



Universiteit
Leiden
The Netherlands

Emergent structures in faculty hiring networks, and the effects of mobility on academic performance

Cowan, R.; Rossello, G.

Citation

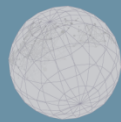
Cowan, R., & Rossello, G. (2018). Emergent structures in faculty hiring networks, and the effects of mobility on academic performance. *Sti 2018 Conference Proceedings*, 717-724. Retrieved from <https://hdl.handle.net/1887/65290>

Version: Not Applicable (or Unknown)

License: [Leiden University Non-exclusive license](#)

Downloaded from: <https://hdl.handle.net/1887/65290>

Note: To cite this publication please use the final published version (if applicable).



STI 2018 Leiden

*23rd International Conference on Science and Technology Indicators
"Science, Technology and Innovation Indicators in Transition"*

STI 2018 Conference Proceedings

Proceedings of the 23rd International Conference on Science and Technology Indicators

All papers published in this conference proceedings have been peer reviewed through a peer review process administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a conference proceedings.

Chair of the Conference

Paul Wouters

Scientific Editors

Rodrigo Costas
Thomas Franssen
Alfredo Yegros-Yegros

Layout

Andrea Reyes Elizondo
Suze van der Luijt-Jansen

The articles of this collection can be accessed at <https://hdl.handle.net/1887/64521>

ISBN: 978-90-9031204-0

© of the text: the authors

© 2018 Centre for Science and Technology Studies (CWTS), Leiden University, The Netherlands



This ARTICLE is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License

Emergent structures in faculty hiring networks, and the effects of mobility on academic performance¹

Robin Cowan* and Giulia Rossello**

*cowan@merit.unu.edu

UNU-MERIT, Maastricht University, Boschstraat 24, Maastricht, 6211 AX (Netherlands)
BETA, Strasbourg University, Av. De la Forêt Noire, Strasbourg, 67085 (France)

**rossello@merit.unu.edu

UNU-MERIT, Maastricht University, Boschstraat 24, Maastricht, 6211 AX (Netherlands)

Abstract

This paper is about the South African job market for PhDs. PhD to first job mobility involves the preferences of both the hiring institution and the candidate. Both want to make the best choice and here institutional prestige plays a crucial role. A university's prestige is an emergent property of hiring interactions, so we use a network perspective to measure it. Using this emergent ordering, we compare the subsequent scientific performance of scholars with different changes in the prestige hierarchy. We ask how movements between universities of different prestige from PhD to first job correlates with academic performance. We use data of South African scholars from 1970 to 2012 and we find that those who make large movements in terms of prestige have lower research ratings than those who do not. Further, looking only those with large prestige movements, those with higher prestige PhDs or first jobs have higher research ratings throughout their careers.

Introduction

After PhD, scholars usually have thin records of research output, so, young faculty hiring can be seen as a problem of asymmetric information. Thus, the hiring committee will have difficulties in evaluating the intrinsic quality of the candidate and will look for signals of "quality". Where the status of the university granting the PhD is one of those (Clauset et al., 2015). Since hiring decisions in PhD to first job mobility involve preferences of both the hiring institution and the candidate, they represent a pairwise assessment of quality. In the aggregate, a collective assessment of each others' quality emerges by sorting the PhD graduates through the first job market; encoding, in this way, an emergent prestige order of universities (Clauset et al., 2015). Following this line, first, we create a new measure of prestige based on the idea that the first job market contains information about how scholars and institutions see each other's quality and then we ask whether movements in this prestige hierarchy correlates with future scholars' performance.

Our contribution connects to past US based research (Burris, 2004; Clauset et al., 2015): again, we find that the 5 most prestigious universities produce more than 50% of PhDs in the country and they tend to hire their own or each other's graduates; and further, females and blacks are more likely to move down in prestige than are white males.

¹ Financial support was provided through the Institut Universitaire de France

Moreover, looking our main finding, with respect to the relationship between different prestige transitions from PhD to first job and academic performance: we find a positive role of inertia and a positive role of prestige. On inertia, we find that scholars who make large movements in prestige have lower performance than those who do not. While, with respect to the role of prestige, looking scholars who make large movements in the prestige hierarchy, those with more prestigious PhDs or first jobs have higher performance.

Background

Besides formal university ranking, as for example the Times Higher Education Ranking, scholars found many methods to measure university prestige: output based measure; subjective survey based; labour market based; or combinations of these. On the one hand, survey measures try to incorporate agents' perception and to address the potential bias of quantitative measures, like the presence of few star scholars (Barnett et al., 2010). On the other hand, they have a problem. It might be possible to rank in a reliable way top institutions, since their relative stature is known. But because of localization, moving down the ranking, respondents are not able to perceive the difference between similar institutions if they are not competing directly to them for students, faculty and resources. Our algorithm to rank universities, according to prestige, takes advantage of this localized knowledge.

Moreover, starting from the PhD to first job faculty hiring network, our measure of prestige incorporates the sociological view of institutional stratification. According to this literature, university prestige enhances stratification in the system because it engages and attracts the talented experts and resources, often drawing them out from lower ranked universities (Jung and Lee, 2016). This produces a strict hierarchy also in the hiring patterns (Bair 2003; May et al., 2015). Thus, this supports the idea that the prestige rankings are emergent and the PhD job market indicates how universities view each other.

With respect to the relationship between university prestige and individual performance literature results are mixed (Miller et al., 2005). Our contribution differs from this, focusing, not on institutional prestige, but looking at the transition in the prestige hierarchy from PhD to first job.

Aim and structure of the work

This paper is about the job market for PhDs. We ask whether the PhD to first job transitions in the prestige hierarchy correlates with future research performance. The structure of the work is the following:

- we compute a new prestige ranking of universities sorting the PhD to first job weighted and directed hiring network;
- we compute for each individual his movement in the prestige hierarchy from PhD to first job;
- we compare the scientific performance² of scholars of same gender, ethnic group, PhD obtained years and first job (or PhD) institution but different movements in the prestige hierarchy.

Data

We use South African National Research Foundation data³ from 1970 to 2012 which contain personal information of the scholars (i.e. gender, ethnic group, affiliation, scientific field, and NRF research rating). Our main variable on individual performance (NRF rating) is available

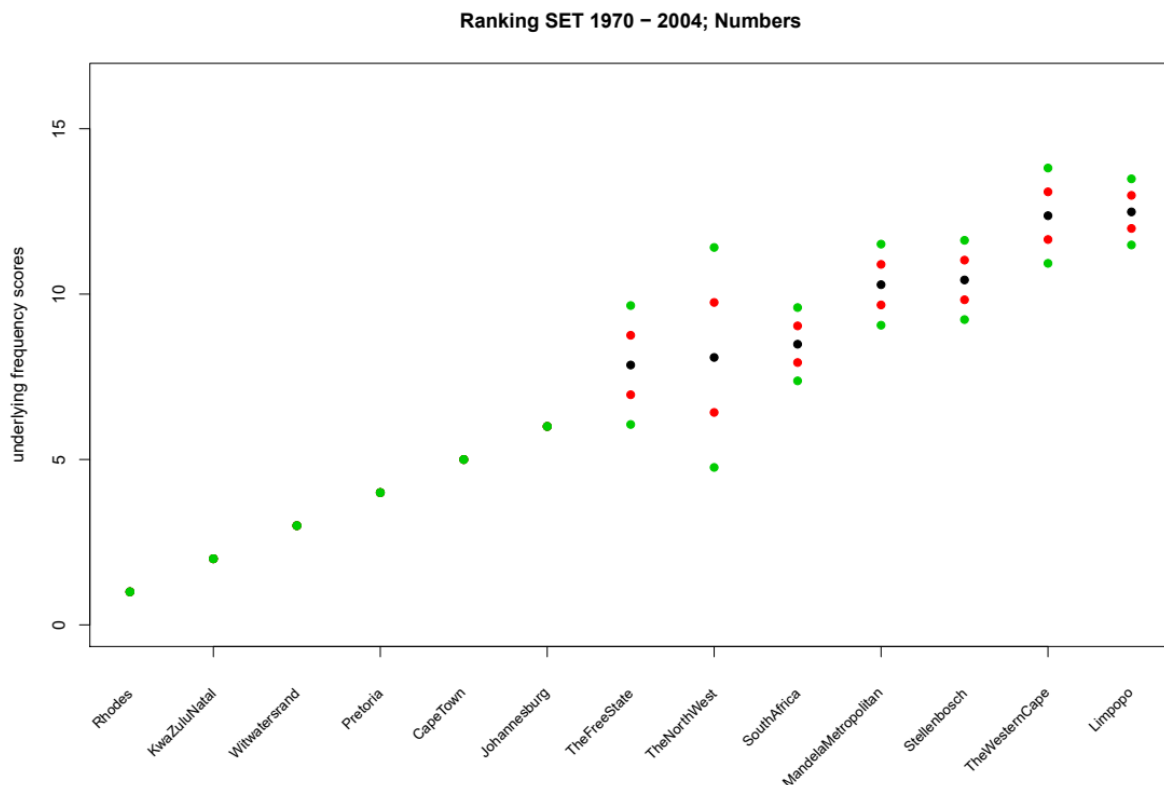
² In four different points in time: 5, 10, 15, and 20 years after PhD.

³ NRF (www.nfr.ac.za) is a state agency that has its mission in the promotion of research and the development of the national research capacity.

from 1983 to 2012. So, to examine long and medium effects on career, we focus on academics who received their PhD from 1970 to 2004 in the broad field of Science Engineering and Technology (SET). NRF rating is made on 13 ordered categories who evaluates individual performance following a rigorous international peer reviewed process.

Prestige Ranking

Figure 1: Prestige Ranking for SET 1970-2004. The frequency scores are in ascending order: the highest ranked university has the lowest score. The black dots are the mean of the orders with maximum scores in set Q, red and green dots are one and two standard deviation from the average. Universities with fewer than 5 PhDs are excluded.



Our algorithm to rank prestige runs on the adjacency matrix of the faculty hiring network from PhD to first job. The adjacency matrix is weighted and directed where rows and columns are the 22 South African universities and each entry m_{ij} represents the number of scholars with a PhD in university i and a first job in university j . The logic behind the algorithm, inspired by Clauset et al. (2015), starts from two hypotheses:

1. *Universities want to improve the quality of research and teaching. A corollary is that they want to hire from universities that are “better” than themselves;*
2. *Scholars want to be hire by the best universities.*

When the PhD institution is a reliable indicator of graduate “quality” and the desires of the two hypotheses are perfectly satisfies, it is possible to order universities so people only move down the ordering, implying a reorder of the matrix with zero weights below the diagonal.

The algorithm reorders rows and columns many times obtaining each time an order and an associated score computed as $\sum_i \sum_{j>i} m_{ij}$. In particular it works as follows:

- it starts with a random order;
- then it tries to improve the score of the current order 100 times. If this improves the initial order it takes the new one otherwise it reverse it;
- we repeat the algorithm 10000 times obtaining 10000 orders with corresponding scores;
- in this 10000 order we take those with maximum scores;
- among those orders with the maximum scores, we compute for each university the average of its ranks.

Figure 1 shows the prestige ranking in ascending order of South African universities from 1970 to 2004.

Matched Pairs Analysis

We study whether prestige transitions from PhD to first jobs correlate with scholars' future research performance. The possible prestige transitions are: up, down, or stay. For example, scholars move up when hired by an institution with higher prestige ranking than the one granting the PhD. The matched pairs analysis matches scholars with equal gender, ethnic group, PhD obtained year, and first job (or PhD) institution but different prestige transitions and compares their performance in NRF rating in four different points in time: 5, 10, 15, and 20 years after the PhD. We compare scholars moving up vs. stay, down vs. stay, and up vs. down. To differentiate the analysis between receiving or sending institution is a control for Matthew effects on performance driven by prestige, possibility to upward (downward) mobility, and training effects.

The matched pairs analysis uses a resampling technique to account for rare prestige movements. The following example describes our methodology:

Up vs. Stay comparison

- we start with the set of people U who move up of size N_u and the set S who stay with size N_s , where $N_s > N_u$;
- we sample with replacement N_u people from U to get U';
- for each observation in U' we find all possible match in S and we pick one at random; so we obtain matched pairs up-stay;
- then we compute and store the proportions of those pairs in which up has a higher NRF rating than stay ($R_{up} > R_{stay}$) and vice-versa ($R_{stay} > R_{up}$);
- we repeat this 10000 times obtaining the distributions of these proportions $F(p|R_{up} > R_{stay})$ and $F(p|R_{stay} > R_{up})$.

To test which group of prestige transitions have higher research performance we use a one-sided Kolmogorov-Smirnov test. In particular, we study whether one distribution stochastically dominates the other. According to the definition a CDF $F(x)$ first-order stochastically dominates $G(x)$ iff $F(x) \leq G(x)$.

Results

We find that one distributions always stochastically dominates the other, in particular:

- Figures 2 and 3 underline the positive role of inertia: with few exceptions, the grey curve (stay) stochastically dominates the black one (up or down). This shows that

scholars' performance of people who make large movements in the prestige hierarchy (up/down) is lower than those who do not (stay).

- Figure 4 shows the positive role of prestige. Comparing scholars with same first job but different PhDs (left column), those with more prestigious PhDs (down, grey curve) have higher ratings. While looking those with the same PhD institution (right column) those with more prestigious jobs perform better (black curve).

Figure 2: Up versus stay comparison. The black curves are cumulative distribution functions of the proportion of observations in which $R_{up} > R_{stay}$ was the case for $p\%$ of the matched pairs. Grey curves are the CDFs for the $R_{stay} > R_{up}$ proportions. From top to bottom 5, 10, 15, and 20 years after PhD. Pairs matched using gender, race, PhD obtained years and first job university (left column) or PhD institution (right column).

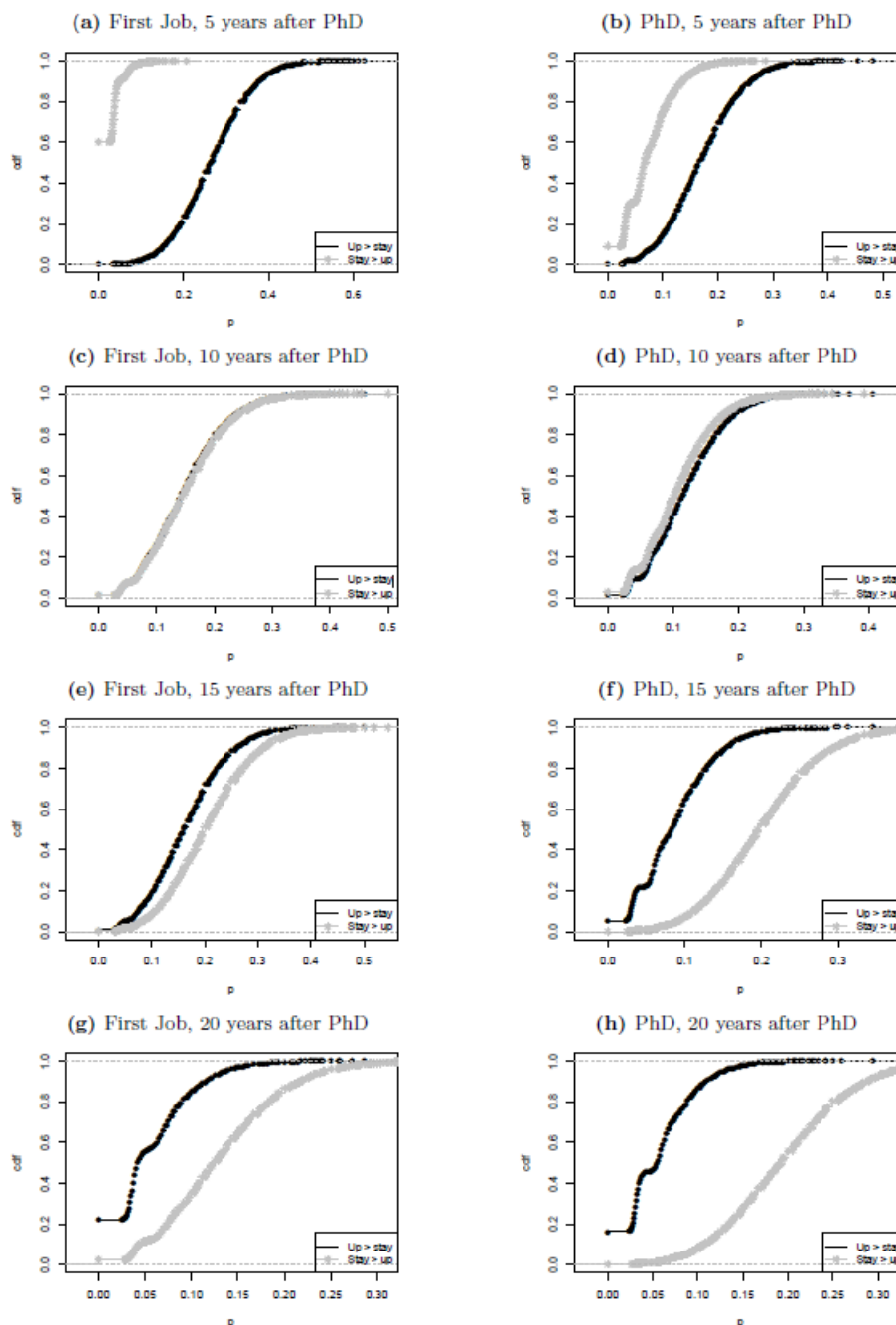


Figure 3: Down versus stay comparison. The black curves are cumulative distribution functions of the proportion of observations in which $R_{\text{down}} > R_{\text{stay}}$ was the case for $p\%$ of the matched pairs. Grey curves are the CDFs for the $R_{\text{stay}} > R_{\text{down}}$ proportions. From top to bottom 5, 10, 15, and 20 years after PhD. Pairs matched using gender, race, PhD obtained years and first job university (left column) or PhD institution (right column).

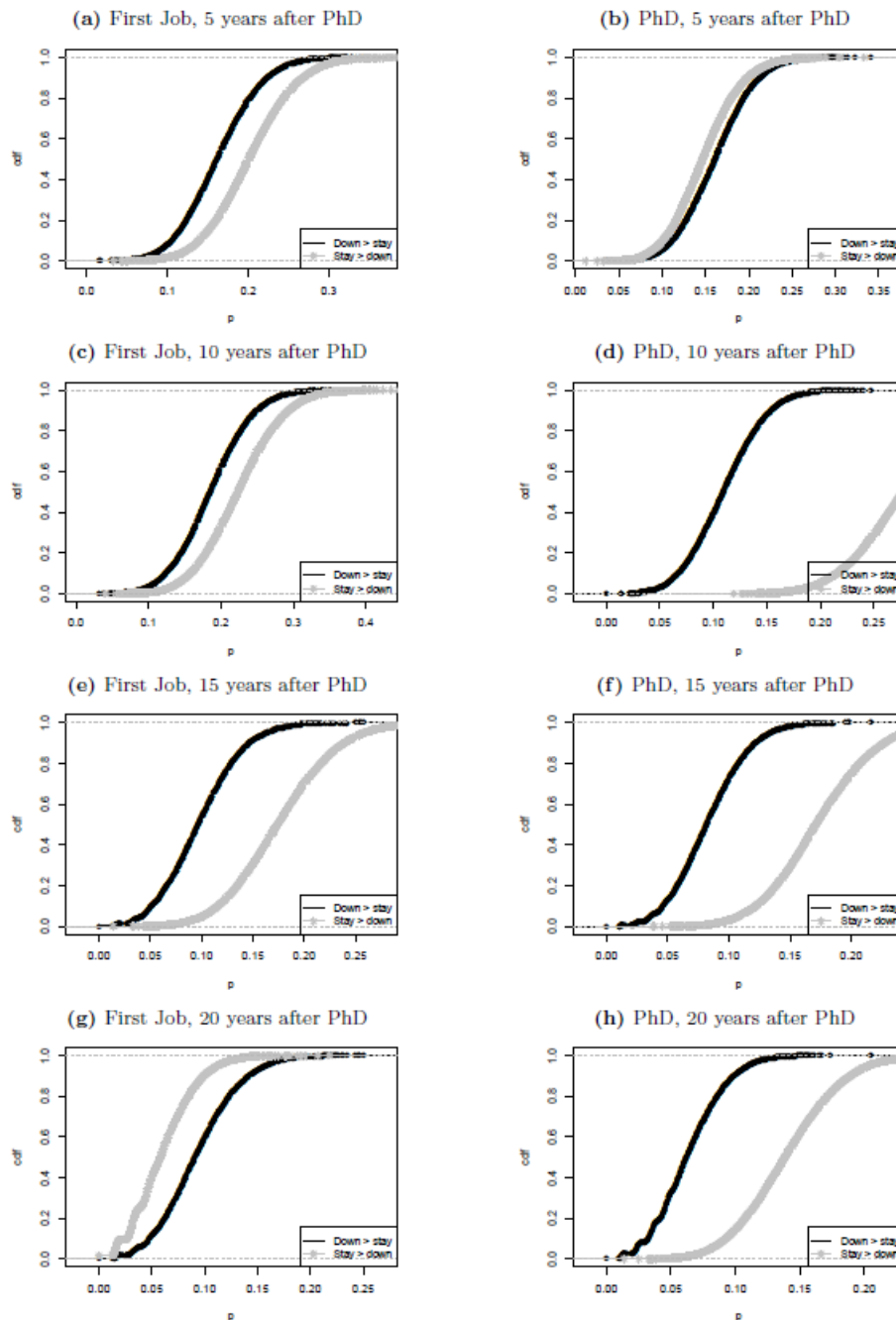
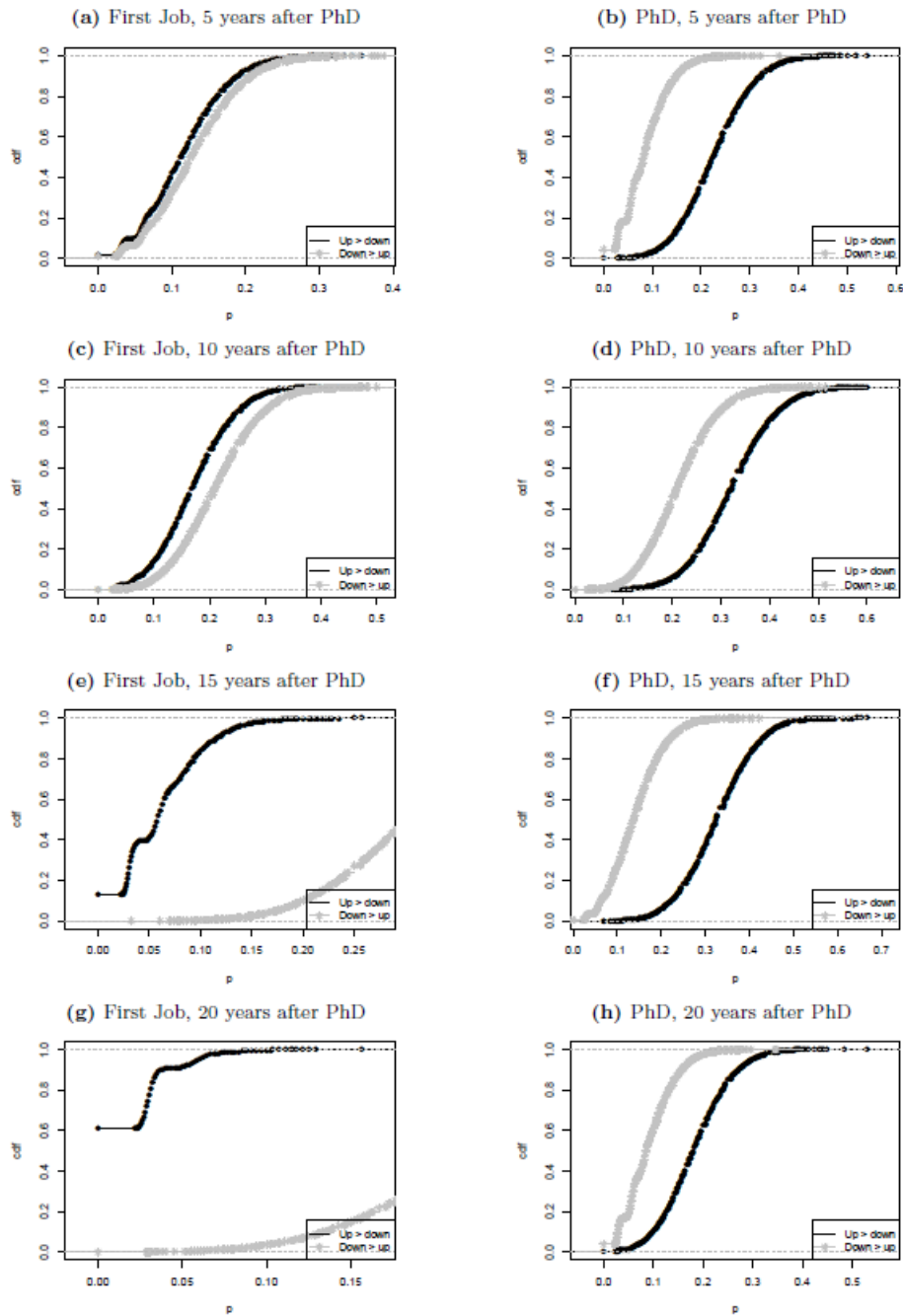


Figure 4: Up versus down comparison. The black curves are cumulative distribution functions of the proportion of observations in which $R_{up} > R_{down}$ was the case for $p\%$ of the matched pairs. Grey curves are the CDFs for the $R_{down} > R_{up}$ proportions. From top to bottom 5, 10, 15, and 20 years after PhD. Pairs matched using gender, race, PhD obtained years and first job university (left column) or PhD institution (right column).



Conclusion

Our results underline a positive role of inertia, those who stay in the same institution after the PhD have higher ratings. This might be due to various factors: training effects from the PhD that make scholars' specialization germane to the in-house research; better ability of the universities to select their own graduates which partially solve information asymmetries in young faculty hiring; or research patterns of those young scholars in terms of collaborations. The comparison of scholars who make large prestige transitions (up vs. down) shows the positive role of prestige: holding PhD constant, moving to a more prestigious first job is better; and holding first job constant, having a more prestigious PhD is better. It appears that training and resources both contribute to individual performance.

References

- Bair, J. H. (2003). Hiring practices in finance education: Linkages among top-ranked graduate programs. *American Journal of Economics and Sociology*, 62(2), 429–433.
- Barnett, G. A., Danowski, J. A., Feeley, T. H., & Stalker, J. (2010). Measuring quality in communication doctoral education using network analysis of faculty-hiring patterns. *Journal of Communication*, 60(2), 388–411.
- Burris, V. (2004). The academic caste system: Prestige hierarchies in Ph.D. exchange networks. *American Sociological Review*, 69(2), 239–264.
- Clauset, A., S. Arbesman, and D. B. Larremore (2015). Systematic inequality and hierarchy in faculty hiring networks. *Science Advances* 1 (1), e1400005.
- Jung, J., & Lee, S. J. (2016). Influence of university prestige on graduate wage and job satisfaction: The case of South Korea. *Journal of Higher Education Policy and Management*, 38(3), 297–315.
- Miller, C. C., Glick, W. H., & Cardinal, L. B. (2005). The allocation of prestigious positions in organizational science: Accumulative advantage, sponsored mobility, and contest mobility. *Journal of Organizational Behavior*, 26(5), 489–516.