

**Review of Choice-Based and Matched Sample Studies  
In Management Accounting Research\***

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## **Review of Choice-Based and Matched Sample Studies In Management Accounting Research**

### **Summary**

Three methodological errors in the analysis of matched and choice based samples in accounting research have been identified by Cram, Karan, and Stuart (CKS, 2006). They assessed that results of 68 of 73 audit research papers using matched and choice-based sampling are questionable because they suffer from one or more of the three errors. In this paper we review the use of these research designs in management accounting research, and so far have identified 24 studies published from 1993 to 2005 for discussion. Goals of this work are to inform consumers of this research of the risk of relying unduly upon some of the reported results and to suggest that authors and other researchers address reanalysis and replication needs. Data analysis using properly specified models might allow researchers to find new results in previously published studies, or to resolve discrepancies of findings within and across papers. Additionally, a better understanding of choice-based and matched sample designs may facilitate productive reanalysis of datasets that have yet to yield publishable results.

## INTRODUCTION

Accounting researchers use choice based and matched sample research designs primarily for their power to reveal statistically significant findings following collection of relatively small data sets. Choice based and matched samples are frequently used to economize when data collection is costly, especially when outcomes of one sort are rare and few would be obtained under random selection. For example, all firms which report adopting a management technique such as TQM or an EVA-based incentive compensation plan for managers may be identified, and for comparison, rather than gathering data for all other firms, a control sample containing matched firms, matching to each adopting firm by industry and firm size, may be collected. This is appropriate if a factor such as industry or firm size is likely to have a large effect on relevant outcomes such as profitability but not itself be of primary research interest. In such a case, the use of a matched sample design allows the researcher to focus power on estimating parameters for variables of interest while applying control for those “nuisance” variables. Or, if nuisance variables are likely to have a nonlinear effect, it suffices to match on those variables without modeling and estimating their effects explicitly. Cram, Karan, Stuart (CKS, 2005) identify, however, that choice based and matched samples have often been misanalysed in accounting research, from Beaver (1966, 1968) and Altman (1968) until now, and identify three widespread errors. Their principal guidance is that choice-based and matched samples are nonrandom samples, and that any analysis has to take the non-randomness into account. The presence of the three errors undermines both the internal and external validity of the research.

For this review, we identify 24 studies in management accounting appearing between 1993 and 2005. These papers either are published in the Journal of Management Accounting Research (JMAR) or they otherwise appear to meet the objectives of that journal, i.e. to improve the theory and practice of management accounting. For JMAR’s purposes, management accounting is “broadly defined”. JMAR aims to include “a variety of theoretical perspectives and research methods” and to address “innovations

in management accounting practices”. JMAR seeks a “variety of topics, e.g. internal reporting and decision making; incentives and performance evaluation; interface between internal and external reporting” in a “variety of settings, e.g. profit and not-for-profit; manufacturing and service organizations; domestic, foreign and multinational.” We identify these 24 papers by literature searching on “matched pairs”, “matched sample”, “choice-based sample” and similar terms. Our intent is to be broadly comprehensive in the final version of this review paper, although the area is deliberately a bit vaguely defined, and in this draft we anticipate we will have missed a number of papers. We seek to be comprehensive for two reasons: to avoid unfairly singling out individual authors unfairly when the practices they follow are widespread, and to provide the maximum benefit to the field by calling appropriate attention to studies that merit reanalysis, in sufficient detail to provide specific guidance.

The present paper explores the extent of misanalysis in management accounting research. We seek to alert researchers to the need for reanalysis of previously published results, as they suffer from problems of internal and external validity. We also suggest that many unpublished studies may benefit from correct reanalysis. CKS provide simulation results and replications to demonstrate the errors in applying statistical methods meant for random samples to these situations. CKS identify six research design categories of studies mixing choice-based and matching techniques which differ in the potential problems and in the most efficient solutions that apply. We will categorize the 24 papers and any additional ones identified in a revised version of this paper.

Accounting researchers often reason persuasively that industry or size or other factors have large effects that must be controlled for, use those factors in selecting their sample, but continue to perform analysis that, erroneously, does not account for the matching. Matching on an effect does not accomplish the desired control if an unmatched method is then used to analyze the sample. Therefore the analysis performed is misspecified, and the researchers have created a strong possibility that their discussion of the relative importance of other factors of research interest is not justified. Briefly, their analysis suffers

from the omission of multiple correlated variables which they themselves have identified as being important, and hence all estimated coefficients and standard errors in their analysis are biased unpredictably, even asymptotically. This omission is described by CKS as their Error 1.

A related, further complication in the analysis arises if the matching has not been perfect, e.g., if matching is done on a continuous variable such as assets or sales, and “closest” rather than exact matches are accepted. Then, the remaining gap in size between treatment and control observations could have a substantial effect. A variable measuring that difference in size might be included in the analysis of differences to attempt to “soak up” its effect. Or, equivalently in an OLS regression analysis where matching is controlled for by pairwise dummy variables, that effect could be controlled for by including the size variable itself. Audit researchers often do not employ this refinement of simpler matched analysis when it is needed. CKS term this Error 2.

Choice based and matched samples are not randomly selected. So, in addition to controlling properly for matching variables, it is also necessary to adjust analyses to take into account the differing sampling rates in strata of the collected data. This can be done by reweighting each observation according to its stratum’s representativeness of the general population. Analyses employing logit regression may be exempt from the need for reweighting. Also exempt are some within-subject designs, such as studies of audit fees paid by individual firms before and after a given event. CKS term the omission of necessary reweighting as Error 3.

This paper is organized as follows. In the next section, we discuss CKS’s six research designs used in choice based and matched sample studies, giving examples from management accounting research. Then we quantify the extent to which we find the three types of errors to be present within the 24 studies in management accounting research where choice based and matched sample approaches have been applied. We report on the frequency of these errors by category of the research design used, by journals where these papers have been published, and by year of publication. Then, to be most useful to management accounting researchers, we discuss these studies categorized within topical streams of research. Finally, we summarize and conclude.

## RESEARCH DESIGNS

In management accounting research, we identify two basic research designs employing non-random samples that have been used: (1) choice based and (2) matched or stratified designs. A choice-based research design is one where a subsample consisting of cases having one outcome (e.g., firm-year observations where a bankruptcy or a going concern qualified audit opinion occurs) is collected, and then a comparison sample of control observations is selected from available data having different outcomes, and then the analysis to follow uses the outcome as the dependent variable to be explained by other variables. “Outcome-based” or “state-based” might be more descriptive, but choice-based is the term generally used, as if the research is explaining discretionary management decisions to declare bankruptcy or not, for example. Choice-based sampling is useful when data collection is costly and one category of the outcome to be explained is rare, so random sampling from the population would not yield very many observations of the rare type unless very costly, large samples were collected. Medical research often takes advantage of this method to examine determinants of patient outcomes such as cancers that rarely occur.

A matched sample research design is one which incorporates non-proportional sampling by its selection of pairs, triples, or other clusters of observations that are similar in certain respects. Matched clusters may consist of “within-subject” data, e.g., the pair of before-treatment and after-treatment observations of the same firm or other subject.<sup>1</sup> Or, in a cross-sectional study, clusters may consist of pairs of firm-year observations that a researcher assesses are similar on observable and available characteristics such as year, industry, and size. These are “between-subject” studies and are usually

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<sup>1</sup> Within-subject, before-and-after studies are not usually highlighted as matched in accounting research; we found relatively few in our review of audit research. Unlike between-subject studies, within-subject studies are usually not misanalysed in accounting research. Many within-subject studies appear in experimental work and are appropriately analysed: in analysis the term “blocking” refers to the control for matching that is accounted for.

misanalysed. In medical research, there are many studies of twins, as many genetic and/or environmental factors can be well controlled for, leaving power to discern the effects, across twins, of differences of dietary or smoking or other habits.

Within the choice based research design, the control sample is often chosen based not only upon the outcome but also by matching on other variables. Thus a choice-based sample may or may not also be a matched sample; to be both, the control sample must be selected on the outcome variable to be explained in analysis as well as matched to the case sample on other variables. A sample of JIT-adopting firms paired to non-adopting firms, with the pair-matching by industry and closest size, and with the analysis to explain adoption or not, is both. If the comparison firms were chosen randomly from the stratum of non-nonadopting firms, this would be just choice based. We distinguish between “fully-matched” samples in which each case observation is uniquely associated with one or more controls, and “semi-matched” samples. The latter are samples that have pairings of case and controls that are nominally but not meaningfully unique. For example, if several case observations in one industry are each matched to a different randomly selected control from that industry, what is achieved is what we term “semi-matching”; the pairs can just as well be combined into matched many-to-many clusters. Each industry-case cluster and each industry-control cluster are strata. These approaches to research design lead to six distinct categories (see Figure 1 not included in this draft), here described as (1) Choice Based Non Matched (CB-NM), (2) Choice Based Semi Matched (CB-SM), (3) Choice Based Fully Matched (CB-FM), (4) Non Choice Based Semi Matched (NCB-SM), and (5a) Non Choice Based Fully Matched (NCB-FM)within-subjects and (5b) Non Choice Based Fully Matched (NCB-FM). This categorization is adapted from Cram Karan Stuart (2005). All six categories are non-random samples, suffer from different potential errors and require differing forms of analysis. Previous researchers have not recognized the need for differing forms of analysis and have often analyzed their data incorrectly.

### **THREE COMMON ERRORS IN DATA ANALYSIS**

Cram Karan Stuart (CKS 2005) identified three errors that can apply to one or more of the six research design categories. We summarize the research designs and the potential for each error in Table 2 (not included in this draft).

Error 1: the Use of Unconditional Analysis, when Analysis Conditional upon Effects of Matching Variables is Needed, can apply to all the matched sample categories, but not to choice-based samples which do not involve matching.

Error 2: Failure to Control for Effect of Imperfectly Matched Variables, can apply to semi-matched categories only.

Error 3: Failure to Reweight Observations According to Differing Sampling Rates, can apply to all research categories. However, a “logit exemption” to the need for reweighting applies to logit regression models in all categories. In management accounting research, we note studies employing weighting to correct for such problems are few or none in number. A limitation of the weighted exogenous sampling maximum likelihood (WESML) method that could be used, and of other weighting approaches, is that exogenous population information is needed. In many research settings the required information-- the proportions of all individuals from the population that fall in each of the matching set categories-- might be readily available, such as when sampling from the finite population of publicly traded firm-year observations appearing in CRSP and Compustat databases, but often it is not. The vast majority of auditing studies using choice-based and matched samples do not, however, employ exogenous weighting. Many, instead, rely upon a special result which we term the “logit exemption”.

The logit exemption, at least as it applies to simple choice-based sampling, has been known in accounting research since Palepu (1986). Notably, Maddala (1991) who described the simple version of the exemption in an invited paper in *The Accounting Review*, has been oft-cited and is at times paraphrased, imprecisely, to represent that as long as logit regression is used, coefficients other than the

intercept will not be biased.<sup>2</sup> Zmijewski (1984) also has been cited on this point. It has not been understood that if matching is used within choice-based samples, however, it is then necessary for an intercept to be estimated for each matched set. Then each of those intercepts are likewise biased, although coefficient estimates on included variables will be consistent. Accounting researchers have also applied unweighted estimation to probit, OLS, discriminant, and univariate analyses where the logit exemption obviously does not apply. These analyses do not yield valid estimates. All six research design categories can include papers suffering from Error 3, because they all involve nonrandom sampling.

### **DISCUSSION OF MANAGEMENT ACCOUNTING RESEARCH STUDIES**

We seek to discuss a large proportion of papers in management accounting research here. The use and frequent misanalysis of choice based and matched sample studies in accounting research is not limited to the management accounting area. Twenty-five papers that appear to use choice-based or matched sample methods and represent different areas of management accounting research are:

1. Aier, Comprix, Gunlock, and Lee (2005). Companies filing accounting restatements with the SEC are matched with non-restating companies, matching on year, company size, and industry. They run a logit regression on restatement or not, pooling all observations, upon CFO experience and education measures as well as firm characteristics. Because CFO experience would be correlated with industry and asset size, and they all would correlate with restating or not, the analytical reasoning is invalid: the industry and asset size characteristics have not been controlled for. In addition to that (error 1), the matching is imperfect, so residual difference in asset size could drive the apparent results (error 2).

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<sup>2</sup> An extended version of the logit exemption is proven in CKS (2005). The logit exemption allows the use of unweighted logit regressions to analyse choice-based matched sample data, delivering asymptotically unbiased coefficient estimates and standard errors on non-intercept variables, *providing* that the model is “fully saturated”, i.e. that an intercept is included for every level of each matching variable. The typical logit application in accounting research, however, erroneously estimates an unweighted and unsaturated model, which does not control for the matching variables’ effects and does not enjoy the logit exemption from need to weight data to reflect population proportions.

2. Balachandran, S. V. (2006). How Does Residual Income Affect Investment? The Role of Prior Performance Measures. To be reviewed.
3. Balakrishnan, Linsmeier, and Venkatachalam (BLV 1996) compose a matched pair sample of 46 firms adopting JIT and 46 control firms matched by industry size, customer concentration. Perform numerous univariate comparisons to explore financial benefits from JIT Adoption. Suffers error 2 and error 3. See further discussion under Kinney and Wempe (2002), below.
4. Bartov and Mohanram (2004). Private Information, Earnings Manipulations, and Executive Stock-Option Exercises. *The Accounting Review*. Includes error 1. To be reviewed.
5. Beasley (1996). An Empirical Analysis of the Relation Between the Board of Director Composition and Financial Statement Fraud. *The Accounting Review*. Includes error 1. To be reviewed.
6. Beneish (1999) examines insider trading problems. He compares 49 firms having SEC enforcement actions on earnings overstatements to firms matched on industry, year and thirdly by assets (or by age of firm). The probit analysis performed provides an invalid statistical argument, as the data is pooled and industry, year, assets are not controlled for. The work suffers error 1, 2, and 3.
7. Botosan and Stanford (2005). Managers' Motives to Withhold Segment Disclosures and the Effect of SFAS No. 131 on Analysts' Information Environment. *The Accounting Review*. To be reviewed.
8. Clarkson and Simunic (1994). The Association Between Audit Quality, Retained Ownership, and Firm-Specific Risk in U.S. vs. Canadian IPO Markets. *Journal of Accounting and Economics*. To be reviewed.
9. Corbett, Montes-Sancho, and Kirsch (2005) examine whether ISO 9000 certification "leads to productivity improvements, market benefits, and improved financial performance." They matched each ISO 9000-certified firm to one or more noncertified firms in the same industry with similar

precertification size and/or return on assets. They note that “(t)he degree to which the precise results vary across control-group specifications indicates that event studies should always include extensive sensitivity analysis, for instance matching by size and performance separately and jointly, using both single firms and portfolios as controls.” Avoids error 1, to be reviewed.

10. Dechow, Sloan, and Sweeney (1996) compare 92 firms subject to SEC enforcement actions to a matched set of control firms, matched by industry (3 digit SIC code, and nearest in assets size). They perform pooled analyses, even allowing differing numbers of case and control firms where data for sample firms were not available, so it is clear that their analyses are not of differences upon differences. Different industry composition is present in the. Even if there were no missing observations so that the 2 samples had the intended-to-be-the-same industry and size composition, it would still be necessary to account for industry and assets size differences in the analyses, which was not done. Industry and asset size factors are not controlled for in the analysis; the analysis suffers from errors 1, 2, and 3.
11. Hendricks and Singhal (2001) compare stock return performance of firms winning TQM awards to firms matched by industry and/or size. Comparing difference in performance avoids error 1, but as with other event studies the generalizability is not established (error 3).
12. Hendricks and Singhal (2005). An Empirical Analysis of the Effect of Supply Chain Disruptions on Long-Run Stock Price Performance and Equity Risk of the Firm. *Production and Operations Management*. To be reviewed.
13. Hogan and Lewis (2002). The Long-Run Operating Performance of Firms Adopting Compensation Plans Based on Economic Profits. Working paper. To be reviewed.
14. Kennedy, T., and J. Affleck-Graves. 2001. The Impact of Activity-Based Costing Techniques on Firm Performance. *Journal of Management Accounting Research*. To be reviewed.

15. Kinney and Wempe (2002) further examine JIT adoptions effect on profitability. Gathers a matched sample similar to that of BLV (1996) but larger and more recent. The authors note “empirical evidence on the association between JIT adoption and financial performance is mixed” and go on to identify new discrepancies of their results vis-a-vis those of Balakrishnan, Linsmeier, and Venkatachalam (1996). To be reviewed.
16. Krishnan, J. 2005. Audit Committee Quality and Internal Control: An Empirical Analysis. *The Accounting Review* 80(2): 649-675. To be reviewed.
17. McGowan, A.S. and V. P. Vondryk. The Relation Between Cost Shifting and Segment Profitability in the Defense-Contracting Industry. *The Accounting Review*. To be reviewed.
18. Nagy, A. L. and T.L. Neal. 2001. An Empirical Examination of Corporate Myopic Behavior: A Comparison of Japanese and U.S. Companies. *The International Journal of Accounting*. To be reviewed.
19. Nicolaou (2004), with discussion by Reck (2004) and Nicolaou’s further response, examines performance of firms implementing ERP systems vs. matched firms not adopting ERP. His regressions of differences on differences avoid error 1 although they do include an unwarranted intercept term. Error 3 applies.
20. Perry, S.E. and T.H. Williams. 1994. Earnings Management Preceding Management Buyout Offers. *Journal of Accounting and Economics*. To be reviewed.
21. Said, A. A., H. R. HassabElnaby, and B. Weir. An Empirical Investigation of the Performance Consequences of Nonfinancial Measures. *Journal of Management Accounting Research*. To be reviewed.
22. Shivdasani, A. 1993. Board composition, ownership structure, and hostile takeovers. *Journal of Accounting and Economics*. To be reviewed.

23. Wallace (1997) examines performance of 40 firms adopting Residual Income-Based

Compensation Plans vs. 40 matched firms traditional accounting earnings-based plans.

Matching was by industry SIC and by asset size. The principal analyses are pooled regressions of within-firm change in performance upon , with a single dummy for “treatment” vs. control firm group membership (rather than 40 dummies for each pairing, in a no-intercept analysis, that are required to control for the industry and asset size. In the analysis performed, industry and asset size being omitted correlated variables, so the analysis suffers from errors 1, 2, and 3.

24. Wertheim and Lynn (1993) apply logit regression analysis to explain hospitals’ closure vs. staying open, using 71 closed hospitals matched to 71 non-closed hospitals, matched by rural vs. urban, size, and geographical area. However, the data is pooled in the analysis as if it were random sample data, and hence all results could be driven by the matching variables, which are omitted correlated variables. Suffers error 1 and 2.

#### **Frequency of Errors by Research Design:**

In this section, we also will discuss tabulation of results tabulated of our review of papers in management accounting research. The 24 papers listed above comprise an interesting set of papers on its own. Current work in the management accounting literature relies upon results of these papers, and authors of many of these papers are active and influential in the field. We expect to find that the majority of these papers suffer one or more of the three technical deficiencies. Papers suffering from Error 1 lack internal validity. To be clear, there is no set of statistical assumptions which would justify the standard errors and t-statistics reported. Cram, Karan, Stuart show by simulation examples that the effect of Error 1 can be to yield entirely erroneous conclusions.

On the second technical criticism, Error 2, we note some of the papers suffer from lack of explicit control for “closest” imperfect matching. A closest-matched variable such as size can still have influence. It might be controlled for by including a linear term. But, as size or another variables

contribution might be non-linear, in general, there is no fully satisfactory resolution. The researcher, CKS argue, must show some effort to eliminate the possibility that their results are merely driven by the omitted residual effect. Sensitivity analyses including linear and quadratic terms, for example, might be performed and given some discussion. Otherwise, the researcher has not established that their effects of research interest are not merely the result of an omitted variable problem. Papers suffering from Error 2 may lack internal validity. The main statistical assumption which would justify excluding the residual effect is that size has no influence upon the outcome. In a OLS regression, the omission of residual size would also be justifiable if size was not correlated with any included variables (it is only omitted correlated variables that cause bias in all other coefficients). However in logit, probit and other analyses, the omission of even an uncorrelated variable that should be in the model will bias estimates of all other coefficients.

On the third technical criticism, that of the need to reweight for sampling rates in each stratum, relatively few of the management accounting papers use logit regression and hence are exempt, at least insofar as inferences based on non-intercept coefficients. Some may be exempt from the need to reweight for the reason that their matching is a within-subjects design, such as before-and-after study of a TQM program adoption where the subject is a firm which is randomly selected from all firms having data available.

In a Table we will report the above totals and also tabulate the distribution of error types across the six research design categories of papers, from Choice-Based Non-Matched to Non Choice Based Fully Matched research design.

We will discuss groupings of the papers by research streams:

Discussion by Research Stream: Effect of Adoption of EVA-Based Compensation

Discussion by Research Stream: TQM Adoption

Discussion By Research Stream: CEO and Other Officer Incentives

Discussion By Research Stream: Prediction of Financial Distress

Discussion By Research Stream: Other

Frequency of Errors by Year and by Journal:

In the revision of this paper, we will tabulate the occurrence of errors through time, and across journals in which the articles appear. We expect no obvious evidence of editorial differences across journals relating to the errors addressed in this paper. In audit research, CKS noted no major time trend, finding the average number of conceptual errors had hovered around two per paper throughout the period studied..

### **SUMMARY AND CONCLUDING REMARKS**

This article examines the use of choice based and matched sample designs in published auditing research, identified model specification issues, and clarified the matched sample research design approach in order to promote its use as an effective tool. Researchers have often selected matched samples based on industry and size, and assumed this effectively controls for industry and size effects in their studies. But, as CKS been demonstrated with simulations and formal proofs, this approach can and does lead to incorrect conclusions. This leaves us with uncertainty in the accuracy of results of a number of published papers within management accounting and beyond (in other accounting and finance research). Perhaps more importantly, the power to detect statistically significant relationships may have been lost in numerous research studies that have gone unpublished, despite researchers having collected data that may have held important results.

Lillis and Mundy (2005) state “While empirical researchers in management accounting frequently address overlapping research issues using a variety of methods, there is little evidence of productive dialogue addressing the uncertainties and ambiguities raised within each stream of research. For example, survey researchers frequently call for deeper field-based insights into conflicting or ambiguous findings. Case study researchers convey rich organizational stories of management accounting in context. However, these field-based findings are rarely used to resolve the ambiguity in construct definition, measurement, and inter-relationships that plague our empirical research bases.” We

support the effort to reconcile varying results and suggest that reanalysis of the matched and choice based sample studies may contribute to that.

Our identification of the need to reanalyze various management accounting research studies could possibly spur expanded use of the choice based and matched sample design in future accounting research. Data analysis using properly specified models might allow researchers to find new results in previously published choice based and matched sample studies, or to resolve discrepancies of findings within and across papers. Additionally, a better understanding of choice-based and matched sample designs may facilitate reanalysis of datasets that have yet to yield publishable results, perhaps due to incorrect analysis. Further the improved understanding could facilitate more rapid penetration of entirely new areas of research interest where data collection is initially costly.

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