How Responsive is Higher Education?
The Linkages between Higher Education and the Labor Market

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Abstract:

Higher education is considered vital for developing a productive and dynamic labor force to meet the demands of the global economy. How effectively does the US higher education sector respond to labor market signals? We match US post-secondary degree completions from 1984 to 2008 with occupational employment statistics and employ an instrumental variables strategy to examine the supply response to changes in occupation specific demand. The supply of educated workers appears weakly responsive to short-term wage signals and moderately responsive to longer-term employment conditions. Analysis reveals a sizeable degree of heterogeneity and lag in the responsiveness across specific occupation-degree pairings. Failure to respond rapidly to changes in labor demand may be one factor driving inequality in wages across occupations and in the aggregate economy. We suggest some simple policy measures to help increase the responsiveness of the higher education sector, both in terms of the output of specific degree programs and the overall mix and composition of graduate completions.

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I: Introduction and Motivation

The last decade has witnessed the rapid growth of a globally integrated labor market. Competitive pressures are increasingly felt not just across countries, but at the level of occupations and individual workers. The changing nature of competition, coupled with an escalating premium on technological skills, poses a challenge to continued domestic job creation and has brought to the forefront issues of foreign outsourcing and skill biased technical change. While academic debate on these subjects continues, there has been a general agreement among researchers and pundits that higher education will play a role in preparing a dynamic work force capable of coping with these challenges. Significant attention has therefore been directed towards education reform -- on reforms in syllabi and subject matter, on training procedures, techniques and methods, and on facilities and equipment in colleges and laboratories. For economists, experts in education policy, and others dealing with issues of competitiveness, the primary concern of education reform has principally revolved around issues of quality, with quantity receiving less attention.

The focus of this paper is on allocative efficiency: an examination of the post-secondary education sector's responsiveness to the needs of a modern labor market in terms of the output *quantities* of particular degrees or field specializations and the overall *composition and mix of specializations and degree completions*. The questions we address include: What is the nature of linkages between the higher education sector and the labor market? How quickly and in what way does the education sector respond and adjust to labor market signals? What are the implications for policy?

Our analysis suggests that the overall system of higher education in the United States is moderately responsive to labor market signals. Previous growth in demand, including both increased employment opportunities and rising wages for specific occupations, is associated with increased current completions. The strength of this association, although moderate overall, is stronger for lags of four or seven years, consistent with the time to degree at a four-year institution or the time to degree for a specialty degree. Degree completions provide a measure of both individual and institutional responsiveness as student interest has to be coupled with increased enrollments made available by schools. Furthermore, we find that there is a great deal of heterogeneity in responsiveness across degree programs and their corresponding occupations. Some programs such as computer science and information technology appear to be highly

responsive to labor market outcomes, whereas others such as doctors of medicine and medical dentistry appear largely unresponsive, consistent with anecdotal evidence that institutional barriers play a large role in affecting the output of higher education in the US.

This paper makes several important contributions. First, we create a new dataset by combining information on post-secondary degree completions from the Integrated Postsecondary Education Data System (IPEDS) of the National Center for Educational Statistics (NCES) with the Current Population Surveys' (CPS) Merged Outgoing Rotation Groups. This entails matching individual degree programs from the former with the detailed occupations in the latter. Second, our analysis focuses on the responsiveness of numbers graduated across these pairings to demand side signals from the labor market at the level of the individual occupation. This unique pairing scheme enables us to examine exactly which degrees are responsive to labor market signals. Third, employing a sizeable subset of consistent occupations from the CPS, we are able to match degree completions and labor market outcomes from 1984-2008. Having matches over a 24 year period enables us to examine long lags and to employ an instrumental variables approach to estimating the effect of occupation specific demand growth. Finally, we discuss some potential informational and institutional reforms to make the "supply-side" of higher education more elastic. Standard theory suggests this would yield social welfare gains.

Motivation and Framework for Analysis

Figure 1 presents a framework summarizing the linkages between the labor market, the student body, and the higher education sector. The supply side of skilled labor is a composite black-box where the response of the student body to market signals is moderated through the post-secondary education sector in the following chain. Initially, prospective students receive a labor market signal either in the form of increasing salaries or rising numbers of vacancies for specific occupations through sources such as friends, family, and the media. Motivated by these signals, student demand results in an increase in applications at entry level for promising degree programs (similarly, lower applications for less desirable degrees). Meanwhile, available slots in post-secondary programs and thus the current year's intake is determined both by the number of applications and by a combination of idiosyncratic factors such as previous years' admissions, available professors, long-range planning, and so forth. If the higher education sector does not react rapidly to changing demands, this results in a relatively inelastic, inflexible, short-run

supply of skilled labor to the economy. Assuming mobility across occupations is imperfect, the short-run labor market adjustment predominantly takes the form of a wage (price) adjustment, rather than an employment (quantity) adjustment.

The framework presented above is of course greatly simplified. There are alternative pressures on the supply channel. Firms, experiencing a need for individuals in specific occupations, could finance research or graduate fellowships at University departments, sponsor increased immigration such as through H1B visas, or fund additional on-the-job training to facilitate flexibility in the existing workforce. In some cases, public universities systematically respond to demand through demographic-linked mandates (Delong, 2008). In others, a combination of private-sector-employer-donor pressure, targeted public policy or sizeable swings in applications impact admission and staffing decisions over a number of years. At the same time, anecdotal evidence suggests that admission numbers, and thus the future composition of the supply of highly educated workers, are often set by administrative fiat, inertia and capacity constraints.

Evidence in the media of the rigidity of the higher education sector is abundant in the current context of the global economic crisis, when large numbers of laid-off employees and discouraged jobseekers are flooding the nation's colleges with applications:

> "Representatives of Harvard, Stanford, Dartmouth, Yale, and Brown, among other highly selective institutions, said in telephone and e-mail exchanges in recent days that applications for the Class of 2013 had jumped sharply when compared to the previous year's class. As a result, the percentage of applicants who will receive good news from the eight colleges of the Ivy League (and a few other top schools that send out decision letters this week) is expected to *hover at – or near – record lows.*
>
> Bill Fitzsimmons, dean of admissions and financial aid at Harvard since 1986, said that the 29,112 applications Harvard received this year represented an all-time high, and a 6-percentage point increase from last year. He said the percentage of applicants admitted would be 7 percent, down from 8 percent a year ago. Dartmouth said that the 18,130 applications it received was the most in its history, too, and that the 12 percent admitted would be its lowest.
>
> Stanford said that the 30,350 applications it received represented a 20 percent increase, and that while it *estimated a 7.5-percent admission rate, which would be its lowest,* it declined to specify a final figure until later in the week."
>
> Steinberg and Lewin (2009). *The New York Times*, March 29 (emphasis added)

While these are specific examples, the relatively inflexible nature of the supply of higher education, and the difficulty of easing capacity constraints likely bedevils all institutions of higher learning. The problem could arise for a number of reasons, including i) an information asymmetry, ii) a coordination problem between institutions of higher education and the private sector, iii) a lack of incentives, and/or iv) a gestation/timing mismatch. The negative correlation of applications and the admissions rate, or endogenous nature of the admissions rate, rather than that of admissions, reflects the widespread mantra of admissions committees "we expect class size to remain steady."

The benefits of increased responsiveness of the educational sector are potentially quite large. They include more flexible markets leading to more allocative efficiency, lower frictional unemployment (search costs), and potentially reduced aggregate inequality if demand is rapidly increasing for skilled or well paid occupations. In the case of a specific occupation, a more elastic and responsive supply would mean that wages would not increase as significantly for a given increase in demand, resulting in a welfare transfer from those working in that occupation to consumers, to the extent that to some extent inequality is a function of inter-occupational terms of trade. Furthermore, there would be a benefit to society above and beyond this transfer as total employment in that occupation would increase by more than prices charged – in other words, there are beneficial terms of trade effects for those purchasing the services of a specific occupational group. An analogous argument has been made before, both in trade theory and in debates on skilled immigration in response to occupational cartels (Baker, 2008).

It is not our contention that the higher education system should be viewed purely through the lens of the labor market. The system of higher education does not operate on market principles alone and arguments have long been made that access to education deserves subsidization as a basic human right or as a societal good with large positive socio-cultural externalities. Above and beyond the direct returns to education in terms of higher wages, education has been associated with increased social mobility, greater economic opportunities, higher entrepreneurialism, and access to "good" jobs with more perks such as health and childcare (Zumeta, 2008). Also, the research capacity of universities generates technological growth, increases productivity, and ultimately promotes an enhanced standard of living.

Section II provides background on related literature. Section III describes the data sources employed and the methodology used in determining linkages between specific occupations and degree programs; Section IV provides summary statistics and discusses selected individual occupation-degree pairs. Section V presents empirical analysis, and Section VI concludes with some policy lessons.

II: Related Literature

The relationship between higher education and the labor market has been studied extensively by economists and a major focus has been on individual students examining applicant or enrollment behavior. A number of papers have analyzed incentives to invest in human capital, returns to education, and individual response models (Card, 2001; Leslie and Brinkman, 1987; Psacharopoulos and Patrinos, 2004). For the economy as a whole, the evidence generally suggests that schooling choices are responsive to changes in the rate of return to education. Mincer (1994) examines the relationship between post-secondary enrollments and changes in the rate of return to education, accumulated stocks of educated workers, and on-the-job training. He finds some evidence that enrollments rise when the return to education rises. Similarly, Mattila (1982) finds that male school enrollment is responsive to changes in the expected rate of return to education in the 1960s and 1970s, even after considering the motivation for increased schooling as a consumption good. Walters (1986) compares the responsiveness of male and female enrollments to labor market prospects and argues that female enrollments are more responsive to signals from the labor market than male enrollments. In addition, he finds that enrollments tend to respond to labor market conditions only during times of rapid economic growth

There is also abundant research examining individual occupations. Freeman (1986) surveys the literature providing labor supply elasticities for a variety of occupations. He argues that in general, these elasticities are large, and that when combined with evidence on wage growth, are sufficient to explain a sizeable share of student enrollment and degree completions. He notes that the "U.S. survey evidence provides additional support for the notion that students are highly responsive to economic rewards in decisions to enroll in college." Other papers have focused directly on individual fields, such as Hansen (1999) who focuses on economics PhDs and bemoans the lack of research on the labor market linkage. Ryoo and Rosen (2004), in a

theoretical analysis of engineers, find a strong connection between observed labor market variables, such as wages and demand shifters like R&D spending, and student enrollment decisions.

The closest exercise to our own is that of Freeman and Hirsch (2007). The authors link US degrees with the "knowledge content" of occupations listed in the O*NET occupational coding scheme. This pairing scheme covers 27 specific areas of knowledge. College major choices are found to be responsive to changes in the knowledge content of occupations and, to a less robust extent, to wage differentials. A relative strength of their work is that by focusing on knowledge categories, they effectively limit concerns over occupational switching – as they build pairings off of broader skill sets.

Our work is similar in spirit, but focuses on a more disaggregated matching scheme, pairing smaller sets of degrees directly with an occupation or groups of occupations, rather than broader knowledge categories. This allows us to control for a range of individual characteristics within specific occupations such as average age and union membership status, to employ an instrumental variable approach, and to examine case studies in more detail. Freeman and Hirsch focus specifically on BA degrees, which drives their empirical approach of fixing a 4 year lag for the analysis. This paper, in contrast, deals with the issue of quantitative responsiveness of the educational sector to labor market demand across a spectrum of occupations and fields at multiple degree levels. As such we take a less parameterized approach, exploring responsiveness across multiple lags.

Other authors have examined efforts to pair educational degrees to the labor market. For instance, Psacharopoulos (1986) provides an evaluation of attempts around the world to integrate higher education more closely with the labor market. He argues that individuals may in fact be better at making this link than institutions, saying "although economic dynamics is the predominant force shaping the long term macrostructure of post-secondary education and training, such changes cannot be easily predicted and translated into micro-day-to-day school policies…."

Similar research has been done outside the US as well. For instance, Boudarbat (2008) examines the Canadian National Graduate Survey and focuses on students' choices concerning field of study. Utilizing a repeated cross section of community college students who graduated from 1990 to 1995, he finds that individuals are heavily influenced by their anticipated earnings

in a given field relative to those in other fields. In related work, Boudarbat and Montmarquette (2007) find that Bachelor's students in Canada are influenced by the expected lifetime earnings from a particular field of study, conditional on their parents having less than a college education.

In most cases, comparative studies which place the US in an international context praise it for having a relatively flexible educational system. For example, Allmendinger (1989) and Jacob and Weiss (2008) contrast the US and German educational systems. They point out that education in the US is more sequential and subjected to a lower degree of standardization. Government intervention in the US, where it exists, tends to take the form of financial support such as through loan schemes, in lieu of regulation.

Research suggests that the structure of the labor market affects the incentives to accumulate different forms of education. For instance, Wasmer (2002) suggests that a relative lack of job security in the US relative to Europe explains why education in the US tends to focus more on general human capital development and why in Europe vocational education is more common. A greater degree of standardization and occupational specificity may be required to convince European employers to initially hire an individual if the costs to fire them are much greater. Similarly, Jacob and Weiss (2008) argue that when labor markets are flexible, there will be higher turnover in the economy. Higher job turnover will be conducive to earlier exits from the education sector and to a lower direct and indirect cost of re-entering the educational system at a later date because vacancies will appear more frequently.

How large are the potential welfare gains from having a more responsive educational sector? Dougherty and Psacharapoulous (1977) analyze the costs associated with the misallocation of educational resources across countries. While their analysis is not focused solely on post-secondary education, the authors find that in some cases, the costs of educational misallocation are as large as the entire educational budget itself. Judson (1998) suggests that an appropriate allocation of educational investment is important for economic growth. He builds a model of growth which takes into account both the level of investment and the allocation of education within the economy. He finds that in countries where educational investments are efficiently allocated, the correlation between human capital investment and economic growth is positive and significant, but in countries where the educational budget is misallocated the correlation is not significant.

Policy discussion surrounding the future direction of the US higher education system is often focused on a broader set of outcomes. For instance, Zumeta (2008) argues that there should be sizeable growth in the total output of the higher education sector. Blinder (2008) makes the case that in order to remain competitive the education sector should focus on training individuals to provide personal or face to face services, because these skill sets will remain valued as the world transitions to freer trade in impersonal and tradable services.

The example of the former Soviet Union is instructive. There, in a centrally planned economy, students graduated with degrees in a specific job code, i.e. there was a formal, institutionalized correspondence between educational degrees and corresponding occupations. In theory, the numbers were tweaked in response to changes in the labor requirements and vacancies to get both a qualitative and quantitative correspondence between the higher education sphere and the labor market. In that sense, the educational system was nominally responsive to the perceived needs of the job market. The problem, of course, was that the perceived needs of the job market were incorrect. Since the price mechanism was largely absent, or more accurately largely administrative, the derived demand for labor turned out to be distorted. Even if it had been present, administrators would likely have still erred. Our contention within the US is simply that some characteristics of the higher education sector prevent students from rapidly adjusting to new economic information. Exploring the degree of responsiveness across similar degree programs and occupations may be informative as to the source of these market weaknesses. The task then is to make the institutional and economic mechanism of supply more flexible as a whole.

III: Data Description

We utilize data from several sources in our analysis.[1] Unlike most of the literature our focus is on completions, not enrollments. Data on educational degree completions and enrollments is available in the Integrated Postsecondary Education Data System (IPEDS), compiled by the National Center for Educational Statistics (NCES). The IPEDS covers all degree completions in programs designed for students beyond the high school level across the country, including vocational and continuing education students but excluding avocational and

[1] A complete discussion of the data can be found in the Appendix.

basic adult education programs. Also excluded are programs that prepare students for one specific exam such as bar courses, as well as on-the-job training provided by businesses.

The IPEDS data cover the period 1984-2008, though in some cases degree coding has been fine-tuned and over the years new degree programs have been added. Degree programs are classified according to the Classification of Instructional Programs (CIP) codes created and maintained by NCES. Beginning in 1980, NCES has since updated the CIP coding system in 1985, 1990, and 2000. In order to create a longer time series for some of the analysis provided in the next two sections, we have employed the official CIP crosswalks provided by NCES to maintain as much comparability as possible over time for many of the major instructional programs.

Data on occupational characteristics, wages, and employment for the period 1984-2008 are available through the Center for Economic Policy Research (CEPR) Uniform Extracts of the Current Population Survey (CPS) Outgoing Rotation Groups. The CPS Outgoing Rotation Groups comprise a subsample of the 60,000 individuals interviewed yearly for the CPS, and who are asked information on their usual working hours and hourly earnings. In a given month this covers information both on labor market outcomes, as well as on background characteristics for approximately 30,000 individuals. Because individuals in the CPS are resurveyed and thus can appear in two years of the sample, we have adjusted our analysis for Huber-White standard errors as suggested in Feenberg and Roth (2007). In addition, the CEPR Uniform Extracts have been manipulated in order to obtain a robust hourly wage series. Adjustments to the CPS data include a log-normal imputation and adjustment for top-coding, exclusion of outliers, and an estimation of usual hours among some survey respondents. This treatment is described in detail in Schmitt (2003). In order to obtain a set of occupations which are consistent in definition and coverage for the period 1984-2008 we employ the Meyer and Osborne (2005) classification scheme for matching across the 1980, 1990, and 2000 census occupational coding schemes.

Description of Matching/Linking between Educational Specialization and Occupation

The NCES provides a crosswalk between CIP educational program codes and the Census 2000 occupation codes used in the CPS. Some pairs are better matched than others. Links are stronger for degrees which have less mobility across different occupations. For example, an individual earning a degree as a licensed vocational nurse is highly likely to seek employment as

a nurse. We have narrowed the NCES crosswalk to a selection of 79 matches for which there is a clear correspondence between educational degree program and occupational code over the entire sample period using systematic rules and common sense.

During the narrowing process, we systematically excluded those links for which individuals earning a degree could pursue a very wide range of occupations, including those which are beyond the crosswalk. For instance, CIP code 260401 for students earning degrees in Cellular Biology and Histology are linked by the NCES to Natural Sciences Managers, Biological Scientists, Medical Scientists, and Postsecondary Teachers. The reason for excluding these matches is twofold – in part because the degree was linked to multiple Census 2000 occupations, and in part because these four occupations would still likely not catch the majority of graduates with this degree.

In a very small number of cases, individuals earning a particular degree would work only in one of a small number of occupations and would be expected to be motivated by the wages and employment prospects of this small number of occupations. For example, individuals earning a degree in funeral service or mortuary science are likely seeking employment in only one of a few specific occupations. Table 1 provides an example of a one to one match, a one to many match, and a many to many match.[2] Where there were multiple matches on the education side, we linked degree and occupation by summing completions across the corresponding unique degree programs. When there were multiple occupation matches on the employment side, we summed employment across the occupations and calculated a weighted average of the wages among the linked occupations, where the weights were defined as the number of individuals employed under each occupational code of a given match. In this way we were able to preserve the total wage bill of the occupations in the pairing and provide a good proxy of the expected wage one might expect from work in one of many similar occupations.

It should be noted that our system of education-occupation pairs adds an additional level of precision to the crosswalk provided by the NCES. In addition to linking degrees to occupations we also take into account the level of the degree program completed. For instance, only individuals receiving a Ph.D in a designated number of CIP fields are linked to post-secondary professors. In this case, limiting to one degree level, Ph.D, gives us a more accurate

[2] The Appendix includes a complete description of the matching exercise and a list of occupation-degree pairings used in the analysis. It also discusses a number of alternative pairings we employ as robustness checks.

link between a specific degree and an occupation. Grouping similar occupations and limiting our analysis to specific occupations within the Meyer and Osborne (2005) set of consistent occupations, we are able to match consistent occupations and degrees for the entire 1984-2008 period.

Sample and Population Characteristics

The previous section highlighted some of the defining features of the linking process and hinted at some of the characteristics of our paired sample relative to that of the entire US. Table 2 explores the degree to which our sample is representative of the US higher education system as a whole. The 79 occupation-degree pairs in the sample actually cover between 390 and 800 degrees because many pairs contain multiple CIP codes. Because this sample is weighted more strongly towards the larger degree programs, our linking covers roughly half of the degree programs and 75 to 80% of total degrees awarded in the US over the sample period. No completions data was released by the NCES for the year 1999, leaving us with 24 years of data.

The statistics presented in Table 2 also reveal a number of important trends in US higher education. Total completions awarded have more than doubled, rising from around 2 million a year in 1984 to 4 million a year today. The variety of degree programs offered (or classified by NCES as distinct) has fluctuated over time, and only grown modestly. Taken together, this implies increasing numbers of degrees awarded per degree program on average. The large overall growth in post-secondary completions in the US is consistent with a larger and increasingly educated population -- masking a great deal of heterogeneity across degree programs in terms of growth which we explore in greater detail in Section IV.

The representative nature of our sample and of our linking exercise in terms of wage and employment is examined in detail in Table 3. Our sample is heavily skewed towards larger and higher paying occupations. While our sample covers roughly one fourth of all occupations, these comprise three-fourths of the total working population. Consistent with most of these occupations requiring a post-secondary education, the mean wage in these occupations is about 135% of the US average. The sample is also a revealing source for macroeconomic patterns over the past 22 years. Total employment has increased from 105 million in 1984 to 145 million in 2008, expanding at a much slower rate than the rate of completions growth. Real wages

calculated using the CEPR's preferred methodology have expanded from about $34,000 in 1984 to around $42,000 today.

Table 4 compares occupation level characteristics from the paired sample to the full US CPS sample, pooling over all 24 years of data. Several things are worth mentioning. Workers in our sample are similar to the total US workforce in many respects. Those in our sample are more likely to be married (60% vs. 65%) or work for the government (15% vs. 21%). At the same time, fewer individuals in our sample are paid by the hour (54% vs. 38%) or unionized (15% vs 12%). Importantly, a significantly larger share of our sample has a degree higher than a high school diploma - 84% have greater than a high school diploma. This compares with 55% for the US as a whole over the same period. This suggests that our paired occupations are appropriate in the sense that they predominantly employ individuals who have completed a post-secondary education.

Our occupation and degree completion pairings therefore constitute a sizeable, significant and representative share of both the US higher education system, as well as the labor market. Ideally, we would have liked a higher share of total occupations and degrees paired and we recognize the limitations of our matching exercise. Nonetheless, we do not believe that selection and construction are likely to introduce systematic bias. Specifically, sample selection is such that a greater share of the narrow or higher specialization degrees are selected. Even if our sample is heavily comprised of jobs which clearly demand a high degree of specialization, because of their inelastic nature, this should also be the segment of higher education where we should care about the responsiveness of individual degrees as opposed to concern over the aggregate supply of college graduates.[3]

Section IV: Data Discussion

The aggregate "output" of the US higher educational sector

The output of the US higher education system has generally outpaced the rate of population growth in the economy over the past 24 years. From 1984-2008, the US population has increased 27%, rising from 235 to 300 million. Meanwhile, annual completions of post-

[3] Very broad and general degrees likely fill a need for flexibility in the labor market and should be extremely relevant among occupations with a good degree of on the job training. We should also be concerned about "aggregate" responsiveness in and of its own right.

secondary degrees have nearly doubled, as suggested in Table 2, increasing some 103%. This rapid growth masks a great deal of heterogeneity in growth rates along a number of lines. First, the number of graduates has been increasing most rapidly among post-secondary degrees of two years or less as can be seen in Figure 2, which charts the growth of post-secondary completions by degree level. At the same time, growth of degree completions at the Masters and Ph.D levels have outpaced those of Bachelors suggesting that a greater fraction of those who complete college are continuing on further with their education.

Figure 3 tracks changes in employment, wages and degree completions at the aggregate level from 1984 through 2008. Mean wages and employment in the US have increased over the period, stagnating only briefly during the early 1990s recession and again from 2002-2004. The high level of degrees earned relative to absorption (net change in employment from year to year) by the labor market reflects both the retirement of skilled workers and an overall increase in the skill level of the labor force as the occupational structure of the economy has evolved.

Figure 4 plots the correlation of degree completions with lagged employment growth across a range of lagged values for absorptions. The correlation rises from roughly .15 the previous year to .3 in years 4 through 7 and then subsequently falls. While these are not particularly large correlations, they are consistently positive and informative about the time lag in responsiveness of the higher education sector. Specifically, this suggests that the largest impact of the labor market on schooling outcomes operates with a rather sizeable delay. Furthermore, these values disguise a great deal of across occupation heterogeneity as we will explore in the following section.

Case Studies

Just how responsive are individual degree programs? One concern is that US level data appear unresponsive only as a result of aggregation across occupations. This section examines a number of case studies for specific occupation-degree pairs. The evidence presented here suggests that only some degree programs are responsive to short-run labor market signals and that degree completions are likely influenced by a large number of factors beyond standard labor market signals. Graphically examining occupation-degree pairs as individual case studies reveals a number of interesting stylized facts.

First, some occupations are highly responsive, but with a lag. Perhaps the clearest case of this is for computer scientists. Figure 5 documents a rather steady rise in absorption and wages for computer scientists in the mid-to-late 1990s. The response of the higher education sector is rather dramatic, with completions nearly doubling from 1998 to 2002. Degree completions are clearly indicative of a lag in responsiveness of roughly 4 years, with employment growth peaking in 2000 and completions peaking around 2003.

Accounting for the lag, completions of computer science degrees appear to be strongly influenced by outcomes in the labor market (in this case to the technological boom occurring in the 1990s). One potential explanation for the rapid responsiveness among computer science is lack of strong barriers to the creation of new IT programs and schools, particularly those with associate and professional degrees, as well as the low cost of adding enrolments/admissions at the margin.

Among other occupations, it is unclear that completions are responsive to even long-term secular growth trends in total population, employment and wages. Figure 6 suggests that in spite of rather large volatility in terms of both job creation and real wages, the number of architectural degree completions has remained relatively flat for the past two decades. Inelastic supply and anemic growth is a phenomenon that appears to classify a surprisingly sizeable number of common and important degree programs. Figure 7 illustrates this case for physicians, but it is typical of other professional occupations as well (such as dentistry). Annual completions of MDs have remained largely unchanged in the US over the past two decades, in spite of rather sizeable growth in real wages, employment and an ageing population. Growth in demand and employment of doctors in the US has in part been met with imported labor. Tapping a foreign supply of educated workers with immigration through programs such as H1B visas, provides a second source of skilled labor in the face of unresponsive domestic supply. The expansion of these programs and a more responsive labor supply in general for doctors is considered a critical concern in the current debate surrounding health care reform (Bhagwati and Madan, 2008).

While technological progress and changes in consumer demand likely drive the volatility in employment for responsive degree programs like computer science, some other degrees are impacted by more subtle but equally important demand factors. Figure 8 profiles new employment, degrees and real wages for licensed practical and licensed vocational nurses. The medical community has long been concerned over a growing shortage of nurses, and successfully

lobbied for special immigration status for nurse practitioners. In spite of this reported shortage, employment levels were actually declining during the 1990s, which at first glance would look like a worsening of employment prospects. Instead, large negative absorption for this occupation is likely attributable to attrition. Nursing is classified by the BLS as an aging occupation, meaning that because the average age of licensed practical nurses is well above the norm, the need for replacements for retirees is above average.[4]

Why are some degree programs like computer science so responsive and others like MDs rather unresponsive? There are a number of possibilities. The first is that specialist occupations such as doctors, dentists, and lawyers operate under a high degree of regulation and oversight. This regulation may come from institutions such as the American Medical Association (AMA), the American Dental Association (ADA), and the American and State Bar Associations, or it may come from state or federal agencies and legislation. Regulation can lead to barriers to entry for new institutions and to heavier restrictions on enrollment or on minimum time to degree, which may not be applicable to other degree programs.

Also, in many cases, individuals in these fields must pass qualifying examinations or obtain certifications even after earning their educational degree, which can take additional months or years of study and may entirely exclude some individuals from entering the labor force in a particular occupation. This is the conclusion of Kleiner and Kudrie (1992), who study licensing restrictions for dentists, and of Tenerelli (2006) who examines entry constraints in the market for physicians. Tenerelli points to a role for the state in designing policy to offset these supply restrictions and achieve an outcome closer to what would occur in unrestricted competitive markets.

Another possibility is that these occupations require a great deal of specialization, learning by doing, or on the job training. Thus, the total time required to become involved in the market may be greater than the actual time to degree completion. This would also serve drive a wedge between labor market signals and degree completions. The high cost of increasing supply, particularly at the extensive margin, with the creation of new schools of medicine is also prohibitively high.

[4] This is true for a number of other occupations such as dentistry. For example, the median age of US employees in 1998 was 39 and the percent employed aged 45 and over was 33.7%. Among dentists the comparable figures are 45 years and 51.3%. For a complete list of occupations, visit: http://www.bls.gov/opub/mlr/2000/07/art2full.pdf.

V: Empirical Results and Analysis

In this section we examine the strength of the relationship between post-secondary degree completions and observable outcomes in the U.S. labor market such as wage and employment growth. Our unique dataset allows us to address several important questions. First, how reactive is the US supply of higher education to the demands of the labor market? If the educational sector is responsive, which signals does it use? If not, what are the implications of changes in the supply of educated workers for labor market outcomes such as wage growth and inequality?

In theory, a number of factors come into play in determining both labor supply and labor demand for educated workers. From an accounting standpoint, we can break down changes in total aggregate employment, with labor force growth coming from factors such as new entrants to the market through degree completions, reentrants of former workers, immigration through programs like H1B visas, and depletion coming from retirements and firings. Conceptually, we would expect absorption to take the following form:

$$employment_t - employment_{t-1} = completions_t + reentrants_t + immigration_t - retirements_t$$

To determine the responsiveness of post-secondary degree completions to labor market signals, we then run a number of OLS regressions of the following form:

$$\text{(A)}\ completions_{it} = \alpha + \beta_1(X_{i,t-\tau}) + \delta_1(Z_{it}) + \Omega_i + \Phi_t + \varepsilon_{it}$$

Where the subscript i indexes a given occupation-degree pair and t indexes time; τ represents the lags on our X variables and varies from 1 to 10 years depending on the specification.[5] X are measures of labor market demand at the occupation level such as occupation-specific absorption (changes in total employment between years), the occupational wage, and a measure of occupation specific demand – the occupation's share of the total wage bill (i.e. US wages*employment). Z is a vector of labor market controls from the CPS data at the occupation level. This includes the share of individuals in a given occupation who are female, married, unionized, self-employed, or government employees, as well as their average age and average weekly hours; Z also includes a time trend; Ω_i is only employed in some specifications and represents individual pair fixed effects and Φ_t captures time fixed effects.

[5] In some specifications we vary the number of lags. In some cases this is for contrast, in others, this is because additional lags were uninteresting, as the association between labor market signals and completions tends to taper out and different rates for different variables.

Discussion of Econometric Issues

Given the complexity of the education-labor market relationship as described in Figure 1, as well as the nature of the data we employ in our analysis, there are a number of limitations to our empirical approach. This section attempts to address them ab initio.

A primary concern in our analysis is the issue of sample selection. The education-occupation pairs included in our sample are predominantly composed of occupations which require a high degree of specialized training. In part this is tautological because pairs are only defined where tertiary completions data exists. But, it also results from the fact that matches are much cleaner for occupations requiring a specific skill set for which there is a particular type of training. Focusing on the most robust matches gives us a more accurate picture of the linkages, but limits the degree to which we can generalize of our results. A good example would be college professors, where in most cases a Ph.D is required, or lawyers where in many cases a J.D. is necessary.

Furthermore, for education-occupation pairs in which tertiary education is not required, the post-secondary degree linked to these pairs may only be relevant for a small subset of new hires. For instance, students may obtain specialized degrees as a musician or composer, but clearly not all individuals working as musicians or composers have these degrees. While we might still expect these degree programs to respond to economic incentives, because of the greater disconnect we might expect to see a greater degree of noise in the relationship. This form of sample selection suggests that our findings are more clearly interpreted in relation to specialized degrees and occupations.

Another key concern is the role that occupational switching plays in our analysis. When demand for a specific occupation rises rapidly, if the higher education sector does not respond promptly, some of that demand may be met by individuals switching from other related occupations. Because our focus is predominantly on occupations requiring a higher education degree, this switching is likely limited to individuals in related fields, and the degree of occupational mobility is likely to vary across groups of occupations and degrees. Given this variation, one concern is that the size of the error induced by this effect will vary across pairs and bias the errors in our regressions. In order to account for this, we have created broad occupational categories on which we cluster our standard errors, with clusters for healthcare,

finance, and computer related occupations for example.[6] Their inclusion makes theoretical sense as well, as higher education creates a workforce capable of rapidly and cheaply migrating across occupations and industries.

Omitted variable bias is another possible issue arising in our analysis, as there are a large number of factors going into both an individual's educational choices and the hiring decisions on the labor market side. As a first pass, we include controls from the CPS such as the average share of the occupation that is female, in a union, or self-employed, as well as the average age of individuals in the occupation. In a number of specifications, we include degree-occupation pair fixed effects. Doing so limits our identification to within pair variation over time, and thus helps isolate the effect of labor market signals on completions changes from any factors which may be specific to any given pairing.

Given the idiosyncrasies from year to year among occupation and degree coding schemes, we include year fixed effects to help limit the consequences of any discrete changes in definition and coverage. Furthermore because both completions and the labor market are heavily influenced by the state of the overall macroeconomy and demographic profile of the US they are likely to both be trending up or down over time. To capture this effect, we include a linear time trend as an additional control.

Since we look at completions and not enrollments, one concern is that it is possible that our results are tempered by drop-outs. If the dropout rate for an occupation is systematically positively correlated with labor market signals, i.e. increasing wages lead to increasing drop-outs then it is possible. However, it is more likely that the opposite is true. Graduates opting for another degree enrolment immediately after graduation can also generate noise in the data, but it is difficult to envision a systematic bias that would be large enough to materially affect our results.

A final concern is the likelihood that causality runs in both directions. Specifically, while labor market variables likely influence decisions regarding schooling, the supply of post-secondary educated workers is also likely to impact wages and employment outcomes as well as business decision making. In order to partially alleviate this concern we employ two strategies in the empirics to follow. The first is to employ lagged values for our labor market variables.

[6] We have run the analysis with and without clustered standard errors and the primary results are not dramatically affected.

Contemporaneous completions should not affect previous years' employment or wage growth – though they may be related to previous years completions and those completions may be related to labor market variables in the past. Our second empirical strategy attempts to address this concern through the use of an instrumental variable.

Results

The results from running regression (A) for the full 1984-2008 period are presented in Table 5. In an effort to be parsimonious, we begin the analysis by including a large series of lags up to 10 years, which is possible without greatly sacrificing sample size because of the long time series. Several things stand out. First, historical growth in employment is associated with increases in completions. For instance, from column (1) we observe that an increase in total employment of 100 jobs the previous year is associated with an increase of 8.1 degree completions in the current year and 100 additional jobs two years in the past would be associated with 8.5 degree completions, while this same number of additional jobs seven years ago is associated with 15 additional degree completions today. This effect seems to level off for employment growth about 7 years prior. These results suggest a sizeable lag in the responsiveness of the educational sector to growth in labor market opportunities.

The inclusion of pair fixed effects column 2 attenuates the results, particularly for longer time lags, which in some cases become insignificant. While in almost all cases the coefficients are still positive and we still observe a monotonically increasing trend in size through six lags, results are both smaller and less significant. Pair fixed effects absorb any information specific to individual sets of paired and occupational degrees, so that identification comes from changes in degree completions and absorptions over time. If there is any concern that factors specific to individual occupation-degree pairs may drive the results, the inclusion of pair fixed effects should soak up this idiosyncratic variation.

Columns (3) and (4) examine the relationship between completions and employment demand proxied by a different measure. Specifically, we create an occupational payroll share measure which captures changes in an individual occupation's share of the total US wage bill; the justification being that a change in an occupation's share of the total US wage bill simultaneously reflects both a quantity (change in numbers employed) and a price (change in wgaes) signal. Specifically, in year t for occupation i, $ShareOcc = Emp_{i,t} * Wage_{i,t}$ /

$Emp_{US,t}$*$Wage_{US,t}$.[7] The coefficients on Δ*ShareOcc* presented are positive and significant. In a levels regression, the Δ*ShareOcc* measure is rather awkward to interpret directly, but the coefficient of 61,418 on a 4 year lag of Δ*ShareOcc* suggests that for an increase of .01% in an occupation's share of the total US wage bill, completions would rise by 6,041.[8] The positive coefficients are consistent with the previous findings on absorption and together are suggestive of a slow and imperfect response of the higher education sector to the needs of the labor market. As with absorptions, longer lags in the Δ*ShareOcc* measure appear to be more strongly related to completions growth than more recent lags.

Weighted Least Squares

Some occupation-degree pairs capture much larger shares of total employment than others. While pair fixed effects may partially alleviate this concern, one additional way to address this is to use weighted least squares (WLS) to account directly for variation in the relative size or share of each linked degree and occupation grouping. A simple way to do this is to utilize the total employment of the paired occupations as weights. This weights each pair by its relative share of total employment in the sample.[9]

Results from OLS and WLS regressions are presented in Table 6.[10] Because the coefficients on absorption lags in Table 5 are positive and significant across the board we can gain sample size by limiting the analysis to fewer lags or by focusing on individual lags themselves. Table 6 separately examines absorptions lagged 1, 4, and 7 years. We examine each lag individually in this instance to maintain comparability across OLS, WLS and IV estimates (which we explore in the next section). The coefficients, presented for the WLS regressions are roughly 10% smaller, but the general pattern and significance is similar to those presented for the OLS.

Because the OLS analysis weights all occupation-degree pairs equally, it gives the average relationship between absorption and completions across our subset of occupations. This means it should be interpreted within the context of occupations requiring post-secondary

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[7] The interpretation is perhaps clearer for changes in occupational shares, which we employ in later specifications. Here $\Delta ShareOcc = Emp_{i,t}*Wage_{i,t} - Emp_{i,t}*Wage_{i,t} / Emp_{US,t}*Wage_{US,t} - Emp_{US,t}*Wage_{US,t-1}$ would represent gains or losses in a specific occupation (or set of occupations) share of US demand.

[8] We revisit this measure in a log specification, with regressions presented in Table 9.

[9] Results are largely unaffected by the decision to use a constant weight or allow the weight to vary across years.

[10] Inclusion of pair fixed effects in WLS results does not create sizably different outcomes from OLS either.

education in the US for which there is a rather clear correspondence between degree programs and occupations. The WLS results are similar, but now take into consideration the fact that some pairs represent a larger share of the total US labor force. WLS results therefore are likely to be more representative of the broader sphere of occupations requiring a post-secondary degree in the US as a whole. While both the OLS and WLS results are of interest for their own interpretations, contrasting the two will help to illuminate to what extent individual pairs may be driving the results.

There are two possible explanations for smaller magnitudes in the WLS results than in the OLS. First, WLS estimates will be smaller than the OLS coefficients if larger occupation degree programs are less responsive. This may be the case, as larger occupations may be subjected to a greater amount of regulation. Furthermore, many of these occupations are also more specialized, and there is the possibility that narrower specializations are less responsive for large fixed-cost reasons.

A second and equally distinct possibility is that the smaller degree pairings are more closely matched, implying that there is more noise in the larger and more heavily weighted pairings. This was a concern raised in our earlier discussion of econometric issues. For instance, smaller programs, such as those for chiropractors and dentists, may be more clearly matched to specific degrees, than larger degree programs such as those for chemical engineers. Furthermore, we have argued that completions in nursing are heavily influenced by the above average retirements in nursing in addition to overall labor market absorption. This would introduce a wedge between absorptions and completions. Because nursing is one of the largest parings, this would bias down the WLS coefficients by a larger amount than the OLS as this pair would be weighted more heavily in the WLS regression. If on average larger occupations are also older occupations, this could vary systematically across occupation-degree pairings and drive the WLS coefficients down relative to the OLS.

In order to address this concern we employ a modified version of incremental analysis in which we systematically exclude individual degree pairings (as opposed to individual observations.) There is no clear evidence that any particular pairing is driving the results alone.

Instrumental Variables

A major concern is that lagging our labor market indicators is not sufficient. Because there is a good deal of autocorrelation in both degree completions and in employment and wages, we have to be concerned about reverse causality. To see this, consider a regression of degree completions this year on a four-year lag of employment growth. If degree completions today are a function of degree completions in previous years, and employment is affected by labor supply, then a four- or five-year lag of degree completions will affect both completions today and employment four years prior. One way to circumvent the problem of simultaneity in the relationship between degree completions and labor market outcomes is through the use of an instrumental variable, correlated with our labor market indicators but unrelated to degree completions.

One possible instrumental variable is the level of retirements. Retirements create job vacancies and are largely a function of employment prospects in the distant past as well as demographic trends. They are likely to be related to growth in employment opportunities, but otherwise unrelated to the number of individuals earning a degree directly. The evidence presented in our case studies and in Dohm (2000) suggests that there is a good deal of variation in the rate of retirements across occupations. For instance the average age of nurse practitioners and dentists is higher than that for the workforce as a whole, and these two occupations are experiencing higher-than-average numbers of retirements as the baby-boomers leave the workforce.

While retirements are not directly observable in our data, we do have a range of demographic information for each occupation. One strength of using the MORG sample is that it contains individual characteristics on employees including age. From this information, we can construct a number of measures including average age for a given occupation as well as the share of individuals in an occupation who are of retirement age, i.e. above age 65. As long as individuals are likely to retire at approximately the same age across occupations than we can construct a proxy for overall retirements in a specific occupation in a given year as a function of the share of workers in the occupation of retirement age.[11] Occupations with a large existing stock of workers of retirement age in a given year are more likely to see increased retirements that year and thus have additional job openings and higher market demand. As an instrument for

[11] This is plausible given that we are already limited to a subsample of white collar occupations requiring post-secondary degrees.

labor market absorption, therefore, we employ the share of workers of retirement age for the previous three years to capture both the level and trend in retirements.[12]

Results from running this IV strategy are presented in the final three columns of Table 6. The estimates from OLS and WLS analysis using the same set of occupation-degree pair years are presented in the first six columns. The magnitude of the coefficients on absorption lagged 1, 4, and 7 years are significantly larger when estimated using IV than when estimated by either OLS or WLS. While the IV strategy reduces precision as seen in the larger standard errors, the estimates remain highly significant, and are nonetheless preferable to both the WLS and the OLS outcomes because they circumvent concerns over omitted variables and address the problem of simultaneity mentioned above. These concerns may help explain why the IV approach yields larger coefficients. Reverse causality or omitted variables may be biasing down the OLS and WLS estimates. The key results confirm the general pattern found above, where labor market signals in a given year impact completions several years down the road. While we do not place too much confidence in individual point estimates, the IV results hint that the higher education sector may be more responsive than the OLS and WLS suggest. Point estimates from the IV analysis suggest that an increase of 100 in the level of absorptions in a given year is associated with 55 additional completions 4 years later.

Price and Demand Signals

A student's information on differences in work force prospects across occupations may come purely from a price/wage signal, i.e. in selecting a degree program or majors, individuals may be more heavily influenced by wages than employment opportunities, since the latter is a dispersed and scattered signal. In order to investigate the relationship between wage growth and completions, we estimate the following logarithmic regression:

$$\text{(B)}\ \ln(completions_{it}) = \alpha + \beta_1(\ln(wage_{i,t-\tau})) + \delta_1(Z_{it}) + \Omega_i + \Phi_t + \varepsilon_{it}$$

With the exception of the logarithmic transformation of completions and wages, this is the same regression specification as (A); τ represents lags and varies across specifications; Z is our vector of labor market controls from the occupation-level CPS data. As before, Ω_i represents degree-occupation pair fixed effects and Φ_t time fixed effects.

[12] Results are rather robust to the number of lags included, with additional lagged values increasing the power of the instrument but reducing the overall sample size.

Results from regression (B) are presented in Table 7. Column (1) excludes pair fixed effects. Wage growth is not significant in explaining completions until we include pair fixed effects in column (2), where we see a strong positive association between real wages and completions for shorter time lags. A coefficient of 0.213 in this specification, suggests that when wages rise by 10%, completions in the following year rise by 2.13%. Several differences from the absorption results are worth mentioning. First, in column (2) which includes pair fixed effects, the relationship between wage growth and completions appears strongest for shorter lags instead of the significant longer lags of the previous analysis which implies that students may view wages as a more proximate signal than vacancies. Columns (3) and (4) replicate the result using WLS, with employment for each occupational pair as weights. The results are remarkably similar suggesting that these results are not being driven by the finite degree of pairings we have chosen.

VI: Conclusion

This paper addresses the question of how quickly and effectively the output of the higher education sector - college educated workers - responds to signals from the labor market. Several conclusions can be drawn from the analysis. First, at the aggregate level, growth in employment opportunities and in demand for specific occupations appears to drive increased completions. This relationship operates with a lag, with the strongest association for lags of 4 to 7 years – consistent with time to a college or higher degree. This relationship proved robust to changes in empirical strategy, such as a WLS specification, the inclusion of pair specific fixed effects, and a novel instrumental variables approach.

The evidence on wage growth, a pure price signal, is similar, suggesting that individuals respond to price signals. Interestingly, our results suggest that the response of degree completions to a wage signal may be more proximate than to changes in employment opportunities. Using a proxy for occupation specific demand combining both price and wage signals, we found that occupations with growing shares of the US wage bill were likely to see increased completions. This effect was robust across several specifications and stronger for lags for 4 to 7 years as with absorptions.

A case by case investigation suggested that there is a great deal of heterogeneity in the responsiveness of higher educational degree programs to corresponding occupations. While

several degree programs such as computer science and information technology are highly responsive to labor market outcomes (albeit with a short lag), other degrees such as for medical doctors or doctors of medical dentistry appear largely unresponsive, even in the face of longer term trends.

Our sample constituted a sizeable share of both the US higher education system and the portion of labor market employing college educated workers. Nonetheless, a remaining concern is that our occupation and degree completion pairings may overweight narrower specializations by the very nature of our matching exercise. To the extent that narrower specializations might be more inelastic in their response to labor market needs, because of institutional, financial and personnel related constraints our results might be biased in terms of magnitudes and the lag structure.

Standard theory suggests that increased flexibility and responsiveness of the educational sector could result in substantial welfare gains in the United States. Given the intricacies of higher education, what implications can be drawn for policy? One possible implication of this analysis is that domestic production of post-secondary educated workers is a powerful economic policy tool and has implications for H1B visas and foreign outsourcing. While the H1B program is effectively an education and labor related economic policy in action, the promotion of a greater domestic supply of those educational categories and degrees that correspond to occupations in greater demand domestically can significantly improve welfare and inhibit inequality by improving inter-occupational terms of trade.

Policies and programs which improve the information flow between the labor market and the institutional supply-side would likely lead to welfare gains. Policy measures may include a central corpus of funds for creating slots in specific specializations in institutions of higher learning; or special subsidies for more responsive institutions. If the US wants to continue to foster specific occupations in the domestic marketplace, one solution is to lower barriers to the creation of new specialty schools (increasing supply on an extensive basis), or to create additional incentives for existing institutions to cope with variable or growing enrollment (on an intensive basis). While in the former case there are large fixed cost issues, in the case of the latter policy bumps up against class-size problems and associated negative externalities.

Finally, it is clear from this analysis that future research is still needed. Additional studies should focus on solving the empirical challenges in estimating the causal relationship

between the supply side of higher education in the US at the level of the individual occupation. The US has both an effective, flexible market system for generation of information signals (at the labor market level), and a responsive, public policy establishment (at the higher education level). Our analysis brings them together.

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Table 1: Sample Pairings

Example 1: Licensed Practical Nurses

Census 2k Code	Census 2K Title	Level	CIP CODE	CIP Title
350	Licensed Practical & Licensed Vocational Nurses	Specialty	511613	Licensed Practical Nurse Training (LPN, Cert, Dipl, AAS)

Example 2: Chemists

Census 2k Code	Census 2K Title	Level	CIP CODE	CIP Title
172	Chemists & Materials Scientists	BA	400501	Materials Science
172	Chemists & Materials Scientists	BA	400502	Chemistry, General
172	Chemists & Materials Scientists	BA	400503	Analytical Chemistry
172	Chemists & Materials Scientists	BA	400504	Inorganic Chemistry
172	Chemists & Materials Scientists	BA	400506	Physical & Theoretical Chemistry
172	Chemists & Materials Scientists	BA	400507	Polymer Chemistry
172	Chemists & Materials Scientists	BA	400508	Chemical Physics (New)
172	Chemists & Materials Scientists	BA	400599	Chemistry, Other

Example 3: Speech Therapists

Census 2k Code	Census 2K Title	Level	CIP CODE	CIP Title
314	Audiologists	BA	51.0201	Communication Disorders, General
314	Audiologists	BA	51.0202	Audiology/Audiologist & Hearing Sciences
314	Audiologists	BA	51.0204	Audiology/Audiologist & Speech-Language Pathology/Pathologist
314	Audiologists	BA	51.0299	Communication Disorders Sciences & Services, Other
323	Speech-Language Pathologists	BA	51.0201	Communication Disorders, General
323	Speech-Language Pathologists	BA	51.0203	Speech-Language Pathology/Pathologist
323	Speech-Language Pathologists	BA	51.0204	Audiology/Audiologist & Speech-Language Pathology/Pathologist
323	Speech-Language Pathologists	BA	51.0299	Communication Disorders Sciences & Services, Other

Note: These pairings are a subset of the NCES Occupational Code Crosswalk for CIP 2000. Broad or general Census 2k and CIP codes have been excluded and we have limited matches to specific degree levels.

Table 2: Educational Degree Completions Characteristics

	Full US Sample			*Paired Sample*			*Relative Coverage*		
Year	Total Degree Programs	Total Degree Completions	Completions Per Program	Paired Degree Programs	Total Paired Degree Completions	Completions Per Paired Program	Share of Degree Programs	Share of Total Degrees	Completions Per Degree Program
1984	1009	1991889	1974	389	1604458	4125	38.60%	80.50%	209%
1990	951	2230371	2345	392	1739609	4438	41.20%	78.00%	189%
1995	898	3038517	3384	508	2248731	4427	56.60%	74.00%	131%
2000	890	3059682	3438	501	2370016	4731	56.30%	77.50%	138%
2005	1184	3763953	3179	815	3142914	3856	68.80%	83.50%	121%
2008	1185	4055000	3422	817	3369209	4124	68.90%	83.10%	121%

Source: IPEDS 1984-1999; 2000-2008

Table 3: Employment and Earnings Characteristics

	Full US Sample				Paired Sample				Relative Coverage		
Year	# of Occupations	Employment* Total	Mean Employment* Per Occ.	Mean Real Wage	# of Paired Occupations	Employment* Total	Mean Employment* Per Occ.	Mean Real Wage	Share of Total Occupations	Share of Total Employment	Relative Wage
1984	363	105041	289	$34,513	79	72700	920	$45,874	22%	69%	133%
1990	363	117914	325	$35,973	79	84500	1070	$49,292	22%	72%	137%
1995	362	124900	345	$37,584	79	89900	1138	$51,401	22%	72%	137%
2000	358	135208	378	$40,883	79	103000	1304	$55,655	22%	76%	136%
2005	321	141730	442	$42,075	79	119000	1506	$55,980	25%	84%	133%
2008	321	145362	453	$42,606	79	126000	1595	$56,961	25%	87%	134%

* Figures are in Thousands of Workers
Source: CEPR CPS 1984-2008

Table 4: Occupation Level Sample Characteristics

CPS-IPEDS Sample

Demographics	*Full US CPS Sample*	*Our Paired Sample*
Average Age	39.08	40.40
Share Female	0.46	0.46
Share Married	0.60	0.65
Employment		
Usual Weekly Hours	37.78	38.74
Share Unionized	0.15	0.12
Share Self Employed	0.11	0.12
Share Public Sector	0.15	0.21
Share Paid By Hour	0.60	0.38
Educational Characteristics		
Share <HS Educ	0.12	0.03
Share HS Educ	0.33	0.13
Share Some College	0.28	0.23
Share BA Grad	0.18	0.34
Share Graduate Degree	0.09	0.27

Source: CPS MORG 1984-2008

Table 5: Regression of Completions on Labor Market Variables
CPS MORG Sample 1984-2008

		Dependent Variable: Completions			
Lag	*Coefficient on:*	Absorption	Absorption	ShareOcc	ShareOcc
1 Lag		0.081***	0.01	72,724**	4,788
		-0.019	-0.007	-21,782	-4,433
2 Lags		0.085***	0.016*	53,865***	5,893
		-0.017	-0.007	-15,117	-4,476
3 Lags		0.077***	0.022**	57,567***	13,346*
		-0.009	-0.009	-12,329	-6,147
4 Lags		0.080***	0.024**	61,418***	18,676***
		-0.01	-0.008	-10,191	-5,508
5 Lags		0.095***	0.029***	64,444***	20,763***
		-0.016	-0.007	-16,221	-4,923
6 Lags		0.133***	0.043	90,007***	30,714***
		-0.031	-0.027	-18,222	-5,003
7 Lags		0.151***	0.033	114,690**	42,419*
		-0.024	-0.019	-36,049	-19,123
8 Lags		0.140***	0.023*	118,895**	39,372**
		-0.026	-0.011	-40,366	-16,196
9 Lags		0.152***	0.016*	116,300***	22,469*
		-0.019	-0.008	-32,400	-11,273
10 Lags		0.154**	0.007	93,507***	5,568
		-0.047	-0.013	-22,055	-7,260
CPS Controls		X	X	X	X
Year Fixed Effects		X	X	X	X
Pair Fixed Effects			X		X
Observations		1092	1092	1170	1170
R-squared		0.27	0.96	0.19	0.96

Notes:

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

CPS Controls: Occupational Share (Female, Married, Self Empl., Public Employees, Paid by the Hour, Union Members) as well as average age and a year trend.

Standard errors are clustered at the industry group level (Financial, Science, Engineering, Healthcare, Computer Related and Other).

Table 6: Alternative Specifications, WLS and IV
CPS MORG Sample 1984-2008

	Dependent Variable: Completions								
Variables:	OLS	OLS	OLS	WLS	WLS	WLS	IV	IV	IV
Absorption 1 Lag	0.134***			0.119***			0.644**		
	-0.011			-0.028			-0.259		
Absorption 4 Lags		0.139***			0.122***			0.547**	
		-0.015			-0.032			-0.222	
Absorption 7 Lags			0.275***			0.252***			1.027*
			-0.071			-0.05			-0.451
CPS Controls	X	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X	X
Clustered S.E.	X	X	X				X	X	X
Observations	1716	1482	1248	1716	1482	1248	1716	1482	1248
R-squared	0.12	0.12	0.13	0.09	0.09	0.1			

Notes:

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

CPS Controls: Occupational Share (Female, Married, Self Empl., Public Employees, Paid by the Hour, Union Members) as well as a year trend.

OLS and WLS sample years restricted to match IV (otherwise IV sample limited by an additional year of lag for the instrument).

Standard errors are clustered at the industry group level (Financial, Science, Engineering, Healthcare, Computer Related and Other).

Robust standard errors for WLS cannot be clustered.

Table 7: Regression of Log Completions on Log Wages
CPS MORG Sample 1984-2008

	OLS		WLS	
Variable	(1)	(2)	(3)	(4)
Ln(Real Wage) 1 Lag	0.328	0.213***	0.315	0.222***
	-0.421	-0.082	-0.418	-0.082
Ln(Real Wage) 2 Lags	0.057	0.160**	0.048	0.164**
	-0.495	-0.076	-0.493	-0.076
Ln(Real Wage) 3 Lags	-0.317	0.116	-0.32	0.118
	-0.527	-0.081	-0.524	-0.081
Ln(Real Wage) 4 Lags	0.231	0.072	0.225	0.072
	-0.565	-0.083	-0.563	-0.082
Ln(Real Wage) 5 Lags	-0.452	-0.034	-0.458	-0.038
	-0.537	-0.078	-0.536	-0.078
CPS Controls	X	X	X	X
Year Fixed Effects	X	X	X	X
Pair Fixed Effects		X		X
Observations	1557	1557	1557	1557
R-squared	0.13	0.97	0.13	0.97

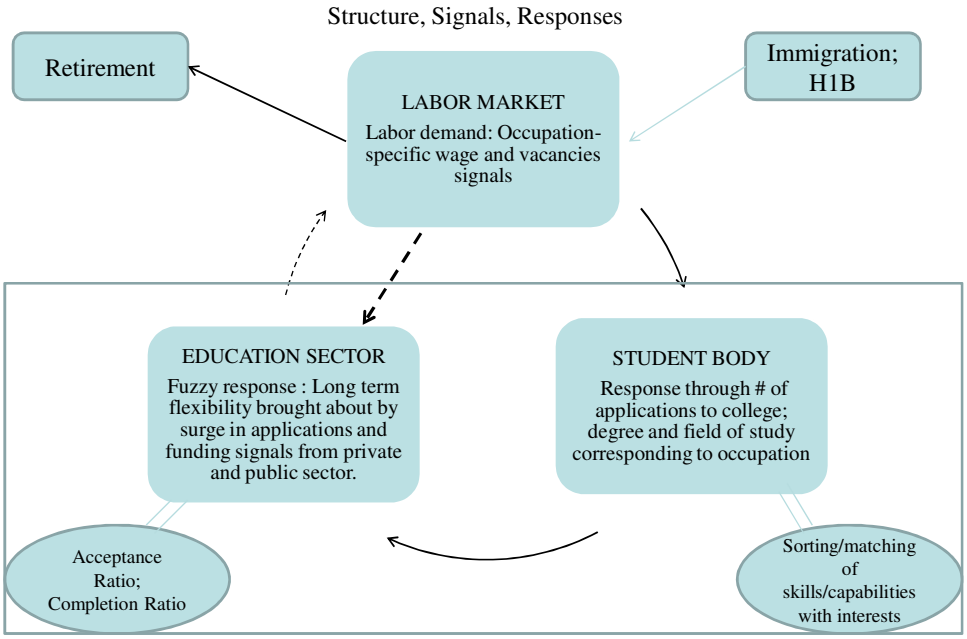
Notes:

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

CPS Controls: Occupational Share (Female, Married, Self Empl., Public Employees, Paid by the Hour, Union Members) as well as average age and a year trend.

Standard errors are clustered at the industry group level (Financial, Science, Engineering, Healthcare,
Computer Related and Other).

Figure 1: Education/Labor Market Linkage



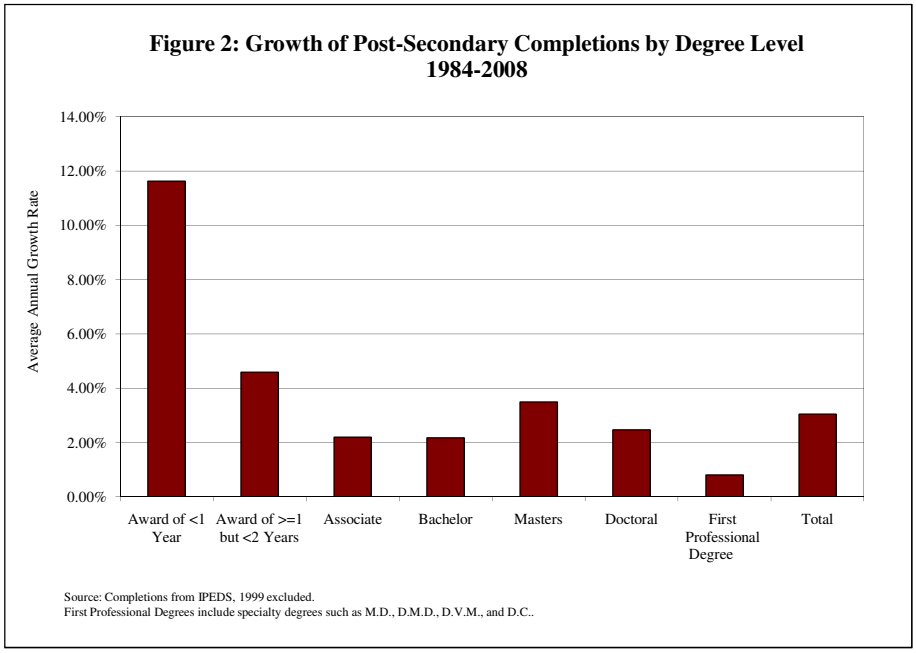
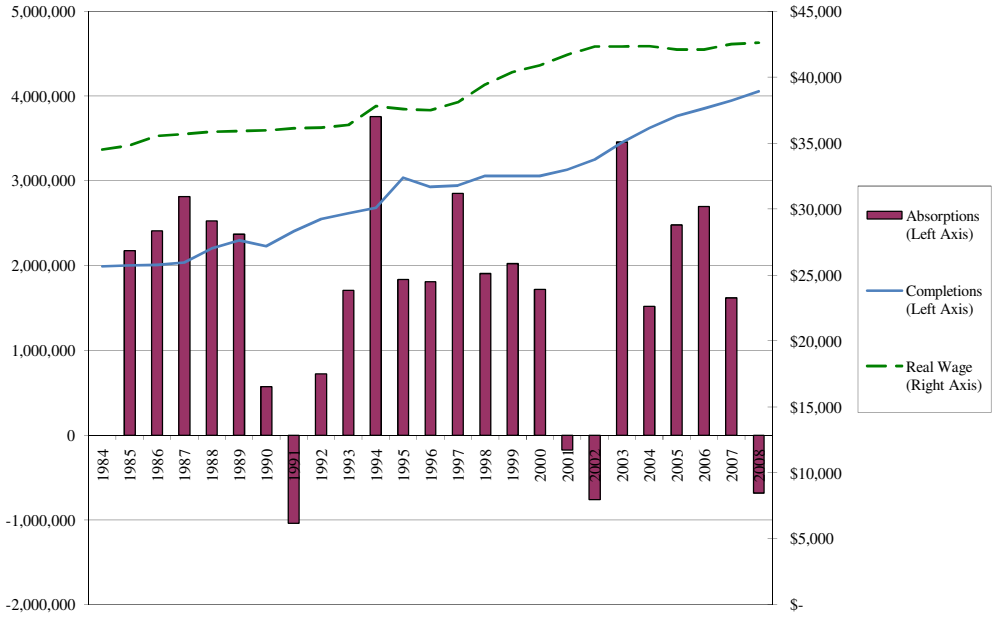


Figure 3: Annual Output of Post-Secondary Degrees, Net Change in Employment and Wages, 1984-2008



Source: Completions from IPEDS, 1999 linearly interpolated. Real wage and absorption data from CEPR CPS ORG extracts. Absorptions are not smoothed.

Figure 4: Correlation of Degree Completions with Labor Market Absorption Including Lags across all Paired Occupations

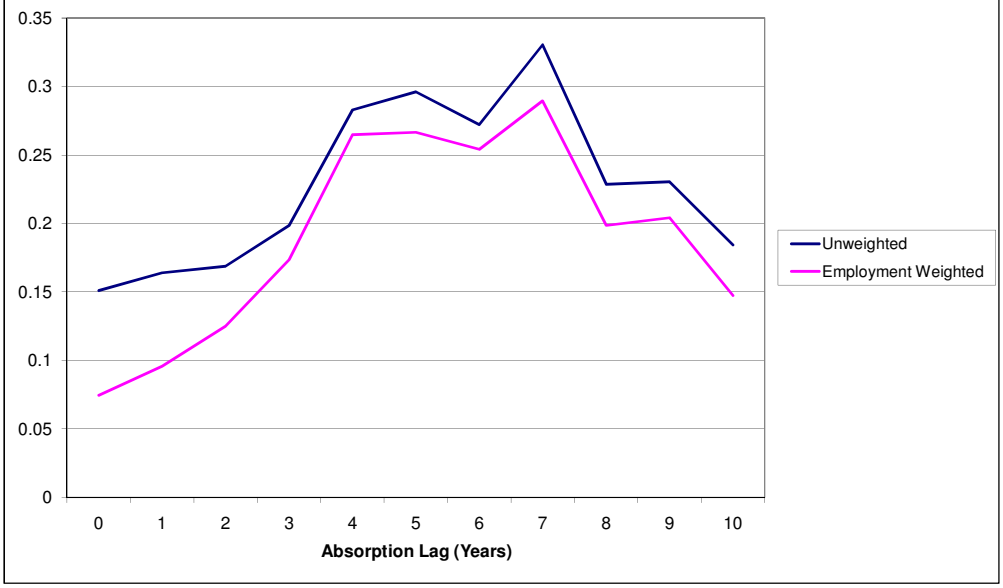
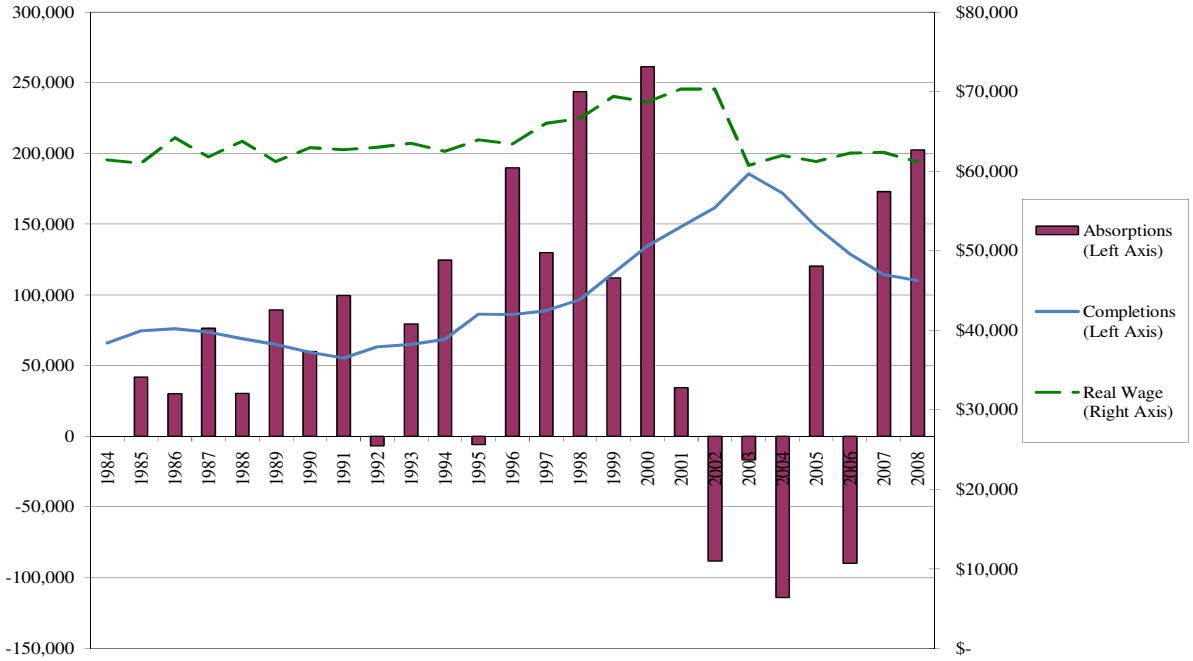


Figure 5: Computer Scientists

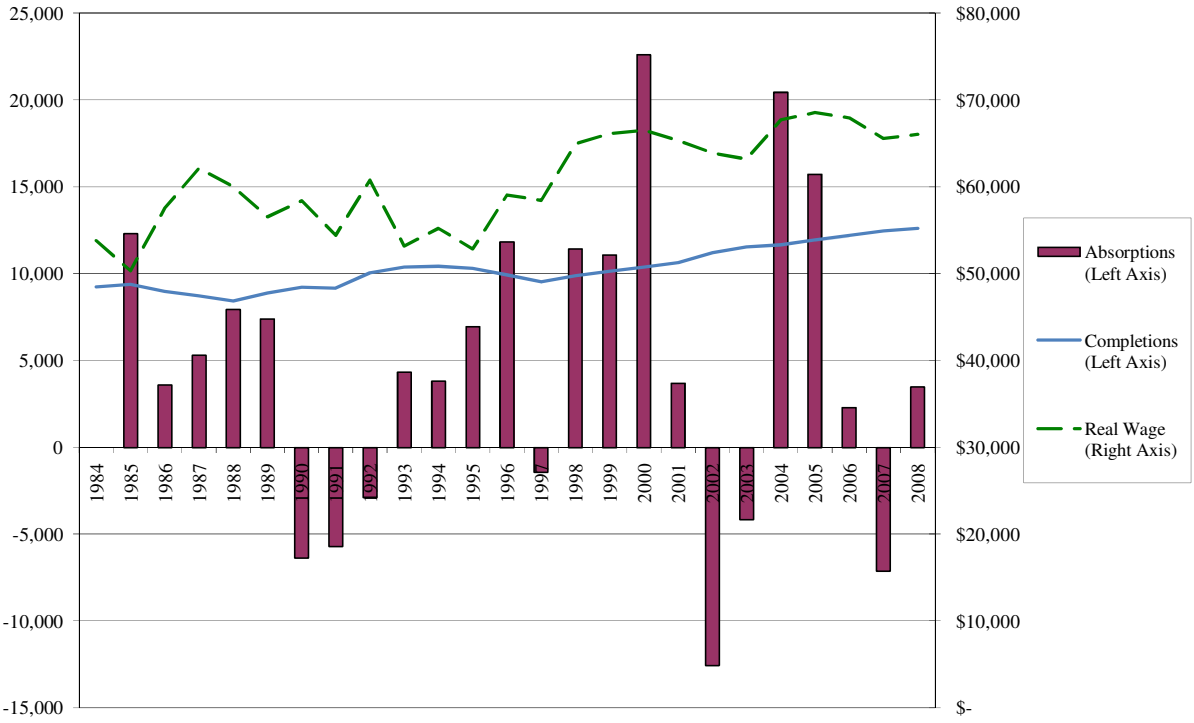
Degree Completions, Employment Changes, and Wages, 1984-2006



Source: Completions from IPEDS, 1999 linearly interpolated. Real wage and absorption data from CEPR CPS ORG extracts. Absorptions are a smoothed using a 3 year moving average.

Figure 6: Architects

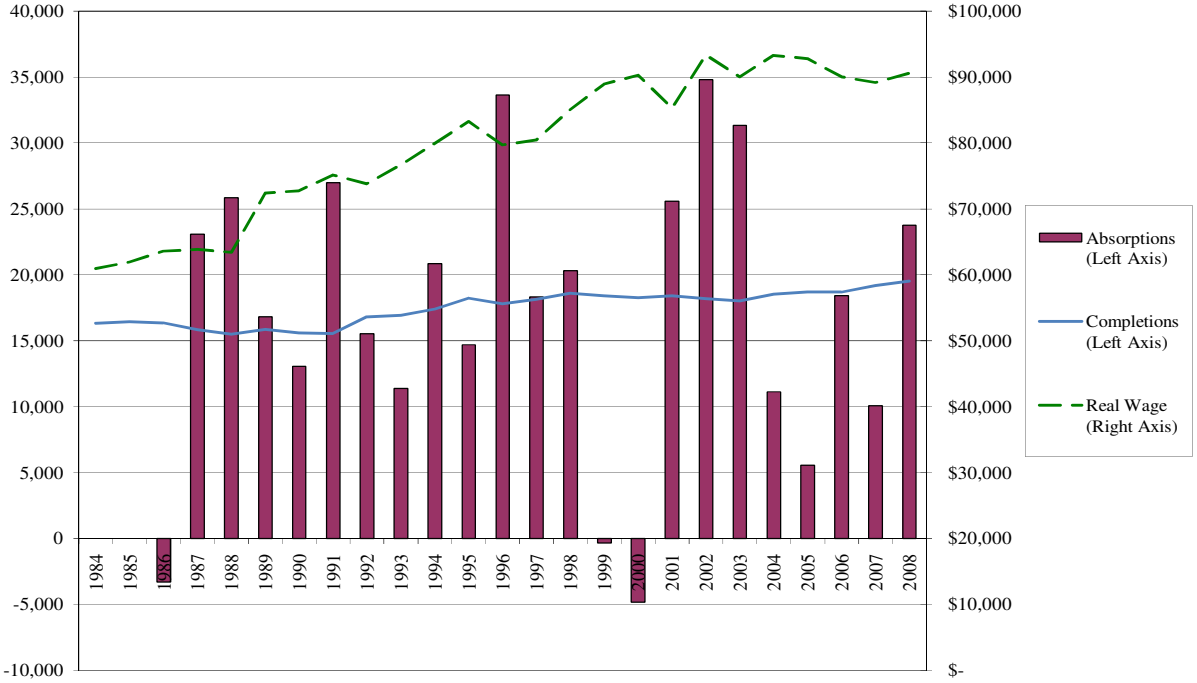
Degree Completions, Employment Changes, and Wages, 1984-2006



Source: Completions from IPEDS, 1999 linearly interpolated. Real wage and absorption data from CEPR CPS ORG extracts. Absorptions are a smoothed using a 3 year moving average.

Figure 7: Physicians

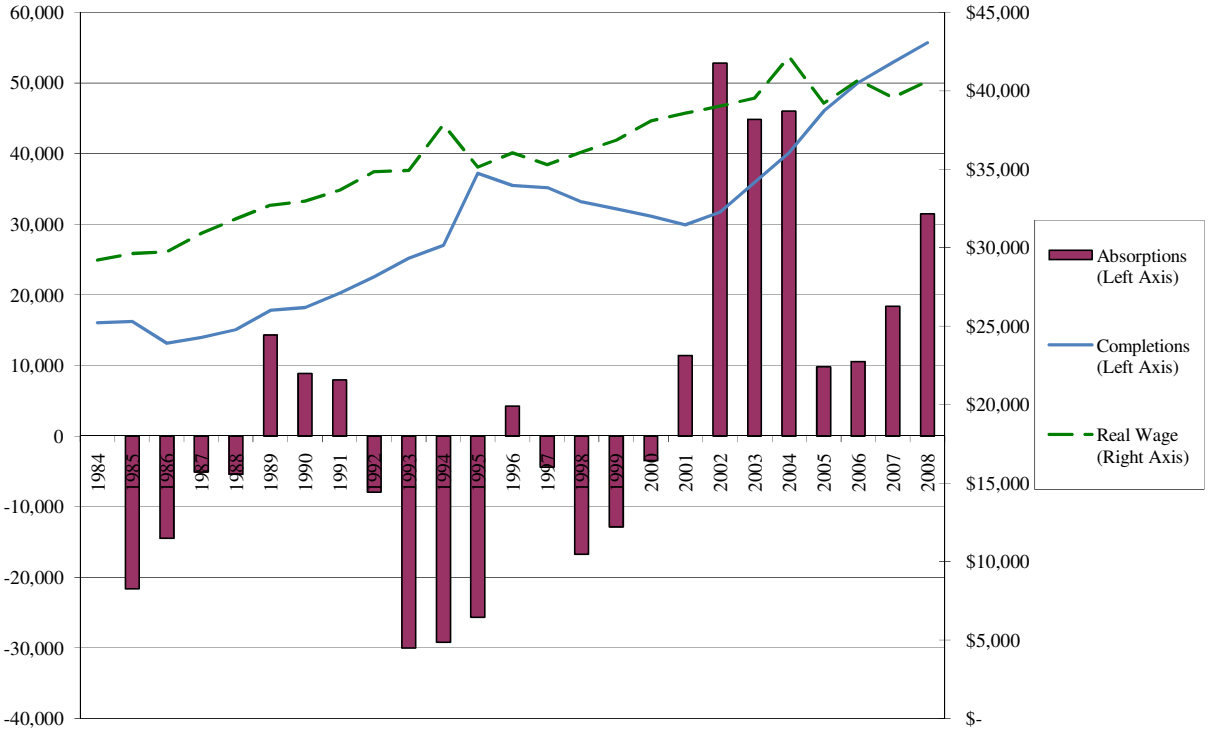
Degree Completions, Employment Changes, and Wages, 1984-2008



Source: Completions from IPEDS, 1999 linearly interpolated. Real wage and absorption data from CEPR CPS ORG extracts. Absorptions are a smoothed using a 3 year moving average.

Figure: 8 Licensed Practical Nurse

Degree Completions, Employment Changes, and Wages, 1984-2008



Source: Completions from IPEDS, 1999 linearly interpolated. Real wage and absorption data from CEPR CPS ORG extracts. Absorptions are a smoothed using a 3 year moving average.