

Population Studies at 75 Years: A scientometric review

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Abstract: For 75 years, the journal Population Studies has advanced research on key substantive demographic topics of fertility, mortality, family, migration, and beyond to contributions in methods, and policy. Yet we lack a systematic and rigorous scientometric review that evaluates how research topics have evolved and by whom has authored them. We review all papers ($N=1,901$) and authorship contributions ($N=3,267$) published in the journal between 1947 and 2020. Our techniques employ natural language processing, social network analysis, and a novel mixed-method approach to incorporate un-supervised machine learning models conjoint with qualitative coders. After a brief history of the journal we show that authorship and articles have evolved over time, with a shift to shorter and multi-authored articles, with 34% female authorships and skewed gender ratios in certain topics. The majority of articles have covered fertility, mortality and family research, studying groups, time and change, with topics expanding and waning in prevalence over time. Children are rarely studied and if examined, in relation to infant mortality or sex-preferences of parents. Research on women focuses on family planning and contraception, fertility decline, unions and divorce, whereas men's domains are migration, historical demography (war, famine) and employment. Geographical bias is also present with family planning examined in Africa and Asia and fertility decline in North American and Europe. Our results inform policy for hiring and tenure committees and identify research gaps relevant for editors, funders and researchers.

Keywords: *demography; gender; fertility; migration; mortality; scientometrics*

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1. INTRODUCTION

For almost 75 years, the journal *Population Studies* has published work advancing our knowledge in the area of demography and population research, from substantive topics related to core foundations of fertility, mortality, migration, families and beyond to advances in theory, methods, policy and practice. Demographic topics, theories and methods both draw from but also penetrate multiple disciplines ranging from economics to sociology, statistics, psychology, development and epidemiology and beyond. Several excellent narrative reviews exist examining the general history of demography, as do other reflections on Population Studies and its editorship ([Grebénik, 1979, 1996](#)). However, after 75 years, we lack a systematic and rigorous scientometric study of the journal, which in the context of this article is a computational or meta-science analysis of the content of the papers and authors to take stock of the research landscape. Given the position and long historical span of Population Studies in this field, the review goes beyond often selective narrative reviews to offer reflect on the discipline over almost one Century of research.

Just as Susan Cotts Watkins asked in the early 1990s, ‘if all we knew about women was what we read in the [journal] *Demography*, what would we know?’, we ask the same of Population Studies ([Watkins, 1993](#)). Inspired by Watkins, but tackling a broader question, we ask: If all we knew about demography and population studies was what we read in *Population Studies*, what would we know? How has demography evolved over the past 75 years and what is the importance afforded to different topics and sub-topics within those realms over time? How has the geographic spread of research changed, both in terms of research focus but also in the origins of authors and their institutions? We likewise delve into a study of the authors themselves, examining differences over the past 75 years by gender, study topic and their individual and institutional networks. Echoing Watkins, we also interrogate the subjects of research and ask if all we knew about women, men and children was what we read in Population Studies, what would we know? And extending this, what would we know about different populations living in across various geographical regions of the world?

This detailed analysis upholds anticipated preconceptions such as gendered authorship patterns, but also exposes unexpected gaps and research vacuums in addition to revealing hidden figures. An overarching contribution of our study is that it offers lessons regarding the past and acts as a guide for future for researchers in the field. We map the evolution of key topics that have been studied and the importance of their focus. By virtue of curating and mapping research topics over time, we reveal areas of research that have been either over or under-represented, but also reveal latent assumptions regarding topics themselves (e.g., fertility examined primarily in women) which in turn impact our general knowledge about these topics. By examining the characteristics of authors, institutes and their geographical spread, we reveal hitherto unconscious bias and how this has evolved over time. By revealing these patterns, the broader goal of this study is to not only reflect

and celebrate research and advances in this discipline but to alert editors, funders, employers, demographers and population centres about the legacy of focus of certain topics and prominence in regions of the world. The clear advances, but also gaps and issues we identify will be useful in terms of planning future investments in data collection, teaching programmes and under-researched populations, as well as under-represented areas of research. Revealing gendered social network patterns and geographical disparities in authorship and general shifts in publication norms (such as in the length of articles and co-authorship), is likewise useful for employers and tenure committees to take into account when considering the promotion of staff.

We first describe the dataset that we compiled and our analytical approach, followed by an introduction to *Population Studies*' history and editorship over time. We then outline the core descriptive aspects of the data, which are all publications in the journal, including the type (classified as articles, editorials, errata, letters, notes, and reviews) and characteristics (e.g., authors, length, citations). Core topics examined over the past are displayed, including how this has evolved across time, and we highlight some of the most prominent articles to date. We employ an un-supervised machine learning approach to derive the distributions of subjects examined across topics, combining this with a qualitatively coded and regular expression-based analysis of topics, contingent on whether papers focus on men, women and children as subjects followed. We then engage in an analysis of the distribution of authorship across different geographical and institutional regions of the world in a continental analysis of participants studied. Delving into authorships, we analysed contributions by gender over time, consider social networks models (which are used to examine the gendered relationships amongst networks of authors), and create a 'Pop-Studies H-Index' to analyse authorship contributions across the entire history of journal articles. We conclude by reflecting upon the main findings, the strengths and weaknesses of our own approach and the future research and policy implications of our review.

2. DATA

The data used in this scientometric analysis are all articles published in the journal Population Studies from inception in January 1947 through to September 2020. We follow and extend our previously developed approaches which were designed to examine genetic discoveries in the area of genome-wide association studies ([Mills and Rahal, 2019, 2020](#)). To catalogue the article information and key characteristics of each article (such as the abstract, and authorship information), we developed custom modules which scraped data from four Scopus APIs (Application Programming Interfaces), namely: 'Scopus Search', 'Abstract Retrieval API', 'PlumX Metrics', and the 'Author Retrieval API'. APIs are a set of functions and procedures in computer programming which consist of a set of subroutine definitions, communication protocols and tools for building software, with academic publishers such as Elsevier increasingly creating APIs to provide rich bibliometric information.

We first query the Search API with the journal's International Standard Serial Number (ISSN), which is 00324728. This provides us with a list of Digital Object Identifiers (DOIs) which are then used to make function calls to request additional information on each individual article. As the journal is not published by Elsevier (but rather Taylor and Francis), we are limited to Scopus, as opposed to Science Direct, used in lieu of a dedicated and openly accessible API provided by the publisher Taylor and Francis themselves. The data is obtained under their Academic Research Use Policy. The creation of both unique author and affiliation profiles (to circumvent the 'many names' problem) is a largely automated process, although content processing is also undertaken manually by the Elsevier Developer team. The total number of papers in the database is 1,901 of which 1,900 are linked to authors. Of these articles with author information, 90.4% have an abstract (182 papers do not). Examining the papers by type, we see that the majority (1,858) are academic articles, followed by Erratum (19), Reviews (11), Editorials (5), Notes (6) and Letters (2). The total number of authorships is 3,267, with 2,027 unique authors.

3. ANALYTICAL METHODS

The analysis was conducted using Python 3.8, which is an interpreted, high-level and general-purpose programming language. To call the Scopus APIs and generate the datasets, we implement a module based on Requests: HTTP for Humans 3.1 (release v2.25.1). To undertake network analysis, we use NetworkX (v.2.5), with network visualisations undertaken in PyGraphViz (a Python interface to the Graphviz graph layout and visualization package, v.1.6.) using the 'neato' algorithm (North 2004). All visualisations are made with matplotlib (v. 3.3.3.), seaborn (v. 0.11.1), and geopandas (v. 0.8.0). For gender inference of authors we used both the Gender Guesser (v. 0.4.0, based on the gender.c files of Michael Jörg) and Gender Detector (v. 0.1.0, based on the Open Gender Tracker's Global Name Data) libraries, with supplementary calls made to genderize.io in order to fill in as many uncertainties as possible. An important caveat is that this does not necessarily reflect an author's self-identified gender, and it merely represents a probabilistic approach based on large caches of administrative data. Our unsupervised Latent Dirichlet allocation algorithm for automated topic modelling is based on a Python wrapper to MALLET. We create an original list of stop words which builds upon that provided by the Natural Language Toolkit (NLTK, v.3.5), from which we also use a default sentence tokenizer (PunktSentenceTokenizer), an implementation of unsupervised Multilingual Sentence Boundary Detection ([Kiss and Strunk, 2006](#)).

Similar to [Mills and Rahal \(2019\)](#) which created a 'GWAS H-Index', we also created a 'Pop-Studies H-Index' which uses the classical metric of the H-Index proposed by Jorge Hirsch ([Hirsch, 2005](#)) which in this case can be defined as defined as the maximum value of h such that the given author has published h papers within Population Studies that have each been cited at least h times. We verified key aspects of our automated and

machine-learning approach with a mixed-method qualitative approach. We (wo)manually parsed the entire list of abstracts to generate a multitude of qualitatively coded fields such as ‘topic’, which were checked and coded by separate coders (classifications defined in Table 1). During this process we also collected additional supplementary information where available, such as information on the datasets used, the populations studied, and the time-period of interest. The result of this (wo)manual curation and our library of functions for scraping, parsing, analysing and visualising is made freely available on GitHub and Zenodo ([Mills and Rahal, 2021](#)), with an accompanying requirements.txt file which takes care of package management.

4. ANALYSIS

4.1. The Foundation of Population Studies and Editors over Time

Demography as a discipline has a long legacy in the UK, with John Graunt – often regarded as the founding father of demography – publishing what is believed to be the first life table (‘Natural and Political Observations Made upon the Bills of Mortality’) c. 1662. Oxford’s Edmond Halley famously queried the ‘estimated degrees of mortality of mankind’ using birth and funeral data in Breslow ([Halley, 1693](#)), and Cambridge’s Malthus began a seemingly never-ending debate on the principles of population ([Malthus, 1798](#)). In addition to this, the origins of what might be considered mathematical and statistical demography similarly began with English mathematicians and actuarial scientists ([Gompertz, 1825](#); [Makeham, 1860](#)), with similar and substantial contributions being made by Galton, Pearson and Fisher.

Given this illustrious legacy, it seems appropriate that the Population Investigation Committee (PIC) established Population Studies – with David Glass as the founding Editor – in 1947. Glass edited the journal for 31 years until his untimely death aged 67 in 1978, latterly joined by foreign editors F.W. Notestein, C.E. Quesnel, A. Sauvy and P.C. Mahalanobis, with it noted that only Notestein took an active role at the journal ([Grebenik, 1996](#)). As described by [Grebenik \(1979, 1996\)](#), Glass – in his earlier years – was a research assistant of Sir William Beveridge, then the director of the London School of Economics and Political Science (LSE). The broad interests of Glass would go on to shape the journal, and were originally in the area of family life, with a focus on family size, divorce and marital fertility. In the late 1930s, he worked with biologists in the area of population genetics and as many of that time, on its relationship with fertility, selection and social mobility. The 1930s was a period of fertility decline in Great Britain, causing considerable concern, focussing policymakers to recognize the urgent need for demographic research in Britain. In 1935, the PIC was formed, with a readership in Demography established at the LSE in 1938. As many demographers, Glass straddled multiple disciplines and some readers (and these authors) may relate to the committee’s reasoning for first rejecting Glass’s application to become a Research Secretary at the PIC: “I have not been able to trace the subsequent

career of this individual, but it did not lie within the field of either demography or the social sciences” ([Grebenik, 1979](#)). This position afforded him freedom from all teaching and administrative duties, and it was noted in his obituary that he worked long hours with his days in libraries, and nights spent writing and harvesting an encyclopaedic knowledge of demography.

After working in wartime employment in the United States, Glass returned to the UK in 1945, where he became a Professor of Sociology in 1948 at the LSE until his death. Amongst his many accomplishments, he directed the Family Census of 1946, covering 10% of all married women in Great Britain (1.25 million), and was the UK delegate of the Population Commission at the United Nations. Fluent in French and German, Glass noted that there was only one other periodical devoted to demography, which was the French journal *Population* started in 1946 by the French National Institute for Demographic Research (INED). As a response in 1947, he instigated *Population Studies*, negotiating an agreement with Cambridge University Press. Although it was suggested that a more appropriate name was the *British Journal of Demography*, Glass insisted that it take a broader international view, hence the more expansive title ([Grebenik, 1996](#)). Although his research largely focussed on contemporary Britain, Glass stimulated research and teaching in Africa, Asia and Latin America, particularly within his UN activities, with a strong and comprehensive interest in historical demography. At the time, it was the only English language journal devoted exclusively to demography. There was also the Population Index published by the Office of Population Research at Princeton, but that was seen as more bibliographic and methodological. At that time, and as a benefit of membership to the International Union for the Scientific Study of Population (IUSSP), members received all three of these (*Population*, *Population Index* and *Population Studies*).

In 1964, the journal Demography was established as the official journal of the Population Association of America, first publishing one issue per year until the late 1960s, followed later by two. Thus for almost two decades from 1946 until the mid-1960s, *Population Studies* was the only demography journal publishing in the English language. Eugene Grebenik became a joint Editor with Glass in 1954, taking over as Research Secretary of the PIC. After Glass’s death, Associate Editors John Hobcraft and Roger Schofield also joined ([Grebenik, 1996](#)). Grebenik – known as ‘Grebbe’ – was an Editor for an incredible 42 years from 1954 until 1996 ([Grebenik, 1996](#); [Hobcraft, 2006](#)), holding other key roles such as Secretary General and Treasurer of the IUSSP for more than a decade. In Grebenik’s outgoing letter welcoming John Simons, he noted: “Unless demographic forecasts of mortality are completely wrong, it seems unlikely that their term of office will be as long as mine has turned out to be” ([Grebenik, 1996](#), p. 304). John Simons edited the journal for 20 years from 1996 to 2016, which under normal circumstances would reflect a substantially long period of editorship. This period brought in considerable changes in the technology and financial management of the journal, moving from the paper handling of manuscripts to an online system accompanied by a change in publisher to Taylor and Francis in 2002

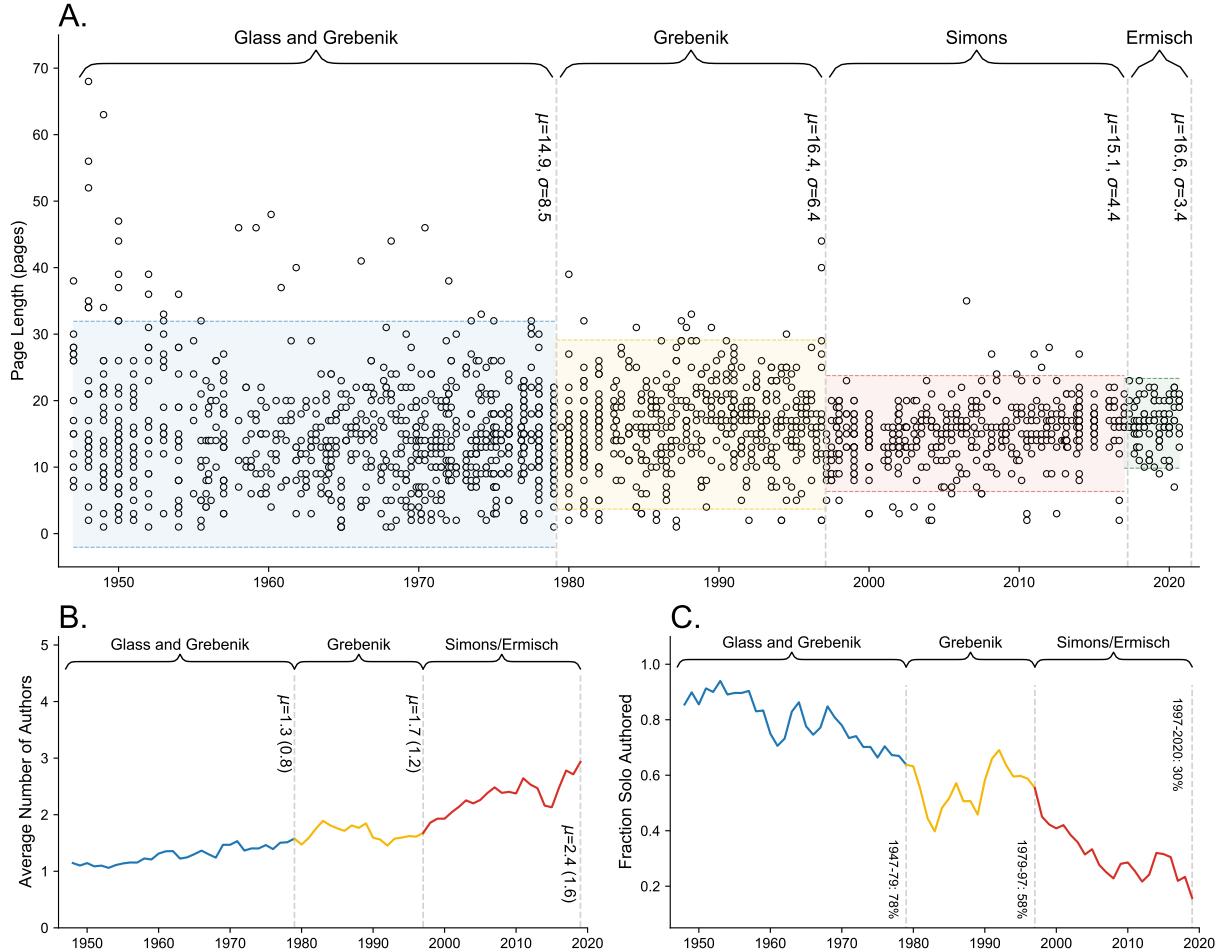


Figure 1: Shifting Modes of Academic Publishing and Editorship over Time. Panel A shows that while the variance of paper length substantially reduces over time (from 8.5 during Glass and Grebenik's tenure, to 3.4 during Ermisch's current tenure), the mean paper length stays approximately the same (15.44 all period). Panel B shows the increasing average number of authors of the articles published on a yearly basis using a three-year rolling window. Panel C shows the decreasing percent of solo-authored articles over time, measured as a percent of all papers published per year.

(Timaeus, 2016). It was only from 2002 that, for the first time, the journal used experts from outside of the Editorial Board to act as reviewers! Simons also made other changes, including introducing a larger and more international editorial board, and moving from the rule that only individuals who could attend editorial meetings in person in London were on the board (Timaeus, 2016). Similar to his predecessors, he personally read and edited articles for content, accuracy and writing style. In 2017, John Ermisch from the University of Oxford took over as Editor-in-Chief, which he holds at the point of this 75-year Anniversary reflection. With a background in economics, his work and interests span the economics of the family, intergenerational transfers, household formation, and housing economics. At its 75 year Anniversary, the Editorial Board includes Francesco Billari, John Cleland, Andrew Foster, Hill Kulu, John McDonald, Tom Moultrie, Mikko Myrsklä, James Raymer, Ronald Skeldon, Alice Reid and Wendy Sigle. Despite the evolution of the journal and publishing itself, Population Studies maintains *classic* remnants of its former Editors,

including the fact that all papers are still substantively edited by a trained, experienced demographer.

Population Studies has also had many hidden figures, ensuring the continued operation of the journal. Incredibly, Doreen Castle ran the administration and finances of the journal for 45 years from 1951 to 1996, followed later by Betty Cohen. Anne Shepherd, who provided us with considerable background information for this review, arrived in 2001 in conjunction with the shift to the online processes and remains the sole member of staff running the editorial office together with the Editor. Following this long line of stability and continuity, Shepherd remains in this position after twenty years. Figure 1 charts general trends over time in publications, separately identifying the four Editorial reigns discussed above. Panel A shows the shift in the variance of the length of articles over time. The mean length of papers over the entire period was 15.44 pages (with a standard deviation of 6.96), and the longest single article was a hefty 68 pages. The average number of references per paper is 24.8, with the largest number of references found in Hobcraft's 2006 article on the 'ABC of Demographic Behaviour', with 311 references ([Hobcraft, 2006](#)). To date, 52 articles are Open Access. Figure 1 also shows how publication norms in demography – likely reflected across the wider social sciences – have changed, by graphing the rise in the number of the authors per article (Panel B) and sharp decline of solo authored articles (Panel C). Panel B alludes to the emergence of some large 'multi-author' collaborations, with as many as 18 authors appearing on one single paper ([Nabukalu et al., 2020](#)), a multi-author collaboration approach common in the natural sciences and other large data collection efforts. Interestingly, over time, titles became longer, too; the mean title-length in the first 37 years was 65.25 characters, compared to 85.40 in the second.

4.2. Topics of Research

We next examined the main substantive topics of research over the 75-year period by engaging in a content analysis of substantive words in the titles and abstracts. Table 1 (shown in a later section) provides an overview of the topics. Figure 2 shows heatmaps of word co-occurrence in abstracts (Panel A) and titles (Panel D), illustrating the frequencies in individual words in the abstracts (Panel B) and titles (Panel C). We see that in terms of substantive topics, the core area of study is clearly fertility, followed by mortality, family, marriage, and migration. The most frequent words refer to the study of groups (population, women, rural, England, children, family), concepts and measures of time (age, year, period) and change (decline, trend, differentiate, transition, change, rate, increase, differ, develop). Turning to co-occurrence, we see that fertility is most often studied in relation to fertility: decline, differentials, trends in, and age of fertility. Mortality is examined more often in relation to infant mortality, child mortality, mortality estimates, age at mortality, and mortality decline. Marriage has been primarily examined in the context of age at marriage and in relation to fertility.

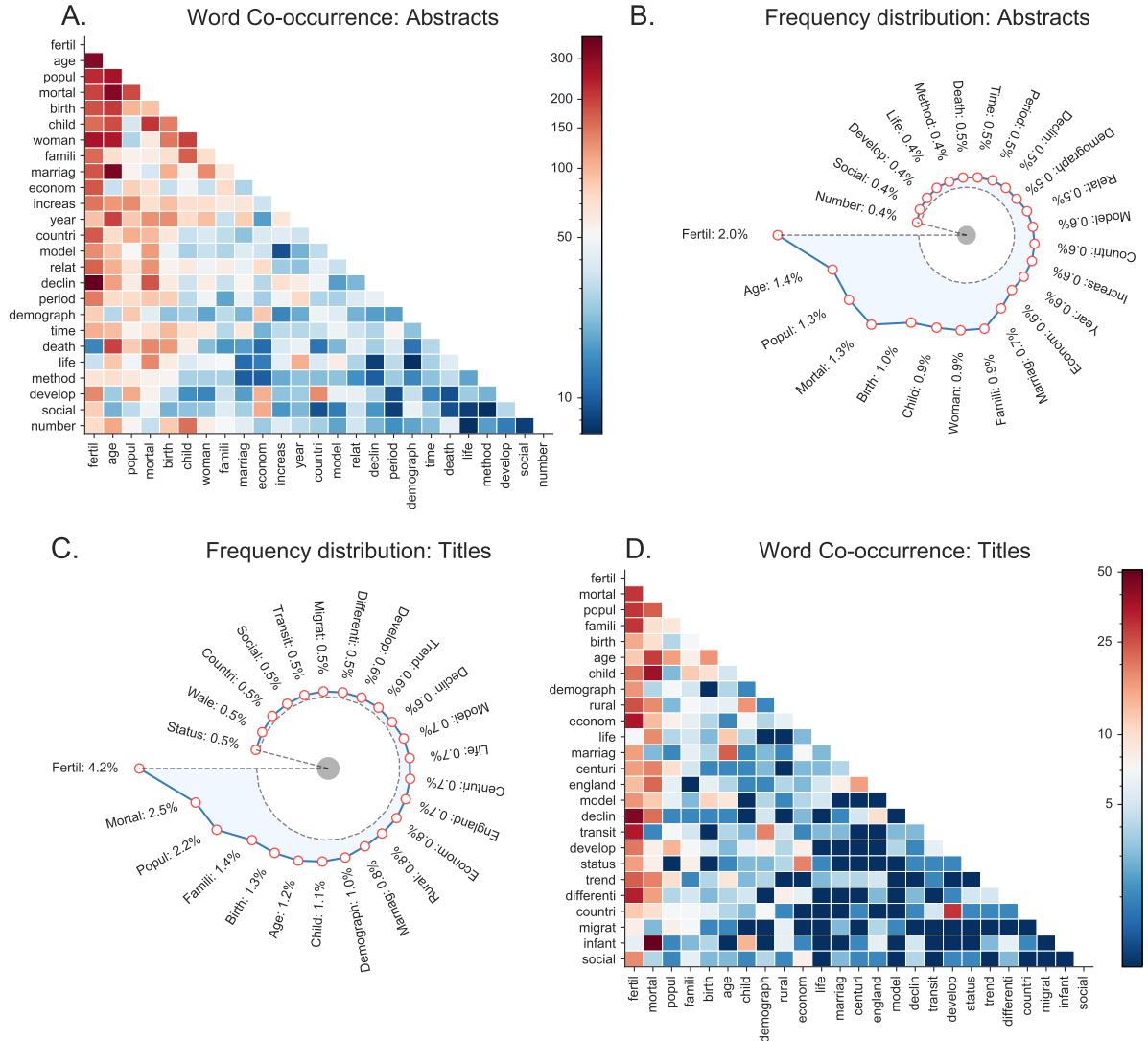


Figure 2: Heatmaps and Radar Plots show individual and co-occurrence frequencies. Panel A. shows the co-occurrence of the 25 most frequently co-occurring terms in article abstracts, B. shows the 25 most frequently individually occurring terms in article abstracts, C. shows the 25 most frequently individually occurring terms in article titles, and D. shows the co-occurrence of the 25 most frequently co-occurring terms in article titles.

Keywords were only introduced in 2003, and therefore our keyword analysis contains only 398 papers which contain keywords (2,591 keywords). It generally concurs with the findings from title and abstract analysis with the top 10 most frequently observed keywords being fertility (83), mortality (46), education (25), China (23), marriage (23), historical demography (19), infant mortality (18), life expectancy (17), and ageing (16). This word frequency approach helped to inform our qualitatively coded topics, which together with knowledge of the field helped us shape and divide the analysis further into distinct sub-fields. Figure 3 uses swarm and scatterplots to map the distribution of topics over time. Here we divided the topics into seven distinct groups (as shown in Table 1) of: 1) fertility (e.g., fertility, birth, contraceptive, pregnancy, reproduction), 2) mortality (e.g., mortality, death, longevity, survival), 3) migration (e.g., immigration, urbanisation), 4) macro-level (e.g.,

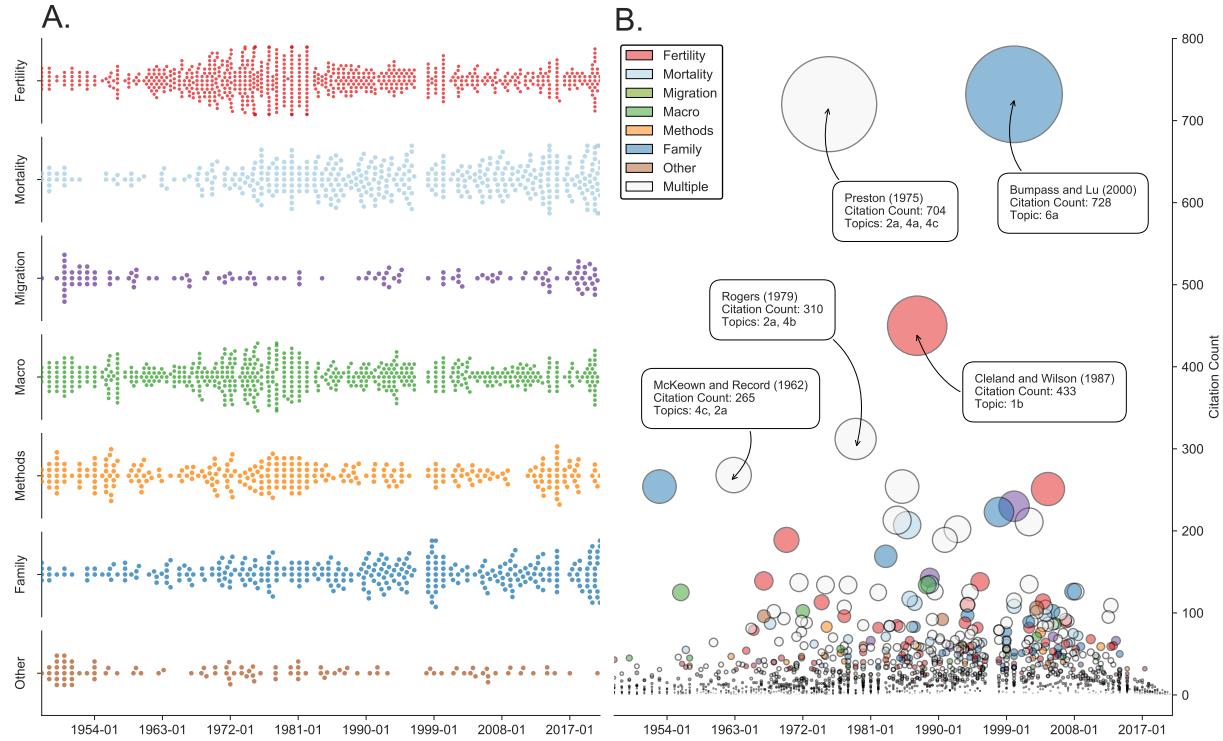


Figure 3: Swarm and Scatter Plots Show Distribution of Topics over Time. Panel A contains seven swarm plots showing the timing and topic of each individual article between 1947 and 2020, grouped into specific meta-topics as described in Table 1. Panel B groups this into one subfigure as a scatter plot, incorporating a new category for 'Multiple' (grey). Note: a paper can seldom fall into more than one category.

development, market, historical, economic), 5) methods (e.g., distribution, linear, statistical, simulation, methodological), 6) marriage and family (e.g., marriage, family, household, divorce, cohabitation), and 7) other (e.g., labour, employment, religious, housing, industrial).

In Panel A we see that in the early years of the journal, the focus was largely on macro-level factors, methods and other topics whereas many topics were examined particularly from the early 1960s to the 1980s. Particularly fertility, but also macro-level and methods have been a constant throughout the life of the journal. Mortality and family demography were examined less in the earlier years but have grown in focus since the 1970s. Migration was a more frequent topic of study in the late 1940s and then re-emerged from 2017, but – due to many specialised journals emerging in the area of migration research – the topic remains one of the least covered topics in this more general-interest journal. Panel B in Figure 3 illustrates the articles by their citation counts and across topic. We see that the two most cited articles are Bumpass and Lu's article on cohabitation and implications for children in the United States ([Bumpass and Lu, 2000](#)), and Preston's classic article on the changing relationship between mortality and economic development ([Preston, 1975](#)). This is followed by Cleland and Wilson's piece on demand theories of fertility transition ([Cleland and Wilson, 1987](#)), Roger's international comparative analysis of income and inequality as determinants of mortality ([Rodgers, 1979](#)) and McKeown and Record's exploration of

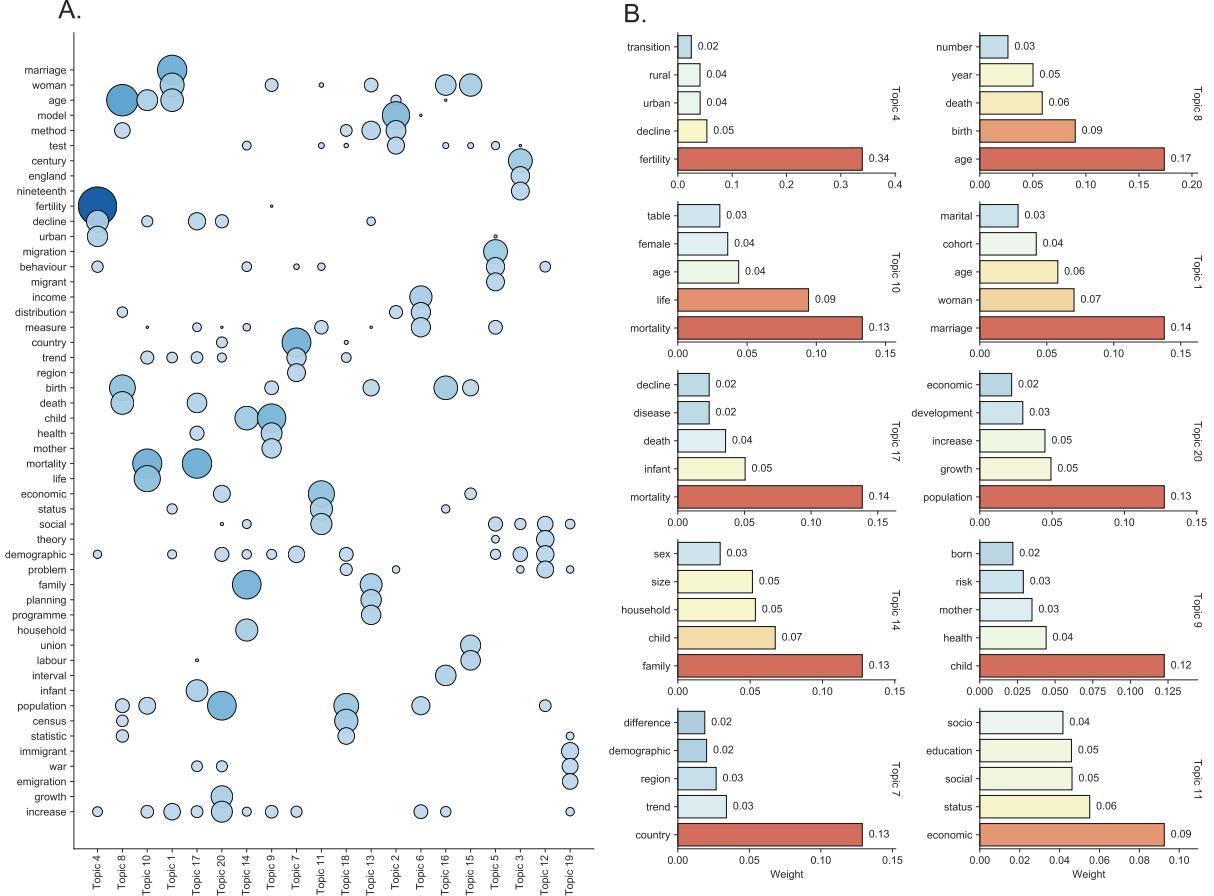


Figure 4: Visualising LDA analysis of automated topic modelling. Panel A. shows the highest weighted words across topics, ordered by topic importance. Panel B. shows the ten most highly weighted topics and indicates the five words most highly associated with each topic.

reasons for the decline in mortality in England and Wales during the nineteenth century ([McKeown and Record, 1962](#)). The mean number of citations per article is 22.35, although 189 articles remain uncited. The figure also highlights the fact that papers frequently address multiple interwoven topics within our qualitative schema.

Figure 4 shows the results of our automated machine-learning topic modelling approach using MALLET. It shows a number of intuitive words grouped together into topics, ordered by topic importance. For example, Topic 4 groups ‘fertility’ and ‘decline’ together, often related to the Second Demographic Transition. Topic 10 groups ‘mortality’ and ‘life’ and ‘table’ together, indicating a general topic related to the analysis of life expectancy and mortality via lifetables. Topic 1 clearly pertains to marriage, and Topic 20 to economic and population development (‘population’, ‘growth’, ‘increase’, ‘development’, ‘economic’). We also see the emergence of some more granular topics: Topic 17, for example, specifically refers to infant mortality, and Topic 13 pertains to fertility, but with a specific focus on family planning and contraception. We also observe a ‘socio-economic status’ (SES) themed topic (Topic 11). In general, and despite not being determined a-priori, all of the topics

which emerge from our LDA analysis are broadly accounted for within the seven groupings of the topics which were qualitatively coded.

4.3. If all we knew about women was...

If all we knew about women, men and children was what we read in Population Studies, what would we know? We then explored which topics focussed on specific demographic groups only, using a regular-expression based analysis. Shown in Figure 5, we examined whether topics consider exclusively men (and not women or children) in Panel A, women and not men or children (B), children and not men or women (C), men and potentially also women and children (E), women and potentially also men and children (F), and children and potentially also men and women (G). We see that fertility is the most studied topic, yet remains largely a study of women, particularly for Topic 1a (family planning and contraception) and 1b (fertility trends and declines). Children are examined less often and emerge as studied largely in relation to infant mortality (2b), a domain also more prominent for the study of women than for men (2b) and sex preference of children (6c). The study of women also dominates beyond fertility in the examination of marriage, unions and divorce (6a) and economic development and growth, including for education (4a), and socioeconomic status and income (4b). The topics where men are the focus of examination more so than women include general migration (3a), historical demography (including war and famine), 4c), and our catch-all ‘Other’ category (7a, which includes topics related to employment and labour markets).

4.4. Geographical concentration of subject matter

As part of our manual qualitative coding, we were also able to extract (from abstract alone) information on the geographical concentration of data used in 70.54% of the papers in our database. By cross-tabulating this information with sub-topics studied, we can see, for example, that the largest number of studies utilize European data (468). Studies utilizing data on African and Asia are twice as likely to be used to study Topic 1a (family planning and contraception) than Topic 1b (fertility trends and decline). For data focused upon European research, it is substantially more likely to be concentrated on Topic 4c (war, famine, and the First Demographic Transition), and we attribute this to the rich availability of historical data and expertise in this geographical area (and in particular, the use of historical demographic data – such as from parish registers – available in England and Wales). Interestingly, data which uses information from multiple continents is relatively evenly split across all topics.

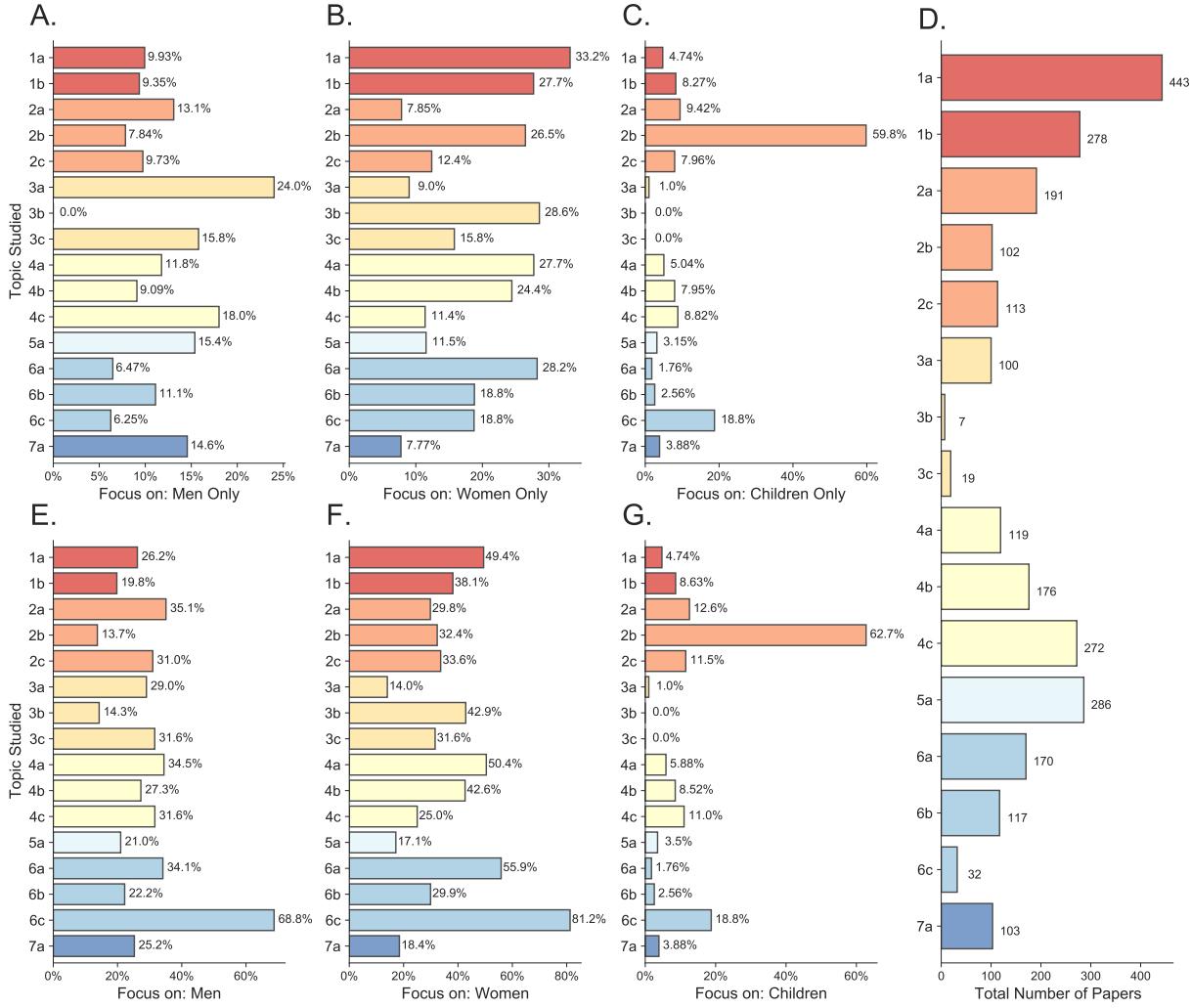


Figure 5: Figure 5: Horizontal bar charts to show research focus on Men, Women and Children. Panels A-C show the percent of all papers which exclusively mention either ‘men’, ‘women’ or ‘children’ (and neither of the other two conjoint terms), Panel D shows the total distribution of papers across all (sub-)topics, and Panels E-G show the percentage of all papers which (non-exclusively) mention either ‘men’, ‘women’ and ‘children’ (potentially in combination with the other terms).

4.5. Gender and authorship

We next examined gender across authorship. We initially begin with an analysis of gender in all authorships over time, as shown in Figure 6. Using two common sources to determine the gender of the author (Gender Guesser and Gender Detector, as described in the Analytical Methods section) and ten-year retrospective rolling windows, we see extremely similar patterns (Pearson’s $r=0.964$). Using a composite of each of the two libraries supplemented by returns from genderize.io, we then estimated the all-time percentage of female authorship in all *Population Studies* articles, which is around 34.11%. However, this mean figure masks substantial gains made towards gender parity in authorship. For example, we estimate that for the initial 37-year period of our analysis, the rate of female authorship was between 25.2-25.85%. However, for the later 37-year period, this increased to between

	Male		Female		Ratio	
	Topic	Sub-topic	Topic	Sub-topic	Topic	Sub-topic
Fertility	539		263		2.05	
1a. Family planning and contraception		305		187		1.63
1b. Fertility trends and declines (inc. SDT)		234		76		3.08
Mortality	344		207		1.66	
2a. General life-expectancy		159		72		2.21
2b. Infant mortality		76		49		1.55
2c. Health (child, maternal), morbidity		109		86		1.27
Migration	97		60		1.62	
3a. General (including (em)immigration)		77		47		1.57
3b. Population replacement		6		4		1.5
3c. Rural-urban migration		14		7		2
Macro-level	399		202		1.98	
4a. Economic development and growth		90		57		1.58
4b. Socioeconomic status, income		136		88		1.55
4c. Historical (inc. war, famine, FDT)		173		57		3.04
Methods, formal demography	219		68		3.49	
Family	225		190		1.18	
6a. Marriage, union, divorce		118		83		1.42
6b. Family dynamics, household size		88		82		1.07
6c. Family planning and sex preference		19		25		0.76
Other (e.g., employment)	54		38		1.4	

Table 1: Disaggregation of manually classified papers into gender of authorship. Ratio indicates male to female ratio across each subtopic. Gender based on an amalgamation of Gender-Guesser, Gender-Detector and the genderize.io API. The ‘Topic’ column is the ‘Sub-Topic’-wise sum per gender. Notes: SDT = Second Demographic Transition, FDT = First Demographic Transition.

37.26% and 37.96%, potentially rising almost to parity of 46.07% in 2017. This figure roughly aligns with the broad estimate made by West et al. (2013) which, using a method similar to ours (and JSTOR, a large digital library of digitized back issues of academic journals), estimates that around 41.9% of authorships over the entire period between 2000-2011 were female. This does, however, indicate that Population Studies as a journal has a lower proportion of female authors in comparison to the broader field of Demography as indexed by JSTOR.

Similar to West et al. (2013), we decomposed our analysis of gendered authorship across sub-topics of interest, as shown in Table 1 (albeit with topics different to JSTOR: we have, for example, no ‘French-language demography’ section). In general, we see a Male to Female ratio under the value of one for all of our sub-topics, with the exception of Topic 6c (‘Family planning and sex preference’), where recent papers in Population Studies by female authors include Attané (2009), Mills and Begall (2010) and Kashyap (2019). Indeed, Topic 6 at its broader hierarchical grouping more generally (family demography) has the male-to-female authorship ratio closest to parity. In terms of the most male dominated

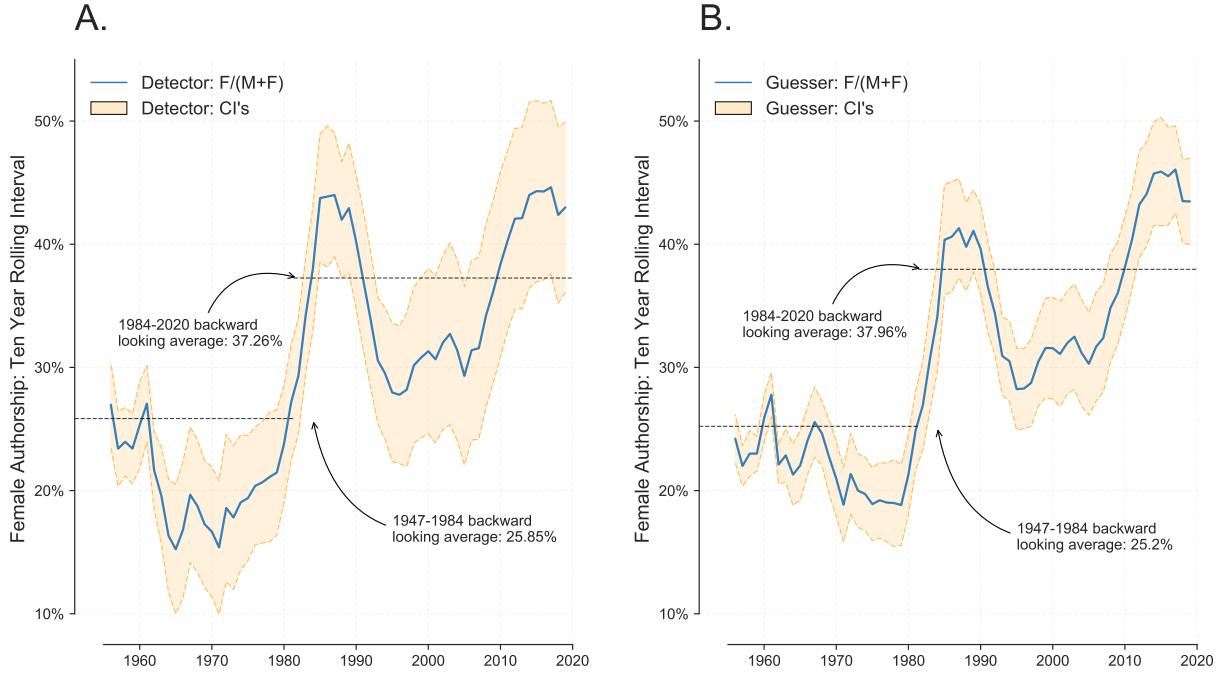


Figure 6: Gender in Authorship Over Time. The two panels show the percent of female authors over time as measured in retrospective ten-year rolling windows (starting at 01/01/1957, analysing the previous ten years of citations). Panel A. uses estimates of gender based on the Gender Detector library, and Panel B. uses estimates of gender based on the Gender Guesser library. Confidence intervals are $\pm 25\%$ of the number of ‘unknown’ names at any given rolling window.

area, we see a male to female ratio of 3.49 in Topic 5 (methods and formal demography). Comparing across the major topics of fertility and mortality in comparison to [West et al. \(2013\)](#), our estimates are substantially higher for fertility (2.05 compared to 1.386), but substantially lower for mortality (1.66 compared to 2.86).

4.6. Social Networks of Authorship

To understand whether the gender, subject, and geographic-related clustering was related to collaboration and power structures, we examined the social network of authorships. Panel A in Figure 7 illustrates the entire network of authors, including sole-authors who have never collaborated with other authors in articles published in Population Studies. Of the 2,026 unique authors ('nodes') in our network, 510 of the authors represent isolates or — in other words — ‘lone wolf’ sole authors, which we know were particularly prominent in the past. In total, there were 2,317 edges (i.e., ‘author-to-author’ links). The overall density of the entire network is 0.00113. There are 926 edges in the Giant component, connecting 433 nodes. Panel B and C show the two largest sub-components of the network, with nodes coloured by gender (women in red, men blue, grey are unknowns, in the most part because an initial was registered in lieu of a full forename), with the size representing the degree centrality of each individual. Highly central authors include Basia Zaba (28 links, an author on [Nabukalu et al., 2020](#)) a now deceased professor of medical demography at LSHTM who worked on demographic estimation and HIV surveillance, Milly Marston,

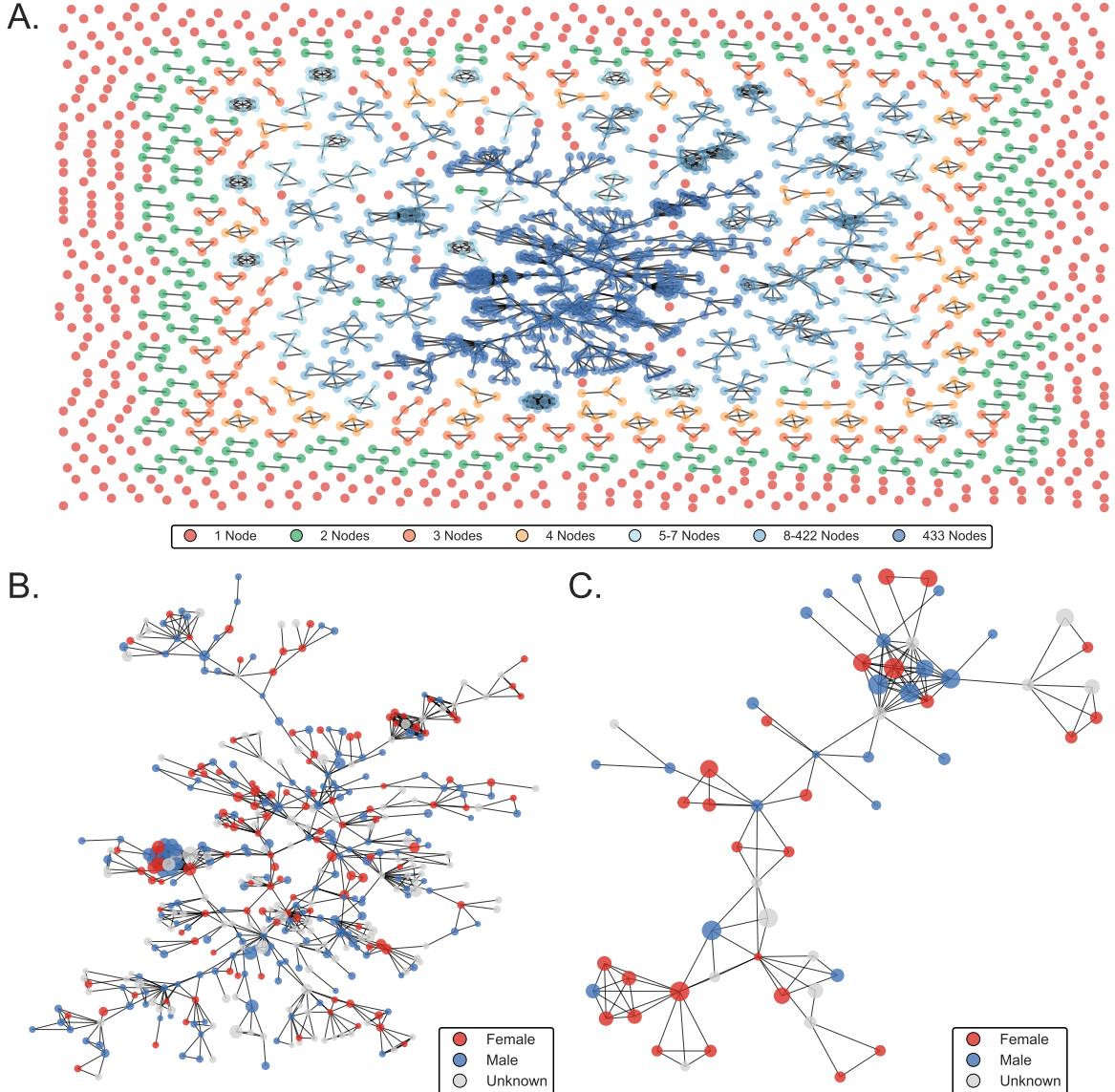


Figure 7: Subcomponents of the Network of Population Studies Authors. Panel A shows the entire network of Population Studies authorships, coloured by the number of authors (nodes) in the subcomponent. Panel B. shows the ‘Giant’ Component, and Panel C. shows the second largest subcomponent of the network. Nodes in Panels B and C are coloured by our composite gender index, and are sized according to their degree centrality. Visualisations are conducted using the ‘neato’ algorithm (North, 2004).

also at LSHTM with expertise in HIV, epidemics and working predominantly in Eastern and Southern Africa (23 links, an author on Nabukalu et al., 2020), and Robert G. Potter from Brown University who worked in fertility, biology and behaviour and co-author of the classic book on the topic with John Bongaarts (19 links, not an author on Nabukalu et al., 2020). We note that the largest paper with the most number of authors – Nabukalu et al. (2020) – forms part of the Giant Component. A cursory analysis shows no significant systematic bias in the formation of gender-based co-authorship cliques, although we leave more formal quadratic assignment procedure (QAP) based tests for gender-based

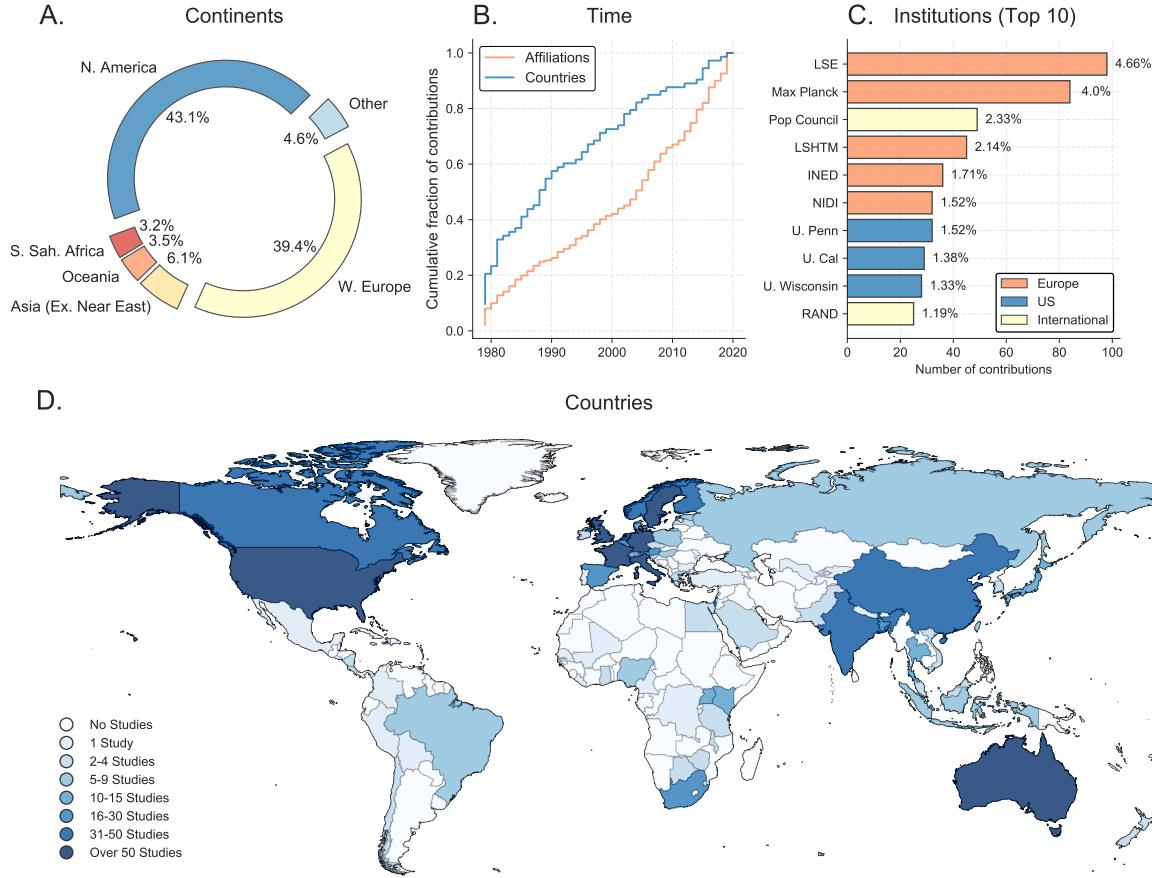


Figure 8: The international distribution of Population Studies Authorships. Panel A. shows the distribution across Continents. Panel B. shows the cumulative fractions of individual institutions and countries contributing to the authorship base of Population Studies. Panel C. lists the institutions which contribute the greatest number of individual authorships. Panel D. shows a choropleth map with a colormap corresponding to the number of authorship contributions made across all countries of the world.

co-authorship and interconnectedness across (sub-)topics for further research (Hubert, L., Schultz, 1976; Krackhardt and Stern, 1988).

4.7. International Trends in Authorship

Demography has always been a global discipline, evident from the inception of the journal and the characteristics of the early Editorial team of Population Studies. To map the field, we next opted to examine the geographic spread of authors conducting the research, beginning in 1980 (the point in time from when authorship information began to be more thoroughly indexed). Perhaps unsurprisingly, we see an overwhelming majority of research being conducted within North America (43.1%) and Western Europe (39.4%), with the gradual increment of new countries and institutional affiliations being associated with contributing authors. We see a slight jump around the turn of the century, which may be attributed to multiple reasons such as shifts in global demography conferences and initiatives, international data collection efforts, and other social and technological factors. We

note that the institution which has been associated with the largest number of contributions (4.66%: almost one in twenty contributions) is the LSE, again perhaps unsurprising given that the Population Information Committee and the journal had been housed at LSE since World War II. Other prominent European institutions feature as expected, in the form of the Max Planck Institute for Demographic Research (MPIDR, 4.00%), the Institut National d'études démographiques (INED, 1.71%) and the Netherlands Interdisciplinary Demographic Institute (NIDI, 1.52%). Global policy organisations, such as the Population Council, and the RAND Corporation also feature towards the top of the list. While 935 authorship contributions in our dataset emanate from the United States of America, at least one authorship contribution has been made from 73 countries, including from institutions within some of the world's lowest income countries, such as the Democratic Republic of Congo ([Bertrand et al., 1983](#)), Liberia ([Rumford and Greene, 1979](#)), and Mali ([Hertrich et al., 2020](#)).

4.8. Top authors in Population Studies

We also engaged in a review of the most prolific authors across the journal over time, ranked according to their 'PopStudies H-Index' (with ties settled by absolute number of cites). Table 2 displays familiar names at the top of the list, such as John Charles 'Jack' Caldwell, a leading demographer in fertility and health transitions, and Michael 'Mike' Murphy (of the LSE since 1980) whose research spanned multiple topics ranging from fertility, ageing, mortality, migration and intergenerational behaviour. Samuel 'Sam' H. Preston – author of the adored 'Demography: Measuring and Modeling Population Processes' – ranks second after John C. Caldwell in terms of citation counts, including the article highlighted in Figure 3 above. Given the gender disparities over time discussed previously, we do not find any female authors with a PopStudies H-Index greater than or equal to 8. Notable female authors publishing in this journal include Gigi Santow, Gabriele Doblhammer, Ulla M. Larsen and Kathleen 'Kath' Kiernan. Uncertain of the gender of Lolagene Coombs, Paula Fomby (of the Population Studies Centre at the University of Michigan) scoured the archives to discover that this path breaking figure was first a graduate student and then a faculty member in demography. David Lam, Director of the Institute for Social Research and Professor of Economics at the University of Michigan wrote in personal communications to us: "I took over her office when I arrived as an Assistant Professor in 1983 and she had just retired. She was very prolific".

5. CONCLUSION AND DISCUSSION

For the past 75 years, demography has revealed itself as a highly interdisciplinary area of research, with researchers emanating across multiple disciplines ranging from sociology, economics, statistics, anthropology, public health, biology and epidemiology. The future seems to be a return to the past in many ways, with early scientists replicating first Editor

	Papers	Cites	H-Index	First	Last
John C. Caldwell	20	1351	13	1963	2004
Samuel H. Preston	14	1204	11	1974	2016
John E. Knodel	15	620	11	1967	2000
Michael J. Murphy	12	383	11	1985	2016
Ronald F. Freedman	13	258	10	1954	1990
John P.M. Bongaarts	11	424	9	1976	2019
James Trussell	10	405	9	1977	1996
Robert G. Potter	21	296	9	1956	1986
John N. Hobcraft	11	644	8	1982	2006
Aart C. Liefbroer	9	311	8	2001	2015
Pekka Martikainen	13	298	8	1995	2018
Alberto Palloni	12	232	8	1975	2009
Dov Friedlander	8	219	8	1966	2002
:					
Gigi Santow	10	358	7	1979	1998
Gabriele Doblhammer	7	215	7	2000	2013
Ulla M. Larsen	7	185	7	1994	2008
Kathleen E. Kiernan	6	428	6	1983	1999
Lolagene C. Coombs	7	181	6	1966	1979

Table 2: Ranking of authors with a ‘Pop-Studies’ H-Index equal to eight or more : ‘Papers’ indicates the total number of papers published by that specific author within the journal, and ‘Cites’ represents the number of citations returned by the Scopus API. ‘First’ and ‘Last’ correspond to the year of the first and last published paper by that author, respectively.

David Glass who embraced knowledge from multiple disciplines and approaches to inform their knowledge. It likely also means moving from theorising about bio-demographical approaches such as in the classic *Population Studies* article by Hobcraft (2006), towards empirical inclusion across topics ranging such as mortality (Vaupel, 1998) and fertility (Barban et al., 2016; Kohler et al., 1999; Mills et al., 2021). We anticipate an increase in interdisciplinary approaches such as empirically infusing biology and genetics as researchers accumulate the necessary skills to accompany recent advances in data availability (Mills and Tropf, 2020).

The world has also changed dramatically over this period. Neo-restatements of Malthusian theories in terms of a ‘Population Bomb’ might not have come to pass, but debates regarding Malthus in light of climate change (whether global population levels should be actively reduced to mitigate global warming) endure. In terms of migration, contemporary issues of population displacement and resettlement continue to be widely debated just as they were in the post-war period in which the journal was launched, repeatedly featuring in Population Studies over time.

Our empirical overview revealed some striking findings. We illustrated how the very

nature of authorship and has evolved over time with articles become shorter, more multiple authors and team scientists but also clear networks working together around a dataset, initiative or intervention. At least in the journal *Population Studies*, we revealed that the core area of enduring study has been fertility, followed closely by mortality, family and ageing research, with migration less often examined. Given that the majority of research is often quantitative, we have organised our theory and understanding around the division of groups (e.g., women, rural), measures of time (e.g., age, year, cohort) and change (e.g., decline, trend, increase).

We then drilled further into the study of larger fields such as fertility, mortality, migration, macro-level, methods, marriage and family and other topics of study (employment, religion, housing). The early years of the journal focussed largely on macro-level factors and fertility, with methods and other topics flourishing from the early 1960s to 1980s. Mortality and family demography emerged in the 1970s with migration having waves of interest in the 1940s and re-emerging in from 2017. Our machine learning topic modelling logically grouped key topics to reveal that subjects such as fertility were often coupled with decline and the SDT or family planning and contraception. Although these couplings are logical, standing back to examine how women, men and children were studied in the journal raises some important questions and exposes unconscious bias and gaps in research. Children remain under-examined in this discipline and when they are, it is largely in the domain of infant mortality or sex-preferences of parents for children and often only linked to women and mothers. If an alien landed on earth and was given *Population Studies* to read and learn about women, they would learn they are central in family planning and contraception, responsible for fertility trends and decline, marriage, union formation and divorce, education and broader economic development and growth. This finding echoes many of the observations from [Watkins \(1993\)](#) regarding women in the journal Demography. If our inter-planetary visitor wanted to understand how the human species procreated, it would seem almost exclusively the task and responsibility of women. For men, they would learn that the relevant information is migration, historical demography (war and famine), and our ‘other’ category of employment, labour markets and housing. Particular topics were also more prevalent in certain parts of the world, with a focus on family planning and contraception in Africa and Asia and fertility decline and tends in European and North American research. Rich historical data sources, particularly in England and Wales have likewise allowed research to flourish in this area.

The policy implications of our research are also clearly apparent and wide reaching. We see general patterns that can inform hiring and tenure committees when comparing and evaluating candidates including: patterns of authorship, shift to shorter and multi-authored articles, fewer women, fewer non-Western European and North American authors and different network dynamics by gender and subject matter. We find that around 34% of authors were women, which has increased somewhat over time but has not reached parity, even lower than other estimates (e.g., 42% from [West et al., 2013](#)). Ranking the

most prolific and cited authors in this journal alone, we find the top authors are men, influenced by multiple factors including women having a shorter publication career in the journal, maternity leaves, representation in academia or other factors that might be related to career paths or bias. This is even lower in other natural science areas such as molecular genetic discovery, where women represent around 37% of authors (Mills and Rahal, 2019).

The policy implications of our research are also far reaching. The general patterns of authorship, shift to shorter and multi-authored articles, fewer women and network dynamics can inform tenure committees when comparing and evaluating candidates. Editors, funders and researchers are able to see clear gaps and entire vacuums of research that although only for one journal, may be symbolic for the broader field. These include the oft-mentioned lack of research in men's fertility (Goldscheider and Kaufman, 1996) or role in family planning or in the area of migration (although the latter is often represented in other specialised journals as well). We challenge funders to draw from scientometric approaches such as ours to identify under-funded and overlooked areas of research or researchers. Those who fund, develop and collect data need to be reminded of large gaps in either the quality, focus or availability of topics, such data collection about children or men's fertility (Joyner et al., 2011) or skewed focuses on data collection and research on certain groups. In terms of bibliometric policies, we encourage the journal to consider mandatory code and data archiving (with the generation of DOIs), or the creation of an article type dedicated to the contribution and description of new datasets.

We provide the first large-scale systematic analysis of what demographers writing in *Population Studies* have studied, who has and where they have studied it, and how this has changed over time. The strengths of our approach are its comprehensive longitudinal nature from the journal's inception in 1947 to the time of writing, providing us with a large number of data points and giving us the opportunity to analyse how patterns have shifted over time. Concordant with our understanding of the prescient demographic issues over the last 75 years, authors in *Population Studies* have given special consideration to fertility declines, improvements in longevity, and population aging. While many central questions remained constant, the data and methods used to examine them evolved substantially. We also go beyond narrative reviews and attempt to provide a more neutral and empirical summary.

We also acknowledge that our approach has limitations, such as the ability to draw generalisable conclusions about demography from the study of only one journal and how the focus and meaning of topics has evolved over time. We are likewise aware that our highly computational approach focuses on grouping and categorising and misses many of the nuances within each area. Our parallel approach to have both a machine-learning approach that allowed topics and sub-topics to emerge compared with manual coding shows that both approaches derived very similar categories. We make the replication code of our analysis openly available, and invite scholars to extend and provide more depth and nuance beyond this initial analysis.

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