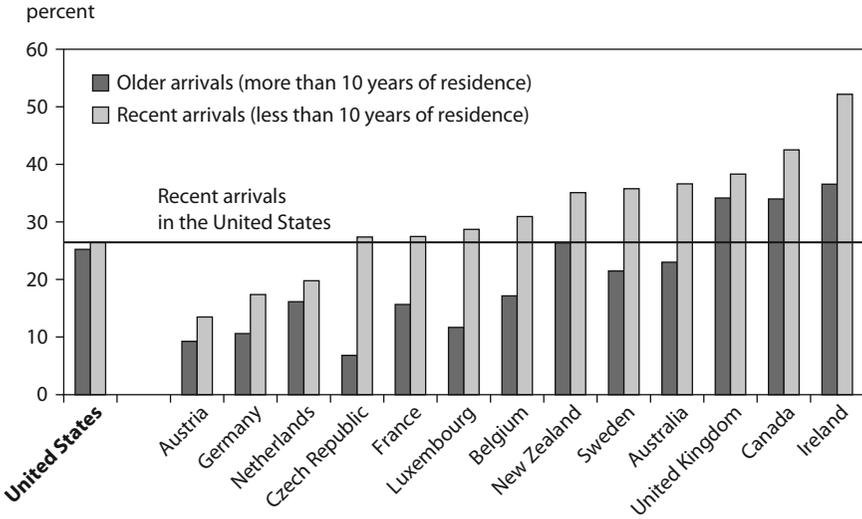
47. See UK Department for Children, Schools and Families, press notice, New International Graduates Scheme—Rammell, March 28, 2007, available at www.dfes.gov.uk.

48. See "Germany Softens Restrictions of Central and Eastern European Workers," Euractiv.com, August 27, 2007, www.euractiv.com.

49. This issue has been explored in greater detail in National Academy of Sciences (2005). Lowell (2007) shows that the inflow of skilled migrants to more developed countries rose rapidly during the 1990s and that European countries increased their share of the increasing total during this period from 20 percent in 1990 to 23 percent in 2000.

50. For a summary description of the Australian high-skilled immigration points system, see White (2007); for Canada, see Clark (2007); and for the United Kingdom, see Feikert (2007). Chapter 3 further discusses these points systems.

Figure 1.10 Share of immigrant population 15 years and older with at least tertiary education, circa 2000



Source: OECD Foreign-born and Expatriates Database.

Managed migration policies invariably mean policies aimed at attracting more high-skilled workers while restricting access to lower-skilled ones. General exceptions are usually made only when it comes to temporary workers in the agricultural sector. The international trend indicating increased competition for high-skilled foreign labor is evident to the degree that similar immigration measures can also be identified among middle-income countries, such as recent EU members and Mexico (OECD 2007c, 96). Indeed, even at the supranational EU level, there are, at the time of this writing, firm signs that change is in the air (and Europe clearly takes inspiration from existing US immigration laws). EU Justice Commissioner Franco Frattini in mid-September 2007 announced that he would shortly propose creating an EU-wide “blue card,”⁵¹ which would provide non-EU skilled workers temporary EU-wide work permits.⁵²

Developing countries like China and India, traditionally the two largest sources in numerical terms of high-skilled immigrants,⁵³ are starting to

51. Blue is of course the color of the EU flag.

52. See “EU to Propose Blue Card for Skilled Workers,” *EU Observer*, September 14, 2007, <http://euobserver.com>.

53. High-skilled emigrants from China and India have a share of only a few percent in their domestic high-skilled workforces. Therefore the risk of serious brain drain from these

preempt possible future skill shortages as they themselves experience high economic growth. As a result of recent data that show that only a quarter of the more than 1 million Chinese students who went overseas to study from 1978 to 2006 returned to China (Chinese Academy of Social Sciences 2007), the Chinese government in March 2007 issued new guidelines for “green passage” of acclaimed overseas Chinese scientists, engineers, and executives willing to return to China. This eased passage would include such perks as guaranteed university spots for the children of returnees, exemption from the Chinese household residence registration (*hokou*) and tax preferences.⁵⁴ The new policy is aimed at luring back up to 200,000 such overseas Chinese by 2010, which is on top of a 50 percent increase in the number of returnees from 20,000 to 30,000 annually between 2003 and 2005. Should these new Chinese policies prove successful, the United States faces the largest potential adverse impact because it has been the traditional destination of most high-skilled Chinese immigrants.

countries is limited. This, however, is not the case for smaller countries particularly in Africa and the Caribbean: Data from the OECD Foreign-born and Expatriates Database show that high-skilled emigrants from these countries make up almost three-quarters of the domestic high-skilled workforce, and hence brain drain concerns are justified.

54. “The Turning Tide of Overseas Chinese,” *China Daily*, May 30, 2007; “China Hit by Brain Drain, Report Says,” *China Daily*, June 1, 2007.