

# Appendix 1: Methodology

The statistical framework presented in Autor, Katz, and Kearney (2008) is based on a simplified model of how the economy functions based on skilled and unskilled labor (a “constant elasticity of substitution production function” in which the earnings of each group of workers equals their marginal product). Their supply and demand framework is based on dividing the economy into two groups: skilled workers (those with a Bachelor’s or graduate degree plus half of workers who have attended college but not received a Bachelor’s degree) and unskilled workers (those with at most a high school diploma plus the other half of the some college group). The relative wage of skilled vs. unskilled workers is determined by the weighted average of the wages of Bachelor’s and graduate degree wages as the wage of skilled workers and the wage of those with a high school diploma or equivalent as the wage of unskilled workers. The relative supply of skilled vs. unskilled workers consists of the wage bill of skilled labor divided by the wage bill of unskilled labor.

From available government data sources, information on prices and quantities (average earnings by level of education and number of workers with different levels of education) is available. Equation 1 is the wage bill, and Equation 2 describes the change in supply. These numbers, along with a reasonable setting of the elasticity of substitution between skilled and unskilled workers, can be plugged into Equation 3 to determine the change in relative demand (which is not observable). The results of these computations for selected years from 1915 to 2005 are presented in Table 8.1 and Appendix D of Goldin and Katz (2008).

1. Wage Bill =  $\log(q_s) / (1 - \log(q_s))$ , where  $q_s$  equals the share of skilled labor of total wages.

2. Change in relative supply  $\left( \log\left(\frac{S}{U}\right) \right)$ :

$$\log\left(\frac{S}{U}\right) = \log\left(\frac{w_s S}{w_u U}\right) - \log\left(\frac{w_s}{w_u}\right)$$

where  $S$  = number of college equivalents (those with a Bachelor’s or graduate degree and half of those with some college but not a four-year degree),  $U$  is high school equivalents (those with a high school diploma or GED, those who have not finished high school, and half of those with some college), and  $w_s$  and  $w_u$  are the composition-adjusted (fixed weights at 1980 levels of division within college and high school equivalents) wages of skilled and unskilled labor.

3. Change in relative demand  $\left( \log(D_{su}) \right)$ :

$$\log(D_{su}) = \log\left(\frac{S}{U}\right) + \sigma_{su} \log\left(\frac{w_s}{w_u}\right)$$

where  $\sigma_{su}$  is the elasticity of substitution between skilled and unskilled labor. From previous research, this figure has been estimated between 1.4 and 1.84; a value of 1.64 is used.

## Estimation of the Number of Extra College-Educated Workers Needed between 1980 and 2005 to Have the Bachelor’s degree to high school Wage Premium be 46 Percent.

In an exercise not discussed in the body of the text, we estimated the number of extra college-educated workers who would have needed to have been produced from 1980 to 2005 to result in a 46 percent wage premium. We begin by setting  $\log\left(\frac{w_s}{w_u}\right)$  at 0.417, rather than the 0.576 that it was. This implies that the change in the wage bill was just 0.25 percent a year rather than the observable 0.9 percent. Using Equation 2, the change in relative supply (2.0 percent per year), the result must be 3.08 percent per year to equal the 3.48 percent change per year in relative demand.

Using Equation 1, the change in the wage bill must now be 3.33 percent per year (3.08 percent and 0.25—the log of the relatives, which is subtracted on the right side of the equation). The relative wage bill is dependent on changes in the number of bodies and the wages of skilled and unskilled labor. To change the relative wages in order to produce a smaller Bachelor’s degree wage premium, we chose to decrease the pay of workers with a Bachelor’s degree and increase the pay of high school wages by the same percentage. The log of the wage bill in 2005 was 1.779; the log of

the simulated wage bill had to be 1.517. Equation 3 shows that a 7.95 percent increase in high school wages and a 7.95 percent decrease in college wages get us to this point.

4.  $1,517 = 1,779 \times (1-p)/(1+p)$  where  $p$  equals the change in wages  
Reordering the terms gets us  $p = (1,779-1,517)/(1,779+1,517)$ .

The next task is to translate this change in earnings into changes in people with more education. To get the extra added demand of 3.33 percent per year, the wage bill has to be higher. Using Equation 4, the new ratio of the skilled to unskilled wage bill must rise from 57.6 percent to 60.0 percent. Because the relative wages have been lowered, the number of college equivalents must be increased by 12.1 percent. Table A1 shows the distribution of workers by educational levels; therefore, the number of college equivalents (approximately 61 million) must be increased by 7.3 million to reach 68.3 million.

TABLE A1: WORKERS 18- TO 65-YEARS-OLD BY EDUCATION, 2005

Education level	Employment	Share	Equivalents
1. HS or less	54,055,955	40.0%	74,109,159
2. AA + SC	40,106,408	29.7%	
3. BA + Grad	40,883,985	30.3%	60,937,189
Total	135,046,348		

Note: HS = high school; SC = some college.

Because some college counts as one-half of a college equivalent, there is no single solution to the number of extra Bachelor's degree recipients and number of extras who have some college. If the number of people with postsecondary education does not change, then all of the increase in college equivalents is accomplished by having 14.6 million people with some college obtain a Bachelor's degree. In this simulation, we can alter the number of people who have at least some college. If we change the 60 percent of the workforce with some postsecondary education to 72 percent, then the number of people with some college would increase by 17.8 million, while the number of people with a Bachelor's degree would decrease by 1.5 million to satisfy the 7.3 million increase in college equivalents.

These two scenarios represent extremes on how to obtain the added college equivalents. We choose to simulate that the labor force shifted to 66 percent going on to postsecondary education, which resulted in 6.6 million extra people with Bachelor's degrees and 1.6 million extra people with some college, to reach the 7.3 million increase in college equivalents needed to result in the lower Bachelor's degree to high school wage premium.

#### **Estimation of the Number of Extra College-Educated Workers Needed between 2005 and 2025 to Have the Bachelor's degree to high school Wage Premium be 46 Percent**

The next task was to estimate the number of additional college-educated workers needed to meet the rising demand for college educated workers and result in a Bachelor's degree to high school wage premium of 46 percent in 2025. We considered the following relevant numbers: From 1915 to 2005, the change in relative demand was 2.83 percent per year, and from 1980 to 2005, it was 3.48 percent; however, from 1980 to 1990 the change was 5.0 percent per year, from 1990 to 2000 it was 3.0 percent, and from 2000 to 2005 it was 1.4 percent annually.

Obviously, the greater the increase in relative skill demands the more extra Bachelor's degrees that will have to be produced. It is tempting to pick the trend line from 1915 to 2005, but we think that this number is too high. The rise during the 20th century started from a position in which there were very few people with postsecondary education, and as a result it was very easy for the economy to incorporate more college-educated workers. If we presume that the relative demand for college-educated labor will increase by nearly 3 percent a year, eventually virtually the entire workforce should have a four-year degree. Therefore, it would seem that there has to be some slowing in the increase in relative demand for skilled labor. To accommodate for this, we chose the lower number of 2.0 percent per year.

Since we are keeping the relative wages fixed from our simulated 2005 numbers (with a 46 percent wage premium), a 2 percent rise in relative demand is accomplished with an annual 2 percent rise in relative supply. This means that the share of the wage bill going to college equivalents must rise to 69 percent: 15 percent higher than 2005 level when adjusted for a lower Bachelor's degree to high school wage premium.

Once again, getting to 69 percent can be accomplished in many different ways, depending on the number of people who have some postsecondary education. To split the adjustment between more people going to college and more people getting a Bachelor's degree among those going to college, we picked a new postsecondary education rate for the workforce in 2025 to be 75 percent (up from the 67 percent of today's young cohorts). To get the number of added college-educated workers needed, we kept the total labor force of 18- to 65-year-olds fixed at its 2005 level. The total labor force will grow because many aging baby boomers will continue to work (resulting in a much expanded number of workers over 65 years old), and because of new immigrants coming into the country.

Finally, if we had used 2.83 percent as a gain in relative demand (trend figure 1915–2005), the added number of workers with Bachelor's degrees required to meet growing technological demand would have been 27.5 million, as opposed to the 18 million with the 2 percent growth in relative demand. Conversely, if relative demand grew by only 1 percent a year, there would be less pressure to change the entire education pipeline. Consequently, the share of the workforce with at least some postsecondary education could be 70 percent, and then the 1 percent growth would require 14 million extra workers with Bachelor's degrees. If the K-12 pipeline produced 75 percent going to postsecondary education (as we presume in our current projection), the added some college would only require 5.9 million new workers with Bachelor's degrees.

## Appendix 2: Simulation to Create Additional 18 Million Bachelor's Degrees through 2025

Year	Share going on to postsecondary education	Additional Bachelor's degree attainment of 25- to 64-year-olds
2011	67.0%	0.1%
2012	68.0%	0.2%
2013	69.0%	0.3%
2014	70.0%	0.4%
2015	71.0%	0.5%
2016	72.5%	0.5%
2017	74.0%	0.5%
2018	75.5%	0.5%
2019	77.0%	0.5%
2020	78.5%	0.5%
2021	80.0%	0.5%
2022	81.5%	0.5%
2023	83.0%	0.5%
2024	84.5%	0.5%
2025	86.0%	0.4%

## Appendix 3: Considering the Costs of College-Going

Stories about one-year tuition, fees, room, and board running to more than \$50,000 a year get a lot of media attention and send chills up the spine of many parents of young children. In reality, this experience of college is the exception. Students have a wide variety of choices when facing college costs and a high proportion of college students from moderate-income families get grants, scholarships, and tax benefits. Consequently, the “net price” that most students pay for a year of schooling is much lower than the “sticker price” of total college costs at all schools, and only a tiny fraction (5 percent) of students in four-year schools pay more than \$50,000 for college.

A slightly different calculation is ‘out of pocket expenses’ which includes room, board, tuition, fees, travel, books, and other expenses but excludes tax benefits. The National Center for Education Statistics reports that in the academic year ending in June 2008, the average out-of-pocket expenses for a ‘lower middle-class’ family was \$10,000 while the comparable figure was \$17,300 for a family in the highest income group. All of these figures include room and board, expenses that a young adult might face regardless of whether they are enrolled in school or not (if they are not living at home).

Finally, the numbers on total debt of graduating seniors are not as dire as some make them out to be. Fully 34 percent of young Bachelor’s degree holders have no debt at all, while the median debt value of all graduating students is about \$12,000. Heavier debt loads apply to progressively smaller shares of student: only one in four have debts over \$30,000 and only ten percent have debts over \$40,000.

A more thorough economic accounting of the costs of college might include the wages lost by attending school instead of working. But two factors make this cost rather low. First, the vast majority of students either work part-time while in school and/or full-time during the summer months. Second, the jobs available to 19-22 year-olds without any postsecondary education pay very little.

Adding up all the direct and indirect costs of choosing to get a four-year degree (which often takes longer than four years) amount to under \$150,000 for most students. Measured against added earnings of over \$25,000 a year for 40 years and it’s clear that the investment in a Bachelor’s degree is a sound one.

For the small share of students whose college costs run over \$200,000, getting a Bachelor’s degree is still a good investment—even allowing for only average returns. Given that these students are in the best schools and come from the wealthiest families, it is highly likely that these students will make considerably more than the typical Bachelor’s degree holder. Consequently, their earnings premium is higher than average and support paying off these high expenses in under 10 years.

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