

# Open Access Economics Journals and the Market for Reproducible Economic Research

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*Abstract:* Most economics journals take no substantive measures to ensure that the results they publish are replicable. To make the data and code available so that published results can be checked requires an archive. Top economics journals have been adopting mandatory data+code archives in the past few years. The movement toward mandatory data+code archives has yet to reach the open access journals. This is paradoxical; given their emphasis on making articles readily available, one would think that open access journals also would want to make data and code readily available. Open access economics journals should adopt mandatory data+code archives en masse. Doing so will give them a competitive advantage with respect to traditional economics journals.

## I. INTRODUCTION

Economics articles are commodities and can be produced via different systems that sometimes overlap: commercial presses, university presses, open-access (OA) and preprint. However they are produced, these articles are commodities with a substantial externality, inasmuch as they purport to constitute scientific research. Regardless of the system by which an article is produced, the producer should seek to maximize, or at least enhance an article's contribution to science; this requires that the results presented in the article are replicable. Despite claims that economics is a science, no applied economics journal can demonstrate that the results published in its pages are replicable, i.e., that there exist data and code that can reproduce the published results. No theory journal would dream of publishing a result (theorem) without a demonstration (proof) that the reader can trust the result, yet applied journals do it all the time. In what appears to be a move by the profession to remedy this gross deficiency, many of the top traditional journals have recently adopted mandatory data+code archives as a means of ensuring that published results are replicable. Thus, the market for publishing economics articles has bifurcated.

As noted by McCullough, McGeary and Harrison (2006, p. 1095): '[E]ach economics journal can be said to operate in one of two distinct markets: the market for reproducible results, and the market for irreproducible results.' What is surprising is that the OA journals, to date, are still

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solidly in the market for irreproducible results. In fact, the top traditional journals are far ahead of OA journals in this regard, which is paradoxical: OA journals emphasize making articles readily available, yet top traditional journals make data and code more readily available than OA journals. In fact, given the OA journals' comparative advantage over traditional journals in the use of the internet, this scenario could properly be called extremely surprising.

If any segment of the economics publishing industry will be able to achieve this goal of publishing applied results that are demonstrably correct, it is the OA economics journals. This author's conversations with editors and editorial board members of traditional economics journals suggests a major impediment to adopting data+code archives: the publisher generally handles all aspects of the journal's web-presence, and getting a publisher to manage the archive is nigh on impossible. The editors and editorial board members of OA journals know all too well how easy it is to create an archive, and it is remarkable that none has created a mandatory data+code archive to date. Perhaps they have been establishing themselves in the marketplace, and have yet to improve their product – the traditional journals already are established and have no such excuse. In addition to entering the market for reproducible economic research, there are other good reasons for OA journals to adopt mandatory data+code archives. Many researchers currently perceive OA journals to be second-class citizens in the world of economics journals. One way for OA journals alter this perception is to be a more desirable place to publish. Already OA journals can disseminate results more quickly, but rapid dissemination is not as important to economists as it is to, say, physicists. Economists are more concerned with citations. If OA journals can offer more citations (and it appears that they do), and if economists are made aware of this, then economists will have an incentive to increase their submissions to OA journals. Section Two discusses the reasons that replication is important. Section Three reviews the literature on replication in economics. Section Four presents the current state of replication in OA economics and explores some reasons that OA journals, while currently behind traditional journals, can easily surpass traditional journals. Section Five presents the conclusions.

## II. REPLICATION IS IMPORTANT

Replication is the cornerstone of the scientific method. Replicable research offers several benefits. First, replication ensures that the method used to produce the results is known. Whether the results are correct or not is another matter, but unless everyone knows how the results were produced, their correctness cannot be assessed. Replicable research is subject to the scientific principle of verification; non-replicable research cannot be verified.

Second, and more importantly, replicable research speeds scientific progress. We are all familiar with Newton's quote, 'If I have seen a little further it is by standing on the shoulders of Giants.' The vast majority of economics journals do not require authors to share their data and code; those journals that do have such a policy generally do not enforce it and, generally speaking, authors are quite reluctant to share their data and code; see Anderson, Greene, McCullough and Vinod (2008) for details. In economics, when one researcher wants to build on the work of another, he must recollect the same data, rewrite the same code, and largely duplicate the effort of those who have gone before him – this is not standing on the shoulders

of one's predecessors. This is the slow way to advance the frontiers of knowledge. The fast way to advance knowledge employs the sharing of data and code quickly and easily – via mandatory data+code archives. As computer programs play an increasing role in economic research, whether via sophisticated econometric techniques or simulation, it is practically impossible for an article to describe each and every calculation performed by the computer. In a very real sense, in many cases it is the data and the code, not the article, that constitutes the real contribution to scientific knowledge. This idea has been formalized by Buckheit and Donoho (1995) as 'Clarebout's Principle': 'An article about computational science in a scientific publication is not the scholarship itself, but merely the advertising of the scholarship.'

Third, researchers will have an incentive to avoid sloppiness. As McCullough and Vinod (2003, p. 889) put it, 'knowing that eager assistant professors and hungry graduate students will scour their data and code looking for errors, prospective authors would spend more time ensuring the accuracy, reliability, and replicability of their reported results.'

Fourth, the incidence of fraud will decrease. When more and more journals have mandatory data+code archives, those journals that do not have such archives will, as Leveque (2006) puts it, become 'the last refuge of the scientific scoundrel.' There are many economists who do not want their work checked. To verify this, simply start contacting authors of applied economics articles at random, tell them that you want to check to make sure that their published results are reproducible, ask them for their data and code, and see how many are forthcoming.

Further discussion on the importance of replication can be found in Kane (1984), King (1995a, 1995b, 2003) and McCullough and McKittrick (2009).

### III. ECONOMIC RESEARCH IS NOT REPLICABLE

There is a good reason that many economists do not want their work checked: all available evidence indicates that replicable economic research is the exception and not the rule. To date there have been four systematic attempts to ascertain whether published economic research is replicable: Dewald, Thursby and Anderson (DTA 1986); McCullough and Vinod (2003); McCullough, McGeary and Harrison (2006) and McCullough, McGeary and Harrison (2008).

DTA attempted to replicate 54 articles that had been submitted to the *Journal of Money, Credit and Banking* and could replicate only two. In response, the AER implemented a 'replication policy' whereby authors agree to make their data and code available upon request. Several other journals, following the lead of the AER, adopted replication policies. DTA had noted the obvious incentive-compatibility problems with an honor policy, and recommended a mandatory data+code archive, but the editors of the AER did not find this argument persuasive. Other authors explored theoretical reasons that an honor policy would not succeed, e.g., Mirowski and Sklivas (1991), Feigenbaum and Levy (1993), Anderson et al. (2008). All offer variations on a common theme: producing replicable research is time-consuming and if no one is checking, the rational economist will not make the effort to produce replicable research.

To determine whether replication policies work, McCullough and Vinod (2003) contacted eight authors from one issue of the AER and found that four would not supply their data and code, and the situation was even worse at two other journals with similar policies. In direct

response, under then-editor Ben Bernanke the AER finally stopped paying lip-service to the idea of replicability in economics, abandoned the ineffectual ‘replication policy’, and adopted a mandatory data+code archive (Bernanke 2004); several other journals followed suit. See *Figure 1*.

Yet, this still left the open question, Do mandatory data+code archives produce replicable research? McCullough, McGeary and Harrison (2006) used the archives of the Journal of Money, Credit and Banking to attempt replication of 62 articles, succeeding only 14 times (186 articles should have had data and code in the archive, only 69 did – seven of which could not be assessed due to software considerations).

McCullough, McGeary and Harrison (2008) used the archives of the Federal Reserve Bank of St. Louis Review (FSLR) to attempt replication of 133 articles, and succeeded only 29 times (266 articles should have had data and code in the archive, only 162 did, 29 could not be assessed). We see that, left to their own devices, the vast majority of economists are incapable of supplying data and code that reproduce published results. The results of DTA also support this conclusion: of the 54 articles with datasets they examined, only eight were sufficiently complete that replication could even be attempted. Clearly, economists could use lessons in creating replicable research and writing code that is conducive to replication; for further details on producing replicable research and code, see Nagler (1995), Koenker and Zeileis (2009), Kovačević (2007) and especially Long (2009).<sup>1</sup>

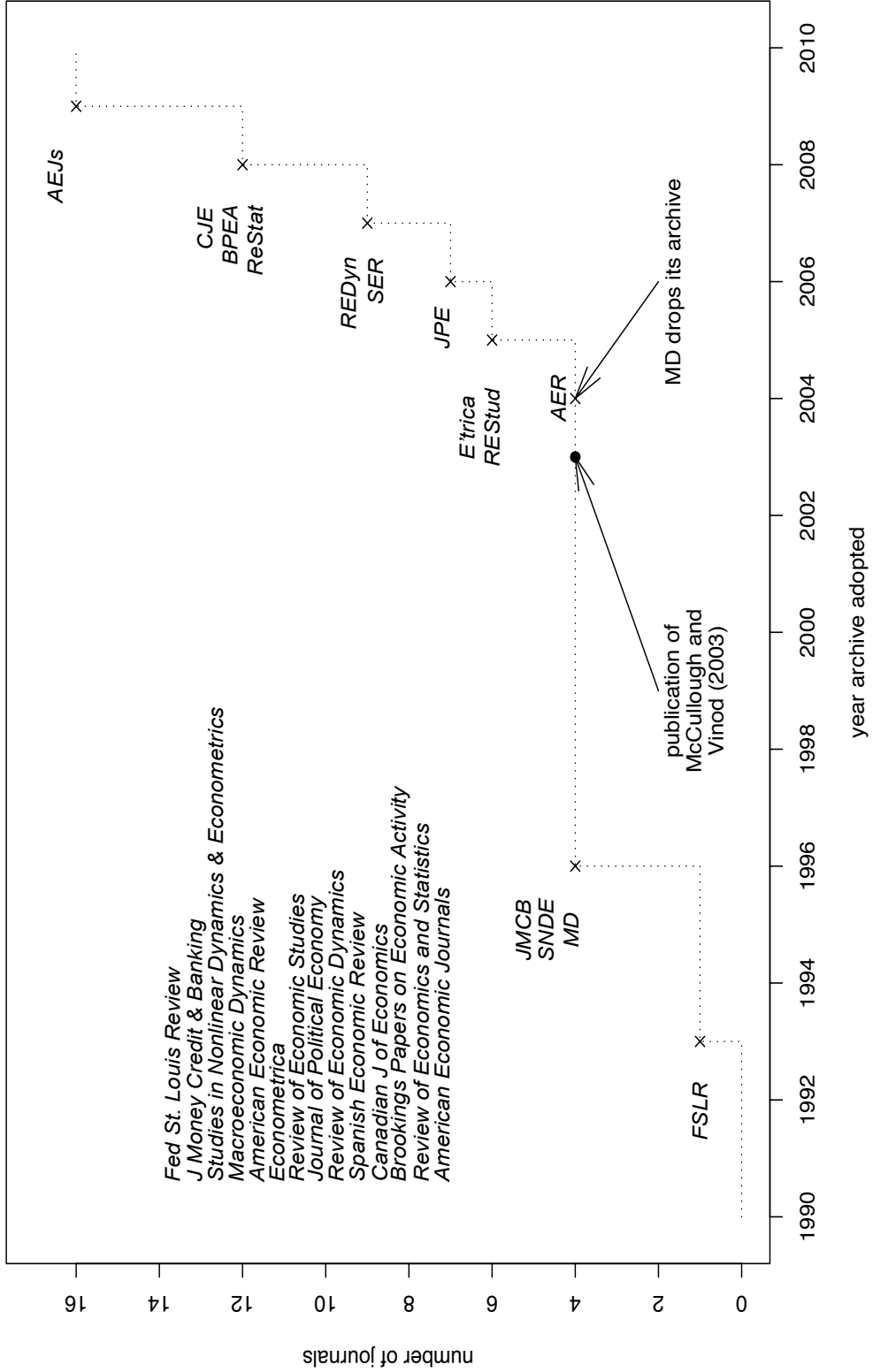
Both the JMCB and FSLR archives were fairly laissez-faire: though authors were required to deposit data and code in the archive, no one was checking to make sure that authors actually contributed data and code and, further, failure to do so resulted in no penalty. Consequently, at the JMCB  $117/186 = 62\%$  of the authors did not bother to provide their data and code to the archive; similarly  $104/266 = 40\%$  for the FSLR. We note in passing that the data-only archive at the Journal of Applied Econometrics has material in the archive for 99% of its articles because the article will not be sent to the publisher until the data are deposited in the archive. (The 1% failure is due to special issues over which the archive manager had no control.) McCullough, McGeary and Harrison (2008) presented a list of recommendations that journals ought to follow if they wish their archives to support replicable research.

#### IV. THE CURRENT STATUS OF ARCHIVES AT TRADITIONAL AND OA ECONOMICS JOURNALS

The directory of open access journals ([www.doaj.org](http://www.doaj.org)) lists 77 OA journals in the economics section. Perusing the links for these 77 journals (at least those in English or Spanish) – taking care to inspect the ‘instructions for authors’ page – suggests that not a one of these journals require authors to submit data and code. There are couple references to replicability, e.g., ‘We encourage the submission of raw data at the time of review, and we can archive the data of accepted articles.’ (Judgment and Decision Making), ‘La publicación de artículos en REVISTA DE ECONOMÍA APLICADA está sujeta a la condición de que los datos utilizados en el

<sup>1</sup> Although the Long book is nominally written for the package Stata, it can be profitably read by anyone who wants to conduct replicable research that employs statistical or econometric software.

Figure 1: Economic Journals with Mandatory Data+Code Archives



análisis estén clara y precisamente documentados y a disposición de cualquier investigador a partir de seis meses después de la fecha de publicación y durante tres años.’ (Revista de Economía Aplicada).

In sharp contrast to OA economics journals, many of the top (traditional) economics journals have recently adopted mandatory data+code archives: AER, Journal of Political Economy, Econometrica, Review of Economic Studies, and Review of Economics and Statistics. Including the American Economics Journals that debut in 2009, as this article goes to press there will be at least sixteen journals with mandatory data+code archives. Yet EconLit currently indexes 1300 journals, so the profession is a long, long way from ensuring that most of its published results are replicable.<sup>2</sup>

Perhaps a better way to view this is to examine the extent to which top economics journals have mandatory data+code archives. There are many such lists of top journals, and they all overlap to some degree, so for present purposes one list is as good as another. We use the list from Kodrzycki and Yu (2007), presented in *Table 1*. Prior to the publication of McCullough and Vinod (2003), only two of the top fifty journals had mandatory data+code archives.

Currently there are ten journals with mandatory data+code archives, so the proportion of ten top journals with mandatory data+code archives has increased from 4% to 20%, a not insignificant increase.<sup>3</sup>

Yet, the vast majority of economics journals do not have mandatory data+code archives. By examining the instructions given to authors at such journals, it is not unfair to suggest that these journals are more concerned with proper numbering of equations than with producing replicable research. While the penetration of data+code archives in traditional journals is small but prominent, it is non-existent in OA economics journals. Besides adherence to the scientific method, there are selfish reasons that OA journals should adopt data+code archives. Evidence suggests that articles in journals that are available freely online are cited more often than articles in other types of journals (Lawrence, 2001). A more compelling study of the impact of OA articles compares OA versus non-OA articles in the the same journal and finds a significant citation advantage for the former (Harnad and Brody, 2004). This tendency toward more citations could be easily enhanced by OA journals because articles that make their datasets available online accrue more citations (Gleditsch and Metelits and Strand, 2003; Piwowar et al, 2007) – making one’s code available, in addition to data, can only increase this effect. For example, Renfro (2003, p. 42) noted the similarity between Quandt’s disequilibrium model and Hamilton’s Markov switching model, and wondered why one became widely cited and the other disappeared into obscurity. His answer was, ‘These two models are actually very closely related but the Quandt models never caught on because essentially Dick Quandt never gave

<sup>2</sup> The author attempts to keep track of economics journals with mandatory data+code archives, but has not systematically examined all 1300 journals indexed in EconLit. For example, in the course of preparing this article, the author was made aware that the Review of Economic Dynamics adopted a mandatory data+code archive in 2007.

<sup>3</sup> Some of these journals have voluntary archives (e.g., Journal of Business and Economic Statistics). Typically, only a small proportion of authors voluntarily put something in the archive, and what they put in the archive does not have to reproduce the published results. It might only be data, and not code; or it might only be some (not all) of the data.

Table 1: Mandatory data+code archives of top-50 economics journals before and after the publication of McCullough & Vinod (2003). Macroeconomic Dynamics closed its archive the same year that American Economic Review opened its archive.

rank	journal	pre-M&V archive	post-M&V archive	rank	journal	pre-M&V archive	post-M&V archive
1	Am Econ Review	no	YES	26	J Fin Quant Analysis	no	no
2	J Finance	no	no	27	J Econ Dyn Control	no	no
3	Q J Economics	no	no	28	Brookings Pap Eco Ac	no	YES
4	Econometrica	no	YES	29	NBER Macroecon Ann	no	no
5	J Financial Econ	no	no	30	J Business	no	no
6	J Political Econ	no	YES	31	Econometric Theory	no	no
7	Rev Financial Stud	no	no	32	J Econ Growth	no	no
8	J Econ Theory	no	no	33	J Dev Economics	no	no
9	Rev Econ Studies	no	YES	34	J Labor Economics	no	no
10	J Econometrics	no	no	35	J Bank Finance	no	no
11	J Econ Literature	no	no	36	J Hum Resources	no	no
12	J Monetary Econ	no	no	37	J Econ Behav Organ	no	no
13	J Econ Perspectives	no	YES	38	Rev Econ Dynamics	no	YES
14	Rev Econ & Stat	no	YES	39	Can J Economics	no	YES
15	Eur Econ Review	no	no	40	J Account Economics	no	no
16	Int Econ Review	no	no	41	J Appl Econometrics	no	no
17	J Int Econ	no	no	42	J Math Economics	no	no
18	Economic Journal	no	no	43	J Int Money Finance	no	no
19	J Public Econ	no	no	44	Macroecon Dynamics	YES	no
20	Game Econ Behav	no	no	45	Soc Choice & Welfare	no	no
21	RAND J Economics	no	no	46	J Indus Economics	no	no
22	J Money Credit Bank	YES	YES	47	Int J Indus Organ	no	no
23	Economic Theory	no	no	48	Int J Game Theory	no	no
24	J Bus & Econ Stat	no	no	49	J Environ Econ Manag	no	no
25	Economics Letters	no	no	50	J Financial Intermed	no	no

out the software to implement them. Hamilton on the other hand gave out GAUSS code for everyone to do it and so created a whole industry.’ As another example, the article by Goffe et al. (1994) on simulated annealing has accumulated several hundred citations because he made code available in C, Matlab and GAUSS.

Therefore, OA journals are uniquely able to offer an increased number of citations (OA journals are more cited, plus the increase in citations that comes from making data and code available) to authors. Moreover, OA journals can do this much more quickly than traditional journals, since the traditional journals have such a long lag time to publication.

To the extent that OA journals are in competition with traditional journals, the faster that OA journals can offer authors the increased citations that come with replicable research based on a data+code archive, the more quickly will OA journals attain parity with traditional journals in the eyes of authors.

A common objection to making data and code available is offered by AER editor Robert Moffitt (2007): ‘Economists call the ‘patent’ problem the problem that those who put the effort into constructing a data set and writing programs (months of work) have the right to use it for further research for X years.’

This idea that the data and code should be embargoed from use by other than the creator for any length of time is inconsistent with the scientific method – unless the data/code can be checked, it cannot be relied upon as a basis for research or policy. Moreover, this sentiment is merely shifting costs from the original researcher onto the entire scientific community, as observed by McCullough, McGeary and Harrison (2006, p. 1097):

‘The objective of an embargo is to permit the author to have sole use of the dataset that he collected. Even without an embargo, some authors will be hesitant to provide data, arguing that it infringes upon the author’s competitive advantage... By the time the article appears in print, the author should already have a second article submitted and be working on his third. If an author really wants to have the dataset all to himself, he can simply write all the articles he wants, and then submit them to journals simultaneously rather seriatim – the cost to the author is that he has to wait to submit his article.’

Thus it can be seen that this so-called patent-problem is a red-herring designed to shift costs from the producer of the research to the user of the research. To show the dangers of assuming that results are replicable when authors do not have to release their data, it is instructive to consider the recent paper on file-sharing by Oberholzer-Gee and Strumpf (2007) that was published in the *Journal of Political Economy*. When Liebowitz attempted to check the reproducibility of the results in their article, they refused to release their data, and the authors gave conflicting reasons for refusing (Liebowitz, 2008). Some of the Oberholzer-Gee results were based on publicly available data. When Liebowitz analyzed these data, he got different results than Oberholzer-Gee and Strumpf. How much confidence should a reader place in the the Oberholzer-Gee results for the data that are publicly available, let alone the data that are not publicly available?

Another problem is confidential data, and that is more nettlesome. Moffitt (2007) suggested two approaches: (1) confidentiality agreements and (2) special facilities where the confidential data are placed on a non-networked computer. However, confidential data is a very small proportion of cases, and should not prevent a journal from adopting a data+code archive. The

truly important problem in this context is how to make sure that when one researcher uses another's data and/or code, the creator of the data and/or code gets proper credit? This issue is discussed in detail in Stodden (2009a). An apparent solution to the problem is offered in Stodden (2009b), which proposed an Open Research License. As part of a virtuous circle, once researchers realize that they will get more citations for depositing data and code in an archive, they will be more inclined to make their data and code available.

## V. CONCLUSIONS

OA journals are often perceived, rightly or wrongly, as having a second-class status compared to traditional journals. Note that in the list of top 50 journals in Table 1, not a single journal is OA. How can the OA journals remedy this undesirable situation? The OA journals already get their articles disseminated faster and can have a higher impact than comparable print articles. They need to increase the impact of their articles even more to compensate for the fact that traditional journals have the firstmover advantage. This can be achieved via mandatory data+code archives. Whether OA journals are serious about competing with traditional journals can be determined by the extent to which they adopt mandatory data+code archives. Given the literature on first-movers, OA journals cannot wait. Traditional journals have a headstart, and if the OA journals delay the adoption of mandatory data+code archives, they may never be able to eliminate the second-class perception. It is inconceivable that even one-half of traditional journals could publish replicable results (or, at least, have mandatory data+code archives) by the end of 2010; it is quite conceivable that all OA journals could do so by then.

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