THE CAREER OUTCOMES OF FEMALE ENGINEERING BACHELOR'S DEGREE RECIPIENTS:

A STUDY USING THE BACCALAUREATE & BEYOND (B&B) LONGITUDINAL STUDY

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The National Research Council

What is the B&B Longitudinal Study?

- Conducted by U.S. Department of Education's National Center for Education Statistics (NCES)
- Examines post-graduation experiences – e.g., education, employment, and family – of those who have graduated with a bachelor's degree
- Captures information on degree recipients' undergraduate experiences and key demographic information
- Follows multiple cohorts of students over time

B&B Cohort 1 (1992-1993)

- Nationally representative sample of approximately 11,000 students who graduated with a bachelor's degree during the 1992-1993 academic year
- Students were surveyed in their last year of college, with follow-up surveys conducted one year after graduation (1994), four years after graduation (1997), and ten years after graduation (2003)

B&B Cohort 2 (1999-2000)

- Nationally representative sample of about 10,000 students who graduated with a bachelor's degree during the 1999-2000 academic year
- A follow-up survey was conducted one year after graduation (2001)

B&B Cohort 3 (2007-2008)

- Nationally representative sample of close to 19,000 students who graduated with a bachelor's degree during the 2007-2008 academic year
- A follow-up survey was conducted one year after graduation (2009)
- Another follow-up survey is in progress

The study emphasizes Cohort 1

- Cohort 1 provides a picture of the career paths of college graduates over a ten year period after graduation, while Cohorts 2 and 3 provide a picture of college graduates only one year after graduation
- Cohorts 2 and 3 are used primarily for cross-cohort comparisons

Key questions study addresses

- What are the career outcomes of women who receive bachelor's degrees in engineering?
- How do these career outcomes compare to men who receive bachelor's degrees in engineering and to women who receive bachelor's degrees in other "career-oriented" majors (e.g., business and management, education, and health)?
- What factors help explain these observed career outcomes?

Primary limitations of the B&B data

- Limited number of engineers represented in each survey
  - For example, of the approximately 8,000 in Cohort 1 who responded to all four surveys, fewer than 7% graduated with a degree in engineering
  - Of these, only about 80 are women
- The online tool that provides access to the data does not permit the pooling of cohorts and limits the ways in which variables can be used and created

Cases for each cohort and survey

Cohort	Survey year	Engineering graduates responding to the survey		
		All	Male	Female
1	1994	640	550	90
	1997	625	535	90
	2003	575	490	85
	All surveys*	520	440	80
2	2001	580	480	100
3	2009	930	750	180

For confidentiality purposes, B&B does not reveal exact sample sizes. Numbers in the table are approximate.

*Includes the base year survey in 1993.

Another limitation of the B&B data

- Survey does not allow us to identify those who have progressed to engineering managers and supervisors
- Rather, individuals are recorded as managers or supervisors, with no information provided on the nature of the work overseen
- This limitation is most problematic for Cohort 1 since one might expect a sizable number of these graduates to have progressed to manager or supervisor by ten years after graduation

Methodology

Key career outcomes examined

- Percentage of graduates in the labor force (“labor force participation”)
- Percentage of employed graduates working in the field of their major (“retention”)

Two types of analyses are utilized:
1. Descriptive comparisons

- To the extent that the B&B surveys are representative, descriptive comparisons describe the population of individuals receiving undergraduate degrees in engineering in the graduation year under consideration (e.g., 1992-1993)
- Such statistics are useful in understanding the gender similarities and differences in career outcomes for those with bachelor's degrees in engineering

Two types of analyses are utilized: 2. Multiple regression

- Enables us to gain insights into what might explain observed differences in career outcomes
- Use to examine the relationship between an outcome of interest – e.g., labor force participation – and a variable that is hypothesized to be related to this outcome – e.g., gender – holding constant other factors that may also be related to the outcome – e.g. age, marital status, undergraduate debt

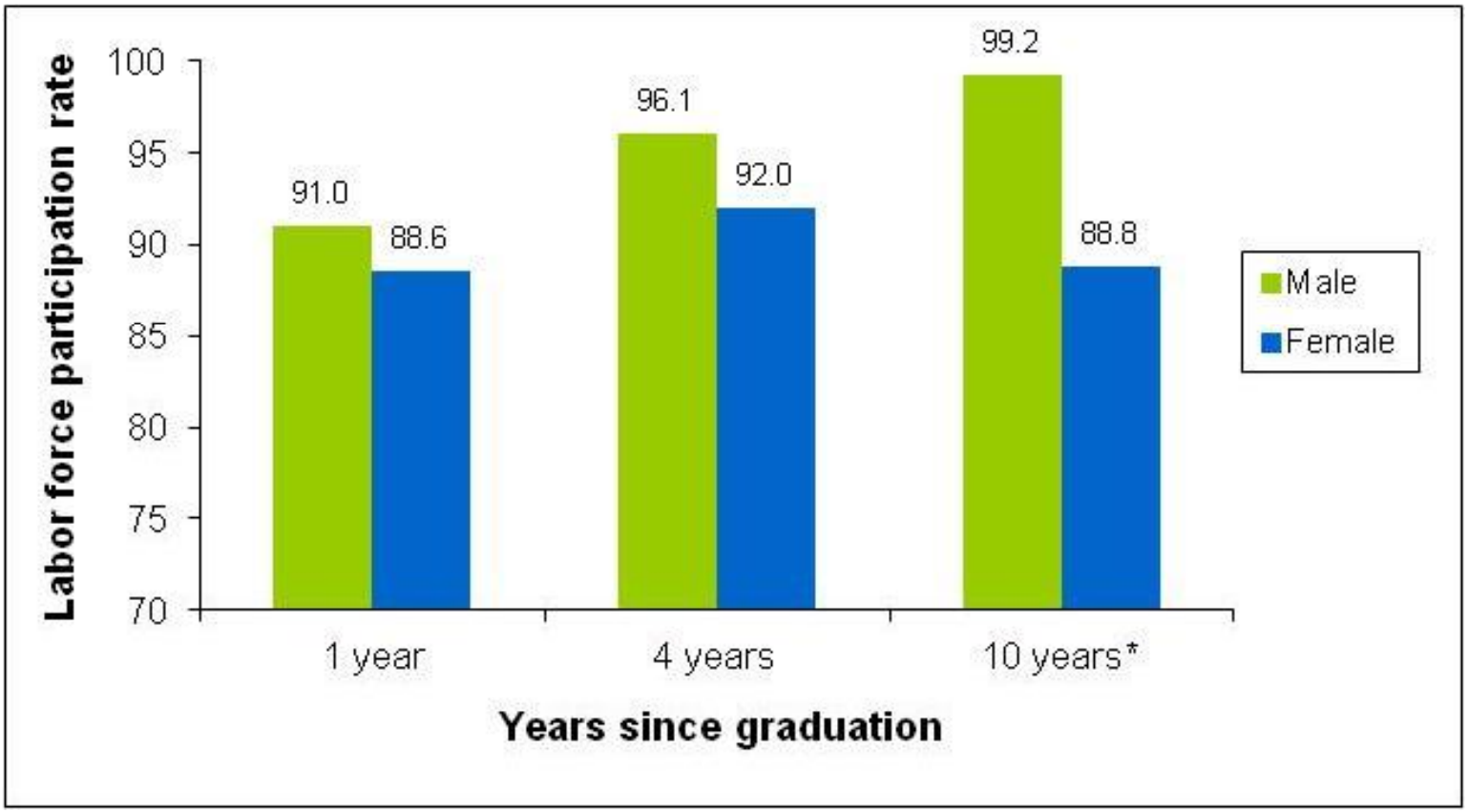
Results of analysis

Descriptive comparisons:
Labor force participation

Labor force participation

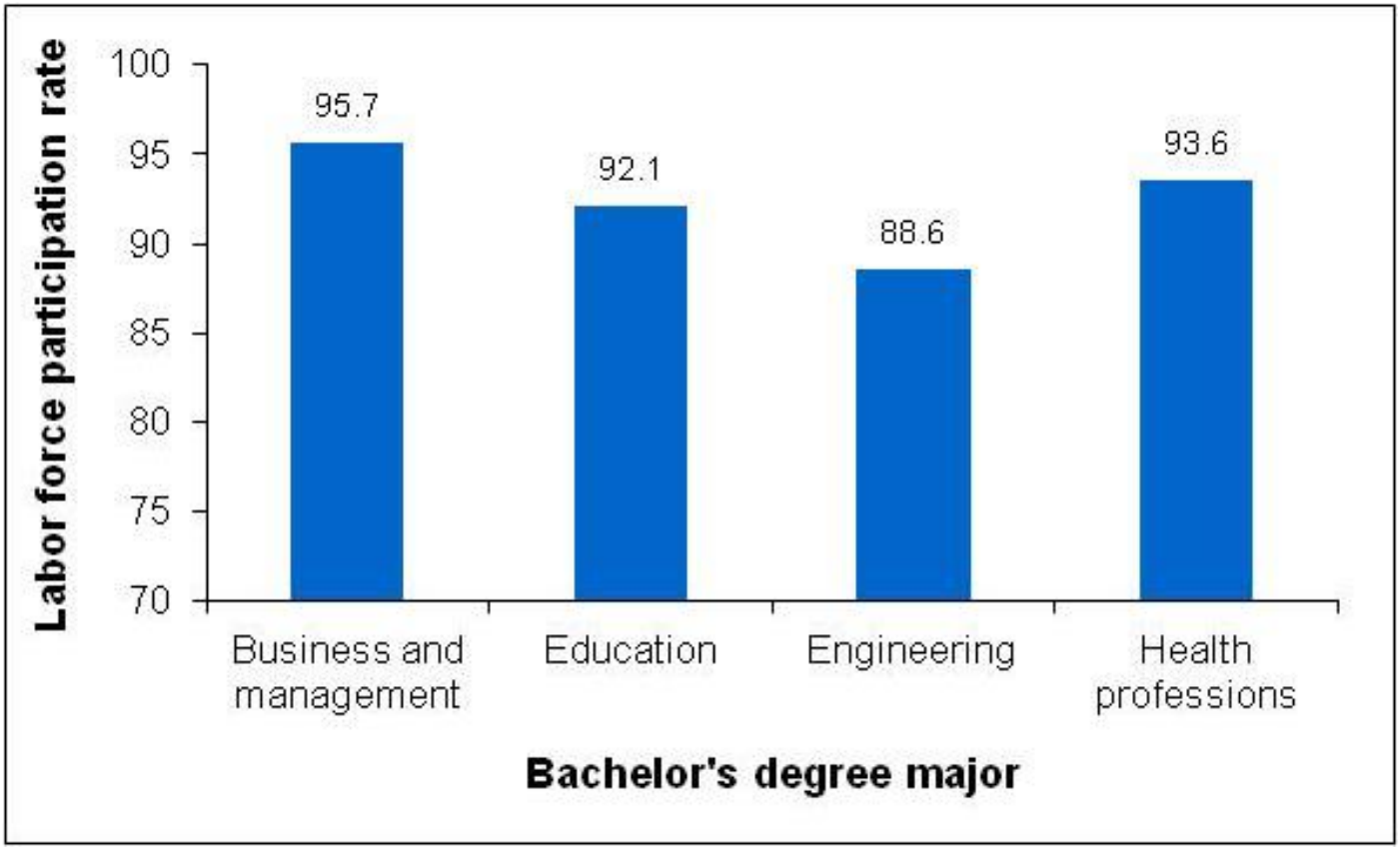
- Upon graduating with a bachelor's degree, one key decision a graduate makes is whether to join the labor force
- Those who choose not to join the labor force do so for a variety of reasons, such as attending school, family responsibilities, health problems, and the like
- This section compares the labor force participation rates (LFPR) of male and female bachelor's degree recipients at various points after graduation

LFPR by gender for engineering bachelor's degree recipients, B&B Cohort 1

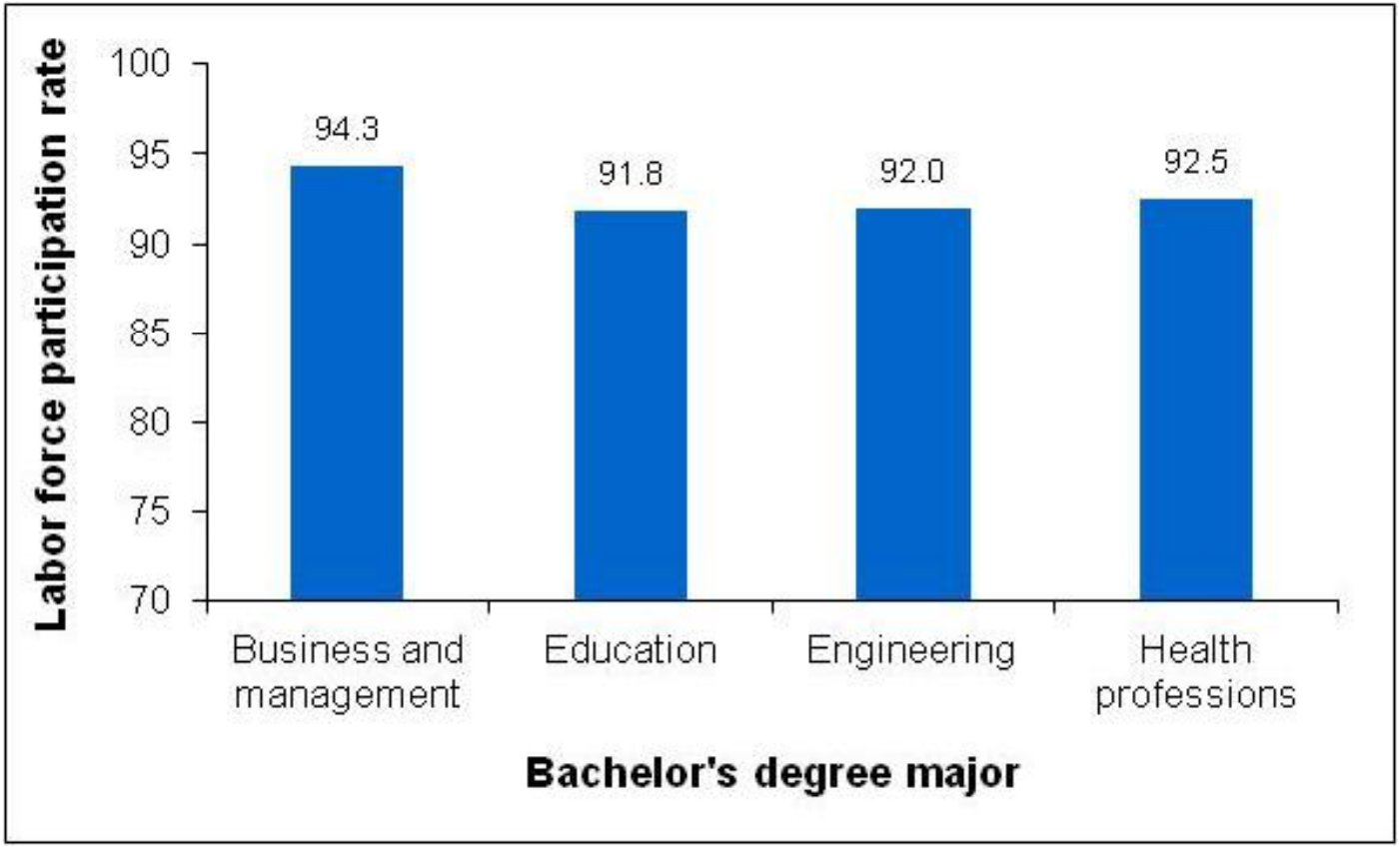


*Difference between male rate and female rate is statistically significant at the 5% level.
Note: The increases in LFPR over time for males are statistically significant at the 5% level.

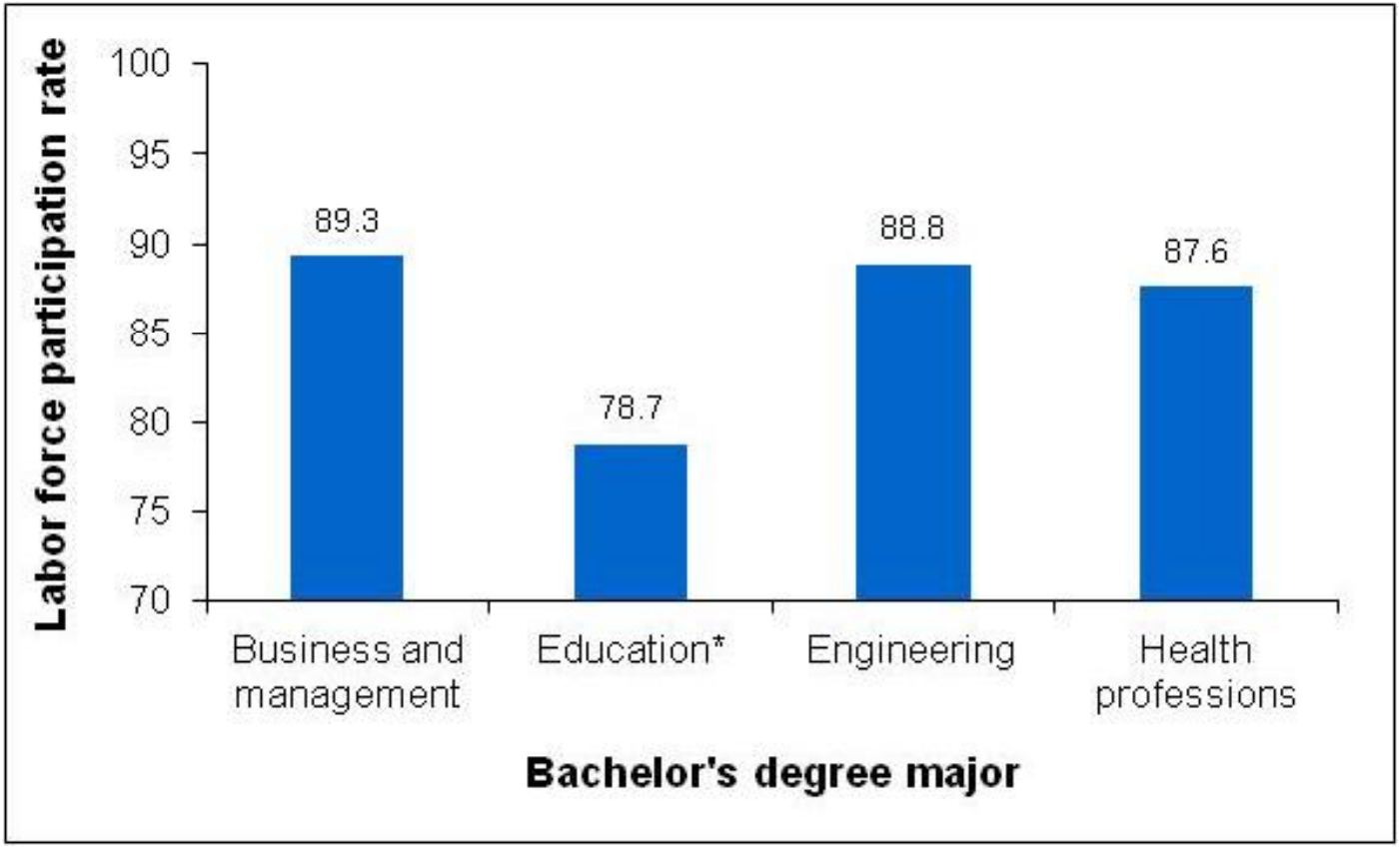
LFPR one year after graduation for female bachelor's degree recipients, B&B Cohort 1



LFPR four years after graduation for female bachelor's degree recipients, B&B Cohort 1

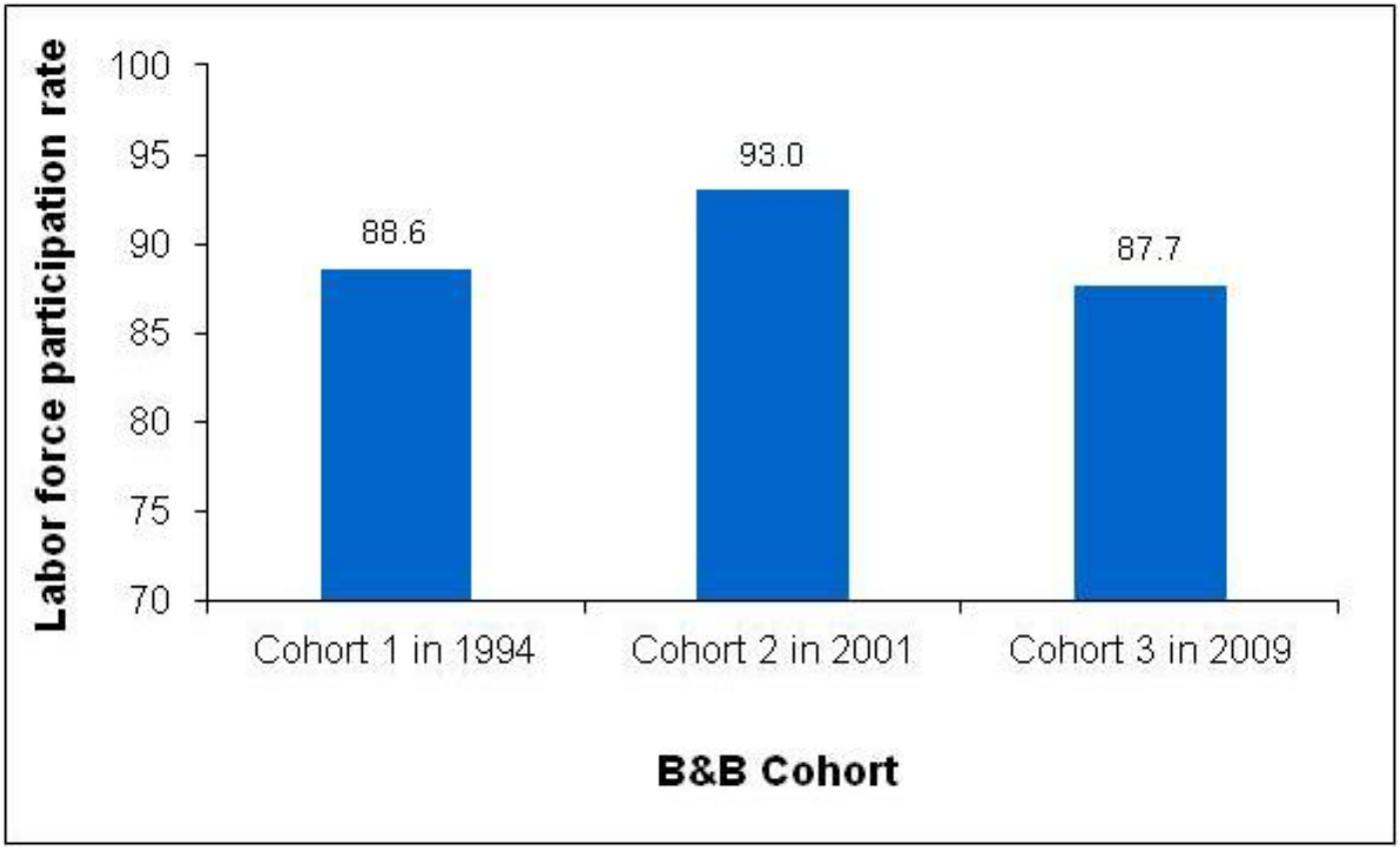


LFPR ten years after graduation for female bachelor's degree recipients, B&B Cohort 1

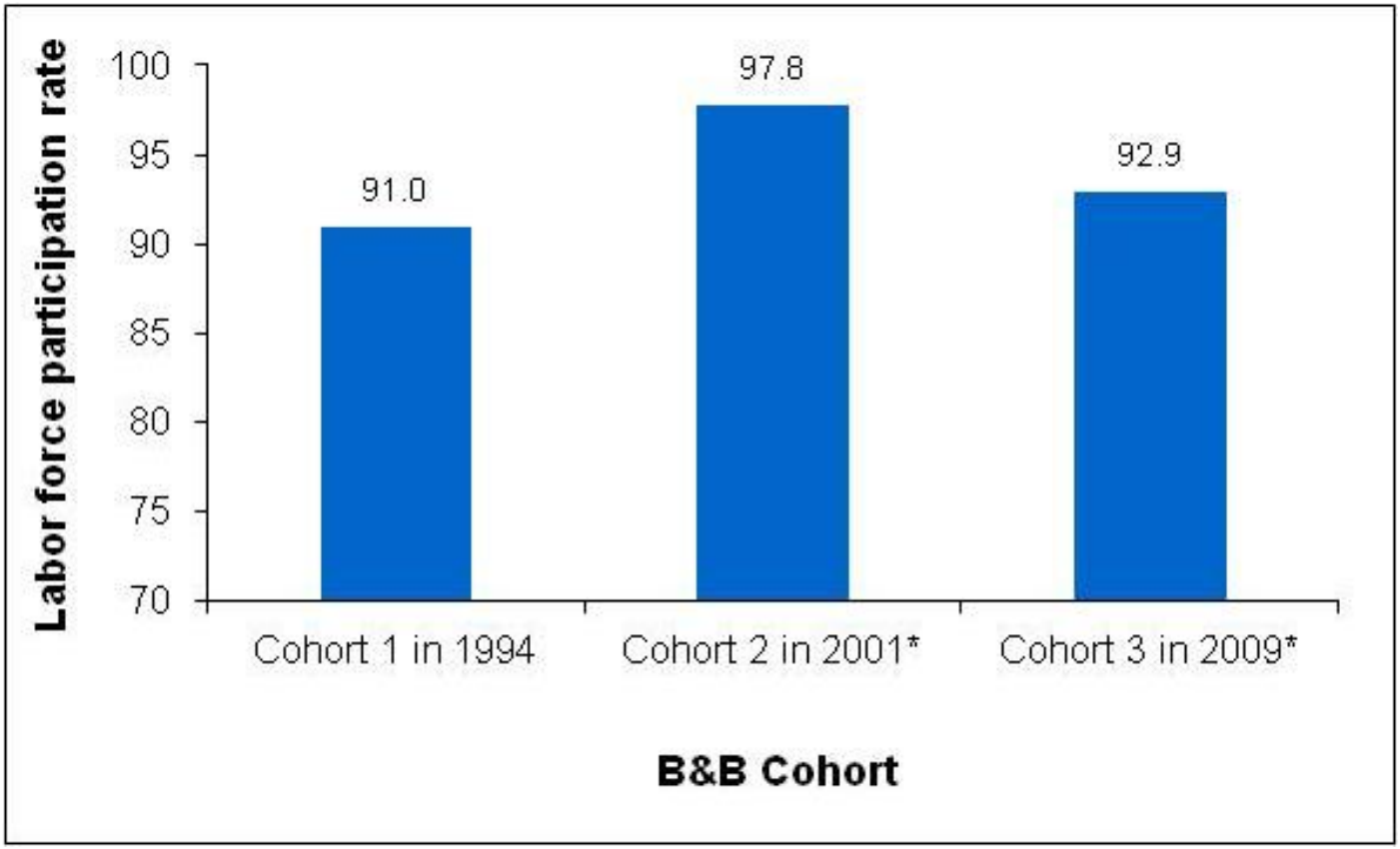


*Difference between this major and engineering major is statistically significant at the 5% level.

LFPR one year after graduation for female engineering bachelor's degree recipients, by B&B cohort



LFPR one year after graduation for male engineering bachelor's degree recipients, by B&B cohort



*Difference between this cohort and prior cohort is statistically significant at the 5% level.

LFPR summary of findings

- For engineering bachelor's degree recipients in Cohort 1, the male LFPR increases with increases in time since graduation; this pattern is not seen for female graduates
- Moreover, by ten years after graduation, the LFPR for females is more than 10 percentage points lower than the rate for males
  - However, the female LFPR ten years after graduation remains high (~89%)

LFPR summary of findings (continued)

- For this same cohort, the LFPR for female engineering bachelor's degree recipients is similar to the rates for female graduates with business/management and health-related majors
- Across B&B cohorts, the LFPR for male engineering bachelor's degree recipients one year after graduation increased from Cohort 1 to Cohort 2 and then fell from Cohort 2 to Cohort 3; a similar (but not statistically significant) pattern can be seen for female engineering bachelor's degree recipients

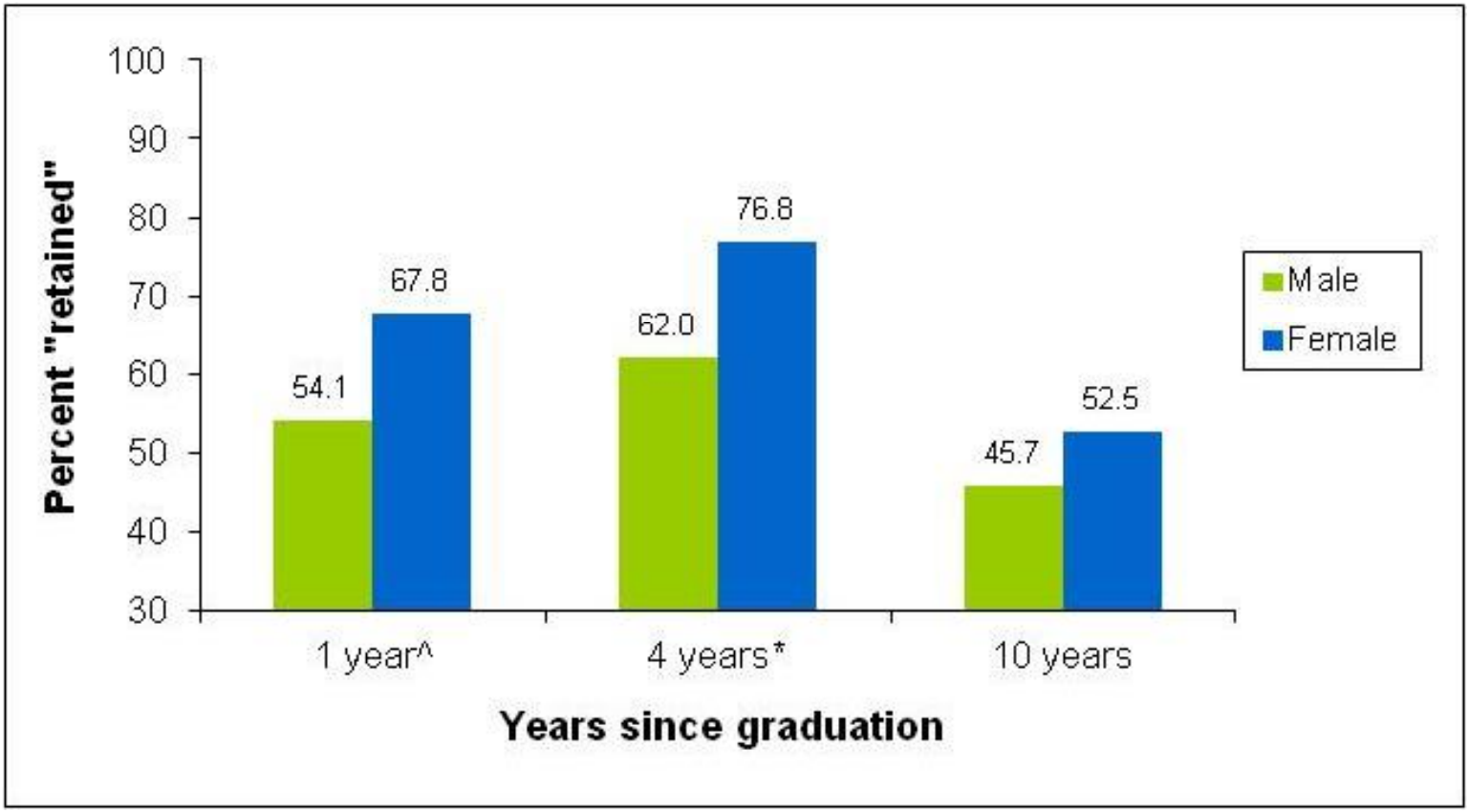
Results of analysis

Descriptive comparisons: *Retention*

Retention

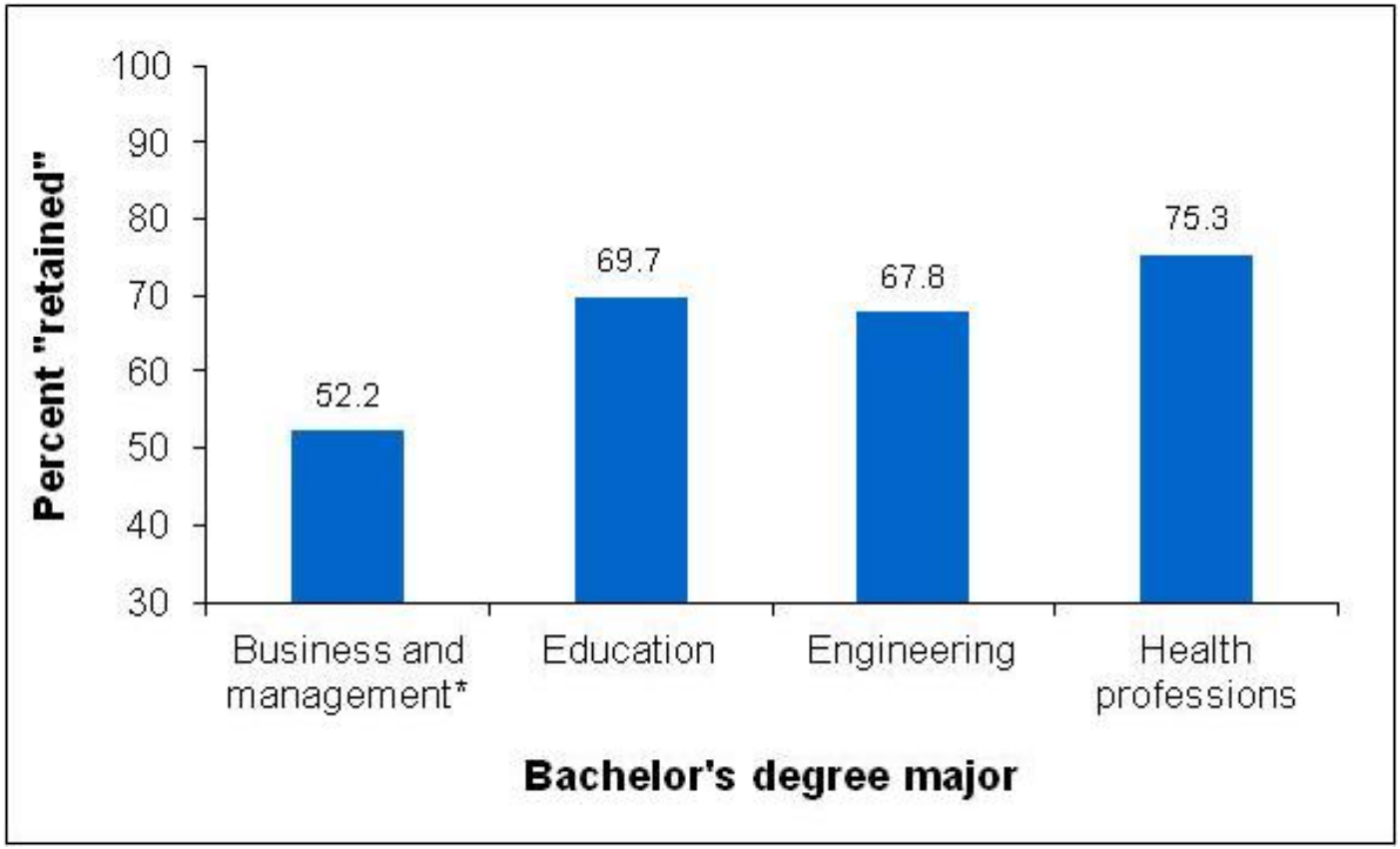
- For those graduates who choose to be in the labor force, a key decision is whether to work in an occupation that is in the field of their major
- This section compares the "retention" rates of employed male and female bachelor's degree recipients at various points after graduation

Employed engineering bachelor's degree recipients in an engineering/architecture occupation, B&B cohort 1



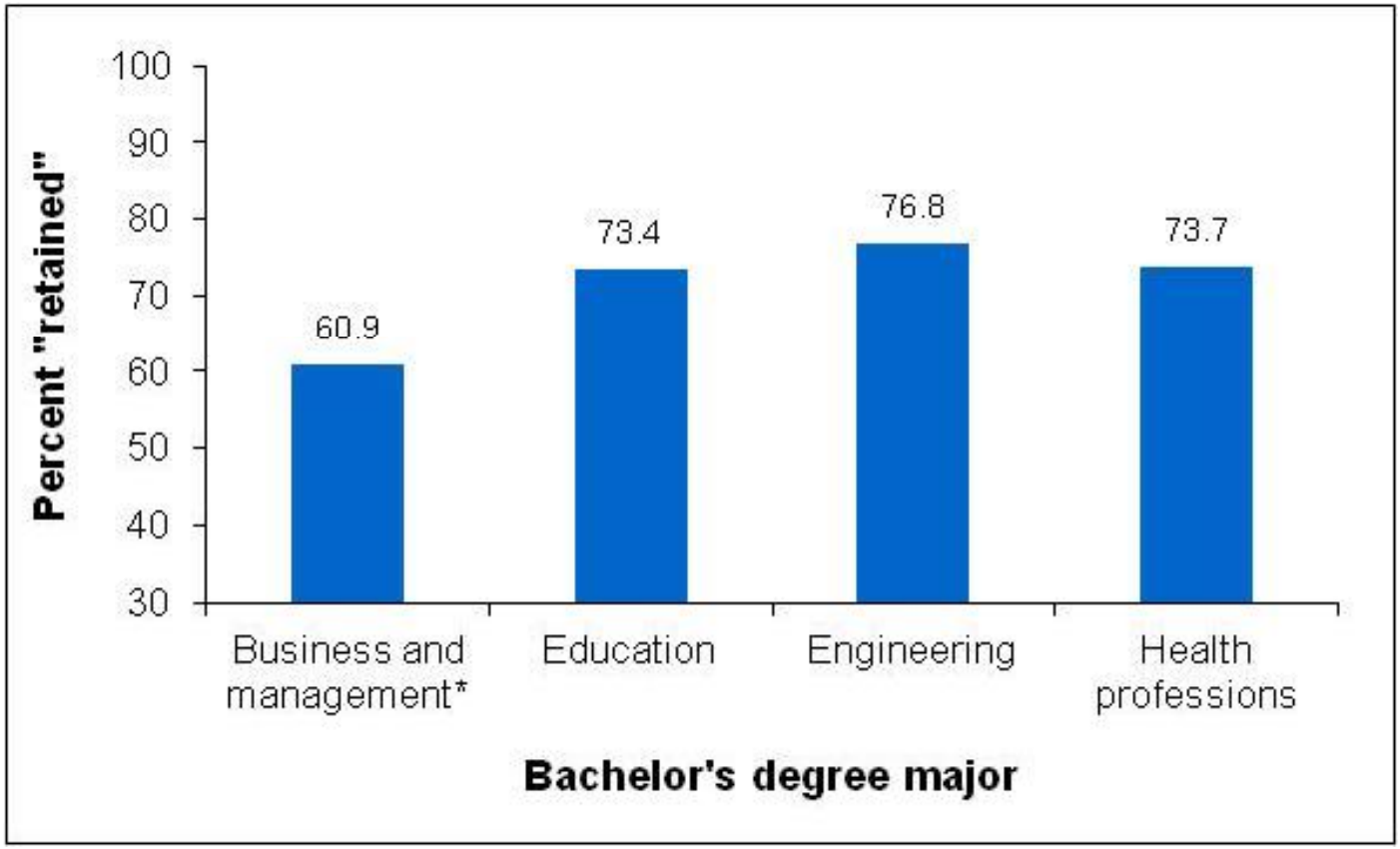
*Difference between the male and female figures is statistically significant at the 5% level.
^Difference between the male and female figures is statistically significant at the 10% level.
Note: The decline in the percent retained from four to ten years after graduation is statistically significant at the 5% level for both males and females.

Employed female bachelor's degree recipients working in field of major one year after graduation, B&B cohort 1



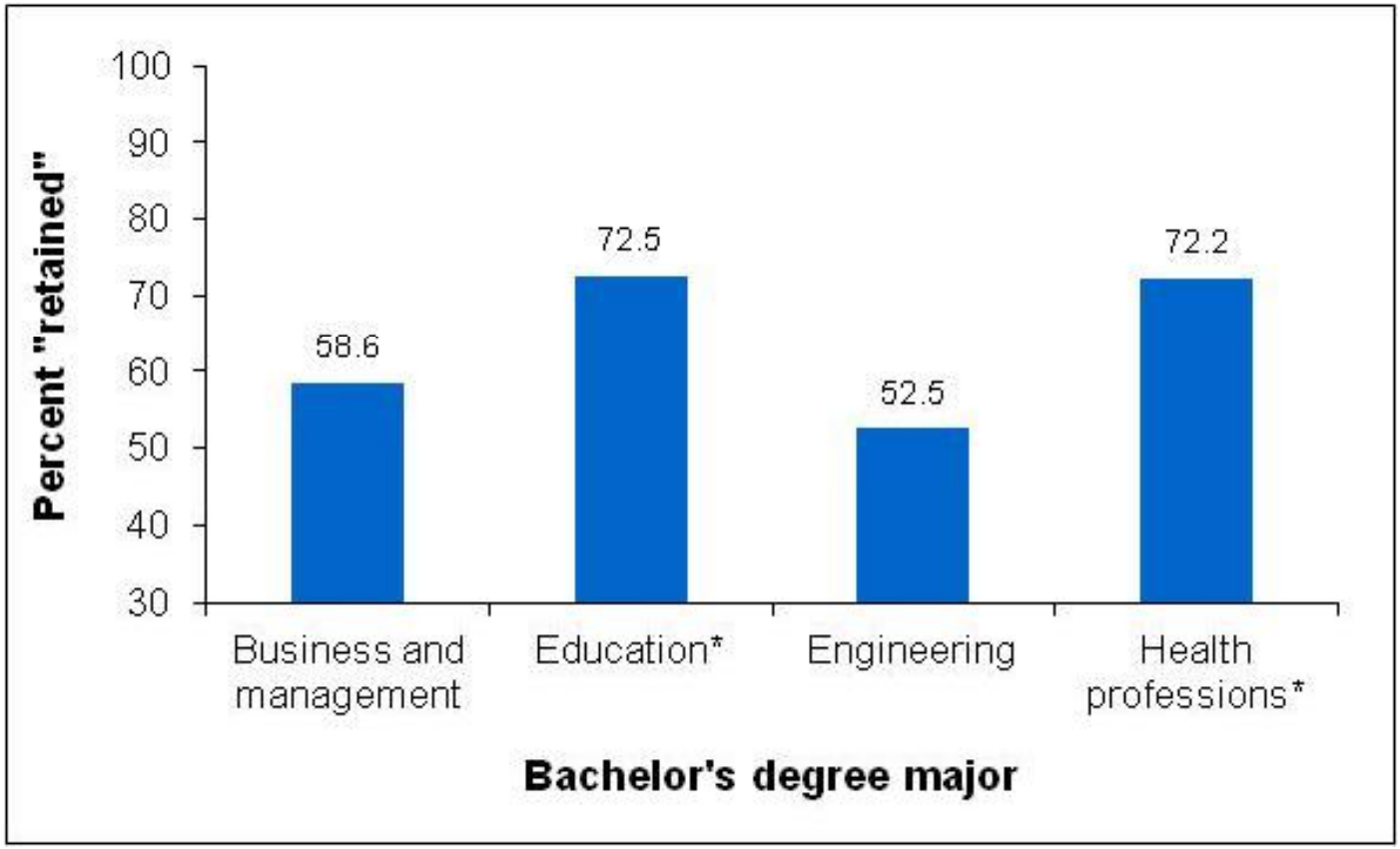
*Difference between this major and engineering major is statistically significant at the 5% level.

Employed female bachelor's degree recipients working in field of major four years after graduation, B&B cohort 1



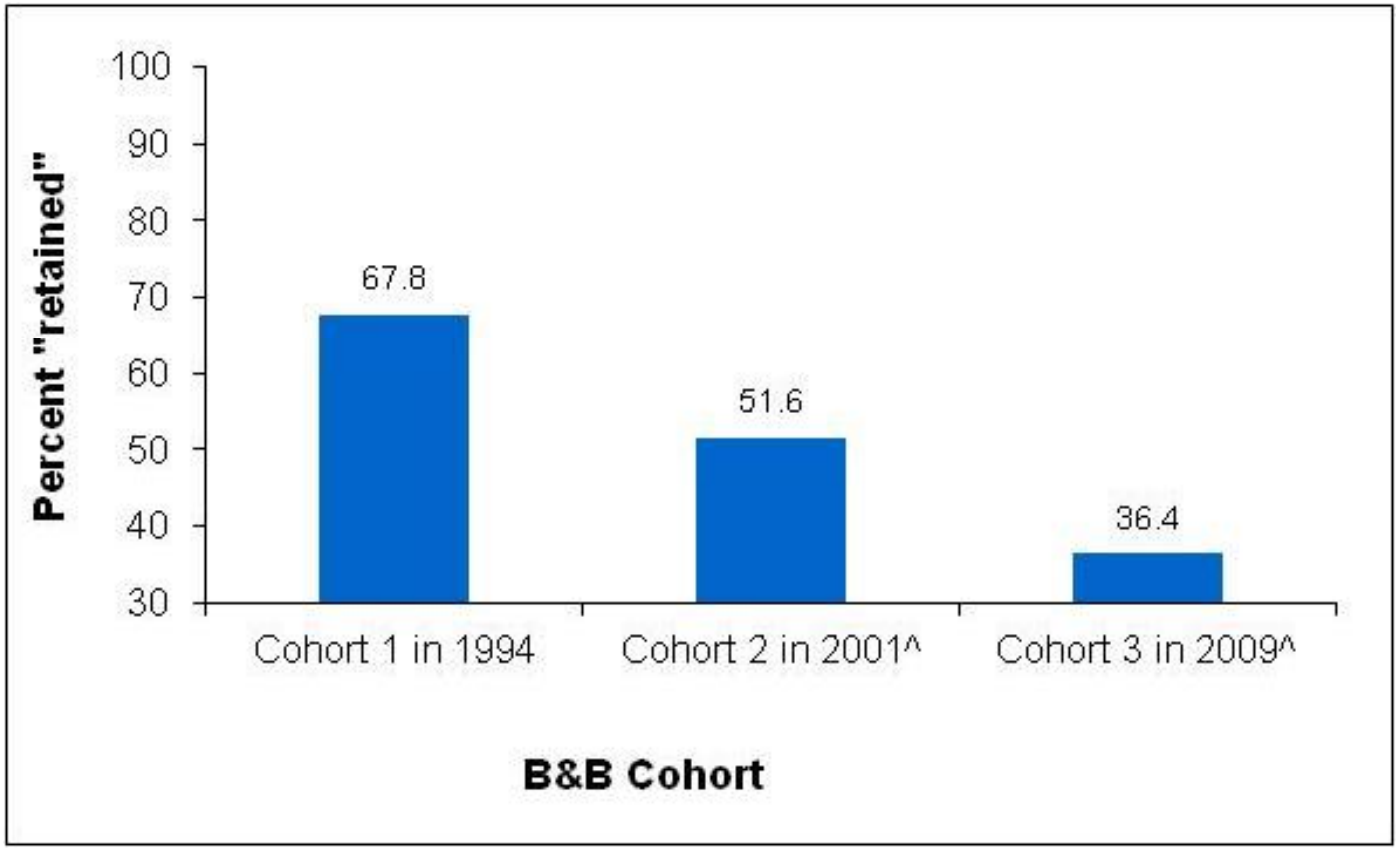
*Difference between this major and engineering major is statistically significant at the 5% level.

Employed female bachelor's degree recipients working in field of major ten years after graduation, B&B cohort 1



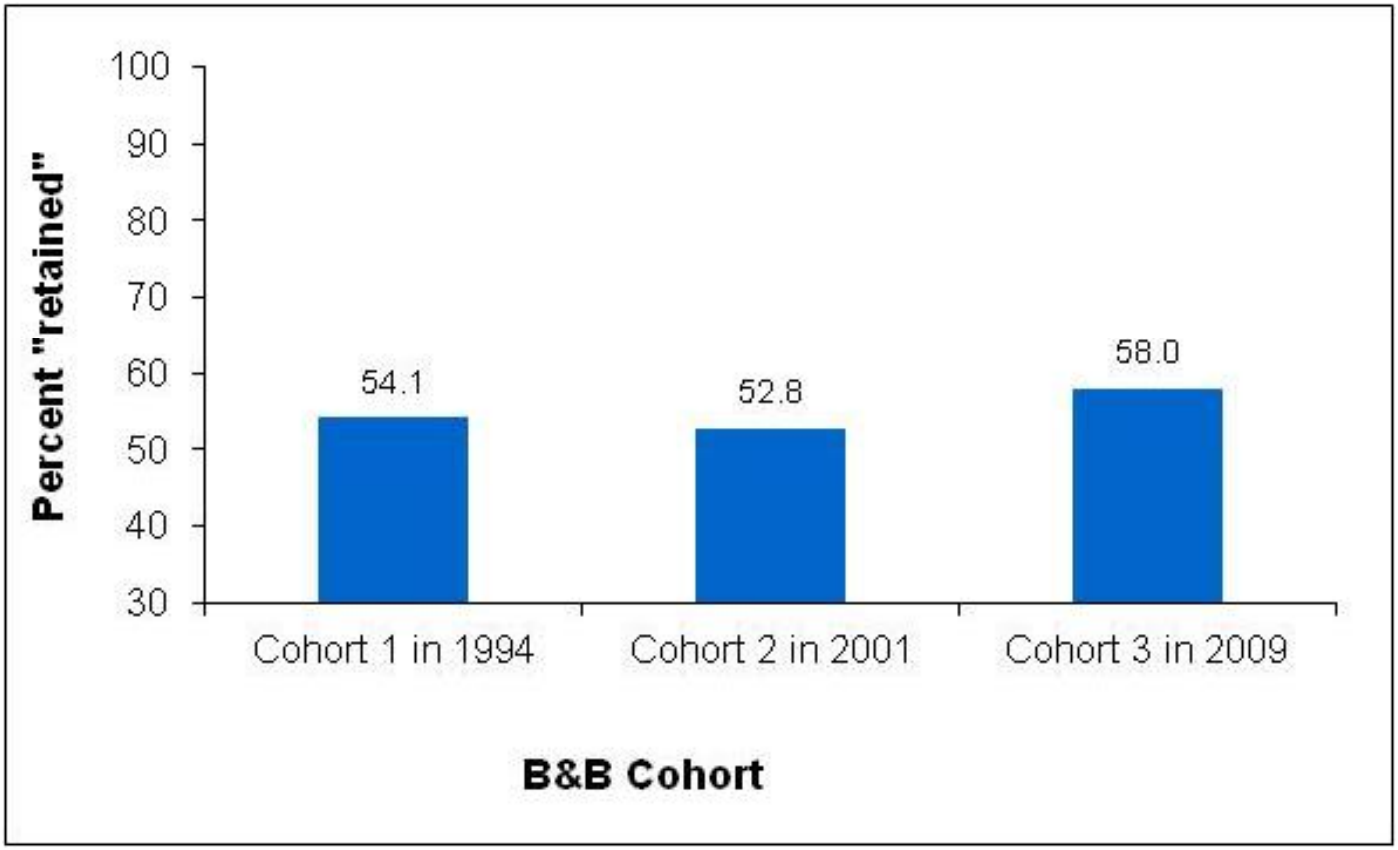
*Difference between this major and engineering major is statistically significant at the 5% level.

Employed female bachelor's degree recipients working in field of major one year after graduation, by B&B cohort



^Difference between this and prior cohort is statistically significant at the 10% level.

Employed male bachelor's degree recipients working in field of major one year after graduation, by B&B cohort



Cohort 3 engineering majors were asked for the primary reason for working outside their degree field

Females

- Job in field not available (47.6%)
- Change in career interests (16.6%)
- Job location (12.4%)
- Pay/promotion opportunities (11%)
- Working conditions (8.5%)
- Other factors (4.0%)
- Family-related reasons (0%)

Males

- Job in field not available (33.8%)
- Pay/promotion opportunities (32%)
- Other factors (25.1%)
- Change in career interests (4.6%)
- Job location (4.0%)
- Working conditions (0.5%)
- Family-related reasons (0%)

Retention summary of findings

- For Cohort 1, the retention rate at each post-graduation follow-up is higher for female engineering bachelor's degree recipients than male engineering bachelor's degree recipients, although the difference is not statistically significant ten years after graduation
- Moreover, for both males and females, there is a statistically significant decline in retention rates between four and ten years after graduation

Retention summary of findings (continued)

- Until ten years after graduation, the retention rate for female engineering bachelor's degree recipients is similar to the rates for education and health-related majors (and higher than that for management/business majors)
- However, by ten years after graduation , the retention rate for female engineering bachelor's degree recipients is significantly lower than the rates for education and health-related majors (and comparable to that for management/business majors)

Retention summary of findings (continued)

- Across cohorts, the percent of female engineering bachelor's degree recipients "retained" has fallen significantly from one cohort to the next
  - The decline in the retention rate is more than 30 percentage points between Cohort 1 in 1994 and Cohort 3 in 2009
  - This same pattern of decline is not seen for male engineering bachelor's degree recipients, although both males and females in Cohort 3 report that the primary reason for working outside their degree field is because a job in their field was not available

Results of analysis

Multiple regression results

Logistic regression

- Logistic regression is used when the outcome examined is categorical (e.g., yes/no; high/medium/low)
- Model predicts the likelihood of an outcome based on a series of explanatory or predictor variables
- Here two outcomes are modeled for Cohort 1:
  - Likelihood that a graduate is participating in the labor force (“participation”)
  - Likelihood that a graduate is working in the field of their major (“retention”)

Predictors considered

- Gender
- Age at graduation
- Ethnicity
- Undergraduate GPA
- Undergraduate degree specialty/sub-field
- Undergraduate debt
- Undergraduate Carnegie code
- Parental education
- Marital status
- Parental status
- Citizenship status
- Spousal employment
- Spousal income
- Graduate degree
- Enrollment status

Not all predictors are included in the final set of models

Characteristics of engineering bachelor's degree recipients, B&B Cohort 1

		Males	Females
Age at graduation	Average	24.3	23.6
Ethnicity	Minority (%)	19.5	26.1
Undergraduate GPA	Average	2.97	3.12
Undergraduate debt	Graduating with debt (%)	52.8	60.0
	Average debt ($)	10,583	10,534
Parental education	High school or less	23.5	23.5
	Post-secondary but less than Bachelor's degree	17.3	29.3
	Bachelor's degree	29.8	19.1 !
	Advanced degree	29.5	28.1

! Interpret data with caution because the standard error represents more than 30 percent of the estimate.

Characteristics of engineering bachelor's degree recipients, B&B Cohort 1 (continued)

		Years since graduation					
		1 year		4 year		10 year	
		Male	Female	Male	Female	Male	Female
Marital status	Married (%)	28.6	29.3	47.4	51.3	75.0	77.7
*Parental status	Has children (%)	11.9	7.0 !	19.9	17.0 !	53.5	65.3
Spousal employment	Employed (%)	89.6	‡	80.4	87.0	66.7	96.5
Spousal income	Average ($)	16,470	‡	26,822	31,477	28,274	66,655
Graduate degree	Has graduate degree (%)	3.6	2.1	17.5	20.2	26.9	27.7
	Has graduate degree in engineering, math, or computer science (%)	2.9	1.1 !!	14.4	16.7 !	15.3	18.0 !
Enrolled in school	Enrolled in school (%)	20.8	23.7	18.7	15.2 !	7.4	8.1 !!

! Interpret data with caution because the standard error represents more than 30 percent of the estimate.
!! Interpret data with caution because the standard error represents more than 50 percent of the estimate.
*For 10 year survey, figure includes only dependent children under the age of 18.
‡ Reporting standards not met.

Interpreting regression results

- If “P” is the probability that a graduate is in the labor force (or working in the field of their major), then the odds of the graduate being in the labor force are P/(1-P)
  - E.g., if P = .75, then the odds are .75/.25 = 3
- Results from these logistic regression models illustrate how a change in a predictor variable changes the odds of a graduate being in the labor force (or working in the field of their major), holding constant all other predictors in the model

Key models examined

Outcome	Study population	Models								
		1 year after graduation			4 years after graduation			10 years after graduation		
		Males	Females	Males & Females	Males	Females	Males & Females	Males	Females	Males & Females
Participation	Engineering graduates	Too few males not in LF	Too few female grads	Too few males not in LF	Too few males not in LF	Too few female grads	Too few males not in LF	Too few males not in LF	Too few female grads	Too few males not in LF
	Engineering & other career-oriented graduates	■	■	■	■	■	■	■	■	■
Retention	Engineering graduates	■	Too few female grads	■	■	Too few female grads	■	■	Too few female grads	■
	Engineering & other career-oriented graduates	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Participation model: Female engineering and other career-oriented graduates, Cohort 1

A blank cell indicates that the predictor was not included in the model. A cell highlighted green indicates that the variable is statistically significant at the 10% level. Only a subset of predictors included in the models are shown in the table.

	Years since graduation		
	1 year	4 years	10 years
	Percentage difference in odds ratio	Percentage difference in odds ratio	Percentage difference in odds ratio
Age when received bachelor's degree	3%	4%	-1%
White, non-Hispanic (vs. minority)	148%	12%	-34%
Has children (vs. no children)	-67%	-73%	-74%
Married (vs. not married)	-19%		
Married with spouse not employed (vs. not married)		-40%	-36%
Spouse income from work < $50,000 (vs. not married)		18%	-30%
Spouse income from work ≥ $50,000 (vs. not married)		-50%	
Spouse income from work $50,000-$100,000 (vs. not married)			-83%
Spouse income from work ≥ $100,000 (vs. not married)			-93%
Incurred debt in undergrad (vs. no debt)	107%	51%	-10%
Undergraduate GPA is 3.0-3.5 (vs. <3.0 GPA)	-21%	66%	9%
Undergraduate GPA is 3.5 or higher (vs. <3.0 GPA)	-19%	7%	12%
Business and management (vs. engineering)	154%	73%	-26%
Education (vs. engineering)	60%	37%	-74%
Health professions (vs. engineering)	47%	82%	-34%
Enrolled (vs. not enrolled)	-89%	-61%	90%
Has graduate degree (vs. no graduate degree)	-44%	-8%	155%

Participation model: Key findings

- Women engineering graduates are generally no more or less likely to be participating in the labor force than graduates in other career-oriented majors
- Women graduates in engineering and other career-oriented majors:
  - Are less likely to be in the labor force if they have children
  - Are less likely to be in the labor force four years and ten years after graduation if their spouse's income is relatively high

Participation model: Key findings (continued)

- Women graduates in engineering and other career-oriented majors: (continued)
  - Are more likely to be in the labor force one year and four years after graduation if they incurred debt in college
  - Are less likely to be in the labor force one year and four years after graduation if they are enrolled in school, but are more likely ten years after graduation
  - Are more likely to be in the labor force ten years after graduation if they have a graduate degree

Retention model: Employed male and female engineering graduates, Cohort 1

A blank cell indicates that the predictor was not included in the model. A cell highlighted green indicates that the variable is statistically significant at the 10% level. Only a subset of predictors included in the models are shown in the table.

	Years since graduation		
	1 year	4 years	10 years
	Percentage difference in odds ratio	Percentage difference in odds ratio	Percentage difference in odds ratio
Age when received bachelor's degree	1%	-1%	-3%
White, non-Hispanic (vs. minority)	87%	12%	26%
Has children (vs. no children)	-8%	-13%	19%
Married with spouse employed (vs. unmarried)		43%	17%
Married with spouse not employed (vs. unmarried)		16%	30%
Incurred debt in undergrad (vs. no debt)	10%	-6%	-4%
Undergrad GPA is 3.0-3.5 (vs. < 3.0 GPA)	30%	47%	47%
Undergrad GPA is 3.5 or higher (vs. < 3.0 GPA)	128%	35%	76%
Enrolled (vs. not enrolled)	-64%		-31%
Graduate degree in engr/math/cs (vs. no graduate degree)			-12%
Graduate degree in other FOS (vs. no graduate degree)			-81%
Female (vs. male)	88%	93%	47%

Retention model: Key findings

- Employed female engineering graduates are not retained in the field of engineering at lower rates than male engineering graduates
  - In fact, female engineering graduates are more likely than male graduates to be working in the field of engineering four years after graduation

Retention model: Key findings (continued)

- Employed male and female engineering graduates:
  - Are more likely to be working in the field of engineering one year and ten years after graduation if their undergraduate GPA was 3.5+
  - Are less likely to be working in the field of engineering ten years after graduation if they have a graduate degree in a non-engineering field

Implications

Implications

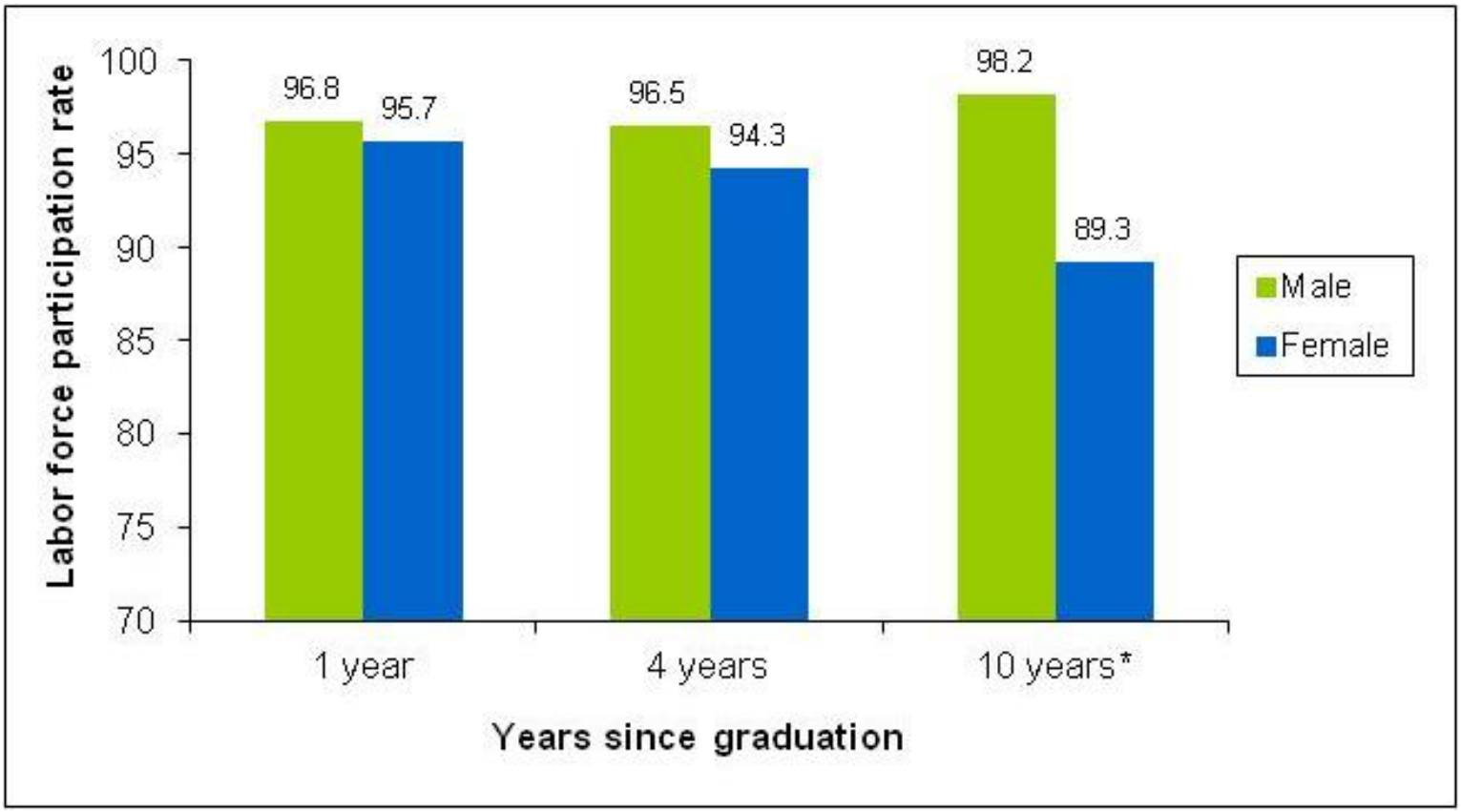
- It's not about participation in the labor force
  - Female engineering graduates in all three cohorts are participating in the labor force at high rates
- Retention in engineering appears to be an issue for both male and female graduates
  - Retention for male and female Cohort 1 graduates fell to around 50% by ten years after graduation
  - Male and female Cohort 3 graduates say that the primary reason for working outside engineering is a lack of jobs in their field

Implications (continued)

- The retention issue appears to be worsening for women
  - The one-year retention rate for female graduates has fallen dramatically from one cohort to the next (more than 30 percentage points between Cohort 1 in 1994 and Cohort 3 in 2009)

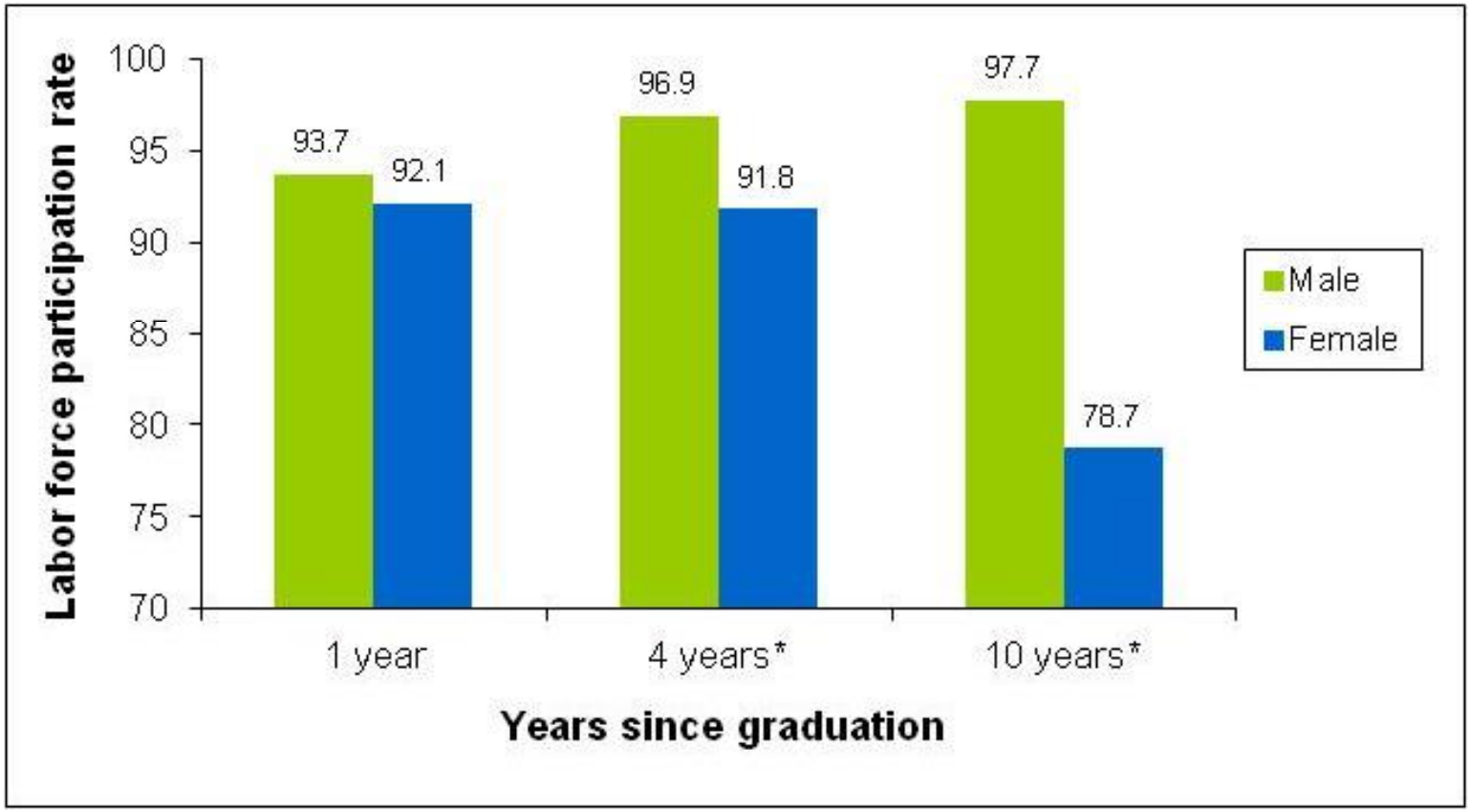
Appendix

LFPR by gender for business/management bachelor's degree recipients, B&B Cohort 1



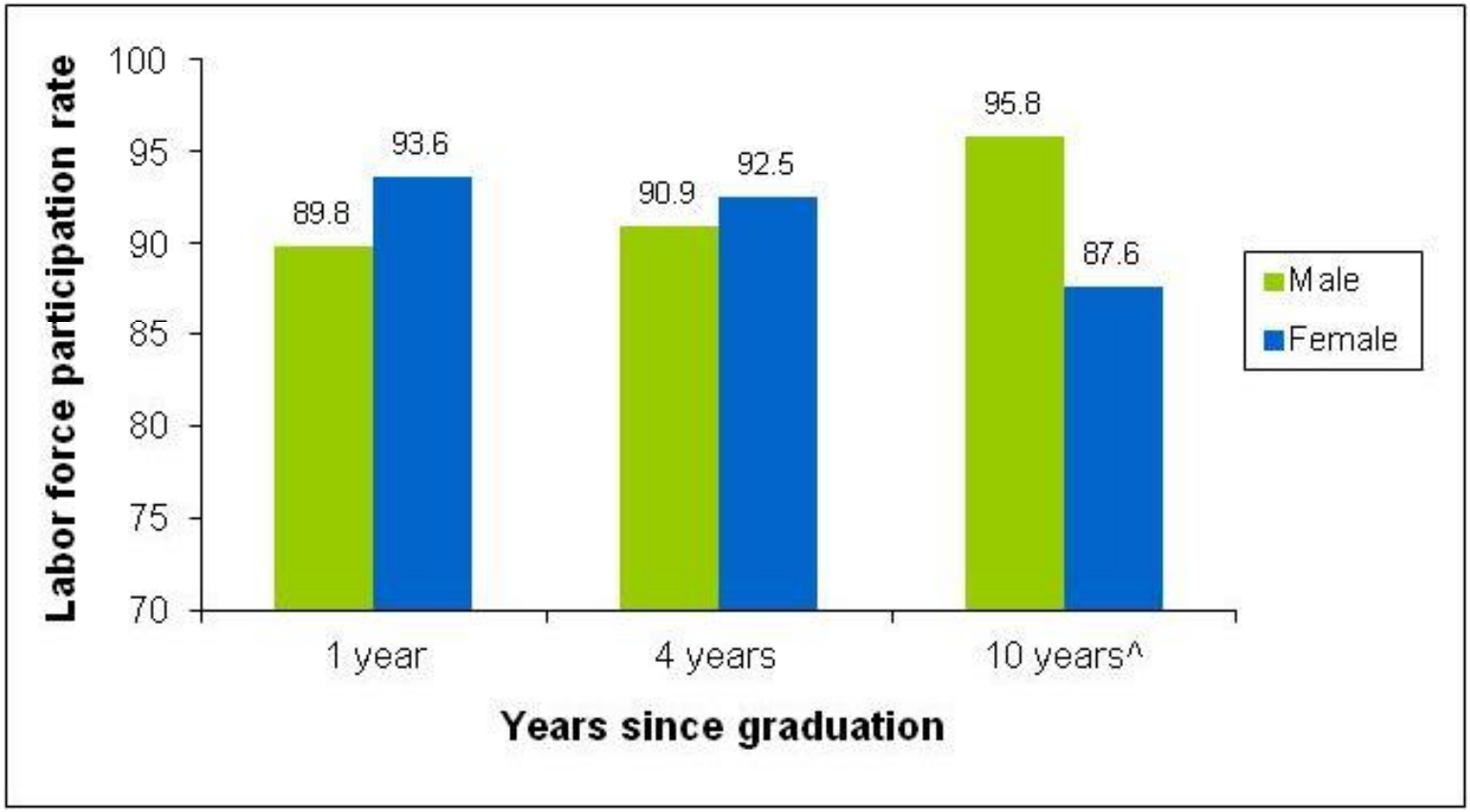
*Difference is statistically significant at the 5% level.

LFPR by gender for education bachelor's degree recipients, B&B Cohort 1



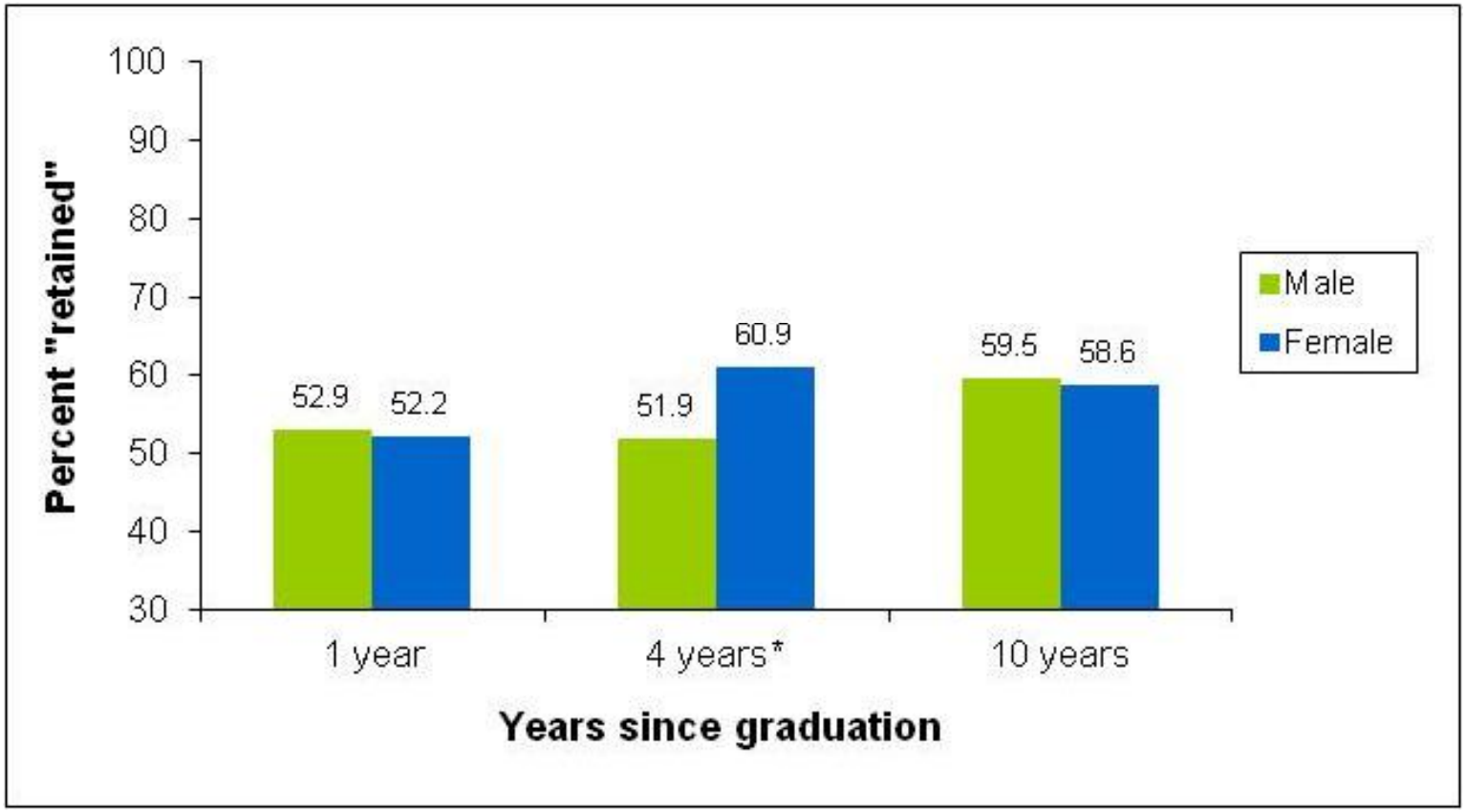
*Difference is statistically significant at the 5% level.

LFPR by gender for health-related bachelor's degree recipients, B&B Cohort 1



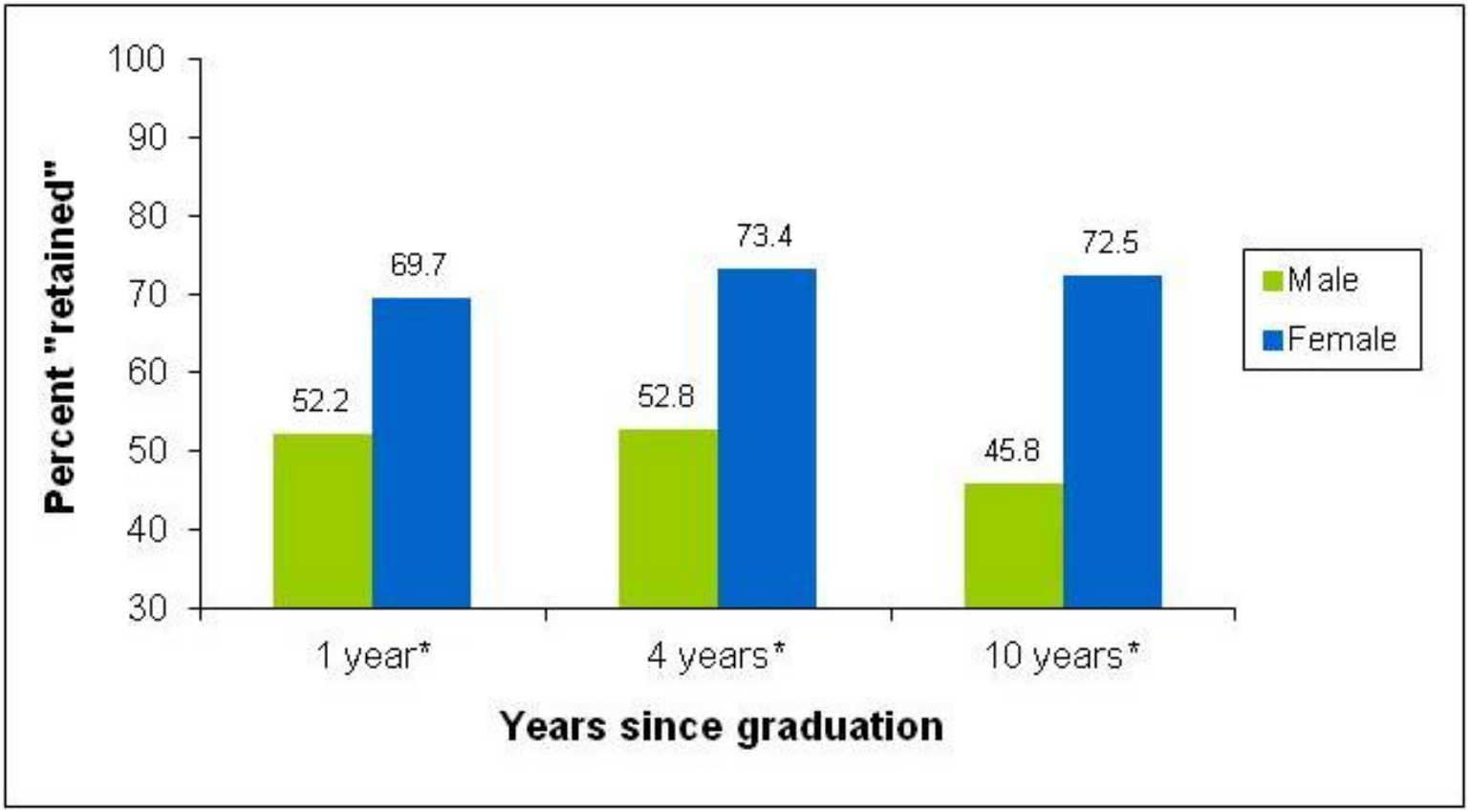
^Difference is statistically significant at the 10% level.

Employed bus/mgmt bachelor's degree recipients in a bus/mgmt occupation, B&B cohort 1



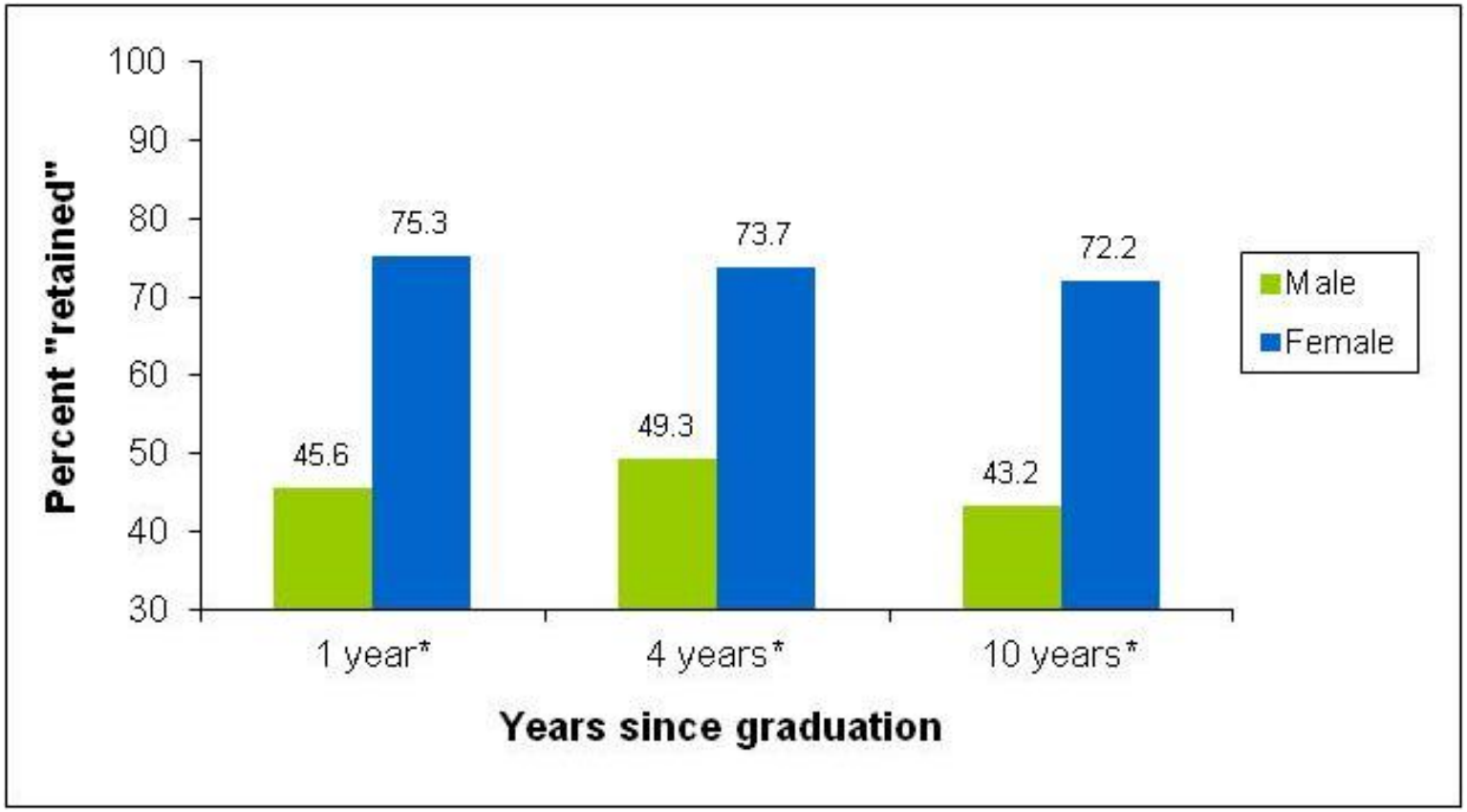
*Difference between the male and female figures is statistically significant at the 5% level.

Employed education bachelor's degree recipients in an education occupation, B&B cohort 1



*Difference between the male and female figures is statistically significant at the 5% level.

Employed health-related bachelor's degree recipients in a health occupation, B&B cohort 1



*Difference between the male and female figures is statistically significant at the 5% level.

B&B majors and their sub-fields*

Engineering

- Electrical engineering
- Chemical engineering
- Civil engineering
- Mechanical engineering
- Other engineering
- Engineering technology

Business/management

- Accounting
- Finance
- Business/Management Systems
- Management/Business Administration
- Secretarial
- Business Support
- Marketing/Distribution

*As reported in variable list for B&B Cohort 1.

B&B majors and their sub-fields* (continued)

Education

- Early childhood education
- Elementary education
- Secondary education
- Special education
- Physical education
- Other education

Health**

- Dental/Medical Tech
- Community/Mental Health
- Nurse Assisting
- Nursing
- Health/Hospital Administration
- Audiology
- Dietetics

*As reported in variable list for B&B Cohort 1.

**Due to the large number of sub-fields in Health, only a subset are shown.

B&B occupational categories*

- Engineering/architecture
  - Eng, architects, software/sys engineers
- Business/management
  - Business/financial support services
  - Financial services professionals
  - Executive manager
  - Midlevel manager
  - Supervisory, office, and other admin
  - Business - other
  - Managers - other

*As reported in variable list for B&B Cohort 1.

B&B occupational categories* (continued)

- Education
  - K-12 teachers
  - Instructors other than K-12
  - Education - other
- Health (Medical professionals)
  - Medical practice professional
  - Medical licensed professional
  - Medical services
  - Medical - other

*As reported in variable list for B&B Cohort 1.

Source information

Source information

- B&B cohort 1:
  - U.S. Department of Education, National Center for Education Statistics, B&B: 93/03 Baccalaureate and Beyond Longitudinal Study
  - The weight variable used in all figures is WTC000
- B&B cohort 2:
  - U.S. Department of Education, National Center for Education Statistics, B&B: 00/01 Baccalaureate and Beyond Longitudinal Study
  - The weight variable used in all figures is WTA000
- B&B cohort 3:
  - U.S. Department of Education, National Center for Education Statistics, B&B: 09 Baccalaureate and Beyond Longitudinal Study
  - The weight variable used in this table is WTA000

Author biography

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Gail Greenfield is Senior Program Officer at the National Research Council. She has been involved with studies of the U.S. geospatial intelligence workforce; the science, technology, engineering, and mathematics (STEM) workforce in the U.S. Department of Defense and defense industrial base; and the U.S. energy and mining workforce. Gail is also a Principal at Mercer, where she has more than 10 years of experience helping organizations improve the management of their human capital. Recent projects include diversity-related analyses of pay for a professional services organization and a hospital system to identify areas of these organizations with systemic pay disparities; measuring the "wage adequacy" of an entertainment organization's workforce and recommending policies to reduce the gap between an employee's wages and the income required to meet an employee's basic needs; and generating diversity benchmarks for four occupations in 18 countries for an international equipment manufacturer. Prior to joining Mercer, Gail was an assistant professor of economics at The College of Wooster. Gail received a PhD in economics from Claremont Graduate University and a BA in business economics from the University of California, Santa Barbara.