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Rise of the Kniesians: The professor-student network of Nobel laureates in economics

Richard S.J. Tol

Department of Economics, University of Sussex, UK
Institute for Environmental Studies, Vrije Universiteit, Amsterdam
Department of Spatial Economics, Vrije Universiteit, Amsterdam
Tinbergen Institute, Amsterdam
CESifo, Munich
r.tol@sussex.ac.uk

Abstract: The paper presents the professor-student network of Nobel laureates in economics. 72 of the 77 Nobelists belong to one family tree. The remaining 5 belong to 3 separate trees. There are 350 men in the graph, and 4 women. Karl Knies is the central-most professor, followed by Wassily Leontief. Harvard is the central-most university, followed by Chicago and Berlin. Most candidates for the Nobel prize belong to the main family tree, but new trees may arise for the students of Terence Gorman and Denis Sargan.

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By Richard S.J. Tol*

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I. Introduction

The highest accolade in economics, indeed in all of science, the Nobel Prize and its winners attract extraordinary attention, including how different Laureates relate to each other. Besides the gossip, particular attention has been paid to schools of thought and influential institutions (McCarty, 2000; Vane and Mulhearn, 2005; Breit and Hirsch, 2009; Boettke, Fink and Smith, 2012; Chan and Torgler, 2012; Claes and de Ceuster, 2013; Spencer and Macpherson, 2015; Solow and Murray, 2015; Offer and Söderberg, 2016). Although anecdotes of who studied with whom are widely known, no one has comprehensively mapped the professor-student relationships of all Nobel Laureates in economics. This paper does just that.

I show that most Nobelists are related, often closely. The 2017 Laureate, Richard H. Thaler, is typically described as an outsider in the press (Appelbaum, 2017; Avent, 2017; Harford, 2017; Partington, 2017; Vitasek, 2017)—but that may be a mischaracterisation of someone with a PhD from the University of Rochester, Gary S. Becker and Robert E. Lucas as academic uncles, and James J. Heckman as an academic cousin. You can interpret the close relationships between Nobelists as a manifestation of the clustering of quality: The best professors congregate in the best schools (Ellison, 2013), reinforce each other (Azoulay,

* Tol: Department of Economics, University of Sussex, BN1 9SL Falmer, United Kingdom, r.tol@sussex.ac.uk; Institute for Environmental Studies, Vrije Universiteit Amsterdam, The Netherlands; Department of Spatial Economics, Vrije Universiteit Amsterdam, The Netherlands; Tinbergen Institute, Amsterdam, The Netherlands; CESifo, Munich, Germany. Richard Blundell, Ernst Fehr, Benjamin Friedman, Jerry Hausman, David Hendry, Edward Lazear, Richard Levin, John Moore, Gerhard Orosel and Larry Summers kindly answered questions about their ancestry. Irwin Collier, Peter Dolton and Stephen Zeff had helpful information and comments.

Zivin and Wang, 2010; Borjas and Doran, 2012; Bosquet and Combes, 2017; Oyer, 2006), and select the best students (Athey et al., 2007). You can also see this as a manifestation of the feudal nature of academia and the nepotism that implies (Combes, Linnemer and Visser, 2008; Hamermesh and Schmidt, 2003; Laband and Piette, 1994; Medoff, 2003). William J. Baumol and his student Lionel W. McKenzie were not honored by a trip to Stockholm, inexplicably so according to some (Minniti, 2016; Weintraub, 2011). What does this imply for the chances of McKenzie's grandstudent, Paul M. Romer? Actually, Baumol is the academic brother of John R. Hicks, and uncle to Franco Modigliani, Amartya Sen and Joseph E. Stiglitz. Some argue that Margaret Reid should have shared the Nobel Prize with Gary S. Becker (Yi, 1996). Whatever the merits of this argument, a lack of connections was not part of it: Reid is Ronald Coase' first cousin once removed, she had a PhD from the University of Chicago, and taught there for many years. A comprehensive map of all Laureates, including a way to connect those that could or should have won, is useful to dispel myths and ugly rumours.

Tracing the Nobel network over time illustrates key features of the development of economics as a discipline. The Scandinavian branches of the network were ascendant for a while, but key people stayed put in or returned to Norway and Sweden and lost global influence, unlike the Dutch who moved to the USA and kept winning. The French branch moved to the USA too, and withered. The current network is dominated by the UK and the USA, with competition between East Coast and Great Lakes, and deep roots in Austria, Germany and France uniting many. Intriguingly, none of the great classical economists—Smith, Say, Ricardo, Malthus, Mill—and pre-classical economists—Ibn Khaldun, Petty, Quesnay, Cantillon, Turgot, Galiani—is connected to the Nobelists, and only one of the neo-classical revolutionaries: Carl Menger—Marshall, Walras, Jevons, Pareto and Pigou made enduring contributions to economic thought, but only through their writings, not through their students. In those days, apparently, economics was not yet a discipline that could be taught to young scholars, or at least the leaders of the profession did not see it this way.

This is specific to economics: Scholars in the humanities and natural sciences can trace their ancestry to great names of times past, and indeed many economists descend from famous non-economists—including people whose work we use, such as the Bernouillis, Gauss, Lagrange, Lyapunov and Pearson, and people whose work is less obviously relevant, such as Bohr, Erasmus, Heisenberg, Luther and Maxwell. In other words, economics was taken over by people from other disciplines, much like economists now work on subjects that traditionally were the exclusive domain of political scientists, anthropologists, psychologists and biologists.

Representing the network as a graph and adding degree-granting institutions, I identify central professors and schools. The results may be surprising. A relatively obscure member of the German Historical School, Karl Knies emerges as the central-most thesis advisor. Knies is not nearly as famous as his students

Eugen Böhm von Bawerk (Von Mises, 2016), John Bates Clark (Homan, 1927; Leonard, 2003), and Richard T. Ely (Rader, 1966; Thies and Pecquet, 2010). Berlin and Gottingen are the third- and fourth-most central schools, after Harvard and Chicago.

I also consider the likely candidates for future Nobel Prizes, revealing that the current network is likely to produce future winners. New networks may emerge as well, particularly around the students, grandstudents and great-grandstudents of Terence Gorman.

The paper proceeds as follows. Data and methods are presented in the next section. Section 3 discusses the results. Section 4 concludes.

II. Data and methods

A. *Data*

The list of Nobel laureates was taken from IDEAS/RePEc. The list of Nobel candidates is Clarivate's 2017 list of Citation Laureates. Speculation is rife in the run-up to the Nobel Prize announcement and lists of candidates abound. The Clarivate list is based on objective criteria—citation numbers in economics journals—and has a reasonable prediction record. It largely overlaps with other lists.

Data on ancestry and final degree were gathered from and stored on AcademicTree.org, a collaborative tool for building an academic genealogy for all disciplines (David and Hayden, 2012). The economics tree contains almost 20,000 economists, the overall tree almost 700,000 academics. Where AcademicTree was incomplete, I added data from the Mathematics Genealogy Project, which actually includes many economists, and from RePEc Genealogy, which focuses on economists but is limited in its historical depth. If all three sources fell short, I used Wikipedia, studied CVs, obituaries and acknowledgements in early papers, and dug up the occasional thesis. When all that failed, I contacted people directly. The results can be found on AcademicTree.org. The data can be amended where needed and extended to include the reader's favorite economists.

The data are not perfect. Formal professor-student relationships are recorded, but may be less important than informal mentoring. The formalization of research training is a recent development, and different countries made this transition at different times. The edges in the graph are not uniform, and particularly change in nature over time. Some data are missing, and some people were self-taught—no distinction is made. For earlier generations, historians have focused on prominent scholars, their professors and their students.

B. *Methods*

Data were transferred to Matlab for visualization and analysis. Five generations were included, unless graphs could be connected by including more distant an-

cestors, in which case the closest common ancestor was included. Without these two restrictions, the network would be dominated by the intricate relationships of non-economists of times long past and the somewhat speculative lineage of Jesus Christ. Data are interpreted as a directed acyclic graph—because in most cases students learn more from their professors than the other way around—with unweighed edges—because we do not know which advisor was more influential. I use a minor modification of an outcloseness measure $c^A(i)$ for network centrality:

$$c^A(i) = \left(\frac{A_i}{N-1}\right)^2 \frac{1}{\sum_j C_{i,j}} \tag{1}$$

where A_i is the number of *Nobel* nodes that can be reached from node i, N is the number of nodes, and $C_{i,j}$ is the distance from node i to any *Nobel* node. If the word *Nobel* is dropped, this reverts to the measure of outcloseness as defined by Bavelas (1950) for a connected graph and extended, in a seemingly *ad hoc* but not unreasonable way, by Matlab to unconnected graphs by multiplication with the square of the fraction of nodes reachable.

In a connected graph, Equation (1) is the *arithmetic* mean of the distance to all other nodes. Marchiori and Latora (2000) propose the *harmonic* mean as a measure of distance:[1]

$$c^H(i) = (N-1)\sum_j \frac{1}{C_{i,j}} \tag{2}$$

The key advantage of the harmonic mean is that it applies to connected as well as unconnected graphs—for unreachable nodes $C_{i,j} = \infty$. In Equation (2), the number of unreachable nodes is penalized linearly; in Equation (1), the penalty is quadratic. In this context, when distance is restricted to distance to a Nobel laureate, the harmonic mean has the additional advantage that proximity is emphasized at the expense of distal relationships. I therefore use the harmonic mean distance as my key measure of centrality, and the arithmetic mean as a robustness check.

For Nobel candidates, what matters is their distance to the graph, rather than the graph's distance to them. This is an incloseness measure, rather than an outcloseness one. It is readily computed by replacing $C_{i,j}$ by $C_{j,i}$ in Equation (2).

I measure the change in the network over time by the Graph Edit Distance (Sanfeliu and Fu, 1983). The edit distance between graph A and B equals the number of nodes and edges that need to be added to (or removed from) A to make A isomorphic to B. Typically, computing the Graph Edit Distance is a n-p hard problem, but in this case the graph for the previous year is a subgraph of the graph for the current year. Indeed, the algorithm that builds the graph for

[1] Earlier, Gil-Mendieta and Schmidt (1996) suggested its inverse as a measure of closeness.

year t uses the graph for year $t-1$ as its starting point. This also means that the edits make the graphs identical, rather than just isomorphic.

Besides the changes in the overall graph over time, I am also interested in changes in the centrality of individuals. While the centrality measures defined above have a cardinal interpretation at any point in time, this is not true for changes in centrality.[2] I therefore use changes in the centrality *rank* to assess changes over time.

III. Nobelists

Ragnar Frisch, Jan Tinbergen and Paul A. Samuelson all start their own graphs. They do not share an ancestor. Simon S. Kuznets and Samuelson do share an ancestor in Christian Gottlob Heyne, an 18th century classicist and archaeologist at the University of Göttingen, Germany. Kenneth J. Arrow starts his own graph.[3] John R. Hicks was a grandstudent of Carl Menger, who was also a great-grandprofessor of Samuelson. Wassily Leontief was advisor of Samuelson, who is thus the first second-generation Nobelist. Leontief was the first to win the Nobel Prize after his student. F.A. Hayek, Hicks' adviser, was the second. Gunnar Myrdal is a distant descendant of Pierre Varignon, an 18th century mathematician at the Royal Academy in Paris, France; Arrow also descends from Varignon. After five years, there are nine Nobel laureates, five of whom are part of a single family tree; there is one tree with two Nobelists (Arrow, Myrdal); and two with one (Frisch, Tinbergen).

Leonid Kantorovich and Leontief are distant descendents of Johann Friedrich Pfaff, a 19th century mathematician at the University of Halle-Wittenberg, Germany. Tjalling C. Koopmans was a student of Tinbergen and Hendrik Kramer, who descends from Heyne. Koopmans thus connects the Tinbergen graph to the main one. Milton Friedman was a student of Kuznets, and shares an ancestor with Samuelson in Karl Knies, a 19th century economist at the University of Heidelberg, Germany.

James E. Meade starts his own graph. Like Myrdal (and Eli Heckscher), Bertil Ohlin was a student of Karl Gustav Cassel. This completes the Swedish branch of the graph—in contrast with the Dutch branch, which continues to grow, as key people moved to the USA.

Herbert A. Simon was a student of Henry Schultz, like Friedman was. Theodore W. Schultz was a great-grandstudent of Knies. W. Arthur Lewis and Hicks are both grandstudents of Edwin Cannan. Lawrence R. Klein was Samuelson's student. James Tobin was Joseph Schumpeter's student, like Samuelson, and a grandstudent of Werner Sombart, who was Leontief's adviser. George J. Stigler was a great-grandstudent of both Clark and Ely. In 1982, 14 years after the Nobel

[2] This is easily seen. Consider a graph. Add a node with a single edge to the central-most node. Add N unconnected nodes. If N is sufficiently large, centrality falls numerically, even though the central-most node has become more central.

[3] Arrow's biological sister was married to Samuelson's biological brother.

Memorial Prize in Economic Sciences was first awarded, there is a well-established family tree.

Gerard Debreu starts his own graph. Like Meade, Richard Stone was a student of John Maynard Keynes. He was also a great-grandstudent of Ely and so related to Schultz and Stigler. Stone thus connects the UK and the US graphs. Stone also brings the first female to the graph: Beatrice Potter Webb,[4] who co-founded the London School of Economics.

Franco Modigliani is a grandstudent of Lionel Robbins, one of Hicks' advisers, and a great-grandstudent of Bawerk. Like Stigler, James M. Buchanan was a student of Frank H. Knight. Like Samuelson, Robert M. Solow was a student of Leontief.

Debreu was a post-doc with Maurice F.C. Allais. This completes the French graph. Trygve M. Haavelmo was a student of Frisch. This completes the Norwegian graph.

William F. Sharpe was a great-grandstudent of Harold Hotelling, who was Arrow's adviser. Merton M. Miller was a grandstudent of Ludwig von Mises, Hayek's advisor. Harry M. Markowitz was Jacob Marschak's student, like Modigliani. Markowitz was also a student of Friedman, who was Kuznets' student. Markowitz is thus the first third-generation Nobelist.

Like Stigler and Buchanan, Ronald H. Coase was a student of Knight. Gary S. Becker was a grandstudent of Schultz, the adviser of Friedman and Simon. Robert W. Fogel was Kuznets' student. Douglas C. North was advised by Melvin M. Knight,[5] who was a grandstudent of Henry Moore, like Friedman and Simon.

John C. Harsanyi was a student of Arrow. John F. Nash and Reinhard J.R. Selten are distant descendants of Carl Gauss, and so is Leontief. Selten also descends from Simeon-Denis Poisson as does Hotelling. Selten thus connects the Arrow-Sharpe-Harsanyi/Myrdal-Ohlin graph with the main one.

Robert E. Lucas was a student of Gregg Lewis, like Becker. Lucas is also a great-great-grandstudent of Ely, and so related to many other Nobelists. James E. Mirrlees was a student of Stone. William S. Vickrey was a grandstudent of Edwin Seligman, like Frank Knight. Robert C. Merton was a student of Samuelson. Myron S. Scholes was Miller's student. Eugene F. Fama was Scholes' other adviser. Sixteen years after receiving his prize, Scholes would become the first Nobelist with two Nobel advisers.

Amartya Sen was a grandstudent of Robbins, like Modigliani. Joan Robinson was an adviser. She is the second woman in the graph. Robert A. Mundell was a great-grandstudent of James Laughlin, Kuznets' grandprofessor, and of Allyn Abbot Young, Knight's professor. Daniel L. McFadden was a grandstudent of Koopmans and Jakob Marschak, who advised Modigliani. James J. Heckman was a grandstudent of Lewis and Tobin, and a great-grandstudent of Klein. George A. Akerlof was a student of Solow, A. Michael Spence a grandstudent of Leontief.

[4] Beatrice Potter and Beatrix Potter are different people.
[5] Melvin was a biological brother of Frank.

Joseph E. Stiglitz was a student of Robinson, a grandstudent of Robbins and a great-grandstudent of Young. Year after year, the Nobel Prize is awarded to close relatives of previous winners.

Vernon L. Smith was a student of Leontief. Daniel Kahneman's great-great-great-great-grandprofessor was John Dewey, who was grandprofessor of Kuznets. One of Kahneman's advisers was Susan Ervin-Tripp, the third woman in the graph. Robert F. Engle was a great-great-grandstudent of Wesley Clair Mitchell, Kuznets' professor. Clive W.J. Granger was a great-great-great-grandstudent of Eliakim Moore, Hotelling's grandprofessor. Finn E. Kydland was a student of Edward C. Prescott, a grandstudent of Leontief. They are the first and only student-professor pair to jointly win. Robert J. Aumann was great-grandstudent of Solomon Lefschetz, who was Nash' grandprofessor. Thomas C. Schelling was Leontief's student, and a grandstudent of Schumpeter, who advised Samuelson and Tobin. Edmund S. Phelps was Tobin's student. Eric S. Maskin and Roger B. Myerson are Arrow's students. Leonid Hurwicz was Koopmans' student and a post-doc with Samuelson. Hurwicz is thus a double third-generation Nobelist. McFadden is a fourth-generation Nobelist, and a double one at that.

Paul Krugman was a grandstudent of Mundell. Oliver Williamson was Simon's student. Elinor Ostrom is the first and only female Nobelist, and only the fourth woman in the graph. Her grandprofessor was Robert K. Merton[6], a descendant of Friedrich Trendelenburg, Dewey's grandprofessor. Like Kahneman before her, Ostrom is part of the main family of Nobelists.

Peter A. Diamond was Solow's student, and Dale T. Mortensen Leontief's grandstudent. Christopher A. Pissarides has his own graph.

Thomas J. Sargeant was a great-grandstudent of Arthur Smithies, Schumpeter's student and Schelling's adviser. Christopher A. Sims was Harold S. Houthakker's student, who was Pieter de Wolff's student, who was Tinbergen's student.[7] Lloyd S. Shapley was Alfred Tucker's student, like Nash. Alvin E. Roth descends from Gauss and Poisson. Lars Peter Hansen is Sims' student, Robert J. Shiller Modigliani's. Eugene F. Fama is Miller's student and Scholes' professor. Jean Tirole is Maskin's student, Angus Deaton Stone's. Bengt Holmström is Robert Wilson's student, like Roth. Oliver Hart is a grandstudent of Solow and Diamond. Like Heckman, Richard H. Thaler is a grandstudent of Lewis, Becker's and Lucas' adviser.

There are 350 men in the graph, and 4 women. There are 76 male Nobelists, one female.

A. The Nobel network over time

Figure 1 shows the complete network for 2017; there is also a video of all networks since 1969. Figure 2 quantifies the changes over time. We start with two

[6]Robert K. was the biological father of Robert C.
[7]De Wolff is my great-grandprofessor.

disjoint graphs. At five occasions, a new, disjoint graph is added. At three occasions, previously disjoint graphs are joined. At the end, there are four disjoint graphs: Frisch-Haavelmo; Allais-Debreu; Pissarides; and all other Nobelists. The final network is messy, as professors group and regroup to advise different students, and professors team up with their students and grandstudents to teach a new generation—but the key point is that Nobelists are connected.

Figure 2 shows that the graph edit distance—the number of new nodes and edges—is often small. In 27 out of 49 years, the distance is 10 or less. This is a different way of revealing the same information: New Nobelists are closely related to previous Nobelists. The largest change in the network was in 1975, when 96 edits were needed to include Kantorovich and Koopmans and connect them to the main graph. 66 edits where needed to connect Kuznets to Samuelson in 1971. 56 edits were needed in 1994 for (Harsanyi,) Nash and Selten. Kahneman (and Smith) in 2002 needed 48 edits, and Ostrom (and Williamson) 40 edits in 2009. These results may strike us as odd, but the current reader sees the earlier Nobel laureates as the ultimate insiders. They were not at the time. As shown above, Kahneman and Ostrom are not as alien to the economics profession as sometimes claimed.

Table 1 shows the central-most professors in the network, over time. On both distance measures—harmonic, see Equation (2), and arithmetic, see Equation (1)—Karl Knies is the most influential person at the moment. Using the arithmetic mean distance, which emphasizes connectivity over proximity, he has been since 1981. Using the harmonic mean distance, which emphasizes proximity over connectivity, Knies and Leontief have frequently swapped rank, with Robert Shiller pushing Knies into the lead in 2013, a position weakened by Oliver Hart in 2016 but strengthened by Richard Thaler in 2017. Others, including Henry Schultz and Josef Schumpeter, were particularly influential in earlier years.

Table 2 shows the current top 10. The key people are Knies and Leontief and their (grand)professors. Schumpeter is included as the professor of Samuelson and Tobin and the grandprofessor of Schelling. Heyne connects three branches of the main graph.

Figure 3 shows selected subgraphs, for Tinbergen (6 Nobelists), Hotelling (6 Nobelists), Keynes (4 Nobelists) and Kuznets (4 Nobelists). These graphs are simple. Figure 4 shows the subgraphs for Knies (37 Nobelists, all distant) and Leontief (15 Nobelists, most close). The Knies graph again shows the complex relationships between Nobelists, the Leontief one the key role he played in economics.

Figure 1 is based on the nearest common ancestor of a new Laureate and any of the previous ones. This algorithm does not necessarily lead to the same, minimum spanning graph if all Nobel Prizes were awarded in 2017. In order to test whether this affects centrality, I include all ancestors of all Laureates, appropriately cut-off at William of Ockham. The expanded graph is quite a bit larger, with 1076 instead of 354 nodes. Centrality does not change much, however. The main difference is

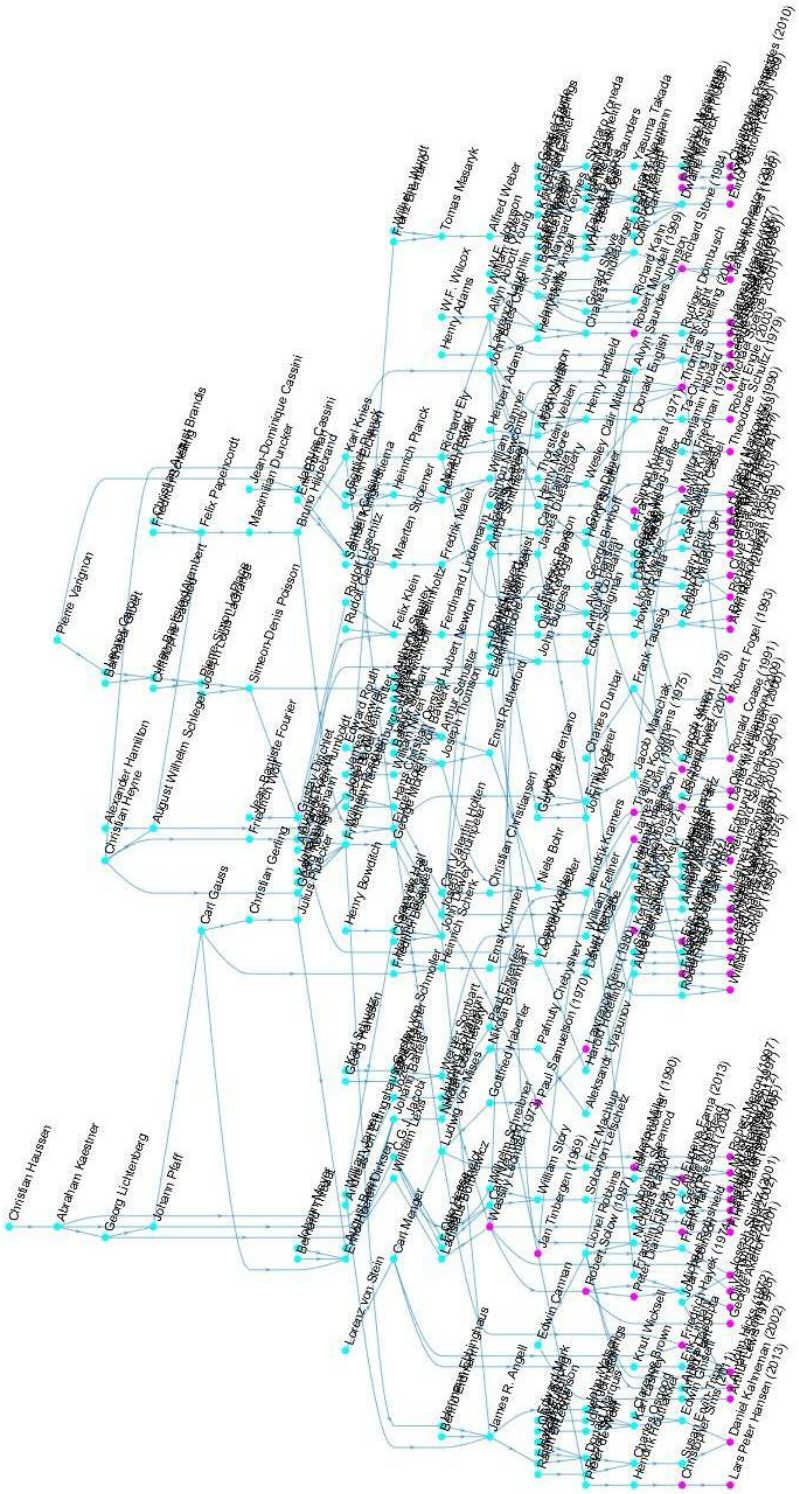

FIGURE 1. THE COMPLETE PROFESSOR-STUDENT NETWORK OF NOBEL PRIZE LAUREATES IN ECONOMICS.

Note: Nobelists are marked in magenta.

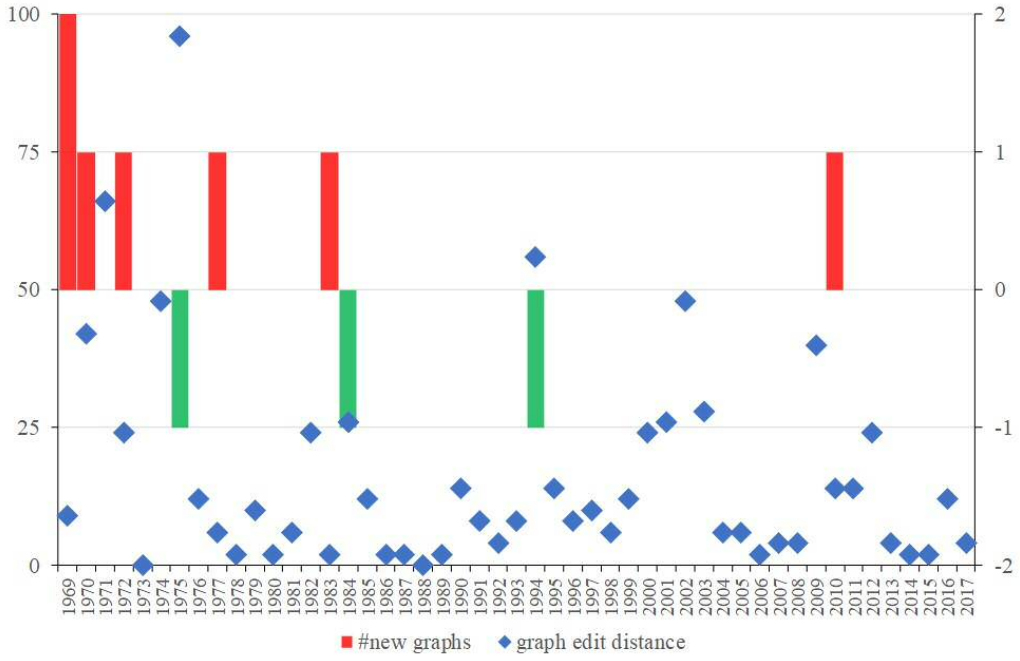

FIGURE 2. GRAPH EDIT DISTANCE AND CHANGE IN THE NUMBER OF DISJOINT GRAPHS.

Table 1—Central-most professors over time.

	arithmetic	harmonic
Knies	1: 1981-2017	1: 2013-2017, 2007-2009, 1982-2004
	2: -	2: 2016, 2010-2012, 2005-2005, 1981
	3: -	3: 1980
Leontief	1: 1970-1972	1: 2010-2012, 2005-2006, 1970-1972
	2: -	2: 2017, 2015, 2007-2009, 2004
	3: 2004-2017, 1973	3: 2002-2003, 1973
Schultz	1: 1978-1980	1: 1978-1979
	3: -	3: 1995, 1980
Bawerk	3: 1990-1992, 1985-1986, 1981	3: 1990-1992, 1985-1986
Sombart	1: 1973	1: -
	2: -	2: 1981
	3: 1987-1989, 1974-1976	3: 1987-1989
Schumpeter	1: 1970-1972	1: 1981, 1970-1972
	2: 1981-1983	2: 1982-1983
	3: 1984, 1973	3: 1984-1986, 1973
Mises	1: 1980, 1974-1976, 1972	1: 1972-1980
	2: 1977	2: 1981
	3: 1978-1979, 1973	3: -
Menger	2: 1974-1976	2: 1980, 1974-1976
	3: 1977	3: 1977
Cassel	1: 1977-1980	1: 1977-1979
	3: -	3: 1980

Note: Shown are the ranks of the most influential professors of economics, as measured by their (arithmetic or harmonic) average distance to Nobelists. Leaders in the period 1969-1978 are omitted. Knies' professor, Bruno Hildebrand, and grandprofessor, Maximilian Duncker, are also left out.

Table 2—Central-most professors in 2017.

	arithmetic	harmonic
1	Knies	Knies
2	Hildebrand	Leontief
3	Leontief	Hildebrand
4	Sombart	Sombart
5	Duncker	Duncker
6	Bawerk	Bawerk
7	Papencordt	Bortkiewicz
8	Bortkiewicz	Papencordt
9	Heyne	Heyne
10	Schlegel	Schumpeter

Note: Shown are the ten most influential professors of economics, as measured by their (arithmetic or harmonic) average distance to Nobelists.

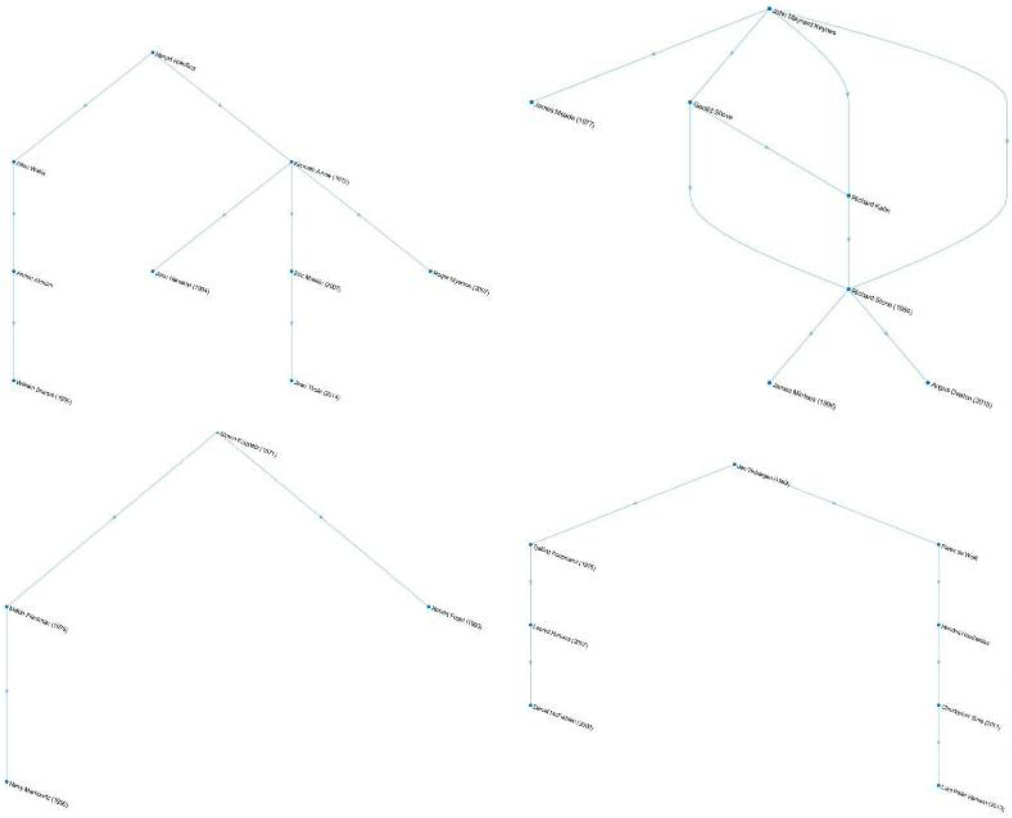

FIGURE 3. SELECTED SUBGRAPHS: HOTELLING, KEYNES, KUZNETS AND TINBERGEN.

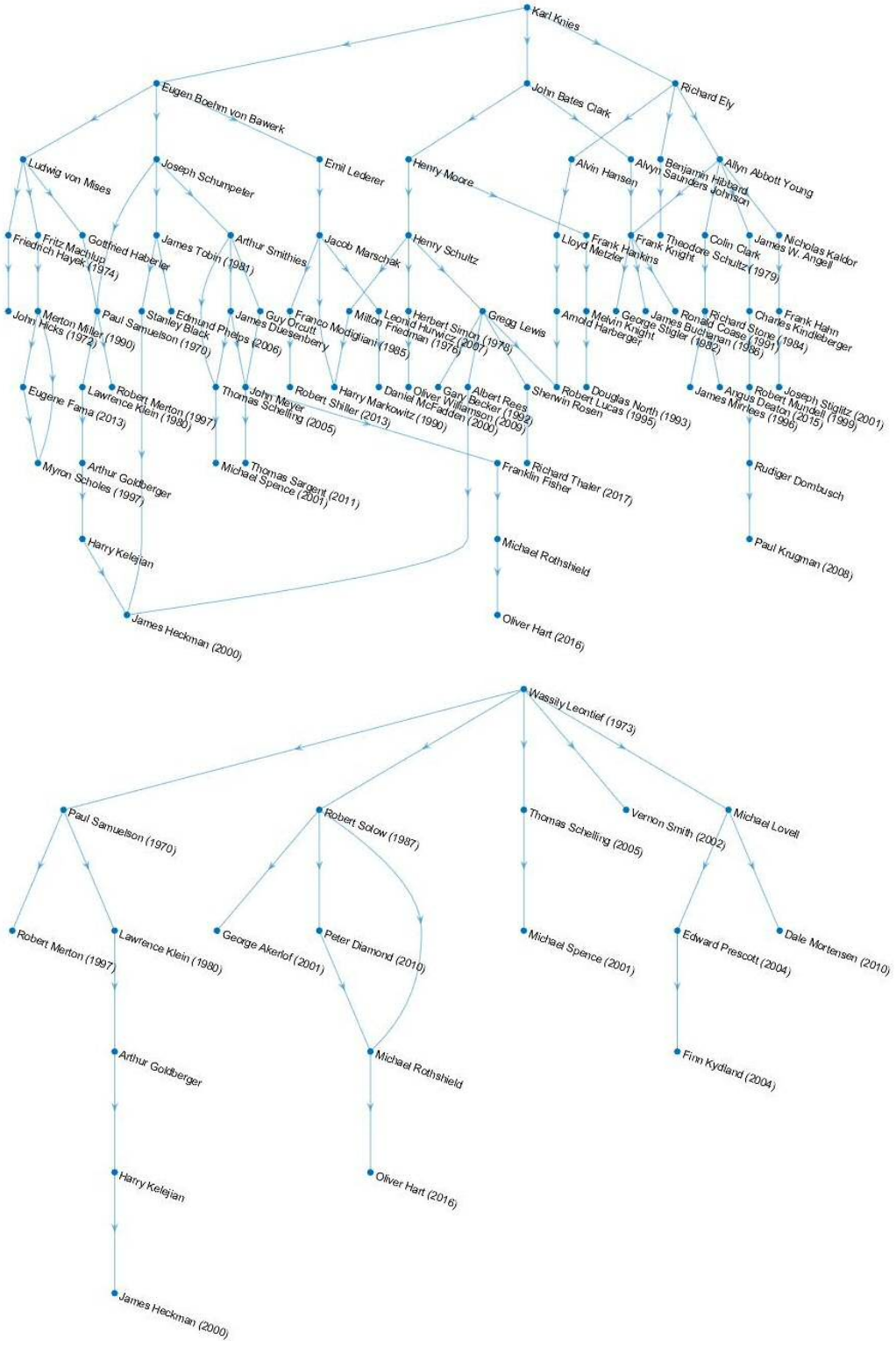

Figure 4. Selected subgraphs: Knies and Leontief.

that Jakob Thomasius enters the top 10 of most central ancestors. Thomasius was a 17th century philosopher at the University of Leipzig, and a common ancestor of common ancestors. The expanded graph contains many famous philosophers, theologists, jurists, physicists, biologists, and chemists—but no classical or pre-classical economists.

Figure 5 shows the key places of learning, ranked by their centrality in 2017. A video shows location and centrality over time. I show total centrality: A university is granted one point if a Nobel Laureate obtained his PhD there. The university where his professor graduated is awarded half a point, with further ancestors' universities granted points in proportion to the arithmetic centrality measure (1). Figure 5 shows market share, as levels increase with time. In total, 60 universities are included but Figure 5 only shows the top 10. Harvard comes out top, closely followed by Chicago and Berlin. Göttingen, Vienna and Heidelberg rank highly for their rich heritage rather than their current prowess. Cambridge and the London School of Economics are the only UK institutes on the list, but highly ranked. MIT and Columbia complete the top 10. Further down the list, Bonn bests Yale and Princeton. Paris ranks 17th and Leiden 20th, just ahead of Stanford and Berkeley. In another upset, Uppsala beats Stockholm. Figure 5 thus reveals the dramatic shifts in the geography of teaching economics.

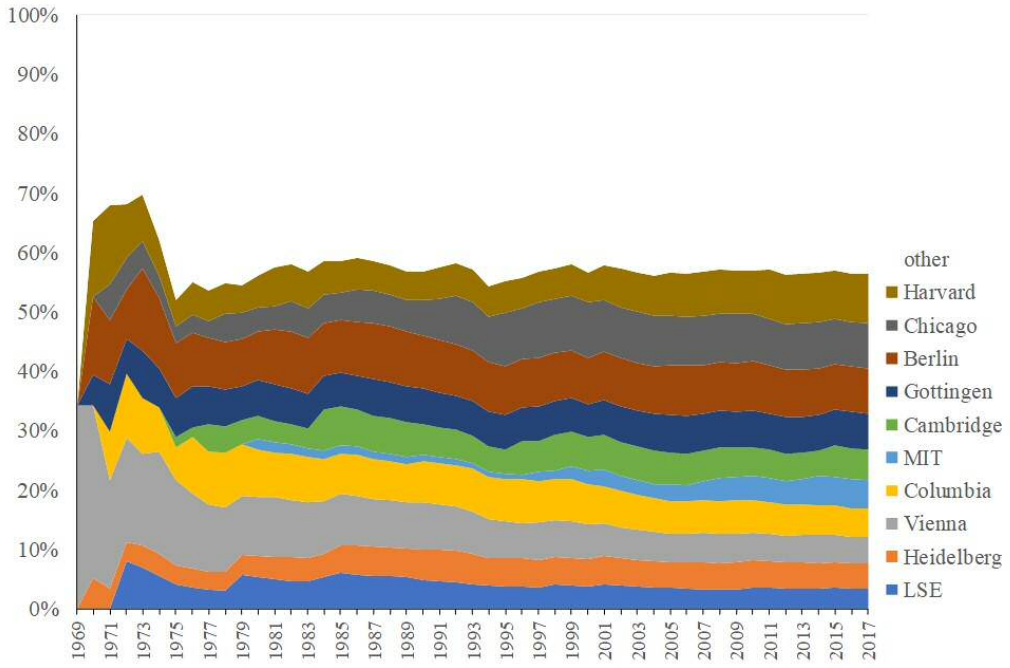

Figure 5. Universities that granted most degrees to Nobel Laureates and their professors.

IV. Nobel candidates

Clarivate's list of citation laureates includes many of world's leading economists, although there are some surprising omissions too. All would be worthy Nobelists, and I suspect many will be. I discuss them in alphabetical order, grouped by their place in the Nobel family tree.

Philippe Aghion and Paul Romer are both grandstudents of Lionel McKenzie, and so descend from Cannan and Knies. Aghion further descends from Poisson.

Alberto Alesina, Richard Blundell, Martin Feldstein, Alan Krueger and John Moore share a common ancestor in Terence Gorman. There are other prominent economists in the same family, which is unconnected to other Nobelists—although Krueger would form a link (see below).

Joshua Angrist and David Card were students of Orley Ashenfelter and so descend from Lewis and Modigliani.

David Barro and Edward Lazear were students of Zvi Griliches, and so descend from Ely. Jagdish Bhagwati, Gene Grossman and Marc Melitz also descend from Ely, via Charles Kindleberger.

Olivier Blanchard, Avinash Dixit, Robert Hall, William Nordhaus and Martin Weitzman were all students of Robert Solow, Jordi Gali and Nobuhiro Kiyotaki are grandstudents, and Marc Melitz a great-grandstudent.

Colin Camerer is a great-great-great-grandstudent of John Dewey, Kuznets' grandprofessor. Like Kahneman and Ostrom, he shared a common ancestry with many prominent economists.

Harold Demsetz is a student of Frank Knight, Sam Peltzman a grandstudent.

Ernst Fehr descends from Ludwig Brentano, Marschak's grandprofessor.

Kenneth French is Fama's grandstudent, Mark Gertler Tobin's. Mark Granovetter is a great-grandstudent of Niels Bohr, who was Koopmans' grandprofessor. Jerry Hausman was Mirrlees' student, Elhanan Helpman Houthakker's.

David Hendry and Peter Phillips were students of Denis Sargan, a self-taught man, unconnected to the Nobel graph. There are other distinguished econometricians in this tree.

Peter Howitt is a great-grandstudent of Koopmans, Michael Jensen a student of Miller. Dale Jorgenson was Leontief's student, Alan Krueger Jorgenson's great-grandstudent. Israel Kirzner was von Mises' student. John List also descends from von Mises.

Anne Krueger is the only woman among the Nobel candidates. Ely is her great-great-grandprofessor.

John List is a great-great-grandstudent of Hicks. Charles Manski was a student of Franklin Fisher, sharing an ancestry with other prominent economists, including several Nobelists. George Loewenstein is a grandstudent of Stiglitz and a great-grandstudent of Solomon Lefschetz. Like Roth and Holmström, Paul Milgrom was a student of Robert Wilson.

Stewart Myers and his student Raghuram Rajan descend from David Alhadeff. This could constitute a disjoint graph: Alhadeff obtained his PhD from Harvard

shortly after World War II.[8] Stephen Ross and his student Douglas Diamond may also form a disjoint graph; Ross has a 1970 PhD from Harvard.

Like Alan Krueger and List, Hashem Peseran descends from Keynes. Matthew Rabin is a grandstudent of Maskin.

John Taylor descends from Everett Lindquist, and is thus related to Amos Tversky. Lindquist was probably taught by Henry Rietz, and so related to Carl Gauss and many Nobelists, but this link cannot be proven.

The future network of Nobelists is thus likely to look much like the current network. There is only one woman among the candidates. New graphs may emerge around Gorman and Sargan, with the Gormanites more readily connected to the main tree than the Sarganites.

A. The Nobel network in the future

The top graph in Figure 6 shows the harmonic average distance from the Nobel candidates to the network in 2017. George Loewenstein, Sam Peltzman and Marc Melitz are closest to the current network, David Hendy, Peter Phillips and Stewart Myers the furthest removed. The bottom graph in Figure 6 shows the harmonic average distance from the Nobel candidates to the current Nobel laureates. Sam Peltzman now comes top, followed by Blanchard, Dixit, Hausman, Hall, Nordhaus and Weitzman in shared second place. 23 of the 47 candidates do not have a Nobel ancestor.

Figure 7 shows the change in the central ranking, based on the harmonic average distance, of Nobel Laureates should all candidates win. Franco Modigliani, Milton Friedman, John Hicks and Tjalling Koopmans are closest to the candidates. Most Nobelists are not directly connected, but drop five places as others are propelled to greater centrality. Paul Samuelson, Lawrence Klein, Robert Mundell and Peter Diamond are furthest removed from the candidates.

V. Discussion and conclusion

I show that the vast majority of winners of the Nobel Memorial Prize in Economic Sciences are connected in a network of professor-student relationships, and that this is likely to remain the case for years to come. The underlying data can be inspected and extended by anyone. A closer look at the wider network quickly dispels the notion of aggrieved economists, or their champions, that they did not want for lack of connections.

The two central figures in the Nobel network are Karl Knies and Wassily Leontief. Leontief needs no introduction (Samuelson, 2004; Baumol and ten Raa, 2009; Dietzenbacher and Lahr, 2004; Debresson, 2004; Duchin, 1995). Who was Karl Knies? Having to raise this question indicates that his contributions to economics lie primarily in taking three young men—Eugen Böhm von Bawerk, John Bates

[8] The registrar argues that student-professor relationships are private information.

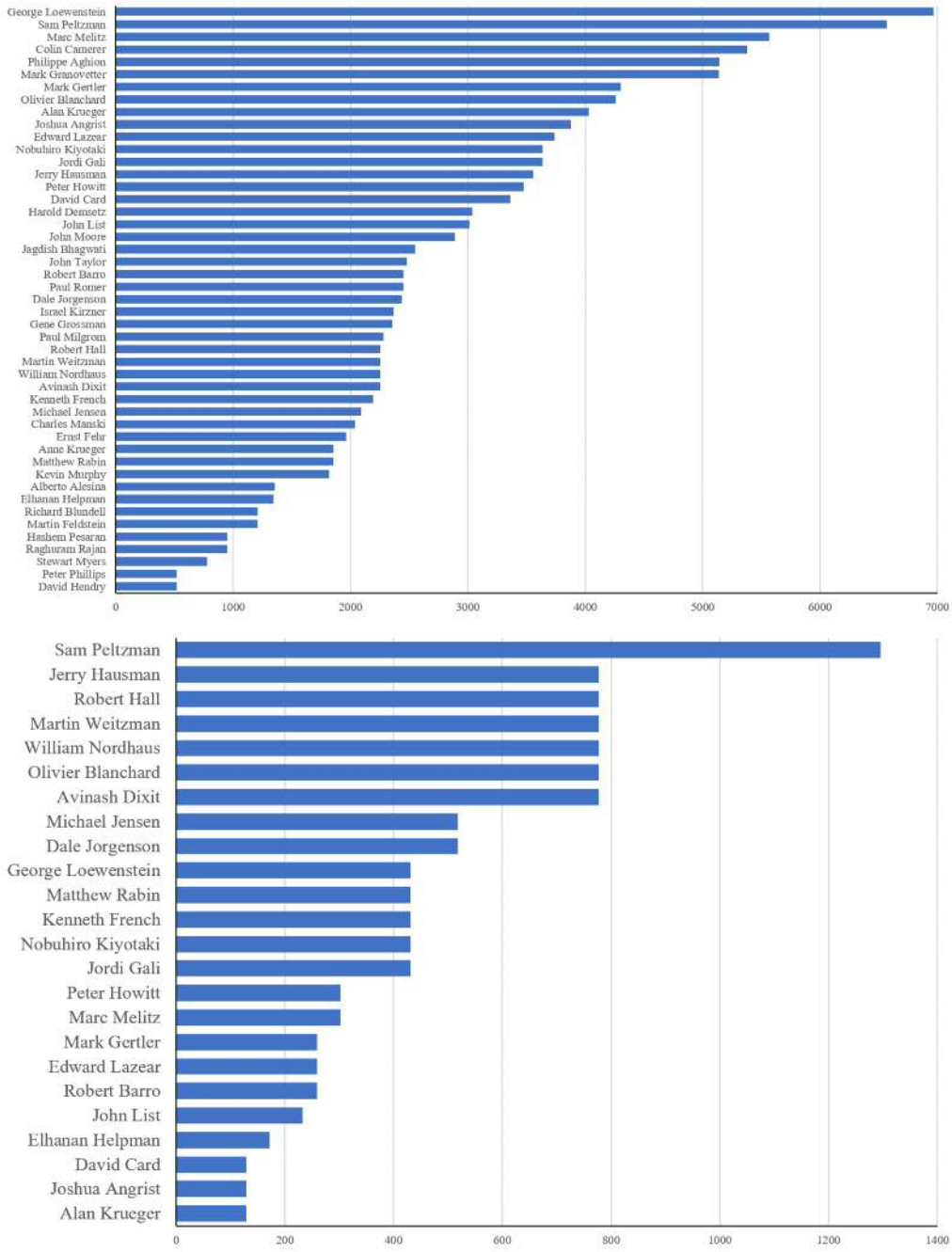

FIGURE 6. HARMONIC MEAN DISTANCE OF NOBEL CANDIDATES TO THE 2017 NETWORK (TOP GRAPH) AND TO THE NOBELISTS (BOTTOM GRAPH).

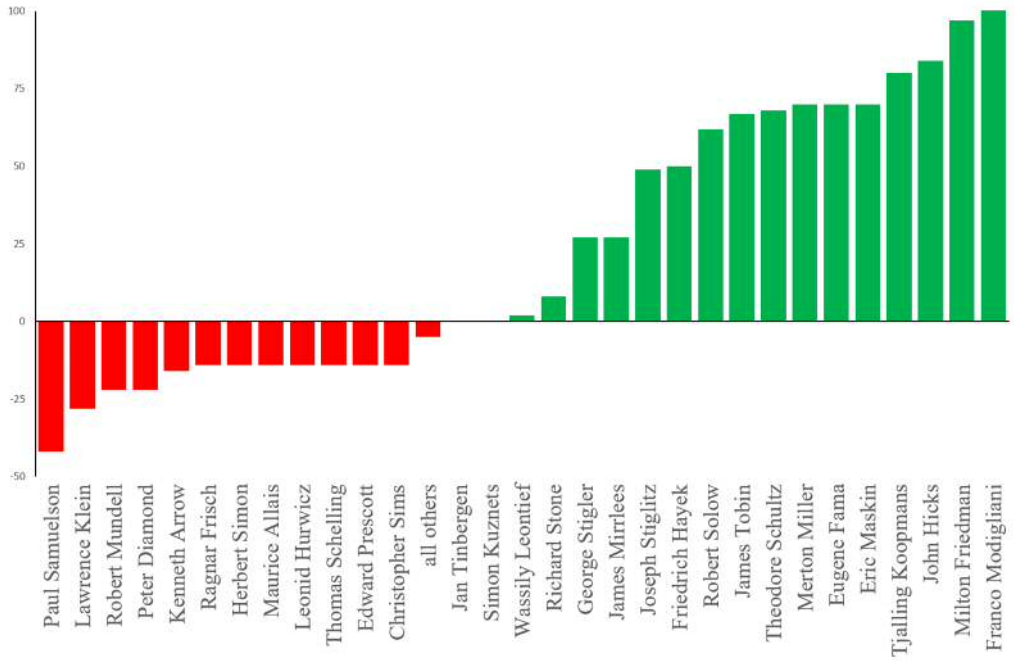

FIGURE 7. CHANGE IN THE HARMONIC CENTRALITY RANK OF SELECTED NOBELISTS IF ALL CANDIDATES WIN.

Clark, and Richard T. Ely—under his wings. Little has been written about Knies (Kobayashi, 2002; Schefold, 2008; Fullerton, 1998; Yagi, 2005). He was a professor of public policy at the University of Freiburg from 1855 to 1865, and a professor of economics at the University of Heidelberg for the thirty years after. He published books on statistics, political economy, railroads, and money and credit. Knies was part of the German Historical School, who argued for empiricism over theory, and thus at the losing end of the *Methodenstreit* (Louzek, 2011; Maki, 1997).

Knies was thus somewhat of an outlier, arguing for empirical analysis as the discipline of economics was turning towards theory. Leontief is best known as the father of input-output analysis (Polenske, 2004), a tool we now rarely see used at the cutting edge of economics. The main prize for heterodox economists is named after Leontief. The central role of Knies and Leontief in economic orthodoxy may thus come as a surprise—unless you realize that economics is at its best when the received wisdom is challenged (Roth, 2018).

If the central professors surprise, so do some of the key degree-granting universities: Berlin, Göttingen, Vienna and Heidelberg are not typically listed among the leading centres of research and education in economics. However, these universities did educate many of the Nobelists' professors and their professors. An-

other surprising finding, the great economists of the past are not included in the family tree, but great scholars in just about any other discipline are. Putting these two findings together, it appears that during the first half of the 20th century, economists in Boston, Chicago and New York combined the ideas of earlier economists with the teaching methods of other disciplines and so created the economics powerhouses we see today. Refugees from the Nazis—Haberler, Hayek, Hurwicz, Machlup, Marschak, von Mises, Morgenstern—played a key role in this, and one who fled the Bolsheviks—Leontief.[9]

The Nobel network has a gender-ratio that is even more biased towards men than the economics discipline as a whole.

I focus on professor-student relationships. There are, of course, many other types of interactions, including citation, co-authoring—Arrow and Debreu (1954), for example—informal advice—John Maynard Keynes was the most senior figure in the Cambridge Circus, to with Joan Robinson also belonged—and seminars—in his autobiography, Herb Simon (1996) fondly reminisces the Cowles seminars, attended by in-house staff Marschak, Koopmans, Lange, Arrow, Klein, Hurwicz and Debreu and regular visitors Modigliani, Stigler, Friedman, Frisch and Haavelmo. Simon also describes a mind-shifting lunch with Carl Menger. Adding such relationships would only make the network more dense. It may well lead to a shift in network centrality. Data on informal contacts are, of course, much harder to obtain.

The descriptive analysis in this paper would be served with additional data on selected ancestors, such as discipline, ethnicity, religion. I identify a set of people who trained exceptional students, a set of people who did exceptional research, and the intersection of the sets. This should form a stepping stone to an analysis of what makes someone an exceptional researcher, professor, or both. The measure, here defined, on incloseness to either the Nobel network or Nobel laureates can be calculated for individual researchers, departments, or editorial boards—and should be tested as a predictor for academic performance and career advancement. All that is deferred to future research.

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[9] See Waldinger (2012) for the impact of the Nazis on physics, chemistry and mathematics.

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Matlab codes

- Matlab code to scrape the ancestry of your favourite economist from Academic Tree and build her family tree.
- Matlab code to build and analyze the data used in this paper.