The Landscape of Contemporary Economics: A Kuhnian Perspective

1. Introduction

How do ideas and information move between economists? To what extent can economics be divided into smaller cohesive intellectual communities? Citation network analysis can provide evidence to help to illuminate these issues. Citation network analysis involves building a network of papers, authors or journals and how they are connected by citing each other. If an economist cites another it indicates that she is engaging with the ideas of the economist she is citing. By mapping these citations we can build a picture of how information flows between economists and investigate whether there are cohesive communities of economists who share a high degree of engagement with each other.

To explore this issue I construct a citation network of 210 economics journals, based upon citation data from 2008 from the *Journal Citation Report*. I then analyse this data using a 'mapping equation' developed by Rosvall et. Al (2010), which partitions the network into clusters of journals which share a relatively large amount of information flow with each other compared to the rest of the network. These clusters are interesting, not simply because they shed light upon the ways that different journals influence each other, but also because they may also indicate a shared paradigm. According to Kuhn (1996), a paradigm is a set of mainly implicit assumptions about the nature of reality and the acceptable questions and methods which can be pursued in research. Rather than being explicitly taught, a paradigm is implicitly learnt through repeated engagement with members of an intellectual community, similarly to learning a language by conversing with native speakers. Due to this, journals which cite each other frequently may have a similar paradigm.

The paper proceeds as follows. Section 2 describes more of the background of citation network analysis. Section 3 describes my methodology and initial results. Section 4 provides an analysis of the network. Section 5 suggests further avenues of research and section 6 concludes.

2. Network citation analysis

Network analysis is the use of techniques, from simple visualisation to complex computer simulation, to study the connections between objects. It is used in areas of research from the study of the interaction of different chemicals within cells in molecular biology, to the analysis of trade flows between countries, and the correspondence relationships between Reformation theologians. Examining the networks created by the links between individuals can reveal information which is not apparent by simply looking a aggregate statistics about the members of a system. The use of network analysis within epidemiology has revealed how diseases with relatively low rates of contagion can successfully spread through a population due to certain individuals acting as ‘hubs’. These individuals have potentially infectious interactions with a much higher than average number of individuals. This means that they are at a much greater probability of being infected with the disease, and once they are infected the average number of others they infect is much higher than it would be for non-hubs. (Barabasi 2002) The resilience of a communication infrastructure depends not just on the number of connections and their average distribution, but also upon whether certain points within the structure are essential as they the only path through which information can travel between two parts of the network, which would otherwise be cut off from each other.

Citation analysis is the study of citations to reveal information about the structure and flow of information and ideas within academic disciplines. Citation analysis has been used to research the natural sciences for over five decades. Price (1965) argues that the ways in which scientists cite recently published work can provide an objective classification of the frontier of research into separate subjects. He bases this upon the premise that scientists are more likely to cite recent work in their own subject, so citation analysis would reveal clusters of papers which cited the same recent papers and clusters of recent papers which were cited in the same papers. This would represent a current subject area on the research frontier of the natural sciences.

As computing technology improved the more sophisticated methods could be used to analyse networks and larger networks could be examined. Rosvall and Bergstrom (2008) use a 'mapping equation' to identify sub disciplines within science. Their analysis is based upon the same basic principle as that of Price: that academics tend to cite works within the same subject area as their own work. However, they use a probabilistic algorithm (the intuition of which is described below) to proxy the flow of information between journals and divide the network into clusters of journals which share a significant amount of information flow with each other compared to the rest of the network.

Pieters and Baumgartner (2002) analyse the citation patterns between economics journals. They found that the journals they analysed could be divided into seven clusters, which seemed to be along subject lines: general interest, labour, public and law, health and natural resources, international, theory and method, and history and society. They also found that the citation network was centralised, with all of the clusters citing the general interest cluster, and all but the history and society cluster citing the theory and method

cluster. The only other cluster which received any citations was the international cluster, which was cited by the history and society cluster. However, they only included 42 journals in their network and their method of analysis did not take into account that citations are directional, from a the citing journal to the cited journal. Whilst they found that the clusters represented the subjects of interest of journals, they also acknowledged that "journals may also be cohesive because they represent similar paradigms, languages, countries, professional or academic societies, and so forth" (Pieters and Baumgartner (2002) pp. 503)

3. The economics journals citation network

To provide an empirical indications of the structure of contemporary academic economics, I constructed a directed network of the journals listed under economics in *2008 Journal Citation Reports*. The titles of the 210 journals included in the network can be found in appendix 1. An arc between two journals indicates that the journal at the base of the arc cited the journal at the end of the arc at least ten times during 2008, the most recent year for which citation data is available. The arcs within the network are weighted by the total number of times the citing journal cited the cited journal in 2008. Self citations were excluded from the network as they do not reveal anything about the relationships between journals.

The network is shown in figure 1. Most of the journals in the network are part of a single component: they are all, at least, indirectly connected to each other through the their citations. The only journals which are not part of the component are isolated journals which did not cite any other journal in the network ten or more times, and was not cited by any other journal ten or more times. The network is too large and densely connected to reveal

its structure merely through visual inspection, so a formal clustering technique is necessary.

To divide the network into clusters, I used the map equation developed by Rosvall, Axelsson and Bergstrom (2010). There is many different ways to divide a network into 'clusters' of nodes which form some kind of cohesive group based upon the links between them. Each method emphasises a different conception of 'cohesion' within a network and is suitable for a different purpose. Rosvall et al.'s method is based upon a the simulation of random walks within the network. At each node the random walker moves into a neighbouring node with probability equal to weight of the link with that neighbour divided by the sum of the weights of all of the links out of that node. If there are no outward links from the node the random walker 'teleports' to another part of the network, chosen at random. To avoid the random walker getting stuck in sinks of nodes which only link to each other, each move there is a small probability that the random walker will teleport to a random part of the network rather than moving onto a neighbour. The equation uses a Huffman coding process to allocate to nodes within the network into clusters. The Huffman coding process minimises the number of bits required to describe a random walk within a network. This is minimised when the network is divided into cluster such that the random walker described above would spend a relatively long time within a cluster once he entered it and movements between clusters would be relatively rare. This method of dividing a network into clusters is particularly suitable for investigating information flows. Ideas are most likely to spread from a journal to another journal with cites it frequently. The clusters found through Rosvall et al's mapping equation are communities who share a relatively large amount of dialogue between themselves and relatively little with the other

nodes in the network. These clusters may reveal sub disciplines or intellectual communities.

The mapping equation divided the network of Economics journals into 15 clusters (appendix 1). Eight of these clusters were simply the isolated journals which did not have any links with any other journals. The other seven clusters, which each contained more than one journal, are visualised, along with their strongest links between each other in figure 2. The size of the cluster and its label in the diagram is proportional to the root of the amount of time a random walker within the network would spend within that cluster. The size of the arrows, which point from a cluster toward a cluster which it cited frequently, are proportional to the probability that a random walker would travel between those two clusters in that direction. Each cluster is labelled to characterise the journals within that cluster. The first cluster is labelled 'Economics' and contains the majority of journals in the network, 168 out of 210. The second cluster mainly contains journals concerned with agricultural economics, although it also includes journals in related fields of ecology and resource management, such as *Ecological Economics* and *Resource and Energy Economics*. The third cluster contains three economic history journals. The fourth cluster contains journals concerned with world development and international political economy. The fifth cluster contains two journals about former USSR countries and one on European integration. Journals within the sixth cluster were concerned with insurance, and journals in the seventh cluster were about real estate.

A significant feature network is that it is dominated by a few journals which receive a very large proportion citations. *American Economic Review* was cited more than 10 times in 2008 by 167 of the journals in the network. Not only was it cited by a lot of journals but

journals also tended to cite it frequently. 39 journals cited it more than one hundred times in 2008 and the *Journal of Economic Behaviour and Organization* cited it 461 times. The mapping equation reveals that a random walker would land in one of the 'top ten' Economics journals 53.7% of the time and would land upon *American Economic Review* 12.7% of the time.

The fact that the network is dominated by these citation 'black holes', which attract large numbers of citations from the rest of the network, obscures the finer structure of the network. The mapping equation divides the network into clusters which a random walker would be relatively unlikely to move between. However, as a random walker would be quite likely to move from most journals within the network to one of the 'top' journals, they are all allocated to the same cluster by the algorithm. The influence of the 'top' journals upon the network structure obscures the patterns of citations between the other journals. To overcome this difficulty I ran the mapping equation on a network of journals with the 'top ten' journals excluded. The results of this are in appendix 2.

The mapping equation divided the network into 34 clusters. 15 of these cluster contain only a single journal and four of these cluster only contain two journals. These pairs are: two journals on the history of economic thought, two South African journals, two Australian journals, and a Czech and a Slovakian journal. A visualisation of the 15 clusters which contain more than 2 journals and the most significant links between them is shown in figure 3.

The largest cluster mainly contains mainstream general interest journals, although it contains some journals which one might expect to find in other clusters, for example

Labour Economics and *Revue of Development Economics*. The second cluster is made up of journals which specialise in econometrics. The third cluster contains journals concerned with finance. The fourth cluster contains interdisciplinary journals concerned with economics and either law or health. It also contains journals about regulated industries, such as the *RAND Journal of Economics*, and industrial organisation. Figure 4 shows the citation patterns within this cluster. Almost all of the journals in this part of the network cited the *RAND Journal of Economics* more than 10 times in 2008. However, the cluster is not entirely dependent upon *RAND Journal of Economics* for its cohesiveness as there are links between the industrial organisation journals and the law journals, and between the *Journal of Health Economics* and the *Journal of Law and Economics* and the *Journal of Economics and Management Strategy*.

Cluster 5 contains the journals which were in cluster 2 of the original network. In addition to these journals on agricultural economics and resource use, the removal of the 'top ten' journals has allowed two journals on the economics of energy systems to be partitioned into this cluster due to their links to the journals concerned with environmental and resource management.

Cluster 6 is made up of journals concerned with development. It also contains *Economics and Society*, the *Review of International Political Economy*, and *New Political Economy*, however this is only because the former two both cite *World Development* and the later cites the *Review of International Political Economy*. Interestingly it does not include the *Review of Development Economics*, which is in the 'general' cluster 1. However, the removal of the 'top ten' journals has shifted six journals into the 'development' cluster from

the ‘general’ cluster. The initial partition didn’t identify them as part of this cluster because their string links to the ‘top ten’ journals pulled them into the general cluster.

Cluster 7 is centred around the *Journal of Human Resources*. All of the other four journals within the cluster cite this journal. The only other links within this cluster are that the *Journal of Human Resources* and the *Journal of Population Economics* both cite the *Journal of Labour Economics*. This cluster contains *Feminist Economics* because it cites the *Journal of Human Resources.*

Cluster 8 contains journals concerned with urban economics and real estate. Its contains the real estate journals which were partitioned into the second cluster in the initial network, but with the removal of the ‘citation black holes’ they are joined by journals on urban economics and transportation.

Cluster 9 is probably best labelled as ‘theory’. The journals within this cluster are concerned with topics such as game theory, experimental economics and decision theory.

Cluster 10 contains several journals which could be viewed as heterodox. It contains the *Cambridge Journal of Economics*, the *Journal of Evolutionary Economics*, the *Journal of Economic Issues* and the *Journal of Post Keynesian Economics.* It also contains several interdisciplinary journals such as *Small Business Economics* and *Economics and Geography.*

Cluster 11 are the economic history journals, which were the third cluster in the original network.

Cluster 12 are journals concerned with transition in communist and former communist countries. These journals were all part of the first cluster in the original network.

Cluster 13 are journals about public tax policy. They were all part of the first cluster in the original network.

Cluster 14 are journals about the former USSR and European integration, which were the fifth cluster in the original network.

Cluster 15 are journals about insurance, which were the sixth cluster in the original network. The journals in the original cluster are joined by *Mathematical Finance*.

4. Analysis of the network

Economics is dominated journals which are very widely and heavily cited, such as *Econometrica* and the *Quarterly Journal of Economics*. These journals give the impression that economics as a whole is relatively cohesive, as they draw in citations from most journals. This includes heterodox journals. The three most cited journals by the *Cambridge Journal of Economics* in 2008 were the *American Economic Review*, the *Quarterly Journal of Economics* and the *Economic Journal*. *Feminist Economics* cited the *American Economic Review* more than any other journal. The *Journal of Post Keynesian Economics'* three most cited journals were the *American Economic Review*, *Econometrica* and the *Journal of Economics*.

Most of the clusters within the network are characterised by the journals within them being concerned with similar or related subject matters, for example agriculture or tax policy, or methodology, such as game theory or econometrics, rather than by a paradigm or school of thought. The only cluster within the network which was characterised by school of thought rather than methodology or subject matter was cluster 10, which contains the *Cambridge Journal of Economics*, the *Journal of Evolutionary Economics*, the *Journal of Economic Issues* and the *Journal of Post Keynesian Economics.* If one followed to argument of Davis (2008), that a 'new heterodoxy' is emerging within mainstream economics based upon research programmes such as game theory and experimental economics, cluster 9, the 'theory' cluster could be said to reflect the division of economics into schools of thought or paradigms. However, it would be wrong to draw too strong a dichotomy between organisation along lines of schools of thought or paradigms and divisions along the lines of subject area. According to Kuhn (1996) natural scientists working within the same speciality are likely to develop shared paradigms, which are subtly different and incommensurable with the paradigms of natural scientists working in different specialities, even if those two scientists do not view themselves as part of two competing schools of thought. Paradigms are implicitly learnt through shared exposure to exemplars and interaction between members of a scientific community, so the members of a particular sub discipline are likely to develop similar paradigms which are subtly different to those of other sub disciplines. In addition to this, a particular topic of investigation, such as agriculture, may present particular empirical facts and place different pressures upon researchers from interests such as industry and policy makers to address certain questions. This will push paradigms within different sub disciplines into adapting in different ways in response to empirical findings, institutional pressures and ideas from different academic disciplines. An unrealistic understanding of the way that people tend to

act when faced with uncertainty will be more likely to be a problem in an area of research concerned with providing pension policy advise, than an area of economics to which uncertainty is peripheral, which is more shielded from empirical data. Thus a pension policy research group would feel more pressure to adapt their paradigm so that it conflicted less with the pension provisioning behaviour they observed, whereas a general theory economics group would be more likely to be able to dismiss the issue as an anomaly or tangential research puzzle. Although the clusters within the citation network appear to mainly be based upon subject matter, they may also reflect differences in economists' paradigms, as the two are closely related.

Several heterodox journals are within the same cluster (cluster 10), although others are scattered throughout the network. The position within the same cluster of the *Cambridge Journal of Economics*, the *Journal of Evolutionary Economics*, the *Journal of Economic Issues* and the *Journal of Post Keynesian Economics* may indicate that they is close interaction between economists who are part of different traditional heterodox schools of thought, such as Post Keynesian and Evolutionary Economics. However, other heterodox journals, such as *Feminist Economics* and *Ecological Economics* were part of different clusters, which were more related to their main topics of interest. This could be related to these journals greater emphasis upon interdisciplinary work. Both may reflect a practice of engaging with ideas based upon their relevance to a particular topic of interest rather than a particular philosophical or methodological approach.

The 'heterodox' cluster within the network does not have much influence upon the rest of the network. The random walker described in section x would only spend 2.4% of her time in the heterodox cluster, as opposed to 13% of her time in the 'finance' cluster, which

contains fewer journals. The ‘urban’ cluster (cluster 8) is the cluster which cites the ‘heterodox’ cluster most frequently, however, the urban cluster is also relatively non-influential within the citation network, as a random walker would only spend 5.6% of her time in this cluster and it itself is most frequently cited by the ‘heterodox’ cluster and the ‘agriculture’ cluster.

A potential question is what is the best strategy for being more influential within the network: forming a cohesive cluster of heterodox journals or interacting with journals of a more ‘mainstream’ orientation, based upon a shared topic of interest. Forming a cohesive cluster of heterodox journals which cite each other frequently could build a momentum and strong collection of well worked out ideas with which to attempt to influence the rest of the discipline. On the other hand, interaction with other journals surrounding a particular topic, particularly if those journals are open to interdisciplinary modes of working and concerned with practical policy proposals, could help to influence the discourse within those sub disciplines, which could then have gradual spill over effects to the rest of Economics as a whole. *Ecological Economics* is more influential than any of the journals in the ‘heterodox’ cluster apart from the *Journal of Economic Geography*. The random walker would spend 0.44% of her time in *Ecological Economics* as opposed to 0.23% in the *Cambridge Journal of Economics* or 0.13% in the *Journal of Post Keynesian Economics*. On the other hand, *Feminist Economics*, within the ‘human resources’ cluster of the network, would only be visited 0.16% of a random walkers time. As most of the differences in influence between these journals is roughly in line with the total number of times each of them was cited by another journal in 2008, it does not provide enough information to judge which strategy may be more successful.

5. Further Work

There are several potential avenues for further work on this topic. One would be to include within the citation network non-economics journals which cite or are cited by articles in economics journals. Excluding these journals from the network is unlikely to have a strong effect upon the overall structure of information flows within it, as economics journals tend to cite non-economics journals very rarely on average. However, these journals more be more important to the areas of the citation network which are topic focused and place an emphasis upon interdisciplinary. It could also provide empirical evidence as to what extent explicit commitment to interdisciplinary is matched with greater engagement with journals from other disciplines.

Another possible avenue of research would be to look at how citation patterns have changed over time. This could be achieved by comparing citation networks of citation for different periods in time, to see whether the clusters which form within them are different and how journals have shifted between journals. Rosvall and Bergstrom (2010) have developed a method to reveal statistically significant changes in citation networks over time and visualise these within “alluvial diagrams”. This technique could be applied to Economics citation networks, although the smaller number of journals involved in the network, as well as the centralisation of the network due to ‘citation black holes’ could pose barriers to applying the technique.

One of the difficulties with making conclusions about heterodox economics from journal to journal citation data, are the relatively small number of heterodox journals. For this reason it may be informative to look at citation information at the level of authors, for example co-authorship networks, in which authors are linked if they have published jointly, or citation

networks at the level of authors. Network techniques could also be used to analyse information about economists' memberships of associations, editorial boards and faculties, to explore a different type of interaction.

6. Conclusion

In this paper I have used network analysis techniques to explore the network of citations between economics journals. In accord with previous studies, I have found that the citation patterns of economics journals are concentrated upon a small number of 'top journals', which attract very large numbers of citations from all parts of the network. Whilst most journals frequently cite the 'top' journals, there is also a structure of journals forming cohesive "clusters' of journals which cite each other frequently. These are mainly along the lines of subject matter, however, it is a mistake to make a sharp division between subject matter and paradigm or school of thought, as shared paradigms are formed through repeated interactions, as occur within sub disciplines. The nature of a topic of study is also likely to shape the paradigms of those studying it.

There several avenues for continued research using citation networks to explore the structure of information flows between economist, such as looking at how the structure has changed over time, how it is influenced by journals in related fields and how citation patterns between authors reveal communication structures.

Appendix 1

Code length 5.63547 in 15 modules.
1:1 0.126764 "AM ECON REV"
1:2 0.0917862 "ECONOMETRICA"
1:3 0.0839068 "J POLIT ECON"
1:4 0.0798547 "Q J ECON"
1:5 0.0496374 "REV ECON STUD"
1:6 0.0385711 "J ECON THEORY"
1:7 0.0254713 "J MONETARY ECON"
1:8 0.0252983 "REV ECON STAT"
1:9 0.0204262 "ECON J"
1:10 0.0203133 "J PUBLIC ECON"
1:11 0.0195658 "J ECONOMETRICS"
1:12 0.0186805 "J ECON LIT"
1:13 0.0180784 "GAME ECON BEHAV"
1:14 0.0173142 "J FINANC ECON"
1:15 0.0169592 "RAND J ECON"
1:16 0.0158444 "J ECON PERSPECT"
1:17 0.0132149 "J INT ECON"
1:18 0.011316 "EUR ECON REV"
1:19 0.00980755 "INT ECON REV"
1:20 0.00809578 "J LABOR ECON"
1:21 0.0077283 "ECON LETT"
1:22 0.00738151 "J HUM RESOUR"
1:23 0.00648166 "J MONEY CREDIT BANK"
1:24 0.00559433 "J MATH ECON"
1:25 0.0054819 "BROOKINGS PAP ECO AC"
1:26 0.00526874 "J BUS ECON STAT"
1:27 0.00525509 "J ECON BEHAV ORGAN"
1:28 0.00522401 "J URBAN ECON"
1:29 0.00501923 "ECONOMET THEOR"
1:30 0.00485375 "J ECON DYN CONTROL"
1:31 0.0047839 "PUBLIC CHOICE"
1:32 0.0047754 "J DEV ECON"
1:33 0.00463655 "ECON THEOR"
1:34 0.00449119 "J LAW ECON"
1:35 0.00430744 "INT J GAME THEORY"
1:36 0.00422952 "J EUR ECON ASSOC"
1:37 0.00397572 "REV ECON DYNAM"
1:38 0.00290791 "J FINANC QUANT ANAL"
1:39 0.00282513 "J ECON GROWTH"
1:40 0.0026741 "J HEALTH ECON"
1:41 0.00249058 "J ACCOUNT ECON"
1:42 0.00236668 "J APPL ECONOM"
1:43 0.00231484 "J BANK FINANC"
1:44 0.00229486 "J LAW ECON ORGAN"
1:45 0.00222327 "J RISK UNCERTAINTY"
1:46 0.00219662 "INT J IND ORGAN"
1:47 0.00179819 "ECONOMICA"

1:48 0.00177034 "ECON INQ"
1:49 0.00176244 "REG SCI URBAN ECON"
1:50 0.0017202 "CAN J ECON"
1:51 0.00170511 "J ECON GEOGR"
1:52 0.00169829 "WORLD BANK ECON REV"
1:53 0.00164934 "J IND ECON"
1:54 0.00164622 "SCAND J ECON"
1:55 0.00161081 "SOC CHOICE WELFARE"
1:56 0.00152841 "ECONOMET REV"
1:57 0.0014727 "INT TAX PUBLIC FINAN"
1:58 0.00144919 "J ECON MANAGE STRAT"
1:59 0.00142907 "OXFORD ECON PAP"
1:60 0.00139335 "NATL TAX J"
1:61 0.00134385 "J COMP ECON"
1:62 0.00132726 "APPL ECON"
1:63 0.00130516 "ECON DEV CULT CHANGE"
1:64 0.00126981 "IND CORP CHANGE"
1:65 0.00119948 "HEALTH ECON"
1:66 0.00117856 "ECON POLICY"
1:67 0.00116042 "S AFR J ECON"
1:68 0.0011436 "OXFORD B ECON STAT"
1:69 0.00114353 "ENERG ECON"
1:70 0.00111187 "ECONOMET J"
1:71 0.00111025 "CAMB J ECON"
1:72 0.00106758 "ECON REC"
1:73 0.00106733 "EXP ECON"
1:74 0.0010635 "J TRANSP ECON POLICY"
1:75 0.00105188 "J HOUS ECON"
1:76 0.00104848 "MATH FINANC"
1:77 0.00101401 "WORLD ECON"
1:78 0.00101278 "ENERG J"
1:79 0.000982464 "HIST POLIT ECON"
1:80 0.000980377 "IMF STAFF PAPERS"
1:81 0.000979472 "LABOUR ECON"
1:82 0.000978229 "FED RESERVE BANK ST"
1:83 0.000974378 "SMALL BUS ECON"
1:84 0.000960064 "J REGIONAL SCI"
1:85 0.000955351 "J POPUL ECON"
1:86 0.000950302 "SOUTH ECON J"
1:87 0.000923934 "THEOR DECIS"
1:88 0.000918528 "CHINA ECON REV"
1:89 0.000906252 "ECON TRANSIT"
1:90 0.000898429 "J EVOL ECON"
1:91 0.000894581 "ECON EDUC REV"
1:92 0.000893835 "MACROECON DYN"
1:93 0.000861828 "J REGUL ECON"
1:94 0.000858821 "EMPIR ECON"
1:95 0.000857604 "J PROD ANAL"
1:96 0.000850706 "J AFR ECON"
1:97 0.000817693 "J ECON ISSUES"

1:98 0.000817287 "J POST KEYNESIAN EC"
1:99 0.000815024 "REV IND ORGAN"
1:100 0.000814633 "EKON CAS"
1:101 0.000805598 "EUR J HIST ECON THOU"
1:102 0.000803625 "QUANT FINANC"
1:103 0.000803477 "KYKLOS"
1:104 0.000799595 "APPL ECON LETT"
1:105 0.000799204 "J ECON EDUC"
1:106 0.000791535 "J ECON PSYCHOL"
1:107 0.000789165 "WORLD BANK RES OBSER"
1:108 0.000787986 "J JPN INT ECON"
1:109 0.000780928 "AUST ECON REV"
1:110 0.000777213 "REV INCOME WEALTH"
1:111 0.000774083 "J INST THEOR ECON"
1:112 0.000768566 "J POLICY ANAL MANAG"
1:113 0.000767064 "RES POLICY"
1:114 0.000764345 "J POLICY MODEL"
1:115 0.000761359 "INT REV LAW ECON"
1:116 0.000761208 "ECON MODEL"
1:117 0.000759799 "INT J FORECASTING"
1:118 0.000759358 "J ECON"
1:119 0.000757935 "B INDONES ECON STUD"
1:120 0.000755916 "MANCH SCH"
1:121 0.000755916 "J MACROECON"
1:122 0.000750321 "J ECON SURV"
1:123 0.00074778 "STUD NONLINEAR DYN E"
1:124 0.000745266 "CONTEMP ECON POLICY"
1:125 0.000741359 "AM J ECON SOCIOL"
1:126 0.000741359 "CESIFO ECON STUD"
1:127 0.000741359 "CHINA WORLD ECON"
1:128 0.000741359 "DEFENCE PEACE ECON"
1:129 0.000741359 "DESARROLLO ECON"
1:130 0.000741359 "DEV ECON"
1:131 0.000741359 "EASTERN EUR ECON"
1:132 0.000741359 "ECON DEV Q"
1:133 0.000741359 "ECON GEOGR"
1:134 0.000741359 "ECON HUM BIOL"
1:135 0.000741359 "ECON PHILOS"
1:136 0.000741359 "ECONOMIST-NETHERLAND"
1:137 0.000741359 "EMERG MARK FINANC TR"
1:138 0.000741359 "FEM ECON"
1:139 0.000741359 "FINANZARCHIV"
1:140 0.000741359 "FISC STUD"
1:141 0.000741359 "HITOTSUB J ECON"
1:142 0.000741359 "INDEP REV"
1:143 0.000741359 "INF ECON POLICY"
1:144 0.000741359 "INT J TRANSP ECON"
1:145 0.000741359 "INVEST ECON-MEX"
1:146 0.000741359 "INVEST ECON-SPAIN"
1:147 0.000741359 "J APPL ECON"

1:148 0.000741359 "J ECON POLICY REFORM"
1:149 0.000741359 "JAHRB NATL STAT"
1:150 0.000741359 "JPN ECON REV"
1:151 0.000741359 "JPN WORLD ECON"
1:152 0.000741359 "OPEN ECON REV"
1:153 0.000741359 "OXFORD REV ECON POL"
1:154 0.000741359 "PAC ECON REV"
1:155 0.000741359 "POLIT EKON"
1:156 0.000741359 "PORT ECON J"
1:157 0.000741359 "POST-COMMUNIST ECON"
1:158 0.000741359 "QME-QUANT MARK ECON"
1:159 0.000741359 "REV DEV ECON"
1:160 0.000741359 "REV ECON APL-SPAIN"
1:161 0.000741359 "REV ECON POLIT"
1:162 0.000741359 "REV WORLD ECON"
1:163 0.000741359 "S AFR J ECON MANAG S"
1:164 0.000741359 "SCOT J POLIT ECON"
1:165 0.000741359 "SPAN ECON REV"
1:166 0.000741359 "TIJDSCHR ECON SOC GE"
1:167 0.000741359 "TRANSFORM BUS ECON"
1:168 0.000741359 "TRIMEST ECON"
2:1 0.0051137 "AM J AGR ECON"
2:2 0.0030435 "J ENVIRON ECON MANAG"
2:3 0.0018774 "LAND ECON"
2:4 0.00179327 "ECOL ECON"
2:5 0.00140488 "ENVIRON RESOUR ECON"
2:6 0.00129347 "AGR ECON-BLACKWELL"
2:7 0.00125121 "J AGR RESOUR ECON"
2:8 0.00112119 "EUR REV AGRIC ECON"
2:9 0.00106181 "REV AGR ECON"
2:10 0.00103338 "RESOUR ENERGY ECON"
2:11 0.000979744 "J AGR ECON"
2:12 0.000960698 "FOOD POLICY"
2:13 0.000800019 "CAN J AGR ECON"
2:14 0.00078082 "AUST J AGR RESOUR EC"
2:15 0.000759901 "FUTURES"
2:16 0.000741359 "J FOREST ECON"
3:1 0.00541675 "J ECON HIST"
3:2 0.0026924 "EXPLOR ECON HIST"
3:3 0.00169387 "ECON HIST REV"
4:1 0.00413726 "WORLD DEV"
4:2 0.00160977 "REV INT POLIT ECON"
4:3 0.00114833 "J DEV STUD"
4:4 0.000765228 "ECON SOC"
4:5 0.000741359 "J AGRAR CHANGE"
4:6 0.000741359 "NEW POLIT ECON"
5:1 0.00230745 "EUROPE-ASIA STUD"
5:2 0.00184246 "POST-SOV AFF"
5:3 0.00160159 "JCMS-J COMMON MARK S"
6:1 0.00176123 "INSUR MATH ECON"

6:2 0.00130728 "J RISK INSUR"
6:3 0.00118212 "ASTIN BULL"
7:1 0.00158401 "J REAL ESTATE FINANC"
7:2 0.001471 "REAL ESTATE ECON"
7:3 0.00103064 "J REAL ESTATE RES"
8:1 0.000741359 "AUST ECON HIST REV"
9:1 0.000741359 "EKON SAMF TIDSKR"
10:1 0.000741359 "GENEVA RISK INS REV"
11:1 0.000741359 "HACIENDA PUBLICA ESP"
12:1 0.000741359 "J MEDIA ECON"
13:1 0.000741359 "J POLICY REFORM"
14:1 0.000741359 "REV ETUD COMP EST-O"
15:1 0.000741359 "WORK EMPLOY SOC"

Appendix 2

Code length 5.99583 in 34 modules.
1:1 0.0382952 "J ECON LIT"
1:2 0.0344744 "J ECON PERSPECT"
1:3 0.0317888 "EUR ECON REV"
1:4 0.0239354 "INT ECON REV"
1:5 0.021897 "J INT ECON"
1:6 0.0192211 "BROOKINGS PAP ECO AC"
1:7 0.0162839 "J MONEY CREDIT BANK"
1:8 0.00722199 "J ECON DYN CONTROL"
1:9 0.0057537 "CAN J ECON"
1:10 0.00513855 "REV ECON DYNAM"
1:11 0.00464911 "J ECON GROWTH"
1:12 0.00461613 "SCAND J ECON"
1:13 0.00333344 "ECON POLICY"
1:14 0.0027062 "WORLD ECON"
1:15 0.00233078 "OXFORD ECON PAP"
1:16 0.00207171 "WORLD BANK RES OBSER"
1:17 0.0020556 "J EUR ECON ASSOC"
1:18 0.00187782 "REV ECON APL-SPAIN"
1:19 0.0015151 "FED RESERVE BANK ST"
1:20 0.00133446 "REV DEV ECON"
1:21 0.00129667 "B INDONES ECON STUD"
1:22 0.00126288 "OXFORD REV ECON POL"
1:23 0.00124684 "ECONOMICA"
1:24 0.00123326 "JPN ECON REV"
1:25 0.00118296 "REV WORLD ECON"
1:26 0.00114161 "OPEN ECON REV"
1:27 0.00111795 "INVEST ECON-MEX"
1:28 0.00109697 "LABOUR ECON"
1:29 0.00106625 "AM J ECON SOCIOL"
1:30 0.00101413 "J ECON SURV"
1:31 0.000880874 "J POLICY MODEL"
1:32 0.000847357 "CESIFO ECON STUD"
1:33 0.000814296 "J MACROECON"
1:34 0.000711637 "ECON MODEL"
1:35 0.000576817 "KYKLOS"
1:36 0.000520085 "J ECON EDUC"
1:37 0.000338982 "SCOT J POLIT ECON"
1:38 0.000111066 "J JPN INT ECON"
1:39 8.96663e-05 "JPN WORLD ECON"
2:1 0.0544992 "J ECONOMETRICS"
2:2 0.018279 "J BUS ECON STAT"
2:3 0.0160412 "ECON LETT"
2:4 0.0118198 "ECONOMET THEOR"
2:5 0.00734851 "J APPL ECONOM"
2:6 0.00500022 "ECONOMET REV"
2:7 0.00283661 "APPL ECON"
2:8 0.00267979 "OXFORD B ECON STAT"

2:9 0.00245636 "ECONOMET J"
2:10 0.0016711 "EMPIR ECON"
2:11 0.00146588 "SPAN ECON REV"
2:12 0.00122032 "MACROECON DYN"
2:13 0.00105833 "ECON EDUC REV"
2:14 0.000915609 "J PROD ANAL"
2:15 0.000871193 "APPL ECON LETT"
2:16 0.000671467 "INT J FORECASTING"
2:17 0.000522888 "J APPL ECON"
2:18 0.000498092 "STUD NONLINEAR DYN E"
2:19 0.000154284 "MANCH SCH"
3:1 0.0734083 "J FINANC ECON"
3:2 0.019591 "J FINANC QUANT ANAL"
3:3 0.0174406 "J ACCOUNT ECON"
3:4 0.0110545 "J BANK FINANC"
3:5 0.00111675 "TRIMEST ECON"
3:6 0.00108295 "PAC ECON REV"
3:7 0.000917738 "EMERG MARK FINANC TR"
3:8 0.000494066 "QUANT FINANC"
4:1 0.0249421 "RAND J ECON"
4:2 0.019912 "J LAW ECON"
4:3 0.00754184 "J HEALTH ECON"
4:4 0.00635569 "INT J IND ORGAN"
4:5 0.00521447 "J IND ECON"
4:6 0.00462431 "J LAW ECON ORGAN"
4:7 0.00439651 "J ECON MANAGE STRAT"
4:8 0.00264957 "ECON INQ"
4:9 0.00210396 "HEALTH ECON"
4:10 0.000924498 "QME-QUANT MARK ECON"
4:11 0.00081833 "INF ECON POLICY"
4:12 0.00074975 "REV IND ORGAN"
4:13 0.000682503 "J REGUL ECON"
4:14 0.000654306 "ECONOMIST-NETHERLAND"
4:15 0.000610065 "INT REV LAW ECON"
4:16 0.000495252 "ECON HUM BIOL"
4:17 0.000301605 "JAHRB NATL STAT"
4:18 0.000168945 "CONTEMP ECON POLICY"
5:1 0.019455 "AM J AGR ECON"
5:2 0.0117109 "J ENVIRON ECON MANAG"
5:3 0.00736502 "LAND ECON"
5:4 0.00456458 "ENVIRON RESOUR ECON"
5:5 0.00441995 "ECOL ECON"
5:6 0.00402121 "J AGR RESOUR ECON"
5:7 0.00371497 "AGR ECON-BLACKWELL"
5:8 0.00338238 "REV AGR ECON"
5:9 0.00289983 "EUR REV AGRIC ECON"
5:10 0.00262483 "FOOD POLICY"
5:11 0.00229947 "J AGR ECON"
5:12 0.00211898 "RESOUR ENERGY ECON"
5:13 0.00203038 "CAN J AGR ECON"

5:14 0.0018989 "J FOREST ECON"
5:15 0.00186086 "AUST J AGR RESOUR EC"
5:16 0.00165091 "ENERG ECON"
5:17 0.00150961 "FUTURES"
5:18 0.00140904 "ENERG J"
6:1 0.0185272 "J DEV ECON"
6:2 0.0145134 "WORLD DEV"
6:3 0.00620023 "WORLD BANK ECON REV"
6:4 0.00566275 "ECON DEV CULT CHANGE"
6:5 0.00559836 "REV INT POLIT ECON"
6:6 0.00358877 "J DEV STUD"
6:7 0.00255338 "J AFR ECON"
6:8 0.00249959 "IMF STAFF PAPERS"
6:9 0.00190307 "J AGRAR CHANGE"
6:10 0.00188697 "NEW POLIT ECON"
6:11 0.00177864 "REV INCOME WEALTH"
6:12 0.00170755 "ECON SOC"
7:1 0.0355805 "J HUM RESOUR"
7:2 0.0220126 "J LABOR ECON"
7:3 0.00157257 "J POPUL ECON"
7:4 0.00115831 "FEM ECON"
7:5 0.000993311 "J POLICY ANAL MANAG"
8:1 0.0184693 "J URBAN ECON"
8:2 0.00778262 "REG SCI URBAN ECON"
8:3 0.00559749 "J REAL ESTATE FINANC"
8:4 0.00519206 "REAL ESTATE ECON"
8:5 0.00386056 "J HOUS ECON"
8:6 0.00362036 "J REGIONAL SCI"
8:7 0.00338514 "J TRANSP ECON POLICY"
8:8 0.0031375 "J REAL ESTATE RES"
8:9 0.00187047 "TIJDSCHR ECON SOC GE"
8:10 0.00181798 "INT J TRANSP ECON"
8:11 0.00141279 "INVEST ECON-SPAIN"
9:1 0.0075838 "J ECON BEHAV ORGAN"
9:2 0.00578034 "GAME ECON BEHAV"
9:3 0.00433134 "ECON THEOR"
9:4 0.00276574 "PUBLIC CHOICE"
9:5 0.00205424 "J RISK UNCERTAINTY"
9:6 0.00175361 "J MATH ECON"
9:7 0.00170405 "INT J GAME THEORY"
9:8 0.00132581 "SOC CHOICE WELFARE"
9:9 0.000987514 "THEOR DECIS"
9:10 0.00083172 "EXP ECON"
9:11 0.000765602 "SOUTH ECON J"
9:12 0.000715144 "DEFENCE PEACE ECON"
9:13 0.000385329 "J ECON PSYCHOL"
9:14 0.000301942 "J INST THEOR ECON"
9:15 0.000199161 "J ECON"
9:16 0.000113127 "REV ECON POLIT"
9:17 8.17137e-05 "ECON PHILOS"

10:1 0.00633819 "J ECON GEOGR"
10:2 0.00330172 "IND CORP CHANGE"
10:3 0.00231433 "CAMB J ECON"
10:4 0.00192449 "SMALL BUS ECON"
10:5 0.00190248 "ECON DEV Q"
10:6 0.00173726 "ECON GEOGR"
10:7 0.00139171 "J EVOL ECON"
10:8 0.00136329 "DEV ECON"
10:9 0.0013467 "J POST KEYNESIAN EC"
10:10 0.00131395 "J ECON ISSUES"
10:11 0.000917521 "RES POLICY"
11:1 0.00874884 "J ECON HIST"
11:2 0.00570774 "EXPLOR ECON HIST"
11:3 0.00311236 "ECON HIST REV"
12:1 0.00444263 "J COMP ECON"
12:2 0.00249885 "ECON TRANSIT"
12:3 0.00229314 "CHINA ECON REV"
12:4 0.00178776 "CHINA WORLD ECON"
12:5 0.00177941 "POST-COMMUNIST ECON"
13:1 0.00541475 "INT TAX PUBLIC FINAN"
13:2 0.00225335 "NATL TAX J"
13:3 0.0018651 "FISC STUD"
13:4 0.00147005 "FINANZARCHIV"
14:1 0.00425595 "EUROPE-ASIA STUD"
14:2 0.00336874 "POST-SOV AFF"
14:3 0.00272944 "JCMS-J COMMON MARK S"
15:1 0.00355931 "INSUR MATH ECON"
15:2 0.00216783 "ASTIN BULL"
15:3 0.00187037 "J RISK INSUR"
15:4 0.00134436 "MATH FINANC"
16:1 0.00347678 "EKON CAS"
16:2 0.00184721 "POLIT EKON"
17:1 0.00301441 "ECON REC"
17:2 0.00215113 "AUST ECON REV"
18:1 0.00243847 "S AFR J ECON"
18:2 0.00127859 "S AFR J ECON MANAG S"
19:1 0.00190785 "REV ETUD COMP EST-O"
20:1 0.00190725 "HITOTSUB J ECON"
21:1 0.00189452 "EKON SAMF TIDSKR"
22:1 0.00186053 "WORK EMPLOY SOC"
23:1 0.00183229 "AUST ECON HIST REV"
24:1 0.00175118 "GENEVA RISK INS REV"
25:1 0.00171042 "DESARROLLO ECON"
26:1 0.00166052 "HACIENDA PUBLICA ESP"
27:1 0.00161777 "EASTERN EUR ECON"
28:1 0.00153208 "TRANSFORM BUS ECON"
29:1 0.00150862 "J MEDIA ECON"
30:1 0.000877378 "J POLICY REFORM"
31:1 0.000331555 "HIST POLIT ECON"
31:2 0.000170584 "EUR J HIST ECON THOU"

32:1 0.000451712 "J ECON POLICY REFORM"
33:1 0.000258462 "PORT ECON J"
34:1 0.00018649 "INDEP REV"

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