# COLLEGE FOR ALL?
# THE LABOR MARKET FOR COLLEGE EDUCATED WORKERS

Paul Osterman
MIT Sloan School of Management

Prepared for the Center For American Progress

May, 2008

This paper addresses the pros and cons of a policy aimed at substantially increasing rates of post-secondary education. The focus is whether projected employer demand justifies an expansion of college education.

Although the emphasis of this paper is the job market it is important to recognize at the outset that the case for expanding post-secondary education rests on a number of considerations, only a sub-set of which are the topic of this paper. Equity is an important concern. Over two thirds of children of low income families aspire to a bachelors degree yet just 19 percent of young people from families with incomes below $25,000 obtain a community college degree or higher compared to 76 percent from families with incomes of $76,000 or more[1]. We also know that college attendance is highly correlated with race. For example, in 2006 the fraction of 20-29 year olds with a four college degree or more was 23.7 percent for whites, 12.2 percent for blacks, and 6.7 percent for Hispanics.[2]

In addition to equity considerations there are social benefits to college attendance that go beyond the purely economic. These benefits include the fact that the quality of people's personal lives and their opportunities to be good citizens are enhanced by education. For example there is good evidence that post-secondary education leads to higher rates of voter participation.[3]

The equity and social arguments for improving access to higher education are strong but any substantial effort to increase the overall rate of post-secondary education must also rest on an understanding regarding the labor market demand for employees with college education. Post-secondary education imparts a set of skills and if the demand for those skills is flat or falling then any substantial investment in increasing their supply may not be a wise use of resources. By contrast, if the trajectory of economic growth points towards greater demand for college level skills then the case for improving access is all the stronger.

On the face of it the economic brief for expanding college access seems very sensible. We know that employees with some college or college degrees earn substantially more than do less educated workers and we know that this gap has widened

over the post World War II period. This would seem to imply that the demand for college educated labor is growing and that a policy to increase college access is appropriate. However, jumping too quickly to this conclusion would be dangerous and indeed there are several arguments that have been put forward that minimize the need for a substantial increase in college enrollment. One such argument points to the wage data and notes that in recent years the earnings advantage of the college educated has leveled off. A second argument claims that the wage data do not reflect productivity enhancing learning but rather that college education may simply be used by employers as a method for sorting employees based on other criteria (e.g. social class or race or ability to sit still for long periods of time) and if many more people attend college then employers will then find another sorting tool. Related to this is the view that college attendance is used by workers as a way of signaling their intrinsic ability and in fact adds little to what they can actually do at work. A third argument against an expansion of post-secondary education focuses on occupational projections and notes that a great deal of expected future job growth is projected to come from low skill work.

Put most starkly, these considerations raise a worry that if we sharply increase the supply of college educated labor we will simply start to see more college educated taxi drivers.

This paper takes these arguments seriously and examines the arguments for and against a substantial expansion in secondary education. The first section provides a framework for thinking about the role of education in the job market. There is a great deal of discussion about "college jobs" and "non-college jobs" but just what these terms mean is ill-defined in most treatments. The paper shows that for any given job there is no formal dividing line between "college" and "non-college" jobs but rather the appropriate question is the relationship between the productivity gains that accrue from college compared to the costs of obtaining that education.

The empirical sections of the paper reach the following conclusions:

- The wage data do show that in the past several years the advantages of college relative to high school attainment have leveled off (although they remain substantial). However there have been previous

ebbs and flows in the wage data and there is no reason to believe that in the long run the gains associated with college will disappear.

- Occupational projections suggest that employers' demand for skill will grow over time albeit at a modest rate.
- Direct observation of trends in work organization lead also supports the view that skill demands are increasing.
- The experience of the Open Admissions program at the City University of New York shows that a sudden substantial increase in college attainment did not depress wages but rather that the graduates reaped substantial benefits. Perhaps more importantly, the children of the graduates also performed better over time.
- A comparison of the projected productivity gains associated with a doubling of the rate of college attendance versus the costs of such a policy show that the increased attendance would be good public policy.

## Thinking About the Question

The underlying question that this paper addresses can be framed simply as "is the demand 'college jobs' growing?" The problem, of course, is that jobs do not come labeled "college" and "non-college" and so it is not clear just what this question means. How do we recognize a "college job" when we see one? We all think we understand that a brain surgeon should have a college degree (and more!) and that when a PhD is driving a taxi something is wrong. But beyond these obvious examples how do we capture the idea?

This is an important question because many discussions of this topic assume that it is possible to label some jobs as "college" and then go on to try to count how many such jobs there are.[4] In part this way of thinking is the result of an older romantic view

in which someone who studies French or history sadly finds themselves after graduation doing something prosaic that does not use their higher learning and refined sensibilities. But it is important to move beyond these images.

The analytical problem is that most jobs can be held, and in fact are held, by both college educated people and people with less education. Very few jobs can be labeled as unambiguously requiring a college degree (Bill Gates is, after all, a college drop-out). The proper way to think about the question from a public policy perspective is to ask whether, and by how much, a college education enhances an individual's productivity on a job and then ask whether the cost of providing that college education is justified by the productivity bump. A similar framing from a firm's perspective is to focus on wages: a college job is one for which the productivity gains of hiring a college person are greater than the additional wage that one would have to pay to obtain such a person. Note that in both cases the issue is relative productivity and relative costs. There are no absolutes. The earlier comment about taxi drivers notwithstanding, college education might enable a taxi driver to plan his or her routes more efficiently or manage their gas consumption more cleverly and if the costs of obtaining such a person, relative to a high school graduate, are low then suddenly taxi-driving is a "college job."

Standard economic theory provides a relatively straightforward way of thinking about these considerations. In the labor market supply and demand sets a relative wage for college and high school educated employees, i.e. the ratio of the wages of all college and all high school employees. At this relative wage there are some employers who are indifferent between hiring a high school or a college employee. The college employee may be more productive but the higher wage just offsets this advantage. However, there are many employers (so called "infra-marginal" employers) who, at the going relative wage, prefer college workers. These are the "college" jobs. The point is that the skills that are learned in college are sufficiently valuable on these jobs that they overcome the higher wages that have to be paid.

In this framework when we speak about the trajectory of technology increasing the demand for college employees what is meant is that the margin is shifting further down the job ladder. In relative terms this could happen if technology simply eliminated some non-college jobs (e.g. computers replacing file clerks) but most of the discussion is

about how technical change re-shapes job content. That is, jobs that at the old wage ratio were "high school jobs" or were in the indifferent category are now "college jobs" because the bundle of tasks that comprise those jobs has changed in a manner that increases the advantage of college level skills. So, for example, in manufacturing the increased use of Statistical Process Control and self-managed work teams has meant that for jobs that used to be high school level are now done more productively if the employee has at least some community college. Note how this is phrased: a high school person (or two high school people) might be able to do the job but the advantage has now shifted to a college educated employee because the job can be done more quickly and accurately by him or her.

The framework outlined above is sensible and gets away from the absolutes that characterize too much popular discussion of the issue. The strength is that it relates productivity gains to costs. However, pushed too hard it can also violate common sense. The difficulty is that in a labor market in which wages adjust flexibly all college people by definition end up in "college jobs" because the wage ratio will adjust to assure that they find work. That is, if there is a big increase in the supply of college educated workers with no demand shift then the wage advantage of college to high school will fall until all those new college people find jobs. Then virtually all college people will be in infra-marginal "college jobs" as defined by the wage/productivity relationship. However, while this process is reassuring to the economist it does violate the common sense.

To preserve common sense we can introduce one of two conditions. The first rests on the college/high school wage differential. It could take the form of insisting that any supply increase of college level workers does not result in a fall in the college to high school wage ratio (or a least that the fall in the ratio is small and/or transitory) or, alternatively, that enrollment be expanded in order to prevent the gap from growing any larger. The problem with this constraint, as I will discuss in greater detail below, is that it rests upon an arbitrary view that the current college/high school wage differential is appropriate and should be maintained. One might quite reasonably think that access should be expanded even if the wage advantage of college graduates narrows.

An alternative way of posing the constraint is more purely economic. This would be that college education be expanded as long as the productivity benefits of the college education exceed the costs of supplying that education (costs and benefits being appropriately measured over the long term and discounted to present value). That is, as the expanded supply pushes college workers down the job queue at some point the productivity gains associated with an additional college worker do not justify the investment or resource opportunity cost of providing that education.

With these constraints in mind we can ask whether the demand for college level skills is shifting out (increasing) at a pace that would justify the investments necessary to increase the supply of college labor. If "too many" college educated workers were produced wages would adjust and they would, in this framework, find work but they would be forced into jobs for which the productivity gains would not justify the investment, public and private, that was necessary to increase the supply of college educated labor.

## The Story In The Numbers

The perception of a strong economic case for expanding post-secondary access rests on the standard story relating supply and demand to wages. Between 1960 and 2005 the fraction of the labor force consisting of college equivalent workers tripled.[5] Yet during roughly the same period the wages of college educated employees grew much more than did the wages of the less educated (details are provided in the Tables below). In standard economic models the way to explain a rising price (the relative wage) in the face of increasing supply is to argue that the demand curve is shifting out, i.e. for some reason over time employers want more college educated people at the same wage than they did in the past. This shifting out of demand is typically attributed to the nature of technological change which is biased in favor of more educated workers.

Data on wages trends and education are shown below in Tables I and II.

Table I
Hourly Wages By Education (2005 Dollars)

| | High School | Some College | College | Advanced Degree |
|---|---|---|---|---|
| 1973 | $14.39 | $15.50 | $21.00 | $25.38 |
| 1980 | 13.92 | 15.08 | 19.86 | 24.14 |
| 1990 | 13.25 | 15.13 | 21.37 | 27.41 |
| 2000 | 13.94 | 15.85 | 24.35 | 30.79 |
| 2005 | 14.14 | 15.89 | 24.67 | 31.49 |

Source: State of Working America

Table II
Wage Ratios

| Year | Some College/High School | College/High School | Advanced Degree/High School |
|---|---|---|---|
| 1973 | 1.07 | 1.45 | 1.76 |
| 1980 | 1.08 | 1.42 | 1.73 |
| 1990 | 1.14 | 1.61 | 2.06 |
| 2000 | 1.13 | 1.74 | 2.20 |
| 2005 | 1.12 | 1.74 | 2.22 |

Source: calculated from data in The State of Working America

There are several broad conclusions that can be drawn from these education attainment and wage patterns.

First, over the long sweep of time the supply of college educated labor (or potential labor) has increased substantially but nonetheless the wage advantage of college educated workers relative to those with less education has also increased. As noted, this suggests, using a standard supply and demand framework, that the demand for the skills associated with college have been increasing over time.

Within this long period of time there have been sub-periods when the pattern has diverged. For example, during the 1970's the wage advantage of college educated relative to others declined. The standard story here is that this period witnessed a surge of college graduates that overwhelmed the (nonetheless increasing) demand for them. This is an important observation because it does imply that for at least some periods there can be "too many" college graduates, at least as measured by wage trends.

With this in mind, the data raise the question of whether we are now in a similar era. In the last five years, and in fact for a somewhat longer period, there has been a marked slowdown in the growth of the wage advantage of college educated labor relative to high school graduates. During this period people with advanced degrees have experienced gains, but others with "just" a college degree have not. Given that (as we will see) the supply of college labor has also de-accelerated recently the combination of slowing supply and stagnant wages does raise the question of whether the market is signaling that it is time to slow down the rates of college entrants into the labor market (this is the flip side of the standard argument that more college is needed: that during earlier periods the wage advantage increased despite the supply increase. Now we see the wage advantage stagnating despite the supply slow-down). This recent deceleration in the advantages of college relative to high school has also been accompanied by a stagnation in the absolute level of college wages as the data above demonstrate.

Associates and Bachelors

The foregoing discussion has not made distinctions between four year degrees, two year degrees, or college attendance without completion of a degree. This has been deliberate because the annual rates of return for two and four year degrees appear to be broadly similar.

Community colleges enroll around 40 percent of all post-secondary students and these students tend to be those of most concern with regard to inequality in the labor market. Fifty-five percent of students in occupational programs are 24 or older, 39 percent are minority, and two-thirds attend part-time[6]. Eighty percent of community college students work full or part time while in school[7]. Another indication is that among

first-time community college students between the ages of 25 and 64 in 1995-96 71 percent were in the lower two income quintiles compared to 50 percent of younger students[8].

In most labor economics treatments of the college wage premium the community college/four year college issue is handled by utilizing the idea of a "college equivalent" worker in which one B.A. or two people with some college count as a "college equivalent." This formulation is roughly justified by the evidence, described below, that the rate of return to one year of community college is equivalent to the rate of one year in a four year college. This approach is reasonable when working with aggregate data and for estimating models of the entire labor force. It is, however, worth noting for more textured policy purposes this formulation is slightly suspect because it ignores content differences between four year and two year colleges. For example, more than half of community college students are in occupational programs that are much more tightly focused than is the typical B.A.[9].

Recent research using the National Education Longitudinal Survey, updated earlier work by Kane and Rouse on returns to community college education[10] For men a year in a community college (regardless of whether a degree was earned) increased annual earnings by 6 percent. This gain was lower, but not significantly so, than a year at a four year college. Earning a certificate at a community college raised the return to 7.9 percent more per year than a high school degree and an associates degree led to a 14.7 percent gain. For women the same patterns prevailed but the returns to post-secondary education relative to high school education were somewhat larger. For example, the annual return (relative to a high school degree) for a year of attendance in a community college was 11.1 percent and the gains to an associates degree were an eye-popping 47.6 percent. The researchers attribute the larger gains that women experience from community colleges to the fact that they are more likely than men to be enrolled in specific occupational training programs such as nursing. The overall pattern of results is robust to various checks for selection bias and is consistent with earlier findings using a different source of data [11]. Finally, given the relatively low rates of rates of degree attainment in community colleges (and frequently low rates of retention) it is worth

noting that obtaining only a few credits had no payoff for men but did have some benefit for women.

Assessing the Wage Data

The conclusions that can be drawn from the wage patterns in the tables above are complex. There remains a substantial advantage to attending college relative to ending education with a high school degree and the advice that one would give to any young person—continue your education—remains sensible (assuming that costs are reasonable). However, this is a different question than whether there should be a large publicly supported increase in college attendance. The advice given to any individual represents a judgment about benefits on the margin and on the margin it pays to go to college. A substantial increase in attendance contemplates shifts for which the marginal gains are not necessarily the relevant data. Given the de-acceleration in the wage gains to college attendees the fear would be that a large surge of college would not be met by a complementary increase in the demand for college labor and that, as a result, college educated employees would find themselves pushed down the occupational distribution into jobs for which the benefits of college education (in terms of productivity) are not great relative to the costs of obtaining that education.

It is also important to note that the growth in the wage advantage of people with more than a college degree and the notable slowdown or stagnation in the advantage of just a college degree is not well understood. It is difficult, for example, to accept the notion that people with "just" a college degree are doing "routine" work that is being replaced by computers. And it is equally difficult to ignore the possibility that the surge at the top of the wage distribution is at least in part driven by trends in top level corporate and Wall Street compensation that are not well captured by standard supply and demand frameworks.

In short, the pattern in the wage data does raise legitimate questions about how far and how hard to push an agenda of substantially increased college enrollment. However, there are several points to be kept in mind

First, as we have seen, there are very substantial inequities in access to college, inequities based on race and on family income. The case for addressing these is strong and since a policy to increase access for some groups and offset this by decreased access for others is neither feasible nor desirable the implication is that expanded college access is important.

Second, there have been previous periods in which the rates of return to college relative to less education have stagnated. One such period was the 1970s, as the data shown above demonstrate. Another period was between 1940 and 1950 when the wage advantage of college relative to high school graduates was almost halved[12]. Despite these episodes America continued to improve access to education. It is hard to imagine that the country would have been better off had we responded to dips in the rate of return to higher education by reducing our investments in human capital. Rather than focus on the slowdown in wage growth of the past decade it is more sensible to emphasize the broader sweep of the past half century in which the demand for educated labor has clearly grown.

All this said, it is apparent that the wage data per se are not a bullet-proof foundation for the case for an expansion of higher education. Relative wages certainly reflect skill demands but they are a noisy measure since a wide range of other considerations (wage regulation, norms, the distribution of power) can influence wage outcomes. And, as we have just seen, the recent trajectory of relative wages leads to somewhat equivocal conclusions. It would be helpful to more directly examine what we know about the trajectory of skill demands in the economy. If it does appear that employers' demands for skill is rising and that they want more of the capacities provided by higher education then we can feel more comfortable. In the next section I turn to more direct efforts to determine whether the future trajectory of the work points towards the need for additional investments in higher education.

## EVIDENCE ON THE TRAJECTORY OF THE DEMAND FOR SKILL

In this section I review a range of research concerning what kinds of skills employers will be seeking in the future and the relationship of these patterns to the need for increased levels of higher education. I will begin by examining the occupational projections that are generated by the U.S. Department of Labor and will then turn to several sources of more textured information. The general conclusion is that the demand for skill will increase and this supports the need for high levels of educational attainment.

Occupational Projections

Every several years the Bureau of Labor Statistics projects future occupational employment. Underlying these projections are the Bureau's estimates of future demands for products and services (which helps determine the need for different occupations), projections of technical change (which can add to or reduce the need for a given occupation's employment), as well as estimates of future labor force participation (which affects both product demand and also the need for replacement hires).

The BLS projections are that between 2006 and 2016 the economy will add 15.6 million jobs. This is the net new job figure that is often used to calculate how the occupational distribution will change (as in statements of the sort that "between 2006 and 2016 xx percent of job growth will occur in the yy occupation."). However, while net new jobs are the key information over a very long time horizon (for example, the decline in typesetters over a thirty year period) over any short or intermediate term replacement hiring is also important because it helps determine what jobs will be open for new entrants and for job changers. Because of the imminent retirement of large numbers of baby-boomers, replacement hiring will substantially outweigh hiring due to new job creation and the BLS projects that between 2006 and 2016 there will be 33.4 million openings due to replacement. The impact of this can be illustrated dramatically in the case of the broad category of jobs the BLS labels "production" occupations. In 2016 there will be, according to the BLS, 528,000 fewer of these blue collar jobs than in 2006 and one might conclude that the occupation has no future. However, although net job creation will be negative because of replacement needs the same period will witness 2.3

million job openings. Despite the fact that this declining occupation would show up as a shorter bar in any graph comparing 2006 and 2016 occupational distributions, there will be plenty of new hires in the field. This is the relevant fact both for policy makers as well as for people considering what kind of education and training to undertake.

Table III below shows BLS projections for major occupational groups. The Table provides data on changes in the distribution of occupations in the economy as well as on openings that are projected due to both growth and replacement.

Table III
Occupational Distribution and Projections (000's)

| | Percent of Employment, 2006 | Percent of Employment, 2016 | Net Change | Openings due to growth and net replacement |
|---|---|---|---|---|
| Total | 100% | 100% | 15,600 | 50,732 |
| | | | | |
| Management, Business, and Financial | 10.2% | 10.2% | 1,596 | 4.575 |
| Professional and Related | 19.8% | 20.9% | 4,970 | 11,067 |
| Service | 19.2% | 20.3% | 4,830 | 12,218 |
| Sales and related | 10.6% | 10.3% | 1,218 | 6,171 |
| Office and Administrative | 16.2% | 15.7% | 1,745 | 7,424 |
| Farming, Fishing, Forestry | .7% | .6% | -29 | 251 |
| Construction and Extraction | 5.5% | 5.5% | 785 | 2,249 |
| Installation, Maintenance, Repair | 3.9% | 3.9% | 550 | 1,502 |
| Production | 7.1% | 6.1% | -528 | 2,323 |
| Transportation and Material Moving | 6.8% | 6.4% | 462 | 2,952 |

Source: Dohm and Shniper, 2007

At this level of aggregation there is relatively little change projected in the economy's occupational distribution. The most dramatic shift is the reduction in production employment from 7.1 percent to 6.1 percent of jobs, but even here as already noted there will be more than two million job openings due to replacement. Service jobs, which tend to be low skilled, account for the largest absolute number of openings but they are closely followed by professional jobs which are at the higher skilled end of the distribution. Hence there is some hint in these data of the "hollowing out" or "loss of middle" that some commentators have emphasized. However, it is important to avoid over-emphasizing these trends. The changes are modest and even in "declining" occupations replacement needs will generate plenty of new hiring.

The occupational projections themselves are difficult to interpret in terms of the need, or lack of need, to upgrade the educational level of the workforce. However, the BLS makes an effort, using two methods, to translate the data into demand for education. In the first method experts in the Bureau designate the "most typical" method of entry into each of the more than 750 occupations for which projections are made. These "typical" entry requirements range from short term on-the-job training to graduate degrees. The difficulties with this approach are twofold. First, it is based on expert opinion (supplemented by conversations with employers) rather than actual practice. Additionally it assumes that there is only one entry path. As the BLS itself notes, there may in fact be more than one entry path for an occupation and employers may combine these.[13] To remedy this in a second method the BLS uses Census data to examine the educational distribution of 25-44 year olds in each occupation and assigns a typical education level to the occupations based on this distribution. The focus is on the younger cohort in order to capture hiring patterns.

The most recent published occupational projections to 2016 only include the first method, which is likely to understate actual educational requirements, but the results of second are available for the earlier projections to 2014.

Table IV below shows the results for the first method and Table V for the second method.

**Table IV**
**Employment By Education and Training Category, 2006 and 2016**

| | Distribution of Jobs, 2006 | Distribution of Job Openings Due to Growth or Replacement, 2006-2016 |
|---|---|---|
| Degree Above Bachelors | 4.0% | 4.5% |
| Bachelors or Higher Plus Work Experience | 4.3 | 4.0 |
| Bachelors | 12.3 | 13.2 |
| Associate Degree | 3.9 | 4.4 |
| Post Secondary Vocational Award | 4.2 | 4.9 |
| Work Experience In Related Occupation | 9.7 | 8.1 |
| Long-Term On The Job Training | 7.6 | 6.5 |
| Moderate Term on the Job Training | 18.1 | 14.8 |
| Short Term on the Job Training | 34.7 | 39.7 |
| | | |

Source: Dohm and Shniper, 2007

**Table V**
**Projected Education Requirements for Job Openings**
**2004-2014**

| | Distribution of Jobs, 2004 | Distribution of Education Requirements for New Jobs Due to Growth and Replacement, 2004-2014 |
|---|---|---|
| High School Occupations | 13.2% | 12.5% |
| High School/Some College | 46.8% | 46.1% |
| High School/Some College/College | 17.1% | 16.8% |
| Some College/College | 11.3% | 12.0% |
| College | 11.6% | 12.6% |
| | | |

High School occupations are those in which 60% or more of 25-44 year olds have a high school degree or less; High School/Some College is defined as those occupations in which 20 percent or more have a high school degree or less and 20 or more have some college and less than 20 percent have a college degree; High School/Some College/College are those in which 20 percent or more are in each category; Some College/College are those in which less than 20 percent have a high school degree or less and greater than or equal to 20 percent fall into each of the other two categories; College occupations are those in which 60 percent or more have a college degree.
Source: www.bls.gov/emp/optd/optd001.pdf

Despite the difference in methodology the story that emerges from these projections is similar. These data show a trend towards more jobs requiring at least some college education, but the trend is modest. Whereas in 2004 22.9 percent of jobs were in the two highest educational categories the projection is that by 2014 the fraction will be 24.6 percent. At the low end whereas in 2004 13.2 percent of jobs were purely high school that will fall to 12.5 percent in 2014. In short, according to the BLS the demand for post-secondary skills is increasing, but at a modest rate.

Qualifying the Projections

There are two concerns regarding these projections. The first is whether they are accurate with respect to the projected occupational distribution. The second is whether there is any systematic tendency to underestimate educational requirements.

Turning first to simple accuracy, it is important to recognize that the projections are based on a complicated mixture of what might be termed fact and judgment. The "fact" comes in when, for example, the analysts use what they know about future demographics to project demand for industries (e.g. for health care or education based on the projected age distribution of the population). Even here, however, mistakes can be made if tastes change from their trend line (e.g. if more or less people than expected decide to move into assisted care facilities). Judgments play a more important role in projecting staffing requirements within industries, for example the number of computer programmers in banking or the extent to which firms choose to off-shore back office operations. The BLS has, of course, data on the current staffing matrix for industries. These are used but the organization recognizes that the matrix is not static. Data on how the matrix has changed over time is utilized to extrapolate future shifts. Furthermore, to take into account the likelihood that the changes may deviate from trend the agency conducts surveys and interviews to get expert opinion about new patterns. In short, the current occupational staffing matrix, past trends in how that matrix has changed, and estimates for the future based on the expert opinion are all utilized by BLS analysts to make their projections. As this should make clear at the end of the day judgment plays a non-trivial role and that there are several possible sources of error.

The BLS does evaluate its work and the conclusions are mixed[14]. For the period 1988-2000 the projections were correct with respect to direction (growth or decline) for eight of the nine major occupational groups. When it came to detailed occupations the patterns are more complicated. The average error for all occupations was 23.2 percent but when weighted by employment the error fell to 4.4 percent. This implies that the projections are most accurate for the largest occupations which is what in fact is the case.

For example, for the twenty occupations that were projected to produce the largest job growth the average error was 9.2 percent. The source of the errors tended to be changing staffing patterns within industries rather than misjudgments about shifts in the nature of final product demand. What is not clear, however, is whether the errors on balance tend to be too conservative with respect to up-skilling. The two occupations with the largest error, in the sense of having the largest employment deviation from what was projected, were professional specialties on the one hand and operators/fabricators/laborers on the other. In both cases actual employment was substantially underestimated and the two groups together accounted for about 60 percent of the total error in the projection of job change.

What one makes of this is, then, something of a matter of judgment (just as the projections include a substantial element of judgment). On the one hand the projections are directionally accurate and for the large occupations tend to be within 10 percent or so of reality. Furthermore as the professional specialty versus operator/laborer example indicates the errors do not seem to be all in the same direction with respect to skill. On the other hand, ten percent represents a substantial number of employees. The bottom line, then, is that the projections are a reasonable guide to the direction and magnitude of the changing occupational mix but that there is a non-trivial margin of error around any particular occupational projection.

With respect to possible biases regarding educational requirements, it is important to recognize that BLS projections represent all jobs in the economy, including those held by youth. In addition the projected job shifts are not weighted by hours worked. Thus a casual part-time after school job held by an 17 year hold counts as much in these projections as does a full-time job held by an adult. In the 2005 13.9 percent of the labor force was made up of 16-24 year olds and of these well over a third worked part-time compared to 11 percent of 25-64 year olds.[15] If one looks at high level white collar jobs[16] then these constituted 34.6 percent of employment if everyone counted but 38.6 percent if the 16-24 year olds were omitted. The gap would be even larger if higher level blue collar and service occupations were considered. In other words, if we look at "adult jobs" then there is more skill demanded that is reflected in the standard occupational projections.

## SOURCES OF RISING SKILL NEEDS

There is a large social science literature regarding the skill trajectory of employment and for many years it had a pessimistic tinge. For example, it was not too long ago that the popular discussion claimed that we were becoming a nation of hamburger flippers. There have been, and certainly still are, jobs that have been de-skilled by technical progress. Nonetheless, the broad conclusion of current research is that direct examination of trends in job supports the view that the skill requirements of work are rising and are rising in a manner that suggests a growing demand for post-secondary education on the part of employers.

A representative study along these lines is by Autor, Levy, and Murnane[17]. They used the U.S. Department of Labor's Dictionary of Occupational Titles to examine trends in skill for the economy as a whole as well as within occupations. Their particular focus was on the impact of computers and hence they distinguished between routine jobs (in the sense that the work can be accomplished via fixed decision rules that can be written into a computer program) and non-routine work that requires human discretion and creativity.

The study finds that beginning in the 1970's and continuing through today the fraction of work in the economy that is routine has fallen and that this decline is steepest in industries and in occupations that have invested the most in computers. These shifts occur within all education groups, a pattern that implies that the trend is driven by computers and not a response to the increased availability of higher educated employees. However, the trend towards non-routine work does shift employer demand in the direction of people who can do that work, i.e. in the direction of people with more years of education.

An illustration of how this plays out is provided in another paper by the same authors[18]. They studied the operations of a large bank which introduced optical scanning for check processing. The result was that processing customer's checks was sub-divided into two broad jobs: routine work and exceptions handling. Much of the routine work

was done by high school educated people and the rest was taken over by the scanning equipment. The result was that far fewer high school employees were required to process a given number of checks (although actual employment fell by much less because of growth in the numbers of checks processed). By contrast, in the exceptions department (which handled, for example, checks that could not be read) the bank hired more skilled college employees because it choose to combine a number of different tasks into more complex jobs. The point is that the computer optical scanning was a technology biased in favor of college educated labor in that it made them more productive while also reducing the need for less educated workers.

This point is also made in a West German study[19]. West Germany is an advanced economy with access to the same technology as the United States. The advantage of the West German research is that it is based on a repeated surveys of employees that asked them about what they do in their work rather than on the DOT which uses experts to make judgments about content of jobs. Between 1979 and 1999 the fraction of tasks that were non-routine roughly doubled although by the same token well over a third of all tasks remained routine.

It should also be noted that the routine/non-routine distinction can be carried too far and can be used in what appears to be a tautological way. For example, the recent paper by Autor, Katz, and Kearney[20] attributes the decline of the earnings of people with just a college degree relative to those with a masters degree or more to the tendency of technology to eliminate routine work. The implication is that college graduates are doing routine jobs just as are people with only a high school education. Keeping in mind that the rise of the college relative to high school relative wage was attributed to college graduates doing non-routine work, the new argument and the extension of routine categorization to college graduates, seems to be quite a stretch and to raise questions about just what the routine/non-routine distinction really means.

General Skills

Another line of research, tentative but intriguing, also suggests that the nature of skill is shifting in the direction of those generated by higher education. A standard distinction in the human capital literature is between general skills, which are usable in a wide range of settings, and specific skills, which are limited to particular employers. Firms are likely to be willing to train for specific skills since they will capture the return but they will avoid investing in general skills since these are useful in other settings. As a result general skills are most typically taught by schools.

It is reasonable to think that the thrust of information technology is to push skills in the more general direction, i.e. to put more emphasis on the importance of formal education relative to on the job training. The research on this is thin but one recent study does find evidence supporting the expectation[21]. This study uses earnings data to demonstrate that wage patterns are converging across sectors into a common structure as opposed to sector specific distributions. The claim is that this convergence is most likely due to skills becoming common across these sectors. Clearly more research, including direct assessment of skills, is needed but the argument is certainly plausible and does reinforce the other evidence regarding the growing importance of school based work skills.

Work Organization

It is well understood in the economic development literature that a nation's ability to grow and increase per capita income is powerfully influenced by it's education level. However, too often this lesson about the importance of the broad educational level of the population gets lost when it comes to developed countries such as the United States. In these discussions the assumption is often made that innovation, and growth, flow from inventions made at high level research universities and corporate R&D labs which are staffed by experts with advanced degrees.

It is certainly true that high level research and inventions are important, one need only consider the surge of growth and productivity that has flowed from the past decades progress in electrical engineering and computer science. However, another lesson of the past few decades is that an educated workforce at the point of production can contribute numerous "smaller" innovations and improvements that taken together add up. However, in order for this process to occur the workforce, both white and blue collar, needs to have a significant level of education and training. This, when combined with new forms of work organization, can lead to significant productivity gains.

The most powerful example of this point is the so-called Toyota Production System. Toyota, as is well known, is the world's most successful car company and in large measure its success is due to an accumulation of process improvements that originate on the shop floor. Recent observers likened the role of production workers to a "community of scientists[22]." This is because the employees are encouraged to identify both problem areas and possible process changes and then develop methods to systematically test their hypotheses about the impact of possible improvements. They work in teams with fellow employees and supervisors in moving this style of improvement forward. The consequence is an accumulation of good ideas that adds up to very substantial efficiency gains.

The lesson of the Toyota system has diffused to an important degree among American firms who responded in the 1980s and early 1990s to competitive challenges by adopting a set of work practices which came to be termed "high performance work organizations." These have been adopted in both blue and white collar settings. At the core of the new systems are changes in how employees do their job. Perhaps the most typical innovation is the introduction of work teams. In many instances these teams are led by a management employee but that person's role has changed to one of a "coach" or "facilitator." In other instances the teams are self-directed. In both instances the idea of teams is that the employees take responsibility for a group of tasks, that there is a sense of responsibility for the team's product, that the workers are broadly skilled, and that there is an element of job rotation.

In many "transformed" firms employees are involved in aspects other than direct work activities. The most common example is problem solving groups in which

employees work in groups, often consisting of a cross-section of employees and hence to some extent obviating traditional managerial/non-managerial distinctions. These groups address problems such as production techniques, quality issues, and health and safety. In the most extreme form these groups can take up topics which in the past have been seen as clearly "managerial," e.g. outsourcing and supplier policy.

Initial research in the early 1990s found that roughly a third of firms had adopted these systems in a substantial way[23] . The firms most likely to adopt these systems were those with relatively high skilled technologies, firms who competed in international markets, firms which placed a high value on product quality, and those which were large and part of multi-location organizations. A second survey executed in 1997 asked whether these new work systems continued to diffuse and what, if any, has been the impact of the labor market turmoil of the 1990's upon their adoption.

Table VI shows the percentage of establishments which in 1997 engaged in each of the four practices with a least a fifty percent level of penetration (i.e. at least half of the "core" employees were involved). To provide a sense of how quickly these systems have spread the table includes comparable data for 1992.

Table VI
Percentage of Establishments With High Performance Work Practices Involving At Least Half of CORE Employees

| | 1992 | 1997 |
|---|---|---|
| Quality Circles/Off Line Problem Solving Groups | 27.4% | 57.4% |
| Job Rotation | 26.6% | 55.5% |
| Self-Managed Work Teams | 40.5% | 38.4% |
| Total Quality Management | 24.5% | 57.2% |
| Two or more practices | 26.0% | 70.7% |
| Three or more practices | 14.2% | 39.5% |

Source: Osterman (2000)

These data show a very extensive diffusion of these high performance practices. Both the substantial rate of diffusion and the increase since 1992 point to the power of these ideas as well as their surprising ability to flourish even in an era of downsizing and employment insecurity.

Several researchers who have studied these High Performance Work Systems conclude that they are associated with higher demands for skill. For example in the survey summarized above employers were asked how the skill levels of their "core" workers, i.e. the employees most directly involved in the high performance systems, had changed in recent years. 55 percent reported no change in skill, 3 percent reported that the skill levels had declined, and 40 percent reported an increase in skill requirements.[24]

Of course, it is also important to remember that while skill requirements may be rising this does not necessarily imply that it is college level skills that are needed. A recent study of the introduction information technology and associated new production systems in the valve manufacturing industry shows that the work of the machine operators has been upskilled with the IT taking over the routine tasks[25]. However, these machine operators are all high school educated. Nonetheless, on balance the spread of high performance work systems does increase employer demand for at least community college level education.

## Are The Benefits Real?

A reasonable question about any policy aimed at increasing the supply of college graduates is whether there will be genuine economic benefits or whether instead a version of musical chairs will ensue. There can be several reasons why this might happen. According to some scholars the wage gains associated with college arise simply because employers use college attendance as a way to sort people into different boxes, i.e. into different quality jobs. In this view there is nothing about college per se that adds value and if more people attended college then employers would find some other sorting mechanism. This point of view originated in early critiques of the role of education in promoting inequality but the more recent signaling literature makes a related point by arguing that investment in education is simply a way for high ability people to signal their capacities.

We have already reviewed the evidence indicating that the demand for college educated employees is growing. However, an advocate of the musical chairs thesis would regard this as suspect because it does not rule out the signaling or sorting

arguments (e.g. the wage advantage of college educated employees might be due to their intrinsic higher abilities or personality traits). There is, however, evidence that does enable us to reach more confident conclusions. This is that (a) cities with higher proportions of college educated residents are more productive; (b) the experience of the City University of New York (CUNY) Open Admissions policy in which college attendance was substantially increased due to an exogenous policy shift and in which the new students enjoyed substantial benefits.

There is considerable evidence that the economic performance of both nations and cities is enhanced when the population has higher levels of education. This is a common finding in studies of economic development but more relevant for our purposes is research that examines American cities. A recent study is representative[26]. Among metropolitan areas with less than 10 percent of adults holding college degrees the growth rate between 1980 and 2000 was 13 percent whereas with areas where at least 25 percent of adults held college degrees the growth rate was 45 percent. The authors examine various explanations for this pattern and also test for spurious correlations and fixed city effects. They conclude that increased college attendance is directly related to higher levels of productivity largely due to the fact that a college educated workforce is better able to respond to unexpected economic opportunities and shocks.

The point here is straightforward: if college was simply a signaling or sorting device then an increase in college education should not have a substantial effect upon productivity (beyond the minor gain that might arise from better matching). The fact that there is a significant productivity and economic adjustment benefit that accrues to more educated cities is powerful evidence that the benefits of higher education represent real gains.

## A "Natural Experiment"

In the 1970's the City University of New York instituted an Open Admissions policy. Admissions to either a four year school or a community college was guaranteed to every high school graduate. This policy, when combined with the fact that tuition

was zero, provides an excellent natural experiment for asking whether substantially enhanced access to higher education provides real benefits. Because of Open Admissions the size of the entering class in the CUNY system doubled and the fraction of enrollments in senior colleges that were black and Hispanic went from 4 percent in 1969 to 16 percent in 1970 [27]. Given the sudden and dramatic increase among people who would have otherwise not gone to college it is hard to think that the gains that accrued were due simply to signaling or sorting.

It is also worth noting that this policy was implemented during a period of what appeared to be excess supply of college labor, i.e. the era of the "Overeducated American" [28]. The wage advantage of college relative to high school labor was falling. This situation would make it more difficult for the Open Admissions policy to succeed.

The results of this initiative were recently analyzed in depth by Attewell and Lavin [29] based upon a survey of 2,000 women from the original cohort (with a response rate of 71 percent). The research focused on two questions: whether the women who attended receive gains that were comparable to those received by college attendees nationally (i.e. whether the increased admissions in New York led to a devaluation of college as the sorting argument would predict) and, secondly, whether the second generation (the children of the attendees) gained as a result of their mothers' experience. This latter question goes directly to the indirect benefits of increasing the rate of post-secondary education.

Attewell and Lavin show that the people who enrolled under Open Admissions completed their education at a high rate: 71 percent earned a degree and of these three-quarters earned a bachelor's degree. Indeed nearly a third of the women who first entered a community college went on to earn a B.A. With respect to earnings, there was no evidence that the degrees were devalued. The women who earned either a B.A. or an A.A. earned as much as women of the same with the same degrees in national data. These results remained after additional controls for social and educational background. Particularly notable were the substantial gains who minority women who had earnings comparable to those of whites.

Equally striking was the subsequent impact upon the outcomes for their children. Attewell and Levin estimate models in which they compare the children of Open

Admissions students with a national sample of women matched on age, family background, race, and high school record. They find that the children of the CUNY graduates had better high school academic records, were less likely to get into trouble in high school, more likely to attend college, and more likely to complete college. In other words, the positive benefits of Open Admissions were inter-generational. Other studies examining the impact of increased in mothers' education upon the subsequent educational attainment of low income children have reached similar conclusions[30] as has research that controls for selection and endogenaity concerns and examines the impact of a mother's higher education attainment upon more general measures of the welfare of her children[31].

## Moving Forward

This paper's goal has been to describe what we know about the labor market demand for college educated workers. The paper has been deliberately cautious along several dimensions. It recognizes that a great many low-skill jobs will continue to be generated. Additionally the growth in the wage of college relative to high school workers is due to institutional and political factors as well as to demands for skill. Furthermore, the marginal gains associated with a given individual attending college do not necessarily translate into gains that would flow from very large numbers of people following that path. These cautions are underlined by the recent slowdown in the relative wage advantage of people with between one and four years of post-secondary education compared to high school graduates.

All of these qualifications are important but at the end of the day it is also clear that the economy is trending in the direction of requiring more education. The technology used by firms and the organizational designs that they are putting into place both point towards this conclusion. Furthermore it would be a mistake to let the recent equivocal trends in relative wages divert our attention from the much longer term, and consistent, trend towards an economy based on skill and education[32]. It is by now a cliché, but nonetheless true, that the competitiveness of the U.S. economy will depend upon our skill at innovation. This is true not just with respect to top level scientists,

engineers, and managers but also in terms of the innovative ideas and productivity improvements that can be contributed by an educated frontline workforce.

Given these conclusions the natural question is whether the supply of post-secondary educated labor will be forthcoming. This paper is not intended to go into education supply in any depth but it is important to briefly review the issue. Forecasting educational attainment is difficult because it is driven both by economic and demographic trends as well as by policy. Nonetheless we can look at the recent past and make educated judgments about the future.

Past enrollment trends are shown in Table VII below. In the mid-1990s the Census changed how it recorded educational attainment and so the long time series has to be viewed with some caution but most scholars are willing to accept data of these kind as broadly accurate. The patterns are both instructive and surprising. The first striking point is that the fraction of each of the cohorts with some college is roughly equal to the fraction with a college degree or more. The point here is that an focus on just

Table VII
Historical Trends In Educational Attainment

| | Percent of 20-24 Year Olds Enrolled In School | Percent of 25-34 Year Olds With 1-3 Years of College | Percent of 25-34 Year Olds With Four or More Years of College |
|---|---|---|---|
| 1960 | 13.1 | 11.2% | 10.9% |
| 1965 | 19.0 | 11.6 | 13.1 |
| 1970 | 21.5 | 14.0 | 15.7 |
| 1975 | 22.4 | 17.9 | 21.4 |
| 1980 | 22.3 | 21.6 | 24.1 |
| 1985 | 24.0 | 21.9 | 23.8 |
| 1990 | 28.6 | 21.5 | 23.8 |
| 1995 | 31.5 | 28.1 | 24.9 |
| 2000 | 32.5 | 28.3 | 29.2 |
| 2005 | 36.1 | 27.6 | 30.4 |

Source: Column 2: Digest of Educational Statistics, Tables 7
http://nces.ed.gov/programs/digest/d06/tables_1.asp;
Columns 3 and 4: Source: Bureau of Census
http://www.census.gov/population/www/socdemo/educ-attn.html

bachelor degrees is misleading. This is particularly true with respect to the concerns of this paper since a good deal of what takes place in community colleges is directly related to job market and vocational skills.

The central point to be taken from these data is that there has been a substantial slowdown in the rate of increase in educational attainment. Whereas from the 1960s to the 1980s the fraction of the cohort with some college or with a degree more than doubled the increase since then has been much more modest. There is a substantial literature on just why this has happened and it does appear that policy variables, e.g. tuition levels and financial assistance, are important[33]. In addition, there appear to have been some behavior shifts [34].

This reduced rate of increase in educational attainment means that the educational composition of the workforce going forward will not change a great deal, that is there will not be the kind of surge in the fraction of the workforce with college education that we witnessed in the past. David Ellwood provides what he terms a "high growth" and

"level growth" estimate of the change in the educational composition of the total labor force between the years 2000 and 2020[35]. The "level" projection assumes that for each gender/race/ethnicity/nativity sub-group educational attainment going forward is the same as it was in 1997-2000. The "high" growth projection assumes that graduation rates from high school grow at .25 points per year and entry rates to college grow at 1 point per year.

With these assumptions and with projections of the changing composition of the workforce and changing labor force participation rates Ellwood provides estimates of the educational composition of the future workforce. Using the level growth assumptions the fraction of the workforce with college degrees rises from 30.2 percent in 2000 to 31.7 percent in 2020. The high level assumptions lead to 35.2 percent of the workforce having college degrees in the year 2020. Ellwood regards the level projections as the most reasonable.

Common sense suggests that these enrollment trends imply substantial opportunity to increase the supply of college educated labor. It is certainly reasonable to assume that the pattern of technological change will not veer substantially from its post-war trend. That is, even if we ignore the period in the 1980s when there appears to have been an explosion in the demand for college labor, the longer sweep still suggests that the educational needs of the American economy will expand. Nothing in the review of the evidence suggests that a reversal will occur. With this in mind then the slowdown in the rate of increase in the college educated labor force implies that as demand continues to shift out shortages will develop.

As noted earlier, one way of testing this intuition is to ask about the evolution of the wage premium associated with college education. If the premium falls in the face an a supply expansion then this might suggest that the labor market demand does not justify the expansion. In fact, this is an unsatisfactory standard. First, there is no basis for believing that any particular college/high school wage differential is the right one. As long as there is any differential then, under the assumption that wages reflect productivity, college labor is more productive than high school labor and the appropriate question is whether the resource cost of developing that college labor is greater than or less than the productivity gains.

There is an additional reason why maintaining the current educational differential may not be the appropriate policy goal. There is good evidence that a large fraction, well over half, of the inequality in earnings which grew from 1973 until now is due to widening education wage differentials.[36] A policy which increased the supply of college educated workers to a degree sufficient to reduce the wage differential would also result in less earnings inequality.

With these considerations in mind it is possible to generate a back of the envelope calculation about how much space there is for expanding college enrollment. This involves several steps. First, we can ask how would happen to the college/high school wage differential if college graduation expanded substantially. Then, with this differential in hand we can calculate the lifetime gain, appropriately discounted to present values, of the college relative to high school degree. Finally, we can compare this benefit to the cost of providing college education and ask if the benefit exceeds the cost.

As is apparent, each of these steps involves assumptions and estimates that are imprecise and hence any answer that emerges if only approximate. Nonetheless the orders of magnitude will be useful. Let us assume that college enrollment expanded so sharply that the wage differential shown in Table I and II above was halved, from .77 to .35, a fall that implies that about more than half of the workforce (not just the younger cohorts) suddenly obtained a college degree.[37] This would in turn imply an annual earnings differential of $10,275 assuming the wage rates in Table I and full time full year work. Discounted over a forty year lifetime of working this implies a total earnings gain of $185,125 if the discount rate is 5 percent and $139, 113 if the discount rate is 7.5 percent. If we assume that the differential falls to .45 instead of .35 then the figures are $243,000 and $183,000 respectively. All of these estimates appear to be above the cost of providing the education and these benefits ignore the non-economic considerations mentioned in the introduction. Keeping in mind that the assumed increased in college enrollment that lies behind these estimates is much larger than anything that could be obtained over the short-run it would appear that there is substantial scope, in cost/benefit terms, for increasing access to post-secondary education.

## Conclusion

The central question this paper addresses is the trajectory of employer demand for educated labor There are, as noted, strong reasons to expand college access that are independent of this question. Higher education improves people's personal lives and also their civic participation in ways that go beyond the purely economic. Furthermore current inequities in access—inequities that are based both on family income and on race—should not be allowed to persist. Nonetheless, it is likely that a strong public policy to expand access needs to be grounded in an understanding of economic demand.

Much of popular perception regarding this issue rests on the surge in the rate of return to college that took place in the 1980s but it now appears that this was an unusual episode. Institutional factors, such as the decline in unions and the stagnation of the minimum wage, played a role as did an atypical conjunction of decreasing supply coupled with rising demand. In recent years the rate of increase in the rate of return to college has leveled off and perhaps declined.

This caution notwithstanding, the economic case for expanding higher education access is strong. Regardless of how we interpret the 1980s there has been a long term trend for the U.S. economy to require more skill in its labor force. This shows up in the pattern of wages over time but there is also more direct evidence. Occupational projections as well as observation of work organization and technology point in the same direction. Fears that education is simply a signaling device with no productivity implications is allayed by the observation that the productivity of cities and regions is tied to the education level of their residents as well as by the experience of Open Admissions in the City University of New York. To top it off, the supply of college educated employees is stagnating due to enrollment trends and this creates both a need and an opportunity to intervene.

The bottom line, then, is that it would be good public policy to expand access to higher education. The effort would make sense on social and civic grounds as well as in terms of the needs of the U.S. economy. Resources devoted to opening the doors of college to more Americans would be well spent.

# REFERENCES


Alpert, Andrew and Jill Auyer, "Evaluating The BLS 1988-2000 Employment Projections," Monthly Labor Review, October, 2003, p. 13-37

Autor David, Lawrence Katz, and Alan Krueger, "Computing Inequality: Have Computers Changed The Labor Market?" Quarterly Journal of Economics, (November, 1998), pp. 1169-12131998

Autor, David, Frank Levy, Richard Murnane, "The Consequences of Increasing the Nation's Supply of College Graduates," Report to the Gates Foundation, n.d.

Autor, David, Lawrence Katz, and Melissa Kearney, "Trends In U.S. Wage Inequality: Revising The Revisionists," March 2007 (Revision of NBER Working Paper 11627)

Bailey, Thomas, Timothy Leinbach, Marc Scott, Mariana Alfonso, Gregory Kienzl, Benjamin Kennedy, "The Characteristics of Occupational Students In Post-Secondary Education," Teachers College, Community College Research Center Brief, 8/04

Bailey, Thomas, Timothy Leinbach, Marc Scott, Mariana Alfonso, Gregory Kienzl, Benjamin Kennedy, "The Characteristics of Occupational Students In Post-Secondary Education," Teachers College, Community College Research Center Brief, 8/04

Currie, Janet & Enrico Moretti, 2003. "Mother'S Education And The Intergenerational Transmission Of Human Capital: Evidence From College Openings," The Quarterly Journal of Economics, MIT Press, vol. 118(4), pages 1495-1532, November.

Bureau of Labor Statistics, Occupational Outlook Handbook, 2006. http://www.bls.gov/emp/optd/home.htm

Bartel, Ann, Casey Ichniowski, and Kathryn Shaw, "How Does Information Technology Affect Productivity? Plant-Level Comparisons of Product Innovation, Process Improvement, and Worker Skills," Quarterly Journal of Economics, v. CXXII, Issue 4, November, 2007, pp. 1721-1758

Brock, Thomas and Allen LeBlanc with Casey McGregor, "Promoting Student Success in Community College and Beyond: The Opening Doors Demonstration," MDRC 2005

Dee, Thomas, "Are There Civic Returns to Education," National Bureau of Economic Research Working Paper 9588, March, 2003

Dohm, Arlene and Lynn Shniper, "Occupational Projections To 2016," Monthly Labor Review, November, 2007, pp. 86-125

Ellwood, David, "The Sputtering Labor Force of the 21st Century: Can Social Policy Help?" NBER Working Paper No. 8321, 2001

Freeman, Richard, The Overeducated American, (New York: Academic Press), 1976

Glaeser, Edward and Albert Saiz, "The Rise of the Skilled City," NBER Working Paper number 10191, December, 2003

Goldin, Claudia and Lawrence Katz, "The Race Between Education and Technology: The Evolution of the U.S. Educational Wage Differentials, 1890-2005," NBER Working Paper 12984, 2007

Kane Thomas and Cecilia Rouse, "The Community College: Educating Students At the Margin Between Education and Work," Journal of Economic Perspectives, v. 13, no 1, Winter 1999, pp. 63-84

Kane Thomas, "College Going and Inequality: A Literature Review," Paper prepared for the Russell Sage Foundation, June, 2001

Lawler Edward, Susan Mohrman, George Benson, Organizing For High Performance: Employee Involvement, TQM, Reengineering, and Knowledge Management in the Fortune 1000, San Francisco, Jossey-Bass, 2001

Lemieux, Thomas, "Post-Secondary Education and Increasing Wage Inequality," NBER Working Paper No. 12077, 2006

Gould Eric , "Rising Wage Inequality, Comparative Advantage, and the Growing Importance of General Skills In the United States," Journal of Labor Economics, vol. 20, no. 1 (January, 2002), pp. 105-147

Marcotte, David, Thomas Bailey, Carey Borkoski, and Greg Kienzl, "The Returns of a Community College Education: Evidence From the National Education Longitudinal Survey, Educational Evaluation and Policy Analysis, v. 27, no. 2 (Summer 2005), pp. 157-175

Magnuson, Katherine, "Maternal Education and Children's Academic Achievement During Middle Childhood," Developmental Psychology 2007, Vol. 43, No. 6, 1497–1512

Osterman, Paul "Skill, Training, and Work Organization in American Establishments," Industrial Relations, April, 1995

Osterman, Paul, Securing Prosperity: How The American Labor Market Has Changed And What To Do About It, (Princeton: Princeton University Press), 1999

Osterman, Paul **"**Work Organization in an Era of Restructuring: Trends in Diffusion and Impacts on Employee Welfare," Industrial and Labor Relations Review, January, 2000.

Prince, David and David Jenkins, "Building Pathways to Success For Low Income Adults Students; Lessons for Community College Policy and Practice From A Statewide Longitudinal Tracking Study," Teachers College, Community College Research Center, April 2005

Rimer, Sara, "Urban Schools Aim Higher Than Diploma," New York Times, January 17, 2008

Spear Steven and Kent Bowen, "Decoding the DNA of the Toyota Production System," Harvard Business Review, September-October, 1999

Cynthia Karen Swank, "The Lean Service Machine," Harvard Business Review, October, 2003, pp.

Toossi Mitra , "Labor Force Projections To 2016: More Workers In Their Golden Years," Monthly Labor Review, November, 2007, pp. 33-52

[1] Rimer, 2008
[2] (www.census.gov/population/www/socdemo/education/cps2006.html)
[3] Dees, 2003
[4] See, for example, Barton, 2008
[5] The data underlying this paragraph is based upon David Autor, Lawrence Katz, and Melissa Kearney (2007)
[6] Bailey et. al., 2004
[7] Brock and LeBlanc, 2005, p. 2
[8] Prince and Jenkins, 2005, p. 2
[9] Bailey et.al, 2004
[10] Marcotte, Bailey, Borkoski, and Kienzl (2005)
[11] Kane and Rouse, 1995
[12] Autor, Katz, Krueger, 1998
[13] "In any number of occupations that put a new employee through lengthy on-the-job training, it is not uncommon to find that employers typically try to hire individuals with at least some college education (and even a bachelor's degree)." (BLS, 2006, Chapter 1, p. 1
[14] Alpert and Auyer, 2003
[15] The figures in this paragraph are based on my analysis of the 2005 Census Outgoing Rotation files.
[16] This list, admittedly arbitrary, consisted of: management occupations, business and financial occupations, computer and math occupations, architecture and engineering occupations, life and physical and social science occupations, community and social service occupations, legal occupations, education and training and library occupations, arts and design, and entertainment occupations, and health care practitioner and technical occupations.
[17] Autor, Levy, and Murnane (2003)
[18] Autor, Levy, Murnane, 2002
[19] Sptiz-Oener, 2006
[20] Autor, Katz, and Kearney (2007)
[21] Gould (2002)
[22] Spear and Bowen, 1999
[23] Osterman, 1994
[24] Osterman, 1995
[25] Bartel, Ichniowski and Shaw(2007)
[26] Glaeser and Saiz (2003)
[27] Attewell and Lavin, 2007, p. 16
[28] Freeman, 1976
[29] Attewell and Lavin (2007)
[30] Magnuson, 2007
[31] Currie and Moretti, 2003
[32] Goldin and Katz, 2007
[33] Kane, 2001
[34] Card and Lemieux, 2000
[35] David Ellwood (2001)
[36] Lemieux, 2006
[37] A recent simulation (Autor, Murnane, Levy, n.d.) asked what would happen to the college/high school differential if the fraction of the workforce (the entire workforce, not just the young cohorts) with a college degree was suddenly increased to 50 percent and if the relative demand for college workers increased that the historical rate that obtained between 1940 and 1970 (a rate that is more modest than the 1970-2000 increase) . The assumption about college attainment is highly ambitious and unrealistic objective but the simulation suggested that if this happened then in the year 2020 the differential would stand at .46 instead of the current .74.