AC 2011-2441: WHAT DO MARKETS TELL US ABOUT DEMAND FOR ENGINEERS IN THE WORKPLACE?

Martin S. High, Oklahoma State University

Marty High is an Associate Professor of Chemical Engineering at Oklahoma State University. His academic interests include teaching in all areas and at all levels of chemical engineering with a focus on instruction in thermodynamics and mass transfer. His research interests are in the areas of mass transfer in polymeric systems, corrosion modeling, equation of state development and refinery catalysis. Marty also writes in the area of sustainability and on the intersection of law, science and society. He received his engineering education at Penn State (B.S., M.S., and Ph.D.) and earned his law degree (J.D.) from the University of Tulsa.

Joseph M. Nowakowski, Muskingum University

Joe Nowakowski is Professor of Economics at Muskingum University in New Concord, Ohio. His teaching areas include international economics and business, and he has published in the areas of efficiency analysis, economic development and education. He attended Occidental College, the Universitaet des Saarlandes and Duke University, where he earned his bachelors degree. He earned his doctorate at the University of North Carolina - Chapel Hill. He has served as a visiting faculty member at Interamericana University, San German, Puerto Rico; University of Castilla - La Mancha, Toledo, Spain and LCC International University, Klaipeda, Lithuania.

What do Markets Tell us about the Demand for and Supply of Engineers in the Workplace?

> "U.S. companies face a severe shortfall of scientists and engineers with expertise to develop the next generation of breakthroughs." – Bill Gates[1]

> "Ask a child if there is a shortage of ice cream in the world, and no doubt, the response will be an emphatic yes—there certainly is. And ask a tech CEO if there is a shortage of engineers, and you will get the exact same answer." – Vivek Wadhawa[2]

"Unfortunately, we are not graduating enough students with degrees in the STEM disciplines to meet the growing demand from U.S. companies for workers in these areas."[3] This refrain is commonly heard spoken by CEOs, Presidents, Senators, Representatives, human resources professionals, and also engineering professors. But is it true? Do the facts support this conclusion? Before we reorient our societal institutions and commit the billions of dollars mentioned as part of the solution to a dearth of engineers and other STEM graduates, it would be wise to examine carefully the "common wisdom."

Butz et al.[4] analyzed the market data relevant to engineering employment and concluded that except for one critical measure that "[w]e have seen that the production of American scientists and engineers is low neither in the sense that it has fallen over some years from previous heights nor in the sense that employers are driving S&E earnings up and unemployment rates down in a scramble to hire more scientists and engineers." The critical measure that stands in contrast is that U.S. production of STEM graduates is low compared to gains by other countries.[5]

So, after the significant economic downturn in the recent years, where do these economic comparisons stand and what do they tell us about U.S. production of STEM graduates, particularly engineering graduates? This paper will attempt to bring into focus what the data tell us relative to the common wisdom.

A Shortage of Engineers?

The perception that the United States is falling behind other countries economically is widely held and even more widely debated. Often, a failure to produce sufficient numbers of highly qualified individuals in various areas is put forward as the reason for this purported decline. One such area is engineering, according to the testimony Bill Gates. Were that true, all else being equal, the result would be extremely low unemployment rates and relatively quickly rising salaries for engineers. But Mr. Gates' testimony was given at the end of a relative decline in engineering salaries, as will be shown below. Moreover, the unemployment rates for engineers, a highly educated and valuable group of potential employees, is relatively high, even in a recessed economy.

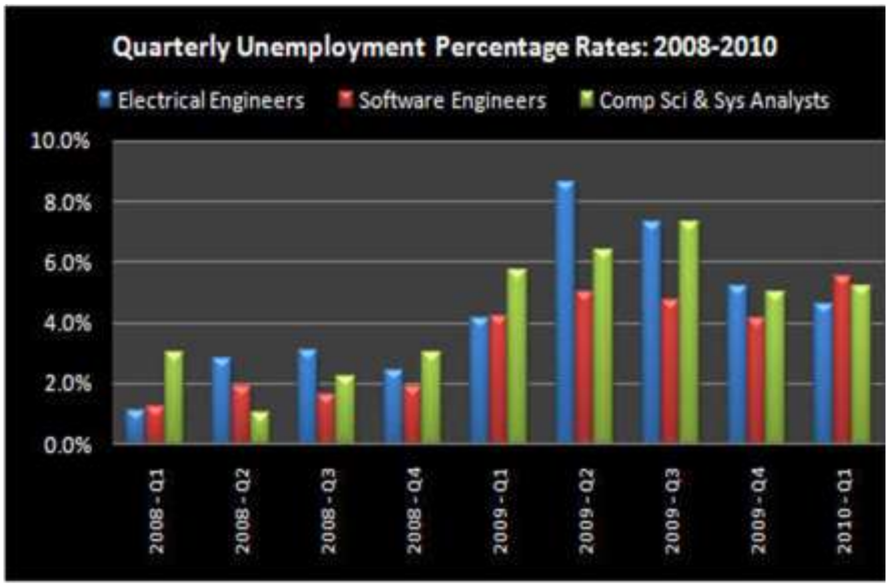


Figure 1 - Source: Department of Labor Bureau of Labor Statistics, The Market for Engineers

Like all markets, the labor market for engineers is subject to the forces of supply and demand. Simply put, an imbalance between the quantity of engineers supplied (i.e., the number of qualified engineers available) and the quantity demanded by government, industry and academia will eventually result in changes in the levels of compensation. A surplus of engineers will push wages down, and a shortage will push wages up. The reduction in wages will presumably encourage aspirants to pursue other professions, while an increase in wages will have the opposite effect. The surplus or shortage may be the result of changes in demand for engineers, or the supply of engineers, or both. In a fluid market, conditions will cause demand and supply to adjust to changes in the economic environment constantly, but not necessarily in tandem. At any point in time, demand for engineers may go up or down, as can the supply. Different combinations of shifting supply and demand may result in wages rising or falling. Regardless of the joint movements in the desires of employers and potential employees, a shortage will be indicated by rising wages and a surplus by falling wages.

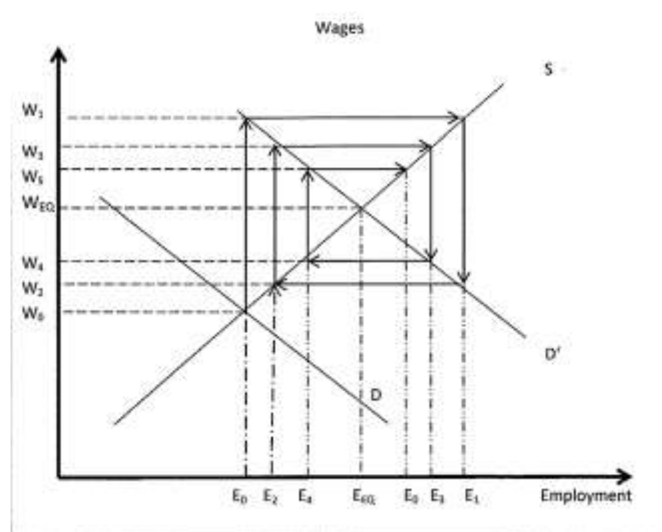
This is not to say that the response to changes in market conditions will be instantaneous in every market. In labor markets with different skill levels there will be a variety of response times. For example, if the need for unskilled labor grows, *ceteris paribus*, wages will rise and workers with low skill levels will be employed relatively quickly. The quick response stems directly from the absence of any requirement that these workers have accumulated specialized skills. Literally, anyone can fill these positions, and the only lag is the time it takes to match employers and employees – a type of unemployment referred to as frictional.

On the other hand, workers with specialized job skills and human capital requirements cannot be produced overnight. Engineers certainly fit that description, and the engineering labor market has become a textbook example of why labor markets may undergo series of booms and busts as they chase a moving equilibrium target. This is, literally, a textbook example: Richard Freeman's work[6] serves as the basis for a discussion of the "cobweb model" in George Borjas's labor economics text.[7] Freeman bases his model on two plausible assumptions. First, the education and training of an engineer takes time, and, second, people make their educational career choices based on labor market conditions they perceive when entering college. This last assumption may be extended to when the potential engineers decide on masters or doctoral programs.

Starting from an equilibrium wage rate for entry-level engineers, an increase in demand will propel wages above the equilibrium wage at least temporarily. This is due to the low elasticity of supply in the short run. New engineers cannot be produced quickly. But, the higher wages will draw more entrants, leading to an excess supply, with the subsequent drop in wages. The students in the pipeline will push wages down below the equilibrium wage, again due to the low elasticity of supply. This back and forth process will eventually deliver an equilibrium wage that brings the quantity of engineers supplied and demanded into balance *if there are no further shifts in demand or supply.* In the real world, supply and demand determinants are constantly changing, and markets follow this cobweb pattern in search of a moving target. The result is the cycle of booms and busts typically seen in the engineering labor market.

Others have pointed to sluggishly adjusting wages leading to imbalances in quantities supplied and demanded.[8] A labor market with a large academic component will have this characteristic due to reduced labor mobility resulting from tenure, rank promotion, colleague networking and other factors.

Figure 2: The Cobweb Model



On the other hand, the wage rate is not fluctuating in isolation from the rest of the economy. Income in the United States grows over time as the economy expands. The basic measure of economic growth is real Gross Domestic Product, which measures overall output at constant price to net out the impact of inflation. Therefore, the yearly wages of engineers is not the most useful variable to examine, as annual salary figures will be distorted by changes in the price level. What is needed is a measure of the relative compensation of engineers – relative to the opportunities that exist in the rest of society. What we attempt to do in the analysis that follows is to produce a metric that indicates surpluses and shortages over time, as well as indicating the pecuniary attraction of engineering as a profession relative to professions.

A look at the numbers of students pursuing engineering degrees is an obvious preliminary step. The data summarized below in Figure 3 are from the National Center for Education Statistics.

Table 1

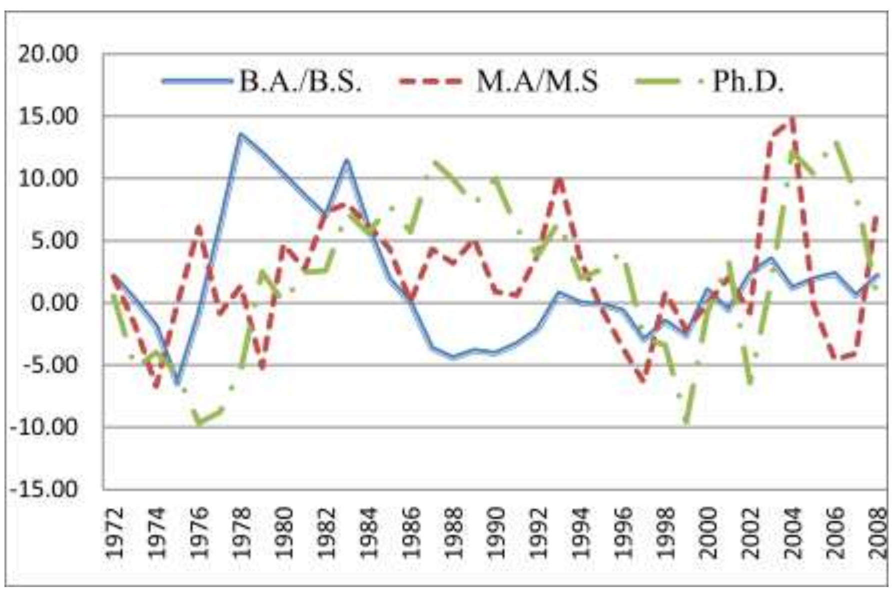
Annual Percentage Changes in Degrees Conferred, 1970-2008

	BA	MA	Ph.D.
Mean	1.51	2.07	2.37
St. Dev.	4.90	5.03	6.35
Min	-6.51	-6.69	-9.65
Max	13.48	14.76	13.18

The data reveal a good deal of fluctuation in the number of undergraduate engineering degrees earned annually, with a range of -6.51% (in 1975) to 13.48% (1978) and a long-run trend of +1.51%. (The Census Bureau reports population growth to be about 1% per annum.) The number of MA level degrees shows a long-term trend of +2.07 , with a range of -6.69 (1974) to +14.76 (2004), and the Ph.D. degrees increased an average 2.37%, with a range of -9.65% (1976) to +13.18% (2006). Figure 3 superimposes all three degree levels, showing some, but not perfect, correlation among the three, reported in Table 2 below. All three degree levels exhibit patterns of rising and falling completion. The number of bachelor's degrees conferred was more volatile in the 1970s and leveled off somewhat after that. The patterns suggest that fluctuations in the numbers of graduates at all levels exhibit natural ebbs and flows, but not necessary in lock step.

Figure 3

Annual Percentage Change in Degrees Awarded in Engineering



The initial picture is one of little correlation between undergraduates and graduate students pursuing engineering degrees, but some (weak) correlation between graduates pursuing masters and doctoral degrees. A very tentative suggestion is that undergraduates may major in engineering, perhaps naively, because they find the discipline interesting, but that graduates consider more carefully the employment prospects and rewards – the positive correlation indicates some joint movement among potential masters and doctoral candidates across time, whether the job market is improving or deteriorating.

Table 2

Correlation Among Annual Percentage Changes in Degrees

	BA	MA	PhD
BA		0.16	-0.08
MA			0.26

Source: National Center for Education Statistics: Digest of Education Statistics 1992-2005; Table 305..

The relatively close match between the growth in degrees conferred at all levels and the overall population does not reflect changes in the labor market for engineers. In a dynamic economy, structural changes lead to ever-shifting supplies of and demand for virtually every occupation. As suggested above, imbalances in labor markets will reveal themselves by changes in wages if markets are free to make adjustments. There may be various impediments that delay the adjustments, but eventually a market surplus or shortage of engineers will lead to changes in the wages for engineers.

There is a great deal of discussion in economics concerning the efficiency of labor markets; the ease with which wages change, or the "sticky wages" issue; and the seeming contradiction of an economy in equilibrium with excess unemployment. These, however, are macroeconomic questions for the most part. The issue addressed here is microeconomic, concerned with a single market (or perhaps multiple markets for engineers simultaneously). Despite the criticisms of neoclassical economics' explanations of business cycles, the traditional explanations of changes in individual markets hold up very well.

The reasons for changes in the demand for engineers are not hard to identify. An increasingly complex economy will have greater need for those services. Any shift in demand leading to greater need for engineers, ceteris paribus, will eventually result in higher offers. Whether those offers result in acceptances depends on conditions on the supply side of the market. It may seem obvious that higher wages on offer in a particular profession will produce an incentive for entrants to pursue that occupation. But every occupation involves specific attractions for the workers, as well as disincentives to enter that profession. The greater the disincentives are, the greater the compensation will have to be to entice entrants. These disincentives may consist of unpleasant or dangerous working conditions, drudgery, risk of periods of unemployment or lengthy periods of preparation for entry exams that may at the last block a candidate from successfully pursuing the chosen profession.

Another phenomenon results from the tradeoff between leisure and labor. Assume that workers allocate their time between labor and leisure to maximize utility, U:

$$U = \mathrm{f}\,(I,L)$$

where I is the income earned by providing labor services and L is the amount of leisure left after the individual has decided how much labor to offer. The utility function can be depicted in a variety of ways, but in general the assumption is that each argument has a positive first and negative second derivative, and there is interaction between the variables. In particular, a higher income level will enhance leisure-time opportunities. In economics, the first derivative is referred to as *marginal utility*, and the negative second derivative leads to *diminishing marginal utility*.

At low income levels, higher wages on offer will be expected to increase the quantity of labor supplied. Workers will willingly trade an hour of leisure for the income associated with another hour of labor supplied. As income increases, however, an extra dollar of income will be less attractive to the worker, partly because of the diminished marginal utility. But the decline in the desire for more income will be exacerbated by the creation of more attractive leisure-time alternatives. As incomes rise, at some point a higher wage on offer may result in a reduction in the quantity of labor supplied.

Economists refer to this as the backward-bending labor supply curve. This is an important possibility to consider regarding the market for engineers. If potential job-seekers do not respond positively to higher wages, they may have considered the difficulties involved with entering the engineering profession, and decided that, given the already high income levels in the United States, a profession that pays less but has lower entry barriers is preferable. Obviously, an alternative occupation that pays more, with the same or lower entry barriers, is even more attractive. Freeman reports that in the 1990s incomes for mathematicians, medical doctors, lawyers and bachelor's level graduates all increased more than for engineers.[9]

Those barriers to entry may not dissuade potential engineers from other countries from pursuing engineering degrees, as the carrot of high incomes is appealing enough to convince them to continue despite what might be a very long and uncertain stick of preparation. Freeman points out the tradeoffs: the benefits of a large, relatively inexpensive and talented international pool of entrants versus the smaller domestic pool.[10]

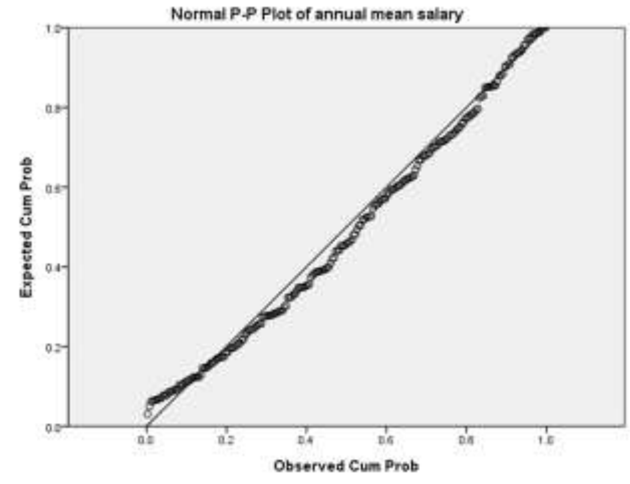
The Data

The following variables were obtained from the Bureau of Labor Statistics: Occupational Employment Statistics[11], mainly for the years 1997 through 2009, although the series is incomplete in some cases:

- *total employment*: the number of engineers of a specific type reported employed in a given year. The list of engineering specialties includes aerospace, agricultural, biomedical, chemical, civil, computer, electrical and electronic, environmental, safety, industrial, marine, materials, mechanical, mining, nuclear and petroleum. As is typical with time series data, the methods change periodically, resulting in some incomplete series. For example, electrical and electronic engineers were combined into one subset at the beginning of the series but were then split into distinct specialties. To avoid confusion, when sub-specialties were at times combined and then isolated, only the isolated variables were included in the analysis.

- *annual mean salary*: because means can be distorted by outliers, it is standard to use median income values. On the other hand, comparisons were to be made to average incomes, so it seemed preferable to retain the means in the analysis if they could be shown not to be distorted by large values. The normal probability plot (below) for the mean annual salaries does not suggest any distortion, so the mean values were retained.

Figure 4



The data on income comes from the Penn World Tables[12] :

- *gdppcus*: per capita Gross Domestic Product in the United States

- *gdppcindia*: per capita Gross Domestic Product in India

- *gdppcprc*: per capita Gross Domestic Product in the People's Republic of China.

A country's per capita GDP in the Penn World Tables is computed based on Purchasing Power Parity as opposed to currency exchange rates. Purchasing Power Parity values compare the relative purchasing powers of currencies in their domestic settings, including all goods and services bought and sold as opposed to just those traded internationally. These series continue only through 2007. The values for 2008 and 2009 were estimated by extrapolating the trend changes in the three countries' GDPs per capita over the years available and estimating the values for the last two years.

<u>Data Issues</u>

The main concern with the data is the limited number of observations. Otherwise, the data are well documented and reliable. There are the usual concerns about inconsistencies in collection methods across the time period examined, and the issues raised by combining data from different sets. The Occupational Employment Statistics are designed as cross-sectional data, and stacking these cross sections as a time series requires that certain limitation be kept in mind. Over time, there are changes in occupational classifications – for example, in 1997 and 1998 electrical and electronic engineers were considered a single sub discipline, but in 1999 and thereafter they were treated separately. The surveys designed to collect employment data may be treated differently by employers, who may classify employees in the same occupation differently. Finally, the OES data are collected as averages across time periods, a methodology that may not reveal sudden changes very quickly. The Bureau of Labor Statistics acknowledges the limitations of the data in the OES, and suggests that conclusions drawn from survey data be viewed with caution. With these caveats in mind, the results and conclusions that follow should be seen as indicative, not definitive.

Methodology

The analysis is relatively simple. For engineers in general, and for each sub discipline for which information is available, the mean salary will be considered relative to the per capita income level. If the ratio of a particular type of engineer's salary to per capita GDP is rising (falling), a labor market shortage (surplus) is suggested. Thereafter, the same ratios will be computed for India and the PRC.

Results

An examination of the correlation matrix above indicates varying degrees of correlation among the various engineering sub disciplines. The strongest positive correlation was between Mechanical Engineer and Electrical Engineer salaries (.98), with the following pairs correlated at least .90: Electronics – Civil; Chemical – Electrical; Chemical – Electronics; Chemical – Environmental; Chemical – Safety; Chemical – Mechanical; Electrical – Industrial; Electronics – Environmental; Environmental – Safety; Environmental – Mechanical and Industrial – Mechanical. The strongest negative correlation was between Agricultural and Biomedical Engineer salaries (-.59).

In Table 3 below, the trends in salaries over time are considered, along with the salary trends for all engineers.

Table 3

Relative Salary Movements over Time

Salaries / GDP pc U.S.

Correlation Coefficients, using the observations 1999-2009

5% critical value (two-tailed) = 0.6021 for n = 11

Civil	Petro	Aero	Agri	Biomed	Chem	Comp	Electrical	Electronics	Environ	Safety	Industrial	Marine	Materials	Mech	Mining & Geol	
1	0.29	0.30	-0.04	0.14	0.82	0.58	0.75	0.93	0.84	0.75	0.62	0.40	0.67	0.82	0.10	Civil
	1	0.75	-0.12	0.33	-0.19	0.76	-0.24	0.07	-0.20	-0.26	-0.47	-0.56	0.53	-0.22	-0.53	Petro
		1	-0.50	0.75	0.03	0.78	-0.16	0.26	-0.09	-0.08	-0.46	-0.20	0.18	-0.11	-0.66	Aero
			1	-0.59	-0.26	-0.40	-0.01	-0.13	0.13	-0.09	0.24	-0.42	0.33	0.04	0.69	Agri
				1	0.17	0.46	0.10	0.22	0.00	0.11	-0.26	0.18	-0.27	0.06	-0.49	Biomed
					1	0.27	0.90	0.92	0.90	0.94	0.80	0.82	0.28	0.92	0.14	Chem
						1	0.03	0.50	0.18	0.21	-0.23	-0.13	0.59	0.09	-0.60	Comp
							1	0.79	0.88	0.85	0.92	0.76	0.23	0.98	0.40	Electrical
								1	0.92	0.88	0.68	0.58	0.52	0.87	0.11	Electronics
									1	0.92	0.87	0.64	0.46	0.94	0.46	Environ
										1	0.79	0.79	0.25	0.88	0.22	Safety
											1	0.71	0.23	0.92	0.65	Industrial
												1	-0.28	0.73	0.16	Marine
													1	0.34	0.10	Materials
														1	0.43	Mech
															1	Mining & Geol

Figure 5
Annual Percentage Changes in BA Degrees Conferred and Relative Salary

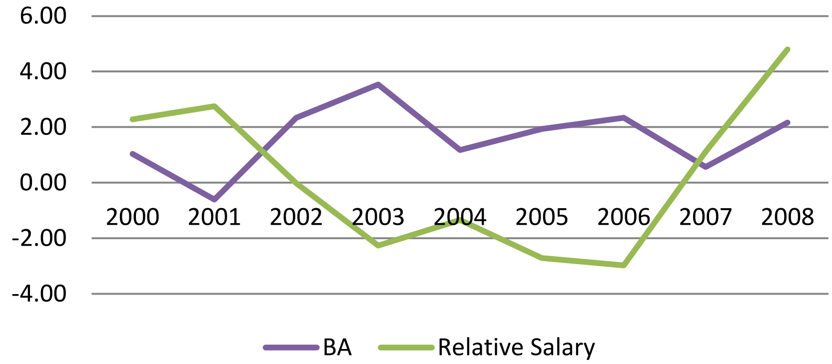


Figure 6
Annual Percentage Changes in MA Degrees Conferred and Relative Salary

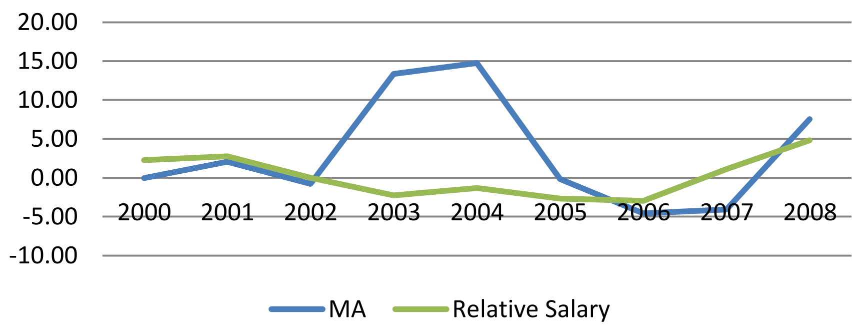
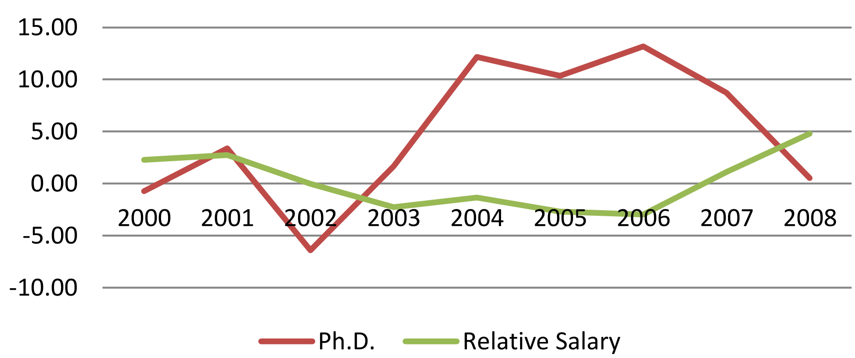
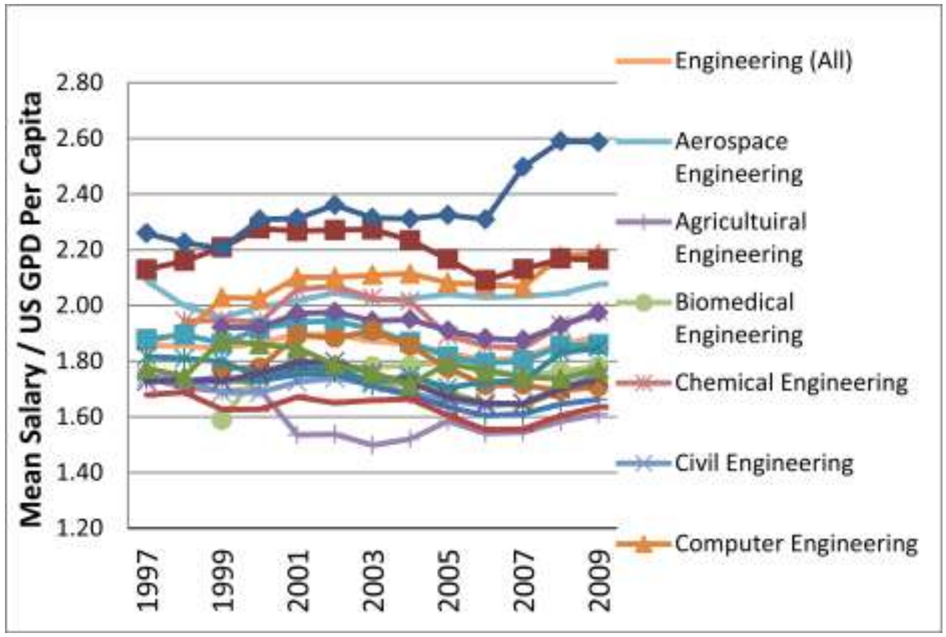


Figure 7
Annual Percentage Changes in Ph.D. Degrees Conferred and Relative Salary



The relative salary movement shown above reveals a cyclical pattern for engineering salaries, broadly defined. Relatively little movement in the late 90s was followed by rising salaries until the about 2001, when engineers received salaries moving toward the average income level. After 2006, however, engineers' salaries rose relative to the rest of the population, suggesting either increased demand or decreased supply of candidates. There is no strong apparent relationship between salary movements and degrees earned at the various levels, even lagging the degree variables to give students time to react to changing opportunities. Apparently, and not very surprisingly, salary alone does not determine a students' decision to enter the engineering profession. On the other hand, there are several varieties of engineers, and employment conditions in each may be different.

Figure 8
Changes in Salaries for various Engineering Disciplines
Relative to Per Capita GDP



From the data shown in Figure 8, some discipline specific conclusions can be drawn:

- All Engineering - The average salary for all engineers is higher than per capita GDP. In 2009 the ratio was 1.89. Sub disciplines were distributed around this mean with low income ratio of 1.61 (agricultural engineers) and a high of 2.59 (petroleum engineers). In all cases, the market rewarded engineers with salaries above the average, but the fluctuations in relative salaries may have in turn caused fluctuations in the number of market entrants.

- Aerospace Engineering - Aerospace engineers' salaries experienced downward pressure in the late 1990s followed by general if uneven increases relative to national income.

- Agricultural Engineering - Agricultural engineers lost almost 25% of their salary premium between 1997 and 2003, and despite an improvement between 2003 and 2009, their relative salaries are still below the 1997 levels.
- Biomedical Engineering - Relative compensation for biomedical engineers grew sharply and then leveled off. Over the time period, salaries for biomedical engineers grew about twenty percent more than GDP per capita.
- Chemical Engineering - After a flat performance, salaries for chemical engineers rose more quickly than national income between 2000 and 2002, whereupon they rose less rapidly than national income until 2007. For the last few years growth relative to national income was almost as high as at the beginning of the decade, but it is still only slightly higher than at the beginning of the time period under consideration.
- Civil Engineering - Salaries for civil engineers also demonstrated fluctuations relative to national income. A dip and recovery over the first part of the time period was followed by a steady decline and finally an even steeper rise between 2006 and 2009.
- Computer Engineering - Computer engineers, perhaps not surprisingly, followed a different salary path: consistent increases, with one period of slight decline, then relatively quick increases.
- Electrical Engineering - Electrical engineers had the smoothest salary transitions, with initital increases followed by steady decline and then recovery. The result is the the relative salaries of electrical engineers is approximately the same level at the end of the period as at the beginning, about 1.86 times the national average income.
- Electronic, Environmental and Mechanical Engineering – Although this disciplines are dissimilar in the scope of the work, their salary patterns are similar. The patterns for electronics, environmental and mechanical engineers are similar to that of electrical engineers, if somewhat choppier: rising compared to GDP per capita, then declining (not necessarily at the same time) and finally rising rather rapidly.
- Industrial Engineering - Industrial engineering salaries grew somewhat faster than GDP per capita until 2002, then saw a steady deterioration. At the end of the period salaries grew more quickly than national income, but the relative salary was lower than in 1997.
- Marine Engineering - Marine engineers were treated favorably by markets for the first part of the time period, but then experienced steady declines in their relative salaries, before the pattern levels off.
- Materials Engineering - Materials engineers' salaries made positive strides at the end after a period of relatively steady decline.

- Mining and Geological Engineering - The salaries for mining and geological engineers moved sharply, making gains and then losing those gains, the result being that relative to the average national income their pay was almost the same at the end as at the beginning of the time period.

- Nuclear Engineering - Nuclear engineers rose to a high income ratio of over 2.28 in the middle of the time period before falling back a bit to about 2.16 times national average income.

- Petroleum Engineering - Petroleum engineers improved their position over the time period, mainly through gains made since 2006.

- Safety Engineering - Safety engineers experienced various periods of rising and falling salaries relative to GDP per capita. Their relative compensation was lower in 2009 than in 1997.

Table 6

Changes in Relative Sub discipline Salaries

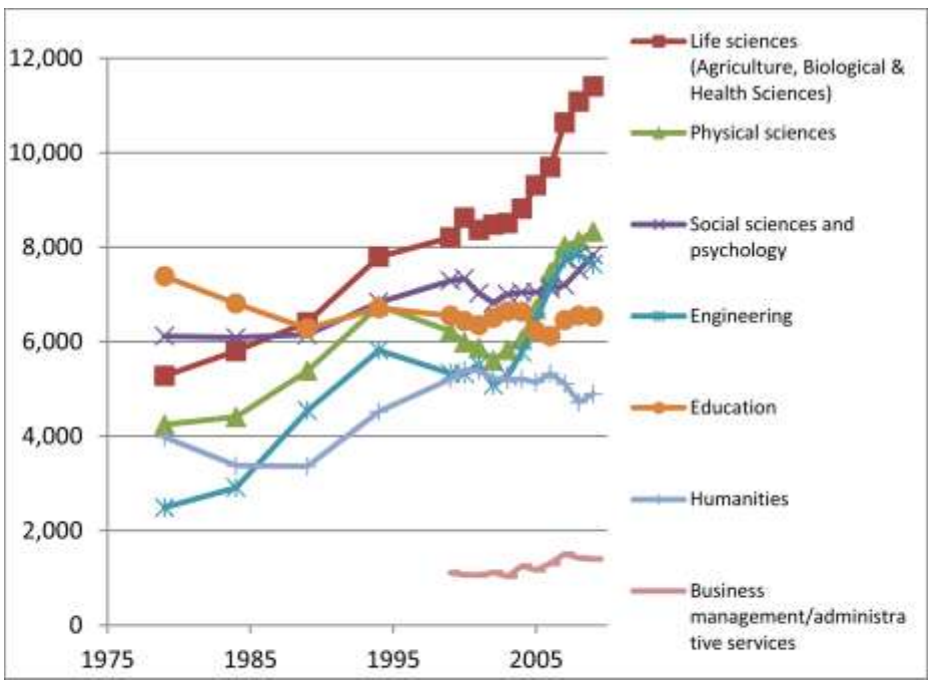
Rank		1999		2009
1	Materials	2.21	Petroleum	2.59
2	Petroleum	2.21	Computer	2.19
3	Computer	2.03	Materials	2.16
4	Aerospace	1.96	Aerospace	2.08
5	Chemical	1.95	Chemical	1.98
6	Electronics	1.92	Electronics	1.97
7	Mining and Geological	1.88	Engineer (All)	1.89
8	Electrical	1.86	Electrical	1.86
9	Engineer (All)	1.85	Materials	1.85
10	Materials	1.80	Biomedical	1.78
11	Marine	1.78	Mining and Geological	1.77
12	Industrial	1.74	Civil	1.75
13	Environmental	1.73	Environmental	1.74
14	Mechanical	1.73	Mechanical	1.74
15	Agricultural	1.69	Marine	1.71
16	Civil	1.69	Industrial	1.66
17	Safety	1.63	Safety	1.64
18	Biomedical	1.59	Agricultural	1.61

Table 6 summarizes the relative movements in subdisciplinary salaries. Engineers overall experienced improved relative salaries, from a ratio of 1.85 to 1.89. Biomedical engineers had the lowest salary ratio in 1999, 1.59, but improved eight spots by 2009 to 1.78. Materials engineers fell from first (2.21 times average national income) to ninth place (1.85). The biggest drop in relative salary was in the miming and geological field (-0.11), with agricultural, industrial, marine and materials engineers also falling toward the national average. Even so, the least well-compensated engineers (agricultural) earn, on average, sixty percent more than the "typical" wage earner. All other fields experienced, despite reverses in some years, incomes rising on average faster than national income, with the biggest gains in petroleum, biomedical, computer and aerospace.

The pattern shown above is one of declining relative compensation for a period in the middle of the last decade. This was followed by a general, if uneven, decline in earned undergraduate degrees, a sharp drop in master's level degrees, but an increase in doctoral degrees. Then, at about the time salaries started to rise in many areas of engineering, there was a drop in graduate activity and a leveling off in undergraduate enrollments.

There are various suggestions that can be made as to why these entry patterns occurred. Each area of specialization experienced a relative decline in compensation, which would plausibly be followed by reduced interest in pursuing that specialty. To the extent that interest in and talent for engineering in an individual is not limited to one specific area, students at all levels would be expected to become more (less) interested in entering fields with higher

Figure 9
Numbers of Ph.D. Conferred



Source: Doctorate Recipients from U.S. Universities: 2009, NSF 11-306, National Science Foundation, available at http://www.nsf.gov/statistics/nsf11306/.

(lower) levels of compensation. But engineering students are likely to be among the most talented individuals in the population, which means their options would not be limited to different engineering fields, but would encompass other technical, medical and scientific fields. If compensation in substitute fields moved favorably relative to engineering, a lower number of available and qualified engineers would be expected, with upward pressure on salaries eventually resulting if the shortages were not filled with engineers from other countries.

As incomes rise in general, however, the difficulties in pursuing an engineering degree may dissuade some potential entrants. Even if the expected compensation is double the national average income that may not be enough to convince someone that entry into the field may be more than twice as difficult as some other career. Students at the undergraduate level may be able to respond to adverse movements by changing majors, and even graduate students will consider other options if the costs of becoming a professional engineer grow to outweigh the benefits. On the other hand, degrees are not earned overnight. Movements in relative wages will likely lead to changes in the number of qualified job candidates in four to six years at the bachelor's level, a couple of years at the master's level and six to seven years at the doctoral level.[13] It would not be surprising if falling relative wages would lead to quicker declines in the number of job candidates than rising relative wages would produce more candidates.

One final note concerns the entry into the market by engineers from India and China, two countries which received a great deal of attention. Freeman acknowledges the importance of these entrants and simultaneously cautions that disruptions in the flow of trained engineers would have serious consequences for both industry and the academy.[14] Increased competition among developed economies for these engineers is one potential threat to continued immigration to the U.S. Some have proposed the adoption of a concerted policy, including direct financial support and increased opportunities funded by the public sector, to increase domestic entrants into the engineering labor force.[15] There are various reasons to question whether this sort of policy will lead to the desired outcomes. As seen above, the markets for the various sub-engineering disciplines all move to their own rhythms. How to determine which will see market shortages? Governments do not have admirable track records when it comes to picking winners in the market. Furthermore, while it is reasonable for the National Science Foundation to place a very high priority on scientists and engineers, every talented student enticed into those fields means one less doctor, lawyer, social scientist, poet or some other profession that also contributes to society. How to compare the benefits of engineering services and the costs of lost services elsewhere?

It is likely that economic considerations play a large role in the decision to migrate: over eighty percent of emigrants from East Asia and the Pacific, with China the largest single source, went to high income countries.[16] To the extent that individuals enter a profession for purely financial reasons (although there are obviously other considerations), the higher the relative compensation in a particular country, the more people would be expected to pursue that profession. If potential migration to the United States plays a role in the decision making process, as is likely, even if actual migration is *unlikely*, the ratio of engineering earnings to the domestic average incomes in China and India becomes a factor. Figure 10 below clearly shows that the potential rewards for an engineering degree are extremely high in both China and India, but the growth in both countries is steadily lowering the ratios. The trend, if continued, would be expected to reduce the number of people pursuing the engineering profession as the benefits less and less outweigh the costs. Also, if GDP per capita continues to rise in China and India, the economic incentives to migrate fall. If, at the same time, the quantity supplied of U.S. engineers grows in response to rising compensation, these engineers may benefit in the form of long-term wage resilience. Although more domestic job seekers would typically bring produce downward pressure on wages, a reduction in entrants from other countries may offset that tendency with a higher wage plateau the result.

Figure 10
Average Engineer Salary Relative to GDP per capita US, PRC and India

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