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

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Abstract:

Innovation is often cited as a panacea for the continued competitiveness of the US economy, and the higher education sector is considered vital in developing the productive and dynamic labor force critical for sustaining this innovation. But how effectively does the higher education sector meet the needs of the labor market? We design a crosswalk to match IPEDS data on post-secondary degrees completed in the US between 1984 and 2006 with occupational employment statistics from the BLS and CPS. Analysis reveals a sizeable degree of heterogeneity and lag in the responsiveness of the higher education sector to the needs of industry 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 and supply elasticity 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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Section I: Introduction and Motivation

The last decade has witnessed the emergence and rapid growth of services offshoring on an international scale. Competition increasingly takes place not just between countries or firms, but between individuals. The creation of a single global labor market means that competitive pressures are being felt across a broader range of occupations and workers. Meanwhile, rapid technological growth continues to dictate changes in the occupational mix. The changing nature of competition coupled with an escalating premium on technological skills pose challenges for continued domestic job creation. Accordingly, greater attention is being focused on the higher education sector as a key factor in preparing a dynamic work force capable of coping with these challenges. What kind of workers are needed and what kinds of jobs will be created? How must the higher education sector be positioned so that it fulfills the needs of a labor market in constant flux?

These developments have brought to the forefront concerns over competitiveness, outsourcing, and skill biased technical change. While academic debate continues on many of these issues, there has been a general agreement among researchers and pundits that innovation and higher education are key policy responses to these mounting challenges. Significant attention has therefore been directed towards education reform -- on the composition of subject matter and syllabi, on reforms in pedagogy and teacher training, on techniques and methods in the classroom, and on facilities and equipment in colleges and laboratories. The primary focus of most research and policy (broadly generalized) has thus been issues of quality.

Our primary concern, which has a similar policy resonance, is on how to make the higher education sector more responsive to the needs of a modern labor market in terms of the output *quantities* of particular degrees or field specializations and 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?

This paper is unique in two important ways. 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 employment and wage data from the Bureau of Labor Statistics' (BLS) Occupational Employment Database and the Current Population Surveys' (CPS) Merged Outgoing Rotation Groups. This entails matching the specializations, fields and degrees from the former with detailed occupations in the latter. Second, our analysis focuses directly on the responsiveness of numbers graduated across these pairings (as a result of admission slots created or made available a few years prior) to demand side signals from the labor market.

We employ several strategies to circumvent issues of endogeneity including exploiting an arguably exogenous source of demand variation across occupations, retirement rates, to undertake an instrumental variables approach. Understanding the linkages and lags involved in the response of higher education are important to answering questions on how to improve this relationship. We discuss some potential informational and institutional reforms to make the "supply-side" of higher education more elastic and argue that standard theory suggests this would yield social welfare gains.

Our analysis suggests that the overall system of higher education in the United States is only moderately responsive to labor market signals. Growth in employment opportunities and wages and in demand for specific occupations do appear to drive increased completions. The strength of this association 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, implying that in some cases choices concerning major and field are made prior to enrollment and that there is inertia in major or field choice once enrolled in degree programs. Furthermore, using the detailed linking possible with our paired dataset, 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.

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 mechanism of the post-secondary education sector. The structural elements suggest a model of responsiveness in the following chain of order: i) Prospective students get a labor market signal either in the form of increasing salaries or in the numbers of vacancies for specific occupations through friends and family, the media, or other sources; ii) Motivated by these signals, student demand results in an increase in applications at entry level for "hot" degree programs (similarly, lower applications for "cold" degrees); iii) The relatively unresponsive nature of available slots in post-secondary programs, where the current year's intake is largely dependent on previous years' admissions and a combination of idiosyncratic factors, results in a relatively inelastic, inflexible, short-run supply of skilled labor to individual sectors in the economy; iv) Short-run labor market adjustment is therefore restricted predominantly to a price (wage) adjustment, and to a much lesser degree a quantity (employment) adjustment, as depicted in Figure 2. These adjustments will be moderated to the extent that there is mobility across sectors.

The framework presented in Figure 1 is greatly simplified. Changes in supply can arrive through a number of alternative channels. 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. 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 more 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 a 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."

New York Times, March 29, 2009[1] (emphasis added)

While these are elite universities, the relatively inflexible nature of higher education supply, and the difficulty of easing capacity constraints bedevils all institutions of higher learning.

An inelastic supply of post-secondary degree completions would imply that the terms of trade among occupations, i.e. relative wages, are not necessarily completely determined by either the overall joint skill-interests distribution of the student body, nor by the economy's derived demand for skills.[2] The problem is not necessarily one of market failure but rather one of market or institutional weakness, and 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 benefit of increased responsiveness of the educational sector are potentially quite large and varied. They include more flexible markets leading to more allocative efficiency and lower structural unemployment (search costs), and less aggregate inequality if demand is rapidly increasing for some occupations and not for others. This argument is depicted graphically in Figure 2. 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. 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 (see for example Baker, 2008).

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[1] Steinberg and Lewin (2009)

[2] The inelastic supply refers more accurately to the entry level vacancies in the educational programs; however, to the extent that the dropout rate is not correlated with the specific process of creating additional vacancies, and if one assumes that it does not vary over time as well as discipline in a systematic manner, then we can just as easily talk of completions)

While it may be true that a more responsive and flexible higher education supply would be welfare enhancing and mitigate inequality, it is not our contention that the higher education system should be viewed purely through the lens of the labor market and job creation. 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 societal good with large positive externalities or simply as a basic human right. 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 new industries, technological growth, increased productivity and ultimately promotes an enhanced standard of living.

Section II provides a 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 for the period 1984-2006 and discusses selected individual occupations. Section V presents empirical analysis, and Section VI concludes with some policy lessons.

Section II: Related Literature

This paper focuses on post-secondary education in the US and its response to signals from the labor market. Empirical evidence on the responsiveness of the higher education sector can be found both at the aggregate level and at the level of individual occupations. Within the US, the relationship between higher education and the labor market has been studied extensively by economists and a major focus has been at the level of the individual student. A number of related 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. Another example of this literature is Mattila (1982) who 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 abundant research at the industry level as well. In a key chapter in the *Handbook of Labor Economics*, 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) fits this mold in a theoretical analysis of engineers. The authors 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. Like most of the literature in this field, it focuses on individual choice and enrollments without reference to the fact that observed student interest in a major does not automatically translate into an admission, an actual enrolment, and subsequently a completion.

Our work is similar in spirit, but differs in several key ways. First, we focus on a more disaggregated matching scheme, pairing smaller sets of degrees with an occupation or groups of occupations, rather than broader knowledge categories, and importantly, focuses specifically on the unversity level degree supply mechanism. This allows us to examine case studies in more detail, control for a range of individual characteristics within specific occupations such as average age and union membership status, and provides a larger number of matched pairs in the analysis (up to 140 depending on the specification). Furthermore, having these occupational characteristics allows us to employ an instrumental variable approach. At the same time, our methodology has different limitations. For instance, in addition to concerns over the relative strength of our matches, we are also forced to address occupational switching in more detail, issues we take up further in Section V.

A second major difference is that Freeman and Hirsch focuses 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. This allows us to include a broader set of degree pairings and to look at several industries with a very high degree of occupational specific training such as doctors, lawyers and college professors.

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 footloose services.

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… the invisible hand of individual student and family decisions on the level and type of education to acquire may lead nearer to a social optimum than central governmental decisions based on complex models of educational planning and detailed legislation."

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 and government regulation. 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. As such, the overall determination of the educational system in the US, particularly among lower tier institutions such as community colleges, is left to a greater extent to the "market".

Research suggests that the overall flexibility of the labor market affects the incentive to accumulate different forms of education and thus the structure of higher education in an economy. For instance, Jacob and Weiss (2008) argue that when labor markets are flexible, as in the US, there will be a higher turnover rate 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. This view is echoed by Wasmer (2002) who suggests that a relative lack of job security in the US relative to Europe explains why education in the US tends to focus on general human capital development and why in Europe it is more common for there to be a greater degree of standardization and occupational specificity within the educational system (i.e. vocational education is more common).

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 under different sets of assumptions. While their analysis is not focused solely on post-secondary education, the authors find that in some cases, the costs of educational misallocation are on par with the entire educational budget.

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.

The example and the experience of the higher education system in the former Soviet Union is instructive. There, in a centrally planned econom, students graduated with degrees in a specific job code. Explicitly, there was a formalized, institutionalized crosswalk from degrees and specializations to corresponding occupations and to the number of job vacancies in the economy. 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 completely responsive to the perceived needs of the job market. The problem, of course, was that the perceived needs of the job market turned out to be all wrong. Since the price mechanism was largely absent, or more accurately largely administrative, the derived demand for labor turned out to be distorted. In a more market oriented economy, we have the advantage of taking into account informative signals from the economy at large, reflecting the relative shortages of various skills and occupations. The task is to make the institutional and economic mechanism of supply more effective.

Section III: Data Description

Data Sources

We utilize data from three different sources in our analysis. 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 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 1984-2006, 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.[3]

Occupational employment and wage statistics come from two sources and form two separate samples in our analysis. The first sample is drawn from the Bureau of Labor Statistics' (BLS) Occupational Employment Statistics (OES) database, and contains information over the period 2000-2006 for a broad range of occupations. This data is collected using a semi-annual mail survey of non-farm establishments, and covers employment and wages for all full and part time workers who are paid a salary, excluding self-employed individuals. Occupations are categorized using the 2000 Standard Occupational Classification (SOC) system. This means that estimates from the 1999 OES data and earlier are not directly comparable with later years, and we exclude that information from this sample.

The SOC system classifies occupations based on the following criteria: work performed, skills, education, training, and credentials. It excludes occupations that are uniquely voluntary in nature. Supervisors and team leaders of technical and specialized occupations are classified in the same occupation as their subordinates as long as they spend at least 20% of their time performing similar work. If workers fit the criteria for more than one occupation they are classified in the occupation requiring the highest level of skill to complete.[4]

Data on occupational characteristics, wages, and employment for the period 1984-2006 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 full 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

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[3] Information about the CIP and relevant crosswalks may be obtained from: http://nces.ed.gov/pubs2002/cip2000/

[4] Further information about the SOC is available from http://www.bls.gov/soc/socguide.htm. Generally the SOC coding system is updated during waves of the Census.

for approximately 30,000 individuals. Because individuals in the CPS are reserveyed 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 order to obtain a consistent series of occupations for the period 1984-2006 we employ the Meyer and Osborne (2005) classification scheme for making occupational groups across the 1980 and 2000 census occupational coding schemes comparable. While this limits the number of education/occupation pairs during the 1984-2006 period, it leaves us with occupations which are consistent in their definition and coverage.

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).

Description of Matching/Linking between Educational Specialization and Occupation

The NCES provides a crosswalk between CIP educational program codes and the SOC occupation codes used in the BLS data for over 680 occupations.[5] Some pairs are likely 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, and the likelihood of that degree leading to a different kind of occupation is remote. Because of this, we have narrowed the NCES crosswalk to a selection of roughly 150 matches for which there is a clear correspondence between educational degree program and occupational code in the 2000-2006 BLS sample period and 61 matches over the 1984-2006 CPS period.

During the narrowing process, we systematically excluded those links for which individuals earning a degree could pursue a very wide range of BLS 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 five distinct BLS occupations.[6] The

[5] NCES also provides a crosswalk from CIP to Census 2k Occupational Codes, which we were then able to link to Meyer-Osborne occupational codes for our CPS sample. We describe in detail the process of linking the CIP and BLS data here, but a similar procedure was used to link the CIP and CPS data.
[6] The five BLS occupations are: (1) Natural Sciences Managers; (2) Biological Scientists, All Other; (3) Epidemiologists; (4) Medical Scientists, Except Epidemiologists and (5) Biological Science Teachers,

reason for excluding these matches is twofold – in part because the degree was linked to multiple BLS occupations, and in part because these five 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 industries. For example, individuals earning a degree in funeral service or mortuary science are likely seeking employment in only one of a few specific occupations. For this form of several-to-one matching, some adjustments were made. Where there were multiple matches on the education side, we linked degree and occupation by summing completions across the corresponding degree programs. Similarly, when there were many possible matches on the employment side, we simply summed employment across the relevant occupations. Table A below provides an example of a many-to-many match:

Table A

BLS Code	BLS Title	Level	CIP CODE	CIP Title
11-9061	Funeral Directors	All	12.0301	Funeral Service & Mortuary Science, General
11-9061	Funeral Directors	All	12.0302	Funeral Direction/Service (New)
39-4011	Embalmers	All	12.0301	Funeral Service & Mortuary Science, General
39-4011	Embalmers	All	12.0303	Mortuary Science & Embalming/Embalmer (New)
39-4021	Funeral Attendants	All	12.0301	Funeral Service & Mortuary Science, General

Computation of other important variables, such as the wage for the composite occupation, required additional work. In order to obtain a consistent wage, we employed 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 face after receiving a degree in mortuary science.

Some additional adjustments had to be made to the 2000-2006 BLS sample. Because we focus in this analysis on the responsiveness of the educational sector to the labor market and the

Postsecondary. In this instance, all are plausible occupations for the degree, but likely represent a much broader set of degrees.

BLS sample is limited to such a short time period, we excluded links for which there is likely a large lag between obtaining a degree and later employment in a specific occupation. For instance, we exclude occupations such as CEOs and managers, positions which are more common among certain degrees, but to attain those an individuals often must move up within an organizations. This limitation does not affect our 1984-2006 CPS sample.

Finally, 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. Table B provides an example, where only individuals receiving a Ph.D in a designated number of CIP fields are linked to post-secondary professors of English language and literature. Limiting to one degree level, Ph.D, gives us a more accurate link between a specific degree and an occupation in this case.

Table B

BLS Code	BLS Occupation Title	Level	CIP Code	CIP Title
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	16.0104	Comparative Literature
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.0101	English Language & Literature, General
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.0401	English Composition
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.0501	Creative Writing
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.0701	American Literature (United States)
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.0702	American Literature (Canadian) (New)
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.0801	English Literature (British & Commonwealth)
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.1101	Technical & Business Writing
25-1123	English Language & Literature Teachers, Post-secondary	Ph.D	23.9999	English Language & Literature/Letters, Other

Appendix Tables (1) – (2) contain a complete listing of the occupations pairs in our 2000-2006 BLS-IPEDS sample and our 1984-2006 CPS-IPEDS.

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 1 explores the degree to which our two samples are representative of the US higher education system as a whole. Panel A presents summary statistics from the BLS-IPEDS 2000-2006 sample and Panel B presents statistics for the 1984-2006 CPS-IPEDS sample. Focusing on Panel A, several things stand out. The 140 occupation-degree pairs in the sample actually cover nearly 500 degrees because many pairs contain multiple CIP codes. In this sense, our linking covers roughly half of all degree programs and 40% of the total degrees awarded in the US over the seven year period.

Panel B repeats the exercise for the CPS-IPEDS sample. No completions data was released by the NCES for the year 1999, leaving us with 22 years of data. While there are only 60 linked degree-occupation pairs in this sample, they are broad in scope, accounting for between 363 and 427 CIP degree programs in a given year. While this is a smaller share than the BLS-IPEDS sample, we are still able to capture about 40% of the total universe of post-secondary completions in the US because this sample is weighted more strongly towards the larger degree programs.

The statistics presented in Table 1 also reveal some important trends in higher education in the US over the past two decades. Total completions awarded have nearly doubled, rising from around 2 million a year in 1984 to 3.8 million a year today. Growth in the variety of degree programs offered (or classified by NCES as distinct) has been more modest. Taken together, these facts imply increasing numbers of degrees awarded per degree program on average. The large overall growth in post-secondary completions in the US is consistent with an increasingly educated, and indeed larger population but masks a great deal of heterogeneity across degree programs in terms of growth. These differences are explored in greater detail in Section IV.

The representative nature of our sample and of our linking exercise in terms of labor market characteristics is examined in detail in Table 2. Each sample is divided by panels, as in Table 1. The BLS-IPEDS sample covers one fifth of the entire universe of SOC occupations, but is heavily skewed towards larger and higher paying occupations. Because of this, our sample covers occupations comprising three-fourths of the total working population. Given that most of these occupations entail work requiring a post-secondary education, it is unsurprising that the mean wage in these occupations is about 140% of the US average.

The CPS-IPEDS sample is different for a number of reasons. First, fewer of the Meyer-Osborne occupations could be clearly linked with IPEDS degrees. This results in a sample covering only half of the US working population. In addition, the paired CPS sample is slanted even more heavily towards larger occupations. Like the BLS sample, these occupations typically pay roughly 40% more than the US average. The CPS sample is also a revealing source for macroeconomic patterns over the past 22 years. Total employment has increased from 105 million in 1984 to 144 million in 2006, expanding at a much slower rate than the rate of completions growth. Real wages calculated using the CEPR's (2006) preferred method have expanded from about $32,000 in 1984 to around $40,000 today.

Finally, the richness of the Current Population Survey allows us to paint a picture of our occupational sample in comparison to that of the US as a whole. Table 3 compares occupation level characteristics from the 2000-2006 sample to the full US CPS sample over the same period. Several things are worth mentioning. Workers in our sample are more likely to be female (47% vs. 37%), married (64% vs. 58%), paid by the hour (54% vs. 38%), and work for the government (21% vs. 15%). At the same time, fewer individuals in our sample are unionized or self-employed. As we would hope, a significantly larger share of our sample has a degree higher than a high school diploma - 86% have greater than a high school diploma. This compares with 50% for the US as a whole over the same period. This is important because it suggests that our occupational choices are consistent with requiring 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 matched degrees and occupations, but while it is not our contention that the pairing is infallible, a priori we do anticipate any systematic bias. Where there is likely bias, the nature of the bias is such that a greater share of the narrower, higher specializations are selected, but our results are often neutral to the level of specialization, except where we note explicitly to the contrary.

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 22 years. From 1984-2006, the US population has increased 27%, rising from 235 to 300 million. Meanwhile, annual completions of post-secondary degrees have nearly doubled, as suggested in Table 2, increasing some 97%. This rapid growth masks a great deal of heterogeneity in growth rates along a number of lines. First, the number of graduates has been most rapidly increasing among post-secondary degrees of two years or less (see Figure 3). At the same time, growth of degree completions at the master's and Ph.D levels have outpaced those of bachelor's suggesting that a greater fraction of those who complete college are continuing on further with their education.

Second, the composition of degrees awarded by field has changed rather dramatically over the past two decades. Figure 4 which tracks degrees by major subcategories over the past two decades suggests that some types of degree programs have gained popularity relative to others. For instance, completions growth among business and the humanities have outpaced the fields of natural sciences and computer science and engineering. The decline in relative popularity of computer science and engineering is surprising given rapid growth in computer science education during the tech boom of the 1990s. It is driven by relatively significant declines in most engineering programs. These trends are consistent and likely at the root of the often bemoaned failure of the US higher education system to sustain production of scientists and engineers in recent years. Our CPS-IPEDS 1984-2006 sample allows us to break down these trends in greater detail in the following subsection.

Figure 5 tracks changes in employment, wages and degree completions at the aggregate level from 1984 through 2006. Mean wages and employment in the US have increased over the period, stagnating only briefly during the early 1990s recession and again in 2002-2003. 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. The steady increases in degree completions are suggestive of an inertia in the aggregate labor supply for post-secondary educated workers that is relatively unresponsive to short-term signals of the labor market.

Figure 6 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

Table 4 presents correlation coefficients for specific occupation-degree pairs from the CPS 1984-2006 sample. Some of the strongest correlations are for physician's assistants, insurance adjusters, and computer scientists and some of the weakest are for nursing and health related occupations. While some occupation-degree pairs appear to have a weak correlation 4 years out, they exhibit a stronger relationship when we look at a longer 8 year lag. This is especially true for many health specialists including physicians, optometrists, dentists and podiatrists.

Just how responsive are individual degree programs? One possibility is that US level data appear somewhat 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 7 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 1998 and completions peaking around 2002. This suggests that labor market variables influence the decision to enter a particular program, and that there is a good deal of inertia once the schooling choice has been made. At the level of the individual, this behavior would make sense if the fixed cost of entering or changing programs outweighed the potential gain from changing direction mid-way.

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. Not all degree programs are as responsive. Figure 8 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 or absent growth is a phenomenon that appears to classify a surprisingly sizeable number of common and important degree programs.

Among other occupations, it is unclear that completions are even responsive to long-term signals such as growth in total employment and wages. Figure 9 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 and employment. Growth in demand and employment of doctors in the US has in part been met with to 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 an 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 10 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 widely reported shortage, aggregate 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 industry is likely attributable to attrition. Nursing is classified by the BLS as an aging industry, meaning that because the average age of licensed practical nurses is well above the norm, the need for replacements from retirees is above average.[7]

Why are some degree programs like computer science so responsive and others like MDs rather unresponsive? There are a couple of leading possibilities. The first is that specialist

[7] 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.

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, barriers to entry may play a role. Individuals in many of 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.

A final 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.

These differences are consistent with the available evidence contrasting the US to other educational systems presented in Section II. Specifically, Jacob and Weiss (2008) argue that in situations where less heavily regulated educational institutions exist, they will operate with greater flexibility and responsiveness. In such situations, degrees can be less standardized and the adaptation or creation of community colleges can offer alternative supply sources. Nowhere is this more evident than in the proliferation of community colleges and specialized degree programs related to the US technology boom of the 1990s, a trend which is consistent with our findings from Figure 7.

Section V: Empirical Results and Analysis

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 explores some of these issues in more detail and attempts to address them.

Because of the matching exercise, 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 chemistry professors, where in most cases a Ph.D in chemistry is required.

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 bartender or flight attendant, but not all individuals working as bartenders or flight attendants have these degrees. This suggests that among these pairs, there is likely to be a greater degree of noise in descriptive statistics from year to year. This form of sample selection suggests that our findings are more applicable 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 ε_i. In order to account for this, we have created broad industry categories (sets of related occupations – i.e. healthcare, finance) on which we cluster our standard errors. Our analysis will include results both with and without clustered standard errors. Their presence appears to improve the precision of our coefficient estimates.[8] To the extent that higher education creates a

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

workforce capable of rapidly and cheaply migrating across industries, as suggested by several authors in Section II, the relevant concern for policy shifts from the composition to the total number of degrees.

We run our regressions on two different samples, highlighting the tradeoffs between comprehensiveness and precision of the linkages we faced when constructing pairs of educational degrees and occupations. The first sample is derived from the CPS Merged Outgoing Rotation Groups and covers the period 1984-2006. In order to obtain occupational data which is consistent for the period, we employ the classification scheme of Meyer and Osborne (2005). Because of the long time frame, our number of comparable degree-occupation pairs is limited (to 60), and the occupations in these pairs are broader in scope than those of more recent occupational coding schemes. The second sample is derived from the current BLS occupational employment statistics and covers a wider range of degree-occupation pairs (140), but is only available starting in the year 2000. We run all our empirical analysis on both samples with a few modifications exploiting the strengths of each particular dataset. For example, with the relative length of the CPS MORG sample we have the advantage of being able to employ several years of data to examine the extent to which the education-labor relationship is subject to long lags in the decision making process, while still maintaining a relatively large sample size.

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. Average age of people employed in an occupation is a key determinant of future job demand, and is akin to a proxy for retirement. 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.

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. 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.

Empirical Results

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, to which specific signals does it react? 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 into its root components, 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.[9] 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 represent individual pair fixed effects and Φ_t captures time fixed effects.

The results from running regression (A) for the full 1984-2006 period using CPS data 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 using the CPS sample without greatly sacrificing sample size. Several things stand out. First, growth in employment is associated with nearly monotonic increases in completions each year, up through seven lags, at which point the relationship appears to weaken. 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 5 degree completions in the current year and 100 additional jobs two years in the past would be associated with 5.8 degree completions, while this same number of additional jobs seven years ago is associated with nearly 25 additional degree completions today. 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. While in almost all cases the coefficients are still positive and we still observe a monotonically increasing trend in size through five 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 within specific pairs. 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 variation.

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[9] 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.

Columns (3) and (4) examine the relationship between employment demand as measured by an indicator of occupational demand. Specifically, we create an occupational share measure which captures changes an individual occupations share of the total US wage bill. Specfically, in year t for occupation(s) i, *ShareOcc* = $Emp_{i,t}$*Wagei,t / $Emp_{US,t}$*$Wage_{US,t}$.[10] The coefficients on *ShareOcc* presented are positive but only significant in some cases. In a levels regression, the *ShareOcc* measure is rather awkward to interpret directly, but the coefficient of 48,674 on a 4 year lag of *ShareOcc* suggests that for an increase of .01% in an occupation's share of the total US wage bill, completions would rise by 4,800.[11] Nonetheless, the positive but generally insignificant coefficients are at the very least consistent with the previous findings on absorption and together are suggestive of slow and imperfect response of the higher education sector to the needs of the labor market. Again, as with absorptions, longer lags in the *ShareOcc* measure appear to be more strongly related to completions growth than more recent lags.

We repeated the exercise of running regression (A) on the 2000-2006 BLS sample with 140 education-occupation pairs over this 7 year period. The results are presented in Table 6. There are some similarities to Table 1 and a few notable differences. The lack of a longer time series clearly limits this portion of our analysis. First, in terms of absorptions, we see that an increase of 100 absorptions in the previous year is associated with 12.3 additional completions in the current year. This is larger than the 1 year lag effect from Table 1, but smaller than the lagged results from the longer sample. The coefficients on 2 and 3 lags of completions are insignificant and don't match well with the findings listed above under which longer lags of employment changes had a larger association with completions.[12]

The results from regressing log completions on wage growth are insignificant in columns (3) and (4). Growth in the shift in share measure (Δ*ShareOcc*) however is both positive and strongly significant in all years, suggesting that growth in the demand share of an occupation is positively associated with completions growth, consistent with the findings from the CPS sample, although this finding disappears when pair fixed effects are included in the analysis.

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[10] The interpretation is perhaps clearer for changes in occupational shares, which we employ in later specifications. Here Δ*ShareOcc* = $Emp_{i,t}$*Wagei,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.

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

[12] Given the short time frame of the BLS sample, the inclusion of additional lags results in a relatively large loss in predictive power.

Weighted Least Squares

One concern with the previous analysis is that our results may fail to accurately represent the responsiveness of the higher education sector because each pair is given equal weighting in the OLS analysis. 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.[13]

Results from OLS and WLS regressions are presented in Table 7.[14] 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 7 examines absorptions lagged 1, 4, and 7 years. The coefficients, presented in column (3) are roughly 30% 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 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. 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, both of which may be factors driving the discrepancy. 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 government

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[13] Results are largely unaffected by the decision to use a constant weight or allow the weight to vary across years.
[14] Inclusion of pair fixed effects in WLS results does not create sizeably different outcomes from OLS either.

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 Ph.D English professors, 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.

Instrumental Variables

A major concern is that lagging our labor market indicators is not sufficient to address concerns of simultaneity. 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) suggest 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.[15] Occupations with a large existing stock of workers of retirement age in a given year should have higher levels of retirements that year and thus have additional job openings and higher market demand. As an instrument for 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.[16]

Results from running this IV strategy are presented in the final three columns of Table 7. 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 roughly one and a half to two times larger when estimated using IV than when estimated by either OLS or WLS. Even though the standard errors increase so, IV results are 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 indeed help explain why the IV approach yields larger coefficients. Specifically, reverse causality or omitted variables may be biasing down the OLS and WLS estimates.

Importantly, the key results confirm the general pattern found above, where labor market signals in a given year impact completions several years down the road. Point estimates from the IV analysis suggest that an increase of 100 in the level of absorptions in a given year is

[15] This is plausible given that we are already limited to a subsample of white collar occupations requiring post-secondary degrees.
[16] 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.

associated with 21 additional completions next year, 32 additional completions 4 years hence and with 62 additional completions 7 years later.

Price and Demand Signals

During periods of economic growth, a student's information on differences in work force prospects across occupations may come more from a price signal rather than from employment. In selecting a degree program or majors, individuals may then be more heavily influenced by wages than employment opportunities. In order to investigate the relationship between wage growth and completions, we estimate the following logarithmic regression:[17]

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

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.

Results from regression (B) are presented in Table 8. Column (1) excludes pair fixed effects. Wage growth is marginally significant for a lag of 3, 4 or 5 years. Once we include pair fixed effects in column (2), we see a strong positive association between real wages and completions for shorter time lags. A coefficient of 0.454 in this specification, suggests that when wages rise by 10%, completions in the following year rise by 4.54%. Several differences from the absorption results are worth illuminating. 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 (exclusion of pair fixed effects, column (1) yields the reverse result).

Finally, Table 9 displays results of a regression of log completions on lagged shifts in *ShareOcc*. As with absorptions, increases in demand for a specific occupation appears to drive future completions. A coefficient of 0.232 in column (3) suggests that an increase of .01% in an occupation's share of the total US wage bill would result in a 2.6% increase in completions the following year. The inclusion of pair fixed effects greatly reduces the magnitude of the effect, but does not render the results insignificant. Consistent with the results for absorptions, the

[17] We also estimate the relationship between log completions and changes in ShareOcc, which are more easily interpreted after a logarithmic transformation of the dependent variable.

relationship between degree completions and *ShareOcc* appears stronger for longer lags of around 5 to 7 years.

Section VI: Conclusion

This paper sought to address 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 appear 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. Although less robust than our employment analysis, our wage growth results suggest that the response of degree completions to a wage signal may be more proximate than to changes in employment opportunities. Using an indicator for occupation specific demand, 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.

Our paired dataset with disaggregated data linking specific degree and occupation pairs permitted us to conduct a case by case analysis. This 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.

It is possible that our occupation and degree completion pairings, while constituting a sizeable share of both the US higher education system, as well as the labor market, may be overweight in 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 somewhat biased in terms of magnitudes and the lag structure. The overall general thrust of results, however, would still hold.

Standard theory suggests that increased flexibility and responsiveness of the educational sector could result in substantial welfare gains in the US. 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 substitute for immigration, outsourcing, and trade. While the H1B program is effectively an education and labor related economic policy in action, promotion of a greater domestic supply in those educational categories where supply is restricted, and degrees that correspond to occupations in greater demand domestically can significantly improve welfare and inhibit inequality.

We see evidence of this in that H1B quotas are frequently explicitly determined by lobbying by industry special interests, i.e. ultimately a proxy for demand, with the caveat, however, that industry would like to get "cheaper" labor from abroad. The notional central planner would improve the information channel from the labor market to the supply-side institutional structure. 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, or to create additional incentives for existing institutions to increase enrollment.

A second intimation is that efforts to examine the responsiveness of higher education to the returns to education which do so at the aggregate level should be taken at face value. Individual occupations and degrees appear to exhibit a great deal of heterogeneity in terms of the education supply elasticity to labor market outcomes and findings for one specific occupation and degree pair may lack broad generalizability. 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.

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Table 1: Educational Degree Sample Characteristics

Panel A: BLS-IPEDS Sample

	Full US Sample IPEDS Degree Programs				*Our Paired 2000-2006 BLS-IPEDS Sample*			*Relative Coverage of Paired Sample to Full US*		
	Degree	**Completions**			**Paired**	**Completions**		**Degree**	**Degree Completions**	
Year	**Programs**	**Total**	**Per Degree**	**Std. Dev.**	**Degrees**	**Total**	**Per Degree**	**Programs**	**Per Program**	**Total**
2000	890	3059682	3438	11363	473	1106362	2339	53.1%	68%	36.2%
2001	892	3130374	3509	11767	473	1132976	2395	53.0%	68%	36.2%
2002	892	3252874	3647	12297	473	1154933	2442	53.0%	67%	35.5%
2003	1152	3453070	2997	11529	508	1395716	2747	44.1%	92%	40.4%
2004	1188	3624741	3051	12112	508	1484910	2923	42.8%	96%	41.0%
2005	1184	3763953	3179	12669	508	1515236	2983	42.9%	94%	40.3%
2006	1187	3853063	3246	13038	508	1537049	3026	42.8%	93%	39.9%

Panel B: CPS-IPEDS Sample

	Full US Sample IPEDS Degree Programs				*Our Paired 1984-2006 CPS-IPEDS Sample*			*Relative Coverage of Paired Sample to Full US*		
	Degree	**Completions**			**Paired**	**Completions**		**Degree**	**Degree Completions**	
Year	**Programs**	**Total**	**Per Degree**	**Std. Dev.**	**Degrees**	**Total**	**Per Degree**	**Programs**	**Per Program**	**Total**
1984	1009	1991889	1974	7703	363	918417	2530	36.0%	128%	46.1%
1985	1029	2004285	1948	7680	363	928743	2559	35.3%	131%	46.3%
1986	1015	2008287	1979	7689	363	916965	2526	35.8%	128%	45.7%
1987	954	2036394	2135	7927	365	894183	2450	38.3%	115%	43.9%
1988	951	2201235	2315	8386	379	887249	2341	39.9%	101%	40.3%
1989	954	2296905	2408	9288	365	888273	2434	38.3%	101%	38.7%
1990	951	2230371	2345	8589	365	910956	2496	38.4%	106%	40.8%
1991	951	2408979	2533	9180	379	952801	2514	39.9%	99%	39.6%
1992	891	2549597	2862	10216	403	1037535	2575	45.2%	90%	40.7%
1993	895	2616080	2923	10291	403	1091363	2708	45.0%	93%	41.7%
1994	893	2682879	3004	10456	403	1139101	2827	45.1%	94%	42.5%
1995	898	3038517	3384	10973	403	1226445	3043	44.9%	90%	40.4%
1996	892	2930215	3285	10805	403	1200723	2979	45.2%	91%	41.0%
1997	890	2943023	3307	10923	403	1195292	2966	45.3%	90%	40.6%
1998	898	3058444	3406	10950	403	1207246	2996	44.9%	88%	39.5%
1999 *										
2000	890	3059682	3438	11363	403	1223241	3035	45.3%	88%	40.0%
2001	892	3130374	3509	11767	403	1244502	3088	45.2%	88%	39.8%
2002	892	3252874	3647	12297	403	1267270	3145	45.2%	86%	39.0%
2003	1152	3453070	2997	11529	427	1515401	3549	37.1%	118%	43.9%
2004	1188	3624741	3051	12112	427	1612897	3777	35.9%	124%	44.5%
2005	1184	3763953	3179	12669	427	1651850	3869	36.1%	122%	43.9%
2006	1187	3853063	3246	13038	427	1681022	3937	36.0%	121%	43.6%

Source: IPEDS 1984-1999; 2000-2006
Full US sample includes post-secondary completions at all degree levels.

* NCES did not release completions data for 1999

Table 2: Employment and Earnings Sample Characteristics

Panel A: BLS-IPEDS Sample

	Full US Sample BLS Occupational Employment Stats				*Our Paired 2000-2006 BLS-IPEDS Sample*				*Relative Coverage of Paired Sample to Full US*		
	# of	**Employment**		**Mean**	**Paired**	**Employment**		**Mean**	**Employment Share**		**Relative**
Year	**Occs**	**Total**	**Mean**	**Wage**	**Occs**	**Total**	**Per Occ**	**Wage**	**Occs**	**Total**	**Wage**
2000	711	121,021,727	170,213	$38,041	153	90,065,486	588,663	$52,369	21.5%	74.4%	138%
2001	710	119,952,441	168,947	$39,351	153	90,591,718	592,103	$54,074	21.5%	75.5%	137%
2002	711	119,619,635	168,241	$41,216	153	90,952,512	594,461	$57,972	21.5%	76.0%	141%
2003	711	120,191,919	169,046	$42,011	153	91,215,922	596,182	$59,146	21.5%	75.9%	141%
2004	802	128,248,863	159,911	$43,838	153	93,144,086	608,785	$60,963	19.1%	72.6%	139%
2005	799	130,370,273	163,167	$45,025	153	95,027,394	621,094	$62,609	19.1%	72.9%	139%
2006	800	132,674,640	165,843	$46,592	153	97,055,266	634,348	$64,911	19.1%	73.2%	139%

Panel B: CPS-IPEDS Sample

	Full US Sample BLS Occupational Employment Stats				*Our Paired 2000-2006 BLS-IPEDS Sample*				*Relative Coverage of Paired Sample to Full US*		
	# of	**Employment**		**Real**	**Paired**	**Employment**		**Real**	**Employment Share**		**Relative**
Year	**Occs**	**Total**	**Mean**	**Wage**	**Occs**	**Total**	**Per Occ**	**Wage**	**Occs**	**Total**	**Wage**
1984	363	105,041,076	289,369	$32,732	61	46,200,000	757,377	$43,765	16.8%	44.0%	134%
1985	363	107,218,797	295,369	$33,136	61	46,800,000	767,213	$44,367	16.8%	43.6%	134%
1986	363	109,628,107	302,006	$33,813	61	48,000,000	786,885	$45,460	16.8%	43.8%	134%
1987	363	112,441,779	309,757	$34,101	61	49,100,000	804,918	$46,246	16.8%	43.7%	136%
1988	363	114,970,476	316,723	$34,352	61	50,200,000	822,951	$47,449	16.8%	43.7%	138%
1989	363	117,342,277	323,257	$34,523	61	52,000,000	852,459	$48,181	16.8%	44.3%	140%
1990	363	117,914,227	324,833	$34,614	61	53,200,000	872,131	$48,492	16.8%	45.1%	140%
1991	363	116,877,300	321,976	$34,588	61	53,800,000	881,967	$48,263	16.8%	46.0%	140%
1992	362	117,598,468	324,858	$34,661	61	54,800,000	898,361	$48,631	16.9%	46.6%	140%
1993	362	119,306,782	329,577	$34,960	61	56,200,000	921,311	$49,785	16.9%	47.1%	142%
1994	362	123,061,469	339,949	$36,855	61	54,600,000	895,082	$51,346	16.9%	44.4%	139%
1995	362	124,899,752	345,027	$36,760	61	56,200,000	921,311	$51,541	16.9%	45.0%	140%
1996	358	126,707,581	353,932	$36,770	61	57,400,000	940,984	$51,443	17.0%	45.3%	140%
1997	359	129,557,938	360,886	$37,386	61	59,400,000	973,770	$51,850	17.0%	45.8%	139%
1998	359	131,463,456	366,193	$38,783	61	60,400,000	990,164	$53,696	17.0%	45.9%	138%
1999	359	133,488,031	371,833	$39,658	60	62,400,000	1,040,000	$55,038	16.7%	46.7%	139%
2000	358	135,208,126	377,676	$40,230	61	63,300,000	1,037,705	$56,190	17.0%	46.8%	140%
2001	358	135,035,861	377,195	$40,850	61	64,700,000	1,060,656	$56,073	17.0%	47.9%	137%
2002	358	134,277,879	375,078	$41,314	61	65,000,000	1,065,574	$57,125	17.0%	48.4%	138%
2003	321	137,735,805	429,084	$37,091	61	72,500,000	1,188,525	$49,292	19.0%	52.6%	133%
2004	321	139,251,986	433,807	$37,158	61	74,000,000	1,213,115	$49,754	19.0%	53.1%	134%
2005	321	141,729,658	441,525	$37,084	61	75,900,000	1,244,262	$49,219	19.0%	53.6%	133%
2006	321	144,427,081	449,929	$37,218	61	76,800,000	1,259,016	$49,491	19.0%	53.2%	133%

Source: BLS, CEPR CPS, and IPEDS
Occupations in BLS-IPEDS classified according to 2000 SOC. Occupations in CPS-IPEDS classified using Meyer (date).
Full US Sample includes all (A) SOC Occupation Codes or (B) Meyer Occupational Codes.

Table 3: Occupation Level Sample Characteristics

CPS-IPEDS Sample

	Full US All CPS Occupations		*Our Paired 1984-2006 CPS-IPEDS Sample*		*Relative Coverage of Paired Sample to Full US*	
Variable Name	**Mean**	**SD**	**Mean**	**SD**	**Ratio of Means**	**T-Stat**
Share Female	0.37	0.29	0.47	0.29	127%	8.87
Average Age	40.56	4.72	41.35	3.57	102%	4.68
Share Married	0.58	0.15	0.64	0.11	110%	10.36
Usual Weekly Hours	39.79	4.91	39.78	4.54	100%	-0.08
Share Unionized	0.13	0.16	0.11	0.12	84%	-3.90
Share Self Employed	0.10	0.15	0.08	0.15	87%	-1.72
Share Public Sector	0.15	0.23	0.21	0.21	140%	6.56
Share Seasonal	0.00	0.01	0.00	0.01	133%	2.99
Share Paid By Hour	0.38	0.27	0.54	0.28	139%	14.40
Share <12 Years Educ	0.12	0.14	0.02	0.05	21%	-19.48
Share HS Grad	0.31	0.19	0.13	0.13	41%	-26.12
Share Some College	0.28	0.15	0.27	0.22	97%	-1.54
Share BA Grad	0.19	0.18	0.27	0.19	146%	13.43
Share Graduate Degree	0.10	0.18	0.30	0.32	304%	21.47

Source: CPS MORG 2000-2006
Mean denotes the share for all variables except average age and usual weekly hours.

Table 4: Correlation Between Completions and Lagged Absorptions by Occupation, 1984-2006

Occupations	Absorption Lag	
Strongest Positive Correlations	**4 Year**	**8 Year**
Physicians' assistants	0.81	0.57
Insurance adjusters, examiners, and investigators	0.72	0.83
Computer systems analysts and computer scientists	0.60	0.18
Aerospace engineer	0.55	0.46
Funeral directors	0.43	-0.02
Electrical engineer	0.34	0.15
Weakest Correlations	**4 Year**	**8 Year**
Licensed practical nurses	0.06	0.09
Speech therapists	0.06	0.00
Urban and regional planners	0.02	-0.15
Health aides, except nursing	0.01	-0.05
Biological scientists	-0.01	-0.04
Health record tech specialists	-0.02	-0.04
Selected Occupations	**4 Year**	**8 Year**
Pharmacists	0.22	-0.11
Registered nurses	0.21	-0.30
Accountants and auditors	0.17	0.06
Electricians	0.17	0.34
Physicians	0.15	0.29
Optometrists	0.14	0.26
Dentists	0.13	0.23
Podiatrists	-0.07	0.15
Lawyers	-0.12	0.10
Veterinarians	-0.17	0.26
Architects	-0.21	-0.07
Average among all paired occupations	**0.28**	**0.23**

Source: 1984-2006, CPS MORG-IPEDS Sample.

Table 5: Regression of Completions on Labor Market Variables
CPS MORG Sample 1984-2006

Lag	*Coefficient on:*	Dependent Variable: Completions Absorption	Absorption	ShareOcc	ShareOcc
1 Lag		0.0503**	-0.00131	14322	-5195
		(0.0156)	(0.00259)	(18231)	(2617)
2 Lags		0.0583***	0.00920**	20964	-6754
		(0.0115)	(0.00313)	(22275)	(3484)
3 Lags		0.0613***	0.0203*	19593	5657*
		(0.0139)	(0.00997)	(22404)	(2478)
4 Lags		0.118**	0.0591	48674*	19512***
		(0.0412)	(0.0482)	(23065)	(2881)
5 Lags		0.107*	0.0618	138892*	68584
		(0.0445)	(0.0488)	(58660)	(37248)
6 Lags		0.177**	0.0450	98515	65451
		(0.0479)	(0.0328)	(81202)	(43442)
7 Lags		0.248**	0.0371	133262*	48062
		(0.0840)	(0.0186)	(64378)	(30558)
8 Lags		0.121**	0.0198	129021**	29893
		(0.0359)	(0.0158)	(48556)	(16396)
9 Lags		0.120**	0.0162	53962	14704
		(0.0410)	(0.0156)	(57313)	(10730)
10 Lags		0.0721**	0.0121	38749	3044
		(0.0215)	(0.0188)	(38036)	(8885)
CPS Controls		X	X	X	X
Year Fixed Effects		X	X	X	X
Pair Fixed Effects			X		X
Observations		624	624	674	674
R-squared		0.393	0.973	0.200	0.973

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: Regression of Completions on Labor Market Variables
BLS Sample 2000-2006

	Dependent Variable:					
Variables:	Comp	Comp	ln(Comp)	ln(Comp)	Comp	Comp
Absorption 1 Lag	0.123***	0.0181***				
	(0.0321)	(0.00467)				
Absorption 2 Lags	0.00871	0.00607				
	(0.0325)	(0.00706)				
Absorption 3 Lags	-0.0450	-0.00496				
	(0.0648)	(0.0134)				
Wage Growth 1 Lag			2.983	0.276		
			(2.545)	(0.357)		
Wage Growth 2 Lags			-0.827	0.285		
			(3.218)	(0.308)		
Wage Growth 3 Lags			-2.138	-0.317		
			(2.316)	(0.268)		
Shareocc Chg 1 Lag					2612***	-263.2
					(999.3)	(684.5)
Shareocc Chg 2 Lags					1106*	-52.00
					(637.6)	(116.3)
Shareocc Chg 3 Lags					1551**	70.80
					(751.9)	(224.8)
Pair Fixed Effects		X		X		X
CPS Controls	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X
Observations	391	391	518	518	518	518
R-squared	0.298	0.993	0.112	0.994	0.330	0.985

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.

Table 7: Alternative Specifications, WLS and IV
CPS MORG Sample 1984-2006

	Dependent Variable: Completions								
Variables:	OLS	OLS	OLS	WLS	WLS	WLS	IV	IV	IV
Absorption 1 Lag	0.0953***			0.0642***			0.213**		
	(0.0227)			(0.0239)			(0.0758)		
Absorption 4 Lags		0.250*			0.176***			0.327*	
		(0.115)			(0.0591)			(0.129)	
Absorption 7 Lags			0.344*			0.255***			0.624*
			(0.153)			(0.0534)			(0.256)
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	X	X	X
Observations	1085	936	789	1085	936	789	679	679	679
R-squared	0.096	0.148	0.179	0.087	0.117	0.144	0.058	0.137	0.109

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 8: Regression of Log Completions on Log Wages CPS MORG Sample 1984-2006

Variable	(1)	(2)	(3)
Ln(Real Wage) 1 Lag	0.239	0.454***	0.426**
	(0.537)	(0.100)	(0.123)
Ln(Real Wage) 2 Lags	-0.343	0.314**	0.253
	(0.552)	(0.119)	(0.142)
Ln(Real Wage) 3 Lags	0.824**	0.217*	0.0547
	(0.310)	(0.107)	(0.0662)
Ln(Real Wage) 4 Lags	0.616*	0.151	0.111
	(0.255)	(0.126)	(0.181)
Ln(Real Wage) 5 Lags	0.666***	0.0885	0.0274
	(0.118)	(0.120)	(0.161)
Ln(Real Wage) 6 Lags			0.155
			(0.148)
Ln(Real Wage) 7 Lags			0.0104
			(0.0452)
Ln(Real Wage) 8 Lags			0.0831
			(0.0676)
CPS Controls	X	X	X
Year Fixed Effects	X	X	X
Pair Fixed Effects		X	X
Observations	935	935	788
R-squared	0.241	0.958	0.967

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 9: Regression of Log Completions on ShareOcc Measure CPS MORG Sample 1984-2006

	Dependent Variable: Ln(Completions)			
Variable	(1)	(2)	(3)	(4)
ShareOcc_Chg 1 Lag	1.586*	0.928	0.232*	0.312**
	(0.690)	(0.847)	(0.108)	(0.0879)
ShareOcc_Chg 2 Lags	1.813	1.211	0.216	0.240*
	(0.927)	(0.908)	(0.163)	(0.101)
ShareOcc_Chg 3 Lags	1.829*	0.956	0.230	0.206
	(0.897)	(0.670)	(0.129)	(0.126)
ShareOcc_Chg 4 Lags	1.738*	0.852	0.253*	0.257**
	(0.828)	(0.758)	(0.102)	(0.0905)
ShareOcc_Chg 5 Lags		3.969***		0.916**
		(0.763)		(0.269)
ShareOcc_Chg 6 Lags		5.124**		0.953***
		(1.383)		(0.234)
ShareOcc_Chg 7 Lags		4.395**		0.936***
		(1.349)		(0.104)
ShareOcc_Chg 8 Lags		3.076**		0.475***
		(1.144)		(0.0651)
CPS Controls	X	X	X	X
Year Fixed Effects	X	X	X	X
Pair Fixed Effects			X	X
Observations	980	784	980	784
R-squared	0.225	0.257	0.955	0.967

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

a) Linkages Between Labor Market and the Higher Education Complex: Structure, Signals, Responses

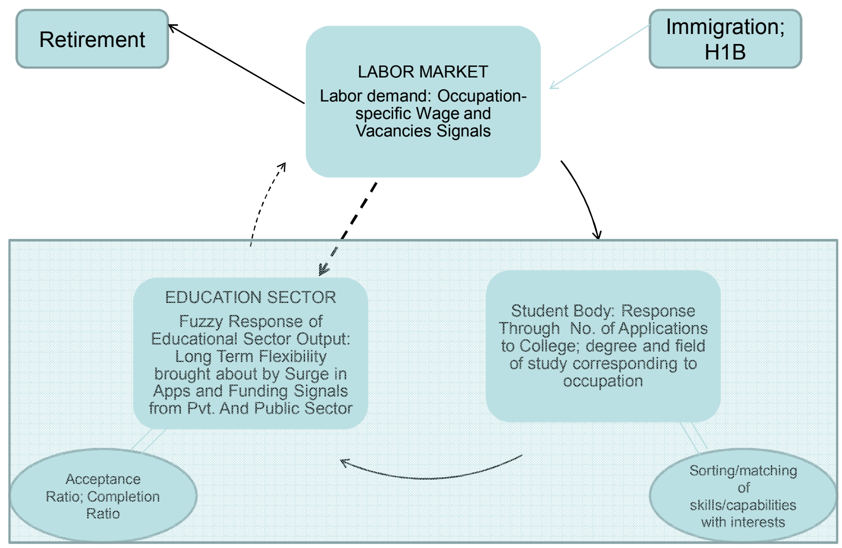


Figure 2: Welfare and Labor Supply Elasticity

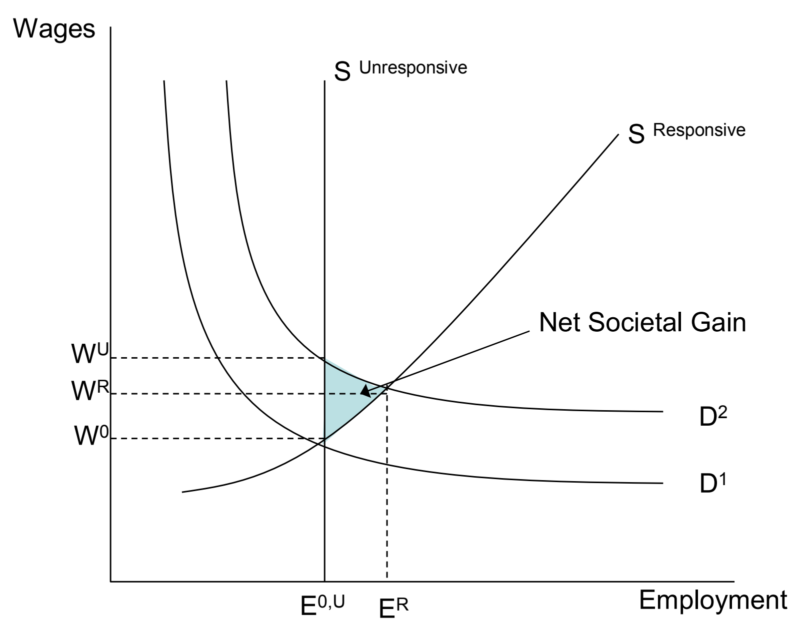
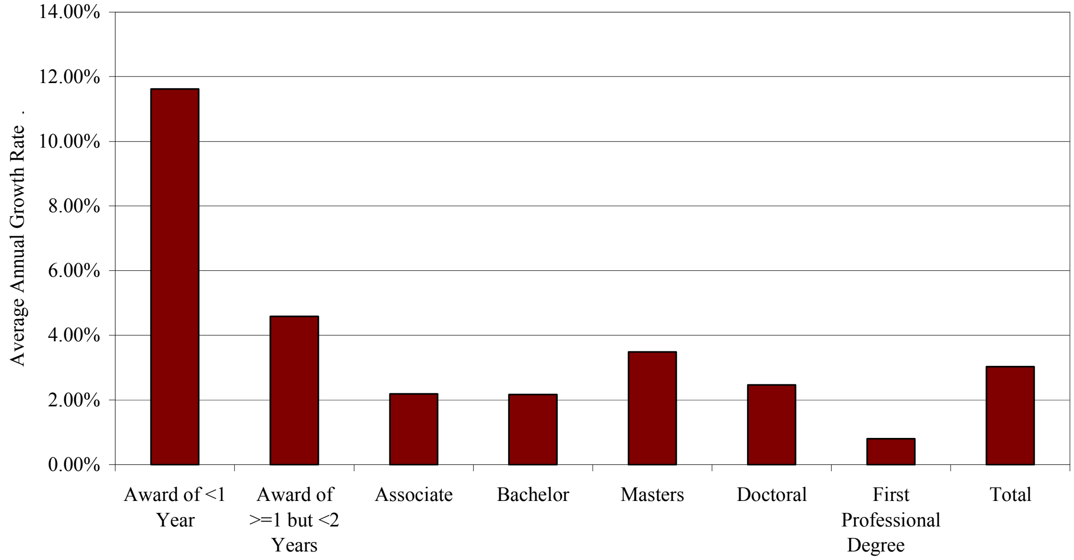
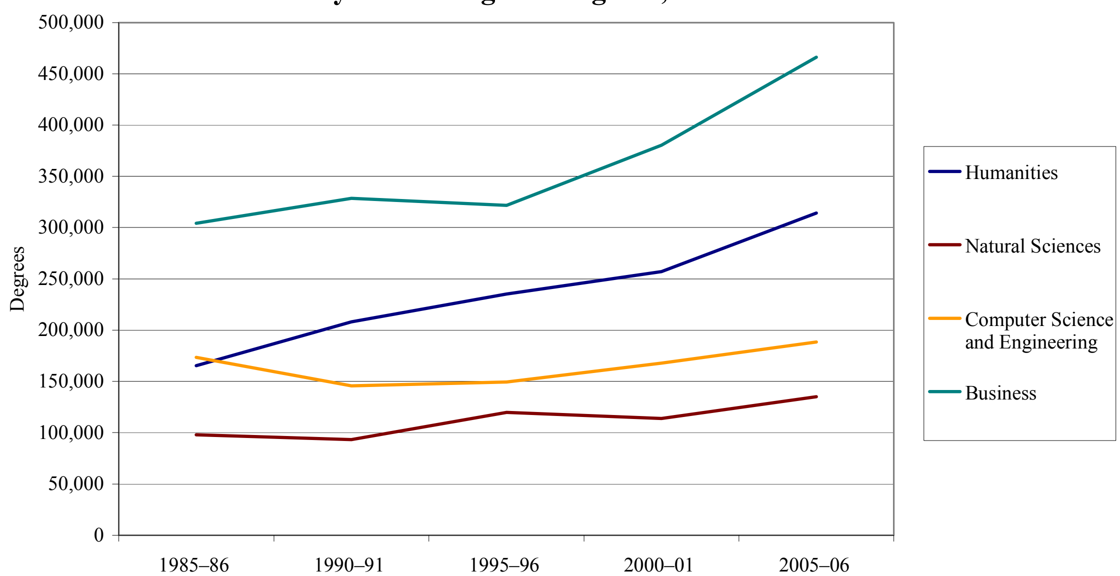


Figure 3: Growth of Post-Secondary Completions by Degree Level, 1984-2006

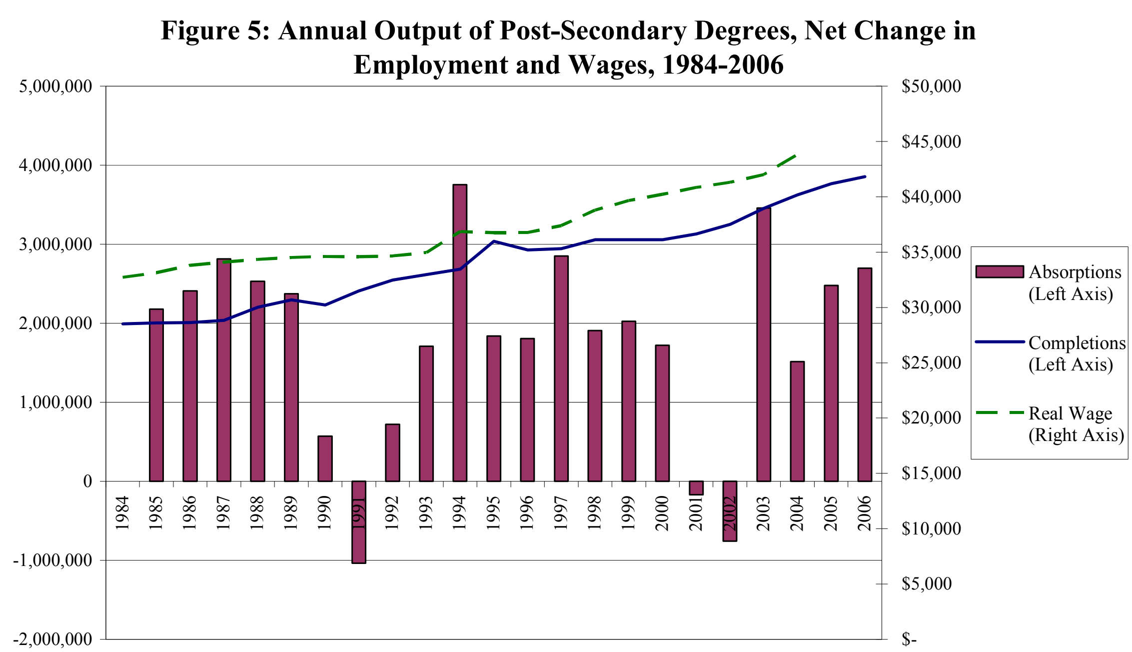


Source: Completions from IPEDS, 1999 excluded.
First Professional Degrees include specialty degrees such as M.D., D.M.D., D.V.M., and D.C..

Figure 4: Post-Secondary Degrees Conferred by Broad Degree Program, 1984-2006



Source: National Center for Economic Statistics, Digest of Education Statistics, Various Years



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

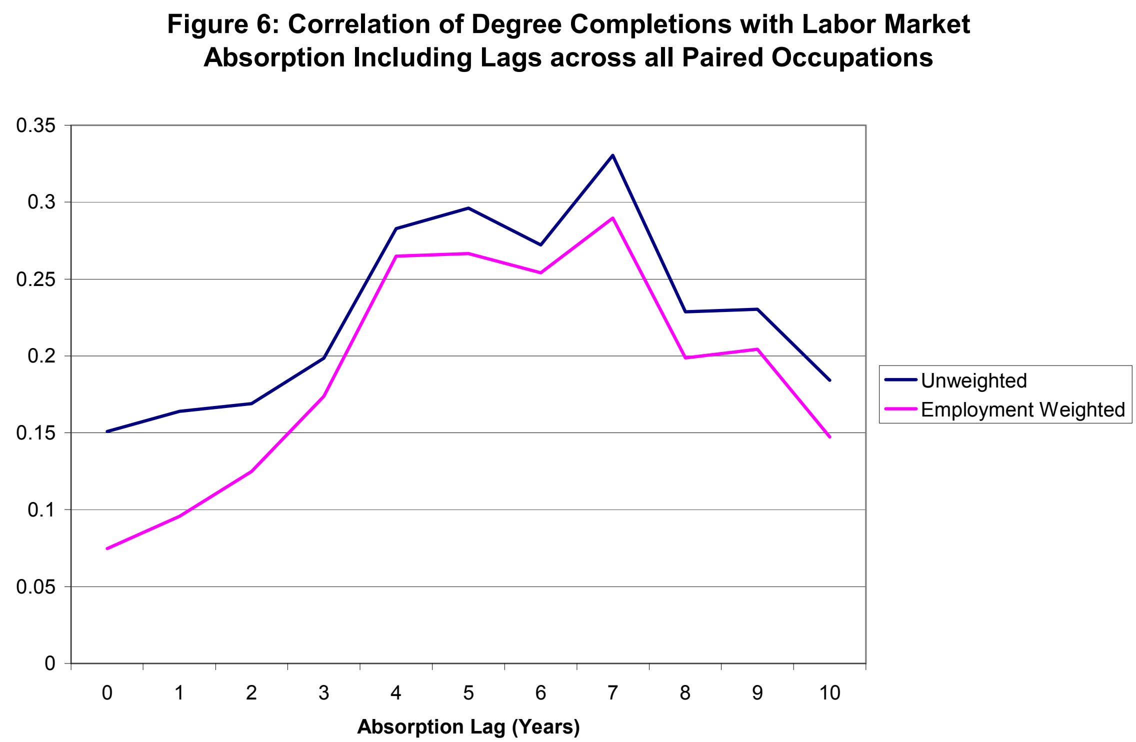
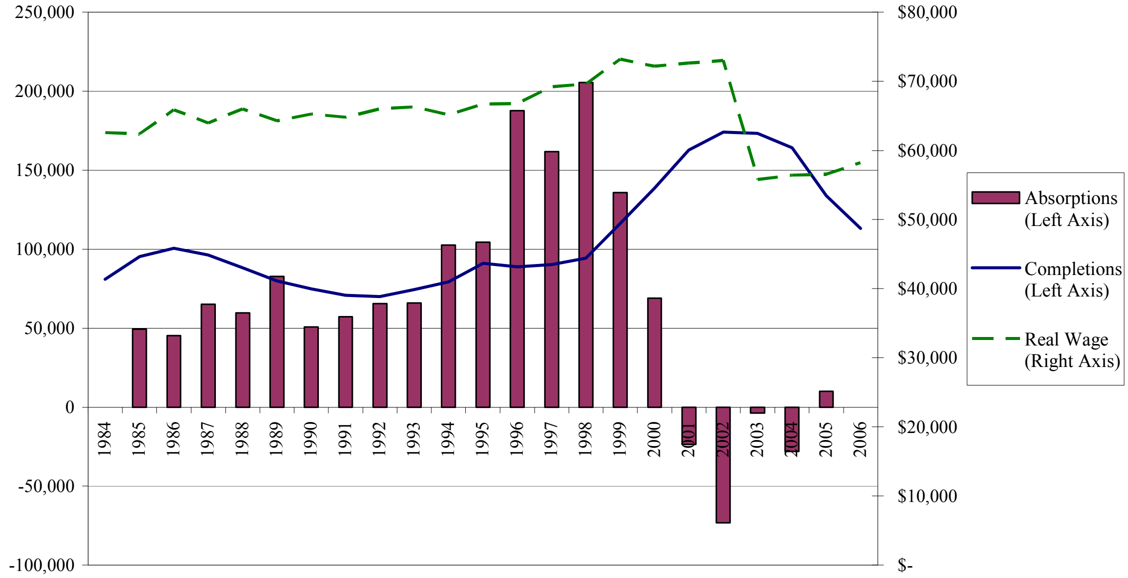


Figure 7: Computer Scientists

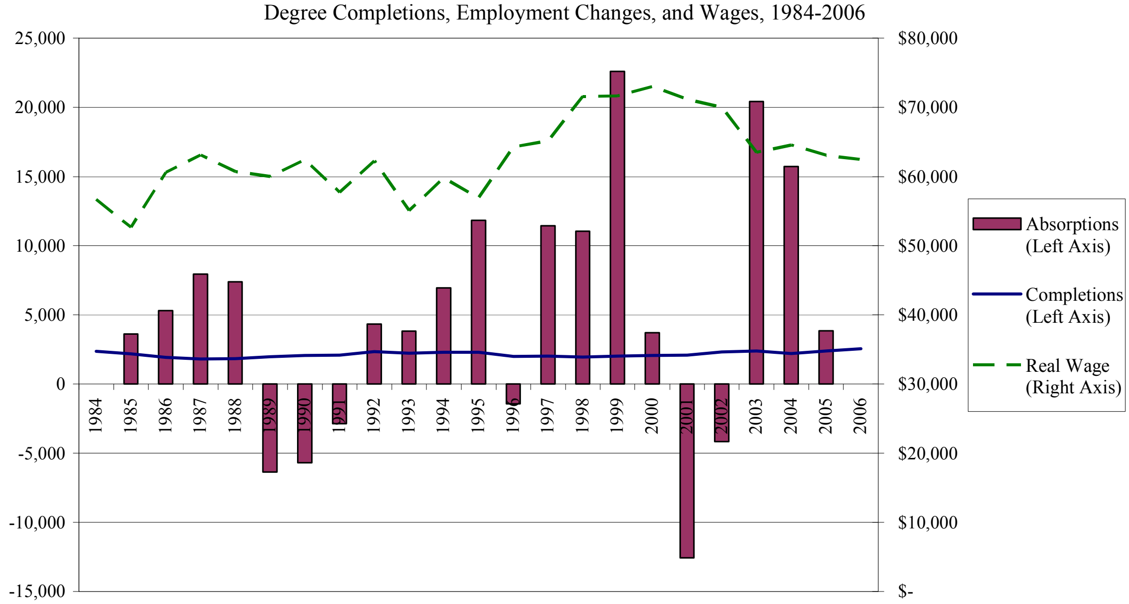
Degree Completions, Employment Changes, and Wages, 1984-2006



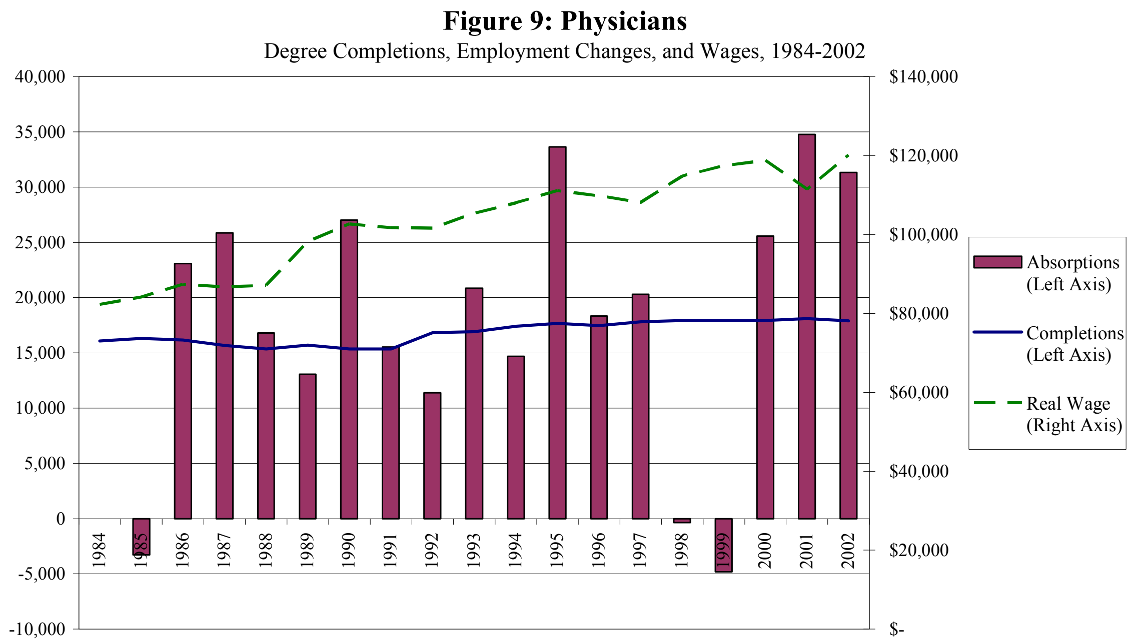
Source: Completions from IPEDS, 1999 linearly interpolated. Real wage and absorption data from CEPR CPS ORG extracts. Absorptions are a smoothed using a 3 year moving average.

Figure 8: Architects

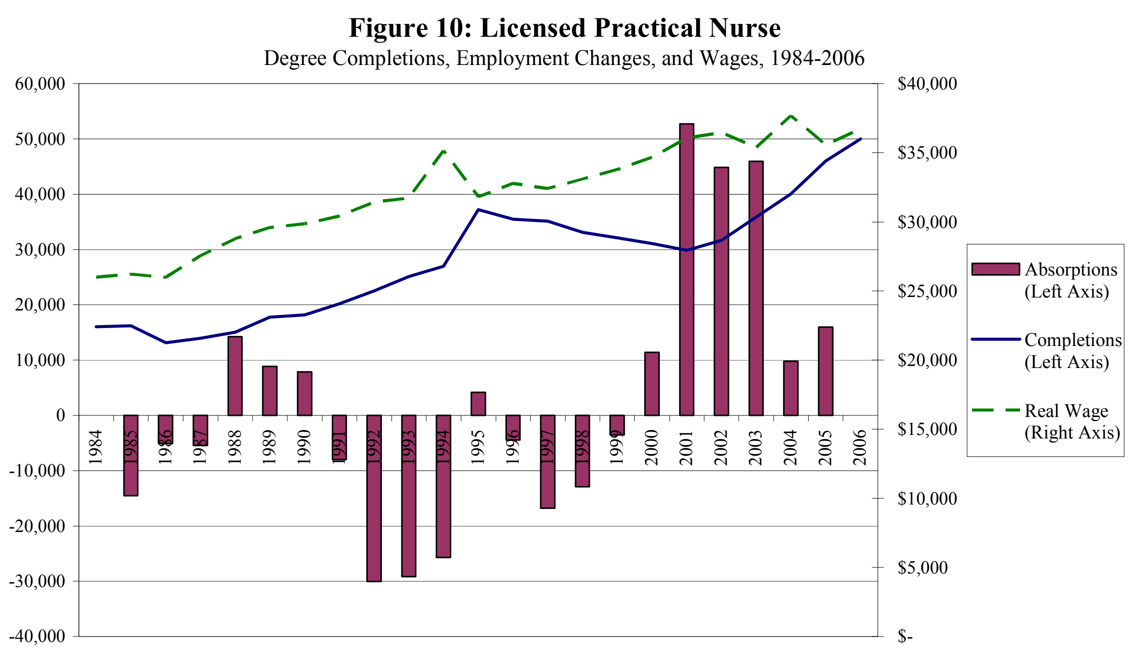
Degree Completions, Employment Changes, and Wages, 1984-2006



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.



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.



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.