

# **Rise of Multi-authored Papers in Economics: Demise of the 'Lone Star' and Why?**

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# Rise of Multi-authored Papers in Economics: Demise of the 'Lone Star' and Why?

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## Summary

The rising incidence of co-authorship has received much attention in recent years especially in the sciences, but has received little attention so far in economics, at least when using large data sets. This paper draws on a very large new data set, covering around 175,000 articles in the top 250 or so economics journals, over the period 1996 to 2014. On the basis of these data several novel insightful charts, adjusted for various factors, are constructed. The incidence of co-authorship by category type (two, three, four-plus authors) is looked at in almost all charts and differences between groups of journals by rank are also explored. Using this framework the following are looked at: co-authorship over time, across countries, citations per paper and per paper per author, length of papers, number of references, frequency of alphabetical ordering of author names and the career profile in terms of co-authorship for 133 top economists, using a specially constructed data set based on detailed CV data. These charts were constructed to throw light on the various explanations posited for the rise in the incidence of co-authorship, and they do so to a surprising extent. In particular, considerable doubt is thrown on the increased specialisation argument, at least as applied to economics. They also throw major doubt on the hypothesis that increased co-authorship can be traced to 'token' acknowledgement for work done of a peripheral nature. It is also argued that several other explanations are not well founded, with the exception perhaps of increased ease of communication and greatly decreased cost of travel. The main explanation though the paper posits could be linked to changing attitudes to the discounting for number of authors by hiring and funding agencies.

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## 1 Introduction

Much has been written about the phenomenon of co-authorship in economics in the last thirty years, as prior to this sole-authored papers were the main output by far in economics journals. For example, McDowell and Michael [1983] noted that the proportion of co-authored articles rose from three per cent in 1945, to ten per cent in 1960, to thirty per cent in 1976 in the ten top economics journals of the time. Hudson [1996] surveying eight top journals noted that in 1950 only six per cent of papers were written by more than one author, a figure that had risen to over fifty per cent by 1993. Wuchty et al. [2007] studied 19.9 million research articles in the Institute for Scientific Information (ISI) Web of Science database and concluded that although social scientists in 1955 wrote just seventeen per cent of their papers in teams, by 2000 this figure had risen to over fifty per cent, an increase similar to that in sciences and engineering.<sup>1</sup> They went on to show that on average, social sciences papers are written in pairs, with a continuing, positive trend toward larger teams.<sup>2</sup>

The purpose of this paper is to develop on this work in three ways. First, to outline the very large data sets used to explore this phenomenon in relation to journal article publications in economics for the period 1996 to 2014. All previous work, related to economists alone, used much smaller data sets. Second, the overall trends in co-authorship using these data are then outlined, followed by a more in-depth analysis which might throw light on the reasons for the trends observed. The paper concludes by reviewing the statistical evidence and arguments to date in relation to the possible causes of these developments.

## 2 Data sources

The primary purpose of our data-collection exercise was to obtain information on the career paths of the most published economists in of the last twenty years (see Kuld [2017]). To choose these we used economic journals listed by Kalaitzidakis et al. [2011]. The over two hundred journals in this list were supplemented with a number of other journals, especially others highly ranked in Ideas RePEc. From this process we ended up with 255 of the highest ranked journals in economics.

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<sup>1</sup>Some articles in science have apparently hundreds even thousands of co-authors, all taking equal credit (The Economist, November 26th 2016, p. 69).

<sup>2</sup>Card and DellaVigna [2013] also looked at this phenomenon, but as part of a wider discussion. For the top nine journals they examined, they show that in the early 1970s three-quarters of articles were single-authored, and the average number of authors per paper was 1.3. By the early 1990s, the fraction of single-authored papers had fallen to 50 percent, and the mean number of authors reached 1.6.

A search was then carried out using Scopus in relation to the chosen journals. There were over 174,266 research articles published in these journals between 1996 and 2014 and all of these were included in the data analysis. For each article Scopus includes information on the authors, journal title, number of pages, year and the number of citations received.<sup>3</sup>

These data then allowed us to examine co-authorship in its various dimensions, as follows, in particular co-authorship involving two, three and four plus individuals and the trends in each by different rankings of journals, citations per paper and per author, average page length and so on (see later).

Using Scopus then details on all of the 174,266 articles published in these journals were downloaded, for the years 1996 to 2014. One key bit of information available in Scopus is the number of times each article was cited, in the same period. This was used, for other purposes, to identify the 1,000 most cited economists, a small subgroup of the total. Using on-line CV data for each, a career profile was then constructed for all, but these data are used in this paper only to a very limited extent, namely to examine the different career-age profiles with regard to preferences/outcomes in relation to different types of authorship (solo, duo, treble or quarto plus). To do this, we looked at the 133 top economists who completed their PhDs 1996 and 1999, inclusive, and then plotted the trend in their publications from year of graduation by type of solo and/or co-authorship.

To add data on international collaborations, a search on Web of Science<sup>4</sup> for economics articles with author affiliations in two specific countries was carried out. We use this additional source to study the rise of increased cross-country co-authorship, potentially due to technological change and cheaper travel, as it has been posited as a reason for the steep rise in co-authorship.

### 3 Key findings

Figures 1 a and b provide the picture of the overall trends in co-authorship in economics. As recently as 1996 solo-authored papers accounted for fifty per cent of all articles published in our sample, with this number dropping to just over twenty-five per cent in 2014. While duo-authored papers share of the total remained steady, the huge pickup was in trio and quarto-plus authored papers, particularly the latter. By 2014 quarto-authored papers accounted for around eight per cent of the total, and trio-authored papers for around twenty-five per cent of the total, more than double that of less than fifteen years earlier. This is a remarkable turnaround in a very short period. This picture is replicated whether the data relate to all journals (top 255, Figure 1a) or the top 20 journals, but different trends are evident (Figure 1b).<sup>5</sup> The rise of trio and quarto-authorship is particularly marked in the top 20 journals, with just over twenty per cent

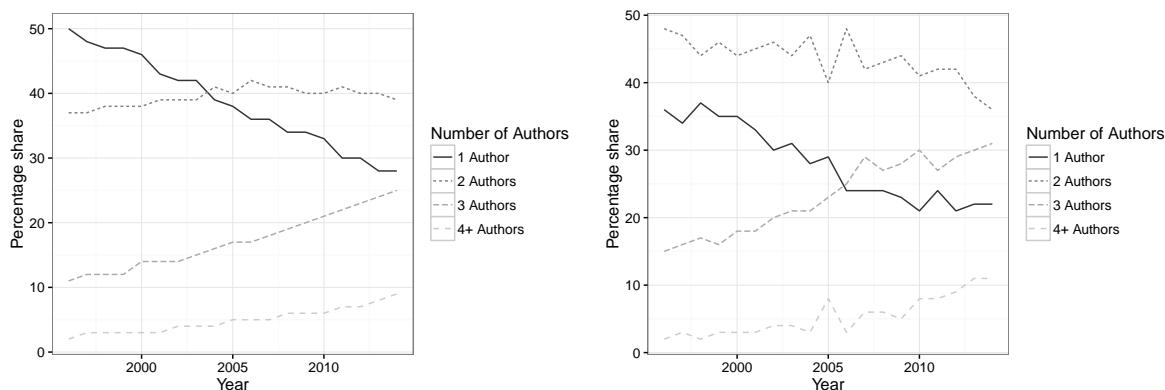
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<sup>3</sup>Other data bases include Google Scholar, RePEc and EconLit. Scopus ([scopus.com](http://scopus.com)) has full coverage of the selected journals from 1996.

<sup>4</sup>[webofknowledge.com](http://webofknowledge.com)

<sup>5</sup>The charts for the top 50 journals are very similar to those for the top 20 and hence are not included in this paper.

Figure 1: Share of articles by number of authors



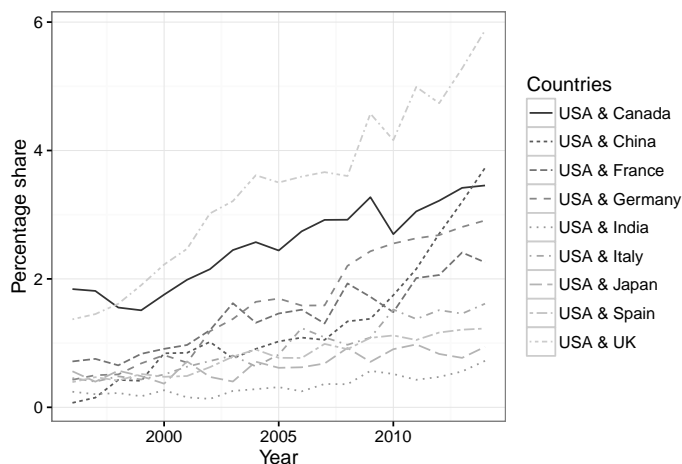
(a) Top 255 journals

(b) Top 20 journals

*Notes:* Number of economic research articles published in a top 255 or top 20 journal as described in text, classed by number of authors and divided by the yearly total number of articles. *Source:* Own calculations based on Scopus data.

now solo authored, with the number of trio and duo-authored papers exceeding the total of single-authored papers by a wide margin. If present trends continue the number of quarto-authored papers could soon exceed the number of single-authored papers. Why such trends are so marked in the top journals could throw light later on one of the key suggested reasons for the overall upward trends in co-authorship.

Figure 2: Co-authored papers across countries, relative to the combined paper output of the two countries



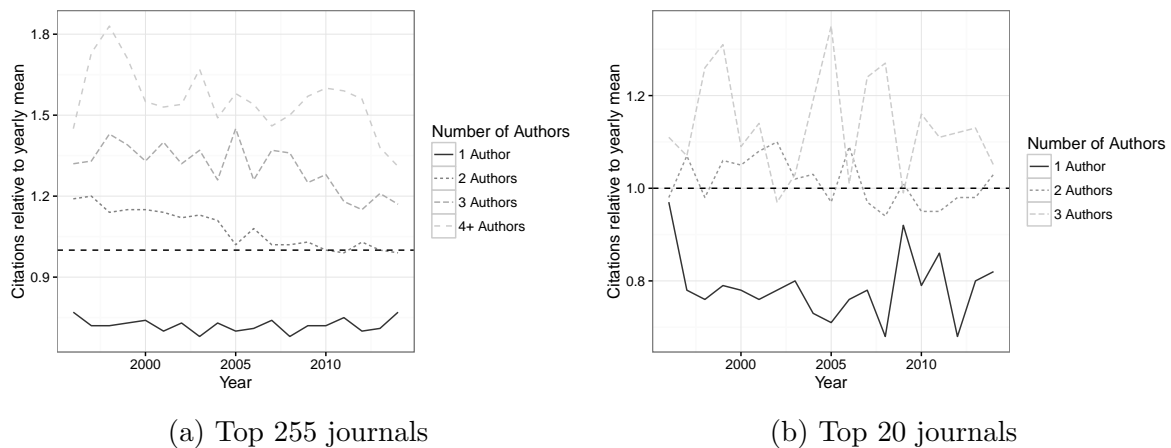
*Note:* Number of economics articles with author affiliations in both respective countries divided by the yearly combined article output of these countries. Affiliation countries as indexed by Web of Science. *Source:* Own calculations based on Web of Science data.

Turning now to the trends in co-authorship between countries (using a different source as seen earlier), we look at the pattern examining co-authorship between US researchers and economists from other countries. This choice of focus is motivated by the ongoing

dominance of US universities in journal article publication in economics (Figure 2).<sup>6</sup> This figure plots the percentage of each category of cross-country co-authored papers as a percentage of the total paper output of the two relevant countries combined. As such, this is a relative measure and hence a better indicator of trends than raw publication numbers.

Since 1990 there has been a huge rise in co-authorship across countries, especially between the US and the UK. The rises for the other country combinations though are large, especially as they are expressed in percentage terms. Of particular note is the rise in co-authored papers with China: their share expressed as a percentage of the total number of articles in both countries has risen from close to zero just fifteen years ago to close to four per cent in 2014. These trends may give us an insight again into the possible reasons for the rise in co-authorship to be looked at later. It is noteworthy though that the highest shares apply to US-UK and US-Canada articles, reflecting perhaps strong cultural connections, not least language. Still, the rises in US-China, US-Germany and US-France co-authored papers has been marked, with the gap between them and US-UK and US-Canada set to close in years to come perhaps.

Figure 3: Citations received per article, relative to yearly mean, by number of authors



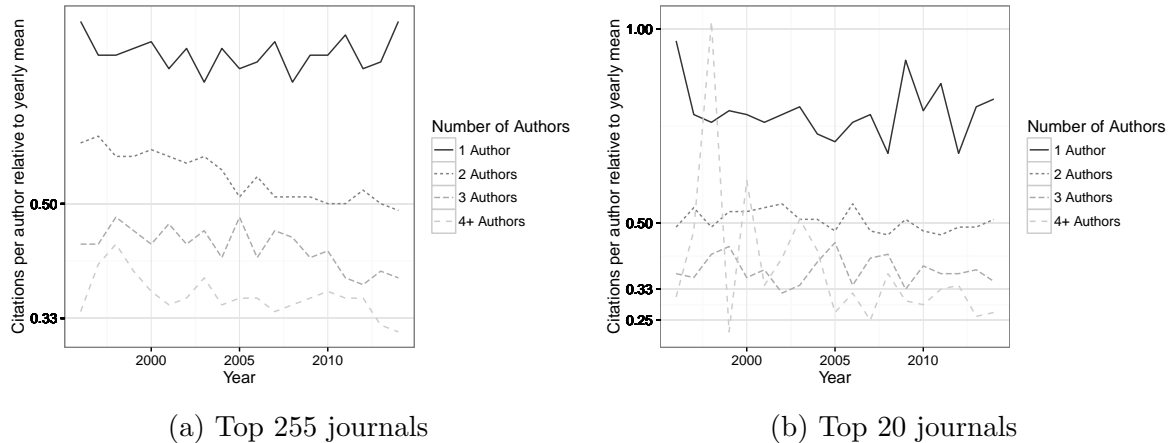
*Notes:* Means of citations to economic research articles published in a top 255 or top 20 journal as described in text, by number of authors and divided by the yearly mean of citations received per top 255 journal article. *Source:* Own calculations based on Scopus data.

Turning now to citations per article by co-authorship type, Figure 3a shows citations per article in the top 255 journals, relative to the yearly mean. It shows that citations per article are highest for quarto-authored articles as one might expect. The picture

<sup>6</sup>See Frey and Pommerehne [1988] and Frey and Eichenberger [1993] for an early discussion of this phenomenon. The CV data discussed earlier has allowed us to undertake detailed data analysis on the top 1,000 or so publishing economists in terms of geographical migration and location, prior, during and after their PhDs, and thereby develop on the very interesting issues discussed in these two earlier papers (see Hellmanzik et al. [2017], which draws on the methodology of earlier work on the CVs of visual artists and composers, Hellmanzik [2010], and O’Hagan and Borowiecki [2010]). It is also hoped using the CV data set to build on the gender dimension examined in Conley et al. [2016].

with regard to the top 20 journals is similar with important differences though (Figure 3b). As can be seen there is huge variability in the citations for quarto-authored papers (mainly due to the very small number of articles in some years), in almost all years their level (relative to the yearly mean for all articles) is higher and in some cases way higher, than those for trio and duo-authored papers. For every year citations are lowest for single-authored papers.<sup>7</sup>

Figure 4: Citations received per article and author, relative to yearly mean, and by number of authors



*Notes:* Means of citations to economic research articles published in a top 255 or in top 20 journal as described in text, by number of authors and divided by the number of authors and the yearly mean of citations received per top 255 journal article. The vertical lines at 0.25, 0.33, 0.5 and 1 refer to the expected values if all citation means are equal.

*Source:* Own calculations based on Scopus data.

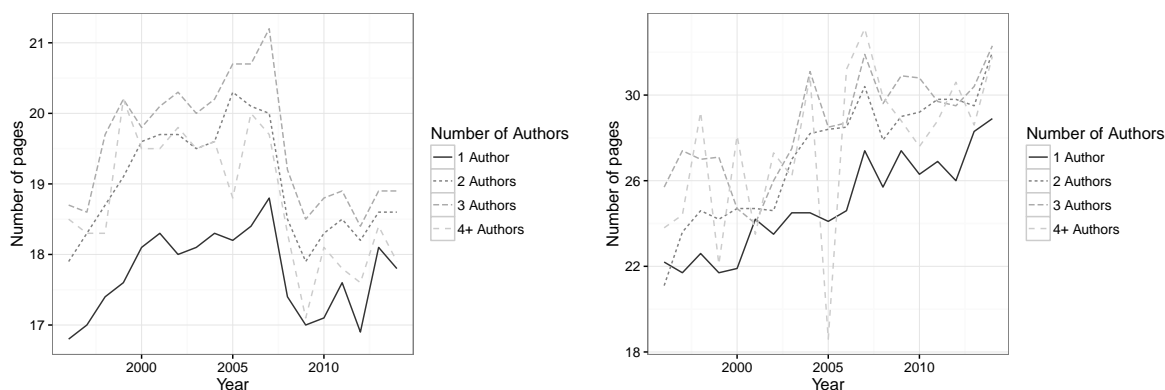
However, when this is adjusted to citations per author a very different picture emerges (6 a and b). As can be seen citations per article per author are much higher for single-authored papers and this one might argue is the better indicator of the contribution of an individual to the field. This is true no matter which category of journal is used. Given these facts the interesting question to be discussed later is how funding agencies and hiring/promotional bodies view co-authored versus single-authored papers.

Are journal articles getting longer and is there much variation by degree of co-authorship? Figure 5a illustrates that for the top 255 journals there was a significant rise in the number of pages per article up to the early 2000s but significant declines following this, with rises again in recent years. The pattern is very similar across all author types, with on balance no increase in the number of pages over the whole period regardless of author type. It is also noteworthy that the number of pages differs by just one to three pages across author types, differences which might be considered very small. This implies that the number of pages per author is much higher for solo-authored paper.

The picture with regard to the top 20 journals is different in some respects (Figure 5b). Overall there have been increases in the number of pages regardless of author type and by the end of the period there was almost no difference in length between duo, trio

<sup>7</sup>Co-authorship is a specific type of collaboration and its impact through peer effects on the quality of articles by top economists is examined in Kuld [2017].

Figure 5: Number of pages by number of authors



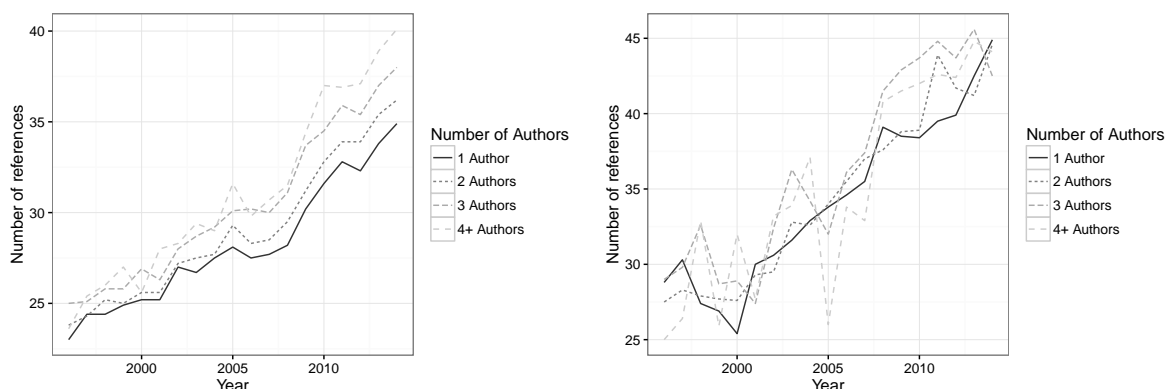
(a) Top 255 journals

(b) Top 20 journals

Notes: Means of number of pages of economic research articles published in a top 255 or in a top 20 journal as described in text. Source: Own calculations based on Scopus data.

and quarto authored papers. Hence the citations per author looked at above would not be counterbalanced by the fact that the article length for the multi-authored papers is much longer (see Card and DellaVigna [2013] and Card and DellaVigna [2014], for discussions of trends in article length, but not from a co-authorship perspective).

Figure 6: Number of references by number of authors



(a) Top 255 journals

(b) Top 20 journals

Notes: Means of number of references in economic research articles published in a top 255 or in a top 20 journal as described in text. Source: Own calculations based on Scopus data.

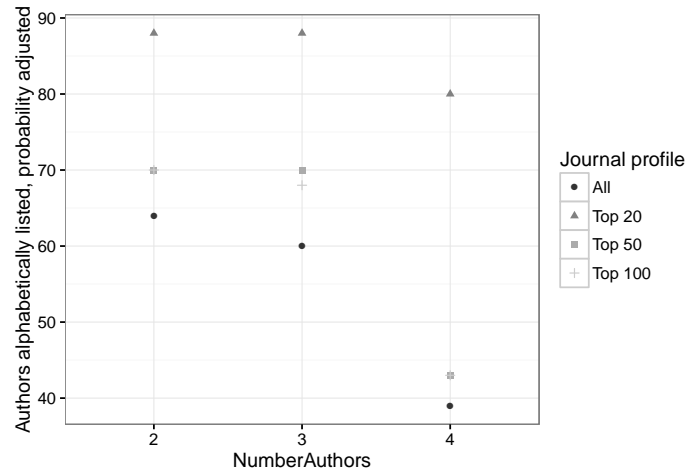
A related issue is the number of cited references by article type, the trends in which are outlined in Figures 6a and 6b. There has been a huge increase in the number of references, in a very short period, particularly in the trio and quarto-authored papers. For example, the number of references in the quarto-authored papers was around 23 with the number rising to over 40 by 2014. Similar increases are evident for the other categories in Figure 6a, with the average number of references for solo-authored papers rising from 22 to 35 in the same period. The other factor of interest in Figure 6a is that



the gap in number of references between solo and quart-authored papers was little more than five.

There were even more dramatic rises in the number of references in the top 20 journal articles (Figure NumRef20). For example, the number of references in trio-authored papers increased from around 26 to around 45, an eighty per cent increase in just fifteen years. The important thing to note though is that the number of references in the top journals vary very little by journal type. The other important finding is that the number of references is greater for all author categories in the top 20 journals compared to the top 255, by a factor of around a third on average.

Figure 7: Alphabetical ordering of author names, adjusted for random alphabetical ordering, according to journal profile

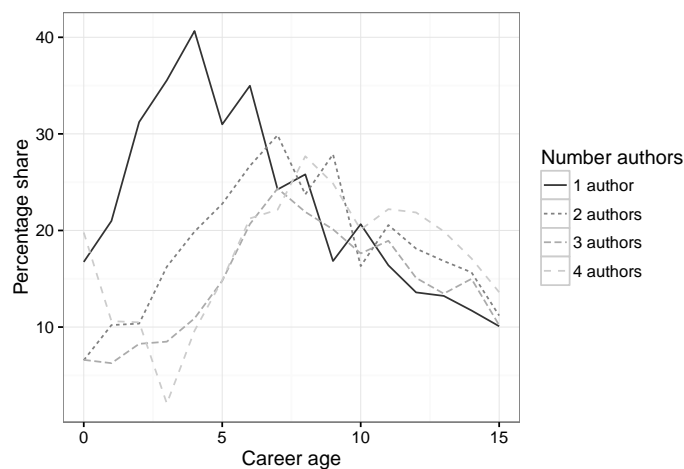


*Note:* Percentages of alphabetically listed authors by number of authors and journal category. Percentage adjusted for different probabilities for random alphabetical ordering between different author group sizes. *Source:* Own calculations based on Scopus data.

Another issue related to the later discussion is the alphabetical ordering of authors on the articles by author type. Figure 7 shows that there is a remarkably high proportion of articles using alphabetical ordering of names on the papers, adjusted for random alphabetical ordering. This is especially true the higher the rank of the journal. This would suggest that the contribution of each author is considered approximately equal. It is interesting to note that while over 30 per cent of double-authored papers have non-alphabetical name ordering, the figure is less than 10 ten per cent for top journals, implying that random ordering is probably much higher for the lower-ranked journals, again a picture that will be returned to later. Alphabetical ordering would suggest that there is less token adding of names of supervisors and/or researchers who made no significant contribution.

One final chart constructed to throw light on the phenomenon of the rise in co-authorship relates to the career profile of 133 highly cited economists who were awarded their Ph.D between 1996 and 1999, the data for which was discussed earlier. It is not clear though how representative this sample might be for other types of economists, but the trends are nonetheless instructive. Figure 8 plots the articles by author type for

Figure 8: Articles by number of authors by year following award of PhD, relative to authors in top 20 journals



*Note:* Number of articles by year following award of PhD, as percentage of the maximal possible number given published articles in top 20 journals with the same number of authors. The maximal possible number is the number of articles in the respective category multiplied by the category's number of authors. Based on 3,874 articles by 136 highly cited economists who were awarded their first PhD between 1996 and 1999. *Source:* Own calculations based on the authors' on-line CVs and Scopus data.

these 133 economists in the years following their PhD graduation, relative to the total number of articles published in top 20 journals. As can be seen in Figure 8, the relative number of solo-authored papers is highest in the first five years and thereafter declines steadily for the following ten years. Taking publications in top 20 journals in the respective years as the basis of comparison, the ratio of solo-authored to multi-authored articles declines over the career of the sample researchers. Seven years after the award of the PhD, this ratio is similar to the average ratio in top 20 journals.

## 4 Throwing light on explanatory hypotheses

The main hypotheses posited in the literature for the rise in co-authorship will be reviewed here and the extensive and detailed evidence from the charts above used in many cases to cast doubt on, or substantiate, some of the arguments. What is striking in relation to all of the following econometric studies is the very small number of journals used for the data. This made the testing of some of the hypotheses feasible but greatly reduced the general applicability of the results.

The earliest substantive paper perhaps to look at the phenomenon of the rise in co-authorship in the economics literature was McDowell and Michael [1983], but using just ten journals in their sample. Barnett et al. [1988] widened the discussion considerably, but using an even narrower data set, namely the AER alone. Their starting point is what they term the 'division of labour' hypothesis, very similar to the specialisation focus of the earlier McDowell and Michael [1983], paper and the later paper of Jones [2009], and put succinctly as follows.

Individuals engaged in economic research have found it increasingly possible (and, indeed, necessary) to specialize in more narrowly defined areas within the profession. As such specialization has proceeded, it has become increasingly necessary to combine the skills of two or more scholars in the conduct of research projects. For example, one who is highly skilled in the testing of hypotheses may find it attractive to collaborate with one skilled in generating hypotheses. Both, in turn, may find it attractive to combine their efforts with one skilled in collecting and organizing the data required to implement empirical tests. Thus, as specialization proceeds, we should expect to observe, over time, an increase in the incidence of co-authorship. (Barnett et al. [1988], p. 539)

Neither of these papers though looked at the breakdown of co-authorship between different numbers of co-authors. Besides they used very narrow data sets. Another strong argument is that the increasing emphasis on publication in refereed journals as a criterion for appointment and/or promotion. The days of books or chapters in books, or policy reports counting towards a person's research record have been it appears in decline since the 1970s and have been largely replaced by verifiable 'scientifically-ranked' journals and citation records. Barnett et al. [1988] argue that this allows less time to assist colleagues, the 'reward' of an acknowledgement or 'thank you' being replaced with the offer of co-authorship to elicit such assistance. This is their opportunity cost of time hypothesis. It is not clear though that if books and reports no longer count that the total demands on research time, and hence the opportunity cost of time, should have risen. Books and reports in many cases would have taken up a huge amount of research time, time now 'free' for journal article research and assistance to colleagues. Besides, Figure 7 suggests that there is very little token adding of names to an article, especially in the top-ranked journals, something that the very high proportion of articles with alphabetical ordering of names is not the case. Hence there is little evidence, if any, to sustain this argument, except perhaps in the much lower-ranked journals where less alphabetical ordering of names is evident, which might suggest the addition of names partly as a 'reward' for input rather than strict co-authorship.

A more convincing hypothesis relates to 'risk-aversion', which says it is better to spread your risks by submitting say four quarto-authored papers than one solo-authored paper. Given the hugely increased emphasis on journal article publication, such considerations would have assumed increasing importance over the time period studied, although again one might argue that this was the case well before 1996, the start year for the charts shown earlier. Barnett et al. [1988] argue that the variance and hence randomness of the process for assessing articles submitted has increased and hence so has the incentive to diversify through co-authorship. The key argument for this assertion is the huge increase in the number of journals and hence the difficulty of finding suitable editors and referees. The risk-aversion argument may have some appeal but to provide convincing evidence as to its validity is another matter. Besides, there is not even substantial reliable anecdotal evidence to back the assertion up in any systematic way. It is true that there has been a huge increase in the number of journals and articles submitted, but there has also been

a large increase in the number of economists upon which to draw on for editorial and refereeing purposes (see Osterloh and Frey [2014]), implying no increase in work-load per referee/editor.

Sauer [1988] tested the hypothesis of a higher return on co-authored papers but found that an individual's return from a co-authored paper with  $n$  authors is approximately  $1/n$  times that of a single-authored paper. One wonders would that be the case today. From anecdotal evidence it appears that the return on a co-authored paper today might be considerably more than  $1/n$  times that of a solo-authored paper, which in itself would be a very strong argument for the rise of co-authorship.<sup>8</sup> Figures 3a to refcitAuth20 throw considerable light on this issue. Citations per article are highest for co-authored papers and if there is no discounting for co-authorship then clearly the return on co-authored papers is higher. However, as seen earlier, citations per paper per author are much higher for single-authored papers, which leads one to wonder again why there is not full discounting by hiring, promotional and funding bodies with regard to the number of authors. If not of course and everyone changes their responses to this new reality, then it will eventually be self-cancelling.

It is likely that the more cross-country the co-authorship the more likely is the chance that there is no discounting of multi-authored papers (see later) and as seen in Figure 2 there have been very large increases in co-authorship across countries, both in absolute and relative terms. This really is a key issue in relation to the phenomenon of the huge rise in co-authorship in economics. Medoff [2003] examines the widely held, but untested, belief that researchers who collaborate produce higher quality research than those who are sole-authors. Like for the other articles he used a small number of journals, eight in this case. The empirical results he argues show that, controlling for article length, journal and author quality, and subject area, collaboration does not result in significantly higher quality research (as measured by the number of citations an article receives) in economics. Figures 3a and 3b would tend not to confirm this, as the citations per article as shown there are higher the more co-authors and this is true whether or not the top 255 or top 20 journal articles are used. Adjusting further for article length (see Figures 5a and 5b) would not appear to alter this conclusion. The key question though is it citations per article or citations per author which matters. And if there are more citations for co-authored articles, which there are, does the small increase in citations compensate for the fact that it took three to four authors, rather than one, to effect this increase?

Rosenblat and Mobius [2004] argue that advances in communication and transportation technologies have the potential to bring people closer together and create a "global village" and hence more collaborative work. They develop a model which they test by looking at the evolution of academic co-authoring between 1969 and 1999. Several new technologies decreased the cost of communication substantially starting around 1980. First fax technology became ubiquitous in the 1980s: second, emailing and file transfer

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<sup>8</sup>Hollis [2001] also addressed this topic in some detail. His work shows that while for most economists collaboration appears to increase the frequency, quality and length of publications, it actually leads to lower total output per author after discounting for the number of authors, although he outlines several caveats applying to this conclusion.

through FTP was common by the beginning of the 1990s; third and perhaps most importantly, the rise of the Internet in the 1990s made it dramatically easier to publish and search for working papers.<sup>9</sup> Moreover, deregulation of the US airline and telephone industries in the 1980s drastically decreased the cost of traveling and making long distance telephone calls. Their data set contains 8,838 authors of whom 6,201 authors published at least one co-authored papers. It is possible though that this simply altered the nature of the co-authorship rather than the quantities of articles co-authored. A wider network from which to choose should change the pattern of co-authorship but should it also increase the incidence of co-authorship? The evidence in relation to co-authorship across countries and in relation to the huge rise in the number of citations would tend to support the argument that technology and transport costs may have been key factors (see Figures 2,6a and 6b).<sup>10</sup>

Jones [2009] took up the division of labour argument also, but applied in this case to scientists and engineers. His starting point is that while physical stocks can be transferred easily, as property rights, from one agent to another, human capital, by contrast, is not transferred easily. The vessel of human capital-the individual-is born with little knowledge and absorbs information at a limited rate, so that training occupies a significant portion of the life cycle. Moreover, if innovation increases the stock of knowledge, then the educational burden on successive cohorts of innovators may increase. Innovators might confront this difficulty through two basic channels. First, they may choose to learn more. Second, they might compensate by choosing narrower expertise. Choosing to learn more will leave less time in the life cycle for innovation. Narrowing expertise, meanwhile, can reduce individual capabilities and force innovators to work in teams, namely be involved eventually in co-authored patents or in the case of economics co-authored journal articles. His empirical work looks at three issues resulting from what he calls the 'burden of knowledge and death of Renaissance man', namely team size, date of first innovation and specialisation.

This though has limited application in economics and besides there is no evidence as seen earlier, as one might expect, that the higher-ranked journals as a result have had

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<sup>9</sup>Agrawal and Goldfarb [2008] examined the effect of a decrease in collaboration costs resulting from the adoption of Bitnet (an early version of the Internet) on university research collaboration in engineering, their interest being the broader question of how changes in collaboration costs may affect the structure of knowledge production. They examined 270 universities that published in seven top electrical engineering journals from 1981 to 1991 and found that a Bitnet connection did seem to facilitate a general increase in multi-institutional collaboration (by 40 percent, on average). Catalini et al. [2016] built on the explanation that links the increase in co-authorship to the drastic reduction in communication costs brought by the internet: as coordination and communication costs go down, scientists are able to sustain collaboration over distance in a more efficient way. In this paper, they test a complementary hypothesis: that the increase in distant collaboration may also be the result of the dramatic reduction in air travel costs that took place within the United States over the last 30 years.

<sup>10</sup>The focus of Fafchamps et al. [2010] was linking the extent of co-authorship to networks. The stronger the networks the greater the degree of co-authorship. They also note though that networks maybe are not as important in determining co-authorship given the greatly increased access to the web. They also address a potential problem, namely the time between when collaboration commenced and when it is noted, namely in a publications.

a greater level and increase in co-authorship over time. In fact the opposite seems to be the case on the basis of the evidence outlined in Figure 1b. It is true though that there has been an increase in length of article in the top journals (Figures 5a and 5b), and a huge increase in the number of references (Figures 6a and 6b) and perhaps these could be partly due to the factors above. However, Figure 8 appears to go against the argument of Jones, when applied to economics, as there is a much higher incidence of solo-authored articles in the five years following PhD graduation than later years. One would expect that the need for group work is most pressing after graduation, especially given the risk-averse arguments outlined earlier, which could suggest an emphasis on co-authorship until tenure is attained. It is possible of course that hiring agencies put a huge emphasis initially on solo-authored papers, especially for young researchers, perhaps to dispel any doubts about the contribution of the recent PhD graduate. But as Figure 7 highlighted, there is little evidence of the 'token' addition of names to journal articles. And why would such a large emphasis be put on solo-authored papers only when hiring and not for promotions and research funding also?

Hamermesh [2013] in a broad overview mused about possible broad explanations for the rise of co-authorship. He also examines the issue of multiple authors, one of the first to do so in economics and argues that co-authorship can be more fun, but why should this have increased over time, and he also refers to the increased opportunity cost of time in the 'rat race' to publish more and more journal articles. In this situation as noted by others already, the 'price' of getting feedback on your work might be the offer of co-authorship. Again though the very high incidence of alphabetical ordering of names would not suggest this to be the case (Figure 7). Ossenblok et al. [2014] analyse co-authorship patterns in the social sciences and humanities (SSH) for the period 2000 to 2010. The basis for the analysis is the Flemish Academic Bibliographic Database for the Social Sciences and Humanities (VABB-SHW). Two interesting things in this study are the following. The first is to suggest that the incentives for co-authorship have changed. Output-based research funding offers researchers one of the most directly tangible publication incentives. Particularly relevant for their case is the fact that the Flemish performance-based research-funding system, actively encourages co-authorship through its use of whole counts (i.e., giving each institution full credit for an article that bears its name and address). This is opposed to systems that use fractional counts (i.e., counting an article as a single unit and fractionalizing the publication credit). They do not indicate though how this might have changed in Flanders or indeed anywhere else, but yet it could be a vital factor, not only in research funding but in global ranking of departments/universities and hence for hiring and promotion. If by adding another person benefits him/her and takes nothing away from you, it is clear that there will be a huge incentive to be involved with co-authored papers, the more authors the better.

Henriksen [2016] examines the rise in co-authorship in the social sciences over a 34-year period. The paper investigates the development in co-authorship in different research fields and discusses how the methodological differences in these research fields together with changes in academia affect the tendency to co-author articles. The study is based on bibliographic data about 4.5 million peer-reviewed articles published in the period 1980-2013 and indexed in the 56 subject categories of the Web of Science's Social Science

Citation Index. The results show a rise in the average number of authors, share of co-authored and international co-authored articles in the majority of the subject categories. However, the results also show that there are great disciplinary differences in the extent of the rises in co-authorship. The subject categories with a great share of international co-authored articles have generally experienced an increase in co-authorship, but increasing international collaboration is not the only factor influencing the rise in co-authorship. Hence, the most substantial rises have occurred in subject categories, where the research often is based on the use of experiments, large data set, statistical methods and/or team production models. This then provides more descriptive evidence for the Barnett et al. [1988] and Jones [2009] hypotheses, but again with little apparent applicability to economics.

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The dramatic rise in multi-authored papers in economics as outlined in Section 2 is at the very minimum of interest to economists. Explaining these trends is a different matter. As always in economics, several different factors are at work simultaneously and despite claims to the contrary, holding for fixed effects and using other techniques, simply cannot overcome the reality that when variables are all moving together it is impossible to separate the effects. A related problem is that many of the key variables cannot be measured and hence have to be excluded from the formal regression analysis. This is particularly the case given the huge variety of factors posited for the trends in co-authorship in science over the last forty years. How for example could you measure the changes, if any, in hiring practices with regard to the emphasis placed on single and co-authored papers? How do you measure the risk-taking hypothesis mentioned above, except perhaps through case studies of academic economists?

Perhaps the most plausible hypothesis relates to increased use of large data sets in economics and the varying skills required to bring the work so resulting to fruition. But is this really the case with large on-line data sets and the availability of modern day computing to analyse these data?<sup>12</sup> The evidence on this is mixed, at least for economics, with Figures 1 a and b suggesting much less change in co-authorship in the top journals, compared to the less highly ranked journals, contrary to what one might expect based on the complexity and hence division of labour focus of modern-day economics research.

What is needed more perhaps is more evidence on hiring, promotional and funding decisions with regard to solo versus multi-authored papers. The patchy evidence would seem to suggest that there is very limited discounting of a published article by number of co-authors. If this has increased over time then perhaps a key part of the explanation may be found here. It is not clear also that the 'publish or perish' phenomenon has increased over the period in question, except perhaps in Europe. This would then suggest that the risk-sharing argument might have considerable validity, but again only if articles are not fully discounted for number of authors.<sup>13</sup> The final explanation with

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<sup>11</sup>Concluding Comments

<sup>12</sup>You could argue that data analysis was much more time-consuming in the past, although much less sophisticated.

<sup>13</sup>See Osterloh and Frey [2014] for a general discussion on the use of citations and rankings in economics, in particular the randomness of some of the reviewing processes. Even if this always existed to a

some validity is the increased ease and cheapness of Internet and Skype contact, plus greatly reduced cost of travel, has opened up greater possibilities for collaboration. It is in relation to these factors that the most substantial evidence has been provided, but this may simply arise from the fact that these are easier to measure. As noted earlier, it is possible also to argue that while a wider network from which to choose should change the pattern of co-authorship should it also increase the incidence of co-authorship?

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certain extent, the non-discounting of multi-authored papers would mean that the latter would be a very useful way of countering this randomness without any loss of individual/institutional ranking.



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