WORKING PAPER SERIES

Replication and Scientific Standards in Economics a Decade Later: The Impact of the JMCB Project

Richard G. Anderson
William G. Dewald

Working Paper 1994-007C
http://research.stlouisfed.org/wp/1994/94-007.pdf

PUBLISHED: Federal Reserve Bank of St. Louis Review, 76(6),
November/December 1994.

FEDERAL RESERVE BANK OF ST. LOUIS
Research Division
411 Locust Street
St. Louis, MO 63102

Abstract

Scientific inquiry embodies skepticism. Researchers are trained to scrutinize every result, doubting not only the truth but also the tests of every hypothesis. Research papers in professional journals typically present only summaries of results, however, providing neither the programs nor data that a reader requires to fully understand -- and question -- the authors' tests. The *Journal of Money, Credit, and Banking* project a decade ago was the first attempt by the editor of a major journal to furnish readers with the data and programs used by the journal's authors. The project revealed the futility of proposing that readers obtain data and programs directly from authors, since data often were lost during the long interval between completion of the research and appearance of the published article. The project also established that professional journals were a low cost mechanism for collecting data from authors and distributing it to readers. A decade later, although the *JMCB* no longer requests data from authors, 2 journals have recently begun collecting such data and distributing it via the Internet.

Keywords

monetary economics, replication, *JMCB* project, data archiving

JEL Classification

A2, B4, C1, C8

Replication and Scientific Standards in Economics a Decade Later:
The Impact of the *JMCB* Project

Richard G. Anderson and William G. Dewald *

Original version, March 1994
First revision April 1994, second revision June 1994

Questioning received wisdom is an essential part of scientific inquiry. In economics, published empirical findings are challenged in three ways: (1) by replication of published results using the authors' original data and programs, (2) by the application of new statistical methods or techniques to the same datasets, and (3) by the application of existing statistical methods to new datasets.[1] All economists are aware, however, that the severe space limitations imposed by professional journals limit at least the first two types of inquiry. Most journals allow only minimal description of the author's research; rare indeed is a journal both willing and able to publish underlying data and programs. Also rare are journals that actively

* Research Officer and Senior Vice President & Director of Research, respectively, Federal Reserve Bank of St. Louis. Revised version of paper presented at the Eastern Economic Association Meetings, Boston, Massachusetts, March 18, 1994. Forthcoming, Federal Reserve Bank of St. Louis *Review*.

[1]In addition, of course, the aggregate amount of scientific knowledge may be expanded by the publication of new models based on new datasets. This classification scheme, due to Kane (1984), has been utilized by a number of authors studying replication including Mittelstaedt and Zorn (1984) and Hubbard and Vetter (1991). Note that the use of the term "replication" has itself been controversial. Lindsay and Ehrenberg (1993) contrast "repetitions" with "replications", arguing that the latter are valuable and the former uninteresting. The chapters in Cooper and Hedges (1994) discuss methods whereby common findings might be distilled from a large number of studies, each slightly different from the other. The nature of the replication process in the *JMCB* project is discussed further below.

solicit data and programs from authors for dissemination to researchers.

The *Journal of Money, Credit and Banking* project was the first attempt by the editor of a major professional journal to make available to the journal's readers not only the authors' published conclusions but their research methodology (including their programs and data) as well. The *JMCB Project* arose from a belief that economists, as scientists, should be as concerned with a researcher's underlying data and statistical techniques as with his or her conclusions. A decade after the *JMCB* project, the collection of data by professional journals is still rare. To our knowledge, only two journals -- the *Journal of Applied Econometrics* and the *Journal of Business and Economic Statistics* -- currently request programs and data from authors.[2]

We found during the *JMCB* project that the ability of authors to collect, document, and submit data and programs diminished rapidly after conclusion of the research project summarized in their papers. Almost uniformly, authors that did not (or could not) submit data said that they would have been able (and willing) to do so if the materials had been

---

[2]Since January 1994, the *Journal of Applied Econometrics* has accepted papers for publication conditional on the authors furnishing an acceptable dataset. As of this writing (June 1994), datasets are reviewed by James MacKinnon and then placed on an Internet ftp server at Queens University. See MacKinnon (1994). In contrast, the *Journal of Business & Economic Statistics* apparently has not required that authors submit datasets (similarly, the *JMCB* never required submission) but has requested that authors submit data for distribution via an Internet FTP server at Duke University. Tauchen (1993) argues, as we do, that readers of journals should be interested in authors' data and programs, and a journal's prestige (and circulation) should increase when such data and programs are made readily available to readers. Regretably, we were not aware of Tauchen's article when we wrote the original draft of this paper.

requested when the manuscript was first submitted to the *JMCB*.[3] The long delays between completion of a research project and publication of its findings, often measured in years, make it understandable that data and programs may sometimes be mislaid.

While the editors and readers of professional journals seem to have generally been disinterested in data collection and replication during the last decade, the primary federal agency sponsoring scientific economic research has not.[4] Following publication of our 1986 *AER* paper, the National Science Foundation reached an agreement with the Interuniversity Consortium for Political and Social Research (ICPSR) regarding data distribution. Under that agreement, ICPSR would accept and distribute data from authors in any economics journal without charge to either the authors or journals. The director the economics program at NSF subsequently contacted the editors of 22 economics journals, seeking participation; all declined to request that their authors participate, even voluntarily.[5] Since that time, the National Science Foundation has adopted a number of mandatory policies regarding data archival and distribution. NSF now requires that authors place any data used and/or developed in conjunction with an NSF-funded project in a public archive not later than six

---

[3]Following the end of the *JMCB* project, the journal began notifying authors at time of *submission* that their data and programs would be requested when and if the paper was later *accepted* for publication. This reduced significantly the number of datasets arriving in the *JMCB* office but also meant that referees did not have access to programs and data; to the best of our knowledge, no referee ever requested the data and programs for an article under review, however.

[4]We thank Dan Newlon, director of the NSF's economics program, for the material in this paragraph.

[5]Some authors have since proposed models of how such collective disinterest among professional journals might arise and be sustained. See Feigenbaum and Levy (1990, 1993).

months following the end of the grant period. (A copy of the NSF's policy is attached as an appendix.) Further, renewal applications for additional funding must contain a statement of how the author(s) have complied with this requirement. Other NSF initiatives have assisted in distributing copyrighted or confidential data. Some data obtained by researchers from commercial vendors are copyrighted and may not be further distributed by the researcher without the vendor's permission, which NSF staff have found is seldom granted. In negotiations with the NSF, one vendor (CRISP) has agreed to maintain researchers' datasets as part of its own database and make them available to all licensed users of its data. In cooperation with the Bureau of the Census, the NSF is exploring opening regional offices that would allow researchers access to confidential data, including datasets used in previously published studies. One pilot office is currently operating in Boston.

These are important policy actions by the largest government agency sponsoring economic research. Yet, although these greatly assist the dedicated researcher interested in replication, they cannot have the immediacy that the reader of a journal might value in understanding exactly how an author obtained his results. In addition, of course, they do not cover non-NSF funded research. Finally, the datasets archived by authors might be much larger than the data used in the final published paper (leaving the reader to distinguish among potential variables) and may not include some transformations of variables within the author's computer programs.

Since March 1993, the research department of the Federal Reserve Bank of St. Louis has made available to the public via its electronic bulletin board all data and programs for

articles published in the Bank's *Review*.[6] Data and programs for the January/February 1993 issue of the *Review* were the first placed on the bulletin board in March 1993, with subsequent materials added as published. During the first year, nearly 200 files from articles in the *Review* have been downloaded from the St. Louis bulletin board. Recently, the rate has increased to about 30 downloads per month, as the number of datasets on FRED has increased.

Today, the growing popularity of the Internet makes submission and distribution of materials for any article in any professional journal extraordinarily easy via an ftp server, as shown by the *JAE* and *JBES*.[7] We believe that prompt availability at very low cost is essential if readers are to routinely retrieve and explore the author's data and programs. The apparent popularity of the St. Louis bulletin board seems to confirm our views.

The *Journal of Money, Credit and Banking* Project

The principal findings of the *JMCB* project were summarized in the *American Economic*

---

[6] The bulletin board is advertised as the Federal Reserve Economic Database, or FRED. FRED's phone number is (314) 621-1824. Unfortunately, the Federal Reserve System does not yet have an ftp server on the Internet although it is under active discussion.

[7]The NSF is already funding a data server administered by the Department of Economics at the University of Michigan. Numerous other servers distribute data and working papers around the world via ftp servers on the Internet. These provide a model for similar access to background material for articles published in professional journals. See for example Goffe (1993, 1994), who also suggests that replication would be enhanced by data distribution via the Internet.

Review in September 1986.[8] Our conclusions were greeted by the profession with an extraordinary mixture of incredulity, hostility, approval, and indifference. So seldom had reproductions of authors' published results been published that the article was carefully reviewed for potential libel or other legal complications by the American Economic Association's legal counsel prior to publication.

We emphasized in our article that there existed a significant divergence between the private and public rewards to replication in economic science. We argued that an individual researcher had strong incentives not to share his/her data and/or programs with other researchers. If the materials are shared and results confirmed, the confirmation provides little (if any) reward to the researcher beyond the original publication of his findings. If his results are found faulty, however, he faces the likelihood of some professional embarrassment. Even casual observers must conclude that this risk/reward calculus suggests that few researchers will share data and programs.[9]

We argued in our 1986 article that economic science as a whole rather than individual

---

[8]Dewald, Thursby, and Anderson (1986).

[9] Stephen Stigler in correspondence has called our attention to a number of related replication studies in psychology. For such experimental sciences, the field of research synthesis (Cooper and Hedges, 1994) provides a way to statistically analyze the conclusions reported by authors relative to the design of their experiments. Such analysis seems to assume, however, that a researcher (1) correctly collects his data; and, (2) correctly calculates his reported statistical results from that data. Randomness arises in that synthesis as a natural, inherent part of the experimentation process and is reflected in slightly different conclusions across repeated studies. In economics, the underlying data are usually collected by the researcher from published sources; careful documentation should enable a second researcher to find the same numbers in the same sources. Further, our experiences suggest that not all economists calculate their reported results correctly from the underlying data, a regrettable event that also of course may occur in other sciences.

researchers reaped the benefits from replication. In this regard, replication resembles the classic Samuelsonian public good that is consumed by all without any diminution of the quantity consumed by each individual. Public goods are a well known example of market failure in economics. Obtaining the optimal supply of public goods requires some mechanism to equate the individual and societal rewards. Our proposal was modest: professional journals should request data from authors. Authors would be put "on notice" that journals would request (and expect) submission of data and programs with manuscripts. In turn, authors would be encouraged to exercise close control over their data during the course of their research and be able to submit their data and programs at very low cost. It is likely, we suggested, that this requirement would reduce the frequency of inadvertent errors in published articles. The journal's prestige would increase, since readers would be assured that articles have been subjected to an extra measure of care in preparation.[10] In the best of all possible worlds, with (almost) all journals requesting and disseminating data from published articles, all researchers would benefit by being able to begin their research while standing on the shoulders of previous researchers. The pyramid of firm, replicable, empirical scientific knowledge would grow more rapidly than ever before.

Alas, this world was not to be. Although our research stimulated increased discussion of replication in economics, to our knowledge no major journal beyond the *JMCB* adopted more than an editorial statement that authors should stand ready to provide data and programs to other researchers. Absent an enforcement mechanism wherein the authors are

---

[10]Further, to the extent that access to such data and programs is valuable to the journal's readers, the subscription price perhaps could be increased to recover associated costs.

requested to submit data and programs to journals for dissemination to readers, such statements could have no more impact on the careful conduct of empirical research than Ed Feige's plea to the editors of the *Journal of Political Economy* a decade earlier.[11] We suspected at the outset of the *JMCB Project* that few researchers could in fact adequately locate important data and computer programs following publication of their research; much to our regret, the suspicions proved to be correct. In 1993, the editors of the *JMCB* discontinued requesting data from the authors of published articles.

The idea that was to become the *JMCB* project was born in discussions at the December 1975 American Economic Association meetings between William Dewald, then editor of the *JMCB*, and James Blackman of the National Science Foundation. Two months after the meeting, in early 1976, Dewald wrote to Blackman:

> ...I am interested in exploring the possibility of collecting data sets from JMCB authors, storing data for a reasonable period, and making it available to anyone willing to pay the marginal cost of retrieval. The benefit of such a policy is that verification and extension of research results would be much less costly than under a system where each research worker must invest a lot of time and money in replication of data.
>
> The experiment I should like to attempt is to require authors of published JMCB articles to supply data and the programs used in evaluating it in a form that makes easy replication possible.

---

[11]Feige (1975). An editor of the *JPE* wrote to us in 1986 that he disagreed with the implication in our *AER* paper that the *JPE*'s "Confirmation and Contradiction" section was a failure, since the *JPE* had published 35 pieces in that section during its first 8 years. He noted however that this was a disappointing performance. "We thought it could become a standard exercise in advanced econometric courses to replicate well-known articles, with the occasional major upsets, but that has not happened." We doubt that such student replication could ever become commonplace absent a journal collecting and distributing the data.

> ...There may be problems of confidentiality.... There also may be problems because some authors have a strong proprietary interest in data and programs. I can sympathize with the author who has poured resources into a data set only to be forced to give it away to others to gain access to the JMCB. Nevertheless, I'm unwilling to allow any scholars to escape the discipline of the careful review that replication and criticism of their work implies.

The idea of journals disseminating data from published articles was raised at conferences and professional meetings throughout the following year. While few disputed the utility of replicating published empirical results, many saw it as a trivial exercise that might in fact worsen rather than improve the quality of scholarly research. Following one such exchange more than a year later, a senior federal official wrote to Dewald that

> ...the reporting of results in journal articles that can not be replicated ... strikes at the scientific credibility of social science research. That the research is often financed with public funds adds insult to injury. Something needs to be done to assure effective access to the data needed to replicate social science research.
> ...it could be solved by all journals in the social sciences adopting an editorial policy requiring the authors of articles to make available at the time of publication of the article the data necessary to replicate their results.

but expressed reservations that

> ...such a policy would have significant costs. By reducing the cost of using data collected by other scholars and increasing the relative cost of collecting and refining data, such a policy would change the composition of research. Some argue that an increase in research by investigators unfamiliar with the primary data sources would decrease the overall quality of research. Documenting some forms of research can be extremely expensive and time consuming. Policing data accessibility would create difficulties. Would a journal refuse future publications of an author who refused to document some aspect of his research published in the past? Should NSF refuse future grants to such an investigator no matter how attractive the proposal submitted? Finally, some argue that replication of results exists now. For an empirical result to have any effect on the views of economists, it has to be replicated by many, independent studies. One article that comes up with a result that sharply contradicts the prior expectations of other scholars or the results of other studies will, by itself, not change the views of the research community but, at most, prompt further research.

Despite such reservations, a proposal for NSF support was submitted. The road to approval

was arduous, paved with negative peer reviews. Typical of reviewers' comments was the response of one prominent economist who wrote that "If you want someone's data, just ask for them!"

The *JMCB* project began officially on July 1, 1982, with the NSF providing a modest amount of seed money. More important to the project than funding, however, was the NSF *imprimatur*. NSF rules required that all data developed as part of an NSF-funded project be freely available. No researcher, whether presently receiving or only hoping to receive public funds in the future, wished to appear unwilling to abide by an NSF requirement. As it continued, the project was largely supported by Ohio State, the JMCB's editorial staff, and the time of the researchers themselves.[12]

Since a chronicle of the *JMCB* project has appeared elsewhere,[13] we review here only a few aspects of the research. Perhaps most revealing was the degree of falsity of the reviewer's position, quoted above, that authors would readily provide data on request. We initially requested data from the authors of 62 articles that had been published in the *JMCB* during 1980-82, prior to the beginning of the project. About 1/3 of the authors did not respond to our request, nor to a second followup letter. We did not pursue them further.[14] Among the responding authors, one-half either could not locate the data for their articles or

---

[12]The primary research team was William Dewald, Jerry Thursby, Richard Anderson, and Hashem Dezbakhsh.

[13]Dewald et. al. (1986).

[14]Some responded after publication of Dewald et.al. (1986). It is of course possible that our letters were misdirected following a job change or perhaps were discarded as questionnaires, as one author suggested.

chose not to submit them. Twenty authors who responded but did not submit data cited the lag between completion of the published research and our request, saying that they could have submitted the material earlier; yet, the oldest of the articles had appeared in print barely two years prior to our request and the newest within the same calendar year. These authors, who likely had not anticipated that the journal's editor would *ex post* request the data and programs for their articles, formed our experimental control group.

At the same time, we requested data from the authors of papers that either had been accepted for publication or were under editorial review. One-fourth of the authors of papers that had been submitted but not accepted for publication did not respond to our request; almost all the responding authors submitted data, however. With one exception, all authors of papers that had been accepted for publication responded promptly. Nevertheless, one-fifth of these latter authors either could not locate or chose not to submit data. Frequently cited reasons were the loss of data during a move between offices and/or jobs and the graduation of the research assistant that had done the data processing (!). One remarkably candid -- or perhaps very optimistic -- author of a paper under review by referees replied that the data for his research already had been lost. We concluded that it was clearly the exception rather than the rule that you could obtain an author's data by just asking for it.

Our third group of authors were those that submitted manuscripts to the *JMCB* after July 1, 1982. These authors almost uniformly supplied requested data. Several authors noted that the increased care required to compile and submit requested data had uncovered inadvertent errors in their preliminary research. Absent the subtle coercion of our request, would these papers have been published with erroneous results? We believe so, since such

errors are all but impossible for referees to identify. All authors noted that preparation of data and programs for the *JMCB* imposed a significant burden on them and their research assistants. We believe that the benefit to their readers more than defrayed those costs.

There is an additional significant cost, however, that we're not certain who should bear. Frequently, a new researcher will have difficulty reproducing a previous study even when the furnished materials are complete and well documented. These costs may be substantial if the researcher is less familiar than the author with either the data or the econometrics software. (Indeed, the author himself may have acquired facility with the software by conducting the research.) What are the responsibilities of the author to assist the researcher with the reproduction? Does the possibility of incurring such costs discourage authors from furnishing research materials? We believe that these costs may reasonably be perceived as higher when an author furnishes materials directly to another researcher than when material is furnished "blind" to a journal. If so, our argument for journals serving as collectors and distributors of material is strengthened. We cannot support the opinions expressed to us by some authors that they have no responsibility to assist other researchers in understanding their research methodology beyond publication of the article and (perhaps) furnishing their data.

The *JMCB* project also distributed data to other researchers. The availability of datasets was brought to the reader's attention in two ways. A general announcement of the availability to the public of datasets for published articles appeared regularly in the *JMCB* between May 1983 and February 1985, asking readers to request a list of available datasets from the *JMCB* office. In addition, a notice regarding the availability of data appeared at the end of each article for which the author submitted data. Although the *JMCB* project officially ended June

30, 1984, the journal continued to collect data from authors and attach notices to published articles.

The numbers of submitted and requested datasets from January 1980 through mid-1989 are shown in table 1. Nearly 150 datasets were submitted and nearly 300 requests for data received. Requests for data surged following publication of our 1986 article but quickly fell back to about their earlier pace. Contrary to the expectations of some reviewer's of the original *JMCB* project NSF grant application, the costs of requesting, receiving, storing, duplicating, and distributing data from published articles were small.[15] As of the end of 1993, the *JMCB* editorial office held about 4 file cabinet drawers of submitted materials[16] and was receiving on average about 8-10 requests for datasets each year.

Beyond data collection, a second important aspect of the *JMCB* project were attempts to determine if the materials submitted by authors were in fact sufficient to allow another researcher to replicate their published empirical results. We labelled these efforts "replications" after what we felt was common usage of the term, since our efforts involved searching for the authors' data based on the author's documentation (if available from published sources) and recalculating the authors' statistical results from the submitted data. Other authors have since proposed a number of alternate terms and classifications for these efforts; these are reviewed by Fuess (1993).

---

[15]The costs likely fell sharply as an increasing proportion of researchers submitted materials on inexpensive floppy disks. Recall that the IBM PC was introduced in 1981 and the XT in 1982.

[16]Some older datasets remain on mainframe magnetic tape, never having been transferred to floppy disks.

Where the authors' documentation allowed, we attempted a complete replication of the authors' research including retrieving the authors' data from the stated original sources and reproducing the published statistical results.[17] In cases where the former was impossible, we sought only to reproduce the authors' published statistical results from the submitted data. We attempted in our replication efforts to place ourselves, as closely as possible, in the position of a researcher who had requested data and/or programs from the *JMCB* editorial office. Were the materials sufficient to reproduce the article? Some replications we attempted ourselves, some were attempted by graduate assistants, while still others were assigned as exercises in graduate (Ph.D.) econometrics classes.

While 54 sets of data and programs were submitted to the *JMCB* during the course of the project (1982-84), we regarded only 8 as complete. All others had some deficiency. In some cases, the sources of the data were not clearly stated and we failed to locate in those sources the data furnished by the author. In others, the author had not saved the data used in the article and either furnished more recent data or cited only his source publications. In others, variables were poorly labelled, leaving a good deal of uncertainty as to whether we

---

[17]The replication process could be pushed to one more remove by asking whether the agencies that compiled and/or published the source data could reproduce those data from their original sources. Although this might bring our methods closer to those of experimental sciences such as psychology and medicine, as one reviewer suggested, we regard it as impractical, to say the least.

In experimental sciences, the data generating processes are deeply stochastic. No matter how high the degree of care exercised by the scientist, 100 trials (replications) of the experiment will produce 100 nonidentical datasets. The stochastic nature of data generating processes differs in the social sciences, however. In general, with the exception of the field of experimental economics, observed data are seen as one particular realization of a stochastic data generating process that could have produced a sharply different outcome, and no further realizations of the process are possible.

had in fact selected the correct variables in our replications. We judged 14 of the 54 submitted datasets to be so incomplete as to be valueless in understanding the authors' published work.

The results of our replication efforts are summarized in our *AER* article. In general, complete sets of data and programs were replicable: data existed in the locations specified by authors and their programs reproduced their statistical results. Among others, the most serious omissions were documentation of data. In some cases, authors could only sight general sources for data ("Survey of Current Business, various issues", or "Federal Reserve Bulletin, various issues", or Citibase database), leaving the reader to guess what issues were used. Since all government data are revised regularly, very different data may be in different issues.[18] In other cases (and what may really be the same thing), the data provided by authors did not correspond to the data in the publications they cited. We concluded via a large computer simulation experiment that statistical results in published articles can be highly sensitive to the "vintage" of the data used by the author, even when the various observations nominally refer to the same month, quarter, or year.Finally, for all but the most incomplete datasets, we found that the submitted data allowed us to obtain statistical results reasonably close to those reported by the authors, if seldom identical.

We have been somewhat surprised by the controversy that subsequently grew up around the issue of whether or not journals should publish the results of replication efforts. The *JMCB* project provided data and programs to its readers to assist their understanding of

---

[18]Anderson and Kavajecz (1994) provide a detailed discussion of the revision and benchmark processes for the monetary aggregates.

authors' research methodology, or in other words, of *how* and *why* the author reached his published conclusions. Further, the interested reader when armed with the authors' data is able to explore the *robustness* of the authors' conclusions to the inevitable compromises that must be made in empirical studies. In turn, we expected that the distribution of data and programs by journals would have two effects on economic research. First, authors would exercise increased diligence in empirical research, guarding against the occasional slip; and second, the reproduction (or replication) of newly-published studies in his/her areas of interest would become a routine part of a professional economist's research practice. In turn, we anticipated that newly-published professional papers would routinely include a discussion of the results of a replication as a springboard to their own findings. In fact, a reading of the *JMCB*'s empirical articles during the last decade suggests that this is still an infrequent occurrence, with no papers focused primarily on replication and only about two papers per year even comparing their results so directly to results in previous studies.[19]

Replication at the Federal Reserve Bank of St. Louis

Our experience at the *JMCB* was, however, only one trial of a replicable experiment. Would another sample of authors also have difficulty providing their data if we "replicated" the entire *JMCB* project? Or do our original findings greatly exaggerate the problem, as some have suggested? In late 1992, we conducted such a "replication" of the overall *JMCB* experiment with papers presented at the Bank's fall economic policy conference. This annual

---

[19]These articles might fall within the category Fuess (1993) labels reexaminations with extensions, although the reproduction/replication portion of the articles is seldom more a sentence or two.

conference typically features 5 or 6 papers by academic economists. Following the 1992 conference, each author was requested to submit data and programs sufficient to permit a research analyst to replicate their results in the same manner as was being done for papers written by Bank staff for the *Review*. The differences among research practices that we had observed at the *JMCB* a decade earlier immediately resurfaced. As before, there seemed to be a direct correlation between the author's difficulty and the time that had elapsed since completion of the research. One author, who said that the research reported in his paper had been completed several years earlier, lacked full documentation of the original sources and expended a great deal of time compiling data for us. Another author, however, promptly submitted a large amount of carefully documented materials including both data and programs.[20] The following year, our 1993 annual conference provided a marked contrast. Each author was informed in writing, at the time their paper was invited for the conference, that we expected data to be submitted with the manuscript. Authors generally found it imposed little burden to submit data and programs with their manuscripts, although some followup requests had to be made regarding missing items or incomplete documentation.

A second part of the *JMCB* project were attempts replication of published papers from materials submitted by authors. The results of our efforts to replicate papers presented at the Bank's 1992 conference are instructive. Eventually, all published results were replicated, including locating the data in stated sources and the authors' statistical results. In one case,

---

[20]Ironically, this author also had published an article in *JMCB* between 1980 and 1982 and hence was in our control group at the *JMCB* project. His materials submitted to the *JMCB* also were complete, and his article was one we fully (and easily) replicated.

however, initial attempts to reestimate an author's models from submitted data and programs failed. Further investigation suggested that the results were extremely sensitive to rounding error and highly unstable.[21] In another case, the research analyst was unfamiliar with the author's econometrics package; the resultant learning-by-doing greatly extended the time required, increased the cost of the replication, and angered the (often challenged) author. Overall, we found that all the replications involved a great deal of communication between our staff and the authors, proving expensive for both parties.

Programs and data that are poorly organized and documented may be nearly useless. To assure that the materials we distribute on our bulletin board are as clear as possible, at St. Louis each article published in the *Review* is replicated prior to publication.[22] This process typically begins with a research analyst checking the author's data against original sources.[23] Next, all statistical results are recalculated. During this process, the author and

---

[21]The instability is both a numerical and economic problem. The author's original data, furnished to us rounded to two decimal places, caused the supplied fortran program to fail. When the data were extended to six decimal places, the program executed correctly. The sensitivity of the results to small differences in the data may suggest that individual effects are very close to not being identified, however.

[22]Excepting the October 1992 conference, papers presented by authors who are not Bank staff at Bank-sponsored conferences are not fully replicated prior to publication. We do collect data from the authors and make it available on our bulletin board (FRED), however.

[23]Some visiting scholars and participants in our annual policy conferences have responded to requests for data used in their articles with incredulity, stating that they obtained their data from our Bank's electronic bulletin board and hence "...we [the Bank staff] already have their data." In fact, the hundreds of economic data series on our bulletin board are frequently updated and revised. We have no way of knowing precisely what data the author used. This problem is exactly the same one faced by any author who obtains data from any source, including DRI, Citibase, and others.

analyst work together to produce the data files and computer programs for the Bank's bulletin board. Finally, all bibliographic and other references are checked by the analyst against original source documents.

Conclusions

The *JMCB* project demonstrated that professional journals could, at very low cost, make a significant contribution to improving scientific standards in economics by requesting datasets and programs from authors of published articles. For the first time, the reader of an empirical article in a professional economics journal could easily move beyond the author's published conclusions to the research methodology by requesting data and programs directly from the journal that published the article.

Subsequent assistance from the NSF and ICPSR that would have expanded this program and reduced its cost to zero was declined by major journals. "Journals" of course do not exist in the abstract; like every firm, they have owners, managers, editors, referees, and subscribers, many of which are economists. How should economists, as scientists, interpret their collective lack of interest in the precise conduct of the research summarized in journal articles? Does the failure of journals to request and distribute data and programs reflect a widespread lack of scientific discipline in economics?

Today, distributing supplemental materials such as an author's data and programs is inexpensive via an Internet ftp server or, as we've demonstrated at St. Louis, on a computer bulletin board. It is surprising, in our opinion, that so few professional journals do so.

In addition, the *JMCB* project demonstrated the value of the replication of empirical

results as a type of quality control for published papers. A number of authors, both a decade ago at the *JMCB* and more recently at St. Louis, have found the accuracy of their research improved by the preparation of carefully documented datasets and programs. We continue to believe that the still considerable costs of replication would fall sharply and scientific standards in economics would be significantly improved if professional journals requested authors to archive their data and programs for distribution to readers.

References

Anderson, Richard G. and Kenneth A. Kavajecz. "An Historical Perspective on the Federal Reserve's Monetary Aggregates: Definition, Construction, and Targeting," Federal Reserve Bank of St. Louis *Review*, March/April 1994, pp. 1-31.

Cooper, Harris and Larry V. Hedges, eds. *The Handbook of Research Synthesis* (New York: 1994)

Dewald, William G., Jerry G. Thursby, and Richard G. Anderson. "Replication in Empirical Economics: The *Journal of Money, Credit and Banking* Project," *American Economic Review*, September 1986.

Feige, Edgar L. "The Consequences of Journal Editorial Policies and a Suggestion for Revision." *Journal of Political Economy*, 1975, vol 83, no. 6

Feigenbaum, Susan and David M. Levy. "The Market for (Ir)Reproducible Econometrics," *Social Epistemology*, 1993, vol. 7, no. 3, pp. 243-244

_____. "The Self-Enforcement Mechanism in Science," mimeo, paper presented at the American Economic Association Meetings, Boston, Massachusetts, January 1994.

Fuess, Scott M. "On Replication in Business and Economic Research: The *QJBE* Case," paper presented at the Eastern Economic Association meetings, Boston MA, March 1994 (mimeo, Department of Economics, University of Nebraska, 1993).

Goffe, William L. "Computer Network Resources for Economists," mimeo, Department of Economics and International Business, University of Southern Mississippi, November 1993. Forthcoming, *Journal of Economic Perspectives*.

_____. "Resources for Economists on the Internet," electronic document maintained

on the Internet (March 1994 version). Contact bgoffe@whale.st.usm.edu.

Hubbard, Raymond and Daniel E. Vetter. "Replications in the Finance Literature: An Empirical Study," *Quarterly Journal of Business and Economics*, Autumn 1991, vol. 30, no. 4

Kane, Edward J. "Why Journal Editors Should Encourage the Replication of Applied Econometric Research," *Quarterly Journal of Business and Economics*, Winter 1984, vol. 23, no. 1

Lindsay, Murray R. and A.S.C. Ehrenberg. "The Design of Replicated Studies," *The American Statistican*, August 1993, vol. 47, no. 3, pp. 217-28.

MacKinnon, James. "Guidelines for Users: Journal of Applied Econometrics FTP Archive Site," *Journal of Applied Econometrics*, vol. 9, April-June 1994, pp. 229-30.

Tauchen, George. "Remarks on my Term at JBES," *Journal of Business & Economic Statistics*, October 1993, vol. 11, no. 4

Data Sets Requested by Month and Year through May 1989							
	1983	1984	1985	1986	1987	1988	1989
January	0	0	12	3	9	5	8
February	0	2	1	1	8	6	4
March	0	1	9	5	4	1	1
April	14	2	2	6	0	1	1
May	1	0	14	1	1	5	2
June	1	0	2	6	5	2	
July	0	4	5	3	2	2	
August	3	2	4	3	0	2	
September	9	4	4	2	1	1	
October	11	6	7	38	2	4	
November	1	2	6	4	3	4	
December	0	1		6	0	3	

Data Sets Available by Issue as of May 1989									
	1980	1981	1982	1983	1984	1985	1986	1987	1988
February	2	3	4	6	4	5	3	2	2
May	1	3	2	5	5	5	3	5	6
August	1	4	3	6	8	2	6	2	6
November	4	0	3	7	7	5	7	1	3
Total	8	10	12	24	24	17	19	10	17

Source: data compiled by JMCB editorial office staff. No later data are available from the JMCB staff.