

Next Steps in the Information Infrastructure in Economics*

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Abstract

This paper updates [Goffe and Parks \(1997\)](#), which examined the Internet infrastructure of the economics profession and advocated changes to it. Much that was predicted and advocated in that paper has come to pass, yet the fundamentals of economic discourse have changed little. Rather than just proposing revolutionary changes, this paper explores the adoption of the most successful Internet service for economists to date, “Research Papers in Economics” (RePEc), which currently has metadata on more than 568,000 items. This paper next explores the reasons for its success and then studies how publication practices have changed in the profession. In this light, it then proposes new information technologies to improve the productivity of the profession.

1 Introduction

On the surface, the Internet has dramatically changed the lives of economists. Instead of going to the library for a journal, we can quickly find it on-line from the comfort of our office or home. With that electronic version, we can easily search for the phrase we remember. Rather than waiting for journals, we can be informed about the latest research via announcement lists delivered by e-mail, then the working paper or article can be immediately read. Likewise, data are now much easier to obtain. Much of this was foretold in [Goffe](#)

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and Parks (1997).^{*} Other practices have changed as well; Hamermesh and Oster (2002) documented the rise of coauthorship and ascribed it to better communications technologies. Kim et al. (2006a) argued that these technologies have reduced the relative productivity of elite departments. More ominously, Ellison (2007) found that members of elite departments are beginning to distribute some of their works on-line and are bypassing peer review.

Yet, to date, the fundamentals of economic research have barely changed. As Gläser (2003) argued for academics in general, on-line practices of economists still generally mirror those of the pre-Internet era: papers (albeit now electronic) are the main medium of discourse, publications filter and archive academic debates, the review process continues as before, and replication studies are rare. A reasonable analogy is presented by David (1990). When electric motors replaced steam and water power in factories circa 1900, at first it was a direct replacement—a large electric motor was used to drive all the machines in a plant via belts and pulleys. Not until the 1920s or so were electric motors placed in individual machines, and only then did productivity dramatically improve with the new technology.[†] This paper describes how the Internet might be used by economists to fundamentally change their research practices to in order to increase the field’s productivity. Put another way, it updates Goffe and Parks (1997).

This paper is organized as follows. The next section looks at the largest provider of Internet services to economists, RePEc, and suggests some reasons for its success and how it might change in the future. This then transitions into the broader question of how economists’ research practices change. Finally, taking these tentative findings, possible changes to the Internet infrastructure for economists are proposed.

2 RePEc — History, Technology, and the Future

RePEc (“Research Papers in Economics”)[‡] is a distributed database describing economics working papers, articles, books, book chapters, and software items. No items are held by RePEc; rather it holds metadata about these items. The actual works are held by those who run participating RePEc archives. The focus here is on RePEc as it is the largest such database in the profession and one of the largest in academia. While the comparison is not exact, as of January, 2008, it described more than 568,000 items (LogEc), while arXiv.org had more than 463,000 e-prints in February, 2008 (arXiv). Certainly the Social Science Research Network (SSRN) has a very substantial impact, but its holdings in February, 2008 were

^{*}If you are reading this electronically, you should be able to click on citations and be taken to the bibliography. At the end of each entry there, you will find the page number; clicking on it will return you to the text. Many of the references include clickable URLs. Links to external sites listed in the text are also clickable.

[†]Today David seems particularly prescient. In 1990 his focus was slow productivity growth in the U.S. despite the expanding use of computers. Robert Solow is said to have quipped, “You can see the computer age everywhere but in the productivity statistics.” Of course, productivity did begin to rise more rapidly in the mid-1990s.

[‡]The author is tangentially involved with RePEc. While he does not offer any RePEc services, he does host one of its machines and is a participant in the main RePEc listserv.

about 175,000 abstracts (and 126,600 full text papers) spread across economics and 14 other fields ([SSRN](#)). While the National Bureau of Economic Research (NBER) and the American Economic Association (AEA) have very extensive Internet operations, their coverage is more focused.* If there are to be significant changes in the on-line experience of economists, one would suspect that RePEc might be involved given its size.

Thomas Krichel founded RePEc. It began as an outgrowth of “NetEc,” which he started in 1993 as a way for economists to use the Internet to aid their research ([Karlsson and Krichel, 1999](#)). In 1997 the basic structure of RePEc was set by the “Guildford Protocol” ([Krichel, 1997](#)). One part describes the structure of text files, stored on ftp or Web servers, that RePEc archives use to describe their holdings. Each work is described by a unique alphanumeric “handle.” An archive might be an economics department, an international organization, or a publisher. Notable archives include Elsevier, Springer, Oxford University Press, University of Chicago Press, the U.S. Federal Reserve, the International Monetary Fund, the World Bank, and the economics departments at Penn, Yale, and Princeton. By the middle of February, 2008, 862 archives had been created. The EconWPA (“Economics Working Paper Archive”) run by Bob Parks[†] and later MPRA (“Munich Personal RePEc Archive”) offer a RePEc outlet for economists whose institutions do not host a RePEc archive. Once the metadata from the archives are collected, they are merged into one database. In Kling’s terminology ([Kling, 2004](#)), RePEc merges “guilds.”

The metadata from the archives are merged together into one master database. RePEc “services” use it for offerings to end users. Perhaps the most important are [IDEAS](#) (“Internet Documents in Economics Access Service”) run by Christian Zimmermann, [EconPapers](#) run by Sune Karlsson, [NEP](#) (“New Economics Papers”) run by Marco Novarese, [RePEc Author Services](#) run by Christian Zimmermann (Ivan Kurmanov helped start it), and [CitEc](#) run by Jose Manuel Barrueco. The first two are Web sites for searching RePEc metadata, while NEP is an e-mail notification service of new RePEc contents broken down into sub-disciplines. By the middle of February, 2008, some 19,957 unique e-mail addresses were subscribed ([New Economic Papers](#)). RePEc Author Services offers a registration service for authors for their current contact information, a research profile of an author’s works, a database of downloads and abstract views for each author, and data for various rankings in the field. As mid-February, 2008, nearly 20,750 have registered with the service and some 15,500 have gone on to claim their works in RePEc and to fill out their publication profile ([RePEc Author Services](#)). By comparison, the AEA had some 16,800 members at the end of 2007 ([AEA](#)). Finally, CitEc performs citation analysis on works in RePEc.

Data on RePEc for January, 2008, are presented in Table 1 ([LogEc](#)).

*The NBER carries works by their associates, and the AEA’s EconLit is more focused on the published literature.

[†]It used the same software as Paul Ginsparg’s then archive at Los Alamos. It no longer accepts new papers after a withdrawal of support from his institution, Washington University.

Journal Articles	334,204
Working Papers	229,875
Chapters	1,869
Software Items	1,565
Books	1,062
Total	568,575
Downloadable	458,588

To understand RePEc’s role, it helps to use [Roosendaal and Geurts \(1998\)](#), which describes the functions of a complete scholarly communication system:

- registration—a work is announced to the interested public with clear attribution;
- certification—in some fashion, the work meets the standards of the field;
- awareness—the work is distributed to interested parties;
- archiving—the work can be retrieved at a later date.

In the classical world of paper journals with no distributed working papers, each of these functions is quite clear: a work is registered when it appears in print, peer review certifies it, journal distribution leads to awareness, and libraries and publishers archive the works. In this light, RePEc is primarily a registration and awareness service: NEP announces new ones and EconPapers and IDEAS let users search for existing works. Its registration services are partial as it reflects the contents of its member archives. It offers no certification, which would of course be problematic for works from journals, and it relies on its archives to store the material.

[Van de Sompel et al. \(2004\)](#) offered an interesting analysis of arXiv in this framework. It functions as a registration service as the entry date of a paper into the system is accepted as its public debut. It only offers a minor amount of certification with light filtering; physics journals do quite a bit more. It clearly offers authors awareness via announcement lists and its searchable database. Finally, papers are archived both on arXiv and at its mirrors.

RePEc owes its success to many factors. First, one must list the persistence of Thomas Krichel and the small group of volunteers he has gathered over more than a decade. For years they worked with little recognition and no compensation. One can honestly wonder if something like RePEc would have come about without their efforts.

Second, it built upon existing practices in the field. Economics is an “open flow field” ([Kling and McKim, 2000](#)) where economists widely share their working papers and often go on to self-archive ([Bergstrom and Lavaty, 2007](#)). Odd as it may sound to economists, many fields do not share this practice.* Thus, while the technology was new, it built upon existing

*For example, as described by [Kling and McKim \(2000\)](#), when PubMed Central, a repository for research in the life and biological sciences was first proposed, it was to distribute working papers. After considerable controversy, it went with distributing peer-reviewed works.

practices; just like arXiv, which stemmed from a strong pre-print culture, at its core it was fundamentally evolutionary, yet also offered something valuable for participants: increased awareness of their works.

A third factor contributing to RePEc's success is the ease with which an organization can set up an archive. Each consists of text files, describing its metadata, on a Web or ftp site. As Kit Baum, who assists in establishing archives has noted, even this taxed many archive administrators. This suggests that archives must be able to work with those with limited technical skills. Baum reported that often an archive maintainer is a secretary or administrative assistant.

Fourth, RePEc was developed by economists for economists so field norms were preserved and "outsiders" did not have to learn and adapt to a field's peculiarities. Like all academics, economists tend to look toward their discipline, and not those outside, for the latest research practices. [Davis and Connolly \(2007\)](#) illustrated how strongly researchers identify with their own field over their institution regarding these practices.* While the impact is unclear, most initial RePEc archives were from mid-tier institutions. Only in the last few years have elite departments joined RePEc, and this was encouraged by the AEA. One might hypothesize that mid-tier departments had a greater need for awareness than elite institutions, and the lower-ranked departments had little to advertise.

[Roosendaal and Geurts \(1998\)](#) illustrated how RePEc might evolve in the future. First, as in [Goffe and Parks \(1997\)](#), it could use "digital time stamping" to offer registration services when RePEc adds works to its database. This software authenticates the existence of an electronic document on a given date. For working papers, and perhaps even for journal articles, it could archive works. As in [Van de Sompel et al. \(2004\)](#), one option might be something like the nonprofit group [LoCKSS \(Lots of Copies Keep Stuff Safe\)](#). As the name implies, they keep multiple copies of works in varied locations to ensure their safety. Direct archiving would certainly be a shift for RePEc from just collecting and describing metadata, but one could argue that many authors might look favorably on the concept as it increases access to their works in the event a local archive becomes defunct or files are lost in a crash. Since this is a significant change, it might be wise to make this an opt-in system. It is hard to envision RePEc sponsoring certification in terms of peer review, but perhaps other systems might be investigated; [MESUR](#) provides various ideas on this point.

Looking beyond [Roosendaal and Geurts \(1998\)](#), one could imagine full-text searches of working papers and perhaps publications. Also, as RePEc handles are largely fixed over time, the profession might decide to use them in bibliographical entries to aid citation analysis. Currently, citation analysis in economics is plagued by numerous problems: the difficulty that CitEc has in analyzing bibliographies written for humans and not machines, in typos by humans, the use of initials for first names by the Web of Science, and the limited coverage of economics journals by the latter. RePEc handles in bibliographies would surmount many of these problems as they could easily be read by software.

Finally, the rise of RePEc illustrates how new technologies engender unforeseen uses. In

*The Internet may increase scholars' identification with their field as they can have more frequent contact with others in it.

an interesting twist, there are reports that editors are using RePEc to scan for papers for their journals. Thus, rather than authors submitting their works, editors are inviting them. It is hard to imagine this in the previous paper-based world.

3 Changes in Publication Practices in Economics

Before examining changes to the research practices of economists that might be facilitated by the Internet, it is useful to briefly examine how research practices have changed in the past. As the history of RePEc suggests, change seems to be evolutionary and based on current practices. This may be a common theme in the decentralized U.S. higher education system—there seem to be few mechanisms to force abrupt change. Further, economics seems less centralized than many academic fields as the AEA sets very few if any policies for economists.* Perhaps this stems from the market-based, decentralized decision-making that economists study.

While change may not be sudden, research practices are influenced by both technology and features of the discipline. [Kling and McKim \(2000\)](#) emphasized this interplay between technology and social forces by the “social shaping of technology” and “New Institutionalism.” The former argues that rather than technology forcing social change, there is an interplay between the two. The latter is described as follows:

...many choices of organizational actors are governed by highly routinized habits, scripts, rote actions, and imitation of elites; these routinized actions are conditioned by and reinforced by centralized institutions...

A comparison to other fields might help illustrate these concepts. In economics, of course, there is a strong working paper culture and the Internet has expanded it. [Davis and Connolly \(2007\)](#) quoted two non-economics Cornell faculty members on why they prefer not to make their works available before formal publication. First, a historian: “There is absolutely no incentive to make your work broadly available electronically before it appears in print.” A biologist: “I’m careful not to clutter the world with mistakes.” Their fields clearly have access to the same technologies as economists but the incentives and practices in their fields are different.

One might argue that disciplines take an implicit cost-benefit approach to designing their practices, but [Ellison \(2002b\)](#) provides an intriguing argument that this is not the case. First, he looks at changes in the review process:

*For instance, the AEA does not publish a style manual (indeed, its three current journals have different styles). The American Psychological Association is strikingly different with its 439-page publication manual; the Modern Language Association offers its own, as does the American Mathematical Society and the American Institute of Physics (an umbrella organization which includes the American Physical Society, the American Astronomical Society, and eight others). The American Psychological Association, the American Historical Association, and the American Anthropological Association publish ethical guides for their professions, while the AEA does not. All of these societies, except the AEA, publicly advocate for their members and make public statements. I also recall the current AEA Secretary-Treasurer, John Siegfried, telling me it is no accident that the AEA does not have an executive director.

What may be most striking is that in the early 1970’s most papers got through the entire process of reviews and revisions in well under a year. If we go back another decade or two, almost all initial submissions were either accepted or rejected—the noncommittal “revise-and-resubmit” was reserved for exceptional cases.

Today, he finds that it now takes about two years for a paper to make it through the process. He goes on to argue that changing social norms explain well over half of the slowdown, and in [Ellison \(2002a\)](#) he proposed a model based on the interaction of referees and authors. One could argue that this view is broadly similar to [Kling and McKim \(2000\)](#).

Taken together, these suggest that research practices do change, but often at a slow pace that may be imperceptible. Also, fields vary widely in their practices. Some practices may not even be by design and might even be to the field’s detriment. Also, in economics, there is no central authority to direct change, but as RePEc demonstrates, innovations seem more likely to come from inside the field from those with an intimate knowledge of its practices than from outside.

4 Proposed Changes in the Economics Infrastructure

4.1 Paper Length and Format

[Ellison \(2002a\)](#) described how paper length varies dramatically by field. Certainly field characteristics and social norms, as in [Ellison \(2002b\)](#) and [Kling and McKim \(2000\)](#), drive some of this, but one could argue that technology also plays a role. In a world dominated by journals without working papers, much of the lag in distributing research results came from reviewing and actually publishing works. As a result, the actual time spent writing papers was unlikely to dominate the total time from conception to awareness by the academic community. The situation today is different—in economics a paper can be distributed as soon as it is finished, so now the entire time between the conception of a paper and its public debut comes from the time spent writing it. As paper length may be roughly proportional to the time spent writing it, this suggests that papers might be shorter in the Internet era in order to promote more rapid dialog.* As [Ellison \(2002a\)](#) documented, papers have gotten longer in the last few decades and this may have hindered the rapid exchange of ideas.

Given the nature of the economics profession, how might a change in paper length be achieved? It would appear that the only place would be journal editors and boards. One might imagine that in an effort to improve their ratings, they would request shorter papers that would be more current, and thus more likely to be cited. They also might appeal to authors looking for a quicker outlet for their works.

Despite several hundred thousand on-line working papers, very few appear to have links in their body to their references, URLs in the references, or working links for those URLs. One cannot imagine a more direct example of David’s point that at first new technologies

*Ironically, the Internet may well encourage longer papers as there are no page limits in the virtual world.

often simply replace the previous generation without using the benefits of the new. Upon reflection, it seems remarkable that such an essential feature of the Internet is lacking in working papers on the Internet.

However, it is not obvious how economists might come to include links in their papers. There is no organization that could conceivably require them for all papers given the structure of the field. It would appear that even the sponsor of the most influential working paper series, the NBER, would not be successful with such a requirement. According to the NBER's Dan Feenberg, they once imposed a very modest requirement on their authors: a margin standard. The number of new submissions then dropped "to near zero." Instead, perhaps a guide on how to add links (at least in LaTeX it is quite easy) and then encouragement would change authors' behavior.

Further in the future, one can envision a document system similar to what [Phelps and Wilensky \(2000\)](#) advocated. With their "multivalent documents" a layer of software interacts with a standard document format to provide new features. One example is a hyperlink to part of a PDF file, so papers could easily cite a specific part of another paper. Currently, papers are quite monolithic; when one is cited, it may take a careful search to find the relevant part that the reference refers to. Productivity might be raised if one could just click to a specific passage, equation, table, or graph so that readers could quickly understand the point of the citation. This might evolve to "compound documents" where parts of one paper are "reused" in another for the reader's benefit (of course, it must be correctly attributed). Or, multivalent document software might call a graphics program to dynamically display data or run a graphical simulation, just like how many Web pages now embed Flash animations. This and compound documents can now be achieved with Microsoft's "Object Linking and Embedding" (OLE), but it requires their software. Other possibilities in the near future include the winner of a competition of sorts for an "open" document format with similar features: the [Open Document Format \(ODF\)](#) which has been proposed by an industry consortium, or Microsoft's controversial [OOXML](#). At some point in the future electronic documents that simply replicate paper ones, much as how the first electric motors naively replaced steam engines, will be a thing of the past. Indeed, with these features, the primary version of a paper will no longer be in hard copy. However, this is likely to be fairly far in the future as the software is not yet ready across platforms and it is hard to see the incentives to bring about this evolution.

4.2 Replication Studies

Replication studies in economics are rare.* Perhaps this is due to social norms in the field or the "New Institutionalism" of [Kling and McKim \(2000\)](#). However, this might change with on-line journal archives containing a paper's data. The *American Economic Review* and a few other journals require that empirical papers submit their data at the time of publication. Clearly, replication aids investigations, disciplining researchers as all aspects of their work can be studied by others, and it aids those trying to learn the latest techniques. To make

*Earlier thoughts on replication studies can be found in [Goffe and Parks \(1997\)](#) and [Goffe \(2004\)](#).

replication studies more common, one could imagine journals offering replication sections. These would not carry the same weight as a regular publication, but they would offer an incentive for researchers to carry out replication studies. Such sections might be only on-line to reduce publication costs.

4.3 The Journal Review Process

Since academia changes slowly, it seems likely that journals will be used for many years to certify research. Thus, rather than the Internet somehow quickly replacing journals, it seems likely that the journal system will evolve with the new technology. The Internet's impact on the distribution of journals is quite obvious—they are now available most anywhere, albeit often at some explicit cost. However, the impact on the “input” side has been minimal. To date, it appears that copy machines did more to aid the peer review process than the Internet. As Ellison (2002b) documented, before they became widespread, papers were reviewed sequentially by referees as journals had only one copy of a submission. Copy machines enabled parallel reviews. While the Internet has sped up the referee process with instant communications, the impact likely has been smaller.

While Internet technology might aid some aspects of peer review, it is hard to envision it directly speeding up the review process. As Ellison (2002a,b) found, much of the slowdown seems to come from changing social norms for greater revisions. Ellison (2007) found that this appears to be leading some elite authors to drop out of the peer review system. Further, there are complaints that authors write for the likely reviewers while reviewers unreasonably promote their own works. Technology will not change these practices, but journals have an incentive to explicitly change them to speed up the process or make it less biased. In 2007, *Economic Inquiry*, under its new editor, R. Preston McAfee, announced a “no revisions” submission experiment where authors agree to an up or down judgment on their submission. One could imagine other journals following their lead to change norms that seem to have slowly crept into the field. Another option that would reduce the burden of revisions would be for editors to require authors to revise based on the intersection of reviewers' comments, not the union of their suggestions.

One obvious way that the Internet could aid peer review would be to let interested readers comment on submitted papers with what some call “open peer review.” This mimics commercial sites like Amazon.com, where numerous customers write product reviews. However, this has been tried by at least four journals outside economics, *Nature*, *Biology Direct*, *Medical Journal of Australia*, *Atmospheric Chemistry and Physics*, and none has been successful. Typically few offer comments and they tend to be short. In the earlier days of the Internet, a predecessor of sorts to RePEc, WoPEc/BibEc, let users comment on papers, but they rarely did. The Society of Labor Economists tried a focused on-line discussion on selected papers, but there was insufficient interest and the project failed. More recently, the new journal *economics* allows readers to comment on papers. For 2007, 46 papers received referee reports, but only 15 received non-invited comments, and just four papers received

more than one comment.* It appears that academics have found few incentives to participate in such a system.

A “journal review consortium” is a more sophisticated way that the Internet could improve the review process.† As pointed out by [Godlee \(2000\)](#), marginal papers take more resources to review due to their likely submission to multiple journals, each with a new round of reviews. Surely it is a poor use of very scarce time to review marginal papers repeatedly. Further, each journal repeats the process of searching for reviewers and cajoling them for a timely response. In a consortium, a rejected paper would be accompanied by its initial reviews when submitted to another journal. To encourage author participation, they would be allowed to respond to the initial review and perhaps revise the paper; in a sense, there would be limited dialog between the reviewers and the authors.‡ In the pre-Internet era a “conversation” between reviewers and authors required some work on the part of the journal editorial staff to mediate the flow of paper, but today a system to keep track of papers, reviews, and responses is easy to fashion. The journal *economics* allows authors to respond to referee reports and to comments from general readers. For 2007, the 46 refereed papers had 34 responses from authors. This suggests that many authors found it valuable to respond to reviews. Further, with public referee reports and with authors having the chance to respond, one might imagine that referees would be more thoughtful and less self-serving in their reviews. One might envision such journals having an edge in the eyes of authors, so journals might have an incentive to adopt this innovation.

Something like this will be used with the four new AEA journals that begin publication in 2009. With the authors’ approval, a paper rejected by the *American Economic Review* will be submitted to one of the new field journals with a reviewer’s evaluations. This proposal expands the AEA process with an author rebuttal and revision, and to all journals that wish to participate.

This consortium would assist journals as they would have to spend less time finding reviewers and managing their responses. The profession would benefit as fewer reviews would be written. Authors too would benefit as they could respond to reviews and potentially only have to revise to one set of them. To encourage authors to submit a paper to an appropriate journal, there would be a lag for an acceptance from the second or later journal, much as there is a lag today when the system starts afresh with each resubmission. Otherwise, one could imagine authors submitting their papers to an elite journal with scant hope of acceptance, but rather for an excellent review and then a quick acceptance by an appropriate journal. As [Azar \(2007\)](#) pointed out, a delay is in order to encourage authors to submit their paper to an appropriate journal.

Given the evolutionary nature of change in the field, this system might start as an expansion of the AEA system with a few additional journals on a trial basis. As experience develops, more journals could be added. Doubtless a great deal would be learned by first

*Some papers had “invited comments,” which the editors solicited; they were not counted here.

†This idea was earlier described, in less detail, in [Goffe \(2004\)](#).

‡In submissions to computer science conferences, authors can respond to reviews. In this field, conference proceedings are taking the place of journals for filtering research and even mid-tier conferences have fairly high rejection rates.

running it on a small number of journals.

Technology might also be used to increase the incentives for good reviews. Currently, the benefits of reviewing seem scant compared to publishing. One may assist editors who might be helpful in the future, or keep up with the literature, or fulfill a sense of professional obligation. There are even fewer rewards to doing a good job or making a considered judgement on the value of a paper. It is little wonder that editors struggle to find good reviewers and to get reviews back in a reasonable time. Yet, some scholars might be better reviewers than authors; after all, talents are distributed unevenly and specialization likely occurs. However, in the current system, they have no outlet that publicly credits their efforts. Put another way, reviewers contribute to the advance of knowledge, but they toil in anonymity with few rewards. [Riggs and Wilensky \(2001\)](#) described a system where reviewers are evaluated based on how well they evaluate papers compared to other reviewers, and are thus rated more highly. Already, commercial sites like Amazon.com rate reviewers of their products. In an extension to their work, one could imagine evaluating reviewers based on how papers they rate highly subsequently “perform” (say based on cites). As [Riggs and Wilensky \(2001\)](#) described, one might look for the “best” papers by the best reviewers or for papers with a high variance to their reviews. While they discuss “herding” (many reviewers rating a paper like other existing reviews), one could tweak their algorithm by not announcing reviews before a set date. To be effective, such a system would likely have to work across journals, so it would be sensible if it was part of the proposed journal review consortium.

As one might expect, there are other proposed changes to the review process. [Varian \(1998\)](#) made the distinction between the importance of a paper and its correctness. The latter hardly matters if the paper is of little significance, so papers should first be evaluated on their importance, which would be publicly revealed for the reader’s use.* This was implemented by [bepress](#), where papers are assigned different levels of importance. [Varian \(1998\)](#) also advocated evaluating papers after publication, as did [Ginsparg \(2004\)](#). Given sufficient time, it becomes easier to evaluate a paper based on cites or an increased number of readers.

4.4 Improved Access to Data

[Kim et al. \(2006b\)](#) described how empirical work has come to dominate the most cited papers in the profession in the last few decades. It certainly appears to dominate less cited works as well. Clearly the Internet makes it easier to obtain empirical data, and one might imagine that Google and its kin make finding data straightforward. However, current search engines are ultimately based on descriptions written for humans and the pattern of links to and from the sites that hold those descriptions.

Rather than a search engine trying to make sense of documents written for humans, the [Semantic Web](#) uses various technologies that describe a site for “understanding” by

*One exception here is that faculty at lower ranked schools are often expected to publish. Partly this is to keep them active as opposed to expanding the frontiers of knowledge. Peer review maintains an important check here, so even if a paper is not cited it may still serve a useful function.

computers. This turns those sites into a searchable database that can understand complex queries like a relational database. One might query a Web site that is connected to economics data sites using these technologies for the most recent values of GDP for the U.S., Botswana, and Uruguay. The answer would be immediate, precise, and would fully represent their holdings. Googling, then visiting multiple sites, and then trying to evaluate their veracity and timeliness would become obsolete.*

The Semantic Web has been worked on for many years under the guise of the World Wide Web Consortium, which is best known for the development of HTML. The Semantic Web is strongly backed by Tim Berners-Lee, the inventor of the World Wide Web and the Director of the Consortium. Its very long gestation, complexity, and potential implementation difficulties have led to extensive criticism. Yet, its promise is vast. Even if the Semantic Web fails to arrive, similar technologies are under development that fulfil much of its promise and suffer from fewer criticisms.

While technology forecasting may be for the foolhardy, it is difficult to believe that Internet search technology has plateaued. It seems likely that searching for economic data might become much easier if implementations for using this class of technologies are developed for economics Web sites and if sites actually deploy it. This would clearly require some sort of collaboration between major data sites. This seems hard to envision, but presumably those who undertake it will gain status and users. As with the other improvements envisioned in this paper, it appears that the work will come from inside the profession.

5 Conclusion

This paper examined the current state of the information infrastructure in economics and proposed changes to it. While on the surface the Internet has seemingly led to significant changes, in reality the changes have mostly been to the facade; the fundamentals of how the profession conducts its business have been remarkably constant. This paper looked at the most successful Internet service for economists, RePEc, and examined why it has succeeded. Several factors stand out: it was built on existing practices in the field, it was easy for institutions to set up archives, and it was developed by economists who were intimately familiar with the field.

In addition, it is surely no surprise that successful Internet innovations clearly appealed to economists' or their institutions' self-interest: registration with RePEc Author Services helped economists advertise themselves (some 20,750 so far), the establishment of RePEc archives so institutions can advertise the works of their members, authors, and customers (862 to date), and registration with New Economic Papers to help find the latest research (some 19,950 so far). However, it seems economists have not found a benefit to commenting on papers they have not agreed to review, and in at least one instance (the NBER's margin standard) they responded negatively to a requirement. Further, given the structure of the field, there is no plausible organization to dictate requirements to all.

*It is striking that while services like Google are barely a decade old, a commonly held implicit assumption seems to be that search technology will continue pretty much as-is.

With these lessons in mind, along with the role of incentives, improvements were proposed to lead economists to a more productive future. The proposals include changing the length and structure of papers; making replication studies common; modifying the review process to give more of a voice to authors, recognizing the contributions of referees, and lessening the need to perform multiple reviews of the same paper; and using better technology for improved access to data.

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