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Travelling in the Social Science Community: Assessing the Impact of the Indian Green Revolution Across Disciplines

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Travelling in the social science community: assessing the impact of the Indian Green Revolution across disciplines[1]

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Abstract

The Indian Green Revolution, which began in the late 1960s, offers an exemplary case for studying the nature of evidence and how it travels between academia and the public sphere, between different academic disciplines and over time. Initial assessments of the Green Revolution's effects were generally positive; yet by the mid-1970s, a more negative view of its impact had come to prominence. By the 1990s this view was, in turn, being displaced by a more optimistic one. The aim of this paper is not to evaluate the impact of the Indian Green Revolution, but rather to examine how the different constituencies of the social science community have communicated with one another on this topic and to examine what facts about it have travelled over time and between the different social science disciplines. By their very nature different social science disciplines are concerned with different aspects of any given issue: an economist might be interested in the impact on output and income over time, whilst a sociologist might be more concerned with the impact new technology has on existing social relations, and a geographer on the use of land and water. Through an in-depth analysis of 76 articles published between 1969 and 2004 in journals covering the range of social science disciplines, this paper shows how (and how well) facts travel between the social sciences.

NB: Figures, tables, and references can be found in the appendix

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> "the optimism of the early years of the Green Revolution has not proved to be well founded" (Ahmad, 1972, p.11)
>
> The high yielding varieties of crops which are at the heart of the Green Revolution are "a greater force for change than any technology or ideology ever introduced into the poor countries" (Blyn, 1979, p.89)
>
> "the new technology intertwined with the lack of infrastructure, lack of education inputs, lack of provision of equal opportunities for credit, along with the existence of wide disparities, has mainly favoured rich farmers" (Bowonder, 1979, p.312)
>
> "the gains [of the Green Revolution] have been real in both ecological and economic terms … [and] have been accompanied by increased equity and political stability" (Leaf, 1983, p.268)
>
> "the prevalence of such symptoms as salinisation, erosion, water-logging, ground-water depletion and pollution, including pollution from inorganic (and hazardous) fertiliser and pesticides, has had a significant negative impact on the economic system and its inhabitants" (Sharma, 1997, p.275)

The Indian Green Revolution, which began in the late 1960s, offers an interesting, if complex, example about the nature of evidence and how it travels between academia and the public sphere, between different academic disciplines and over time. At its heart lay the adoption of High Yielding Varieties of wheat and rice, but it also encompassed the greater use of fertilisers, pesticides and irrigation and the adoption of other new agricultural techniques and technologies.[3] However, the speed of adoption of the new techniques, their diffusion (geographically, economically and socially), and their impact (on production, productivity, income distribution, the labour market, the environment, etc) have all been the subject of academic controversy, as the quotes above, which

[3] For a more detailed discussion of the origins of the GR and its course in India see: Brown, 1970; Frankel, 1978; Balasubramanyam, 1984, ch.5; Byres, 1989; Tomlinson, 1993, pp.206-10.

come from different social science journals over the last three decades, illustrate. Beyond the normal academic disputation that is to be associated with any topic, there are two broad reasons for these disparate views of the social science community, one disciplinary in nature and the other temporal. By their very nature different social science disciplines are concerned with different aspects of any given issue: an economist might be interested in the impact the Green Revolution has on output and income over time whilst a sociologist might be more concerned with the impact the introduction of new technology has on existing social relations and a geographer may analyse how it affects the use of land and water and its potential environmental impact. Also, the impact of something as broad as the Green Revolution might change over time – perhaps because the long term effects are different from the short or medium term effects; or because it is not a static process either in terms of its implementation or effects; or in terms of how the economy, society, or individuals respond to it. The latter is possibly best illustrated by how, in broad terms, the impact of the Indian Green Revolution has been assessed by economists. After its introduction in the mid-1960s, the initial assessments were generally positive, as high yielding varieties of crops were taken up and their output increased. However, by the mid-1970s, a more negative view of its impact had come to prominence: as one of the quotes above suggests, the new crops and other associated innovations were primarily taken up by rich farmers and were concentrated geographically in the north-west of the sub-continent. The reasons for this were complex, but primarily related to risk. Although the new crops *did* have a higher yield (and therefore generated a higher income) than traditional crops, they were more prone to disease and required more water and fertiliser than traditional crops – and this combination of higher risk and greater need for capital deterred poorer farmers from adopting the new crops. By the 1990s this view was, in turn, being

displaced by a more optimistic one: it was argued that over time there was a demonstration effect in that poorer farmers were able to see that despite the higher risks and capital input associated with the new crops they did yield an income stream that was better than that provided by more traditional crops. This, combined with improvements in the capital market and with various schemes of support from the state, led to wider and deeper uptake of the new crops. However, it is not clear that this is the end of the story: more recently, economists have become concerned about the negative macroeconomic costs associated with the environmental impact of the new crops, for example in terms of the impact of the massive increase in fertiliser usage.

The aim of this paper is not to evaluate the impact of the Indian Green Revolution but rather to examine how the different constituencies of the social science community have communicated with one another on this topic and to examine what facts about it have travelled over time and between the different social science disciplines. This will be done through an in-depth analysis of 76 articles published between 1969 and 2004 in journals covering the range of social science disciplines. Initially, travelling is assessed in a relatively traditional citation analysis mode, first considering intra-sample journal citations before moving on to consider all journal citations. To examine travelling between the different social science disciplines, use is made of the headings employed for all journals by the *Social Science Citations Index* (*SSCI*).[4] The final section if the paper considers what travels with the citation, in particular our concern is with whether the citation carries some form of fact and whether the type of fact carried differs across the different social science disciplines. One important issue to emerge from the analysis in general is the importance of communication spaces, spaces which are not owned by one particular discipline but which are designed

[4] The *SSCI* is complied by Thomson Scientific. It was accessed online via the *The ISI Web of Knowledge Service for UK Education* **(**http://wok.mimas.ac).

to be areas where multi- and inter-disciplinary, communication is encouraged. These spaces may be journals or may themselves be classified as a "discipline," such as Area Studies.

The Sample

This study is concerned only with traveling facts within journal articles and as such ignores the importance of books, edited volumes, and conference proceedings to debates about the Indian Green Revolution. This decision was taken because by concentrating on journals the analysis is made more transparent and manageable, in terms of deciding on the sample, in terms of classifying material by discipline, and in terms of the citation analysis. However, if there is a disciplinary bias in terms of how important journal articles are to this particular debate, or indeed in general, this will affect the interpretation of some of what follows.[5] The sample was compiled in late November and early December 2005. Four major databases were used to search for articles: the International Bibliography of Social Sciences, JSTOR, PCI Full Text and the catalogue of the London School of Economics (LSE) library (the British Library of Political and Economic Science).[6] The parameters used for the search were "Green Revolution" within the title, abstract, keyword and/or subject fields. No geographic restriction was placed at this stage. Nor was there any restriction by academic subject, although the focus of the search was clearly on journals dealing with social science subjects. The initial search results, both titles and abstracts, were scanned for geographic focus and wherever these revealed that the focus was clearly not on India, Punjab, South-Asia or Asia including

[5] In particular, given that "books often reach wider and more diverse audiences than the specialised contents of professional periodicals" (Rigney and Barnes, 1980, pp.115-6) this approach will under-estimate the interdisciplinary or cross disciplinary dimension of the debate.

[6] Although the *SSCI* is used in the analysis below, it was felt that the initial selection of sample articles should not also rely on this as a source choice. For a critical assessment of the *SSCI* see Klein with Chang, 2004.

the subcontinent, those articles were removed from the sample. The remaining articles were then reviewed and a second round of winnowing occurred: this time articles that were not, despite their title or abstract, focused on the Green Revolution, or articles which paid little or no attention to India, or were not in English were removed from the sample. Finally, articles in Indian journals were removed from the sample. The first reason for doing this is that the although the search procedure captured articles from journals such as the *Indian Journal of Agricultural Economics* and the *Indian Journal of Economics*, as well as *Economic and Political Weekly*, an examination of these publications (not surprisingly) revealed that they contained far more than the dozen or so articles the search procedure had yielded. In effect, the search procedure had captured articles used in teaching at the LSE. If all the relevant articles published in the Indian journals were included in the sample they would completely dominate it. Furthermore, an examination of the references in the Indian journal articles captured by the search procedure revealed that they rarely cited the non-Indian journal articles in the sample (this is what will be characterized below as a “ghetto”). Thus, the Indian journals in many ways do provide a richer, and certainly more plentiful, account of the Green Revolution in their country but they do so in a relatively insular manner. Including relevant articles from them in the sample would unbalance it in a way that would not be helpful in terms of our aims; a more appropriate course of action would be to do a similar but separate study based on them alone. Having said that, the analysis will pay special attention to the role that certain Indian journals play in the citations of the sample articles.

This process left a sample of 76 articles, which are specially denoted in the reference list at the end of the paper, covering the period 1969 to 2004: 30 were published between 1969 and 1979, 15 in

the1980s, 23 in the 1990s, and 8 between 2000 and 2004.[7] The articles were distributed across 44 different journals and table 1 shows the number of articles by journal. Given the importance of the Indian Green Revolution the size of the sample was surprisingly small. In part, this might reflect that a large part of the academic debate takes place in books rather than articles but it may also reflect the search criteria as there are undoubtedly articles which deal with this topic but which do not use the term “Green Revolution” in their title or mention it in their abstract.

Intra-sample citations

The first question that can be asked is did articles in the sample cite each other? This would be the most basic evidence of travelling as a citation suggests that the citing article is taking something from the article being cited - what travels with the citation will be discussed below. If there were no intra-sample citations, all of which are concerned with the Green Revolution in India, it would be a depressing comment on the nature of academic dialogue. Fortunately, table 2 shows that dialogue, or travelling, did occur. Excluding self-citations, there were 49 intra-sample citations which encompassed 27 of the sample articles (36%); including self-citations raises the total to 61 citations, covering 33 articles (43%). The articles that make the most intra-sample citations are spread throughout the period, the earliest being Franke from 1974 and the latest being Das from 2002. In contrast, the three most cited intra-sample articles are the three oldest articles in the sample and the Cleaver articles is also an article elder, dating from 1972. Another contrast is that whereas the articles making the most intra-sample citations are spread across a range of social science journals, although it is noteworthy than none are pure economics journals, three of the most cited intra-sample articles are from political

[7] Appendix 1 shows the annual breakdown.

science journals, although the most cited, Falcon, is from an economics journal.[8] The latter also generally show great longevity: the most recent citation of Falcon in the sample occurred in 1989, 19 years after its publication, whilst the most recent citations to Cleaver and Wharton were, respectively, 23 and 26 years after their publication.

The intra-sample citation analysis can be taken a step further by utilising a "listening citation tree." This has some similarity to family trees as it traces a citation hereditary map; it takes a particular article and shows all the other articles in the sample that it cited and then it takes each of those articles in turn and repeats the process, and so on. It is called a listening citation tree because it shows which articles are formally acknowledged as having been listened to by the parent article in its construction. The listening tree is a top down process; in contrast the "talking citation tree" is a bottom up process which asks which other articles a particular article talks to. Thus, the talking citation tree takes a particular article and shows all the other articles in the sample that cite it and then it takes each of those articles in turn and repeats the process. Figures 1 and 2 provide an example of a talking citation tree whilst figure 3 shows an example of a talking citation tree. Two other things to note about reading these citation trees: bold text indicates a self-citation and a boxed citation indicates a dead-end, that the boxed article has no reference to any other article in the sample.

Figure 1 shows the listening citation tree for the article by Das from 2002; this was chosen because table 2 showed it to be the article that made the most intra-sample citations. It is very interesting and revealing, not least because it shows that the debate about the Indian Green Revolution can be traced from one of the most recent articles in the sample back to the three earliest articles in the sample. This

[8] The title of the Falcon article is: "The Green Revolution: Generations of Problems" which is provocative and may explain its popularity. Also, although it was published in an economics journal it is deliberately non-technical, there is no model, no theory and very little data, and instead provides a broad overview.

suggests that there was some form of long-term temporal travelling in this debate. The longest chain of citations has 8 levels, from Das 2002, through to Yapa 1993 and then all the way down to Wharton 1969. Furthermore, it was noted above that the intra-sample citations, including self-citations, encompassed 33 articles and of the 32 articles that Das 2002 might have been connected to figure 1 encompasses 19 (or 59%) of them. Another impressive feature of figure 1 is that the articles range across the social science community: the Das paper is in a geography journal, but the other articles encompass area studies, anthropology, development studies, economics and political science. Another feature to note in figure 1 are the dead-ends: the lack of intra-sample references by the two earliest articles requires no comment but the other two dead ends are interesting. Neither Corta and Venkateshwarlu 1999 nor Gill 1994 has any citations to other articles in the sample. Furthermore, both are anthropology articles and the only other anthropology article in figure 1 is Bhalla 1999, whose only intra-sample citation is to Gill 1994. This is a striking outcome and suggests that, at least in the context of figure 1, anthropology is a "ghetto," a discipline which although discussed by the rest of the social science community does not itself reach out to that wider community.[9] Overall figure 1 provides some initial evidence that in terms of the Indian Green Revolution the academic debate has both temporal length and disciplinary breadth. What that means – in terms of what was travelling over time or across disciplinary divides, in particular what facts, if any,

[9] At first this reflection regarding anthropology contradicts the more general view provided by Rigney and Barnes in their 1980 study: "True to its calling as a holistic discipline, anthropology has been among the most interdisciplinary of the social sciences, with close citation ties to the periodicals in general science (e.g., *Science* and *Nature*), sociology, biology, history and linguistics, and weaker ties to medicine, psychology and the arts" (p.120). However, this observation is based on their analysis of *American Anthropologist* between 1936 and 1975(table 3, p.121) and this also reveals that social science disciplines central to our analysis such as economics, political science and geography, accounted for less than 1% of the citations in that journal.

about the Green Revolution were travelling and, if they did travel, how *well* did they travel – will be investigated below.

Of course, many of the articles in the sample do not listen or talk to other articles in the sample. Also, some of the listening is self-referential. Figure 2 shows the listening citation tree for Foster and Rosenzweig 2004 and is an example of a listening citation tree which is entirely self-referential; all four articles in the tree are also in economics journals. The listening citation trees for all the other articles in the sample which make intra-sample citations are either embedded within figure 1 or have relatively short chains, in that most only have one or two levels of citations. Similarly many of the talking citation trees also have relatively small chains of one or two levels; those that were longer were embedded in figure 3. Figure 3 is the talking citation tree for Falcon 1970, chosen because it was the most cited article in the intra-sample citations. Figure 1 showed that Das 2002 was linked to Falcon 1970 and so it is not surprising that much of article coverage in figures 1 and 3 is similar, in terms of number of articles covered (17 in figure 3 compared to 19 in figure 1) and in terms of their temporal and disciplinary breadth. Figure 3 has been organised so that the right and left side of the figure show where it differs from figure 1: the chains in all these cases (which end with Ahmad 1972, Dhanagare 1988 and Corbridge 1997) are short.

General sample citations

The analysis of the intra-sample citations gives a narrow perspective on the dialogue between the social sciences, which is one of our main points of interest. Thus, the analysis was extended to look at citations in the sample articles to journal articles more broadly. However, a constraint was placed on the journals that would be considered, and the reason for this will be explained more fully below: the analysis of general citations was limited to those journals that were listed in the

SSCI for 2006, plus 11 non-*SSCI* journals which were already in the sample. The sample articles also cited heavily two Indian publications, neither of which was in the *SSCI* list of journals, and so citations to them were also noted. The *Indian Journal of Agricultural Economics* played a particular and important role in this literature and citations to it are included in the analysis. On the other hand, the *Economic & Political Weekly* is not an academic journal per se, although it does publish serious articles by academics, but plays a special role in the intellectual life of India being a forum where important economic, political and social issues are discussed by academics, politicians and business; as such, citations to it were noted but not included in the main analysis. In total there were 235 citations to the *Economic & Political Weekly*, with 38 of 76 sample articles including at least 1 *Economic & Political Weekly* citation.

In total the sample articles had 744 citations to journal articles, excluding the *Economic & Political Weekly*. Limiting the citations included for analysis on the basis set out above yielded 518 different citations (70% of the total number of journal citations), spread across 102 journals.[10] There were 14 sample articles which provided no countable citations but these exhibited no discernable pattern, except perhaps that there has a bias towards the early part of the sample period (half of them were published before 1976 and only two were published after 1990).[11] It is the 518 citations that the rest of the analysis will concentrate on. Table 3 provides a list of the 15 most cited journals; these 15 journals account for 326, or almost two-thirds, of the total citations. The first thing to note is that the *Indian Journal of Agricultural Economics* is third on the list, with 36 citations (6.9% of the total) which provides a justification for including it in the analysis. Table

[10] The sample articles were spread over 44 journals and thus these journals accounted for 43% of the journals covered by the general citations.
[11] It should be noted that all but 3 of the 14 articles had some form of journal citation that was not counted, and 6 had at least one *Economic and Political Weekly* citation.

3 also suggests that this is a literature which, in terms of journal articles, economics has been to the fore.

Defining social science disciplines and categories

One of our aims is to assess to what extent the influence on the sample articles was cross-disciplinary, to examine the extent of travelling between social science disciplines: for example, did economists listen to sociologists and anthropologists and political scientists in writing their articles? In order to do this we first need to decide on a way of categorising journals by the discipline(s) they are aimed at. Rather than impose my own subjective categories, it was decided to use, with some minor adjustments, a disciplinary categorisation that is well-known, that employed by the *SSCI*; indeed this was a major reason for utilising *SSCI*-listed journals in the citation analysis.[12] Some minor adjustments were made to the *SSCI* categories: the disciplinary name used by the *SSCI* was occasionally amended and sometimes categories were merged, for example, the *SSCI* categories "International Relations" and "Political Science" were merged into a single "Political Science" category. An additional layer of complexity in the *SSCI* scheme, but one which is from our perspective a strength of the scheme, is that many journals do not fit neatly into one single disciplinary category and indeed many have an explicit aim to appeal across such disciplinary boundaries. Thus, the *SSCI* often classifies journals under two or even three different disciplinary headings; for example, the journal *Economic Development and Cultural Change* is classified by the *SSCI* as "Area Studies," "Development Studies" and "Economics" whereas the *American Sociological Review* is simply classified under "Sociology." The use of multiple headings explicitly recognises that there some journals are specifically created to act as intra-disciplinary

[12] The 12 non-*SSCI* journals included in the analysis were provided with disciplinary categories that corresponded to the *SSCI* categories, largely based on their own description of their remit or audience.

communication spaces where social scientists from different disciplines can talk; this should aid the travelling of "facts" between the different disciplines, which is presumably important when the topic being investigated is, like the Indian Green Revolution, one whose very nature, in origin, implementation and effects, ranges across the concerns of the whole of the social science community.[13]

To help simplify the discussion below this study thus allocates all journals, and hence citations, to a **category** based on the *SSCI* headings. Therefore a category can refer to more than one social science discipline; hence *Economic Development and Cultural Change* belongs to the category "Area Studies – Development Studies – Economics" and *American Sociological Review* belongs to the category "Sociology." In terms of disciplinary analysis, the question then becomes how we treat journals whose category covers more than one discipline. The path chosen here is to treat them as truly having a cross-disciplinary reach: thus whereas the *American Sociological Review* will be treated as if its reach is only to sociologists, *Economic Development and Cultural Change* will be treated as if it does reach three different disciplines. Thus, when the analysis operates at the level of the social science discipline a reference to an article in the *American Sociological Review* will register only once, in Sociology, just as it registers only once at the category level. However, a reference to an article in *Economic Development and Cultural Change* will register three times, once in each of the disciplines of Area Studies, Development Studies and Economics, whereas it only registers once at the category level. Therefore, in this analysis a **discipline** is defined as the summation of all separate headings; given that this process involves for some citations multiple counting the sum of "citations" in the disciplinary

[13] These communication spaces share something in common with Campbell's (1969) "fish-scale model of omniscience" "wherein new specialties are created to overlap with existing specialties in order to provide comprehensive coverage of the known world" (Rigney and Barnes, 1980, p.126).

analysis will exceed 518, in fact the total is 703. Finally, another term that will be utilised below is **mono category**. There is obviously for each discipline, a category which is the same as the discipline (that is, many journals, such as the *American Sociological Review* are only denoted under one heading by the *SSCI*) – such a category will be termed a mono category. To summarise the terminology used below: a **category** reflects the headings provided by the *SSCI* for each journal and may be **mono categories**, where only one heading (say, “Sociology”) is given, or may involve multiple headings, such as “Area Studies – Development Studies – Economics”; the citation count for a social science **discipline** is the summation of all relevant category citations, and may involve the multiple counting of a citation where the relevant journal is not a mono category.

Table 4 shows the distribution of the sample articles by category and by discipline. In terms of categories, the table shows that most of the categories which have more than one article are mono categories, and indeed overall mono categories account for two-thirds of all categories. It also shows that economics is well represented in that its mono category accounts for the second highest number of sample articles and that it is also part of the third and fourth most popular categories. This feeds though to the ranking by discipline shown in the bottom part of table 4: economics is the highest ranked discipline. In general the distribution of the sample articles by discipline is very uneven, with the top three disciplines accounting for almost two-thirds of the total whilst the share of the bottom six disciplines is less than 10%. There is also a noticeable gap between Economics (on 27.5%) and Area Studies (19.3%) and Development Studies (18.3%), and a similar gap between them and the next two disciplines, Geography and Political Science (both on 8.3%). It is also worth noting that the second and third highest ranked disciplines are not necessarily what we would think of as traditional disciplines but are communities that do exist in most social

science schools as departments or institutes – Area Studies and Development Studies. What is interesting about both is that they are another example of communication spaces that are explicitly intra-disciplinary or even multi-disciplinary in that they do typically contain social scientists from several of the traditional social science disciplines, and indeed Area Studies departments often also include specialists from the humanities. So as well as journals that are explicitly trying to act as communication spaces between different social scientists, there are also "disciplines" (in terms of the *SSCI* classification, and in terms of how the term is used here) that are communication spaces. Thus, it does seem that a significant part of the social science community recognises that its various disciplines should not live in isolation, that most issues of concern to the social scientist do cross disciplinary boundaries.

Citation analysis by category and discipline

Table 5 shows the distribution of citations by category and discipline, for those categories or disciplines that account for at least 1% of the total number of citations. The total number of categories covered by the citations is 39, which is almost double the number of categories covered by the sample articles; another indication, if not a surprising one, that travelling does occur within the social sciences. The most striking feature table 5 in terms of category distribution is the dominance of the mono category "Economics," which accounts for an astonishing 38.2% of all citations. This strongly suggests that within the debate on the Indian Green Revolution, or at least within the constraints of that debate analysed here, economics is the discipline that is listened to most within the social science community. This conclusion is further emphasised when it is remembered that table 4 showed that the "Economics" category only accounted for 14.5% of the sample articles and therefore its citation share is almost three times this. Interestingly, the other

categories where the share of citations is greater than their share of the sample articles are also mono categories, “Anthropology” (7.7% vs. 3.9%), “Sociology” (4.2% vs. 1.3%) and “Development Studies” (1.9% vs. 1.3%). However, it should also be noted that another mono category, “Area Studies” does particularly poorly in terms of “under-representation” (4.5% vs. 17.1%).

Turning to disciplines, it is no surprise to see that table 5 shows that “Economics” is the dominant discipline in terms of citations with 45.8% of the total, which is more than three times the share of the next discipline, “Development Studies” (13.7%). “Development Studies,” in turn, has nearly twice the citation share of the next discipline, “Area Studies” (7.8%), which is followed by disciplines that have shares of between 4% and 6% (“Anthropology,” “Geography,” “Social Science Interdisciplinary,” “Political Science,” “Sociology”). Comparing the distribution of discipline citations to the distribution of sample articles by discipline those disciplines which received a higher proportion of references relative to their share of the sample articles were: “Economics” (whose share of citations was 1.67 times its share of sample articles), “Anthropology” (1.65), “Sociology” (1.57), and “History” (1.11).[14] Amongst those that were “under-represented” in these terms were both “Area Studies” (0.41) and “Development Studies” (0.75). If we believe that citations are one means by which facts can travel within the social science community this, admittedly rather basic, analysis could be taken to suggest that whilst the existence of communication spaces like Area Studies and Development Studies is important, when it comes to travelling those facts, or citations, that come from the traditional

[14] “Social Science Interdisciplinary” (SSI) had a 5% share of citations but only accounted for 1.2% of the sample articles. One potential issue with the discipline count for “SSI” is that some of the journals captured could easily be re-classified; for example, half of the “SSI” discipline citations are accounted for by citations to the journal *Econometrica* which comes under the category “Econ - SSI” but could just as easily be classified simply as “Econ” as its readership is almost certainly dominated by economists. Further, there are of course several disciplines that were not represented in the sample articles but are represented in the citations.

disciplines (Economics, Anthropology, Sociology) are more likely to travel than those that come out of journals which target more than one discipline.[15]

Of course, there is a problem in this simple form of citation analysis, not least because it is driven by the number of citations and you really need to, for example, weight the results by the relative number of citations in particular journals. This could be done by some form of association analysis.[16] However, our primary interest is not in the quantity of references or even the strength of citation links, rather it is to know if there was any sort of communication across the different social science communities in terms of their analysis of the Green Revolution in India. To assess this, the method used here is the "single count" approach, captured in the **single count matrix analysis**. The method is as follows: if the sample article has any reference to a category, this is recorded as 1, otherwise it is recorded as 0 (that is, for each article, each category will have record either 1 or 0); these scores where then summed across all sample articles, producing a cited category to citing category matrix; finally, aggregating across categories yields a discipline matrix, expressed in percentage terms.

The single count discipline matrix for the sample article citations is shown in table 6.[17] Reading down a column gives the percentage of the sample articles in that discipline which cited articles in the row discipline; for example, the first cell in the "Anth" column shows that 75% of the Anthropology sample articles cited at least 1 Anthropology journal reference, whilst the second cell in this column shows that 25%

[15] A similar conclusion is reached by Pieters and Baumgartner 2002 in their far more sophisticated citation analysis of economics journals: "journals aimed specifically at interdisciplinary issues play only a modest role in transferring knowledge from economics to its sister discisplines and the other way around" (p.504).
[16] Examples of more sophisticated forms of citation analysis, all concerned with economics, are: Liebowitz and Palmer, 1984; Pieters and Buamgartner, 2002; Fok and Franses 2007.
[17] For ease of presentation, table 6 only includes the main disciplines, and as such is portion of a larger matrix.

of the Anthropology sample articles cited at least 1 Area Studies journal reference. Reading down the shaded main diagonal of the matrix shows the percentage of the sample articles which citied at least 1 reference in their own discipline; also, the bold entries in the matrix indicate that at least half the citing articles in that discipline cited an article in the row discipline. Looking at the main diagonal shows that for 5 out of the 8 disciplines shown, at least half of the sample articles cite at least one journal reference which is in their own discipline; indeed, the surprise is that three disciplines, "Area Studies," "Political Science," and "Sociology" fail to do this. Perhaps the main characteristic of the matrix is that it confirms the dominance of economics in this literature on the Indian Green Revolution: reading along the "Econ" row shows that between 56% and 95% of the sample articles in all the other disciplines, except for "Industrial Relations and Labour," has at least one economics citation; indeed, ignoring the "Others" category, "Economics" accounts for 6 of the 10 off-diagonal cases where the figure exceeds 0.5.[18] Furthermore, the average for the "Economics" row is 0.68, with the next highest row average being 0.44 for Development Studies; if we exclude own discipline citations, the shaded main diagonal, the gap between "Economics" (0.65) and the next discipline, "Area Studies" (0.39), widens. More broadly, if we take the citations as an indication of "travelling" (or least potential travelling) between the different social science communities, table 6 provides a positive message. Looking down the columns, with the exception of "Industrial Relations and Labour," it is clear that there are very few 0 cells – most disciplines do make citations to most other disciplines. True to their calling as communication spaces, the columns for Areas Studies and Development Studies have no 0 cells; but it is also worth noting that

[18] This again chimes with the conclusions of Pieters and Buamgartner, 2002: "economics emerges as the primary source of knowledge in this network of socials science and business disciplines" (p.504).

nether does Economics, although, as we shall see below, there is an important caveat to that.

Travelling facts

Up to now it has been assumed, at least implicitly, that a citation is synonymous with a travelling fact but this is not necessarily the case. This final section will therefore look inside the black box of the travelling citation to see what fact, if any, travels with the citation. In examining this two main questions will be posed. First what “fact” does the reference carry? Of course, there may be cases where the citation does not seem to carry any fact, or where it is not possible to discern what fact travels with the citation. In the latter case, for example, one article in the sample has a fairly impressive list of references at the end of the paper but in the body of the paper there are no explicit mentions of any of these citations either in the text or footnotes. The second question to be posed about travelling is how is the fact used in the receiving domain? This also raises the issue about whether the fact is transformed or misconstrued in the receiving domain. The nature of this assessment of “quality” makes it a more subjective process than that in the rest of the paper and at this stage should be regarded as a tentative rather than conclusive analysis; as such, no attempt was made to be comprehensive, rather a selection of material was examined to see if any patterns emerged. Thus, to examine these issues about travelling facts, three disciplines were considered: Economics, Anthropology and Area Studies. The contrast between Economics and Anthropology provides insights into whether there was a different use made by two different traditional social sciences whilst the contrast between them and Area Studies will reveal if communication space disciplines are different from traditional social sciences.

To aid the discussion some terms will be used to denote different types of facts and travelling; an example for each term taken from the

sample articles is provided. In trying to answer the first question, a fact may be referred to as a headline fact, a descriptive fact, a particular fact, or a generic fact.[19] An example of a **headline fact** would be: “The over-all employment impact is still not easy to discern … (cf. [Falcon], 1970, p.705” (Ahmad, 1972, p.9, fn.2). A **descriptive fact** is a fact that is non-controversial or is not the outcome of research; if the fact that is cited is a specific, perhaps even detailed, fact that is an outcome of the research it will be referred to as a **particular fact**. The following are respectively examples of a descriptive fact and a particular fact from the sample articles: “Information was provided to growers in India through what is known as the Training and Visit (T&V) system of agricultural extension (Feder and Slade, 1986 provide details of this system)” (Munshi, 2004, p.210); “Assadi [1994] describes physical attacks on Dalit labourers by members of KRRS for not accepting lower wages and not agreeing to live in segregated quarters” (Nanda, 1999, p.26, fn.22). Where the fact that emerges from the research in the cited article is presented not as a specific piece of evidence but as more general evidential claim this fact will be denoted as a **generic fact**. An example of a generic fact is: “continued residence of sons after death of a head is both unusual and not likely to be random (Foster, 1993)” (Foster and Rosenzweig, 1996). The cited facts may also be used in a number of ways, including as any of the fact types already mentioned (a descriptive fact may simply be used as descriptive fact). One of the most common ways a fact is used is, however, to support the argument or evidence presented by the citing author, that is, it is used as a **corroborative fact**; the quote above from Ahmad is an example of a headline fact that was being used as a corroborative fact. Another obvious way a fact may be used is for the citing author to criticise the

[19] I have taken these terms from internal discussion papers of the “How Well Do “Facts” Travel?” research team which were concerned with concepts. The terms expressed here are by no means exhaustive of the concepts or definitions employed in those papers and the interpretation of the terms used here does not necessarily reflect how they were used in those papers.

evidence of someone else; this would the case of a **contested fact**. An example of this is: “It is, however, unrealistic to make statements of the order “Output would increase 50% if areas not actively adopting GR technology were to adopt the best practices of Punjab wheat farmers and Japanese rice farmers in the 1930s” (Neale and Edwards, 1983)” (Farmer, 1986, pp.180-1). Using these terms should enable us to determine whether there is any pattern and if this varies across time or discipline. For example, is it the case that generic facts find it easier to travel in the communication space of Area Studies whereas particular facts find it easier to travel in Economics? In what follows use is made of categories rather than disciplines and thus “discipline” effect will be assessed via the relevant mono category and hence citations made by sample articles in the mono categories of “Economics,” “Anthropology” and “Area Studies” were considered.

The mono category “Economics” yielded 92 citations but of these 65 (71%) were citations to other “Economics” articles and a further 14 were to articles in *Econometrica* or *Review of Economics and Statistics* both of which although classified as “Econ – SSI” are in essence economics journals. Of the remaining 13 citations, 5 were mono category (in the sense that the cited journal was classified as being mono category) and 8 were multiple category. The mono category citations were comprised of two “Demography” citations and one citation each to “Political Science,” “Sociology,” and “SSI.” However both of the “Demography” citations were self-citations (Foster and Rosenzweig again) as was the “SSI” reference. It was decided that these self-citations should be ignored, as it is not clear if there is any travelling across disciplinary boundaries with such citations. For example, in the case of the “Demography” self citations, Foster and Rosenzweig 1996 cited Foster 1993 whilst Rosenzweig 1982 cited Boulier and Rosenzweig 1978. In both cases, whilst demography has shown a willingness to embrace other disciplines by allowing an economist to

publish a paper in a demography journal, the economists do not appear to have found anything worth listening to in the demography journal, other than their own work.[20] In the remaining mono category citations, that from "Political Science" uses a headline fact as a corroborative fact whilst that from "Sociology" takes a particular fact, about technological diffusion in Iowa in the 1930s, and uses it as a generic fact.[21] The citations, excluding self-citations, to the multiple categories are all to categories which include economics: there are three citations to "Development Studies – Economics" and one citation each to "Area Studies – Development Studies – Economics," "Economics – Industrial Relations and Labour," and "Economics – Political Science." Two things stand out about these 6 citations: in only 1 case is the travelling fact concerned with India (and it is the only example of a descriptive fact) and in five of the cases what travels is a generic fact (although the generic fact is then used in a variety of ways). Overall, mono category "Economics" articles concerned with the Indian Green Revolution when they cite outside of "Economics" seem reluctant to stray too far from their comfort zone, as only 8% of the 92 citations were not self-citations or citations to other "Economics" articles and only 2 of these were to categories that would fall outside of the discipline "Economics."[22] Furthermore, the facts that do travel into the "Economics" category from

[20] This of course, in turn, raises a larger question about citation analysis which tries to measure communication or association between different academic communities. Obviously, excluding self-citations can get round some of the problem, but, to take an extreme position, what if the only demography article referenced by economics journals was Foster 1993?

[21] As these are the first examples of facts travelling through citations it is worth setting them out in a bit more detail. Falcon 1970 notes that "[this essay] continues, albeit more pessimistically, in the same vein as recent writings by Barker… Johnston, and Wharton" (p.698); the Wharton 1969 article is a "Political Science" paper. The "Sociology" citation is from Munshi 2004: "Ryan and Gross (1943), in an influential study that spawned an enormous diffusion literature in rural sociology, estimated that it took 14 years before hybrid seed corn was completely adopted in two Iowa communities" (footnote 2, p.186).

[22] Pieters and Baumgartner 2004 also note that "economics has not established strong reciprocal communication relationships with any of the sister disciplines in this network" (p.504).

other categories are overwhelming generic in nature, and rarely facts that are specific to India or indeed the Green Revolution.

Turning to "Anthropology" there are 23 citations, only one of which is a self-citation. Excluding the latter there are 9 citations to "Economics" and 3 citations to "Development Studies – Economics." Thus there is an immediate contrast to citations made by "Economics" in that "Anthropology" is far more open, with half of its citations being accounted for by categories other than "Anthropology," and indeed to disciplines outside "Anthropology." There is another striking contrast between the two in the way they use the *Indian Journal of Agricultural Economics*: for the mono category "Economics," only 2 of the 65 citations to "Economics" were to this journal whereas for "Anthropology" 7 of the 8 citations to "Economics" are to the *Indian Journal of Agricultural Economics*.[23] One of the main qualities of the *Indian Journal of Agricultural Economics* articles, at least in terms of the way they are used by "Anthropology" and indeed generally by the sample articles, is that they typically provide detailed empirical studies and as such are normally cited as particular facts, providing specific information on aspects of the Green Revolution in India.[24] This again contrasts with the use made of most "Economics" journals where the fact carried by the citation is often a generic fact.

The first thing to note about "Area Studies" is that its use of citations across the social science spectrum does seem to confirm its role as a communication space. The mono category "Area Studies"

[23] Both of the "Economics" citations to the *Indian Journal of Agricultural Economics* were from an article published in *Food Policy*, which is not a mainstream economics journal (for example, it did not make it into the list of 42 economics journals analysed by Pieters and Baumgartner 2004).

[24] This is not to say that they are used only as corroborative facts in the receiving domain for sometimes they come packaged with an explicit or implicit causal story which it disputed by the citing author. For example, Bhalla cites a study of Hayana which claimed that "a large proportion of households with small and marginal land holdings were forced to enter the wage labour market due to failure of the monsoons" (quoting Unni, 1997, p.20) but claims this is at best a partial explanation of what was happening (Bhalla 1999, pp.47-8).

yields 50 citations, of which 40 are to external citations (ie, citations which are not mono category “Area Study;” citations). Thus, “Area Studies,” in these terms, is even more open to other categories than “Anthropology” with almost 70% of all citations being external to the discipline “Area Studies.” Furthermore, these are also spread across several different social sciences, for example in terms of mono categories it reaches into “Anthropology” (12 citations), “Economics” (8), “Political Science” (5), “Development Studies” (3), and “Geography” (2). It is also worth noting that, after excluding a small number of self-citations, three-quarters of the external citations are to articles in mono category journals and only a quarter to multiple category journals; of the 9 to multiple categories only 4 are outside the “Area Studies” discipline. Thus, whilst being a communication space “Area Studies” appears to be more likely to draw its facts from categories that are not communication spaces. In terms of the type of facts carried by the citations are how they are used there was no obvious discernable difference between the mono and multiple category citations: in most cases, the facts related to India and were used mainly used as corroborative facts. The main exception to this was the case of citations from “Political Science” in that most of the 11 cases of cited facts did not concern India.[25] These “Political Science” citations also exhibited several examples of facts being used as contested facts, more so than was observed in the other category citations. Finally, it is worth noting that of the facts culled from citations from “Economics,” there were only two cases of particular facts, both of which were used as corroborative facts, and these were both taken from the *Indian Journal of Agricultural Economics*.

[25] The number of facts for “Political Science” exceeds the number of citations because, as is the case generally, in some articles there are multiple references to a particular citation.

Conclusion

This paper has examined fact travelling in the social science community through the journal literature on the Indian Green Revolution. This was done by examining 76 articles published between 1969 and 2004 which were spread across 44 journals and 13 social science disciplines (as defined above). The method was broadly twofold, first an analysis based on citations, both intra-sample and more generally, and secondly a more detailed consideration of the facts, if any, carried by the citations. The intra-sample citation did show that more than half (indeed, if self-citations were excluded, almost two-thirds) of the articles did not cite any of the other articles in the sample. This might be taken as an indication that there was not much travelling but it should be remembered that the topic of the Indian Green Revolution is a very broad one which encompasses many different debates and this is reflected in the sample. The intra-sample citations did reveal that there was a significant core of papers that had a shared academic genealogy which ranged across several disciplines and reached, as shown in figure 1, from 1969 to 2002; also some of the citations did have a long life, for example Wharton 1969 was still being cited 26 years later. The analysis also revealed the usefulness of considering both "listening citation trees" and "talking citation trees" as they do reveal different communication connections. Overall, the intra-sample analysis, which by its very nature is restrictive, did provide a clear indication that there was some form of both temporal and spatial travelling.

"Economics" clearly emerged as the dominant discipline, and indeed category, in terms of the sample itself, in terms of the general citations of the sample, and in terms of the single count analysis.[26] Other social science disciplines listen to what economics has to say; notably, however, the reverse is not true, something that was further

[26] However, there were sample articles in the category "Area Studies" than in "Economics'.

emphasised when the citations, and what they carried, was looked at in more detail.[27] The communication spaces of "Area Studies" and "Development Studies" also emerge as important, although it was suggested that they were maybe relatively less important than more traditional disciplines when it came to citation travelling. The more general analysis of citations also revealed the importance of two Indian journals to this topic. *Economic & Political Weekly* plays a crucial role in most debates about Indian economic, political and social issues, in many ways it is a prime example of an effective communication space; here it was found to account for almost a quarter of all journal citations in the sample articles and half of all of the sample articles had at least one citation to it. The *Indian Journal of Agricultural Economics* is an important source of empirical research by Indian scholars and as such is heavily cited in the sample, being the third most cited journal. However, there is an interesting distinction in the use made of the *Indian Journal of Agricultural Economics* by economics compared to the social sciences. Of the 36 citations to the *Indian Journal of Agricultural Economics* only two were made by articles in the same mono category of "Economics", even though citations in that category were overwhelmingly citations to articles in that category. Comparing the *Indian Journal of Agricultural Economics* to its American equivalent, the *American Journal of Agricultural Economics*, is also instructive: whereas two-thirds of all citations to the latter are in articles that fall under the discipline of "Economics" only one-third of all citations to the former do.[28] One reason for this would seem to be the way facts are used in "Economics": economists seem to have a preference for generic facts as opposed to particular facts and it is particular facts that the *Indian Journal of Agricultural Economics* typically supplies. This in turn

[27] Although the "Economics" column in table 6 has no zero cells, most of the citations being picked up are citations in multiple categories where "Economics" is one of the headings.
[28] For the mono category "Economics" the figures are, respectively, 28% and 5%.

explains the popularity of the *Indian Journal of Agricultural Economics* with the other social sciences – they often want to cite a specific piece of evidence from Indian agriculture to support their arguments. This is one example of where the final section, which considered what facts travelled with the citation, was able to provide more insight into how facts travelled across the social science community. It demonstrated that there was a marked difference between “Economics” and “Anthropology,” both in terms of how open they were to other disciplines and what sort of facts they cited, and it showed that “Area Studies” was indeed more open than either to other disciplines, hence fulfilling its communication space role. This is encouraging in that it suggests that further work in this area, in digging below the surface of citation analysis and examining what facts travel and how they are used by the citing author, will provide us with a better understanding of how the social sciences communicate with each other.

Tables, Figures,
& References

Table 1. Distribution of sample articles by journal

Economic Development and Cultural Change	8
International Labour Review	6
Journal of Development Studies	4
American Journal of Agricultural Economics	4
Bulletin of Concerned Asian Scholars[1]	3
Journal of Peasant Studies	3
World Development	3
Annals of the Association of American Geographers	3
Economic Geography	3
Foreign Affairs: an American Quarterly Review	2
Journal of Contemporary Asia	2
Journal of Development Economics	2
Journal of Political Economy	2
Modern Asian Studies	2
Pacific Affairs	2

Notes: (1) Now known as *Critical Asian Studies*. The other 29 articles were spread across 29 journals.

Table 2. Most popular intra-sample citations[1]

Author	Year	Journal	Number of intra-sample citations
Articles making most citations			
Das	2002	*Geoforum*	7
Franke	1974	*Bull. C.A.S.*	4
Freebairn	1995	*World Dev.*	3
Parayil	1992	*Tech. & Cult.*	3
Sisaye & Stommes	1985	*Pub. Adm. & Dev.*	3
Mayer	1984	*Pea. St.*	3
Most cited articles			
Falcon	1970	*Am. J. Agr. Econ.*	6
Wharton	1969	*For. Aff.*	5
Ladejinsky	1970	*For. Aff.*	4
Cleaver	1972	*For. Aff.*	3[2]

Notes: (1) Excluding self-citations. If self-citations were included there would be two changes to the table: first, the number of citations made by Das would rise to 8; secondly, Foster and Rosenzweig 1996 would appear under the “Most cited articles” list with 3 citations, 2 of which were self-citations. (2) The Cleaver article also appeared in same year in shorter version and without references in the *American Economic Review* and this version was cited by 2 other articles in the sample, giving Cleaver 5 citations in total.

Table 3. Most cited journals

Journal	Number of citations
American Journal of Agricultural Economics	43
Journal of Peasant Studies	37
Indian Journal of Agricultural Economics	36
American Economic Review	32
Economic Development and Cultural Change	30
World Development	29
Journal of Political Economy	25
Econometrica	17
Journal of Development Studies	17
Foreign Affairs	13
Food Policy	10
Rural Sociology	10
Agricultural Economics	9
Bulletin of Concerned Asian Scholars	9
Economic Geography	9

Table 4. Distribution of sample articles by category and discipline

	Number of articles	As Per cent of all articles
Category[1]		
Area Studies	13	17.1
Economics	11	14.5
Area Studies-Development Studies-Economics	8	10.5
Development Studies-Economics	8	10.5
Political Science	7	9.2
Geography	6	7.9
Industrial Relations and Labour	6	7.9
Anthropology	3	3.9
Economics-Geography	2	2.6
Social Sciences Interdisciplinary	2	2.6
Discipline[2]		
Economics	30	27.5
Area Studies	21	19.3
Development Studies	20	18.3
Geography	9	8.3
Political Science	9	8.3
Industrial Relations and Labour	6	5.5
Anthropology	4	3.7
Sociology	3	2.8
Business Studies	2	1.8
Social Sciences Interdisciplinary	2	1.8

Demography	1	0.9
History	1	0.9
Public Administration	1	0.9

Notes: (1) Total number of articles is 76. The categories with only one sample article in them, not shown in the table, are: “Anthropology-Sociology”, “Business Studies”, “Business Studies-Development Studies”, “Demography-Sociology”, “Development Studies”, “Development Studies-Economics-Political Science”, “Development Studies-Public Administration”, “Geography-Political Science”, “History”, “Sociology’. (2) Due to multiple counting, the total number of “articles” by discipline is 109.

Table 5. Distribution of citations by category and discipline

The table shows all categories or disciplines
which account for at least 1% of the total citations

	Number of citations	**As Per cent of all citations**
Category[1]		
Economics	198	38.2
Development Studies-Economics	48	9.3
Anthropology	40	7.7
Area Studies-Development Studies-Economics	30	5.8
Economics- Social Sciences Interdisciplinary	24	4.6
Area Studies	23	4.4
Geography	23	4.4
Political Science	23	4.4
Sociology	22	4.2
Development Studies	10	1.9
Economics-Geography	9	1.7
Industrial Relations and Labour	6	1.2
Social Sciences Interdisciplinary	6	1.2
Discipline[2]		
Economics	322	45.8
Development Studies	96	13.7
Area Studies	55	7.8

Anthropology	43	6.1
Geography	38	5.4
Social Sciences Interdisciplinary	35	5.0
Political Science	31	4.4
Sociology	31	4.4
Environmental Studies	10	1.4
Industrial Relations and Labour	9	1.3
History	7	1.0

Notes: (1) The total number of category citations is 518. In addition to the 13 categories shown in the table there were 2 categories which had 4 citations each, 7 categories with 3 citations each, 10 categories with 2 citations each and 7 categories with 1 citations each. (2) The total number of discipline “citations” is 703. The disciplines with less than 1% of total citations were Demography (6 citations), Health Studies (4), Psychology (4), Law (2), Urban Studies (2), Public Administration (1) and Social Issues (1).

Table 6. Single count discipline matrix

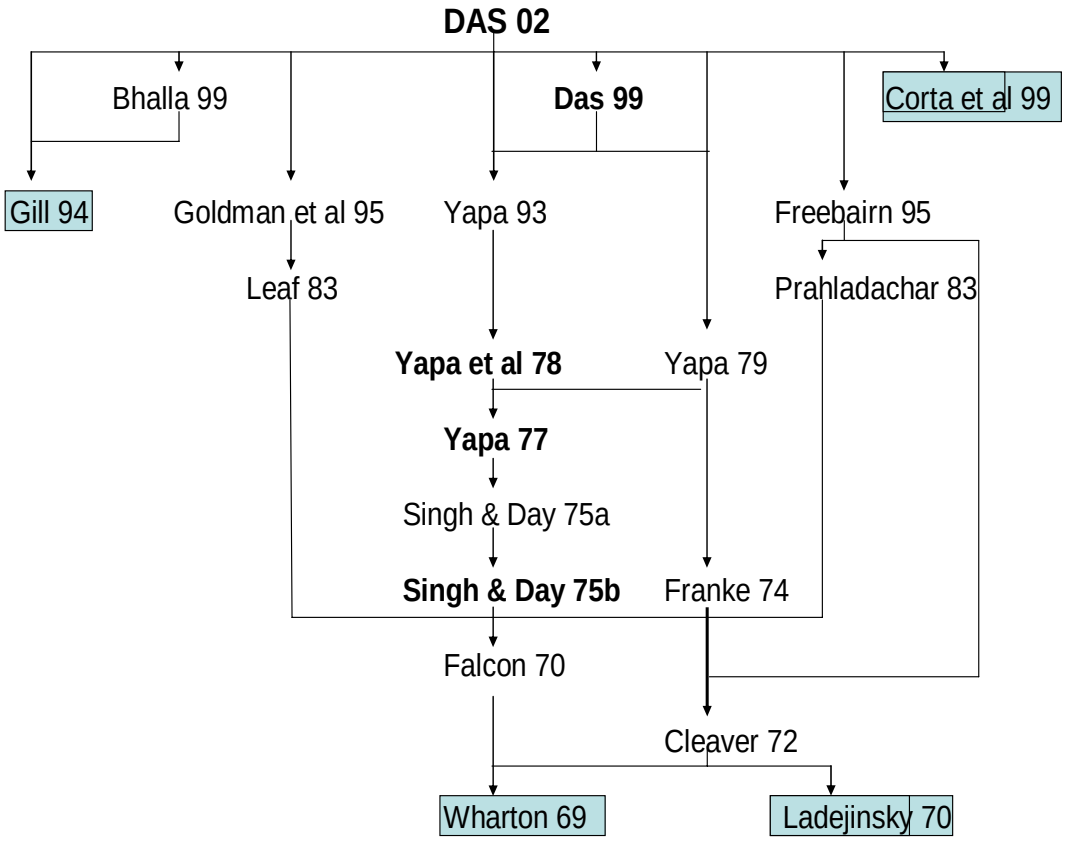
Bold indicates figure is greater than 0.5

	Anth	ArSt	DevSt	Econ	Geog	IndRL	PolSci	Soc	Other
Anth	**0.75**	0.29	0.25	0.13	0.22	0.00	0.22	0.00	0.00
ArSt	0.25	0.33	**0.50**	0.27	**0.56**	0.00	0.44	**0.67**	0.43
DevSt	0.25	0.43	**0.85**	**0.60**	0.44	0.00	0.44	0.33	**0.57**
Econ	**0.75**	**0.57**	**0.95**	**0.90**	**0.56**	0.33	**0.56**	**0.67**	**0.86**
Geog	0.00	0.10	0.10	0.07	**0.56**	0.00	0.11	0.00	0.14
IndRL	0.00	0.14	0.15	0.17	0.00	**0.50**	0.00	0.00	0.00
PolSci	0.25	0.24	0.25	0.20	0.33	0.33	0.22	0.33	0.29
Soc	0.00	0.05	0.25	0.17	0.11	0.00	0.22	0.33	0.14
Other	0.00	0.29	**0.60**	**0.60**	**0.89**	0.00	**0.56**	0.33	**0.71**

Note: Columns represent the citing discipline and rows the cited discipline.
Abbreviations: “Anth”, Anthology; “ArSt”, Area Studies; “DevSt”, Development Studies, “Econ”, Economics; “Geog”, Geography; “IndRL”, Industrial Relations and Labour; “PolSci”, Political Science; “Soc”, Sociology.

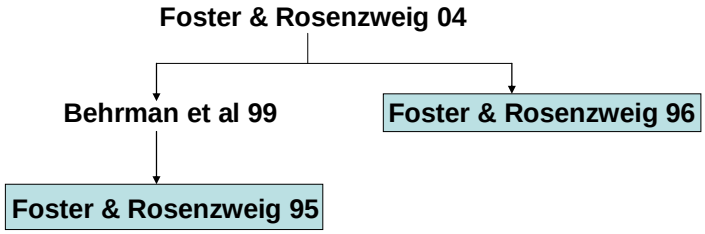
Figure 1. Listening citation tree for Das 2002

The name of the author is followed by two digits representing the year of publication (thus 02 represents 2002)



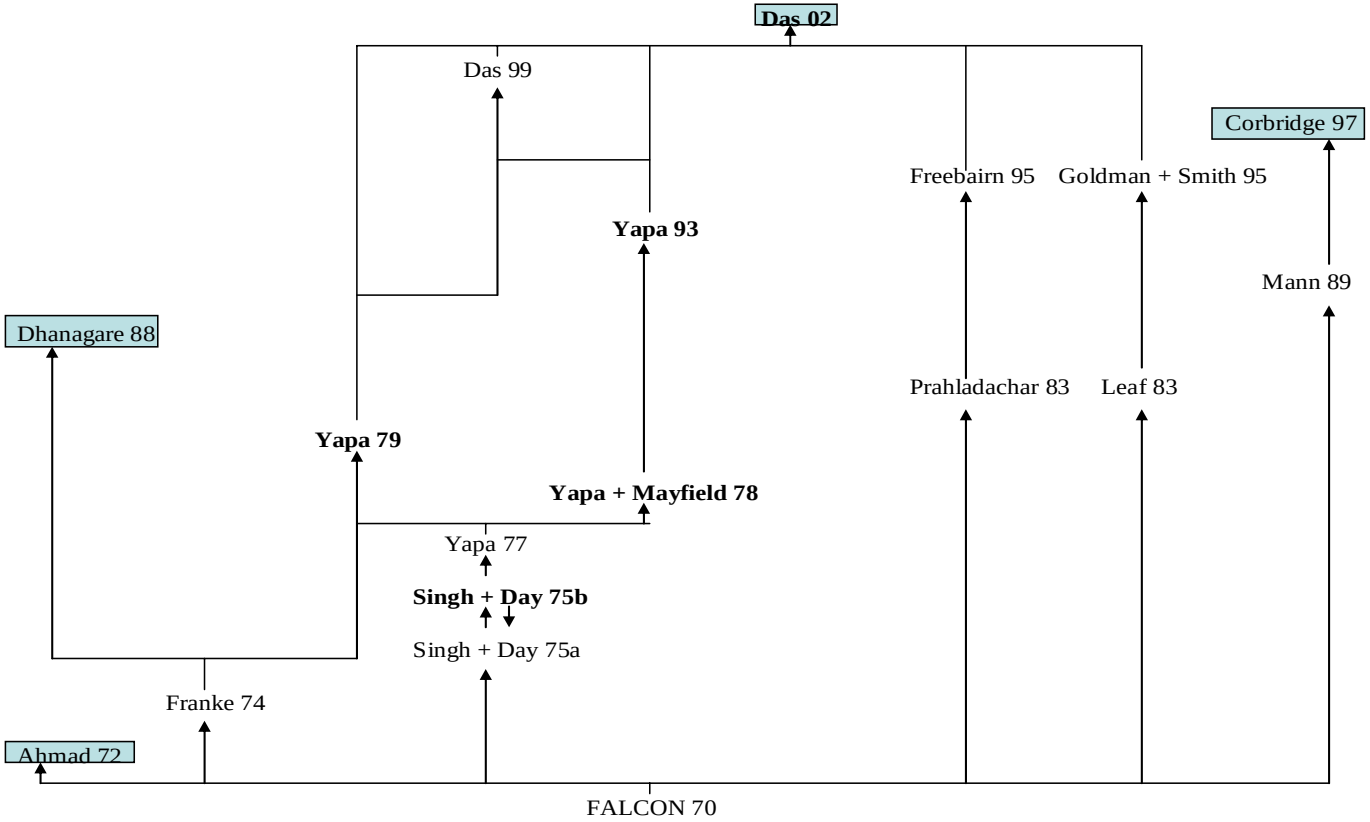
Note: in order to make the diagram manageable and relatively easy to read, in some cases not all the citations made by an article are shown if they are shown through some other link. For example, above Franke 1974 is only shown as citing Cleaver 1972 and Falcon 1970 but he also cited Ladejinsky 1970 and Wharton 1969.

Figure 2. Listening citation tree for Foster and Rosenzweig 2004

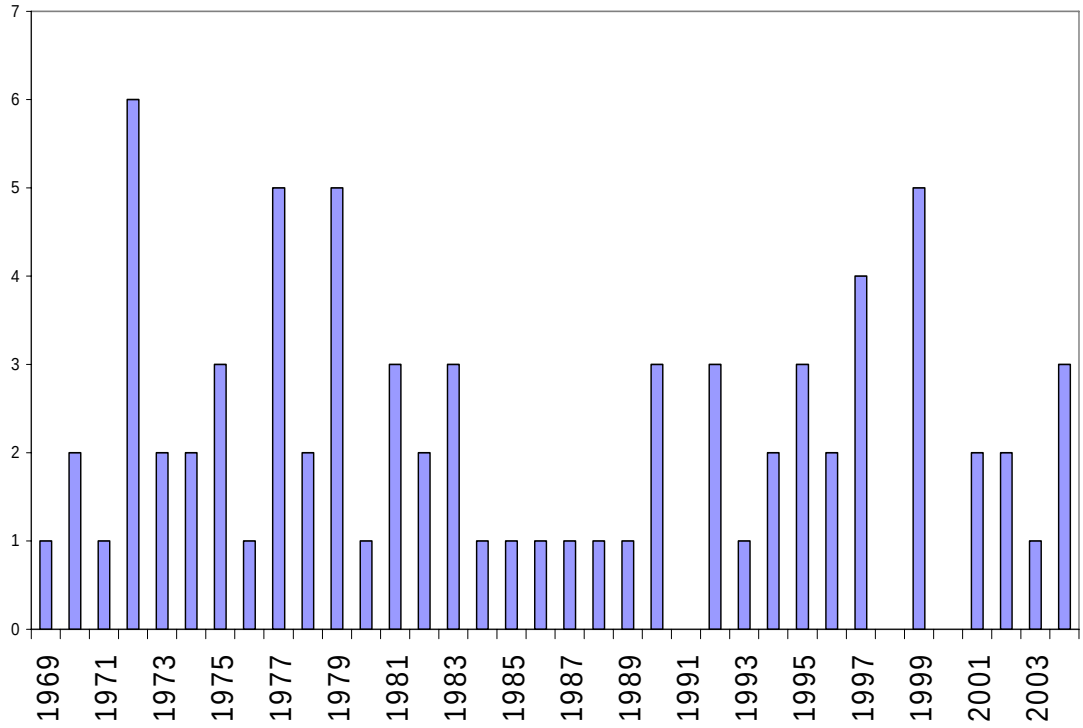


Note: Behrman et al is: Behrman, J. R., Foster, A. D., Rosenzweig, M. R. and Vashishtha, P..

Figure 3. Talking citation tree for Falcon 1970



Appendix 1. Distribution of sample articles by year



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* *indicates article was part of sample*

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