Heterogeneous Returns to Knowledge Exchange:

Evidence from the Urban Wage Premium

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Abstract: This paper explores whether different types of knowledge experience greater returns to agglomeration. We posit that some kinds of knowledge are harder to exchange remotely and thus certain workers benefit more from close physical proximity to others. We first present a theoretical framework in which individuals randomly search for partners to exchange ideas, but that the returns to finding a partner are heterogeneous. In particular, some knowledge is more dependent on interpersonal exchange and most productive when shared with similar individuals. In this manner, we propose that agglomerative environments favor individuals with knowledge that is typically associated with "soft skills" where creativity and informal networking are important. We test this prediction using the most recent sample of the American Community Survey (ACS) in which college graduates are asked about their undergraduate major. Controlling for demographic and regional productivity effects and instrumenting for city size, we find that the urban wage premium varies considerably across majors. In line with the predictions of our model, the highest wage premiums are observed in majors linked to soft skills. This finding is consistent with the notion that large cities are particularly good at facilitating informal networking and promoting creativity whereas majors typically associated with "hard" skills tend to experience a smaller urban wage premium. We also study how the urban wage premium varies by terminal degree. Our estimates imply that the largest urban wage premium is associated with a master's degree. In the spirit of our results for majors, terminal degrees associated with the mastery of any existing cannon of knowledge such as a JD or MD experience a smaller urban wage premium.

Keywords: Human Capital, Wages, Agglomeration

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I. Introduction

There has been great progress towards understanding the determinants of agglomeration economies in recent years. Through this research, spillovers of knowledge have emerged as one of the major forces behind agglomerative behavior. The role of information sharing in cities was first posited by Marshall (1890), "Great are the advantages which people following the same skilled trade get from near neighborhood to one another." Moreover, Kuznets (1962) proclaims that "creative effort flourishes in a dense intellectual atmosphere..." The seminal work of Jacobs (1969) also emphasizes that information sharing plays a large role in urbanization. As is well known, Lucas (1988) cites externalities from human capital as an important engine of economic growth. Notably, he stresses that cities provide a highly fertile environment for the transmission of information between individuals.

There has also been substantial progress in developing rigorous formal models of information spillovers and agglomeration. Glaeser (1999) constructs a theoretical framework in which cities promote the transmission of knowledge along the vertical dimension. That is, cities promote learning by younger, less skilled workers from older, skilled individuals. By comparison, Berliant, Reed, and Wang (2006) develop a random matching model of spillovers between individuals with horizontally differentiated types of knowledge. In particular, they posit there is an optimal range of idea-diversity between people. Consequently, optimizing agents select a range of individuals with different types of knowledge to collaborate and share ideas.

Existing work on human capital and agglomeration economies recognizes that individuals are different – they either have different *types* of knowledge or different *levels* of knowledge. However, an important limitation was that knowledge was treated as *symmetric* and the *external gains from human capital were identical*. In this manner, existing theoretical models would predict that the tendency of firms to co-agglomerate would be the same across industries. However, a wide array of evidence demonstrates that there are differences in the potential to learn from others. For example, Bernstein and Nadiri (1989) find that there are substantial differences in R&D spillovers across industries.[1] In fact, Audretsch and Feldman (1996) point out that there are substantial differences in the tendency of innovations to cluster spatially across industries and this clustering increases with the number of skilled workers the industry. Moreover, both Ellison and Glaeser (1997) and Ellison, Glaeser, and Kerr (2010) show that there are sizable differences in the tendency of firms to co-agglomerate.

One might be inclined to believe that knowledge spillovers play the greatest role in promoting productivity in high technology industries where formal measures of human capital are an obvious input to production. Yet, Glaeser and Kahn (2001) find that high human-capital industries such as finance have a strong tendency to agglomerate. Conversely, Lee (2010) finds a flat or even negative urban wage premium for medical workers. However, Lucas conjectures "New York City's garment district, financial district, diamond district, advertising district, and many more are as much intellectual centers as is Columbia or New York University." As fashion and advertising are highly reliant on creativity and collaboration, Lucas also considers that agglomeration economies are likely to emerge in areas based upon "soft" skills. Arzaghi and Henderson (2008) explicitly focus on information sharing in the advertising sector in New York City where networking and creative vision are important.

The objective of this paper is to investigate the role of agglomeration according to an individual's human capital. In contrast to previous theoretical research, we incorporate that the gains from information sharing vary across individuals due to the different types of knowledge that they possess. As our primary focus is on horizontal differences in knowledge, we extend the framework of Berliant, Reed, and Wang by positing that the benefits of matching vary across individuals. In our

[1] In addition, Bernstein (1988) observes differences in intra-industry spillovers and inter-industry spillovers in Canadian data. Bernstein and Yan (1997) study differences in intra-national and international spillovers for manufacturing industries in Canada and Japan. Interestingly, they find that in some industries spillovers are more likely to occur from Canada to Japan than Japan to Canada. In this vein, Holod and Reed (2009) examine the role of asymmetric spillovers across countries in a Lucas-type human capital model of economic growth.

framework, some individuals have types of knowledge with large potential gains from information sharing and others less so.

The heterogeneous returns to in-person knowledge exchange could arise for a number of reasons. Some types of knowledge may only be acquired with only diligent study or extensive laboratory work. Workers who specialize in this type of knowledge learn more from technical manuscripts than social interactions. An alternative but functionally equivalent hypothesis is that the type of knowledge exchanged may depreciate at different rates. For example, medical knowledge may exhibit slow and steady but permanent advance whereas the entire stock of fashion knowledge from three years ago may be effectively worthless. In either case, it may be more important for some types of knowledge workers to meet than others. Our model allows the benefits of agglomeration economies to vary across the types of knowledge. In particular, agglomeration favors “soft” skills much more than “hard” skills.

Our hypothesis is intuitive and is also based on support from the data. Notably, Berger (1988) studies earnings growth from experience across individuals with different college majors. The strongest gains from experience occur amongst business and liberal arts majors. The smallest gains occur in science and education. In fact, the gains from experience in business and liberal arts are more than twice as large as the other two fields of study. Presumably, the differences also reflect that there is more learning on the job. A large part of the increased productivity likely results from information sharing over time.

Following the equilibrium predictions of the model, we proceed to test it empirically.
We build on the work of Glaeser and Mare (2001) and Bacolod, Blum, and Strange (2010), where productivity gains from agglomeration are manifest in the urban wage premium. If different types of human capital are rewarded differently in dense environments, then the urban wage premium should vary with an individual’s type of knowledge.

In order to examine how the urban wage premium varies across types of human capital, we study individuals in the American Community Survey (ACS). The ACS is particularly well-suited for our question as it contains an individual's field of degree for college graduates. The individual's college major serves as the empirical counterpart for an individual's type of knowledge in the model.

In addition to serving as a useful group for a test of the model, studying the labor market performance of college graduates in dense environments is interesting in its own right. A wide volume of evidence points out that firms in industries with a high propensity to generate spillovers of knowledge are attracted to large pools of skilled, college-educated workers (Rosenthal and Strange, 2009). Moreover, the ACS also records the level of educational attainment of survey respondents. That is, we also observe if an individual obtains a master's degree, a graduate professional degree, or a Ph.D. Therefore, we are able to study how the urban wage premium varies according to the *type* of knowledge, the *level* of human capital accumulation, and *interactions between them*. Most important for this paper, the ACS provides a rich amount of information on differences in the type of human capital individuals may possess. The ACS reports data for 174 different majors, which we aggregate into twenty-one knowledge categories.[2] The ACS geocodes respondents by Primary Use Microdata Area (PUMA) that we then match to MSAs. MSA population size and its interactions with college major type are our principal independent variables of interest.

While individuals with hard science degrees tend to earn more on average, the urban wage premium tends to be highest for individuals that majored in humanities or social sciences.[3] The five majors with the largest wage premium had degrees that might typically be associated with soft skills: social science, government, history, media, and liberal arts. Each of these majors likely depends on

[2] Majors related to military science were dropped from the sample as we are primarily interested in civilian labor markets.
[3] Indeed, when aggregating the computer science, engineering, mathematics, medicine, and science fields into a STEM category the results clearly show that on average hard skills earn more and are less sensitive to city size.

creativity, interpersonal skills, or informal networking capabilities. The lowest (and statistically significant) urban wage premiums are observed in STEM, agriculture, and architecture.

While the literature to date has typically treated city size as exogenous with respect to the urban wage premium, it is possible that wages and total population simply reflect underlying (unobserved) productivity of different cities. We attempt to address these concerns by using the scarcity of developable land around the urban core (Saiz, 2010) as an instrument for population. This measure has been used in a number of papers as an instrument for house prices and by extension we think it can serve as a supply shifter for population. Employing the IV for population and interacting it with college major, the ranking among the statistically significant categories of majors is: psychology, government, liberal arts, fine arts, social science, STEM, and business. The other majors do not experience a statistically different urban wage premium. While there is somewhat greater evidence for hard skills in dense environments, we think the overall results to be consistent with softer skills realizing a greater urban wage premium.

We also study how the urban wage premium varies by terminal degree. Our estimates imply that the largest urban wage premium is associated with a master's degree. In the spirit of the results for majors, terminal degrees associated with the mastery of any existing cannon of knowledge such as a JD or MD experience a smaller urban wage premium than do non-terminal degree holders that may require more on-the job training. Finally, as previously mentioned, we are able to study how the urban wage premium varies according to the type of knowledge at various levels of human capital depth. In particular, we find that many measures of lateral variation in human capital are significant at both the bachelor's and master's levels. However, regardless of the depth of human capital, the same basic insights emerge – majors related to soft skills are more highly rewarded than hard skills in dense economic environments.

The remainder of the paper is as follows. Section 2 presents the model which provides the theoretical underpinnings for our empirical work. Section 3 describes the data to be studied. Section 4 outlines the empirical model. Section 5 provides a detailed discussion of the empirical results. Section 6 offers concluding comments. The appendix provides additional details of the data and full tables of regression results.

II. Theoretical Model

The urban wage premium represents a source of uncompensated knowledge spillovers. As discussed in Duranton and Puga (2004), one of the ways that dense environments promote productivity is by information sharing. In particular, Berliant, Reed, and Wang (2006) develop a model of agglomeration economies in which individuals with different types of knowledge search for opportunities to exchange ideas. (Hereafter, we refer to Berliant, Reed, and Wang as BRW) In cities with a higher population size, search frictions are lower and support more productive intellectual exchange.[4] However, in their framework, all agents derive the same expected benefits from matching, and thus, the value of being in a city that affords intellectual exchange (typically large cities) is invariant to an individual's knowledge base. That is, in previous work, the external gains from knowledge exchange are identical across individuals.

The objective of this section is to provide a formal framework to demonstrate how the productivity gains from agglomeration vary across individuals with heterogeneous types of knowledge. Our framework builds on BRW, however, we consider that individuals vary according to their dependence on interpersonal exchange and information sharing. That is, the productivity gains from information sharing and matching depend upon the type of knowledge that an individual commands.

[4] See also Helsley and Strange (1990) who show that agglomeration economies enhance matches between firms and workers with heterogeneous skills.

Benefits of Knowledge Exchange

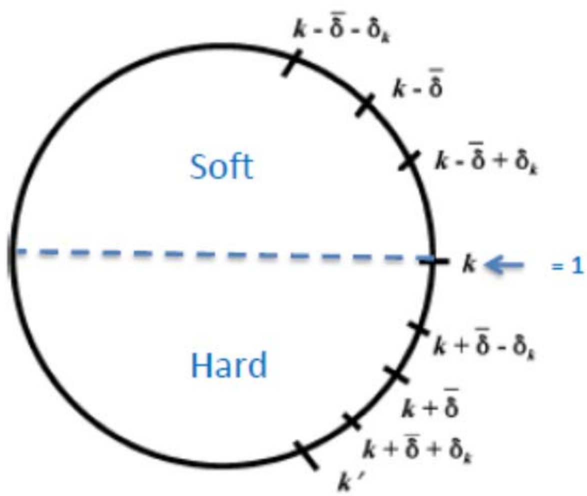
Notably, in our extension of the BRW model, while all individuals benefit with matching, and the likelihood of matching improves with city size, those endowed with "soft knowledge" benefit more from matching than others with "hard knowledge." Moreover, individuals with soft knowledge benefit the most from exchanging ideas with agents who are also highly soft-knowledge based. As an example, an individual trained in the arts would benefit more from interactions with someone else trained in the arts. They can share information on techniques, identify trends in tastes (of art buyers, for example), and provide individuals with better connections or social capital. On the other hand, someone trained in the sciences or engineering can increase their productivity without as much personal interaction as they can acquire additional information from professional journals or technical manuscripts which they can easily obtain remotely. This is true of others who are also highly endowed with hard knowledge.

Although our assumptions regarding the productivity of knowledge exchange are much different than BRW, many of the elements of the basic structure of the economy are similar. Therefore, we simply highlight the most important elements of the framework. The reader can refer to BRW for additional details.

We consider an economy in which individuals are endowed with different types of knowledge. The types of knowledge are indexed by positions along a circle with unit circumference. An individual's position reflects their base of knowledge. As in BRW, κ represents the set of all types of knowledge. An individual's specific type of knowledge is denoted by $k \in \kappa$. For tractability, the population N of individuals is uniformly distributed across the knowledge space. Following BRW, we abstract from differences in levels of knowledge as doing so would generate multiple steady-state equilibria. In contrast to BRW, which allows for an optimal dissimilarity in agents' types of knowledge, we assume that the returns to matching are monotonically increasing as knowledge similarity increases.

However, the principal theoretical innovation of this paper is to allow the productivity gains from matching to depend on the *type* of knowledge exchanged. In particular, the smaller an individual's 'location' in the knowledge space depicted in Figure 1, the lower the potential productivity gains from interaction. That is, such individuals place a lower value on interpersonal knowledge exchange and collaboration.

Figure 1: Knowledge Space



For example, an individual with a knowledge type at location '0' on the unit circle in the figure places the lowest weight on exchanging ideas with others. However, individuals at higher locations are more dependent on interpersonal communication, but they also require more specialized interactions. Therefore, individuals endowed with higher amounts of 'soft' knowledge benefit the most from interactions with other agents who are also highly outward oriented. They gain very little from meetings with agents who are much different. In order to clarify how the productivity of information sharing depends upon the differences in types of knowledge, we use the Euclidean metric where $\delta(k, k')$ is the knowledge distance between two individuals with knowledge types k and k'.

The additional knowledge obtained by individual with knowledge type k in sharing ideas with someone of type k' is $S(k,k')$ and it is reflected as:

$$S(k,k') = q + k(1-\delta(k,k')) \tag{1}$$

While q reflects the value of matching regardless of differences in knowledge, higher values of k reflect that individuals are endowed with more soft knowledge and therefore derive greater gains from information sharing. However, it is important to note that specialization and soft knowledge are complements in terms of generating ideas. The greater the differences in types of knowledge, the lower are the benefits of intellectual exchange. Nevertheless, individuals with hard skills are less sensitive to differences in knowledge.

Thus, in contrast to BRW, the value of exchanging information varies across types of individuals. Individuals with higher values of k have greater potential to learn from exchanging ideas with others. In contrast, the benefits from matching are the same across all agents in BRW. As we will demonstrate below, the benefits from agglomeration are higher for individuals with higher values of k.

The additional knowledge obtained is temporary, but it immediately translates into higher income.[5] Moreover, the utility from meeting is equal to the additional knowledge obtained from exchanging ideas. Time in the model is continuous and the rate at which individuals discount future utility is $r > 0$.

[5] As previously emphasized, our primary goal is to study horizontal differences in knowledge on knowledge exchange and the implications for agglomeration economies. If matching would permanently affect individuals' human capital, the model generates multiple equilibria and non-stationary dynamics. Similar restrictions are also embedded in BRW.

Meetings and Matches

As previously mentioned, one of the primary benefits of agglomeration economies is an increase in the rate of interactions between individuals. In more dense environments, transactions costs are lower. Consequently, the flow probability of meetings in an economy is $\alpha(N)$ and it is increasing in the population mass.[6]

However, not all meetings result in a match between agents. This is because the additional knowledge generated from matching is decreasing in differences in knowledge between individuals. Moreover, there is complementarity between an agent's knowledge type and the degree of similarity between two individuals. Yet, because of search frictions, individuals will match with individuals who are different. As we will derive below, individuals will choose an optimal 'knowledge spread' of agents in which they will exchange ideas, $\delta(k,k')$. The knowledge spread represents the maximum knowledge distance that an individual of type k will accept and exchange ideas. Given that the knowledge space has a circumference of 1, it also represents the fraction of individuals to collaborate. As the flow probability of a *meeting* is $\alpha(N)$, the flow probability of a *match* is $\alpha(N)\ \delta(k,k')$. Matches break-up with exogenous flow probability η.

Bellman Equations

At any point in time, an individual will either be unmatched or matched. Our primary attention focuses on activity in the steady-state where all variables are time-invariant. Individuals who are matched will generate income from sharing ideas and collaborating while others are seeking opportunities for intellectual exchange. Thus, they will have different streams of utility over time. The expected discounted utility of an agent of type *k* who is unmatched is $V_U(k,\hat{\delta}_k;N)$. For an agent that is

[6] The specification of the matching technology follows Glaeser (1999) for tractability.

matched, it depends on the quality of the collaboration. Hence, it is dependent on the individual's base of knowledge and the type of knowledge of their partner: $V_M(k,\delta;N)$.

We begin with the expected discounted utility of a matched agent with knowledge type *k:*

$$rV_M(k,\delta;N) = \left[q + k(1-\delta(k,k'))\right] + \eta\left[V_U(k,\hat{\delta}_k;N) - V_M(k,\delta;N)\right] \tag{2}$$

As is standard in continuous-time search models, the flow value of a matched agent is the flow income they generate in addition to the expected capital loss that one would incur if the match breaks up. The derivation of the Bellman Equation follows directly from the discussion in BRW.

By comparison, the Bellman equation for unmatched agents is a bit different in that agents do not know ex-ante the quality of their match:

$$rV_U(k,\hat{\delta}_k;N) = \alpha(N)\int_0^{\hat{\delta}}\left[V_M(k,\delta;N) - V_U(k,\hat{\delta}_k;N)\right]d\delta \tag{3}$$

where $\hat{\delta}_k$ is the knowledge spread which is chosen to maximize an unmatched agent's expected lifetime utility. The flow value of an unmatched individual reflects the expected capital gain that occurs upon matching. The ex-post value of a match depends upon the knowledge distance between the two agents while the ex-ante measure reflects the range of agents that an individual selects to exchange ideas.

Based upon the Bellman equations for matched and unmatched agents, we obtain the following Lemma:

Lemma 1 *(Unmatched Value). An agent's unmatched value depends on the agent's type k:*

$$V_U(k;\hat{\delta}_k;N)=\frac{\left(\frac{\alpha(N)}{r}\right)\hat{\delta}_k\left[q+k\left(1-\frac{1}{2}\hat{\delta}_k\right)\right]}{r+\eta+\alpha(N)\hat{\delta}_k} \quad \textit{if } \hat{\delta}<1$$

$$=\frac{\left(\frac{\alpha(N)}{r}\right)\left[q+\frac{k}{2}\right]}{r+\eta+\alpha(N)} \qquad \textit{otherwise} \tag{4}$$

Steady-State Populations

In the steady-state, the number of unmatched individuals must be constant. Since the search strategies vary across types of individuals, we begin by assuming that the population of unmatched agents of *each type* is constant. That is, in each period, the flow of individuals of type k who become unmatched is equal to the number of type *k* individuals who find a match:

$$\alpha(N)\hat{\delta}_k U_k=\eta M_k \tag{5}$$

At any point in time, there is a population of agents of type k who are not currently matched. This measure is equal to U_k. As the flow probability that each of these individuals will become matched is equal to $\alpha(N)\hat{\delta}_k$, the total number of agents of type k who become matched is $\alpha(N)\hat{\delta}_k U_k$. On the other side, $M_k=N-U_k$ agents will be in matches that are susceptible to breaking up.

Therefore, the steady-state population of unmatched agents for each knowledge type is:

$$U_k=\left(\frac{\eta}{\alpha(N)\hat{\delta}_k+\eta}\right)N \tag{6}$$

Note that as the knowledge spread for any type of agent is larger, the steady-state number of unmatched individuals for each type will be lower. Moreover, each type will choose different knowledge spreads. Therefore, the steady-state population of unmatched individuals across the entire economy is:

$$U = \int_0^1 U_k dk = \int_0^1 \left(\frac{\eta}{\alpha(N)\hat{\delta}_k + \eta} \right) dk$$

(7)

Steady-State Equilibrium

We now study the steady-state pure strategy Nash equilibrium for the economy. We first provide a formal definition for the steady-state equilibrium:

Definition. *(Steady-State Equilibrium). A non-degenerate steady-state equilibrium consists of* $\{\{R(k)_{k\in\kappa}, \hat{\delta}_k, U\}$ *satisfying the following conditions:*

(E-1) agents maximize their expected lifetime utilities through their choice of the knowledge spread, that is, $\hat{\delta}_k$ is the best response given $\hat{\delta}_{k'}, k' \in \kappa \setminus \{k\}$;

(E-2) equilibrium range of agents for *k* to exchange ideas, $R(k) = [k - \hat{\delta}_k, k + \hat{\delta}_k]$

(E-3) steady-state population, (7)

(E-4) there is interaction among agents (the steady-state equilibrium is non-degenerate); $\hat{\delta}_k > 0$.

Steady-state levels of interaction are reflected in the following:

Proposition *(Steady-State Knowledge Spread for type k) Let* $\alpha(N)=\alpha N$ *and* $k>\overline{k}=\dfrac{2(r+\eta)q}{\alpha N}$*.*

Suppose that a steady-state population mass for unmatched individuals exists and is unique. Then, the steady-state equilibrium knowledge spread of a type k agent solves the following quadratic equation:

$$\hat{\delta}_k^2+\left(\frac{2(r+\eta)}{\alpha N}\right)\hat{\delta}_k-\left(\frac{2(r+\eta)}{\alpha N}\right)\left(\frac{q+k}{k}\right)=0 \tag{8}$$

Moreover, $\dfrac{\partial\hat{\delta}_k}{\partial N}<0, \dfrac{\partial\hat{\delta}_k}{\partial k}<0,$ *and* $\dfrac{\partial^2\hat{\delta}_k}{\partial N\partial k}<0$*. If* $k\le\overline{k}$*,* $\hat{\delta}_k=1$*.*

The first result, the knowledge spread is decreasing in the population size for interior solutions of the knowledge spread, occurs for the same reasons as BRW. In more dense environments, frictions interfering with intellectual exchange are lower. In turn, individuals will select a more narrow range of individuals to exchange ideas and there are productivity gains from agglomeration.

However, in our framework, the knowledge spread is type-dependent. Therefore, the second comparative static demonstrates that different types of agents will select different ranges of individuals for collaborations. Therefore, as demonstrated in the Proposition, an individual's knowledge spread will be smaller if they have a higher value of k. That is, individuals with a greater soft-knowledge base will select more specialized interactions. In contrast to soft-knowledge types of individuals, individuals with a lower value of *k* are not sensitive to knowledge gained from matching and would meet with any agent. However, they accomplish relatively little in interpersonal exchange.

The final comparative static, $\dfrac{\partial^2\hat{\delta}_k}{\partial N\partial k}<0$, indicates that individuals with more soft-knowledge will become even more selective as the population is higher. Because the quality of information sharing improves in more dense environments, *the productivity from matching will be higher among those with* *soft knowledge rather than hard knowledge. In this manner, the model demonstrates that worker productivity among those with soft knowledge will increase more in agglomerative environments than those with hard knowledge. Therefore, the model implies that that the urban wage premium varies according to individuals' base of knowledge*. The balance of the paper is dedicated to finding empirical evidence of this.

III. Data

We proceed by describing the data that will be used to empirically test the implications of our model. The focus of our empirical work will be based on the American Community Survey (ACS). The ACS provides a cross-sectional look at various socioeconomic, demographic and housing characteristics of the United States population. In particular, it provides detailed information on individuals' educational attainment and since 2009, undergraduate field of degree. The responses to these questions provide a rich measure of the depth and types of human capital in the US population. The ACS is also large, as it is intended to replace the long-form from the decennial census. The Census Bureau annually releases 1-year, 3-year, and 5-year panels of this large dataset. 1-year releases are the results from a 1% sampling of the population and contain over 3 million observations. Thus, the ACS is uniquely able to inform questions about the level, type, and concentration of human capital across cities.[7]

The ACS reports the Primary Use Microdata Area (PUMA) as the smallest identifiable geographic unit of individual residence. PUMA boundaries encompass contiguous census tracts, counties, and places consisting of 100,000 to approximately 200,000 people, and are redefined each decade according to decennial census population estimates. While PUMAs do not cross state boundaries, it is not uncommon for them to lie in more than one MSA. MSAs describe regions of high economic and social integration as captured by commuting patterns. The relatively relaxed boundaries of MSAs offer greater

[7] Since new data is available each year, the 1-year estimates only sample from areas with a population of 65,000 or greater. The 3 and 5-year estimates reach smaller populations.

variation in local labor market size and human capital. Therefore, it becomes necessary to aggregate the reported PUMAs to the MSA level. [8]

We sum the populations of PUMAs to find MSA population. After merging this information with the ACS data, individuals living in PUMAs identified as non-metropolitan are dropped from the dataset. We further characterize local labor market conditions with data on the MSA-level unemployment rate from the Bureau of Labor Statistics via the FRED database of the Federal Reserve Bank of St. Louis.

We seek to study how the urban wage premium responds to human capital heterogeneity. The ACS is uniquely suited to looking at such questions because it contains detailed questions on higher educational attainment and because it asks very fine questions about undergraduate degree. In particular, the individual's college major serves as the empirical counterpart for an individual's type of knowledge in our theoretical model. For individuals who have earned an undergraduate degree or higher, the ACS identifies which of 174 different majors a respondent obtains. We aggregate the responses into twenty-one categories. These areas of expertise in alphabetical order are: agriculture, architecture, arts, business, computer science, education, engineering, fitness, government, history, languages, law, liberal arts, mathematics, medicine, media, psychology, religion, science, social science, and social work. As we are primarily interested in studying civilian labor markets, majors with a military science degree are dropped from the sample of college majors.

The theoretical framework that we seek to test focuses on horizontal differences in human capital accumulation. However, one might also be concerned that any of our empirical results for college majors are biased because some majors tend to serve as pathways towards post-baccalaureate education. Yet, another advantage of the ACS is that also contains rich measures of human capital depth

[8] The Missouri Census Data Center's MABLE/Geocorr2K Geographic Correspondence Engine streamlines the process by generating customized, downloadable reports of the relationship between PUMAs and MSAs based on year 2000 boundaries and population size. This resource provides the corresponding MSA name and code, and population for each PUMA.

so that we can also control for attainment of a master's degree, professional degree, or a Ph.D. Consequently, such concerns will be taken into account in our empirical results.

In fact, the ACS allows us to construct nine indicators for educational attainment: less than high school, GED, high school, some college, associate's degree, bachelor's degree, master's degree, professional degree, and Ph.D.[9] These measures also allow us to study how the urban wage premium varies across rich dimensions of vertical human capital attainment among workers in the labor force. We view that such analysis is also warranted as many papers on wage models rely on a continuous measure of educational attainment or aggregate responses for relatively coarse measures of educational attainment such as high school or college completion.[10] Results from these methods unrealistically imply either the return to human capital investment is constant, or that individuals with the same level of education should expect the same return in wages.

In order to study individuals who are active labor market participants, we focus on individuals age 16 or older that earned at least $10,000 and completed a bachelor's degree. Along with human capital, we control for standard demographic information such as gender, marital status, white/non-white race, veteran status, immigrant status, and age which we enter as a quadratic expression. Other variables include occupational controls for weekly hours worked, indicators for industry in which the individual is employed, and industry share of MSA employment. To address variation in the urban wage

[9] Bacolod et al. (2009) only study three categories of educational attainment: less than high school, high school, and a college degree. However, in comparison to our work, they also control for quality of undergraduate institution.

[10] See, for example, Rauch (1993), Roback (1982), and Bacolod et al. (2009).

premium due to tenure in a city we use an indicator for having recently moved to a larger MSA.[11] Lastly, we add indicators for the Census-defined geographical division in which the individual resides.[12]

We obtain two samples. The unrestricted sample for 2011 includes individuals with any level of educational attainment and has 875,255 observations. Our subsample of college graduates has 339,724 observations. The demographic breakdown of the data is rather consistent across 2009-2011, the years for which ACS data on field of degree is available however we study the most recent sample in our analysis. Each year, about half the dataset is female. Eighty percent of the population is white, and two-thirds are married. The average age of the sample is around 43 years old. Approximately 7% of the sample is a veteran.[13]

The rest of the discussion of the data focuses on the geographical distributions of key variables. To determine the relative city size we categorize MSA population size as follows: VS (very small, less than 100,000; example, Cheyenne, WY); S (small, 100,000 – 500,000; Tallahassee, FL); M (medium, 500,000 – 1 million; Birmingham, AL); L (large, 1 million – 4 million; Memphis, TN-AR-MS); and VL (very large, greater than 4 million; New York-Northern New Jersey-Long Island, NY-NJ-PA).[14] Sample representation of the city size groups from very small to very large are: 0.38%/0.28% (VS), 17.38%/13.81% (S), 9.74%/8.43% (M), 31.64%/31.24% (L), and 40.86%/46.24% (VL).[15] Thus, nearly half of the sample population lives in MSAs with more than 4 million people. Less than 20% reside in MSAs with populations smaller than 500,000 people. Limiting the sample to the college educated causes us to have fewer individuals in small towns and more in very large cities relative to the population as a whole.

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[11] The migration PUMA (MIGPUMA) identifies the PUMA of residence one year ago. As discussed, PUMAs are aggregated to the MSA-level by population. The difference in the relative size of cities follows our previous definitions.

[12] Census region and division definitions are available at: http://www.census.gov/econ/census07/www/geography/regions_and_divisions.html.

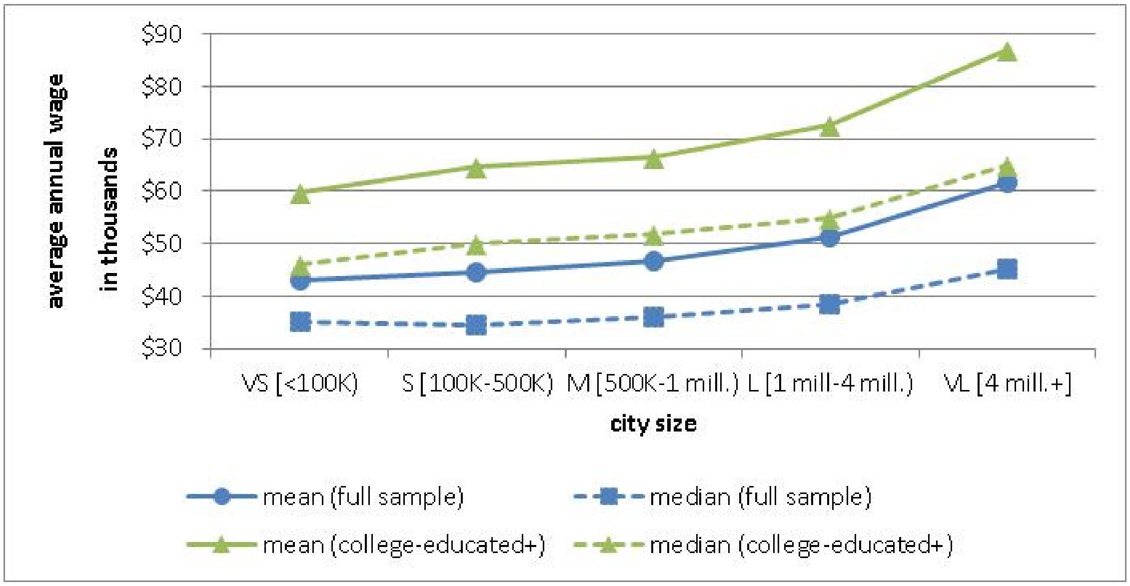
[13] In 2011, these values hold between the full and restricted samples as well, with the exception that the college-educated are more likely to be married (66% vs. 60%) and less likely to serve in the military (7% vs. 9%).

[14] See appendix table 1 for a listing of all MSAs within each city size category.

[15] % representation in the full sample/% representation in the restricted sample.

Initial observations provide cursory evidence of an urban wage premium. Average annual wages in very small cities are less than $45,000. By comparison, in the largest cities, average annual income is over 40% larger (at $61,487).[16] In fact, average annual wages monotonically increase with city size. Please see Figure 2 below for details.

Figure 2: Average Earnings Across City Sizes



Educational attainment presents a similar monotonic relationship with city size. (Please see Table 1 below) The distribution of educational attainment within each city size reveals very small, small and medium cities are largely composed of individuals with some college experience. The modal level of educational attainment in large and very large cities is the bachelor's degree.

[16] Among the college-educated, the average annual wage in very small cities is $59,732 and $86, 965 in very large cities; approximately 46% higher.

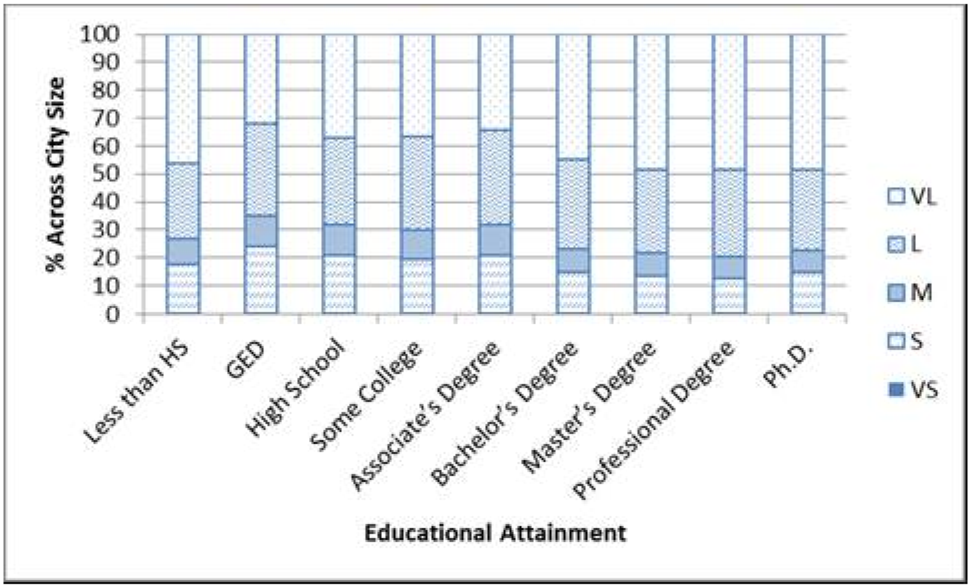
Table 1: Distribution of Educational Attainment within Cities

	VS	S	M	L	VL	U.S.
Less than HS	6.42	7.52	7.25	6.5	8.68	7.64
GED	4.53	3.82	3.32	2.96	2.24	2.86
High School	25.34	23.13	22.28	19.37	17.76	19.67
Some College	25.43	24.31	23.42	23.28	19.84	22.08
Associate's Degree	9.87	10.38	10.14	9.57	7.56	8.95
Bachelor's Degree	18.44	19.37	20.7	23.94	25.72	23.54
Master's Degree	7.14	7.84	9.04	9.84	12.52	10.5
Professional Degree	1.53	2.05	2.33	2.83	3.46	2.9
Ph.D.	1.32	1.58	1.53	1.72	2.23	1.88

Values represent the percent of population within each city size category with a particular level of educational attainment. The last column shows the national distribution of educational attainment. Very large cities consistently have greater representation of college-educated individuals relative to the nation as a whole. Small and Medium cities typically have greater than average presence of GED-Associate's degree recipients.

To gain further insights into the relationship between educational attainment and city size, it is also useful to look at the breakdown of city size categories at each level of depth of human capital as in Figure 3 below:

Figure 3: Distribution of Educational Attainment across City Sizes



While the largest cities are likely to promote creative activity among the educated population, Figure 3 shows that the bulk of those with less than a high school degree live in the largest areas. Moreover, there appear to be two distinct patterns between those with a college degree and those without. The highly educated largely flock to very large cities while those without a bachelor's degree appear slightly indifferent between large and very large cities.

As observed in Table 2, the education, business, science, and engineering fields maintain the highest representation within all city size groups. Education dominates in very small cities, while business type degrees are the most prevalent everywhere else. After grouping science, engineering, medicine, computer science, and mathematics into the STEM category, we see STEM fields are the largest group of majors consisting of at least 25% of college-educated population in all city sizes. Education, business, and social science follow STEM.

Table 2: Field of Undergraduate Degree Distribution within Cities

	VS	S	M	L	VL	U.S.
Education	17.83	15.21	13.5	11.08	8.56	10.7
Business	16.35	19.91	20.93	22.49	21.36	21.46
Science*	9.39	8.75	8.19	8.54	8.75	8.64
Engineering*	7.7	8.1	8.9	8.96	10.09	9.35
Medicine*	7.59	8.54	8.64	7.4	6.56	7.27
Liberal Arts	5.27	4.18	4.28	4.2	4.97	4.56
Social Science	5.06	5.48	5.54	6.15	7.15	6.46
Arts	4.43	2.99	3.28	3.62	4.39	3.86
Agriculture	4.32	2.61	1.68	1.38	0.98	1.4
Government	3.9	4.85	4.82	4.98	5.32	5.11
Comp. Sci.*	3.06	2.42	2.39	3.17	3.54	3.17
Psychology	2.95	4.49	4.94	4.84	4.84	4.8
Media	2.53	3.35	3.51	4.49	4.16	4.09
History	2.43	2.09	2.3	2	2.55	2.29
Math*	1.69	1.34	1.46	1.46	1.81	1.61
Social Work	1.58	1.36	1.33	1.07	0.82	1.01
Languages	1.27	0.94	0.99	0.97	1.24	1.09
Religion	1.16	1.61	1.61	1.39	1.26	1.38
Fitness	0.95	1.11	0.87	0.87	0.59	0.78
Architecture	0.53	0.53	0.68	0.78	0.9	0.79
Law	0	0.15	0.17	0.17	0.16	0.16
*STEM	29.43	29.15	29.58	29.53	30.75	30.04

STEM is the sum of values for the fields marked with an asterisk within each city size.

IV. Empirical Model

Lucas (1988) demonstrates that an individual's productivity does not solely depend on private choices of human capital investment and hours worked. He argues there are external returns to education and skill development due to the subsequent increase in the local human capital stock. The externality emanating from the growth of this aggregate measure of human capital is captured via a wage premium.

Empirically, this premium is commonly identified within a wage regression as the statistically significant coefficient for local population size in the presence of private educational attainment. For example, Roback (1982) identifies population size as a productive amenity in her spatial equilibrium model of wages and rents. In particular, population size drives up firm demand for land. In turn, there is an increase in the provision of public goods that provide cost-cutting benefits to production. The empirical model verifies the existence of a positive productive externality from human capital by estimating wages as a function of population size, education attainment, standard individual characteristics, and other local public goods.

Roback's model serves as the benchmark for many subsequent studies of the urban wage premium, including Bacolod, Blum and Strange (2009).[17] Bacolod et al. expand the wage regression by defining individual human capital investment with educational attainment and indices of minimum occupational skill requirements. Standard educational attainment captures one form of human capital while the indices for cognitive, people, and motor skills capture horizontal variation. They then interact these measures of human capital with population size to determine which skills are rewarded in larger cities.

Like the existing literature, we regress (log) wages on a set of demographic controls and education and interact education with city population size. Our initial contribution is to include and interact with population much finer measures of educational attainment and undergraduate major than was available to earlier researchers. We specify the following regression:

$$ln(w_{ise}) = \alpha + X_{is}\beta + L_{is}\theta + ln(MSA\ pop)_{is}\delta + Z_{ies}\gamma + [\ln(MSA\ pop)_{is} \cdot Z_{ies}]\varphi + \varepsilon_{ies} \qquad (9)$$

where w_{ise} is the annual wage earnings of individual i in location s with educational characteristics e (such as major and depth of human capital attainment). In matrix Z_{ies}, educational attainment is composed of seven indicator variables representing highest level of education completed by the individual where the reference group is the attainment of a high school diploma. Field of degree is a composed of twenty binary indicators for the individual's area of undergraduate study. Business, the

[17] Rauch (1993) follows Roback by estimating social returns from human capital accumulation. In particular, Rauch finds that an individual's wage is higher in MSAs with higher average years of education.

most common undergraduate major, is omitted. To find which fields of expertise and levels of education are most rewarded in urban areas, equation 9 contains population and human capital indicators. We also include demographic variables, X_{is}, which includes age and age^2 and a dummy indicator for race (white = 1), marital status (married = 1), gender (female = 1), immigrant status (foreign-born = 1), and veteran status (veteran = 1). We also control for local labor market conditions, L_{is}, with MSA-level unemployment rates, seventeen indicators of industry of employment, own-industry share of employment, and weekly hours worked.[18]

Consistent with Roback (1982) and the subsequent literature, we assume free mobility for workers and do not control for cost of living or amenities across cities. The iso-utility constraint for spatial equilibrium assumes the individual is indifferent across locations after controlling for the cost of housing and local amenities. Therefore, individuals' preferences for the local amenities compensate for higher rent or lower wages. Firms may choose to locate in high-rent (or low-amenity) cities and compensate the workers for living there by paying a higher wage if workers are more productive in those cities. Nevertheless, we allow for some regional variation in productivity by including dummy variables for Census division.[19]

Work on the urban wage premium has typically treated population as an exogenous determinant of wages. While population agglomerations are quite persistent and may in some cases be artifacts of history (Bleakley and Lin, 2012), treating population as persistent and exogenous is inconsistent with our assumption of free mobility. Thus, in some specifications, we instrument for population size with the share of developable land around the CBD of the MSA. Specifically, we use Saiz's (2010) measure of developable land around cities. This measure, which is accounts for the share

[18] The represented industries are: agriculture (reference group), extraction, utilities, construction, manufacturing, wholesale trade, retail, transportation, information, finance, professional services, administrative services, educational services, social assistance, entertainment, military, medical, and other services.
[19] The south Atlantic division serves as the reference group.

of land surrounding a city center that is either covered with water or contains steep slopes yields a measure of land supply elasticity. A number of papers have used this land supply elasticity as an instrument for house prices or house price appreciation including work by Mian and Sufi (2009) and Chetty and Szeidl (2010). A natural extension of this supply elasticity framework is that, all else equal, cities surrounded with a lot of developable land will be bigger than more constrained cities. The key assumption is that buildable land does not otherwise increase the productivity of workers with a college degree or higher.

V. Empirical Results

In this section, we seek to empirically test the primary prediction from our theoretical model. That is, we want to study how the urban wage premium varies according to an individual's horizontally differentiated base of knowledge. As previously demonstrated, the model predicts that the productivity gains from agglomeration are the highest among those individuals trained with "soft" types of knowledge where interpersonal knowledge exchange, networking, and creativity are important.

In order to empirically assess the predictions of our framework, it is necessary to attempt to isolate any productivity effects due to the depth of human capital through vertical measures of educational attainment. Moreover, as previously discussed in Section III, the ACS contains rich measures of the depth of human capital accumulation which are also likely to be rewarded differently at various levels of agglomeration.

As previous work largely imposes relatively coarse measures of vertical attainment on the empirical specification of the labor market earnings equation, studying how the urban wage premium varies across the depth of human capital accumulation is also important. We view that such analysis is also warranted as many papers on wage models rely on a continuous measure of educational attainment or aggregate responses for relatively coarse measures of educational attainment such as high school or college completion. For example, Rauch (1993) studies human capital externalities across cities based upon years of formal schooling which implies that each year generates the same returns in terms of labor productivity. Alternatively, Glaeser and Mare (2001) impose various educational dummies across years of schooling in an attempt to mimic different classes of educational attainment. However, as previously outlined, the ACS contains nine different measures of educational attainment. Thus, we begin by looking at the relationship between the urban wage premium and these vertical measures of human capital. The omitted indicator for the level of human capital attainment is a high school diploma. In our first wage regression, the logarithm of MSA population reflects the urban wage premium. A subset of coefficient estimates are presented in Table 3, and the full set of estimates are presented in Appendix Table 3.

Table 3: Earnings Equations for Depth of Human Capital

	Dependent variable: Log of annual wages			
	OLS			IV
ln (MSA population)	0.073 ***	0.061 ***	0.054 ***	0.078 ***
	(0.006)	0.005	0.005	0.004
Female	-0.198 ***	-0.197 ***	-0.180 ***	-0.176 ***
	(0.004)	0.003	0.003	0.001
White	0.107 ***	0.084 ***	0.069 ***	0.070 ***
	(0.011)	0.006	0.005	0.002
Married	-0.048 ***	-0.040 ***	-0.037 ***	-0.038 ***
	(0.001)	0.001	0.001	0.000
Age	0.058 ***		0.056 ***	0.058 ***
	(0.001)		0.001	0.000
Age^2	-0.001 ***	-0.001 ***	-0.001 ***	-0.001 ***
	(0.000)	1.03E-05	0.000	0.000
Veteran	-0.024 ***	-0.039 ***	-0.011 **	-0.010 ***
	(0.006)	0.005	0.005	0.003
Immigrant	-0.179 ***	-0.068 ***	-0.137 ***	-0.146 ***
	(0.020)	0.0141	0.010	0.002
Unemployment rate	-0.018 ***	-0.010 **	-0.008 **	-0.010 ***
	(0.005)	0.004	0.004	0.000
Experience		0.057 ***		
		0.001		
Years Schooling		0.129 ***		
		0.002		
Less than High School			-0.181 ***	-0.186 ***
			(0.011)	(0.003)
GED			-0.052 ***	-0.048 ***
			(0.007)	(0.004)
Some College			0.123 ***	0.128 ***
			(0.004)	(0.002)
Associate's degree			0.216 ***	0.217 ***
			(0.005)	(0.003)
Bachelor's degree			0.462 ***	0.466 ***
			(0.007)	(0.002)
Master's degree			0.661 ***	0.666 ***
			(0.009)	(0.003)
Professional degree			0.913 ***	0.904 ***
			(0.011)	(0.004)
Ph. D.			0.846 ***	0.845 ***
			(0.011)	(0.005)
Observations	859007	859007	859007	696130
1st stage F-statistic (p-value)				8110.79 (0.0001)
R^2	0.3443	0.4288	0.461	0.33912

* significant at 10%
** significant at 5%
*** significant at 1%

Unmarried, white men native to the U.S. earn the highest wages on average. Veterans earn slightly less. Finally, there is a concave relationship between earnings and age. The standard urban wage premium (UWP) for the population is about 7.3% according to OLS estimation.[20]

Vertical Differentiation of Human Capital

The results in the above table provide direct comparisons to the literature which are typically based on continuous measures of years of formal schooling, implying a constant return to wages for each year. As a benchmark, we present results using experience and years of schooling in column 2. Both experience and years of schooling both have positive effects on wages but decrease the urban wage premium. Consistent with Rauch (1993) and others, experience tends to have less of an impact than formal education.

The benefit of our study stems from the richness of data on human capital. Column 3 shows how we use this information to disaggregate the effects of education on wage across the different levels of educational attainment. The final column provides the corresponding IV estimates of column 3. Aside from the UWP, these coefficients do not differ much between estimation methods.

All estimates for educational attainment are statistically significant at the 1% level. The interpretation of results (relative to a high school diploma) shows the average return to educational attainment. In terms of the return to a degree, it appears the labor market does not perceive the GED as equivalent to a high school diploma. Wages for GED recipients tend to be 4.8-5.2% lower. As discussed in Heckman et. al. (2006), this may be because individuals with high school diplomas have

[20] In the second column of appendix table 3 we present the coefficient estimate for the effect of population size on wages when we instrument for population size using a city's endowment of developable land. Land suitable for building homes serves as a supply shifter that lowers land rents, and, ceteris paribus should make the city bigger, independent of any unobserved city productivity or business amenity. The coefficient estimate on instrumented population, 10.8%, is actually larger than the OLS results.

higher levels of non-cognitive skills which are rewarded in the workplace. Even those with some college experience earn benefits over a high school diploma. Individuals with a bachelor's degree earn wages nearly 50% higher than a high school graduate.

As for graduate degrees, a master's degree commands nearly a 70% premium. Individuals with a Ph.D. earn wages that are a bit higher than a master's degree. However, the highest returns come from earning a professional degree. Pharm.D. and J.D. are examples of professional designations that can potentially earn salaries 90% greater than those of high school graduates. Thus, professional degrees appear to be better rewarded in the labor market than research or theory-oriented skills honed during the attainment of a Ph.D. Such inferences regarding the return to human capital attainment are not possible in standard datasets which contain continuous measures of years of schooling but not degrees.

We next seek to inquire how the urban wage premium varies according to the depth of human capital. The statistically significant cross-effects in Appendix table 4 indicate the sensitivity of wages to changes in population size. The coefficient for log MSA population is the urban wage premium for individuals with a high school diploma as their highest level of educational attainment. The sum of the coefficients for log MSA population and the interaction terms for the relevant group defines the premium for that group. Please see Table 4 below for a summary of the results.

Table 4: Urban Wage Premium by Educational Attainment

	OLS		IV	
Less than High School	-1.2	***	-1.0	***
GED	2.2	***	7.1	***
High School	0.9		1.4	*
Some College	2.1	***	3.2	***
Associate's degree	1.5	**	3.0	**
Bachelor's degree	3.0	***	2.4	*
Master's degree	4.1	***	6.2	***
Professional degree	0.1		-1.8	***
Ph. D.	1.1		4.7	**

The shaded rows are non-terminal levels of educational attainment. All model specifications include controls for standard demographics including veteran and immigrant status, labor market conditions, industry of employment, and regional location. Reference Appendix table 3 for full model specification.

The urban wage premium for those with less than a high school education is the lowest of all the groups under IV estimation, likely reflecting low amounts of non-cognitive skills which are increasingly valued in dense agglomerative settings.

Interestingly, the urban wage premium is non-monotonic across educational attainment. Those with a master's degree (which is not typically considered terminal), are the most sensitive with an urban wage premium of 4.1-6.2%. Upon dissecting the range of attainment between completion of high school, junior college, and university, it appears the attainment of a terminal degree in each institution results in decreased sensitivity of wages to population size. From one perspective, those with the highest attainment in each educational regime earn relatively higher wages on average than others in the same class of education. That is, those with the highest attainment in each educational regime earn relatively higher wages on average. Therefore, they can more reasonably expect to receive that wage in any location resulting in a smaller urban wage premium.

Alternatively, the relative stability of wages for those with a terminal degree may reflect the terminal nature of their degree in which they become less flexible and able to adapt their attained skills to various available jobs. By comparison, the skills learned in non-terminal degrees are more generic and can be easily modified to meet specific needs of labor demand. For example, individuals with a vocational high school diploma, an associate's degree in nursing, or a D.D.S. have very specific career paths subject to less variation in earnings. Thus, the urban wage premium is smaller for specific skills gained from formal education as opposed to on-the-job training which also involves learning and interacting with others.

Horizontal Differentiation of Human Capital

As we have shown that our dataset can effectively control for the influence of vertical differences in human capital on the urban wage premium, we turn to a rigorous empirical test of our theoretical framework. In particular, we seek to investigate how the urban wage premium varies according to horizontal differences in human capital. To do so, we include new controls for lateral variation in human capital, by using up to twenty dummy variables for undergraduate major within the specification above. Recall that business major is the omitted category. In order to determine the urban wage premium for each field, we interact major with MSA population (in logs). As we only have data on this category for those who have acquired at least a bachelor degree, the sample is restricted. In Appendix Tables 4A-1 and 4B-1, we report the average returns and premia for 21 fields of knowledge, respectively. We aggregate the fields in columns 1-4 of these tables to see the labor market performance of STEM fields overall and will emphasize these results in the following text.

Prior to looking at measures of the urban wage premium across fields, we begin by reviewing the average return to field of degree. As can be observed in the first two columns of Table 5A-1, STEM majors earn about 17% more than all other college graduates on average. Upon expanding the "other" category, we see most majors earn less than someone with a business degree in columns 3 and 4. Government is the only significant non-STEM category to earn higher wages than business—about 1%

point greater. STEM fields earn 12% more. Columns 5 and 6 show our full disaggregation of the field of degree categories where the top five statistically significant fields are STEM-related. Though their income is lower than someone with a business degree, other high-earning areas are psychology, languages, and liberal arts. The lowest-earning fields are religion, fine arts, and social work – all earning at least 10% less than someone with a business major.

Appendix table 4B-1 shows how the urban wage premium varies with field of degree, serving as the primary evidence for the empirical test of the predictions of the model. The coefficient for log MSA population is the urban wage premium for individuals with a bachelor's degree in business. The urban wage premium for individuals with a bachelor's degree in each field is listed below in Table 5.

Table 5: Urban Wage Premium by Field of Degree

	OLS			IV		
1	Social Science	6.6	***	Psychology	7.2	***
2	Law	6.4		Social Work	7.1	
3	Government	6.4	**	Government	6.8	**
4	History	5.6	**	Languages	6.1	
5	Languages	5.6		Liberal Arts	5.4	*
6	Media	5.5	**	History	5.4	
7	Liberal Arts	5.3	*	Fine Arts	5.0	*
8	Fine Arts	5.1		Media	5.0	
9	Psychology	4.9		Social Science	4.9	*
10	Business	4.6	***	Education	4.4	
11	Social Work	4.6		*STEM*	4.3	*
12	Education	4.0		Religion	3.5	
13	Fitness	3.8		Business	2.7	*
14	Religion	3.6		Agriculture	2.1	
15	*STEM*	3.3	**	Architecture	-1.3	
16	Agriculture	2.8	***	Fitness	-2.6	
17	Architecture	2.5	**	Law	-6.9	

The above table provides a ranking of the UWP for our fields of degree when computer science, engineering, mathematics, medicine and science are aggregated into the STEM group. Out of these 17 categories, the five majors most sensitive to city size under OLS are: social science, government, history, media, and liberal arts with an urban wage premium that is on average 27% higher than a business major. Each of these majors likely depends on creativity, interpersonal skills, or informal networking capabilities. The lowest (and statistically significant) urban wage premiums are observed in STEM, agriculture, and architecture.

We attempt to address the endogeneity of population size by using land scarcity as an instrument for population. The results between OLS and IV estimation differ in a few ways. For example, IV estimation introduces negative premiums in architecture, fitness, and law. However, none of them are statistically significant. Architecture is one of several fields that lose statistical significance after correcting for endogeneity, while fine arts gained significance at the 10% level.

After estimation through two-stage least squares, the ranking among the statistically significant categories of majors is: psychology, government, liberal arts, fine arts, social science, STEM and business. Our results under IV estimation continue to line up with the predictions of our model though there is a somewhat greater role for hard skills in dense environments after attempting to control for endogeneity of city size.

In other model specifications reported in Appendix table 4B-1, “hard” skills acquired through science, engineering, and medical training fall in the bottom half in the bottom half of the ranking, which is consistent with our OLS estimation of the UWP comparing STEM to all other fields. On average, the STEM UWP equals 3.2% and is highly significant. With IV estimation, STEM has a higher point estimate and greater relative magnitude to other fields, but it is not significant. (Please see columns 1 and 2 of Table 4B-2) It could easily be argued that individuals with “hard” skills engage in relatively autonomous career paths in which social or interpersonal skills are less important, explaining why they are less sensitive to population and line up with predictions of the model.

Multi-dimensional Variation in Human Capital

Finally, we seek to rigorously control for vertical levels of educational attainment in analyzing the urban wage premium across types of knowledge. In this manner, we aim to demonstrate that the results in Table 5 are largely robust to controls for depth of human capital. In particular, we estimate the average return and UWP for educational attainment and field of degree interactions. The results are still relative to an undergraduate business degree. Please see appendix Table 5A-1 for the formal results. However, we must invoke a simple caveat that the ACS does not report the discipline studied at the graduate level. For example, the results for the master's degree-business interaction provide wage estimates for an individual with a bachelor's degree in business that goes on to earn a master's degree in *any* field.

As in our previous analysis, we first look at the average return to degree prior to studying how the urban wage premium varies across the knowledge spectrum. In the ranking for average returns, found in appendix tables 5A-2 and 5A-3, all observations above the 75th percentile are statistically significant. Half of the possible twenty STEM-degree combinations we control for lie in the fourth quartile, earning around 45% more than a bachelor's in business. Appendix table 5A-3 shows engineering-master's and computer science-master's are the only non-terminal degrees in this group. Computer science-professional is the only terminal STEM human capital combination to lie below the 75th percentile.

Under IV estimation, all terminal STEM combinations occur in the fourth quartile. Science-bachelor's earns 4.5% less than the business-bachelor's and is the only STEM-related group below the 25th percentile. In fact, seventeen of the twenty-one reported return to bachelor's degrees are concentrated in the first quartile.[21] The human capital representation within the second and third quartiles is quite diverse in terms of field and attainment.

We turn to the final component of our analysis – how does the urban wage premium vary across multi-dimensional variation in human capital? Alternatively, how do the results in Table 5 change with additional controls for the depth of human capital attainment? Recall under OLS, rankings in the top-five majors are: social science, government, history, media, and liberal arts.

As all but one of the statistically significant premiums in the top quartile of appendix table 5B-3 is non-terminal, we concentrate on comparisons at both the bachelor's and master's level.[22] The top five fields at the bachelor's ranking among all fields are: 1. Social Science (5.53%***), 2. History (5.29%**), 3. Media (5.06%***), 4. Liberal Arts (4.92%**), and 5. Business (4.01%***). This ranking is very much in line with the previous results, highlighting the higher level of productivity of individuals with soft skills in agglomerative settings.

Turning to the results at the master's level, the ranking based upon OLS is: 1. Social Science (7.57%***), 2. Languages (6.05%**), 3. Liberal Arts (5.93%**), 4. Government (5.83%**), and 5. History (5.48%*). All of these measures of the urban wage premium are greater than their bachelor's level counterparts. Again, the ranking is highly consistent with earlier comparisons – fields related to creativity, interpersonal communication, and informal networking generate high returns in dense economic environments.

[21] 70% of the bachelor's degrees are in the bottom 25% of the distribution of returns.
[22] Formal results can be found in appendix table 5B-1.

VI. Conclusions

This paper explores whether different types of knowledge experience greater returns to agglomeration. Specifically, we posit that some kinds of knowledge are harder to exchange remotely and thus certain workers benefit more from close physical proximity to others. We first present a theoretical framework in which individuals randomly search for partners to exchange ideas, but that the returns to finding a partner are heterogeneous. In particular, some individuals have knowledge which is not only dependent on interpersonal exchange but is also the most productive when shared with similar individuals. In this manner, we propose that agglomerative environments favor individuals with knowledge that is typically associated with “soft skills” where creativity and informal networking are important.

We test this prediction using the most recent sample of the American Community Survey (ACS) in which college graduates are asked about their undergraduate major. Controlling for demographic and regional productivity effects and instrumenting for city size, we find that the urban wage premium varies considerably across majors. In line with the predictions of our model, the highest wage premiums are observed in majors linked to soft skills. This finding is consistent with the notion that large cities are particularly good at facilitating informal networking and promoting creativity whereas majors typically associated with “hard” skills tend to experience a smaller urban wage premium. We also study how the urban wage premium varies by terminal degree. Our estimates imply that the largest urban wage premium is associated with a master’s degree. In the spirit of our results for majors, terminal degrees associated with the mastery of any existing cannon of knowledge such as a JD or MD experience a smaller urban wage premium.

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Appendix Table 1: Ranking of Metropolitan Statistical Areas by 2000 Population

Metropolitan Statistical Area	Population, 2000
Very Small Cities (< 100,000)	
1. Casper, WY	66,533
2. Pocatello, ID	75,565
3. Corvallis, OR	78,153
4. Great Falls, MT	80,357
5. Cheyenne, WY	81,607
6. Jonesboro, AR	82,148
7. Victoria, TX	84,088
8. Pine Bluff, AR	84,278
9. Pittsfield, MA	84,699
10. Rapid City, SD	88,565
11. Dubuque, IA	89,143
12. Bangor, ME	90,864
13. Elmira, NY	91,070
14. Owensboro, KY	91,545
15. Bismarck, ND	94,719
16. Grand Forks, ND-MN	97,478
17. Lawrence, KS	99,962

Small Cities (100,000 - 500,000)

18. Kokomo, IN	101,541	29. Anniston, AL	112,249
19. Cumberland, MD-WV	102,008	30. Sheboygan, WI	112,646
20. St. Joseph, MO	102,490	31. Goldsboro, NC	113,329
21. Gadsden, AL	103,459	32. Decatur, IL	114,706
22. San Angelo, TX	104,010	33. Lawton, OK	114,996
23. Sumter, SC	104,646	34. Auburn-Opelika, AL	115,092
24. Jackson, TN	107,377	35. Grand Junction, CO	116,255
25. Danville, VA	110,156	36. Muncie, IN	118,769
26. Sherman-Denison, TX	110,595	37. Williamsport, PA	120,044
27. Iowa City, IA	111,006	38. Sharon, PA	120,293
28. Hattiesburg, MS	111,674	39. Bloomington, IN	120,563

40.	Albany, GA	120,822
41.	Flagstaff, AZ-UT	122,366
42.	Sioux City, IA-NE	124,130
43.	Rochester, MN	124,277
44.	Glens Falls, NY	124,345
45.	Wausau, WI	125,834
46.	Alexandria, LA	126,337
47.	Abilene, TX	126,555
48.	Dover, DE	126,697
49.	La Crosse, WI-MN	126,838
50.	Waterloo-Cedar Falls, IA	128,012
51.	Altoona, PA	129,144
52.	Billings, MT	129,352
53.	Texarkana, TX-Texarkana, AR	129,749
54.	Greenville, NC	133,798
55.	Columbia, MO	135,454
56.	State College, PA	135,758
57.	Dothan, AL	137,916
58.	Yuba City, CA	139,149
59.	Jamestown, NY	139,750
60.	Wichita Falls, TX	140,518
61.	Pueblo, CO	141,472
62.	Punta Gorda, FL	141,627
63.	Florence, AL	142,950
64.	Rocky Mount, NC	143,026
65.	Decatur, AL	145,867
66.	Monroe, LA	147,250
67.	Santa Fe, NM	147,635
68.	Panama City, FL	148,217
69.	Eau Claire, WI	148,337
70.	Terre Haute, IN	149,192
71.	Jacksonville, NC	150,355
72.	Bloomington-Normal, IL	150,433
73.	Parkersburg-Marietta, WV-OH	151,237
74.	Janesville-Beloit, WI	152,307
75.	Bryan-College Station, TX	152,415
76.	Athens, GA	153,444
77.	Lima, OH	155,084
78.	Joplin, MO	157,322
79.	Jackson, MI	158,422
80.	Charlottesville, VA	159,576
81.	Yuma, AZ	160,026
82.	Benton Harbor, MI	162,453
83.	Barnstable-Yarmouth, MA	162,582
84.	Redding, CA	163,256
85.	Tuscaloosa, AL	164,875
86.	Bellingham, WA	166,814
87.	St. Cloud, MN	167,392

88. Burlington, VT	169,391	112. Waco, TX	213,517
89. Topeka, KS	169,871	113. Lynchburg, VA	214,911
90. Fort Walton Beach, FL	170,498	114. Amarillo, TX	217,858
91. Sioux Falls, SD	172,412	115. Gainesville, FL	217,955
92. Fargo-Moorhead, ND-MN	174,367	116. Yakima, WA	222,581
93. Las Cruces, NM	174,682	117. Asheville, NC	225,965
94. Tyler, TX	174,706	118. Green Bay, WI	226,778
95. Mansfield, OH	175,818	119. Johnstown, PA	232,621
96. Champaign-Urbana, IL	179,669	120. Wilmington, NC	233,450
97. Medford-Ashland, OR	181,269	121. Roanoke, VA	235,932
98. Elkhart-Goshen, IN	182,791	122. Odessa-Midland, TX	237,132
99. Lafayette, IN	182,821	123. Lubbock, TX	242,628
100. Lake Charles, LA	183,577	124. Portland, ME	243,537
101. Cedar Rapids, IA	191,701	125. Duluth-Superior, MN-WI	243,815
102. Richland-Kennewick-Pasco, WA	191,822	126. San Luis Obispo-Atascadero-Paso Robles, CA	246,681
103. Laredo, TX	193,117	127. Lincoln, NE	250,291
104. Houma, LA	194,477	128. Naples, FL	251,377
105. Myrtle Beach, SC	196,629	129. Fort Collins-Loveland, CO	251,494
106. Springfield, IL	201,437	130. Binghamton, NY	252,320
107. Chico-Paradise, CA	203,171	131. Ocala, FL	258,916
108. Clarksville-Hopkinsville, TN-KY	207,033	132. Anchorage, AK	260,283
109. Fort Smith, AR-OK	207,290	133. South Bend, IN	265,559
110. Longview-Marshall, TX	208,780	134. Columbus, GA-AL	274,624
111. Merced, CA	210,554		

135. Erie, PA	280,843	159. Provo-Orem, UT	368,536
136. Tallahassee, FL	284,539	160. Rockford, IL	371,236
137. Savannah, GA	293,000	161. Reading, PA	373,638
138. New London-Norwich, CT-RI	293,566	162. Corpus Christi, TX	380,783
139. Evansville-Henderson, IN-KY	296,195	163. York, PA	381,751
140. Utica-Rome, NY	299,896	164. Beaumont-Port Arthur, TX	385,090
141. Fayetteville, NC	302,963	165. Lafayette, LA	385,647
142. Fayetteville-Springdale-Rogers, AR	311,121	166. Shreveport-Bossier City, LA	392,302
143. Killeen-Temple, TX	312,952	167. Santa Barbara-Santa Maria-Lompoc, CA	399,347
144. Huntington-Ashland, WV-KY-OH	315,538	168. Salinas, CA	401,762
145. Fort Pierce-Port St. Lucie, FL	319,426	169. Saginaw-Bay City-Midland, MI	403,070
146. Macon, GA	322,549	170. Canton-Massillon, OH	406,934
147. Eugene-Springfield, OR	322,959	171. Pensacola, FL	412,153
148. Springfield, MO	325,721	172. Spokane, WA	417,939
149. Montgomery, AL	333,055	173. Madison, WI	426,526
150. Brownsville-Harlingen-San Benito, TX	335,227	174. Boise City, ID	432,345
151. Reno, NV	339,486	175. Jackson, MS	440,801
152. Hickory-Morganton-Lenoir, NC	341,851	176. Fort Myers-Cape Coral, FL	440,888
153. Huntsville, AL	342,376	177. Modesto, CA	446,997
154. Peoria-Pekin, IL	347,387	178. Lansing-East Lansing, MI	447,728
155. Appleton-Oshkosh-Neenah, WI	358,365	179. Kalamazoo-Battle Creek, MI	452,851
156. Davenport-Moline-Rock Island, IA-IL	359,062	180. Des Moines, IA	456,022
157. Biloxi-Gulfport-Pascagoula, MS	363,988	181. Chattanooga, TN-GA	465,161
158. Visalia-Tulare-Porterville, CA	368,021	182. Lancaster, PA	470,658

183. Melbourne-Titusville-Palm Bay, FL 476,230

184. Augusta-Aiken, GA-SC 477,441

185. Lexington, KY 479,198

186. Johnson City-Kingsport-Bristol, TN-VA 480,091

187. Lakeland-Winter Haven, FL 483,924

188. Daytona Beach, FL 493,175

Medium Cities (500,000 - 1,000,000)

189. Fort Wayne, IN 502,141

190. Colorado Springs, CO 516,929

191. Columbia, SC 536,691

192. Mobile, AL 540,258

193. Wichita, KS 545,220

194. Charleston-North Charleston, SC 549,033

195. Stockton-Lodi, CA 563,598

196. McAllen-Edinburg-Mission, TX 569,463

197. Little Rock-North Little Rock, AR 583,845

198. Sarasota-Bradenton, FL 589,959

199. Springfield, MA 591,932

200. Youngstown-Warren, OH 594,746

201. Baton Rouge, LA 602,894

202. Toledo, OH 618,203

203. Scranton--Wilkes-Barre--Hazleton, PA 624,776

204. Harrisburg-Lebanon-Carlisle, PA 629,401

205. Allentown-Bethlehem-Easton, PA 637,958

206. Bakersfield, CA 661,645

207. El Paso, TX 679,622

208. Knoxville, TN 687,249

209. Albuquerque, NM 712,738

210. Omaha, NE-IA 716,998

211. Syracuse, NY 732,117

212. Tulsa, OK 803,235

213. Tucson, AZ 843,746

214. Albany-Schenectady-Troy, NY 875,583

215. Honolulu, HI 876,156

216. Birmingham, AL 921,106

217. Fresno, CA 922,516

218. Dayton-Springfield, OH 950,558

219. Greenville-Spartanburg-Anderson, SC 962,441

220. Richmond-Petersburg, VA 996,512

Large Cities (1,000,000 - 4,000,000)

221. Louisville, KY-IN 1,025,598

222. Oklahoma City, OK 1,083,346

223. Grand Rapids-Muskegon-Holland, MI 1,088,514

224. Rochester, NY 1,098,201

225. Jacksonville, FL 1,100,491
226. West Palm Beach-Boca Raton, FL 1,131,184

227. Memphis, TN-AR-MS 1,135,614
228. Buffalo-Niagara Falls, NY 1,170,111

229. Hartford, CT 1,183,110
230. Raleigh-Durham-Chapel Hill, NC 1,187,941
231. Providence-Fall River-Warwick, RI-MA 1,188,613

232. Nashville, TN 1,231,311

233. Austin-San Marcos, TX 1,249,763
234. Greensboro--Winston Salem--High Point, NC 1,251,509
235. Salt Lake City-Ogden, UT 1,333,914

236. New Orleans, LA 1,337,726
237. Charlotte-Gastonia-Rock Hill, NC-SC 1,499,293

238. Columbus, OH 1,540,157
239. Las Vegas, NV-AZ 1,563,282
240. Norfolk-Virginia Beach-Newport News, VA- 1,569,541

241. San Antonio, TX 1,592,383

242. Indianapolis, IN 1,607,486

243. Orlando, FL 1,644,561

244. Milwaukee-Racine, WI 1,689,572

245. Kansas City, MO-KS 1,776,062

246. Sacramento-Yolo, CA 1,796,857
247. Cincinnati-Hamilton, OH-KY-IN 1,979,202

248. Portland-Salem, OR-WA 2,265,223

249. Pittsburgh, PA 2,358,695
250. Tampa-St. Petersburg-Clearwater, FL 2,395,997
251. Denver-Boulder-Greeley, CO 2,581,506

252. St. Louis, MO-IL 2,603,607

253. San Diego, CA 2,813,833

254. Cleveland-Akron, OH 2,945,831
255. Minneapolis-St. Paul, MN-WI 2,968,806

256. Phoenix-Mesa, AZ 3,251,876
257. Seattle-Tacoma-Bremerton, WA 3,554,760
258. Miami-Fort Lauderdale, FL 3,876,380

Very Large Cities (> 4,000,000)	
259. Atlanta, GA	4,112,198
260. Houston-Galveston-Brazoria, TX	4,669,571
261. Dallas-Fort Worth, TX	5,221,801
262. Detroit-Ann Arbor-Flint, MI	5,456,428
263. Boston-Worcester-Lawrence, MA-NH-ME-CT	5,819,100
264. Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	6,188,463
265. San Francisco-Oakland-San Jose, CA	7,039,362
266. Washington-Baltimore, DC-MD-VA-WV	7,608,070
267. Chicago-Gary-Kenosha, IL-IN-WI	9,157,540
268. Los Angeles-Riverside-Orange County, CA	16,373,645
269. New York, Northern New Jersey, Long Island, NY-NJ-CT-PA	21,199,865

Appendix Table 2: Field of Degree Category Components

Agriculture

- General Agriculture
- Agriculture Production And Management
- Agricultural Economics
- Animal Sciences
- Food Science
- Plant Science And Agronomy
- Soil Science
- Miscellaneous Agriculture
- Environmental Science
- Forestry
- Natural Resources Management

Architecture

- Architecture

Business

- General Business
- Accounting
- Actuarial Science
- Business Management And Administration
- Operations Logistics And E-Commerce
- Business Economics
- Construction Services
- Marketing And Marketing Research
- Finance
- Human Resources And Personnel Management
- International Business
- Hospitality Management
- Management Information Systems And Statistics
- Miscellaneous Business & Medical Administration

Computer Science

- Computer And Information Systems
- Computer Programming And Data Processing
- Computer Science
- Information Sciences
- Computer Administration Management And Security
- Computer Networking And Telecommunications

Education

- General Education
- Educational Administration And Supervision
- School Student Counseling
- Elementary Education
- Mathematics Teacher Education
- Physical And Health Education Teaching
- Early Childhood Education
- Science And Computer Teacher Education
- Secondary Teacher Education
- Special Needs Education
- Social Science Or History Teacher Education
- Teacher Education: Multiple Levels
- Language And Drama Education
- Art And Music Education
- Miscellaneous Education

Engineering

- General Engineering
- Aerospace Engineering
- Biological Engineering
- Architectural Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Engineering Mechanics Physics And Science
- Environmental Engineering
- Geological And Geophysical Engineering
- Industrial And Manufacturing Engineering
- Materials Engineering And Materials Science
- Mechanical Engineering
- Metallurgical Engineering
- Mining And Mineral Engineering
- Naval Architecture And Marine Engineering
- Nuclear Engineering
- Petroleum Engineering
- Miscellaneous Engineering
- Engineering Technologies
- Engineering And Industrial Management
- Electrical Engineering Technology
- Industrial Production Technologies
- Mechanical Engineering Related Technologies
- Miscellaneous Engineering Technologies
- Electrical, Mechanical, And Precision Technologies And Production

Fine Arts

- Cosmetology Services And Culinary Arts
- Fine Arts
- Drama And Theater Arts
- Music
- Visual And Performing Arts
- Commercial Art And Graphic Design
- Film Video And Photographic Arts
- Art History And Criticism
- Studio Arts
- Miscellaneous Fine Arts

Fitness

- Physical Fitness Parks Recreation And Leisure

Government

- Criminal Justice And Fire Protection
- Public Administration
- Public Policy
- Criminology
- International Relations
- Political Science And Government
- Transportation Sciences And Technologies

History

- History
- United States History

Languages

- Linguistics And Comparative Language And Literature
- French German Latin And Other Common Foreign Language Studies
- Other Foreign Languages

Law

- Court Reporting
- Pre-Law And Legal Studies

Liberal Arts

- English Language And Literature
- Composition And Rhetoric
- Liberal Arts
- Humanities
- Library Science

Mathematics

- Mathematics
- Applied Mathematics
- Statistics And Decision Science
- Mathematics And

Computer Science

Media

- Communications
- Journalism
- Mass Media
- Advertising And Public Relations
- Communication Technologies

Medicine

- General Medical And Health Services
- Communication Disorders Sciences And Services
- Health And Medical Administrative Services
- Medical Assisting Services
- Medical Technologies Technicians
- Health And Medical Preparatory Programs
- Nursing
- Pharmacy Pharmaceutical Sciences And Administration
- Treatment Therapy Professions
- Community And Public Health
- Miscellaneous Health Medical Professions

Psychology

- Cognitive Science And Biopsychology
- Psychology
- Educational Psychology
- Clinical Psychology
- Counseling Psychology
- Industrial And Organizational Psychology
- Social Psychology
- Miscellaneous Psychology

Religion

- Philosophy And Religious Studies
- Theology And Religious Vocations

Science

- Biology
- Biochemical Sciences
- Botany
- Molecular Biology
- Ecology
- Genetics
- Microbiology
- Pharmacology
- Physiology
- Zoology
- Neuroscience
- Miscellaneous Biology
- Nutrition Sciences
- Physical Sciences
- Astronomy And Astrophysics
- Atmospheric Sciences And Meteorology
- Chemistry
- Geology And Earth Science
- Geosciences
- Oceanography
- Physics
- Materials Science
- Multi-Disciplinary Or General Science
- Nuclear, Industrial Radiology, And Biological Technologies

Social Science

- Area Ethnic And Civilization Studies
- Family And Consumer Sciences
- Multi/Interdisciplinary Studies
- Intercultural And International Studies
- Interdisciplinary Social Sciences
- General Social Sciences
- Economics
- Anthropology And Archeology
- Geography
- Sociology
- Miscellaneous Social Sciences

Social Work

- Human Services And Community Organization
- Social Work

Appendix Table 3: Average Return and Urban Wage Premium Estimates for Educational Attainment

	Dependent variable: Log of annual wages										
	Standard UWP				AVG				UWP		
	OLS		IV		OLS		IV		OLS		IV
ln (MSA population)	0.073	***	0.108	***	0.054	***	0.078	***	0.009		0.014
	-0.006		-0.004		(0.005)		(0.004)		(0.006)		(0.008
Less than High School					-0.181	***	-0.186	***	0.141		0.177
					(0.011)		(0.003)		(0.089)		(0.092
Less than High School*ln (MSA pop)									-0.021	***	-0.024
									(0.006)		'(0.006
GED					-0.052	***	-0.048	***	-0.242	***	-0.907
					(0.007)		(0.004)		(0.045)		(0.163
GED*ln (MSA pop)									0.013	***	0.057
									(0.003)		(0.011
Some College					0.123	***	0.128	***	-0.043	*	-0.154
					(0.004)		(0.002)		(0.022)		(0.078
Some College*ln (MSA pop)									0.011	***	0.019
									(0.002)		(0.005
Associate's degree					0.216	***	0.217	***	0.132	***	-0.036
					(0.005)		(0.003)		(0.041)		(0.100
Associate's degree*ln (MSA pop)									0.006	**	0.017
									(0.003)		(0.007
Bachelor's degree					0.462	***	0.466	***	0.159	***	0.318
					(0.007)		(0.002)		(0.045)		(0.076
Bachelor's degree*ln (MSA pop)									0.021	***	0.010
									(0.003)		(0.005

Table 3 Cont. (1)

Master's degree			0.661***	0.666***	0.190***	-0.06
			(0.009)	(0.003)	(0.046)	(0.095
Master's degree*ln (MSA pop)					0.032***	0.04
					(0.003)	(0.006
Professional degree			0.913***	0.904***	1.036***	1.38
			(0.011)	(0.004)	(0.080)	(0.168
Professional degree*ln (MSA pop)					-0.008	-0.03
					(0.006)	(0.011
Ph. D.			0.846***	0.845***	0.821***	0.33
			(0.011)	(0.005)	(0.079)	(0.205
Ph. D.*ln (MSA pop)					0.002	0.03
					(0.006)	(0.013
Female	-0.198***	-0.192***				
	(0.004)	(0.002)				
White	0.107***	0.111***				
	(0.011)	(0.002)				
Married	-0.048***	-0.049***				
	(0.001)	(0.000)				
Age	0.058***	0.059***				
	(0.001)	(0.000)				
Age^2	-0.001***	-0.001***				
	(0.000)	(0.000)				
Veteran	-0.024***	-0.025***				
	(0.006)	(0.003)				
Immigrant	-0.179***	-0.194***				
	(0.020)	(0.003)				
Unemployment rate	-0.018***	-0.019***				
	(0.005)	(0.001)				

Table 3 Cont. (2)

Big move	-0.082	***	-0.074	***
	(0.015)		(0.011)	
Hours worked	0.024	***	0.025	***
	(0.000)		(0.000)	
Health Care	1.280	***	1.539	***
	(0.146)		(0.025)	
Oil and Gas Extraction/Mining/Quarrying	1.431	***	1.822	***
	(0.183)		(0.031)	
Utilities	1.394	***	1.654	***
	(0.148)		(0.026)	
Construction	1.052	***	1.329	***
	(0.159)		(0.027)	
Manufacturing	1.187	***	1.465	***
	(0.154)		(0.025)	
Wholesale trade	1.229	***	1.530	***
	(0.167)		(0.028)	
Retail trade	0.932	***	1.192	***
	(0.147)		(0.025)	
Transportation/Warehousing	1.101	***	1.386	***
	(-0.163)		(-0.027)	
Information	1.411	***	1.719	***
	(0.177)		(0.028)	
Finance/Insurance	1.380	***	1.666	***
	(0.164)		(0.026)	
Professional/Scientific/Technical services	1.272	***	1.532	***
	(0.154)		(0.024)	
Educational services	1.172	***	1.436	***
	(0.150)		(0.025)	

Table 3 Cont. (3)

Social assistance	1.002***	1.295***				
	(0.167)	(0.028)				
Entertainment/Arts/Recreation	0.850***	1.115***				
	(0.149)	(0.025)				
Other services	0.971***	1.248***				
	(0.166)	(0.027)				
Public Administration	1.409***	1.703***				
	(0.174)	(0.027)				
Military	1.105***	1.412***				
	(0.173)	(0.029)				
Industry employment share	0.018***	0.026***				
	(0.004)	(0.001)				
New England	0.057**	0.032***				
	(0.027)	(0.004)				
Middle Atlantic	-0.006	-0.037***				
	(0.028)	(0.005)				
East North Central	-0.050**	-0.067***				
	(0.021)	(0.003)				
West North Central	-0.047*	-0.035***				
	(0.025)	(0.004)				
East South Central	-0.019	0.010				
	(0.020)	(0.006)				
West South Central	-0.069***	-0.066***				
	(0.022)	(0.003)				
Mountain	-0.007	-0.002				
	(0.027)	(0.004)				
Pacific	0.070*	0.034***				
	(0.041)	(0.005)				
Observations	859007	696130	859007	696130	859007	6961

1st stage F-statistic (p-value)		9729.15 (0.0001)		8110.79 (0.0001)		6663.89 (0
R^2	0.344	0.339	0.461	0.46	0.462	0.46

* significant at 10%

** significant at 5%

*** significant at 1%

Appendix Table 4A-1: Average Return to Field of Degree

	Dependent variable: Log of annual wages											
	STEM				STEM-FOD				FOD			
	OLS		IV		OLS		IV		OLS		IV	
ln (MSA population)	0.070	***	0.085	***	0.070	***	0.083	***	0.070	***	0.083	***
	(0.005)		(0.007)		(0.005)		(0.007)		(0.005)		(0.007)	
STEM	0.168	***	0.166	***	0.126	***	0.125	***				
	(0.006)		(0.003)		(0.005)		(0.003)					
Agriculture					-0.070	***	-0.081	***	-0.070	***	-0.081	***
					(0.009)		(0.011)		(0.009)		(0.011)	
Architecture					-0.109	***	-0.118	***	-0.109	***	-0.117	***
					(0.017)		(0.013)		(0.017)		(0.013)	
Computer Science*									0.113	***	0.114	***
									(0.012)		(0.007)	
Education					-0.084	***	-0.088	***	-0.085	***	-0.090	***
					(0.005)		(0.005)		(0.006)		(0.005)	
Engineering*									0.146	***	0.143	***
									(0.009)		(0.005)	
Fine Arts					-0.175	***	-0.176	***	-0.176	***	-0.177	***
					(0.008)		(0.006)		(0.008)		(0.006)	
Fitness					-0.098	***	-0.094	***	-0.100	***	-0.096	***
					(0.011)		(0.014)		(0.011)		(0.014)	
Government					0.007		0.011	*	0.007		0.010	*
					(0.009)		(0.006)		(0.009)		(0.006)	
History					-0.008		-0.004		-0.008		-0.004	
					(0.007)		(0.008)		(0.007)		(0.008)	
Languages					-0.050	***	-0.048	***	-0.051	***	-0.049	***
					(0.013)		(0.011)		(0.013)		(0.011)	

Table 4A-1 Cont.

Law			-0.111 ***	-0.106 ***	-0.112 ***	-0.106 ***
			(0.035)	(0.029)	(0.035)	(0.029)
Liberal Arts			-0.068 ***	-0.067 ***	-0.070 ***	-0.068 ***
			(0.007)	(0.006)	(0.007)	(0.006)
Mathematics*					0.118 ***	0.122 ***
					(0.011)	(0.009)
Media			-0.076 ***	-0.076 ***	-0.077 ***	-0.077 ***
			(0.005)	(0.006)	(0.005)	(0.006)
Medicine*					0.114 ***	0.113 ***
					(0.007)	(0.006)
Psychology			-0.038 ***	-0.037 ***	-0.040 ***	-0.039 ***
			(0.007)	(0.006)	(0.007)	(0.006)
Religion			-0.215 ***	-0.210 ***	-0.216 ***	-0.211 ***
			(0.012)	(0.010)	(0.012)	(0.010)
Science*					0.119 ***	0.117 ***
					(0.006)	(0.005)
Social Science			-0.004	0.001	-0.005	0.000
			(0.011)	(0.005)	(0.011)	(0.005)
Social Work			-0.124 ***	-0.128 ***	-0.127 ***	-0.131 ***
			(0.011)	(0.012)	(0.012)	(0.012)
Observations	333530	282668	333530	282668	333530	282668
1st stage F-statistic (p-value)		4016.16 (0.0001)		2901.52 (0.0001)		2699.19 (0.0001)
R^2	0.36	0.351	0.363	0.355	0.363	0.355

* significant at 10%
** significant at 5%
*** significant at 1%

Appendix Table 4A-2: Ranking of Average Returns to Field of Degree

	STEM				STEM-FOD				FOD			
	OLS		IV		OLS		IV		OLS		IV	
1	***	STEM	***	STEM	***	*STEM*	***	*STEM*	***	*Engineering*	***	*Engineering*
2	(ref)	Other	(ref)	Other		Government	*	Government	***	*Science*	***	*Mathematics*
3					(ref)	Business		Social Science	***	*Mathematics*	***	*Science*
4						Social Science	(ref)	Business	***	*Medicine*	***	*Computer Science*
5						History		History	***	*Computer Science*	***	*Medicine*
6					***	Psychology	***	Psychology		Government	*	Government
7					***	Languages	***	Languages	(ref)	Business		Social Science
8					***	Liberal Arts	***	Liberal Arts		Social Science	(ref)	Business
9					***	Agriculture	***	Media		History		History
10					***	Media	***	Agriculture	***	Psychology	***	Psychology
11					***	Education	***	Education	***	Languages	***	Languages
12					***	Fitness	***	Fitness	***	Liberal Arts	***	Liberal Arts
13					***	Architecture	***	Law	***	Agriculture	***	Media
14					***	Law	***	Architecture	***	Media	***	Agriculture
15					***	Social Work	***	Social Work	***	Education	***	Education
16					***	Fine Arts	***	Fine Arts	***	Fitness	***	Fitness
17					***	Religion	***	Religion	***	Architecture	***	Law
18									***	Law	***	Architecture
19									***	Social Work	***	Social Work
20									***	Fine Arts	***	Fine Arts
21									***	Religion	***	Religion

Appendix Table 4B-1: Urban Wage Premium by Field of Degree

	Dependent variable: Log of annual wages											
	STEM				STEM-FOD				FOD			
	OLS		IV		OLS		IV		OLS		IV	
ln (MSA population)	0.049	***	0.048	***	0.046	***	0.027	*	0.0456	***	0.0238	
	(0.007)		(0.013)		(0.007)		(0.015)		(0.007)		(0.015)	
STEM*ln (MSA pop)	-0.017	***	0.000		-0.013	**	0.016	*				
	(0.005)		(0.007)		(0.006)		(0.008)					
Agriculture*ln (MSA pop)					-0.018	***	-0.006		-0.0185	***	-0.0067	
					(0.007)		(0.028)		(0.007)		(0.028)	
Architecture*ln (MSA pop)					-0.021	**	-0.040		-0.0209	**	-0.0397	
					(0.010)		(0.032)		(0.010)		(0.032)	
Computer Science*ln (MSA pop)									0.0074		0.0662	***
									(0.010)		(0.018)	
Education*ln (MSA pop)					-0.007		0.017		-0.0066		0.0171	
					(0.007)		(0.011)		(0.007)		(0.011)	
Engineering*ln (MSA pop)									-0.0193	**	-0.0143	
									(0.008)		(0.012)	
Fine Arts*ln (MSA pop)					0.005		0.023	*	0.0049		0.0235	*
					(0.005)		(0.014)		(0.005)		(0.014)	
Fitness*ln (MSA pop)					-0.009		-0.053		-0.0089		-0.0530	
					(0.011)		(0.034)		(0.011)		(0.034)	
Government*ln (MSA pop)					0.018	**	0.041	**	0.0177	**	0.0405	**
					(0.008)		(0.016)		(0.008)		(0.016)	
History*ln (MSA pop)					0.010	**	0.027		0.0096	**	0.0264	
					(0.005)		(0.020)		(0.005)		(0.020)	
Languages*ln (MSA pop)					0.009		0.034		0.0093		0.0341	
					(0.010)		(0.029)		(0.010)		(0.029)	
Law*ln (MSA pop)					0.018		-0.096		0.0179		-0.0958	
					(0.025)		(0.087)		(0.025)		(0.087)	

Table 4B-1 Cont.

	(1)	(2)	(3)	(4)	(5)	(6)
Liberal Arts*ln (MSA pop)			0.007 *	0.027 *	0.0067 *	0.0269 *
			(0.004)	(0.014)	(0.004)	(0.014)
Mathematics*ln (MSA pop)					0.0188 ***	0.0280
					(0.007)	(0.022)
Media*ln (MSA pop)			0.008 **	0.023	0.0084 **	0.0229
			(0.003)	(0.015)	(0.003)	(0.015)
Medicine*ln (MSA pop)					-0.0128 **	0.0306 **
					(0.006)	(0.012)
Psychology*ln (MSA pop)			0.002	0.045 ***	0.0022	0.0450 ***
			(0.005)	(0.014)	(0.005)	(0.014)
Religion*ln (MSA pop)			-0.011	0.008	-0.0106	0.0082
			(0.010)	(0.022)	(0.010)	(0.022)
Science*ln (MSA pop)					-0.0213 ***	0.0114
					(0.006)	(0.012)
Social Science*ln (MSA pop)			0.020 ***	0.022 *	0.0197 ***	0.0217 *
			(0.005)	(0.013)	(0.005)	(0.013)
Social Work*ln (MSA pop)			0.000	0.044	0.0000	0.0444
			(0.010)	(0.027)	(0.010)	(0.027)
Observations	333530	282668	333530	282668	333530	282668
1st stage F-statistic (p-value)		3732.06 (0.0001)		2174.82 (0.0001)		1958.09 (0.0001)
R^2	0.36	0.351	0.364	0.355	0.364	0.355

* significant at 10%
** significant at 5%
*** significant at 1%

Appendix Table 4B-2: Ranking of Urban Wage Premium for Field of Degree

`	STEM						STEM-FOD					
	OLS			IV			OLS			IV		
1	***	Other	4.91%		*STEM*	4.77%	***	Social Science	6.60%	***	Psychology	7.18%
2	***	*STEM*	3.21%	***	Other	4.75%		Law	6.42%		Social Work	7.09%
3							**	Government	6.41%	**	Government	6.76%
4							**	History	5.60%		Languages	6.08%
5								Languages	5.56%	*	Liberal Arts	5.37%
6							**	Media	5.47%		History	5.35%
7							*	Liberal Arts	5.31%	*	Fine Arts	5.01%
8								Fine Arts	5.12%		Media	4.98%
9								Psychology	4.85%	*	Social Science	4.86%
10							***	Business	4.64%		Education	4.38%
11								Social Work	4.63%	*	*STEM*	4.26%
12								Education	3.99%		Religion	3.51%
13								Fitness	3.75%	*	Business	2.70%
14								Religion	3.58%		Agriculture	2.05%
15							**	*STEM*	3.31%		Architecture	-1.28%
16							***	Agriculture	2.80%		Fitness	-2.59%
17							**	Architecture	2.54%		Law	-6.87%

Table 4B-2 Cont.

`		FOD				
		OLS			IV	
1	***	Social Science	6.52%	***	*Computer Science*	9.00%
2	***	*Mathematics*	6.44%	***	Psychology	6.88%
3		Law	6.35%		Social Work	6.82%
4	**	Government	6.33%	**	Government	6.43%
5	**	History	5.52%		Languages	5.79%
6		Languages	5.48%	**	*Medicine*	5.44%
7	**	Media	5.39%		*Mathematics*	5.18%
8		*Computer Science*	5.30%	*	Liberal Arts	5.07%
9	*	Liberal Arts	5.23%		History	5.02%
10		Fine Arts	5.05%	*	Fine Arts	4.73%
11		Psychology	4.77%		Media	4.67%
12	***	Business	4.56%	*	Social Science	4.55%
13		Social Work	4.55%		Education	4.09%
14		Education	3.90%		*Science*	3.52%
15		Fitness	3.66%		Religion	3.20%
16		Religion	3.50%		Business	2.38%
17	**	*Medicine*	3.28%		Agriculture	1.71%
18	***	Agriculture	2.70%		*Engineering*	0.95%
19	**	*Engineering*	2.62%		Architecture	-1.59%
20	**	Architecture	2.46%		Fitness	-2.92%
21	***	*Science*	2.42%		Law	-7.20%

Appendix Table 5A-1: Average Return to Field of Degree-Educational Attainment Interactions

	Dependent variable: Log of annual wages							
	STEM-FOD				FOD			
	OLS		IV		OLS		IV	
ln (MSA population)	0.066	***	0.075	***	0.066	***	0.075	***
	(0.005)		(0.007)		(0.005)		(0.007)	
STEM*Bachelor's	0.088	***	0.086	***				
	(0.004)		(0.004)					
STEM*Master's	0.249	***	0.249	***				
	(0.008)		(0.005)					
STEM*Professional	0.524	***	0.506	***				
	(0.016)		(0.008)					
STEM*Ph. D.	0.392	***	0.390	***				
	(0.017)		(0.008)					
Agriculture*Bachleor's	-0.101	***	-0.120	***	-0.103	***	-0.121	***
	(0.012)		(0.013)		(0.012)		(0.013)	
Agriculture*Master's	0.094	***	0.105	***	0.093	***	0.104	***
	(0.020)		(0.022)		(0.020)		(0.022)	
Agriculture*Professional	0.260	***	0.270	***	0.261	***	0.271	***
	(0.036)		(0.040)		(0.036)		(0.040)	
Agriculture*Ph. D.	0.302	***	0.259	***	0.301	***	0.260	***
	(0.041)		(0.046)		(0.041)		(0.046)	
Architecture*Bachelor's	-0.082	***	-0.093	***	-0.081	***	-0.092	***
	(0.016)		(0.016)		(0.016)		(0.016)	
Architecture*Master's	0.025		0.023		0.026		0.024	
	(0.029)		(0.023)		(0.029)		(0.023)	
Architecture*Professional	0.017		0.003		0.018		0.004	
	(0.054)		(0.049)		(0.054)		(0.049)	
Architecture*Ph. D.	0.214	**	0.191		0.214	**	0.191	*
	(0.093)		(0.116)		(0.093)		(0.116)	
Business*Master’s	0.195	***	0.196	***	0.195	***	0.196	***
	(0.006)		(0.006)		(0.006)		(0.006)	
Business*Professional	0.332	***	0.331	***	0.333	***	0.332	***
	(0.020)		(0.013)		(0.020)		(0.013)	
Business*Ph. D.	0.321	***	0.294	***	0.321	***	0.294	***
	(0.033)		(0.027)		(0.033)		(0.027)	
Computer Science*Bachelor's					0.115	***	0.114	***
					(0.009)		(0.008)	
Computer Science*Master's					0.316	***	0.315	***
					(0.022)		(0.013)	

Table 5A-1 Cont. (1)

Computer Science*Professional					0.281	***	0.283	***
					(0.060)		(0.052)	
Computer Science*Ph. D.					0.408	***	0.425	***
					(0.042)		(0.045)	
Education*Bachelor's	-0.122	***	-0.134	***	-0.126	***	-0.137	***
	(0.007)		(0.006)		(0.007)		(0.006)	
Education*Master's	0.121	***	0.123	***	0.116	***	0.118	***
	(0.009)		(0.007)		(0.010)		(0.007)	
Education*Professional	0.174	***	0.170	***	0.171	***	0.167	***
	(0.024)		(0.020)		(0.023)		(0.020)	
Education*Ph. D.	0.268	***	0.260	***	0.264	***	0.257	***
	(0.017)		(0.021)		(0.017)		(0.021)	
Engineering*Bachelor's					0.127	***	0.121	***
					(0.009)		(0.006)	
Engineering*Master's					0.301	***	0.298	***
					(0.011)		(0.007)	
Engineering*Professional					0.338	***	0.344	***
					(0.023)		(0.020)	
Engineering*Ph. D.					0.444	***	0.442	***
					(0.018)		(0.016)	
Fine Arts*Bachelor's	-0.179	***	-0.178	***	-0.181	***	-0.180	***
	(0.010)		(0.007)		(0.010)		(0.007)	
Fine Arts*Master's	-0.015		-0.018		-0.018		-0.021	*
	(0.013)		(0.013)		(0.014)		(0.013)	
Fine Arts*Professional	0.119	***	0.133	***	0.120	***	0.133	***
	(0.039)		(0.032)		(0.038)		(0.032)	
Fine Arts*Ph. D.	0.181	***	0.167	***	0.177	***	0.164	***
	(0.029)		(0.035)		(0.029)		(0.035)	
Fitness*Bachelor's	-0.128	***	-0.125	***	-0.130	***	-0.126	***
	(0.010)		(0.017)		(0.010)		(0.016)	
Fitness*Master's	0.094	***	0.105	***	0.093	***	0.104	***
	(0.0249)		(0.028)		(0.025)		(0.028)	
Fitness*Professional	0.260	***	0.220	***	0.265	***	0.225	***
	(0.0630)		(0.057)		(0.063)		(0.057)	
Fitness*Ph. D.	0.268	***	0.261	***	0.271	***	0.265	***
	(0.0915)		(0.074)		(0.091)		(0.074)	
Government*Bachelor's	-0.050	***	-0.048	***	-0.050	***	-0.049	***
	(0.008)		(0.007)		(0.008)		(0.007)	
Government*Master's	0.143	***	0.142	***	0.142	***	0.141	***
	(0.011)		(0.011)		(0.011)		(0.011)	

Table 5A-1 Cont. (2)

Government*Professional	0.359	***	0.364	***	0.358	***	0.363	***
	(0.018)		(0.013)		(0.018)		(0.013)	
Government*Ph. D.	0.330	***	0.323	***	0.328	***	0.321	***
	(0.0309)		(0.029)		(0.031)		(0.029)	
History*Bachelor's	-0.098	***	-0.092	***	-0.099	***	-0.093	***
	(0.011)		(0.011)		(0.011)		(0.011)	
History*Master's	0.077	***	0.083	***	0.074	***	0.081	***
	(0.012)		(0.014)		(0.012)		(0.014)	
History*Professional	0.408	***	0.407	***	0.408	***	0.407	***
	(0.018)		(0.018)		(0.018)		(0.018)	
History*Ph. D.	0.232	***	0.217	***	0.230	***	0.215	***
	(0.028)		(0.032)		(0.028)		(0.032)	
Languages*Bachelor's	-0.106	***	-0.101	***	-0.108	***	-0.102	***
	(0.013)		(0.016)		(0.014)		(0.016)	
Languages*Master's	0.076	***	0.075	***	0.074	***	0.073	***
	(0.013)		(0.018)		(0.013)		(0.018)	
Languages*Professional	0.264	***	0.267	***	0.265	***	0.267	***
	(0.043)		(0.036)		(0.043)		(0.036)	
Languages*Ph. D.	0.236	***	0.240	***	0.233	***	0.238	***
	(0.0426)		(0.037)		(0.042)		(0.037)	
Law*Bachelor's	-0.199	***	-0.191	***	-0.200	***	-0.192	***
	(0.038)		(0.034)		(0.038)		(0.034)	
Law*Master's	0.202	***	0.222	***	0.201	***	0.221	***
	(0.0614)		(0.077)		(0.062)		(0.077)	
Law*Professional	0.247	***	0.250	***	0.247	***	0.250	***
	(0.081)		(0.066)		(0.081)		(0.065)	
Law*Ph. D.	0.252		0.278		0.252		0.278	
	(0.187)		(0.191)		(0.188)		(0.190)	
Liberal Arts*Bachelor's	-0.111	***	-0.108	***	-0.113	***	-0.109	***
	(0.008)		(0.008)		(0.008)		(0.008)	
Liberal Arts*Master's	0.055	***	0.056	***	0.052	***	0.053	***
	(0.012)		(0.010)		(0.012)		(0.010)	
Liberal Arts*Professional	0.352	***	0.350	***	0.352	***	0.350	***
	(0.022)		(0.017)		(0.022)		(0.017)	
Liberal Arts*Ph. D.	0.231	***	0.220	***	0.228	***	0.217	***
	(0.027)		(0.025)		(0.027)		(0.025)	
Mathematics*Bachelor's					0.052	***	0.053	***
					(0.017)		(0.013)	
Mathematics*Master's					0.244	***	0.253	***
					(0.018)		(0.015)	
Mathematics*Professional					0.507	***	0.498	***
					(0.050)		(0.036)	

Table 5A-1 Cont. (3)

Mathematics*Ph. D.					0.430	***	0.432	***
					(0.024)		(0.026)	
Media*Bachelor's	-0.076	***	-0.074	***	-0.078	***	-0.075	***
	(0.006)		(0.007)		(0.006)		(0.007)	
Media*Master's	0.091	***	0.092	***	0.089	***	0.090	***
	(0.011)		(0.014)		(0.011)		(0.014)	
Media*Professional	0.281	***	0.272	***	0.280	***	0.272	***
	(0.031)		(0.029)		(0.031)		(0.029)	
Media*Ph. D.	0.214	***	0.197	***	0.212	***	0.194	***
	(0.0402)		(0.047)		(0.041)		(0.047)	
Medicine*Bachelor's					0.141	***	0.141	***
					(0.009)		(0.007)	
Medicine*Master's					0.244	***	0.244	***
					(0.009)		(0.010)	
Medicine*Professional					0.472	***	0.447	***
					(0.021)		(0.015)	
Medicine*Ph. D.					0.508	***	0.510	***
					(0.020)		(0.020)	
Psychology*Bachelor's	-0.106	***	-0.104	***	-0.107	***	-0.105	***
	(0.006)		(0.008)		(0.006)		(0.008)	
Psychology*Master's	0.076	***	0.081	***	0.075	***	0.080	***
	(0.013)		(0.009)		(0.014)		(0.009)	
Psychology*Professional	0.379	***	0.365	***	0.382	***	0.368	***
	(0.020)		(0.018)		(0.020)		(0.018)	
Psychology*Ph. D.	0.275	***	0.267	***	0.275	***	0.267	***
	(0.018)		(0.018)		(0.018)		(0.018)	
Religion*Bachelor's	-0.250	***	-0.252	***	-0.251	***	-0.253	***
	(0.016)		(0.015)		(0.016)		(0.015)	
Religion*Master's	-0.174	***	-0.162	***	-0.175	***	-0.162	***
	(0.020)		(0.018)		(0.0198)		(0.018)	
Religion*Professional	0.212	***	0.197	***	0.213	***	0.198	***
	(0.025)		(0.028)		(0.024)		(0.028)	
Religion*Ph. D.	0.003		0.011		0.002		0.010	
	(0.035)		(0.030)		(0.035)		(0.030)	
Science*Bachelor's					-0.046	***	-0.045	***
					(0.007)		(0.007)	
Science*Master's					0.153	***	0.155	***
					(0.009)		(0.009)	
Science*Professional					0.590	***	0.572	***
					(0.019)		(0.009)	
Science*Ph. D.					0.346	***	0.340	***
					(0.014)		(0.010)	

Table 5A-1 Cont. (4)

Social Science*Bachelor's	-0.053	***	-0.047	***	-0.054	***	-0.048	***
	(0.009)		(0.006)		(0.009)		(0.006)	
Social Science*Master's	0.139	***	0.146	***	0.138	***	0.145	***
	(0.017)		(0.009)		(0.018)		(0.009)	
Social Science*Professional	0.413	***	0.411	***	0.413	***	0.412	***
	(0.019)		(0.016)		(0.019)		(0.016)	
Social Science*Ph. D.	0.364	***	0.354	***	0.362	***	0.352	***
	(0.020)		(0.021)		(0.019)		(0.021)	
Social Work*Bachelor's	-0.171	***	-0.171	***	-0.171	***	-0.171	***
	(0.017)		(0.017)		(0.018)		(0.017)	
Social Work*Master's	0.051	***	0.043	**	0.051	***	0.044	**
	(0.014)		(0.018)		(0.014)		(0.018)	
Social Work*Professional	0.212		0.179	***	0.213		0.181	***
	(0.141)		(0.069)		(0.134)		(0.069)	
Social Work*Ph. D.	0.108		0.118		0.108		0.119	
	(0.069)		(0.089)		(0.069)		(0.089)	
Observations	333530		282668		333530		282668	
1st stage F-statistic (p-value)			1482.44 (0.0001)				1287.35 (0.0001)	
R^2	0.39		0.382		0.393		0.384	

* significant at 10%
** significant at 5%
*** significant at 1%

Appendix Table 5A-2:

Ranking of Average Returns to Field of Degree-Educational Attainment Interactions (STEM)

		STEM-FOD					
		OLS			IV		
1		***	*STEM*Professional*	52.35%	***	*STEM*Professional*	50.63%
2		***	Social Science*Professional	41.25%	***	Social Science*Professional	41.09%
3		***	History*Professional	40.81%	***	History*Professional	40.71%
4		***	*STEM*Ph. D.*	39.22%	***	*STEM*Ph. D.*	38.95%
5		***	Psychology*Professional	37.93%	***	Psychology*Professional	36.55%
6		***	Social Science*Ph. D.	36.41%	***	Government*Professional	36.36%
7		***	Government*Professional	35.86%	***	Social Science*Ph. D.	35.40%
8		***	Liberal Arts*Professional	35.21%	***	Liberal Arts*Professional	34.98%
9	Q4	***	Business*Professional	33.19%	***	Business*Professional	33.11%
10		***	Government*Ph. D.	32.99%	***	Government*Ph. D.	32.27%
11		***	Business*Ph. D.	32.10%	***	Business*Ph. D.	29.36%
12		***	Agriculture*Ph. D.	30.15%		Law*Ph. D.	27.76%
13		***	Media*Professional	28.07%	***	Media*Professional	27.22%
14		***	Psychology*Ph. D.	27.47%	***	Agriculture*Professional	26.99%
15		***	Fitness*Ph. D.	26.78%	***	Languages*Professional	26.66%
16		***	Education*Ph. D.	26.75%	***	Psychology*Ph. D.	26.65%
17		***	Languages*Professional	26.40%	***	Fitness*Ph. D.	26.10%
18		***	Fitness*Professional	26.00%	***	Education*Ph. D.	26.03%
19		***	Agriculture*Professional	25.96%	***	Agriculture*Ph. D.	25.95%
20			Law*Ph. D.	25.24%	***	Law*Professional	25.03%
21		***	*STEM*Master's*	24.87%	***	*STEM*Master's*	24.95%
22		***	Law*Professional	24.70%	***	Languages*Ph. D.	24.03%
23		***	Languages*Ph. D.	23.59%	***	Law*Master's	22.19%
24		***	History*Ph. D.	23.21%	***	Fitness*Professional	22.00%
25		***	Liberal Arts*Ph. D.	23.08%	***	Liberal Arts*Ph. D.	21.98%
26	Q3	**	Architecture*Ph. D.	21.45%	***	History*Ph. D.	21.74%
27		***	Media*Ph. D.	21.43%	***	Religion*Professional	19.72%
28		***	Religion*Professional	21.22%	***	Media*Ph. D.	19.66%
29			Social Work*Professional	21.22%	***	Business*Master’s	19.60%
30		***	Law*Master's	20.21%		Architecture*Ph. D.	19.07%
31		***	Business*Master’s	19.51%	***	Social Work*Professional	17.92%
32		***	Fine Arts*Ph. D.	18.06%	***	Education*Professional	16.98%
33		***	Education*Professional	17.35%	***	Fine Arts*Ph. D.	16.67%
34		***	Government*Master's	14.30%	***	Social Science*Master's	14.61%

Table 5A-2 Cont.

35		***	Social Science*Master's	13.93%	***	Government*Master's	14.21%
36		***	Education*Master's	12.07%	***	Fine Arts*Professional	13.26%
37		***	Fine Arts*Professional	11.94%	***	Education*Master's	12.26%
38			Social Work*Ph. D.	10.80%		Social Work*Ph. D.	11.83%
39		***	Agriculture*Master's	9.41%	***	Agriculture*Master's	10.49%
40		***	Fitness*Master's	9.40%	***	Fitness*Master's	10.46%
41		***	Media*Master's	9.14%	***	Media*Master's	9.22%
42		***	*STEM*Bachelor's*	8.81%	***	*STEM*Bachelor's*	8.64%
43	Q2	***	History*Master's	7.65%	***	History*Master's	8.33%
44		***	Languages*Master's	7.65%	***	Psychology*Master's	8.13%
45		***	Psychology*Master's	7.61%	***	Languages*Master's	7.54%
46		***	Liberal Arts*Master's	5.46%	***	Liberal Arts*Master's	5.60%
47		***	Social Work*Master's	5.10%	**	Social Work*Master's	4.34%
48			Architecture*Master's	2.51%		Architecture*Master's	2.35%
49			Architecture*Professional	1.67%		Religion*Ph. D.	1.14%
50			Religion*Ph. D.	0.29%		Architecture*Professional	0.32%
51		(ref)	Business*Bachelor's		(ref)	Business*Bachelor's	
52			Fine Arts*Master's	-1.48%		Fine Arts*Master's	-1.84%
53		***	Government*Bachelor's	-4.96%	***	Social Science*Bachelor's	-4.71%
54		***	Social Science*Bachelor's	-5.34%	***	Government*Bachelor's	-4.84%
55		***	Media*Bachelor's	-7.65%	***	Media*Bachelor's	-7.41%
56		***	Architecture*Bachelor's	-8.23%	***	History*Bachelor's	-9.21%
57		***	History*Bachelor's	-9.80%	***	Architecture*Bachelor's	-9.30%
58		***	Agriculture*Bachleor's	-10.15%	***	Languages*Bachelor's	-10.11%
59		***	Psychology*Bachelor's	-10.61%	***	Psychology*Bachelor's	-10.38%
60	Q1	***	Languages*Bachelor's	-10.62%	***	Liberal Arts*Bachelor's	-10.81%
61		***	Liberal Arts*Bachelor's	-11.13%	***	Agriculture*Bachleor's	-11.97%
62		***	Education*Bachelor's	-12.22%	***	Fitness*Bachelor's	-12.54%
63		***	Fitness*Bachelor's	-12.85%	***	Education*Bachelor's	-13.36%
64		***	Social Work*Bachelor's	-17.06%	***	Religion*Master's	-16.17%
65		***	Religion*Master's	-17.43%	***	Social Work*Bachelor's	-17.07%
66		***	Fine Arts*Bachelor's	-17.91%	***	Fine Arts*Bachelor's	-17.81%
67		***	Law*Bachelor's	-19.92%	***	Law*Bachelor's	-19.13%
68		***	Religion*Bachelor's	-25.04%	***	Religion*Bachelor's	-25.23%

Appendix Table 5A-3: Ranking of Average Returns to Field of Degree-Educational Attainment Interactions

		FOD					
		OLS			IV		
1		***	*Science*Professional*	58.96%	***	*Science*Professional*	57.22%
2		***	*Medicine*Ph. D.*	50.79%	***	*Medicine*Ph. D.*	50.96%
3		***	*Mathematics*Professional*	50.74%	***	*Mathematics*Professional*	49.82%
4		***	*Medicine*Professional*	47.24%	***	*Medicine*Professional*	44.65%
5		***	*Engineering*Ph. D.*	44.43%	***	*Engineering*Ph. D.*	44.21%
6		***	*Mathematics*Ph. D.*	43.04%	***	*Mathematics*Ph. D.*	43.21%
7		***	Social Science*Professional	41.32%	***	*Computer Science*Ph. D.*	42.52%
8		***	History*Professional	40.83%	***	Social Science*Professional	41.16%
9		***	*Computer Science*Ph. D.*	40.80%	***	History*Professional	40.72%
10		***	Psychology*Professional	38.19%	***	Psychology*Professional	36.81%
11	Q4	***	Social Science*Ph. D.	36.21%	***	Government*Professional	36.33%
12		***	Government*Professional	35.83%	***	Social Science*Ph. D.	35.24%
13		***	Liberal Arts*Professional	35.22%	***	Liberal Arts*Professional	35.00%
14		***	*Science*Ph. D.*	34.57%	***	*Engineering*Professional*	34.45%
15		***	*Engineering*Professional*	33.85%	***	*Science*Ph. D.*	34.03%
16		***	Business*Professional	33.28%	***	Business*Professional	33.20%
17		***	Government*Ph. D.	32.83%	***	Government*Ph. D.	32.12%
18		***	Business*Ph. D.	32.07%	***	*Computer Science*Master's*	31.50%
19		***	*Computer Science*Master's*	31.61%	***	*Engineering*Master's*	29.76%
20		***	Agriculture*Ph. D.	30.15%	***	Business*Ph. D.	29.36%
21		***	*Engineering*Master's*	30.12%	***	*Computer Science*Professional*	28.27%

Table 5A-3 Cont. (1)

22		***	*Computer Science*Professional*	28.13%		Law*Ph. D.	27.77%
23		***	Media*Professional	28.04%	***	Media*Professional	27.20%
24		***	Psychology*Ph. D.	27.51%	***	Agriculture*Professional	27.13%
25		***	Fitness*Ph. D.	27.14%	***	Languages*Professional	26.73%
26		***	Fitness*Professional	26.51%	***	Psychology*Ph. D.	26.71%
27		***	Languages*Professional	26.46%	***	Fitness*Ph. D.	26.54%
28		***	Education*Ph. D.	26.41%	***	Agriculture*Ph. D.	26.03%
29		***	Agriculture*Professional	26.14%	***	Education*Ph. D.	25.71%
30			Law*Ph. D.	25.21%	***	*Mathematics*Master's*	25.34%
31		***	Law*Professional	24.67%	***	Law*Professional	25.01%
32	Q3	***	*Medicine*Master's*	24.37%	***	*Medicine*Master's*	24.35%
33		***	*Mathematics*Master's*	24.37%	***	Languages*Ph. D.	23.81%
34		***	Languages*Ph. D.	23.33%	***	Fitness*Professional	22.50%
35		***	History*Ph. D.	22.95%	***	Law*Master's	22.05%
36		***	Liberal Arts*Ph. D.	22.78%	***	Liberal Arts*Ph. D.	21.70%
37		**	Architecture*Ph. D.	21.41%	***	History*Ph. D.	21.51%
38			Social Work*Professional	21.35%	***	Religion*Professional	19.76%
39		***	Religion*Professional	21.25%	***	Business*Master’s	19.64%
40		***	Media*Ph. D.	21.18%	***	Media*Ph. D.	19.45%
41		***	Law*Master's	20.08%	*	Architecture*Ph. D.	19.10%
42		***	Business*Master’s	19.54%	***	Social Work*Professional	18.07%

Table 5A-3 Cont. (2)

43		***	Fine Arts*Ph. D.	17.73%	***	Education*Professional	16.73%
44		***	Education*Professional	17.08%	***	Fine Arts*Ph. D.	16.37%
45		***	*Science*Master's*	15.34%	***	*Science*Master's*	15.48%
46		***	Government*Master's	14.17%	***	Social Science*Master's	14.51%
47		***	*Medicine*Bachelor's*	14.15%	***	*Medicine*Bachelor's*	14.11%
48		***	Social Science*Master's	13.81%	***	Government*Master's	14.10%
49		***	*Engineering*Bachelor's*	12.71%	***	Fine Arts*Professional	13.35%
50		***	Fine Arts*Professional	11.98%	***	*Engineering*Bachelor's*	12.11%
51		***	Education*Master's	11.59%		Social Work*Ph. D.	11.88%
52		***	*Computer Science*Bachelor's*	11.46%	***	Education*Master's	11.80%
53	Q2		Social Work*Ph. D.	10.81%	***	*Computer Science*Bachelor's*	11.44%
54		***	Agriculture*Master's	9.31%	***	Agriculture*Master's	10.40%
55		***	Fitness*Master's	9.29%	***	Fitness*Master's	10.37%
56		***	Media*Master's	8.93%	***	Media*Master's	9.03%
57		***	Psychology*Master's	7.49%	***	History*Master's	8.13%
58		***	History*Master's	7.43%	***	Psychology*Master's	8.02%
59		***	Languages*Master's	7.39%	***	Languages*Master's	7.30%
60		***	*Mathematics*Bachelor's*	5.22%	***	Liberal Arts*Master's	5.33%
61		***	Liberal Arts*Master's	5.17%	***	*Mathematics*Bachelor's*	5.30%
62		***	Social Work*Master's	5.13%	**	Social Work*Master's	4.38%
63			Architecture*Master's	2.56%		Architecture*Master's	2.41%

Table 5A-3 Cont. (3)

64			Architecture*Professional	1.79%		Religion*Ph. D.	1.01%
65			Religion*Ph. D.	0.15%		Architecture*Professional	0.44%
66		(ref)	Business*Bachelor's		(ref)	Business*Bachelor's	
67			Fine Arts*Master's	-1.75%	*	Fine Arts*Master's	-2.10%
68		***	*Science*Bachelor's*	-4.60%	***	*Science*Bachelor's*	-4.50%
69		***	Government*Bachelor's	-5.05%	***	Social Science*Bachelor's	-4.79%
70		***	Social Science*Bachelor's	-5.44%	***	Government*Bachelor's	-4.93%
71		***	Media*Bachelor's	-7.77%	***	Media*Bachelor's	-7.53%
72		***	Architecture*Bachelor's	-8.14%	***	Architecture*Bachelor's	-9.20%
73		***	History*Bachelor's	-9.92%	***	History*Bachelor's	-9.33%
74	Q1	***	Agriculture*Bachleor's	-10.27%	***	Languages*Bachelor's	-10.23%
75		***	Psychology*Bachelor's	-10.71%	***	Psychology*Bachelor's	-10.47%
76		***	Languages*Bachelor's	-10.76%	***	Liberal Arts*Bachelor's	-10.95%
77		***	Liberal Arts*Bachelor's	-11.28%	***	Agriculture*Bachleor's	-12.07%
78		***	Education*Bachelor's	-12.56%	***	Fitness*Bachelor's	-12.64%
79		***	Fitness*Bachelor's	-12.96%	***	Education*Bachelor's	-13.68%
80		***	Social Work*Bachelor's	-17.13%	***	Religion*Master's	-16.24%
81		***	Religion*Master's	-17.50%	***	Social Work*Bachelor's	-17.14%
82		***	Fine Arts*Bachelor's	-18.07%	***	Fine Arts*Bachelor's	-17.96%
83		***	Law*Bachelor's	-20.04%	***	Law*Bachelor's	-19.24%
84		***	Religion*Bachelor's	-25.09%	***	Religion*Bachelor's	-25.27%

Appendix Table 5B-1: Urban Wage Premium for Field of Degree-Educational Attainment Interactions

	Dependent variable: Log of annual wages							
	STEM-FOD				FOD			
	OLS		IV		OLS		IV	
ln (MSA population)	0.040	***	0.013		0.039	***	0.008	
	(0.007)		(0.015)		(0.007)		(0.015)	
STEM*Bachelor's*ln (MSA pop)	-0.010	*	0.006					
	(0.005)		(0.010)					
STEM*Master's*ln(MSA pop)	-0.001		0.051	***				
	(0.006)		(0.012)					
STEM*Professional*ln(MSA pop)	-0.061	***	-0.029					
	(0.011)		(0.018)					
STEM*Ph. D.*ln(MSA pop)	-0.024	***	0.012					
	(0.007)		(0.021)					
Agriculture*Bachleor's*ln(MSA pop)	-0.026	***	-0.044		-0.025	***	-0.045	
	(0.008)		(0.032)		(0.008)		(0.032\	
Agriculture*Master's*ln(MSA pop)	0.011		0.147	**	0.012		0.147	**
	(0.014)		(0.064)		(0.014)		(0.064)	
Agriculture*Professional*ln(MSA pop)	-0.004		-0.082		-0.005		-0.084	
	(0.023)		(0.107)		(0.023)		(0.107)	
Agriculture*Ph. D.*ln(MSA pop)	-0.077	***	-0.058		-0.076	***	-0.057	
	(0.021)		(0.150)		(0.021)		(0.150)	
Architecture*Bachelor's*ln(MSA pop)	-0.016		-0.018		-0.016		-0.018	
	(0.010)		(0.038)		(0.010)		(0.038)	
Architecture*Master's*ln(MSA pop)	-0.014		-0.037		-0.014		-0.037	
	(0.022)		(0.067)		(0.022)		(0.067)	
Architecture*Professional*ln(MSA pop)	-0.040		-0.152		-0.039		-0.153	
	(0.035)		(0.110)		(0.035)		(0.110)	

Table 5B-1 Cont. (1)

Architecture*Ph. D.*ln(MSA pop)	-0.101		-0.090		-0.100		-0.092	
	(0.078)		(0.221)		(0.078)		(0.221)	
Business*Master's*ln(MSA pop)	0.006	*	0.017		0.006	*	0.017	
	(0.003)		(0.017)		(0.003)		(0.017)	
Business*Professional*ln(MSA pop)	0.002		-0.001		0.002		-0.002	
	(0.014)		(0.037)		(0.014)		(0.037)	
Business*Ph. D.*ln(MSA pop)	-0.043	*	0.209	*	-0.042	*	0.208	*
	(0.025)		(0.107)		(0.025)		(0.107)	
Computer Science*Bachelor's*ln(MSA pop)					0.002		0.027	
					(0.008)		(0.020)	
Computer Science*Master's*ln(MSA pop)					0.008		0.120	***
					(0.019)		(0.038)	
Computer Science*Professional*ln(MSA pop)					0.020		-0.018	
					(0.043)		(0.131)	
Computer Science*Ph. D.*ln(MSA pop)					0.009		0.188	
					(0.027)		(0.143)	
Education*Bachelor's*ln(MSA pop)	-0.019	***	-0.003		-0.019	***	-0.002	
	(0.007)		(0.016)		(0.007)		(0.016)	
Education*Master's*ln(MSA pop)	0.006		0.050	***	0.006		0.050	***
	(0.008)		(0.014)		(0.008)		(0.014)	
Education*Professional*ln(MSA pop)	-0.029	**	-0.091	*	-0.029	**	-0.091	*
	(0.012)		(0.050)		(0.012)		(0.050)	
Education*Ph. D.*ln(MSA pop)	-0.003		-0.007		-0.003		-0.006	
	(0.013)		(0.056)		(0.013)		(0.056)	
Engineering*Bachelor's*ln(MSA pop)					-0.024	***	-0.050	***
					(0.007)		(0.015)	
Engineering*Master's*ln(MSA pop)					-0.012		0.018	
					(0.008)		(0.019)	

Table 5B-1 Cont. (2)

Engineering*Professional*ln(MSA pop)					-0.010		0.052	
					(0.019)		(0.065)	
Engineering*Ph. D.*ln(MSA pop)					-0.027	**	0.072	*
					(0.012)		(0.043)	
Fine Arts*Bachelor's*ln(MSA pop)	0.008		0.027	*	0.008	*	0.027	*
	(0.005)		(0.016)		(0.005)		(0.016)	
Fine Arts*Master's*ln(MSA pop)	0.009		0.042		0.009		0.043	
	(0.009)		(0.027)		(0.009)		(0.027)	
Fine Arts*Professional*ln(MSA pop)	-0.011		0.015		-0.010		0.014	
	(0.031)		(0.073)		(0.031)		(0.073)	
Fine Arts*Ph. D.*ln(MSA pop)	-0.025		-0.076		-0.025		-0.076	
	(0.020)		(0.075)		(0.020)		(0.075)	
Fitness*Bachelor's*ln(MSA pop)	-0.005		-0.044		-0.006		-0.044	
	(0.008)		(0.043)		(0.008)		(0.043)	
Fitness*Master's*ln(MSA pop)	-0.009		-0.063		-0.009		-0.064	
	(0.019)		(0.063)		(0.019)		(0.063)	
Fitness*Professional*ln(MSA pop)	-0.058	*	-0.094		-0.059	*	-0.094	
	(0.032)		(0.133)		(0.032)		(0.133)	
Fitness*Ph. D.*ln(MSA pop)	-0.054		-0.039		-0.053		-0.037	
	(0.083)		(0.116)		(0.084)		(0.116)	
Government*Bachelor's*ln(MSA pop)	0.007		0.035	*	0.007		0.035	
	(0.007)		(0.019)		(0.007)		(0.019)	
Government*Master's*ln(MSA pop)	0.018	**	0.078	**	0.018	**	0.077	
	(0.008)		(0.035)		(0.008)		(0.035)	
Government*Professional*ln(MSA pop)	0.030	**	0.025		0.030	**	0.024	
	(0.013)		(0.038)		(0.012)		(0.038)	
Government*Ph. D.*ln(MSA pop)	-0.005		0.102		-0.005		0.102	
	(0.024)		(0.077)		(0.024)		(0.077)	

Table 5B-1 Cont. (3)

History*Bachelor's*ln(MSA pop)	0.013	**	0.040		0.013	**	0.040
	(0.006)		(0.026)		(0.006)		(0.026)
History*Master's*ln(MSA pop)	0.015	*	0.008		0.015	*	0.007
	(0.008)		(0.034)		(0.008)		(0.034)
History*Professional*ln(MSA pop)	-0.010		-0.026		-0.010		-0.027
	(0.013)		(0.054)		(0.013)		(0.054)
History*Ph. D.*ln(MSA pop)	-0.004		0.041		-0.004		0.040
	(0.019)		(0.073)		(0.019)		(0.073)
Languages*Bachelor's*ln(MSA pop)	0.011		0.070	*	0.011		0.070
	(0.010)		(0.041)		(0.010)		(0.0407)
Languages*Master's*ln(MSA pop)	0.020	**	0.069		0.020	**	0.070
	(0.010)		(0.046)		(0.010)		(0.046)
Languages*Professional*ln(MSA pop)	0.004		-0.141		0.004		-0.141
	(0.033)		(0.128)		(0.034)		(0.128)
Languages*Ph. D.*ln(MSA pop)	-0.014		0.035		-0.014		0.035
	(0.031)		(0.084)		(0.031)		(0.084)
Law*Bachelor's*ln(MSA pop)	0.000		-0.117		0.000		-0.117
	(0.027)		(0.095)		(0.027)		(0.095)
Law*Master's*ln(MSA pop)	0.055		-0.029		0.054		-0.032
	(0.038)		(0.287)		(0.038)		(0.286)
Law*Professional*ln(MSA pop)	0.037		-0.176		0.037		-0.175
	(0.059)		(0.262)		(0.059)		(0.262)
Law*Ph. D.*ln(MSA pop)	-0.106		-0.146		-0.106		-0.144
	(0.120)		(0.936)		(0.121)		(0.934)
Liberal Arts*Bachelor's*ln(MSA pop)	0.009	**	0.034	**	0.009	**	0.034
	(0.004)		(0.017)		(0.004)		(0.017)
Liberal Arts*Master's*ln(MSA pop)	0.019	**	0.072	***	0.019	**	0.071
	(0.008)		(0.024)		(0.008)		(0.024)

Table 5B-1 Cont. (4)

Liberal Arts*Professional*ln(MSA pop)	-0.008		-0.087	*	-0.008		-0.089	
	(0.014)		(0.051)		(0.014)		(0.051)	
Liberal Arts*Ph. D.*ln(MSA pop)	-0.040	***	-0.018		-0.040	***	-0.019	
	(0.012)		(0.050)		(0.012)		(0.050)	
Mathematics*Bachelor's*ln(MSA pop)					-0.003		-0.056	*
					(0.012)		(0.031)	
Mathematics*Master's*ln(MSA pop)					0.041	***	0.072	**
					(0.008)		(0.035)	
Mathematics*Professional*ln(MSA pop)					0.021		-0.015	
					(0.037)		(0.088)	
Mathematics*Ph. D.*ln(MSA pop)					0.014		0.167	**
					(0.018)		(0.070)	
Media*Bachelor's*ln(MSA pop)	0.011	***	0.018		0.010	***	0.017	
	(0.003)		(0.016)		(0.003)		(0.016)	
Media*Master's*ln(MSA pop)	0.010		0.072	**	0.010		0.072	*
	(0.008)		(0.036)		(0.008)		(0.036)	
Media*Professional*ln(MSA pop)	0.010		-0.057		0.010		-0.059	
	(0.019)		(0.077)		(0.019)		(0.077)	
Media*Ph. D.*ln(MSA pop)	-0.025		-0.038		-0.025		-0.039	
	(0.034)		(0.175)		(0.034)		(0.175)	
Medicine*Bachelor's*ln(MSA pop)					-0.004		0.049	***
					(0.007)		(0.014)	
Medicine*Master's*ln(MSA pop)					-0.010	*	0.032	
					(0.006)		(0.022)	
Medicine*Professional*ln(MSA pop)					-0.068	***	0.014	
					(0.013)		(0.035)	
Medicine*Ph. D.*ln(MSA pop)					-0.005		0.007	
					(0.017)		(0.052)	

Table 5B-1 Cont. (5)

Psychology*Bachelor's*ln(MSA pop)	0.003		0.043	**	0.003		0.043	
	(0.006)		(0.019)		(0.005)		(0.019)	
Psychology*Master's*ln(MSA pop)	0.014	**	0.051	**	0.014	**	0.051	
	(0.007)		(0.022)		(0.007)		(0.022)	
Psychology*Professional*ln(MSA pop)	-0.025	*	0.019		-0.025	*	0.019	
	(0.014)		(0.057)		(0.014)		(0.057)	
Psychology*Ph. D.*ln(MSA pop)	-0.030	***	0.020		-0.030	***	0.020	
	(0.011)		(0.051)		(0.011)		(0.051)	
Religion*Bachelor's*ln(MSA pop)	-0.008		0.074	**	-0.008		0.074	
	(0.012)		(0.032)		(0.012)		(0.032)	
Religion*Master's*ln(MSA pop)	-0.017		-0.091	***	-0.018		-0.091	
	(0.012)		(0.034)		(0.012)		(0.034)	
Religion*Professional*ln(MSA pop)	-0.025		0.079		-0.025		0.078	
	(0.020)		(0.078)		(0.020)		(0.078)	
Religion*Ph. D.*ln(MSA pop)	-0.031		-0.028		-0.031		-0.029	
	(0.019)		'(0.060828)		(0.019)		(0.061)	
Science*Bachelor's*ln(MSA pop)					-0.003		0.034	**
					(0.004)		(0.017)	
Science*Master's*ln(MSA pop)					-0.002		0.064	***
					(0.008)		(0.023)	
Science*Professional*ln(MSA pop)					-0.067	***	-0.048	**
					(0.014)		(0.022)	
Science*Ph. D.*ln(MSA pop)					-0.033	***	-0.042	
					(0.007)		(0.028)	
Social Science*Bachelor's*ln(MSA pop)	0.015	***	0.019		0.015	***	0.019	
	(0.005)		(0.016)		(0.005)		(0.016)	
Social Science*Master's*ln(MSA pop)	0.036	***	0.069	***	0.036	***	0.069	***
	(0.008)		(0.022)		(0.008)		(0.022)	

Table 5B-1 Cont. (6)

Social Science*Professional*ln(MSA pop)	-0.008		-0.058		-0.008		-0.060	
	(0.013)		(0.043)		(0.013)		(0.043)	
Social Science*Ph. D.*ln(MSA pop)	-0.008		0.096		-0.007		0.096	
	(0.011)		(0.061)		(0.010)		(0.061)	
Social Work*Bachelor's*ln(MSA pop)	0.008		0.084	**	0.008		0.084	
	(0.013)		(0.036)		(0.014)		(0.036)	
Social Work*Master's*ln(MSA pop)	-0.002		0.058		-0.002		0.058	
	(0.010)		(0.040)		(0.010)		(0.040)	
Social Work*Professional*ln(MSA pop)	-0.182	*	-0.414	***	-0.182	*	-0.411	
	(0.099)		(0.142)		(0.098)		(0.142)	
Social Work*Ph. D.*ln(MSA pop)	0.010		-0.442		0.010		-0.440	
	(0.036)		(0.286)		(0.036)		(0.286)	
Observations	333530		282668		333530		282668	
1st stage F-statistic (p-value)			896.59 (0.0001)				759.14 (0.0001)	
R^2	0.391		0.382		0.394		0.384	

* significant at 10%
** significant at 5%
*** significant at 1%

Appendix Table 5B-2: Ranking of Urban Wage Premium for Field of Degree-Educational Attainment Interactions (STEM)

		STEM-FOD					
		OLS			IV		
1			Law*Master's	9.48%	*	Business*Ph. D.	22.25%
2			Law*Professional	7.69%	**	Agriculture*Master's	16.07%
3		***	Social Science*Master's	7.57%		Government*Ph. D.	11.52%
4		**	Government*Professional	6.98%		Social Science*Ph. D.	10.95%
5		**	Languages*Master's	6.05%	**	Social Work*Bachelor's	9.68%
6		**	Liberal Arts*Master's	5.93%		Religion*Professional	9.26%
7		**	Government*Master's	5.83%	**	Government*Master's	9.08%
8		***	Social Science*Bachelor's	5.53%	**	Religion*Bachelor's	8.69%
9	Q4	*	History*Master's	5.48%	**	Media*Master's	8.52%
10		**	Psychology*Master's	5.44%	***	Liberal Arts*Master's	8.49%
11		**	History*Bachelor's	5.29%	*	Languages*Bachelor's	8.35%
12			Agriculture*Master's	5.15%		Languages*Master's	8.25%
13			Languages*Bachelor's	5.07%	***	Social Science*Master's	8.24%
14		***	Media*Bachelor's	5.06%		Social Work*Master's	7.11%
15			Media*Master's	5.04%	***	*STEM*Master's*	6.42%
16			Social Work*Ph. D.	4.97%	**	Psychology*Master's	6.42%
17			Media*Professional	4.97%	***	Education*Master's	6.28%
18			Fine Arts*Master's	4.95%	**	Psychology*Bachelor's	5.65%
19		**	Liberal Arts*Bachelor's	4.92%		Fine Arts*Master's	5.54%
20			Social Work*Bachelor's	4.85%		History*Ph. D.	5.39%
21			Fine Arts*Bachelor's	4.84%		History*Bachelor's	5.33%
22			Government*Bachelor's	4.73%	*	Government*Bachelor's	4.86%
23			Education*Master's	4.60%		Languages*Ph. D.	4.78%
24		*	Business*Master’s	4.58%	**	Liberal Arts*Bachelor's	4.78%
25			Languages*Professional	4.44%	*	Fine Arts*Bachelor's	3.98%
26	Q3		Psychology*Bachelor's	4.33%		Government*Professional	3.85%
27			Business*Professional	4.18%		Psychology*Ph. D.	3.31%
28		***	Business*Bachelor's	4.01%		Psychology*Professional	3.24%
29			Law*Bachelor's	3.97%		Social Science*Bachelor's	3.19%
30			*STEM*Master's*	3.94%		Media*Bachelor's	3.08%
31			Social Work*Master's	3.78%		Business*Master’s	3.01%
32			Education*Ph. D.	3.72%		Fine Arts*Professional	2.82%
33			History*Ph. D.	3.61%		*STEM*Ph. D.*	2.51%
34			Agriculture*Professional	3.60%		History*Master's	2.08%

Table 5B-2 Cont.

35			Government*Ph. D.	3.49%		*STEM*Bachelor's*	1.97%
36			Fitness*Bachelor's	3.46%		Business*Bachelor's	1.33%
37			Social Science*Professional	3.25%		Business*Professional	1.18%
38			Social Science*Ph. D.	3.23%		Education*Bachelor's	1.07%
39			Liberal Arts*Professional	3.20%		Education*Ph. D.	0.59%
40			Religion*Bachelor's	3.18%		Liberal Arts*Ph. D.	-0.49%
41			Fitness*Master's	3.10%		Architecture*Bachelor's	-0.50%
42		*	*STEM*Bachelor's*	3.05%		History*Professional	-1.31%
43	Q2		History*Professional	2.99%		Religion*Ph. D.	-1.50%
44			Fine Arts*Professional	2.95%		Law*Master's	-1.53%
45			Languages*Ph. D.	2.63%		*STEM*Professional*	-1.61%
46			Architecture*Master's	2.61%		Architecture*Master's	-2.40%
47			Architecture*Bachelor's	2.41%		Media*Ph. D.	-2.45%
48			Religion*Master's	2.27%		Fitness*Ph. D.	-2.53%
49		***	Education*Bachelor's	2.10%		Fitness*Bachelor's	-3.03%
50		***	*STEM*Ph. D.*	1.58%		Agriculture*Bachleor's	-3.07%
51			Religion*Professional	1.53%		Media*Professional	-4.36%
52		*	Psychology*Professional	1.52%		Agriculture*Ph. D.	-4.44%
53			Fine Arts*Ph. D.	1.51%		Social Science*Professional	-4.51%
54			Media*Ph. D.	1.49%		Fitness*Master's	-4.99%
55		***	Agriculture*Bachleor's	1.44%		Fine Arts*Ph. D.	-6.27%
56		**	Education*Professional	1.11%		Agriculture*Professional	-6.86%
57		***	Psychology*Ph. D.	1.03%	*	Liberal Arts*Professional	-7.41%
58			Religion*Ph. D.	0.93%		Architecture*Ph. D.	-7.63%
59			Architecture*Professional	0.05%	***	Religion*Master's	-7.81%
60	Q1	***	Liberal Arts*Ph. D.	0.00%	*	Education*Professional	-7.81%
61		*	Business*Ph. D.	-0.25%		Fitness*Professional	-8.02%
62			Fitness*Ph. D.	-1.39%		Law*Bachelor's	-10.35%
63		*	Fitness*Professional	-1.84%		Languages*Professional	-12.73%
64		***	*STEM*Professional*	-2.12%		Law*Ph. D.	-13.29%
65		***	Agriculture*Ph. D.	-3.69%		Architecture*Professional	-13.92%
66			Architecture*Ph. D.	-6.09%		Law*Professional	-16.24%
67			Law*Ph. D.	-6.56%	***	Social Work*Professional	-40.05%
68		*	Social Work*Professional	-14.21%		Social Work*Ph. D.	-42.89%

Appendix Table 5B-3: Ranking of Urban Wage Premium for Field of Degree-Educational Attainment Interactions

			FOD				
			OLS			IV	
1			Law*Master's	9.35%	*	Business*Ph. D.	21.60%
2		***	*Mathematics*Master's*	8.01%		*Computer Science*Ph. D.*	19.54%
3			Law*Professional	7.60%	**	*Mathematics*Ph. D.*	17.44%
4		***	Social Science*Master's	7.50%	**	Agriculture*Master's	15.54%
5		**	Government*Professional	6.89%	***	*Computer Science*Master's*	12.79%
6			*Mathematics*Professional*	6.07%		Government*Ph. D.	11.00%
7		**	Languages*Master's	5.98%		Social Science*Ph. D.	10.34%
8			*Computer Science*Professional*	5.95%	**	Social Work*Bachelor's	9.21%
9		**	Liberal Arts*Master's	5.84%		Religion*Professional	8.60%
10		**	Government*Master's	5.73%	**	Government*Master's	8.50%
11	Q4	***	Social Science*Bachelor's	5.46%	**	Religion*Bachelor's	8.15%
12		*	History*Master's	5.39%	*	*Engineering*Ph. D.*	8.02%
13		**	Psychology*Master's	5.34%	**	*Mathematics*Master's*	7.96%
14			*Mathematics*Ph. D.*	5.29%	**	Media*Master's	7.94%
15		**	History*Bachelor's	5.20%	***	Liberal Arts*Master's	7.89%
16			Agriculture*Master's	5.09%	*	Languages*Bachelor's	7.81%
17			Languages*Bachelor's	5.01%		Languages*Master's	7.77%
18		***	Media*Bachelor's	4.98%	***	Social Science*Master's	7.67%
19			Media*Master's	4.97%	***	*Science*Master's*	7.23%
20			Social Work*Ph. D.	4.96%		Social Work*Master's	6.54%
21			Media*Professional	4.88%		*Engineering*Professional*	5.95%

Table 5B-3 Cont. (1)

22			Fine Arts*Master's	4.87%	**	Psychology*Master's	5.88%
23		**	Liberal Arts*Bachelor's	4.85%	***	Education*Master's	5.76%
24			*Computer Science*Ph. D.*	4.84%	***	*Medicine*Bachelor's*	5.68%
25			Social Work*Bachelor's	4.78%	**	Psychology*Bachelor's	5.10%
26		*	Fine Arts*Bachelor's	4.77%		Fine Arts*Master's	5.04%
27			*Computer Science*Master's*	4.69%		History*Ph. D.	4.78%
28			Government*Bachelor's	4.64%		History*Bachelor's	4.74%
29			Education*Master's	4.51%		Languages*Ph. D.	4.33%
30		*	Business*Master’s	4.51%	*	Government*Bachelor's	4.29%
31			Languages*Professional	4.33%	**	Liberal Arts*Bachelor's	4.21%
32	Q3		Psychology*Bachelor's	4.25%	**	*Science*Bachelor's*	4.20%
33			*Computer Science*Bachelor's*	4.14%		*Medicine*Master's*	3.98%
34			Business*Professional	4.10%		*Computer Science*Bachelor's*	3.48%
35		***	Business*Bachelor's	3.93%	*	Fine Arts*Bachelor's	3.46%
36			Law*Bachelor's	3.90%		Government*Professional	3.21%
37			*Science*Master's*	3.75%		Psychology*Ph. D.	2.79%
38			Social Work*Master's	3.70%		Psychology*Professional	2.66%
39			*Mathematics*Bachelor's*	3.64%		Social Science*Bachelor's	2.64%
40			Education*Ph. D.	3.63%		*Engineering*Master's*	2.64%
41			*Science*Bachelor's*	3.60%		Media*Bachelor's	2.52%
42			History*Ph. D.	3.52%		Business*Master’s	2.46%

Table 5B-3 Cont. (2)

43			*Medicine*Bachelor's*	3.50%	*Medicine*Professional*	2.23%
44			Agriculture*Professional	3.46%	Fine Arts*Professional	2.22%
45			*Medicine*Ph. D.*	3.43%	*Medicine*Ph. D.*	1.46%
46			Government*Ph. D.	3.41%	History*Master's	1.45%
47			Fitness*Bachelor's	3.37%	Business*Bachelor's	0.79%
48			Social Science*Ph. D.	3.18%	Education*Bachelor's	0.59%
49			Social Science*Professional	3.14%	Business*Professional	0.58%
50			Liberal Arts*Professional	3.11%	Education*Ph. D.	0.16%
51			Religion*Bachelor's	3.11%	*Mathematics*Professional*	-0.71%
52			Fitness*Master's	2.99%	Architecture*Bachelor's	-1.00%
53	Q2	*	*Medicine*Master's*	2.98%	*Computer Science*Professional*	-1.01%
54			*Engineering*Professional*	2.94%	Liberal Arts*Ph. D.	-1.07%
55			Fine Arts*Professional	2.90%	History*Professional	-1.93%
56			History*Professional	2.88%	Religion*Ph. D.	-2.11%
57			*Engineering*Master's*	2.75%	Law*Master's	-2.38%
58			Languages*Ph. D.	2.57%	Fitness*Ph. D.	-2.89%
59			Architecture*Master's	2.57%	Architecture*Master's	-2.91%
60			Architecture*Bachelor's	2.36%	Media*Ph. D.	-3.14%
61			Religion*Master's	2.18%	*Science*Ph. D.*	-3.43%
62		***	Education*Bachelor's	2.04%	Fitness*Bachelor's	-3.61%
63		***	*Engineering*Bachelor's*	1.51%	Agriculture*Bachleor's	-3.68%

Table 5B-3 Cont. (3)

64			Religion*Professional	1.43%	**	*Science*Professional*	-4.04%
65			Media*Ph. D.	1.43%	***	*Engineering*Bachelor's*	-4.17%
66		*	Psychology*Professional	1.43%	*	*Mathematics*Bachelor's*	-4.86%
67			Fine Arts*Ph. D.	1.42%		Agriculture*Ph. D.	-4.93%
68		***	Agriculture*Bachleor's	1.38%		Media*Professional	-5.07%
69		**	*Engineering*Ph. D.*	1.27%		Social Science*Professional	-5.18%
70		**	Education*Professional	1.03%		Fitness*Master's	-5.63%
71		***	Psychology*Ph. D.	0.97%		Fine Arts*Ph. D.	-6.78%
72			Religion*Ph. D.	0.83%		Agriculture*Professional	-7.63%
73		***	*Science*Ph. D.*	0.61%	*	Liberal Arts*Professional	-8.06%
74	Q1		Architecture*Professional	0.00%	*	Education*Professional	-8.31%
75		***	Liberal Arts*Ph. D.	-0.08%	***	Religion*Master's	-8.36%
76		*	Business*Ph. D.	-0.28%		Architecture*Ph. D.	-8.40%
77			Fitness*Ph. D.	-1.32%		Fitness*Professional	-8.63%
78		*	Fitness*Professional	-1.98%		Law*Bachelor's	-10.89%
79		***	*Science*Professional*	-2.76%		Languages*Professional	-13.31%
80		***	*Medicine*Professional*	-2.91%		Law*Ph. D.	-13.60%
81		***	Agriculture*Ph. D.	-3.68%		Architecture*Professional	-14.52%
82			Architecture*Ph. D.	-6.11%		Law*Professional	-16.67%
83			Law*Ph. D.	-6.66%	***	Social Work*Professional	-40.34%
84		*	Social Work*Professional	-14.26%		Social Work*Ph. D.	-43.22%