PPIC | PUBLIC POLICY INSTITUTE OF CALIFORNIA

Will California Run Out of College Graduates?

Technical Appendices

CONTENTS

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Appendix A: Data and Methods

Our projections are estimates of the expected supply and demand for workers by educational attainment in California as of 2030. The projections were developed based on the assumption that historical trends will continue into the future. The recent economic recession yielded substantial swings in the California job market. Projections that rely on historical trends (like ours, and most) must use recent patterns with caution when trying to forecast.

Wherever possible, we rely on official, publically available estimates of the future economy and population. California Department of Finance population projections and U.S. Bureau of Labor Statistics/California Employment Development Department job projections are the foundation for our estimates, augmented with a number of modules of data and analysis specific to educational trends. In this way, our work is comparable to widely published official statistics. Table 1 walks us through each step taken to project California's skills gap by 2030; we explain the details of each step in Appendices B and C.

Table 1 provides a summary of our projections. Column 1, the total number of people in the labor force by 2030, is projected using DOF population projections and assuming that labor force participation rates will remain at 2013 levels. The educational distribution assumes a continuation of the educational attainment trends observed between 2008 and 2013 for each population cohort defined by race/ethnicity, gender, age and nativity. Column 2 provides unemployment rates by education category as observed in 2007. Column 3 applies the unemployment rates to the projected labor force, thereby allowing for future unemployment to be set at pre-recession levels. Column 4, total employment by 2030, is projected by extrapolating EDD's projected number of jobs for 2022. The educational distribution of employment assumes that educational shares will grow at a constant rate equal to the annualized growth rate observed between 2000 and 2013. Column 5 is the average of moonlighting rates between January 2011 and March 2015, which is used to generate column 6 (allowing us to convert the projected occupational jobs from EDD into projections of the number of people required to perform these jobs). Finally, column 7 shows the difference between the projected supply (column 3) and demand (column 6) by educational categories.[1] We project that California's economy will demand almost 1.1 million more college graduates in 2030 than is likely to be supplied by the state's population.

[1] The state's official population and employment projections are not interdependent. EDD does not make any final adjustments to their employment projections based on any population projections that are currently available. To overcome this limitation of the data, we adjust our projected total supply (after acknowledging some level of unemployment) to match our projected number of workers in 2030.

TABLE 1
California projected workforce skills gap by 2030

	Projected labor force (1)	Unemployment rate (2)	Supply (3)	Demand (jobs) (4)	Moonlighting rates (5)	Demand (workers) (6)	Supply-Demand (7)
Less than high school	2,762,503	11.6	2,443,052	1,826,638	1.8	1,793,008	650,044
High school graduate	4,638,939	6.3	4,345,046	4,483,911	2.8	4,357,665	(12,619)
Some college	5,297,988	4.3	5,070,687	4,740,863	4.6	4,522,516	548,171
Associate degree	1,621,733	3.5	1,565,465	1,726,515	5.1	1,637,625	(72,160)
Bachelor's degree or more	**6,758,840**	**2.6**	**6,580,721**	**8,128,874**	**5.3**	**7,694,158**	**(1,113,437)**
Total	21,080,003	5.1	20,004,972	20,906,801	4.3	20,004,972	–

SOURCES: Authors' projections based on data from Decennial Census, American Community Survey, Current Population Survey, California Department of Finance, and California Employment Development Department.

Projections of workforce skills shortages are best thought of as a window into how the state's trends in population and the economy will or won't match up, rather than a prescriptive set of facts. In reality, the labor market will adjust to shortages or excesses, with wages typically rising for workers whose skills are in high demand and falling (or stagnating) for the rest. This creates an incentive for workers to train for in-demand jobs. The time frame for such labor market adjustment is highly uncertain, however. It depends on individual choices to acquire additional training, experience, and education. Such investments may take years to accomplish, especially in the realm of educational credentials, and may be limited by availability or other factors. Labor market adjustments also depend on employer choices to adjust wages and hiring practices. Firms choose how much labor and capital to employ in production – and make tradeoffs between the two to the extent they are substitutable. An industry could, for example, create a robot to fill the role of a worker who is either unavailable or prohibitively expensive to hire. They also may choose whether or not to exist – at all or in California – in part depending on the availability and cost of the needed workforce. All of these choices, both at the individual and firm/employer level, may have implications for economic success and the growth pattern of the economy.

Appendix B: Supply Projection

Our projection of the educational credentials of the California workforce in 2030 relies on official California population projections, augmented with PPIC-estimated information about the distribution and trajectory of educational attainment. The following steps summarize our methodology:

1. We use California DOF population projections by age, ethnicity, and gender as the base.
2. We add nativity (US born vs. foreign born) to the DOF projections.
3. We add educational attainment to the projections from step 2.
4. We apply labor force participation rates and unemployment rates to the projections from step 3.

We summarize each step in turn and provide additional figures and detailed tables.

Step 1: Population projection baseline data

The California Department of Finance Demographic Research Unit develops long term population projections every three to five years. A new projection series is also prepared following the release of Decennial Census data.

The Department of Finance uses a baseline cohort-component method to project population by age, gender, and race/ethnicity. A cohort-component method traces people born in a given year throughout their lives. As each year passes, cohorts change in accordance with mortality and migration assumptions. Applying fertility assumptions to women of childbearing age forms new cohorts. We use the latest set of projections available, released December 2014. These population projections are used by state and local government agencies to anticipate and plan for future population needs and to measure incidence rates and program effectiveness.

Step 2: Projections by nativity

Our projections include nativity, which is highly predictive of educational attainment. For groups with small populations (or small numbers of foreign born), whose trends across time are unstable, we simply hold the projected share of foreign born by age at the average of 2008–13 levels (combining years). This applies to American Indians, African Americans, and multiracial groups.

For other groups, we allow nativity to continue to change at the same pace as it did from 2008 to 2013 (percentage point difference continued). For each age and gender cohort, we project each five-year period based on the percentage point rate of cohort change. For the youngest cohort (0–4), we use the change in foreign born shares among the 0–4 age group from 2008 to 2013; for all others, we use .75*cohort percentage point change. Projections for 2022 are interpolated between 2018 and 2023, and projections for 2030 are interpolated between 2028 and 2032.

Step 3: Projections by educational attainment

We project educational attainment distributions based on a continuation of historic trends for each of our population cohorts, identified separately by gender, nativity, ethnicity, and age.[2] We then apply these projected educational attainment distributions to our population projections to produce counts of people by educational attainment level. Our base year for the projections is 2013, with educational distributions derived from the American Community Survey. We develop projections for five educational categories (less than high school, high

[2] In the case of multiracial ethnicity, American Indians, and African Americans, US-born and foreign-born are combined because of small sample size concerns.

school, some college, associate degree, and bachelor's degree or more). Cohorts are defined by gender, nativity, ethnicity, and age, with the following exceptions:

We develop our educational attainment projections using either a cohort approach or a period approach depending on the age group. For adults aged 30 and over in 2013, we use a dynamic cohort approach. In this method, we follow cohorts across time so that educational attainment in 2030 is based on 2013 levels for the cohort with adjustments based on historic patterns of change in educational attainment observed for similarly aged cohorts from 2008 to 2013. Specifically:

$$p_{e,x,i,s,n,2030} = p_{e,x-17,i,s,n,2013} + \left(p_{e,x,i,s,n,2013} - p_{e,x-5,i,s,n,2008}\right) * 17/5$$

Where p equals the portion of adults in educational category e within age group x, ethnicity i, gender s, nativity n and year. This approach allows for continuing improvements in educational attainment across age-specific cohorts, and also allows us to examine the degree to which older workers continue to acquire new educational skills.

For younger cohorts, those aged less than 30, historic patterns of change in educational attainment for the age group are allowed to continue at the same pace. Using the same notation as above:

$$p_{e,x,i,s,n,2030} = p_{e,x,,i,s,n,2013} + \left(p_{e,x,i,s,n,2013} - p_{e,x,i,s,n,2008}\right) * 17/5$$

This approach assumes that for each of our population subgroups under age 30, changes in educational attainment observed from 2008 to 2013 will continue from 2013 to 2030. Finally for adults 80 and over, we use a cohort approach but do not allow for any changes in educational attainment.

$$p_{e,x,i,s,n,2030} = p_{e,x-17,i,s,n,2013}$$

Step 4: Adjusting projections to reflect labor force participation rates and unemployment rates

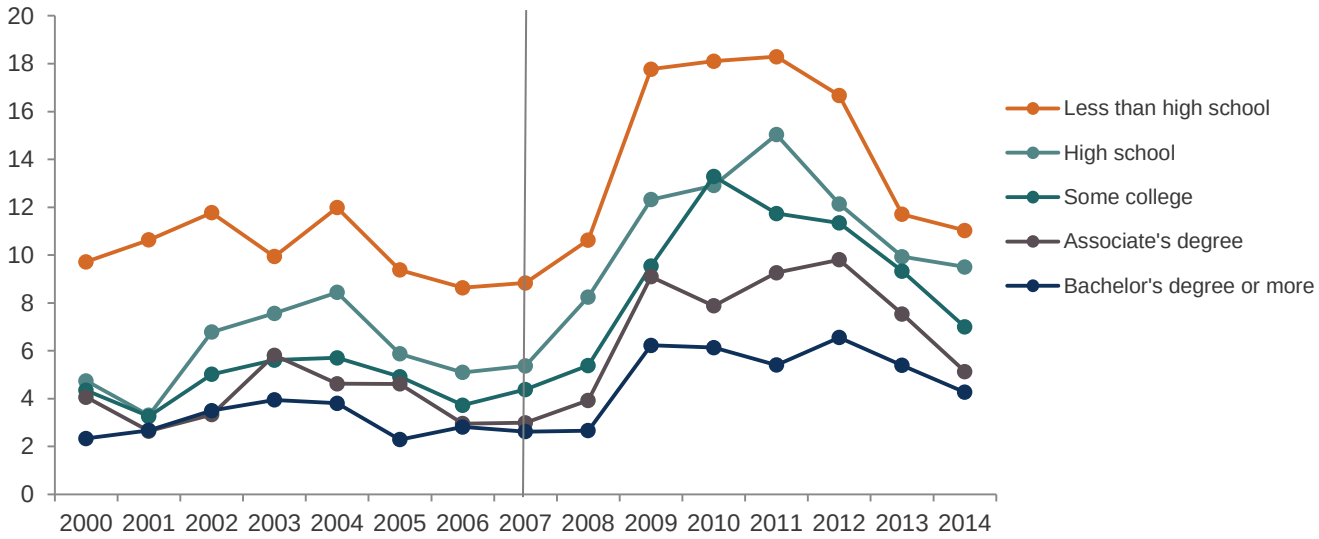
Population projections are not, of course, the same thing as labor force projections. To project the supply of workers ages 16 and over in 2030, we apply labor force participation rates to the projections from step 3. We use 2013 labor force participation rates from the American Community Survey for each of our population and education subgroups, in other words we assume the same labor force participation rates in the future as in 2013. This seems a reasonable assumption considering that labor force participation rates by age and gender have not changed much at all between 2006 and 2013.

Our labor force projections include all workers, both those employed and unemployed. We adjust labor force projections to acknowledge for the possibility of unemployment. We assume that by 2030, unemployment rates would be back at their pre-recession levels. Specifically, we are using unemployment rates by educational attainment as observed in 2007.[3] Because unemployment rates are higher for the less educated, failing to acknowledge for the possibility of unemployment would overstate supply relative to demand for the low-education groups.

[3]Alternatively, if we assume constant unemployment rate across educational categories equal to 5.5 percent (natural rate of unemployment), we get a skills gap that is 15 percent higher than in our preferred scenario.

FIGURE 1

Unemployment rates by educational attainment, 2000–2014



SOURCE: Current Population Survey March Supplement.

NOTE: Civilian labor force, excludes armed forces and people in group quarters. Universe restricted to adults 25 and older.

Appendix C: Demand Projections

Similar to the supply side, our projection of the skills demanded by future jobs uses official estimates of future jobs, appended with PPIC-estimated skill distributions of jobs in the state. Our procedure takes the following steps:

1. Use EDD projections of jobs by occupation through 2022
2. Extend EDD projections to 2030
3. Estimate skill distribution of future jobs using educational attainment data from the American Community Survey
4. Adjust our projections to account for multiple job holders using moonlighting rates by education category

Step 1: Occupational projection baseline data

Predicted job growth in California is an important input to many decisions made across the state and, as such, a number of agencies and organizations produce estimates at various levels of detail. Our objective is to project skill needs of future jobs, but most readily available job growth projections focus on regional, industry, or occupation level detail only (or in some combination). We thus must choose baseline jobs projections upon which to layer estimates of skill needs. Our baseline job projections are based on the EDD's Occupational Employment Projections through 2022. Prior PPIC work examined the implications of relying upon projections based on occupations versus industry (Reed 2008) and of utilizing EDD projections compared to those available from other sources like CalTrans or the UCLA Anderson estimates (Neumark 2005). In sum, we prefer EDD occupational projections because they are available publically, at a very detailed level of occupation (allowing for a fine-tuned estimate of educational trends), and show little difference with industry-based models. One drawback to the EDD projections is that, at time of this publication, only estimates through 2022 are available. We discuss our methodology for forecasting to 2030 in the next subsection.

EDD employment projections are based on a complex model of the US economy maintained by the US Bureau of Labor Statistics (BLS). The model uses historical trends, certain assumptions, and estimated relationships between key segments of the economy to project overall economic growth and output of goods and services. Note that population projections are a key input; the size of the future population largely determines the level of goods and services that will be demanded and is a limiting factor on the workforce available to produce them. Future jobs within industries and occupations are determined – essentially – by estimates of the labor it takes to make the projected amount of goods and services. These estimates are based on long-standing historical patterns of productivity and employment within industries and occupations but are also adjusted for recent patterns at a more detailed level (for example, recent shifts in technology or staffing).

Alternative projection estimates use similar overarching methodology but differ on details. The CalTrans estimates, the other publically available projections we considered using, are based on a relatively less complex model and provide less detailed future job breakdowns but a longer projection window – out to 2040. The 11 industries within which they project future jobs are quite broad compared to the nearly 300 industries or 800 occupations within which EDD-BLS project future jobs. At an aggregate level, however, we find the estimates to be quite comparable (see Table 3).

TABLE 2
Comparing EDD and CalTrans employment projections

	EDD Industry share (nonfarm) 2012	EDD share 2022	CHANGE (PP)	CalTrans Industry share (nonfarm) 2012	CalTrans 2022	CHANGE (PP)
Mining and logging	0.2%	0.2%	0.0%	NA	NA	NA
Construction	4.0%	4.7%	0.6%	4.0%	4.4%	0.4%
Manufacturing	8.5%	7.1%	-1.4%	8.5%	7.7%	-0.8%
Wholesale and retail trade	15.3%	15.2%	-0.1%	15.3%	14.3%	-1.0%
Transportation, warehousing, and utilities	3.3%	3.3%	-0.1%	3.3%	3.5%	0.2%
Information	3.0%	3.0%	0.0%	0.0%	0.0%	0.0%
Financial activities	5.3%	5.1%	-0.2%	5.3%	4.9%	-0.3%
Professional and business services	15.2%	16.4%	1.2%	15.2%	16.9%	1.7%
Educational services, health care and social assistance	14.8%	16.2%	1.4%	14.8%	16.1%	1.3%
Leisure and hospitality	10.9%	11.2%	0.3%	10.9%	10.9%	0.0%
Other services	3.4%	3.3%	-0.2%	NA	NA	NA
Government	16.2%	14.5%	-1.6%	16.2%	14.4%	-1.7%
Total	**100.0%**	**100.0%**		**93.4%**	**93.2%**	

SOURCES: EDD Industry employment projections 2012–2022, CalTrans Industry employment projections through 2040.

NOTES: Wage and salary employment only. EDD and CalTrans estimates utilize the same projected level of wage and salary employment estimated in 2022, at 17,446,300. CalTrans does not estimate jobs in Other Services or Mining industries, and as such the projected jobs do not total to 100 percent.

Step 2: Extend EDD projections through 2030

The present set of EDD-BLS projections covers the 2012–2022 period. According to EDD's projections, California's occupational employment is expected to add more than 2.4 million jobs between 2012 and 2022, reaching a total of about 18.7 million jobs by 2022. This means annual increases of 1.4 percent. If the same annual growth where to persist between 2022 and 2030, California's occupational employment would reach 20.9 million by 2030.

To extend EDD-BLS occupational employment projections to 2030 we work under the assumption that between 2022 and 2030 the share of employment in each minor occupational group (three-digit Standard Occupational Classification-SOC) is going to grow at the same pace as EDD is projecting it will change between 2012 and 2022. However, given that there are differences in the occupational distribution of employment between EDD and ACS in the base year[4], we apply EDD's projected change in occupational shares to the 2013 ACS occupational shares.

Let's use other management occupations (SOC 119) as an example. According to EDD, 3.1 percent of the state jobs in 2012 were in this occupational category. This share is projected to decrease to 2.9 percent by 2022, which means an annual decrease of 0.0246 percentage points between 2012 and 2022. Under our assumption that occupational shares will grow at the same annual pace as projected by EDD, then we are talking of a projected

[4] Which remain even after adjusting for moonlighting rates.

decrease of 0.419 percentage points accumulated over our entire projection horizon. Now, instead of applying this rate of change to EDD's 2012 occupational share, we use the share as observed in the 2013 ACS (5.8%). Based on these calculations, we are projecting that other management occupations would make up for 5.3 percent of total jobs in 2030.

	2012 occupational share (%)	2022 occupational share (%)	Annualized change between 2012–2022	Projection horizon (#years)	Projected growth between 2013–2030 (pp)	ACS 2013 occupational share (%)	2030 occupational share (%)
Other management occupations (119)	3.1	2.9	-0.0246	17	-0.4190	5.8	5.3

Step 3: Estimate skill distribution of future jobs

Our approach for projecting education requirements of workers within occupations assumes that empirical employment practices are a good measure of workforce skills needs. Educational requirements of the workforce are projected to change because of both predicted changes in occupational composition of employment and the continuation of past changes in education within occupations. In projecting the educational requirements of workers by 2030, we assume a steady rate of growth between 2013 and 2030 in the educational distribution of workers within minor occupational groups (three-digit SOC). Specifically, we set this steady rate of growth to be equal to the annualized growth rate observed between 2000 and 2013. If the trend projected a negative number of workers with a given educational level in an occupation, that number was set to zero, and the additional workers implicitly added to that cell were removed from the other educational categories in that occupation in proportion to their representation. Educational attainment data comes from the 2000 Decennial Census and the 2013 American Community Survey (ACS) and covers workers 16 years and older.

Using the same example as before, according to the 2000 Decennial Census 45.7 percent of workers in this occupational category had at least a bachelor's degree. By 2013, this share had increased to 52.5 percent, which means an annual growth of 0.521 percentage points between 20000 and 2013. Under our assumption that between 2013 and 2030, educational shares will grow at the same annual pace as they did between 2000 and 2013, then we are talking of a projected increase of 8.9 percentage points accumulated over our entire projection horizon. This leaves us with a projection of 61.3 percent of workers with at least a bachelor's degree by 2030.

Soc3		Educational shares 2000 (%)	Educational shares 2013 (%)	Annualized change between 2000–2013 (pp)	Projected growth between 2013–2030 (pp)	Educational shares 2030 (%)
119	Less than high school	7.6	5.1	-0.191	-3.240	1.8
119	High school diploma	13.5	13.3	-0.016	-0.266	13.0
119	Some college	25.3	21.1	-0.320	-5.448	15.7
119	Associate degree	7.9	8.0	0.006	0.103	8.1
119	Bachelor's degree and above	45.7	52.5	0.521	8.851	61.3

Step 4: Adjust for moonlighting

EDD employment projections are counts of jobs, not individuals. To turn EDD job projections into projections for the number of people required to perform those jobs we calculated moonlighting rates by educational level using Current Population Survey (CPS) data on multiple jobholders.

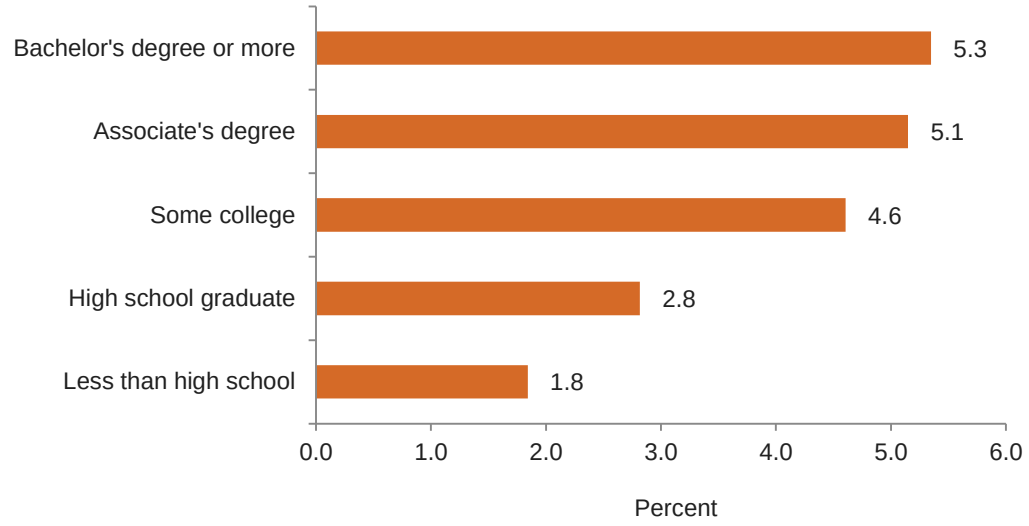
In the CPS, a multiple jobholder is defined as a person who responds affirmatively to the question "LAST WEEK, did you have more than one job (or business), including part-time, evening, or weekend work?" and, (1) had a job as a wage and salary worker with two employers or more, (2) combined a wage and salary job with self-employment, or (3) combined a wage and salary job with one as an unpaid family worker. Persons with two self-employed jobs and persons who were self-employed or unpaid family workers on their primary jobs and held a secondary job as an unpaid family worker are excluded from the count of multiple jobholders. The primary job is defined as the one at which the greatest number of hours were worked. Multiple jobholding rates are calculated by dividing the number of multiple jobholders in a specified worker group by total employment in the same group.

Specifically we used the average moonlighting rates between January 2011 and March 2015 using CPS monthly files from National Bureau of Economic Research-NBER. Our projections assume that moonlighting rates are going to remain constant at those average levels. However, is important to know that California's multiple-jobholding rate has declined gradually during the last several years.

The incidence of multiple-jobholding generally increases as workers achieve higher levels of education. Among workers age 25 and older, those with less than a high school diploma had a low multiple-jobholding rate (1.8%). The rate was much higher (5.3%) for workers with at least a bachelor's degree, especially those with a master's degree or a doctoral degree. Primary reasons for holding more than one job differed by educational attainment. As educational attainment increases, the proportion of multiple jobholders who moonlighted for economic reasons declines. Conversely, as educational attainment increases, multiple jobholders are more likely to have worked more than one job because they enjoyed the second job or because they wanted to build a business or get experience. It is possible that workers with more education are more apt to work at secondary jobs that involve intellectual pursuits that they enjoy, whereas secondary jobs held by less-educated people might be held mainly to increase incomes. Indeed, 37 percent of multiple jobholders with advanced degrees held secondary jobs in management occupations or in education, training, and library occupations. In contrast, among multiple jobholders with less than a high school diploma, 41 percent held secondary jobs in food preparation and serving occupations or in building and grounds maintenance occupations (Hipple, S. 2010).

FIGURE 2

Average moonlighting rates by educational attainment, 2011–2015



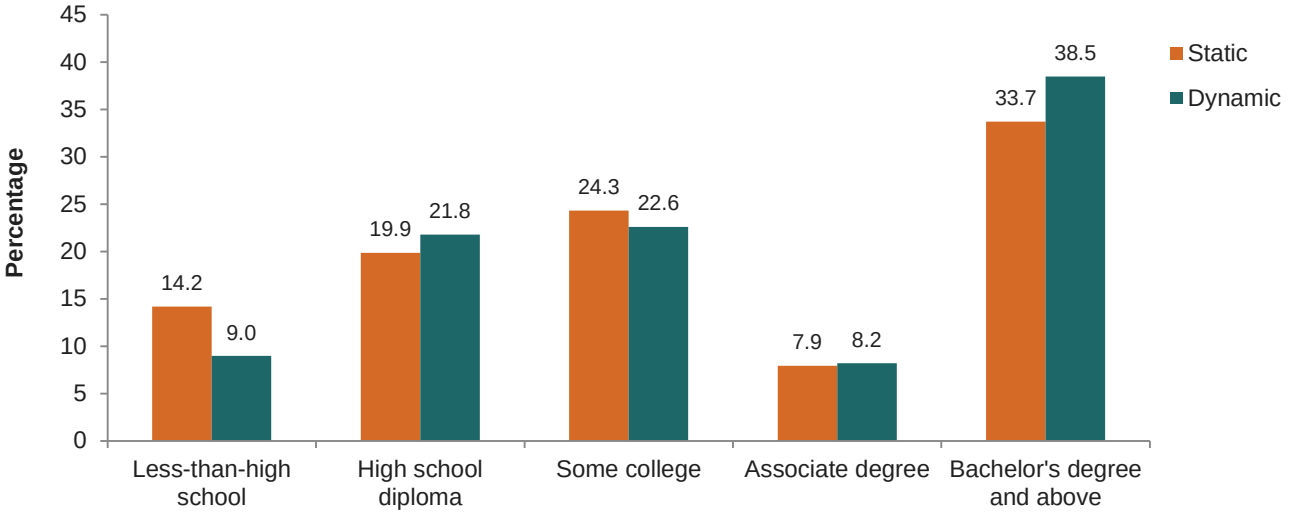
SOURCE: Current Population Survey monthly files from NBER.

Static versus dynamic approach to educational attainment of the workforce

We could have assumed that that in the future the educational distribution within each occupation would be the same as observed in 2013. In this case, educational requirements of the workforce change only because of changes in the occupational mix of employment ("static" scenario). This assumption reduces the projected skills gap to only about 86,000, which is substantially lower relative to its magnitude when we let the educational attainment vary according to past trends ("dynamic" scenario). This evidence points to the fact that educational changes within occupation are what seem to be driving the skills gap.

FIGURE 3

Projected educational distribution of the workforce, 2030



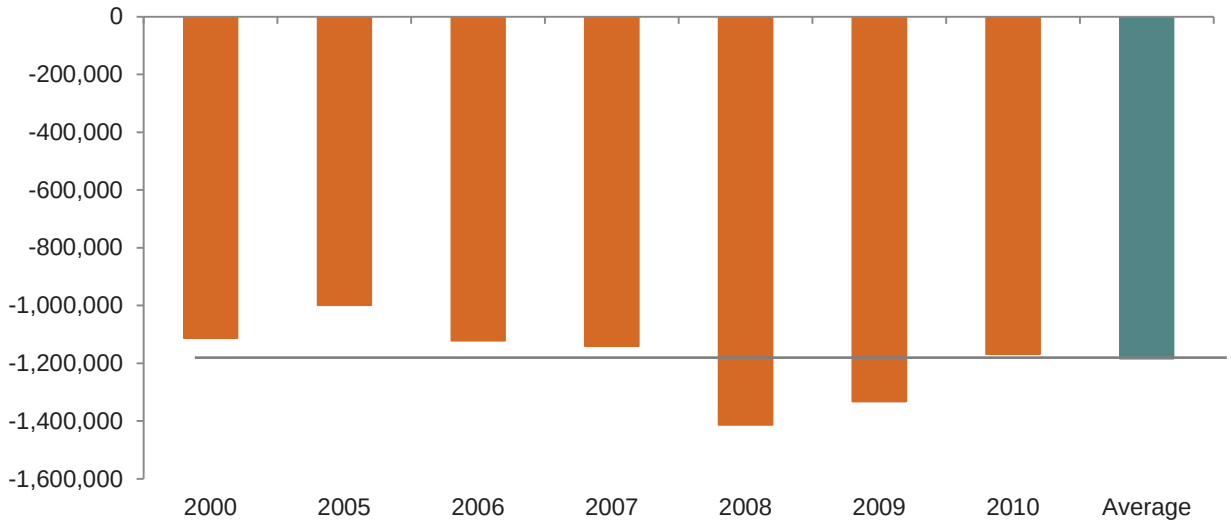
SOURCE: Authors' calculations based on 2000 Decennial Census, 2013 American Community Survey data, and EDD.

Demand-side projections robustness checks

We performed multiple robustness checks on our projections of skills gaps on both the demand and the supply sides of the equation. On the demand side, the first thing we wanted to see is how robust our projections were to the choice of the base years used in projecting the growth rate of skilled workers between 2013 and 2030. As Figure 5 shows, our projected skills gap varies from about one million to 1.4 million; with an average projected gap of 1,184,000, which is six percent higher than the skills gap that we get when we use the growth rate between 2000 and 2013, our preferable scenario.

FIGURE 4

Effect on the skills gap of using different base years in projecting the demand for college educated workers



SOURCE: Authors' calculation based on 2010 Decennial Census and American Community Survey data.

NOTE: Each bar is a different scenario. The 2000 bar corresponds to our preferred scenario.

Second, instead of assuming that between 2022 and 2030 employment will grow at the same pace that EDD is projecting it will grow between 2012 and 2022, we could assume that 1) total employment will grow 7.3 percent between 2022 and 2030, which is consistent with the CalTrans projection of total employment growth for that period, and 2) the occupational shares estimated by EDD for 2022 will remain constant between 2022–2030.[5] This scenario leads to a 4 percent decrease in the skills gap (Scenario 2). Third, instead of using past educational attainment trends of workers 16 and over, we use past trends for workers ages 25 to 64, which results in an 7.3 percent higher skills gap (Scenario 3). Finally, if we overlook the existence of moonlighting (i.e. assume jobs equal workers), we find a skills gap that is 47 percent higher (Scenario 4).

[5] Given that CalTrans annual estimates are for total wage and salary employment only (which excludes self-employment, unpaid family workers, and private household workers), the underlying assumption is that non-wage and salary employment would grow at the same rate as wage and salary employment.

TABLE 3
Demand-side robustness checks

	Our preferable scenario (1)	(2)	(3)	(4)
Less than high school	650,044	624,363	(21,023)	(67,283)
High school graduate	(12,619)	(12,120)	(24,653)	(151,364)
Some college	548,171	526,515	1,317,106	1,135,657
Associate degree	(72,160)	(69,309)	(76,512)	(165,717)
Bachelor's degree or more	**(1,113,437)**	**(1,069,449)**	**(1,194,917)**	**(1,634,582)**

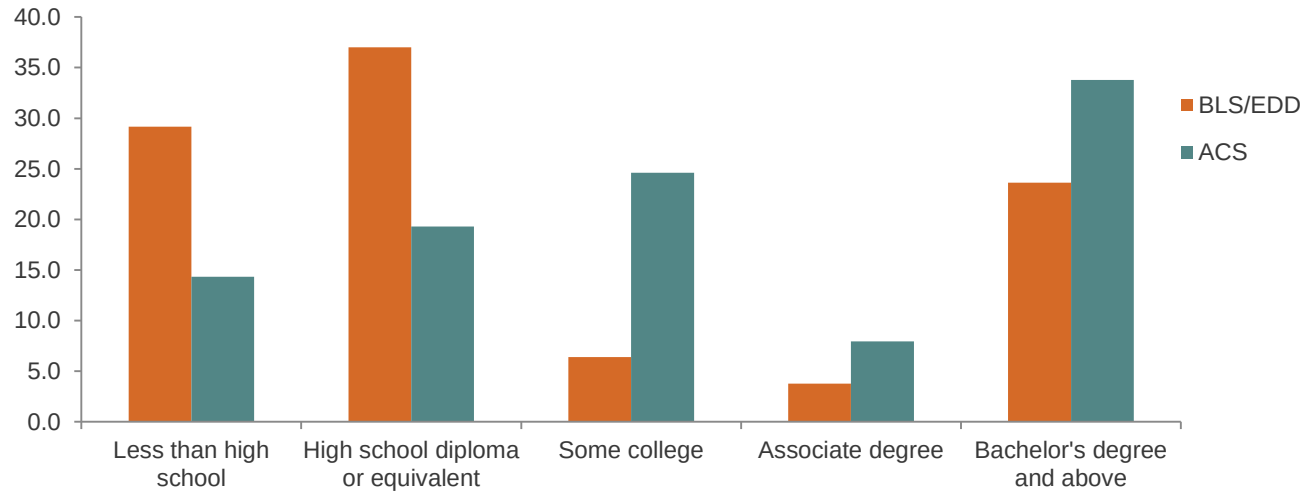
SOURCE: Authors' calculations.

BLS education and training requirements

The BLS provides information about education and training minimum requirements for detailed occupational categories (six-digit SOC). BLS uses a system to assign categories for typical entry-level education, work experience in a related occupation, and typical on-the-job training. Alternatively, educational attainment data from the ACS provides information about the highest level of education attained by those in the current workforce. The BLS-based approach considers whether employers need college-educated workers to staff positions. Educational attainment data from the ACS consider whether employers are choosing workers with a certain level of education.

Workers today—and in recent history—have education levels far above minimum requirements (Figure 5). Therefore, using BLS minimum requirements in our projections would lead to underestimates of the skill demanded by employers.

FIGURE 5
BLS typical entry-level education requirements versus ACS Educational attainment, 2012



SOURCE: Authors' calculation based on data from the 2012 American Community Survey and California Occupational Employment Projections.

Moreover, BLS-EDD projects occupational growth, but holds education within occupational groups constant in its projections, which ignores the possibility of upgrading. In our projections, with the use of ACS educational attainment data, we account for changes over time in the educational distribution of workers in each minor occupational group.

Upskilling

Upskilling is a trend in a vast majority of occupations. Some of the projected increase in educational requirements comes from shifts in economic growth toward occupations that require higher levels of education. However, increases in educational attainment within specific occupations seem to be the major driving force behind the increase in the demand for college-educated workers.

TABLE 4

In most occupational categories the share of college-educated workers is increasing

	Share of workers with at least a Bachelor's degree (%)		Occupational share of employment (%)		change in the share 2013-2030 (pp)	
2-digit SOC	2013	2030	2013	2030	College-educated workers	Occupational employment
Management	57.0	67.0	10.1	9.8	10.0	-0.3
Business operations	59.8	74.1	2.7	3.0	14.3	0.3
Financial operations	72.6	82.7	2.3	2.3	10.0	0.1
Computer and mathematical science	72.1	83.4	3.0	3.4	11.3	0.4
Architecture and engineering	74.7	86.8	2.2	2.1	12.1	-0.1
Life, physical, and social science	87.7	90.7	1.0	1.0	3.0	0.1
Community and social services	67.5	73.4	1.5	1.4	5.9	0.0
Legal	81.5	84.8	1.3	1.2	3.3	0.0
Education, training, and library	74.4	79.5	5.4	5.0	5.1	-0.4
Arts, design, entertainment, sports, and media	59.1	68.7	2.8	2.7	9.6	-0.1
Health care practitioner and technical	62.6	63.7	4.7	5.0	1.2	0.3
Health care support	14.7	17.2	2.0	2.3	2.5	0.3
Protective service	23.5	27.4	2.1	1.9	3.9	-0.1
Food preparation and service	8.8	12.1	5.7	6.4	3.3	0.7
Building and grounds cleaning and maintenance	4.1	3.6	4.3	4.3	-0.4	0.0
Personal care and service	16.4	22.8	4.6	5.9	6.4	1.3
Sales and related	27.1	31.9	11.0	10.6	4.7	-0.3
Office and administrative support	21.0	28.4	12.7	11.6	7.4	-1.1
Farming, fishing and forestry	2.0	1.4	1.6	1.5	-0.6	-0.1
Construction and maintenance	5.6	5.4	4.7	5.5	-0.2	0.7
Extraction	0.6	0.0	0.1	0.1	-0.6	0.0
Installation, maintenance and repair	8.8	10.9	2.9	2.8	2.2	-0.1
Production	9.0	11.6	5.2	4.3	2.6	-0.9
Transportation and material moving	7.1	8.2	5.8	5.8	1.1	0.0
Military specific occupations	20.9		0.4	0.0	-20.9	-0.4

SOURCES: Authors' calculations based on 2012 ACS (three-year estimates) data.

College wage premium

One way to assess whether our projections based on ACS educational distributions reflect real demand for skill among employers rather than an excess supply of educated workers is to examine college wage premiums--the difference between average earnings among those with a college degree and those with only a high school diploma- within occupational categories. If we observe positive college wage premiums then we can take that as a sign of greater productivity and increased demand for those workers. There is not an incentive for employers to hire college educated workers and pay them the market wage premium unless the more-educated workers were in fact more productive.

For our analysis of wage premiums, we use the 2012 ACS (three-year estimates) and rely on standard wage equations. Specifically, wage premiums were estimated using OLS regressions of the natural log of real annual wages on dummy variables for educational attainment (less than high school, some college, associate degree, bachelor's degree or above, with high school omitted). Our regressions control for age (as a proxy for years of experience), age squared, and include dummy variables for race/ethnicity (Hispanic, African American, Asian, and other, with white omitted), sex, and citizenship status. We ran separate regressions by three-digit occupational categories, limiting our sample to full-time and year-round workers 25 to 64 years of age employed in the public or private sector. Workers in the military and institutionalized or unincorporated self-employed workers are excluded. Annual wages below $1,700 in 2013 dollars are also dropped.[6]

Our estimates suggest that wage premiums are lower in the occupations where the share of workers with at least a bachelor's degree is lower. However, for every occupation, wage premiums are positive (Table 5).

TABLE 5

The economic returns of a college degree are widespread across all occupational categories

3-digit SOC	Occupation	Share of workers with at least a bachelor's degree (%)	Wage premium
111	Top executives	62.2	0.477
112	Advertising, marketing, promotions, public relations, and sales managers	70.8	0.569
113	Operations specialties managers	58.8	0.551
119	Other management occupations	56.4	0.620
131	Business operations specialists	58.1	0.471
132	Financial specialists	73.6	0.406
151	Computer occupations	74.5	0.380
172	Engineers	84.7	0.382
173	Drafters, engineering technicians, and mapping technicians	23.8	0.205
211	Counselors, social workers, and other community and social service specialists	67.8	0.391
231	Lawyers, judges, and related workers	98.6	0.677
232	Legal support workers	43.8	0.204

[6] The estimates do not account for unobservable factors that may increase an individual's wage and educational attainment simultaneously (ability or "drive," for example) and thus should not be interpreted causally. However, a wealth of research that does estimate causal returns to education concludes that the returns are large, and that OLS model estimates are only about 10 percent higher than those from causal models (Card 1999).

3-digit SOC	Occupation	Share of workers with at least a bachelor's degree (%)	Wage premium
252	Preschool, primary, secondary, and special education school teachers	90.4	0.482
253	Other teachers and instructors	52.5	0.277
271	Art and design workers	62.7	0.473
273	Media and communication workers	79.3	0.343
291	Health diagnosing and treating practitioners	77.3	0.645
292	Health technologists and technicians	24.5	0.367
311	Nursing, psychiatric, and home health aides	15.0	0.354
319	Other health care support occupations	12.8	0.224
333	Law enforcement workers	31.5	0.358
339	Other protective service workers	19.6	0.424
351	Supervisors of food preparation and serving workers	14.7	0.218
352	Cooks and food preparation workers	4.9	0.124
353	Food and beverage serving workers	15.2	0.180
373	Grounds maintenance workers	3.4	0.265
395	Personal appearance workers	7.2	0.372
399	Other personal care and service workers	19.7	0.276
411	Supervisors of sales workers	31.6	0.460
412	Retail sales workers	20.2	0.412
413	Sales representatives, services	53.0	0.559
414	Sales representatives, wholesale and manufacturing	47.4	0.592
419	Other sales and related workers	46.6	0.459
431	Supervisors of office and administrative support workers	32.6	0.404
433	Financial clerks	19.2	0.235
434	Information and record clerks	23.9	0.337
435	Material recording, scheduling, dispatching, and distributing workers	13.5	0.247
436	Secretaries and administrative assistants	24.0	0.180
439	Other office and administrative support workers	23.7	0.273
452	Agricultural workers	2.2	0.472
471	Supervisors of construction and extraction workers	9.7	0.126
472	Construction trades workers	4.8	0.169
492	Electrical and electronic equipment mechanics, installers, and repairers	17.6	0.212
493	Vehicle and mobile equipment mechanics, installers, and repairers	5.2	0.164
499	Other installation, maintenance, and repair occupations	7.0	0.229
511	Supervisors of production workers	16.4	0.430
512	Assemblers and fabricators	5.6	0.203
514	Metal workers and plastic workers	3.6	0.367
516	Textile, apparel, and furnishings workers	4.6	0.376

3-digit SOC	Occupation	Share of workers with at least a bachelor's degree (%)	Wage premium
519	Other production occupations	12.2	0.383
537	Material moving workers	3.6	0.136

SOURCES: Authors' calculations based on 2012 ACS (three-year estimates) data.

NOTES: Included are occupations with a sample size of at least 1,000 workers and where the estimated college wage premium was statistically significant.

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