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Abstract and Keywords

Print ISBN	978-0-226-
eISBN	978-0-226-
Title	*U.S. Engineering in the Global Economy*
Editors	Richard B. Freeman and Hal Salzman

Book abstract *5 –10 sentences, or around 200 words and no more than 250 words*	The labor market for specialists in STEM jobs is a complex and controversial topic for economists, labor market researchers, and policy makers. *U.S. Engineering in a Global Economy* continues a long tradition of research by the NBER into both the supply and demand sides of the engineering job market, while also expanding the scope beyond the United States to consider the practice of engineering and innovation in a global economy. Contributors draw on the most up-to-date data on engineering education and practice to explore the challenges of developing an engineering workforce that can contribute substantially to the innovation driving modern economic growth. These authors highlight what economists and labor market researchers have learned and identify issues that might be addressed in future research, including a labor market that is not optimally employing STEM qualified workers in their field of training, and the ways in which US students, firms, and educational institutions are responding to increased competition in the global economy. This book examines both the demand and supply side of the engineering job market in the United States and the practice of engineering and innovation in a global economy. The authors provide assessments of engineering education, engineering practice, and careers which can inform science and engineering educational institutions, funding agencies, and policy makers about the challenges facing the U.S. in developing its engineering workforce in the global economy.
Book keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	Engineering labor force Engineer supply and demand Engineer demographics Engineering education Productivity Innovation STEM H-1B Guestworkers Engineering licensing

Chapter number	**0**
Chapter title	**Introduction**
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	The National Bureau of Economic Research (NBER) has a long history analyzing the science and engineering workforce and *U.S. Engineering in a Global Economy* follows the NBER tradition of quantitative analysis of the demand and supply sides of the engineering job market in the United States. Many of the chapters use novel data or approaches to examine engineering education, practice, and careers in ways designed to inform science and engineering educational institutions, funding agencies, and policymakers about the challenges and opportunities for developing and employing engineers in ways that can most efficaciously contribute to the innovation driving modern economic growth.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	Engineering labor force Engineer supply and demand Engineer demographics Engineering education Productivity Innovation H-1B Guestworkers Engineering licensing

Chapter number	**Chapter 1**
Chapter title	The Engineering Labor Market: An Overview of Recent Trends
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	Chapter one sets the stage for the rest of the book with a review of the engineering labor force, focusing on the employment, salary, and career trajectories of graduates that obtain engineering degrees and work in the field. Lacking a single comprehensive data source on engineers, this chapter draws on a wide variety of longitudinal career data and establishment-based employment and earnings data available from different government surveys of scientists, engineers and employers and on education administrative data on the supply of engineers coming from U.S. universities to Census survey data on the numbers from overseas. It disaggregates engineering into major subfields, whose employment differs sufficiently to face different supply and demand conditions.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	Engineering labor force Engineer supply and demand Engineer demographics Engineering education STEM

Chapter number	Chapter 2
Chapter title	Career Plans of Undergraduate Engineering Students: Characteristics and Contexts
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	This chapter examines undergraduate engineering students' career plans, and the environments and experiences that influence their intentions to enter the engineering profession. We augment survey data collected from over 2,000 engineering students with data from three national sources. Our results indicate, first, that a substantial majority of engineering students are not committed to an exclusively engineering career. Second, students with engineering focused plans have distinctive profiles compared with their peers; namely, they are more likely to major in civil/environmental engineering, report higher intrinsic motivation to study engineering, have higher levels of involvement in their coursework, and have lower levels of professional/interpersonal confidence. Third, one's expected engineering salary modestly differentiates engineering focused students from non-engineering focused ones. Finally, institutional characteristics are associated with students' engineering career plans, and socioeconomic background may influence plans through the types of institutions at which higher and lower SES students differentially enroll. Implications for educational research and practice are discussed.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	engineering education, engineering student career plans, early career pathway, multi-level modeling, URM women, socioeconomic background, between-major differences, engineering labor market, institutional characteristics

Chapter number	Chapter 3
Chapter title	Engineering Educational Opportunity: Impacts of 1970s and 1980s Policies to Increase the Share of Black College Graduates with Major in Engineering or Computer Science
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	Throughout the 1970s and 1980s, U.S. institutions of higher education began to address long-standing patterns of exclusion. Initial efforts to improve the access of black students to engineering education focused on six historically black engineering colleges, and evolved into a truly nationwide movement. Later, a larger group of Historically Black Colleges and Universities (HBCUs) expanded educational opportunities in engineering, computer science and other technical fields, "to prepare their students for expanded career choices." Geographic and institutional features of the higher education infrastructure led to differential impacts of these policies on students born in different states. A data panel assembled for the project links changes in educational opportunities to current outcomes. The panel includes more than 30 years of complete counts of the number of bachelor's degrees conferred in each field by each U.S. institution of higher education (collected by the U.S. Department of Education and the Engineering Manpower Commission), merged to current labor force data. These data facilitate description of the geography and timing of changes in opportunities for black college students to choose engineering or computer science college majors, and current labor market outcomes among those born in the right place and time to pursue careers in these fields.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	Education College Major College Black African American Engineering Computer Science STEM HBCU Earnings Inequality

Chapter number	**Chapter 4**
Chapter title	Bridging the Gaps between Engineering Education and Practice
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	

Chapter number	**Chapter 5**
Chapter title	The Effects of Scientists and Engineers on Productivity and Earnings at the Establishments Where They Work
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	This paper uses linked establishment-firm-employee data to examine the relationship between the scientists and engineers proportion (SEP) of employment, and productivity and labor earnings. We show that: (1) most scientists and engineers in industry are employed in establishments producing goods or services, and do not perform research and development (R&D); (2) productivity is higher in manufacturing establishments with higher SEP, and increases with increases in SEP; (3) employee earnings are higher in manufacturing establishments with higher SEP, and increase substantially for employees who move to establishments with higher SEP, but only modestly for employees within an establishment when SEP increases in the establishment. The results suggest that the work of scientists and engineers in goods and services producing establishments is an important pathway for increasing productivity and earnings, separate and distinct from the work of scientists and engineers who perform R&D.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	Productivity, Technological Change, Science Based, Occupation, Earnings, Research and Development, Innovation

Chapter number	Chapter 6
Chapter title	What Goes on Under the Hood? How Engineers Innovate in the Automotive Supply Chain
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	The questions addressed in this volume are motivated by the recognition that engineers play an important role in generating innovation and economic growth. In this chapter, we seek to offer some description of engineering work by looking in detail at a specific manufacturing industry—firms that supply automakers—to gain insight into how engineers create innovation. Autos account for 5% of US GDP and in 2011, 70% of auto suppliers contributed design effort, a task typically performed by engineers, making the auto supply chain an important context in which to study engineering and innovation. Some highlights from our original survey data include a wide range in terms of size and strategies of supply chain companies; a majority was small- to medium-sized, often family-owned. We observed barriers to patenting for manufacturing firms developing process rather than product innovations. And interviews revealed the importance of customers for the innovative efforts of supplier firms. Certain Japanese customers were preferred because they shared expertise and helped suppliers improve, while other, American, customers were viewed as having unreasonable demands for regular, incremental price reductions and did not offer technical or organizational support.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	engineering, auto industry, supply chain, innovation, knowledge overlap, incremental innovation, new product innovation, interorganizational relationship

Chapter number	**Chapter 7**
Chapter title	The Influence of Licensing Engineers on their Labor Market
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	Our paper presents an analysis of the role of occupational licensing requirements on the labor market for civil, electrical, and industrial engineers. These groups of engineers represent the largest number of engineers that are covered by occupational licensing statutes in the United States. We initially trace the historical evolution of licensing for engineers. Second, we present a theoretical rationale for the role of government in the labor market for the occupation. In the model, the government's ability to control supply through licensing restrictions and the pass rate could limit the number of engineers, which may drive up wages. We then estimate a panel data model for the engineers in our sample using the American Community Survey and regulatory statutes. Our estimates show a small and often insignificant influence of occupational licensing on both wages and hours worked in a variety of specifications and sensitivity analysis tests. The current modest stage of occupational regulation for engineers appears to be too diffuse to influence wages and the number of hours worked in the occupation.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	wages and employment of engineers engineers occupational licensing labor markets and regulation wage effects employment effects occupational regulation

Chapter number	**Chapter 8**
Chapter title	Dynamics of Engineering Labor Markets: Petroleum Engineering Demand and Responsive Supply
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	This chapter examines a quasi-natural experiment in science and This chapter examines a natural experiment in science and engineering labor market elasticity, providing an empirical study of the responsiveness of supply to demonstrated demand of employers. U.S. petroleum engineering expanded in the 1970s and then stabilized for three decades. By the early 2000s, this cohort was retiring at the same time there were sharp increases in oil prices and new exploration. Together, these factors led to dramatic increases in hiring and in starting salaries. In response, U.S. universities increased petroleum graduates fourfold over the decade 2003 to 2013, almost entirely of U.S. students. In this study of petroleum engineering demand and supply, the authors provide empirical analysis that addresses broader questions about the capacity of the education system to meet industry demand for highly skilled labor. It suggests that highly skilled labor markets are responsive to demand that results in wage increases, and universities are able to expand capacity, even in highly specialized and skilled areas such as petroleum engineering.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	Demand and supply of engineers Petroleum engineering Shortages of engineers U.S. education system high skill labor markets

Chapter number	**Chapter 9**
Chapter title	Bridge to Permanent Immigration or Temporary Labor? The H-1B Visa Program Is a Source of Both
Chapter abstract *3–5 sentences, or around 120 words and no more than 200 words*	The H-1B visa is a large scale guest worker program that grants high-skilled foreigners temporary work authorization in the United States. It is an employer-driven program, meaning that an employer must sponsor the H-1B visa for the worker. Further, employers have the discretion to sponsor an H-1B worker for lawful permanent residence. Many policymakers have highlighted sponsorship for permanent residence as a key feature of the H-1B program because it has become a significant source of employment-based permanent immigration for high-skilled foreigners. The paper examines sponsorship for permanent residence by the top H-1B employers, which have received a large share of the visas in recent years. Clear patterns emerge from the data, with some firms sponsoring large shares of H-1B workers for permanent residence, whereas, other firms sponsor few or none of its H-1B workers. Those firms with high rates of permanent resident sponsorship tend to make products, while firms sponsoring at low rates employ an offshore outsourcing business model. Other important patterns emerge. Offshore outsourcing firms tend to pay H-1B workers significantly lower wages, their H-1B workers have lower educational attainment, and the H-1B workers mostly come from one country, India.
Chapter keywords *Around 5 keywords. No fewer than 3 and no more than 10. Type each keyword on its own line.*	immigration H-1B visa offshoring outsourcing guest workers