

# A historical portrait of female economists' co-authorship networks\*

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February 2022

## ABSTRACT

This paper describes how women have contributed to the research published in influential general interest journals between 1940–2019. We find that the share of women published in these journals follows a U-shaped curve that troughs in the late 1970s—a decline that is possibly related to an increase in the number of papers being published as well as a rise in co-authoring. By the late 1970s and early 1980s, however, the share of women began increasing again, largely thanks to a rise in mixed-gendered papers. Co-authorship between women, on the other hand, was almost non-existent until around 2010. A decade-by-decade comparison of men's and women's co-authorship networks suggests female–female networks in the most recent decade in our data (2010–2019) roughly resemble male networks from earlier decades (1940–1969); they also highlight the key role prominent individuals play in network formation. We hypothesise that the recent growth in papers by female teams may signal that research by women collaborating with other women is receiving greater recognition in the field.

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\*We are grateful to Victoria Bateman, Cléo Chassonnery-Zaïgouche, Evelyn Forget, John Singleton, Sarah Smith, participants at the 2021 History of Political Economy conference and two anonymous referees for excellent and extensive comments and suggestions. We also owe a particular debt to Christopher Brunet for data collection, research assistance and providing crucial input at an early stage of the project.

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# 1 Introduction

In her 2002 *History of Political Economy* article “Female contributions to economic thought, 1900–1940”, Kirsten Madden remarked (p. 2):

Judging from the syllabi of most economics courses and the references contained in leading history-of-thought textbooks, students are likely to conclude that women, with the notable exception of Joan Robinson and, to a lesser extent, Rosa Luxemburg, have played a negligible role in the development of modern economics.

Yet as she and others have documented, women have always been active in the field. Between 1900–1940, there were more than 1,000 female-authored theses submitted for advanced degrees in economics and twice that many non-thesis scholarly outputs by women (Madden 1993). Edith Abbot and Sophonisba Breckinridge published numerous articles on women’s employment and wages in the *Journal of Political Economy* (Folbre 1998). Mabel Timlin made significant contributions to economic theory and Canadian immigration policy (Ainley 1999). Other influential women include Beatrice Webb, Edith Penrose, Margaret Reid—and of course, Rosa Luxemburg and Joan Robinson.

In this paper, we document further evidence of women’s contributions. Our focus, however, is on the authors and research published between 1940–2019 in the following general interest economics journals: *American Economic Review* (*AER*), *Econometrica* (*ECA*), *Economic Journal* (*EJ*), *Journal of Political Economy* (*JPE*), *Quarterly Journal of Economics* (*QJE*) and *Review of Economic Studies* (*REStud*). We selected these journals for the influence they’ve had in setting the tone and agenda of economics research in the post-war period. The resulting analysis therefore catalogues and describes the women whose research has arguably had the greatest impact on modern economics.

Our data confirm trends identified by Forget (2011). The share of women publishing in influential economics journals follows a U-shaped curve that troughs in the late 1970s. Part of this decline appears to be related to a shift in the numbers and types of papers being published: immediately after the war, general interest journals published more papers and more co-authored papers, a change which coincided with a growing share of male authors. Nevertheless, we still find several women with substantial clout in the profession—*e.g.*, Ursula Webb, Eveline Burns, and Irma Adelman—as well as female–female mentoring relationships and co-authoring partnerships.

By the late 1970s and early 1980s, however, the share of women publishing in influential journals began to increase again, largely thanks to a rise in mixed-gendered papers—including between peers. For example, Janet Yellen published papers with Jim Adams, her colleague at Harvard, and Nancy Schwartz co-authored extensively with Morton Kamien, her classmate from Purdue. We also see clear evidence of increased support for the next generation of female economists. David Gale, a professor at Berkeley, co-authored with several junior women including Gabrielle Demange and Marilda Sotomayor. Schwartz and Kamien are noteworthy for creating an environment at Northwestern’s Department of Managerial Economics and Decision Sciences that facilitated the careers of many young women, including Esther Gal-Or, Jennifer Reinganum and Nancy Stokey.

From the 1990s onwards, most prominent women in economics exclusively co-authored. This rise in women co-authoring with men coincides with a period of sharp growth in co-authorship—both in general (Hamermesh 2013; Seltzer and Hamermesh 2018) and in our data. Between 1960–1979, 77 percent of exclusively male-authored papers were solo-authored; between 1980–1999, only 53 percent were. Yet co-authorship between women was almost non-existent: conditional on publication in an influential journal, the percentage of exclusively female-authored papers that were solo-authored was the same in 1980–1999 (94 percent) as it was in 1960–1979 (93 percent). Indeed, over this entire 40-year period, general interest journals collectively published, on average, just one article per year that was co-authored by two or more

women.

We see evidence, however, that this may be starting to change. Between 2000–2019, general interest journals published, on average, 14 exclusively female co-authored papers a year. There is also an initial emergence of identifiable clusters in women’s co-authoring networks. A mapping of female–female and male–male co-authoring networks by decade suggests that female networks in 2010–2019 roughly resemble male networks from 1940–1969. It also emphasises the key role prominent individuals play in their formation.

Although papers by women co-authoring with other women still represent only a tiny fraction of all articles published in influential general interest journals (4 percent), their recent rapid growth may signal that research by female teams is receiving greater recognition and impact in the field of economics. Building on the “four-phases” construct of Forget (2011), we therefore tentatively suggest that we may be entering a new fifth phase in the representation of women in the profession—one that is characterised by more female–female collaborations.

This paper contributes to several literatures. Our primary contribution is to document the co-authorship patterns and networks emerging from women’s publications in influential general interest economics journals. In this sense, the papers closest to our own are Seltzer and Hamermesh (2018) and Hamermesh (2013), which find similar growth in co-authorship at a smaller set of journals and time periods. We add to this research by illustrating that past waves of increasing co-authorship have appeared to coincide with a relative decline in the share of female authors.

Second, we build on research highlighting women’s contributions to economic thought and theorising about the factors behind the historical evolution of their representation (see *e.g.*, Becchio 2020; Dimand *et al.* 2000; Forget 2011; Madden and Dimand 2019; Pujol 1992). In particular, our study quantitatively investigates the hypotheses in Forget (2011) and extends her theory by suggesting that we may be entering a fifth phase of women in the economics profession, characterised by the increasing impact of research by women collaborating with other women. Our paper also extends and complements the work of Madden (1993) by focusing on women’s contributions in the post-war period.

Third, this paper joins research documenting trends over time in economics research and how it is perceived by the most prestigious economics journals. For example, Hamermesh (2013) and Biddle and Hamermesh (2017) note a significant shift in the focus of papers published in general interest journals: prior to the 1990s, most of these journals published papers that used formal economic theory to identify questions and interpret results; by the early 2000s, however, research design was increasingly used as the guiding principle for identifying empirical questions. They argue that this shift suggests a change in the status and impact of applied fields relative to other areas of research. We contribute to this literature by documenting that the rise in the prestige of applied fields—as proxied for by top journal publications—coincides with (and is possibly connected to) an increase in the numbers of female authors published by these journals.

Finally, we contribute to the broader conversation on the under-representation of women in economics (see *e.g.*, Auriol *et al.* 2019; Bateman *et al.* 2021; Gamage *et al.* 2020; Lundberg and Stearns 2019). Most relevant to our work, Hengel (2019) highlights the dearth of female economists published in *AER*, *ECA*, *JPE* and *QJE* between 1950–2015; Hengel and Moon (2020) add data from *REStud* and describes further trends in men’s and women’s co-authorship patterns.

The paper proceeds in the following order. In Section 2, we discuss our data. In Section 3 we show aggregate trends in the representation of women at general interest economics journals between 1940–2019 as well as trends in men’s and women’s co-authorship patterns. In Section 4, we explore these trends in more detail in light of Forget (2011)’s four phases by graphing and describing men’s and women’s co-authorship networks. Section 5 concludes.

Table 1: Article count, by journal and decade

Decade	<i>AER</i>	<i>ECA</i>	<i>EJ</i>	<i>JPE</i>	<i>QJE</i>	<i>REStud</i>	Total
1940-49	334	196	184	287	262	96	<b>1,359</b>
1950-59	233	291	315	332	331	215	<b>1,717</b>
1960-69	345	441	281	577	434	265	<b>2,343</b>
1970-79	710	744	331	779	377	466	<b>3,407</b>
1980-89	718	676	512	605	438	521	<b>3,470</b>
1990-99	707	495	844	513	435	393	<b>3,387</b>
2000-09	928	601	780	411	426	436	<b>3,582</b>
2010-19	1,209	624	897	428	411	550	<b>4,119</b>
<b>Total</b>	<b>5,184</b>	<b>4,068</b>	<b>4,144</b>	<b>3,932</b>	<b>3,114</b>	<b>2,942</b>	<b>23,384</b>

*Note.* Papers published in the May issue of *AER Papers & Proceedings*, errata, corrigenda and book reviews are excluded. Final row and column display total article counts by journal and decade, respectively.

## 2 Data

The purpose of this paper is to document and analyse women’s contributions to influential general interest economics journals between 1940–2019.<sup>1</sup> A complication, however, is that journal influence changes over time. In the early to mid-twentieth century, leading research was often published in the *AER*, *Economica* and *EJ*.<sup>2</sup> *EJ* retained its outsized influence into the 1980s, but by 1995, *AER*, *ECA*, *JPE*, *QJE* and *REStud* had acquired a major lead (Ductor *et al.* 2020).<sup>3</sup>

Given the aims of our study and the effort involved in data collection, we decided to restrict our analysis to articles published in the following six journals: *AER*, *ECA*, *EJ*, *JPE*, *QJE* and *REStud*.<sup>4</sup> The data were originally collected and analysed in Hengel (2019) and Hengel and Moon (2020) and expanded in scope here to include *EJ* and articles published between 1940–2019.<sup>5</sup> Unless otherwise mentioned, articles from the May (*Papers & Proceedings*) issues of the *AER*, book reviews, errata and corrigenda are excluded. See Table 1 for a break down of article counts by journal and decade.

Our final dataset contains basic bibliographic information on 23,384 articles by 13,910 unique authors. For each author, we manually assigned a gender using the following hierarchy of information: (i) obviously gendered given names; (*e.g.*, “James” or “Brenda”); (ii) photographs on personal or faculty websites; (iii) personal pronouns used in text written about individuals; and (iv) by contacting authors themselves or people and institutions connected to them.

<sup>1</sup>Madden (1993), in contrast, considers women’s contributions from a broader range of research outputs, including monographs, books and government reports.

<sup>2</sup>For example, *Economica* published A. William Phillips famous paper, “The relation between unemployment and the rate of change of money wages in the United Kingdom, 1861–1957” in 1958 and Ronald H. Coase’s “The nature of the firm” in 1937; see Gans and Shepherd (1994, p. 174) for qualitative evidence that the *EJ* was the “premier economics publication” for much of the first half of the 20th century.

<sup>3</sup>These latter “top-five” journals are particularly important to the economics profession today—for example, publishing in them significantly increases one’s probability of receiving tenure, decreases time-to-tenure and positively influences career advancement (Ellison 2002; Heckman and Moktan 2020).

<sup>4</sup>A more complete analysis would include *Economica*, given the influence it had in the earlier decades. Additionally, we emphasise that there are costs and benefits to restricting the data to these six journals. An important benefit is that by localising data collection, we are sure to consistently identify research (and researchers) that have made an impact on the field of economics (as opposed to sociology or other related disciplines). However, the restricted sample may overstate the extent to which economics is elitist or male-dominated (Madden and Dimand 2019).

<sup>5</sup>The original dataset analysed in Hengel (2017) included only articles published with an abstract between 1950–2015 in the *AER*, *ECA*, *JPE* and *QJE*. Later, Hengel (2019) added articles published with a submit-accept date in *REStud*. A research assistant expanded these datasets to include articles published between 1940–2019 in *AER*, *ECA*, *EJ*, *JPE*, *QJE* and *REStud* and gender coded the authors not already included in the earlier datasets.

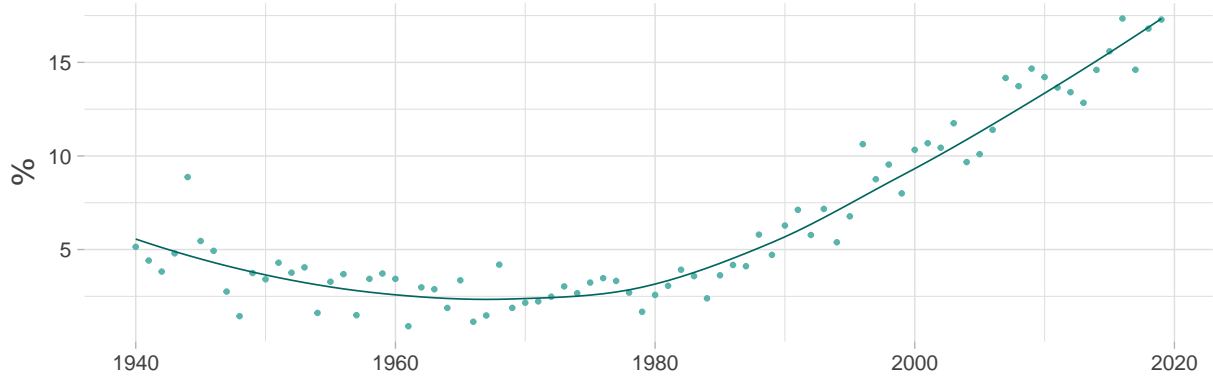


Figure 1: Percentage of women publishing in influential general interest journals

*Note.* Figure plots female authors as a percentage of all authors published in the *AER*, *ECA*, *EJ*, *JPE*, *QJE* and *REStud* by year. Lines of fit estimated using a quadratic LOESS model (smoothing span  $\alpha = 0.75$ ).

### 3 Aggregate trends in female authorship

Figure 1 plots the percentage of female authors published in the *AER*, *ECA*, *EJ*, *JPE*, *QJE* and *REStud* between 1940–2019. The U-shaped curve suggests women enjoyed a somewhat more prominent role in the profession during World War II, but their influence declined in the decades that followed (Forget 2011).

Part of this decline appears to be related to changes in the numbers and types of papers being published.<sup>6</sup> Immediately after the war, general interest journals published more papers and more co-authored papers. Article counts are almost three times higher in the 1970s than they were in the 1940s (Table 1); between 1940–1949, 96 percent of papers were solo-authored; three decades later, only 72 percent were (see also Figure 2, top left-hand graph).

These changes led to an increase in male authors relative to female authors. In the 1970s, general interest journals published double the number of solo male-authored papers—but exactly the same number of solo female-authored papers—as they did in the 1940s. They also published 19-times more papers co-authored exclusively by men; however, mixed-gendered papers only increased by a factor of four, and papers co-authored exclusively by women were almost non-existent. As a result, the share of women publishing in general interest journals declined in the post-war period.

Starting in the 1980s, however, it began to increase again, largely thanks to a rise in mixed-gendered papers. The first two graphs in the second row of Figure 2 plot the numbers of solo female-authored papers and co-authored papers with a single female author, respectively. Between 1980–1999, there was a sharp increase in mixed-gendered papers, alongside a more modest rise in solo female-authored papers. Around 2000, general interest journals also began publishing a non-negligible number of articles by female teams (Figure 2, bottom right-hand graph).

### 4 The evolution of female co-authoring networks

In this section, we investigate how female co-authoring networks have evolved over time. To structure our analysis, we interpret empirical patterns through the lens of Forget (2011). Forget (2011) divides the

<sup>6</sup>It may also be related to the hypothesis that women were expected to cede the relative gains they had made in earlier eras in order to make way for men in the post-war period. Indeed, we find this sentiment reflected in the words of Mary Anderson (then head of US Department of Labour Women’s Bureau) in a letter to Mary Barnett Gilson: “we would do well not to quibble over who is going to have the jobs after the war is over.” (Anderson 1942). Eleanor Lansing Dulles remarked in 1958 that “[The Federal Public Service] is a real man’s world if ever there was one. It’s riddled with prejudices. If you are a woman in Government service you just have to work ten times as hard.” (New York Times 1996b).

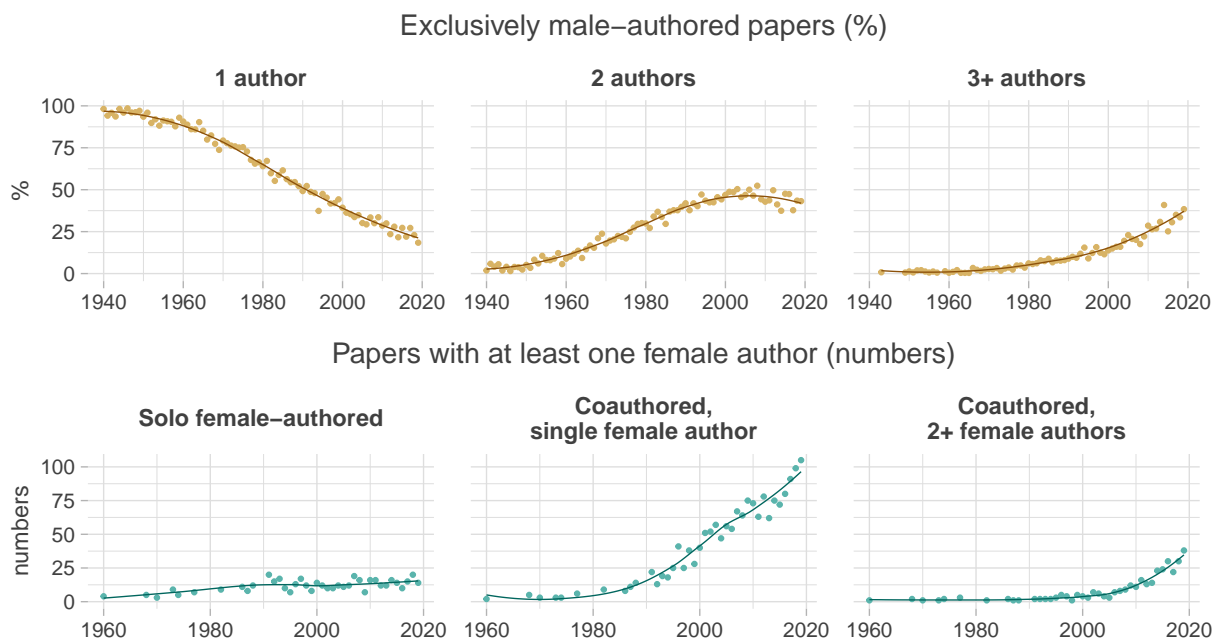


Figure 2: The rise in co-authorship

*Note.* Top row of graphs show the percentage of exclusively male-authored papers published each year that are solo-authored, co-authored by two authors, and co-authored by three or more authors. In the second row of graphs, the first graph plots the absolute number of solo-authored papers by women published each year, the second graph plots the numbers of papers co-authored by a single woman and at least one man and the third graph plots the number of papers co-authored by at least two women. Lines of fit estimated using a quadratic LOESS model (smoothing span  $\alpha = 0.75$ ).

history of women in the economics profession into four phases. The first phase (before 1918) pre-dates our data, but created the conditions that enabled many influential female economists to study economics and thrive in the profession several decades later.<sup>7</sup> During the second phase—which coincides with the first decade of our data (1940–49)—women were often routed from “core” economics subjects towards adjacent disciplines (*e.g.*, social work and home economics). They returned to the “core” in phase three (1950–1969), thanks in part to increased demand for the statistical skills many women had learned while working as government researchers. The final phase (post 1970) is characterised by more rapid growth in women’s representation as barriers fell and women began to enter the profession in substantially higher numbers.

To make patterns in the data more obvious, we graphically map collaborations over time. Results are shown in Table 2. Its top two rows display graphs of male–male and female–female co-authorship networks by decade. The table below the graphs displays the number of unique authors ( $N$ ), average degree (Deg.), average weighted degree (Wt. deg.) and the average clustering coefficient (Clust.) for men and women publishing in the relevant decade. (See the notes for Table 2 for each statistic’s definition.) By diagramming these relationships, we aim to better understand how women’s research connections to one another have evolved since 1940 (conditional on publication in a general interest economics journal), analyse the extent to which they differ from men’s and observe whether the two are converging over time.

<sup>7</sup>Forget (2011)’s first phase (pre-1918) pre-dates our data. Nevertheless, a defining feature of this phase one was the expansion of women’s colleges in the US, many of which supplied the women who went on to earn graduate degrees in economics elsewhere and then hired them back to teach economics to the next generation of students. Consistent with this hypothesis, we noted while hand-coding author gender that many women publishing in the 40s and 50s had an earlier connection to the women’s liberal arts college Bryn Mawr.

Table 2: Network decomposition by decade

	1940–49		1950–59		1960–69		1970–79		1980–89		1990–99		2000–09		2010–19	
Men	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
$N$	45	970	43	1,422	45	2,300	91	2,454	146	2,722	308	3,280	568	4,623	1,110	1,110
Deg.	0.15	0.32	0.00	0.57	0.09	0.88	0.15	1.30	0.07	1.57	0.16	1.85	0.30	2.41	0.66	0.66
Wt. deg.	0.00	0.39	0.00	0.64	0.18	1.01	0.15	1.56	0.07	1.88	0.17	2.13	0.31	2.84	0.72	0.72
Clust.	0.71	0.66	0.00	0.41	0.00	0.47	0.00	0.51	0.00	0.55	0.00	0.59	0.81	0.67	0.70	0.70

*Note.* Graphs in the top rows plot the network evolution for male–male and female–female connections over decades. Each diagram is restricted to individuals who have authored a paper in the *AER* (including *P&P* issues), *ECA*, *EJ*, *JPE*, *QJE* or *REStud* during the relevant decade. Nodes represent individual authors; the size of a node reflects the number of co-authoring relationships (regardless of co-author gender) an author has in the data. Authors of the same gender who co-author with one another are connected by a line, where the weight of that line is determined by the number of papers the pair have co-authored together. The table below the network graphs displays the number of unique authors ( $N$ ), average degree (Deg.), average weighted degree (Wt. deg.) and the average clustering coefficient (Clust.) for men and women publishing in the relevant decade. Average degree is the average number of edges per node on a graph and is calculated by dividing the number of co-authoring pairs in the data (number of edges) by the number of authors (number of nodes). The average weighted degree is the degree weighted by the number of papers a pair of authors have co-authored together. The average clustering coefficient measures the extent to which nodes in a graph cluster together (*i.e.*, how often an author’s co-authors also co-author with each other). Network visualisations were created in Gephi using the Fruchterman and Reingold algorithm.

## 4.1 Phase two (1940–1949)

Forget (2011)’s second phase overlaps with the first ten years of our data (1940–1949). During this decade, 80 percent of women published in general interest economics journals solo-authored; the rest co-authored with men—there were no female–female co-authoring relationships during this period. Among men, 92 percent of research contributions were solo-authored, and another 7 percent were co-authored with other men; the remaining 1 percent were co-authored with women.

These patterns are also apparent in Table 2. The network graph for female authors consists only of disconnected nodes and its average degree is zero,<sup>8</sup> confirming that there were no female–female co-authoring relationships in the 1940s. Men’s network graph suggests they were more connected to one another; however, its average degree is still only 0.15—like women, men in the 1940s predominantly solo-authored.

The two most prominent female authors during the 1940s were Joan Robinson, a theorist, and Ursula Webb (mariée Hicks), a public finance economist. Both women largely published solo-authored papers in the *EJ* and *REStud*. Hicks and Robinson were founding members of *REStud*’s Board of Editors (*Review of Economic Studies* 2021) and Hicks served as its managing editor from 1933–1961 (*Review of Economic Studies* 2013).

Other prominent female authors during this period include Grace Gunn and Eveline Burns. Each published several articles in American journals (*AER*, *JPE* and *QJE*). Burns’s research was in the area of social insurance systems and entirely solo-authored;<sup>9</sup> Gunn worked on marginal productivity and production functions with Paul Douglas, with whom she helped to develop the Cobb–Douglas production function (Biddle 2020; Douglas 1976).<sup>10</sup>

Several women during this period co-authored with their husbands. Examples include Gladys and Roy Blakey who co-authored two papers in the *AER* on the Revenue Acts of 1940 and 1941; Gertrude and Alfred Oxenfeldt conducted a survey of businessmen and jointly published the results in the *JPE*; Winifred and Charles Hyson co-authored a paper in the *QJE* in the area of regional economics. During the 1940s, Nancy and Richard Ruggles both published solo-authored papers in general interest journals—Nancy published two papers on marginal cost pricing in *REStud*; Richard published a paper on wage rates in the *QJE*. The Ruggles would go on to co-author frequently together in later decades (Qian 2020).

Despite the important work female economists were conducting at the time, many still had to fight for recognition. For example, after 13 years working as a Lecturer at Columbia University, Eveline Burns was told “that there is no possibility of advancement to professorial rank or to permanent status” (Burn and Haig 1940). Some women may have also published under pseudonyms—*e.g.*, Raya Dunayevskaya used the pseudonym Freddie Forest<sup>11</sup>—while others like Edith Hirsch may have adopted their husbands’ names (New York Times 2003).<sup>12</sup> Finally, many women left the profession entirely. For example, Carrie Glasser earned a Ph.D. in economics from Columbia University and later published “Some problems in the development of the communications industry” in the September 1945 issue of the *AER*. After her

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<sup>8</sup>Average degree is the average number of edges per node on a graph. It is calculated by dividing the total number of edges (*i.e.*, the number of co-authoring pairs in the data) divided by the total number of nodes (*i.e.*, the number of authors).

<sup>9</sup>Burns was a member of Roosevelt’s Committee on Economic Security, where she helped design the 1935 “Social Security” Act (Kasper 2012).

<sup>10</sup>In the acknowledgements of his paper “The Cobb–Douglas production function once again: its history, its testing, and some new empirical values”, Paul Douglas writes (p. 903): “Work on the production function was carried on by a large number of persons who deserve to be credited as coauthors. Foremost among these is Grace Gunn who participated, over a period of 40 years, in no less than three separate phases of the work.”

<sup>11</sup>Raya Dunayevskaya was a prominent Russian economist and philosopher specialised in the study of Marxian economics. She published an article on Marxian economics in the *AER* in 1944 under her actual name.

<sup>12</sup>Hirsch’s husband, Julius Hirsch, published an article in 1944 in the *AER* titled “Facts and fantasies concerning full employment”. It is not clear whether Julius wrote the article or Edith did under his name.



husband (and fellow economist) took a position at Stanford, however, she left the profession to become an artist (David *et al.* 2003).

## 4.2 Phase three (1950–1969)

The next two decades (1950–1969) correspond to Forget (2011)’s third phase. Solo-authoring continued to dominate, although to a slightly lesser extent: 66 percent of women’s contributions during this period—and 75 percent of men’s—were solo-authored. When women co-authored, they usually did so with men: of the 40 co-authored papers by women, 90 percent were co-authored with men.

Nevertheless, the 1960s produced two female–female co-authoring relationships in our data. The first pair was Irma Adelman and Cynthia Taft Morris, who published three development economics papers together—two in the *QJE* and one in the *AER*. Adelman and Morris formed a long lasting research partnership that emphasised the importance of political and social forces for economic performance (Headlee 2013); toward the end of phase three, they even published two books together: *Society, Politics and Economic Development* (1967) and *Economic Growth and Social Equality in Developing Countries* (1973).

The second female–female co-authoring connection was between the Australian mathematician and statistician Alison Harcourt (née Doig) and the British economist Ailsa Land. Land and Doig worked together on a project for British Petroleum at the London School of Economics (Informs 2021), and in 1960, they published their landmark paper “An automatic method for solving discrete programming problems” in *Econometrica*. It developed an optimisation algorithm now known as “branch and bound”.

Ailsa Land is also the first woman in our data who was clearly mentored by another woman: Helen Makower (Land 2018). Makower studied at Newnham College, an all-women’s constituent college of the University of Cambridge; she earned a Ph.D. from the London School of Economics, where she later joined as faculty. Makower was a mathematical economist with very strong links to the Cowles Foundation (*History of Economic Thought* 2021). She also solo-authored theory papers in *REStud* (1945) and the *EJ* (1953).

Most other contributions by female economists during this period were by a small number of prominent women in particular sub-disciplines, including Joan Robinson in economic theory, Edith Penrose in managerial economics, Anne Krueger in macroeconomics and trade and Margaret Reid in household production and consumption. Most prolific by far was Joan Robinson, who published 16 solo-authored papers between 1950–1969, most of which revolved around the Cambridge Capital Controversy.<sup>13</sup> Irma Adelman published the second highest number: in addition to her three papers with Morris, she solo-authored two papers in the *AER*, one in the *EJ* and published another in *ECA* that she co-authored with her husband, physicist Frank Adelman.

Finally, employment opportunities for women were undoubtedly better between 1950–69 than they had been in the 1940s; nevertheless, female academics still had to fight for recognition and equal access to university jobs. For example, despite significant publishing success, Irma Adelman had difficulty securing a tenure-track position; instead, she accepted various non-tenure appointments at the University of California at Berkeley, Mills College, and Stanford (Adelman *et al.* 2014).

These authoring patterns are apparent in the network topology of Table 2. The 1950s and 1960s graphs for women largely consist of disconnected nodes. In the 1950s, women’s average degree was zero; a decade later it rises to 0.09 thanks to the Adelman–Morris and Doig–Land partnerships. In contrast, men were forming stronger connections to each other. Compared to the 1940s, men’s 1950s and 1960s network graphs include noticeably more connections. Their average degree is also 2–4 times higher.

<sup>13</sup>The Cambridge Capital Controversy was a dispute Robinson and several other faculty members at the University of Cambridge had with Paul Samuelson and Robert Solow at MIT.

### 4.3 Phase four (post 1970)

In the 1970s and 1980s, general interest journals continued to publish a number of solo-authored papers by prominent women. For example, in 1974 Anne Krueger published her famous “rent seeking” paper in the *AER*, and Barbara Bergmann solo-authored several papers in the *AER*, *ECA* and *JPE*.

However, women during this period were also increasingly collaborating with men—and especially with their male peers. For example, Katharine Abraham co-authored papers with Henry Farber (*AER* 1987), James Medoff (*QJE* 1980) and Lawrence Katz (*JPE* 1986). In 1985, Janet Yellen co-authored three papers with her husband, George Akerlof: two were published in the *QJE* and one in the *AER*; while an assistant professor at Harvard, she also co-authored papers with Jim Adams, another junior faculty member at the time (*QJE* 1976 and *EJ* 1977) (McCulloch 2017).

The most prolific female author during this period, Nancy Schwartz, also co-authored. Schwartz was an industrial organisation theorist, an associate editor of *ECA*, on the board of editors at the *AER* and the first woman appointed to an endowed chair at Northwestern’s Kellogg School of Management (Kamien 1998). Schwartz co-authored extensively with Morton Kamien, her classmate from Purdue (Kamien 1981) and (later) colleague at Northwestern.<sup>14</sup> During the 1970s, Kamien and Schwartz published three papers in *ECA*, another three in *REStud*, two in *AER* and one in *QJE*.

Schwartz and Kamien were well-known for nurturing young talent at Kellogg’s Department of Managerial Economics and Decision Sciences. According to their colleague Donald Jacobs: “Mort and Nancy had an unwavering belief in caring for the basic work and for the people who would make real contributions. The culture and department were set up to give people what they needed to advance their work—guidance, colleagues to help them discuss ideas, relief from teaching.” (Lindell 2011). Schwartz and Kamien jointly supervised Ph.D. students Jennifer Reinganum and Esther Gal-Or. During the 1980s, Gal-Or published three solo-authored papers in general interest journals; Reinganum published six—including a paper from her dissertation that built on Schwartz and Kamien’s earlier work on patent races.

While at Northwestern, Reinganum also worked closely with Nancy Stokey, an assistant professor hired by Schwartz and Kamien. Reinganum thanks Stokey in several of her papers, and in 1985 they published “The importance of the period of commitment in dynamic games” in the *International Economic Review*. Stokey, in turn, is a well-known mathematical economist and served as *ECA*’s first (and until 2020, only) female editor. Between 1970–1989, she solo-authored four theory papers in the *JPE*, *QJE* and *REStud*; she also co-authored with Jerry Green (*JPE* 1983) and her partner Robert Lucas, Jr. (*ECA* 1987).

During the 1970s and 1980s, the University of California at Berkeley was another incubator for young female theorists. Beth Allen and Graciela Chichilnisky studied at Berkeley under Gérard Debreu. In the 1980s, Chichilnisky and Allen each published three solo-authored papers in general interest journals. Around the same time, Gabrielle Demange and Marilda Sotomayor studied with David Gale, another prominent mathematical economist at Berkeley. Demange solo-authored two papers in *ECA* and co-authored a paper with Gale in the *JPE*. In 1986, Sotomayor, Demange and Gale published “Multi-item auctions” in the *JPE*;<sup>15</sup> three years later, Sotomayor also published a paper in *ECA* with Alvin Roth.

Despite growth in co-authorship more generally, papers by women co-authoring with other women were still relatively rare. During the 1970s, women’s average network degree was 0.15 (Table 2) thanks to several collaborations between women, including Irma Adelman and Cynthia Taft Morris, Adelman and Barbara Bergmann, Rachel McCulloch and Janet Yellen and Barbara Wolfe and Anita Summers (née Arrow). In the following decade, however, general interest journals only published one co-authored

<sup>14</sup>Both Schwartz and Kamien were hired by Stanley Reiter, who had been a faculty member at Purdue during their doctoral studies and supervised Schwartz’s Ph.D. (Kamien 1998).

<sup>15</sup>Sotomayor, Demange and Gale also worked closely with Myrna Wooders at the Institute des Hautes Études Scientifique (Sotomayor 2009). Wooders published three papers in *ECA* during the 1980s and 1990s: two solo-authored and one co-authored with William Zame.

paper exclusively by women—“Women’s labour supply and marital choice” by Shoshana Grossbard and Shoshana Neuman (*JPE* 1988). As a result, their average degree returned to the single digits (0.07).<sup>16</sup>

From the 1990s onwards, most prominent women in economics exclusively co-authored. For example, between 1990–1999, Janet Currie and Raquel Fernández each published seven co-authored articles in general interest journals and Anne Case published five; the following decade, Esther Duflo, Marianne Bertrand and Susan Athey collectively published 27 articles, only three of which were solo-authored. Table 2 suggests that co-authorship between women was also becoming more common. Between 1990–2009, women’s average network degree doubled each decade: in the 1990s, general interest journals published 12 papers co-authored exclusively by women; the following decade, they published 31—including three papers co-authored by three women.

This steep increase in women co-authoring—both with men and other women—coincides with the rising prominence of applied empirical microeconomics (Biddle and Hamermesh 2017). Although Anne Case and Raquel Fernández continued to rely heavily (or exclusively) on theory in their earlier papers—for example, Fernández’s “Strategic models of sovereign-debt renegotiations” (*REStud*, 1990) and Case’s “Vote-seeking, tax-setting, and yardstick competition” (*AER*, 1995)—Janet Currie’s approach put less of an emphasis on formal theory.<sup>17</sup> The following decade, Duflo pioneered the use of randomised controlled trials in economics and Bertrand has focused on field experiments and inference using observational data. Athey, however, is an applied theorist—in fact, her Ph.D. was supervised by Paul Milgrom and John Roberts, two of Nancy Schwartz’s protégés (Bryan 2016).

#### 4.4 Phase five?

Since 2010, female–female collaborations have continued to rise. Between 2010–2019 general interest journals published 73 exclusively female co-authored papers—including four by four women—and 148 mixed-gendered papers by at least two women. As a result, women’s average degree doubled again, a trajectory that mirrors the growth rate in men’s average degree between 1940–1969. Table 2 also suggests that women’s average clustering coefficient—a measure of how frequently one’s co-authors collaborate with each other—has resembled men’s since 2000.

Women’s 2010 network graph in Table 2 further suggests an initial emergence of identifiable clusters. Figure 3 explores in more detail the largest of these, which is centred on several prominent women working in or adjacent to the field of development economics: Nava Ashraf, Marianne Bertrand and Esther Duflo. Ashraf, Bertrand and Duflo are professors at the London School of Economics, Chicago Booth School of Business and MIT, respectively. Bertrand was co-editor at the *AER* from 2011–2017 and the *EJ* from 2004–2005. Duflo is the current editor of the *AER* and a winner of the 2019 Nobel Prize in Economics.

Conditional on publication in a general interest journal, Ashraf has co-authored with Oriana Bandiera—her colleague at the London School of Economics—Alessandra Voena and Erica Field. Duflo has co-authored with Rohini Pande, Petia Toplova, Rema Hanna and Marianne Bertrand. Bertrand has also co-authored with Hanna, as well as Adriana Lleras-Muney and Sandra Black, her classmate from Harvard. Pande and Lleras-Muney are further connected to Seema Jayachandran and Jayachandran, in turn, is connected to Ilyana Kuziemko, who studied with her at Harvard. Finally, Petia Toplova has co-authored with Pinelopi Goldberg, the editor of the *AER* from 2011–2016.

Authors’ connections to one another are actually much thicker than Figure 3 suggests. For example,

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<sup>16</sup>However, in the 1980s, general interest journals published four mixed-gendered papers co-authored by at least two women—*e.g.*, the paper by Sotomayor, Demange and Gale already mentioned.

<sup>17</sup>Nevertheless, even Currie did not entirely avoid theory, particularly in her earliest papers. Indeed, one of her first papers in the data, “An experimental comparison of dispute rates in alternative arbitration system” (*ECA* 1992) interpreted its results through the lens of a formal model of arbitrator behaviour.

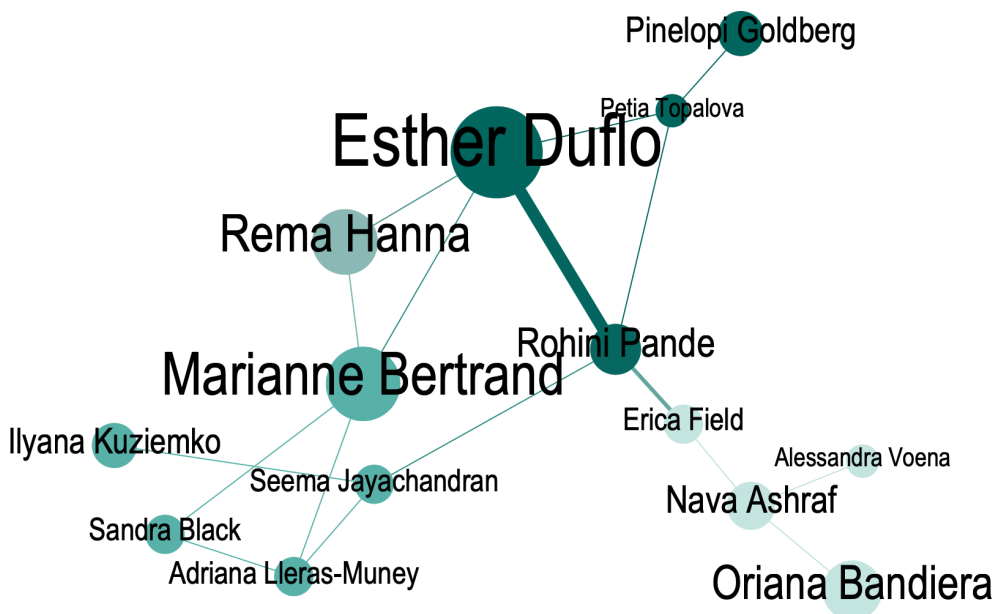


Figure 3: Ashraf–Bertrand–Duflo cluster of female–female collaborations

*Note.* Graph represents the largest component network from the female–female co-authorship network structure shown in Figure A.1 (Appendix A). Nodes represent individual authors who are highly connected (having four or more co-authoring relationships in the data); their size is increasing in the number of co-authoring relationships they have (and the smallest nodes indicate authors who only solo-author). Authors who co-authored with one another are connected by a line and the weight of that line is determined by the number of papers the pair have co-authored together. Network visualisations were created in Gephi using the Fruchterman and Reingold algorithm.

Topalova and Hanna were close friends and room-mates while studying at MIT (Topalova 2005). Several authors have also co-authored with each other on papers published in journals outside of the six we cover—*e.g.*, Jayachandran and Field have published together in the *American Economic Journal: Economic Policy* and the *AER P&P*; Field has also co-authored a paper with Voena (*AER P&P* 2017).

Many of the authors in Figure 3 are also indirectly connected to one another via a third author. Pande, Bandiera and Bertrand have all co-authored with Robin Burgess; Topalova and Pande thank him in their Ph.D. theses (Pande 1999; Topalova 2005). Both Topalova and Hanna thank Sendhil Mullainathan in their theses (Hanna 2005; Topalova 2005); Mullainathan in turn was Ashraf’s Ph.D. adviser and has frequently co-authored with Bertrand. Benjamin Olken has co-authored with Duflo, Pande, Jayachandran and Hanna. Olken—who is married to Amy Finkelstein (New York Times 1996a)—also links the Ashraf–Bertrand–Duflo network to the Finkelstein network shown in Figure A.1 (Appendix A). Other “connecting co-authors” include Jesse Rothstein (co-author with Bertrand and Black), Ray Fisman (co-author with Bertrand and Kuziemko), Edward Glaeser (co-author with Ashraf and Bertrand), Claudia Goldin (co-author with Kuziemko, Lleras-Muney and Bertrand), Emir Kamenica (co-author with Bertrand and Ashraf) and Nina Pavcnik (co-author with Topalova and Goldberg).

Several of the individuals in Figure 3 are also connected to each other via their Ph.D. supervisors. Together with Michael Greenstone, Duflo supervised Hanna’s Ph.D.; she also co-supervised Topalova’s with Abhijit Banerjee, her own Ph.D. supervisor, later husband and co-winner of the 2019 Nobel Prize. Greenstone and Banerjee have co-authored with Pande; Banerjee has also worked together with Bertrand. Michael Kramer—who shared the 2019 Nobel Prize with Duflo and Banerjee—supervised Ashraf’s and Jayachandran’s Ph.D. dissertations. Ashraf was also advised by Lawrence Katz, as were Black, Kuziemko and Bertrand. Voena was supervised by (and has co-authored with) Michèle Tèrtilt, who has also co-authored with Field.

Finally, many of the women in Figure 3 are further connected to one another through their Ph.D. students. Pande supervised Lori Beaman and Jessica Leight. Beaman co-authored several papers with Duffo, Pande and Topalova; Leight has worked with Field and Ashraf. Goldberg supervised Nina Pavcnik who has gone on to work with Topalova. Ashraf supervised B. Kelsey Jack, and they also co-authored a paper together with Bandiera. Jack has also co-authored with Jayachandran and Michael Greenstone.

## 5 Conclusion

Immediately after the war, general interest journals published more papers and more co-authored papers. These changes appear to have coincided with—and possibly led to—a decline in their shares of female authors. Nevertheless, we still find pockets of women during this period who continued to publish, including Joan Robinson, Ursula Webb, Eveline Burns, Edith Penrose, Anne Krueger, Irma Adelman and Margaret Reid. There are also instances of women collaborating with each other—Ailsa Land with Alison Doig and Irma Adelman with Cynthia Taft Morris—and at least one case of a senior female economist (Helen Makower) mentoring a junior woman (Ailsa Land).

Thanks to a rise in mixed-gendered papers, the share of women publishing in influential journals began increasing again in the late 1970s and early 1980s. For example, Janet Yellen co-authored with George Akerlof and Jim Adams; Nancy Schwartz collaborated extensively with Morton Kamien.

The 1970s and 1980s are also noteworthy for the level of support provided to the next generation of female economists. Schwartz and Kamien were well-known for nurturing young talent at Kellogg’s Department of Managerial Economics and Decision Sciences—including Jennifer Reinganum, Esther Gal-Or and Nancy Stokey. At the University of California at Berkeley, Gérard Debreu and David Gale mentored several other influential women, including Beth Allen, Graciela Chichilnisky, Gabrielle Demange, Myrna Wooders and Marilda Sotomayor.

From the 1990s onwards, most prominent women in economics exclusively co-authored—and since 2000 (and especially post 2010) increasingly with other women. As a result, we observe an initial emergence of identifiable clusters in women’s co-authoring networks. These networks centre on several prominent female economists, all of whom have mentored (and often co-authored with) junior women. Building on Forget (2011), we hypothesise that this rise in women collaborating with other women suggests we may be entering a new phase in the representation of female economists in the discipline.

There are undoubtedly a multitude of factors driving the recent rise in female-authored papers published in general interest journals. We do not, however, believe that increasing co-authorship alone has been a fundamental cause of it. Indeed, the initial increase in co-authorship that occurred during the 1960s and 1970s did not coincide with rising shares of female authors. Moreover, given gender homophily in co-authorship networks (Ductor *et al.* 2021) and the fact that journals have historically published so few female co-authored papers, we suspect that any trend toward greater co-authoring that occurs in isolation may actually reduce women’s influence in the profession.

Instead, we believe other factors—either on their own or in combination with increasing co-authorship—have probably contributed to the rising share of women that we see in the data. These include cultural changes within economics departments and efforts to increase the share of women in influential research networks like the NBER. We hope future work will explore these and other hypotheses in more detail.

Our sample of co-authoring relationships is, by design, highly selected. For that reason, we have so far refrained from drawing general conclusions about women’s collaboration patterns. Yet if we do, there are three plausible hypotheses that might explain the patterns we see. First, women may have always collaborated with each other but published their research in other outlets—either due to personal choice or, as argued in Hengel (2019), Card *et al.* (2020) and Hengel and Moon (2020), because general interest

journals hold female-authored papers to higher standards. A second hypothesis is that women are now flocking to the profession thanks to shifting norms about the value of empirical research (Biddle and Hamermesh 2017). A related final hypothesis is that the rise in prestige of applied work has been driven by prominent female economists who value this type of work and serve as strong advocates, role models and mentors for future generations of women—*e.g.*, Barbara Bergmann was an influential supporter of the (then controversial) applied empirical work championed by David Card and Alan Krueger (Bergmann 2005) as well as a vociferous advocate for women in the profession (see *e.g.*, Bergmann 1998).

We conclude by asking whether it matters if general interest journals publish research by female teams. Why can they not simply publish papers by women co-authoring with men? Although our data cannot directly answer this question, we stress that the majority of published papers are predominantly male-authored: even in 2019, most were either entirely authored by men (67 percent) or have at least one male co-author (94 percent). Thus, the research that sets the tone and agenda for the economic profession is still predominantly written from the viewpoint of men. It is difficult to appreciate the consequences such a one-sided perspective has had, but one obvious repercussion is a body of evidence that disproportionately relies on male-only samples (Manchester and Wasserman 2022).<sup>18</sup>

Moreover, Irma Adelman attributes the productivity of her co-authoring relationship with Cynthia Taft Morris to a mutual bond fostered by their close friendship: “[Morris] and I really hit it off, not only in terms of our social commitment but also in terms of our personal attributes. We really liked each other.” (Adelman *et al.* 2014, p. 15). While men and women can and do form collaborative partnerships from strong friendships, such relationships are probably more likely to be found within genders than between them, all else equal. Thus, by publishing more research by female teams, journals may incentivise a more efficient allocation of available resources, thus improving the overall quality of economic research.

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<sup>18</sup>This is actually an issue that medical practitioners and public health officials have been grappling with for years. For example, until recently many health trials excluded women. As a result, some health issues specific to women have been historically understudied, more poorly understood and led to worse health outcomes for women (for a discussion, see Holdcroft 2007).

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# Appendices

## A Identifiable female–female clusters

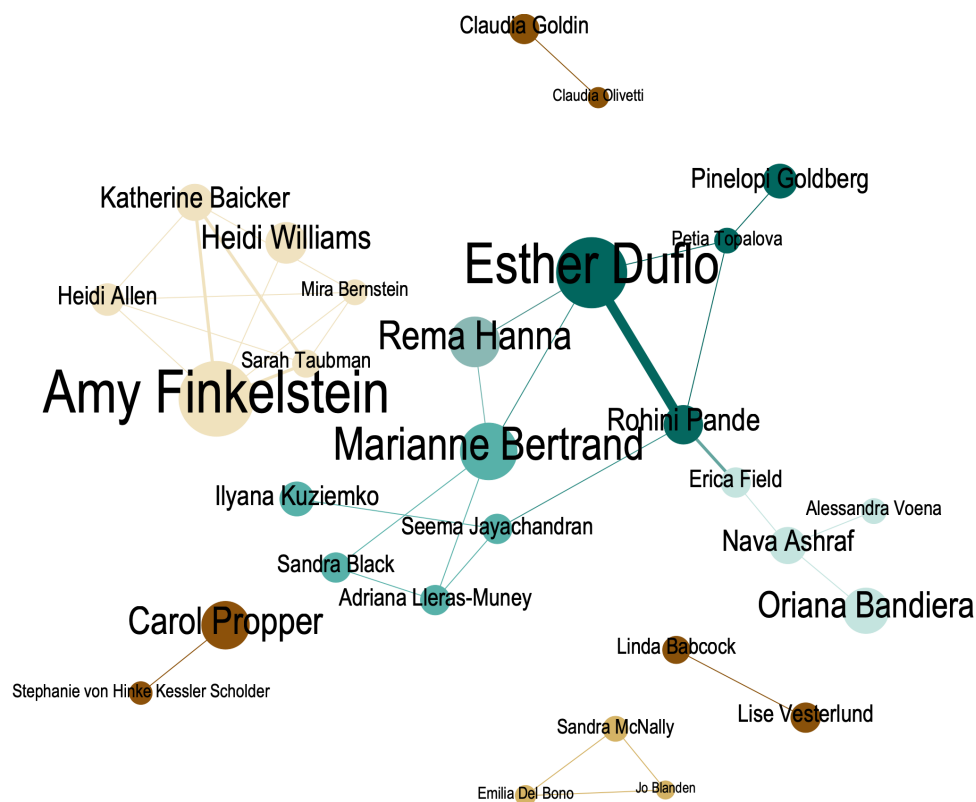


Figure A.1: Largest sub-networks among identifiable female–female clusters

*Note.* Graphs are the largest sub-networks among identifiable female–female clusters publishing in general interest journals between 2010–2019 and include publications in the *Papers and Proceedings* issue of the *AER*. Nodes represent individual authors who have four or more co-authoring relationships in the data; their size is increasing in the number of co-authoring relationships they have. Authors who co-authored with one another are connected by a line and the weight of that line is determined by the number of papers the pair have co-authored together. Network visualisations were created in Gephi using the Fruchterman and Reingold algorithm.