Network-driven Choices of Economics Ph.D. Programs

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Contents

Introduction

It's difficult to choose the right Economics Ph.D. programs for prospective applicants. They need to collect too much information to make a good choice, such as various rankings, placement quality, faculty interests, financial support, location, etc. In particular, placement is the hardest metric to be quantified and ranked. However, placement records are essential for their choices as students rely on them to predict their future careers after finishing the programs. Using network analysis, this paper discovers the patterns of U.S. Economics Ph.D. graduates' initial placements in academia from 2010 to 2017.

This paper will provide many empirical evidences and insights for helping applicants identify the programs that fits most for their career goal. As a result, it will answer some questions or rumors about the economics job market. Starting from the macro level, this paper provides a trend analysis of the size and quality of the job market. Then it focuses on the individual programs by treating them as nodes and their placements as edges in the network. Thus, the paper measures the densities of the job market and also calculate the centralities for programs. As a case study, the paper shows there is no real division between the Saltwater School and Freshwater School in terms of placement, while Saltwater School seems to do better in the job market.

The paper uses the open-source networks package in Python and has provided the code for replication (Link). Also, the methods and analysis could be easily be applied to study the placement patterns in other academic disciplines, as long as the placement data is collected.

Literature Review

Studies on economics graduate programs, such as rankings, determinants of placement quality and program characteristics, are popular among economists. Siegfried and Stock (1999) surveyed Ph.D. graduates about their placement and satisfaction level to highlight the differences across sectors. Stock and Siegfried (2001) investigated the job types and salaries by surveying the 1996-1997 cohort. Athey et al. (2007), using a sample of 1029 graduate students in top five programs, found the quality of job placement would not be affected by demographic characteristics, GRE scores or master's degrees. Amir and Knauff (2008) rank economics department worldwide by calculating the total values of its Ph.D. graduates' current employing departments.

This paper builds upon the previous research. The contributions to the literature are in three aspects: Firstly, the data spans across Top 100 US programs from 2010 to 2017. Secondly, it provides a new methodology for easily measure placement quality for all global schools. Thirdly, it uses network analysis to identify the trend, structure, densities, centralities, and divisions for the Top US and global economics job market.

Data

a. Placement Data

I collected the initial job placement from the 110 U.S. Economics doctoral programs' departmental websites. I selected the graduation years from 2010 to 2017 to analyze the underlying dynamics of the Economics job market. Five programs (Auburn, Northern Illinois, Rensselaer Polytechnic Institute, SUNY Buffalo and Utah State) don't have available placement information. I left them out in the analysis and will use the term "Top 100 US" as the reference to these programs.

	ID	Source	Year	Placement
0	2	arizona state university	2011	Hofstra University
1	2	arizona state university	2015	University of Winnipeg
2	2	arizona state university	2014	Nanjing University School of Business, Jiangsu...
3	2	arizona state university	2011	Yeshiva University
4	2	arizona state university	2016	Virginia Commonwealth University, Virginia
...	...	...	...	...
3904	110	yale university	2015	Middlebury College
3905	110	yale university	2014	Bryn Mawr College, visiting
3906	110	yale university	2014	EUROPEAN UNIVERSITY INSTITUTE Postdoc
3907	110	yale university	2014	Queensland University
3908	110	yale university	2014	Williams College

Figure 1. Illustration of the Placement Data Table-Academic

After compiling the placements together, I got 6187 observations specifying each student's pedigree, graduation year, initial employer and corresponding positions. Although other

information (such as fields, advisors, nationality, gender, publication, age, undergraduate schools) would be relevant for this research, they are generally unavailable to collect as most of the placement records don't list the graduates' names or resumes. Also, for the later analysis, I created several sub-data. Firstly, I divided the data according to placement type into "Academic" (See Figure 1) and "Non-Academic." Secondly, I extracted the academic placements in Top U.S. programs from the Academic table.

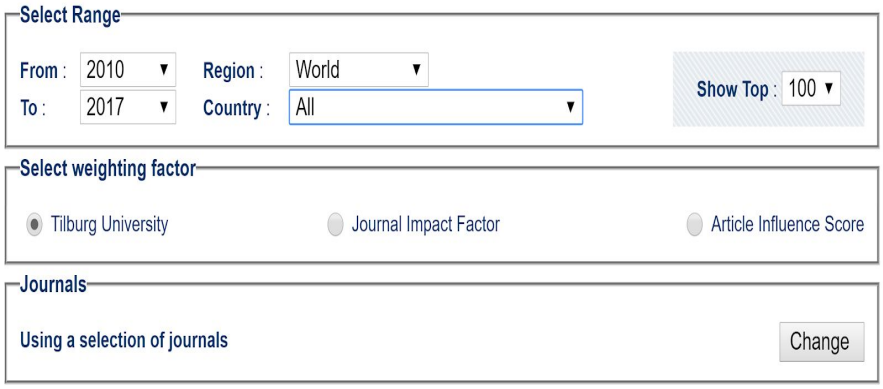
b. Program Attributes

The National Research Council's "A Data-Based Assessment of Research-Doctorate Programs" in 2010 examines the program characteristics of 110 Economics Ph.D. doctoral programs in the U.S (use Top US Programs for reference). It provides the program-level data such as private or public universities, location, scholarship amount, size, providing office space or not, diversity, the number of publications per faculty member, student activities, the median time to degree, graduate student funding, citations per publication, number of grants per faculty member, diversity, student GRE scores, student health insurance, etc. This objective information is useful for identifying different programs' impact on graduates' placement and career decisions.

c. Prestigious Scores Data

Among the academic placement data, around 78% are not among the Top US programs. Instead, the placements are non-US schools, regional universities or liberal arts colleges, etc. So rankings

by U.S news or NRC are not comprehensive enough as they only compare the Top US programs. As a result, I adapted the ranking created by the CentER for Research in Economics and Business at Tilburg University. It maintains the database covers publications of global institutions in leading economics journals. Using its "sandbag" option, I selected the year period of 2010-2017 to get the journal counts of 1262 global economics departments (See Figure 2).



Rank	University	Score
1.	HARVARD UNIVERSITY	853
2.	UNIVERSITY OF CHICAGO	687
3.	STANFORD UNIVERSITY	580
4.	LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE	516
5.	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	502
6.	UNIVERSITY OF CALIFORNIA, BERKELEY	501
7.	UNIVERSITY OF PENNSYLVANIA	483
8.	COLUMBIA UNIVERSITY	473
9.	NEW YORK UNIVERSITY	458
10.	YALE UNIVERSITY	440

Figure 2. Tilburg Publication Ranking Example

The journal counts are treated as the scores (denote as α) to indicate the placement quality. The top three departments are Harvard (783), Chicago (566), Stanford (509). 3003 out of 3915

placements (77%) are successfully paired with the departments in the Tilburg list. The remaining 912 entries are assigned 0.

However, there are different positions for the placements in the same school, such as lecturer vs. assistant professor. To account for this, I use the discount rate proposed by Krueger and Wu (2000) to recognize the quality differences of various academic positions. A most ideal academic placement is "tenure-track assistant professor". For other positions, the discount rates are determined by the following three factors:

1. How related is the position compared to the tenure-track assistant professor?
2. Whether the position emphasizes on research?
3. How competitive is it to get such positions?

Position	**Rate(λ)**	**Freq.(%)**	**Comment**
Tenure-track assistant professor	1	3231 (83%)	most ideal academic placement
Postdocs	0.6	520 (13%)	Most postdocs will become assistant professors later.
Lecturer, Visiting/Practice/Clinical assistant professor	0.4	130 (3%)	Non-tenure track positions, focusing on teaching.

Table 1: Discount rates for different academic positions

For example, for a graduate k from program i, his/her placement score is the product of the scores $\alpha(k)$ and corresponding discount rate $\lambda(k)$. Thus, the whole program's placement score is the average of all graduates' placement scores. The following formula gives a measure for each Top 100 US program' placement quality:

$$y(i) = \frac{Aggregated\ discounted\ scores\ of\ graduates'\ employers}{Number\ of\ students\ graduated\ from\ the\ program} = \frac{\sum_{k=1}^{n(i)} \alpha(k)*\lambda(k)}{n(i)}, \text{ i=1,2,...105}$$

Quantiles	**Index Values**	**Example Institutions**
0%	0.0000	Gettysburg College
25%	15.4825	Miami University
50%	27.2950	Fordham University
75%	44.7375	University of Georgia
100%	236.9200	Cornell University

Table 2. Examples of prestigious scores

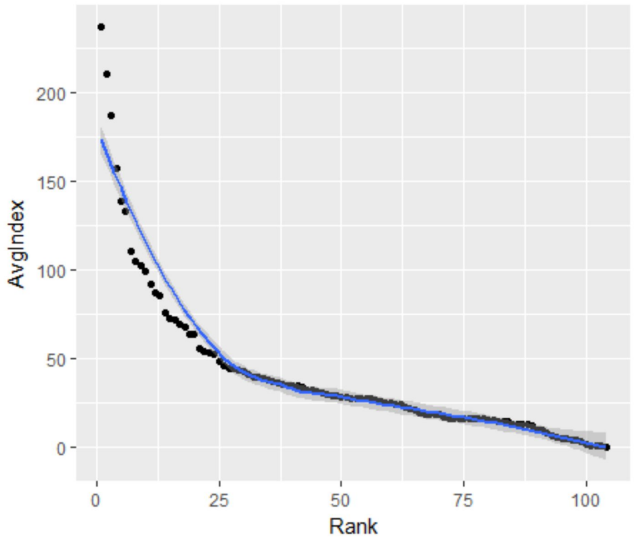


Figure 3: Strong correlation between ranking and prestigious scores

From Figure 3, I find that as the ranking goes up, the prestigious scores increase more quickly as the slope becomes steeper. This nonlinear relationship indicates that top programs graduates have placements significantly better than the rest.

Overview of the Econ Job Market

1. Types of Placements

Siegfried and Stock (2014) described the primary sector of employment for economics doctoral graduates was academia, followed by government, international organizations, research organizations, and a smaller percentage in business and industry. Thus, I divide the positions categories into three groups by the keywords matching algorithm:

0: Academic Institutions (Universities, Liberal Arts College, Research Institutions...)
1: Private Sectors (Technology firms, Financial Services, Consulting Companies...)
2: Government, Non-Government Organization, Federal Reserve, World Bank, IMF, Think Tank, International Organizations

During 2010-2017, around 63% of students landed a position in academia. 19% of them got hired by companies, banks or firms as various roles, such as consultants, economists, econometricians, data scientists, associates, statisticians, analysts and so on. The remaining 18% of them work for government departments, policy-research institutes, and NGOs. This result confirms that academia is still a major destination. However, industry employment rises steadily, from 14% in 2010 to 25% in 2017. One reason is the rise of technology companies, as they hire economists as data scientists for solving problems related to econometrics, demand estimation, marketing, etc.

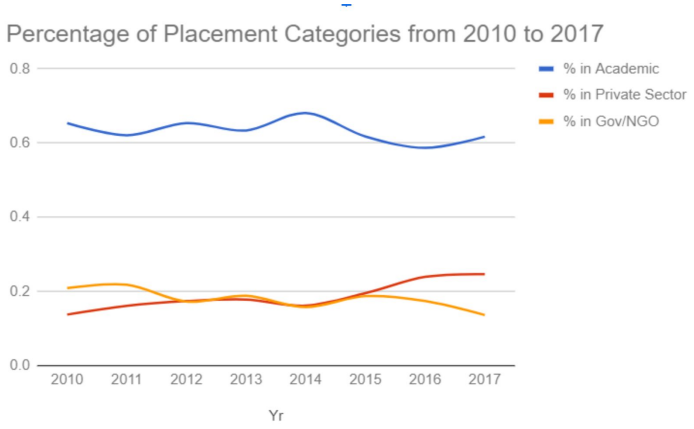
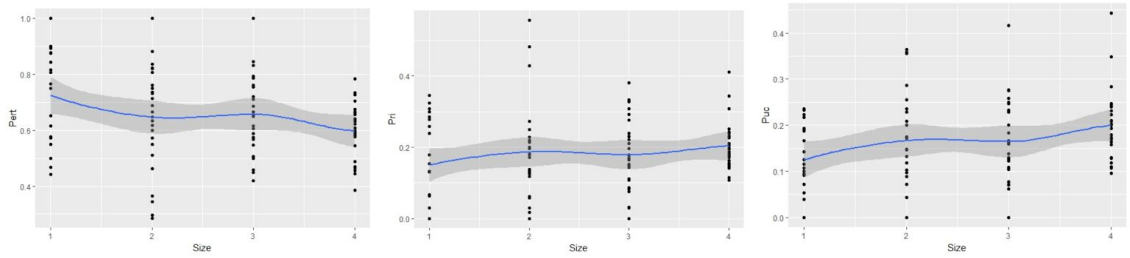


Figure 4. Percentage of Placement Categories, 2010-2017

2. Size of the Programs

Intuitively, graduates from smaller programs should be more likely to find academic jobs, since they would receive more attention and resources. To evaluate this hypothesis, we first control for the program size to validate its impact on programs' percentages of placement categories. We adopt the size quantiles provided by NRC where "1" is the smallest cohort size (smaller than 5 students) and "4" (larger than 20 students) is the largest. Ceteris paribus, compared with a smaller program (1 quantile lower), graduates are 3% less likely to find academic jobs, 1.5% and 2.2% more likely to land positions in private and public sectors, respectively (See Figure 5). This might suggest graduates from larger programs are more diverse in terms of career choices. They may also have more resources and freedom to pursue different fields and interests, which prepare them for non-academic positions. Another situation is that larger programs allocate more resources to a fraction of top students who are likely to become academic stars in the market.

Thus, the mediocre students and the rest would choose a non-academic career if they are not confident to get a good academic placement.



Academia Private Sectors Public Sectors

Figure 5: Percentage of 3 types of placement at different size quantiles

3. Tiers of the Programs

One shortcoming of ranking is it imposes a linear ordering among the programs. Instead, I divide the programs into 5 tiers to test whether better programs produce a higher ratio of academic placements. The rank is based on NRC's ranking scores (calculated by programs' overall quality and reputation). The cutoff of tiers are the following:

Tier	Rank
1	Top 1-10
2	Top 11-30
3	Top 31-50
4	Top 51-70
5	Top 71-105

About 30% of the students obtained their Ph.D. degrees from Tier 2 programs. By comparison, Tier 1 has 22% of graduates and Tier 5 has only 15% of graduates, even though Tier 1 consists of 10 programs and Tier 5 has 35 programs (See Figure 6). The average cohort size of top-ranked programs is 7% larger than the bottom-ranked programs. This is reasonable as they have more resources, faculty, and funding to train more future economists.

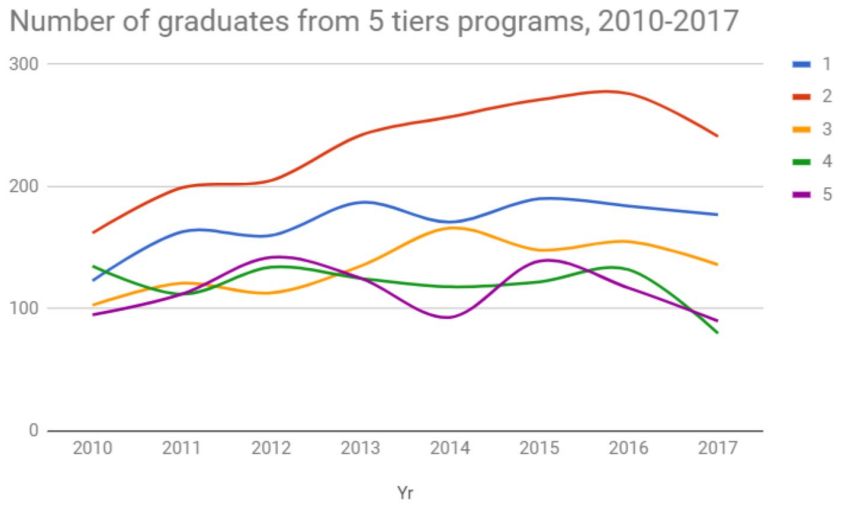


Figure 6. Number of graduates from programs of 5 tiers, 2010-2017

Athey et al (2007) found that more than half of graduates at Top 10 programs accepted an academic job in the 1990s. From the data from 2010 to 2017, I find the ratio at Top 10 is around 68%, which is consistent with the previous findings. However, without controlling for the placement quality, this ratio doesn't decrease as the Tier number goes up. 66% of the Tier 5

programs graduates stay in academia as well. Their target employers are typically regional teaching universities and liberal arts colleges.

Moreover, there are no significant differences in industry placements ratios. This makes sense as the private sectors need graduates at various levels. For the government/NGO placements, the ratio at Tier 4 is 7% higher than the Tier 1's (See Figure 7).

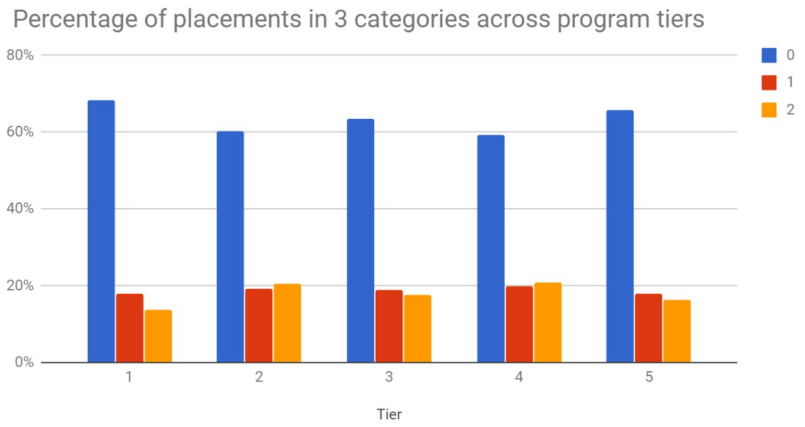


Figure 7. Percentage of placements in 3 categories across program tiers

Academic Hiring Network

1. Big Picture

The main analysis of this paper will focus on academic placements for two reasons. Firstly, I am interested to use network analysis to uncover the faculty hiring pattern. Secondly, most of the prospective applicants' motivation to pursue a Ph.D. is to find a tenure-track assistant professor position.

As a result, the network analysis will only uses around 63% of the data. I will primarily use two subsets of the data: the first is the academic placements only in Top US Programs and the second is the placements in all global schools. In both of the data, each row tells the story that a graduate from school A is hired by school B in year Y (2010-2017), and the prestigious score of school B is X (0-853).

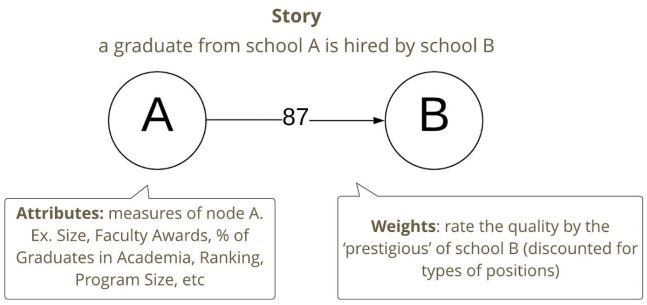


Figure 8. Story behind the placement data

2. The Trend of Placement

There are always rumors about the Economics job market that getting a good academic job is harder and harder. In Figure 9 and Figure 10, I find that only around 25% of the academic students are in Top US schools and these placements are around twice more prestigious than the global placements. However, the average placement prestige of Top US in 2017 hits the lowest point. The conclusion is that prospective applicants should be aware that getting a PhD from Top 100 schools does not necessarily guarantee a job at other Top 100 schools.

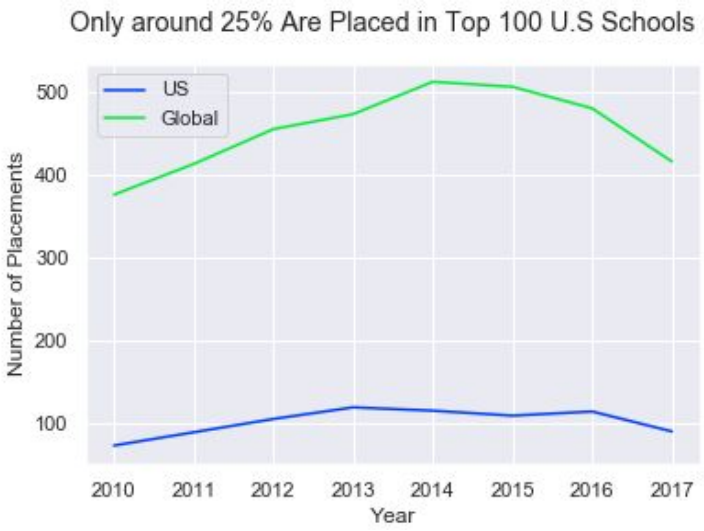


Figure 9. Trend of number of placements

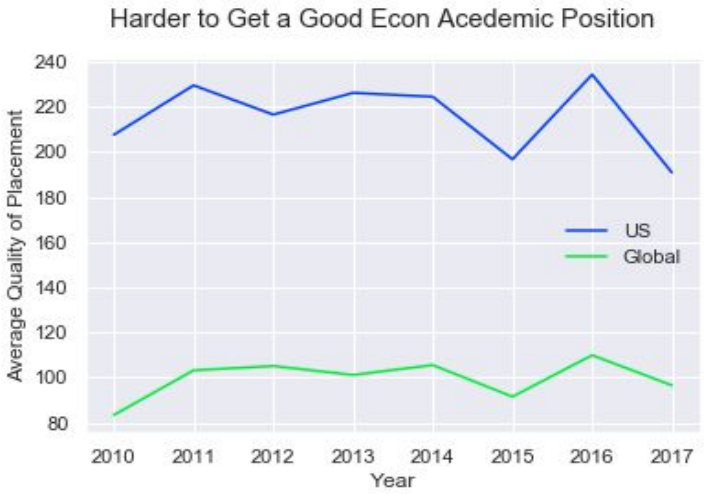


Figure 10. Trend of placement prestige

3. Network Structure

I use the networkx package in Python to visualize the large network structure of the placement. In Figure 11 and Figure 12, I find the placements in both Top US and Global have the core-periphery structure, where the core nodes are mostly the most prestigious US programs, such as Harvard, MIT, Chicago, Yale, Stanford. However, peripheries, which are sparsely connected on the margins of the network, are generally schools that are not very well-known in economics. Also, they tend to only hire faculty from better schools instead of placing students into other programs.

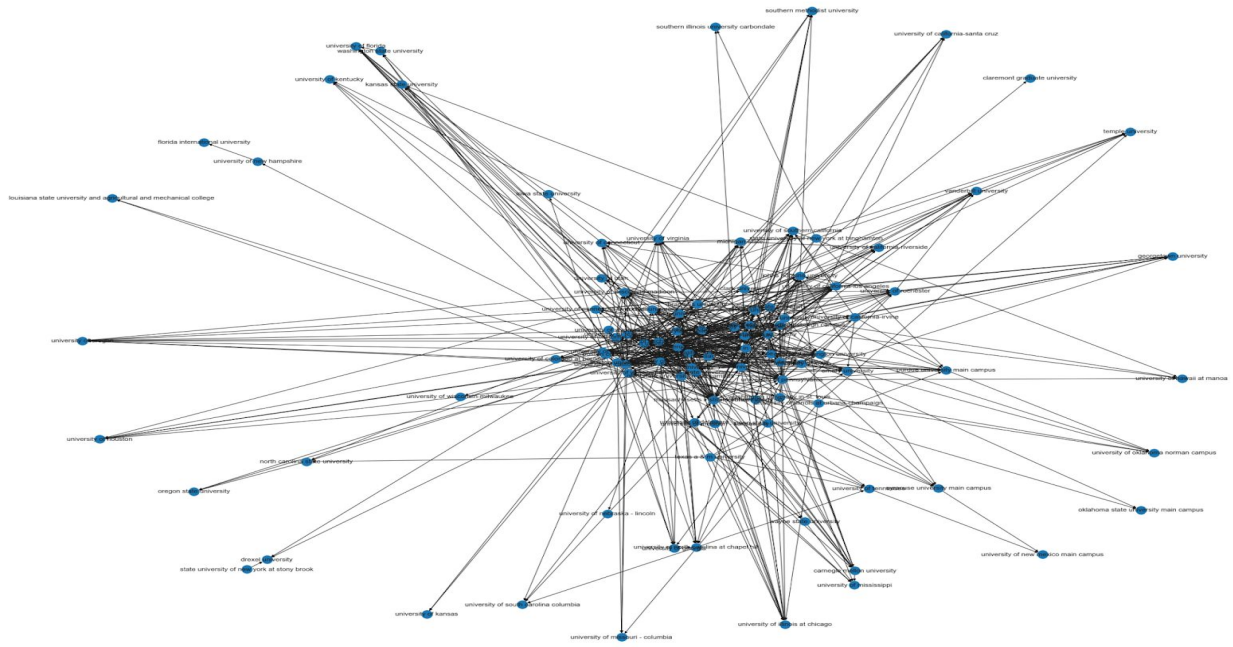


Figure 11. The network of Top US placement

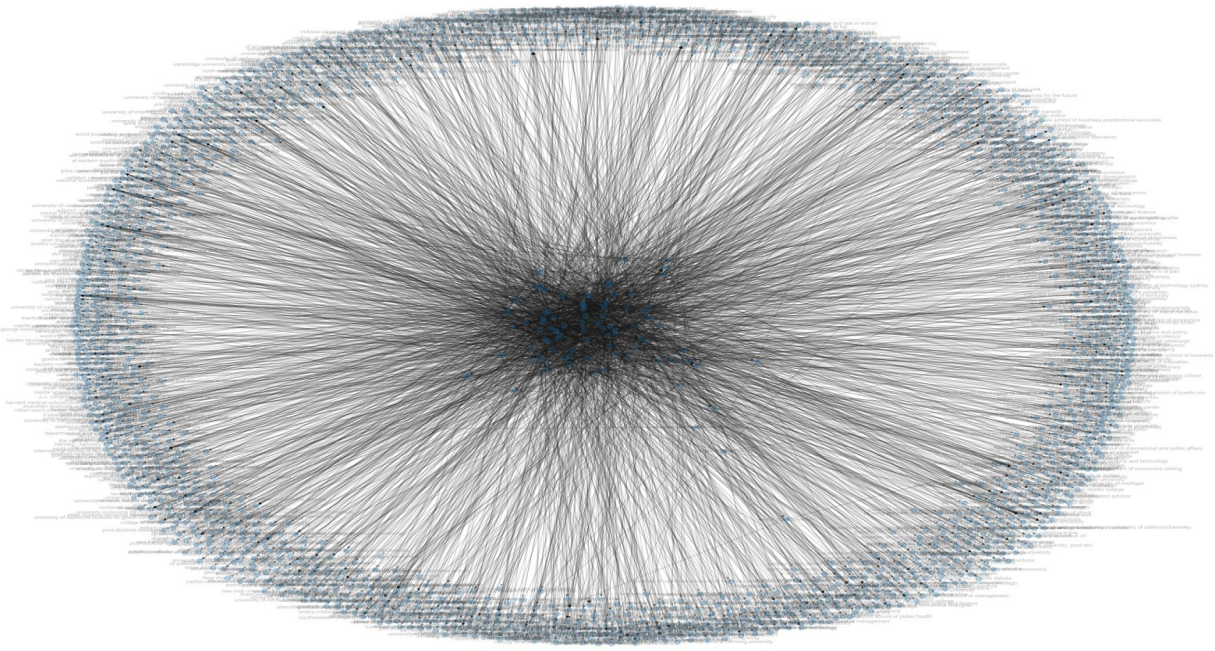


Figure 12. The network of global placement

4. Network Densities

I'm interested in how the job market evolves throughout the 8 years in terms of internal connections. Thus, I apply the density to measure how closely knit the network is. Density is defined by the ratio of actual edges in the network to all possible edges in the network. A 0 would mean that there are no connections at all, and a 1 would indicate that all possible edges are present.

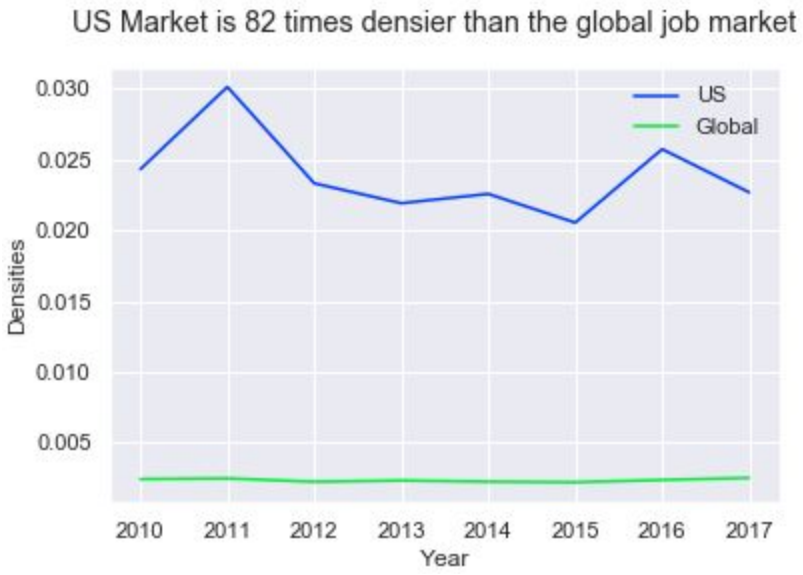


Figure 13. Network Densities of Top US and Global Placement

From Figure 13, the density data suggests that Top US network is 82 times denser than the global network. Although we don't include the placements from non-US schools to US schools, I assume this number is not large from my observation of the economics profession. So generally, the network densities remain stable and Top US programs have more placements with each other.

5. Network Centrality

Through network analysis, I can identify the programs that place students well. This could be measured by centrality, which is used to identify the most important vertices within a graph. There are typically three centrality measures. The first is eigenvector centrality, which looks at a combination of a node's edges and the edges of that node's neighbors. The second is betweenness centrality, which looks at all the shortest paths that pass through a particular node. The third one is closeness centrality, which looks at the sum of its distances to all other nodes. I

compare the Top 3 most prestigious programs, which are MIT, Harvard, UChicago, by the centralities.

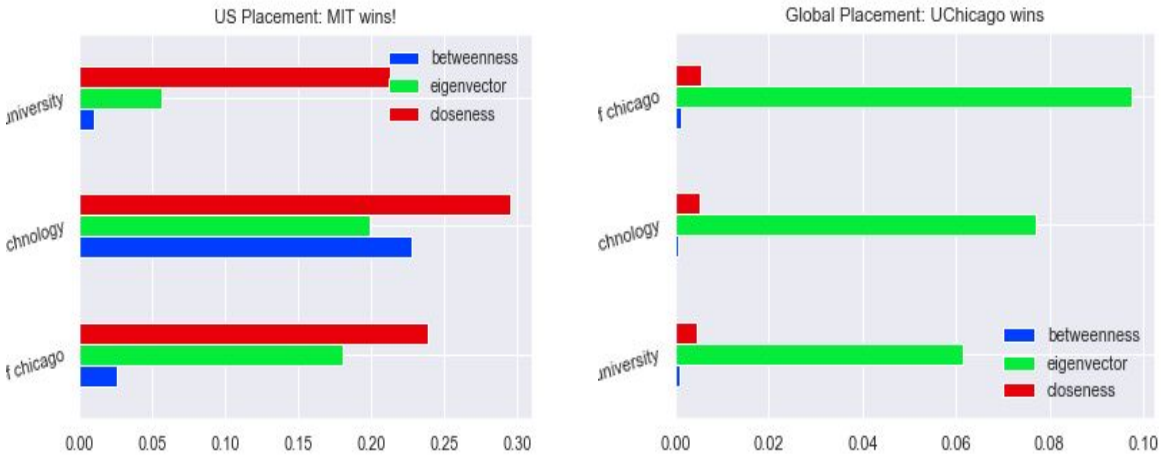


Figure 14. Comparisons of network densities for MIT, Harvard, UChicago

From Figure 14, I find that MIT is the star in the Top US network as all three centralities are larger than the other two. However, UChicago stands out in the Global network. In the NRC data, I find that UChicago has 73% of the international students in the economics programs, while Harvard and MIT have 51% and 58%, respectively. So one interpretation is that more international students from UChicago go back to home universities. However, another reason is UChicago, compared with Harvard and MIT, doesn't provide enough resources for international students to get a position in the US.

6. Clash of Ideas

In Economics (especially in Macroeconomics), there used to be an informal division between

Freshwater v.s. Saltwater Schools. One example of the division is that Freshwater schools argue for the free market and rational behavior, while Saltwater schools are critical about these assumptions. Freshwater School got its name because its members are schools near the Great Lakes, including University of Chicago, Carnegie Mellon University, Northwestern University, Cornell University, The University of Minnesota, The University of Rochester. On the other side, Saltwater School was named because its members are near the east and west coast of the United States, including University of California, Berkeley, Brown University, Harvard University, University of Pennsylvania, Princeton University, Columbia University, and Yale University.

I want to use data to see if there exists such division between the two Schools in terms of the placements. The assumption is that if there exists a clash of ideas, the graduates from one School will not be welcomed as new faculty at the other School.

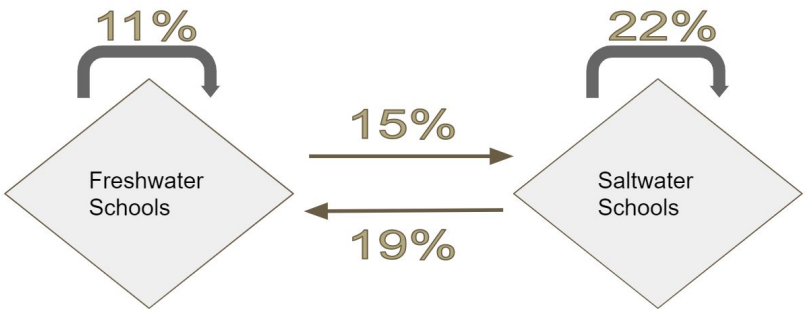


Figure 15. Illustration of Freshwater and Saltwater Placements Ratios

In Figure 15, I show the ratios of graduates who find placements at certain School among all graduates from that School. In the data, there are 90 graduates from Freshwater School and 273 graduates from Saltwater School. 19% means 52 students among the 273 Saltwater graduates got placed at Freshwater schools. In addition, I observe that 22% of the graduates from all Saltwater schools got placed at another Saltwater school, which is twice the ratios of Freshwater School.

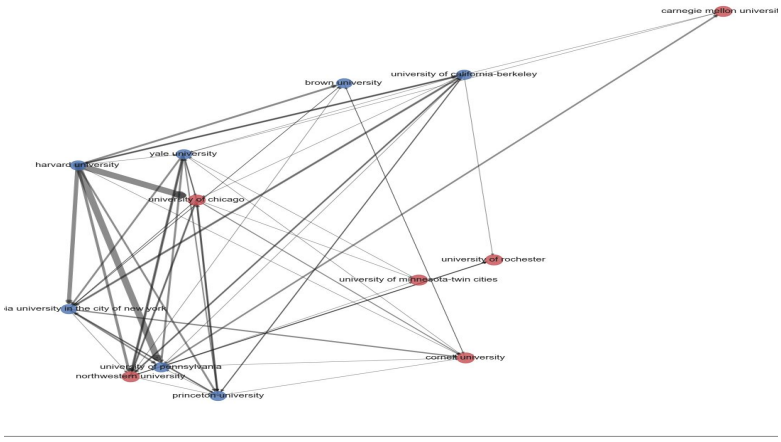


Figure 16. Network visualization of placements among Freshwater and Saltwater Schools

In Figure 16, I find there is no obvious divide between the two Schools. Only University of Rochester and Carnegie Mellon University have only indegrees, which means they didn't place graduates at the other peer schools during the period. The insight for prospective applicants would be that they don't need to worry too much about the division among Schools. However, it appears that Saltwater schools generally have larger program sizes, more likely to stay in the peer Saltwater schools, and have better placements.

Discussion

One limitation is that there are potentially some missing placement data. The actual number of graduates should be slightly larger for two reasons. Firstly, programs might only report the "best" or "example" placements instead of the whole cohort. Secondly, students who don't enter the academic job market or get the job offer after graduation might not be well recorded.

The second limitation is that the Tilburg ranking methodology is based on the sum of the selected journal publication numbers. As a result, larger programs in English-speaking countries are more advantageous over the others. Although the selected 35 journals are regarded as prestigious and top-notch worldwide, some other great journals published in foreign languages are not counted in this ranking.

The third limitation is the individual heterogeneity, which is unobservable from the current data. A prestigious score of 100 could result from the average of 0 and 200. In particular, the variances could be greater at large programs as only the few star students get the resources. As a result, prospective students might roughly guess whether they will stand out or barely survive during the programs. When they progress through the program, this guess of class standing would change with the courses, dissertation, field popularity, etc. As a result, it's necessary to survey students' feelings and self-assessment, in order to further develop the model of career choice.

Conclusion

The central goal of this paper is to inform prospective applicants to economics PhD programs with empirical strategies and insights by analyzing the economics job market from 2010 to 2017. Also, it analyzes the network behind the academic placements by measuring the trend, densities, centralities, divisions. However, it also acknowledge the potential limitations in the data and analysis.

There are several next steps for this paper. Firstly, I will look further at the non-academic placements and find its relationship with the academic placements. Secondly, I will provide a new measure for the variance among placements from the same programs. Thirdly, I will combine all these new measures and make an interactive web application, so that users could adjust their weights for different variables and get a personalized recommendation list of programs to make better choices.

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