The Issue of Endogeneity within Theory-Based, Quantitative Management Accounting Research

ROBERT H. CHENHALL** & FRANK MOERS†

*Monash University, **James Cook University, Australia and †Maastricht University, The Netherlands

ABSTRACT A current issue of potential concern in theory-based management accounting research is the extent to which endogeneity limits the validity of empirical testing of models. This paper aims to stimulate debate as to the meaning of endogeneity as it applies to (management) accounting research. The paper explains what endogeneity is, its causes and consequences, and potential ways of managing the problem. Specifically, the paper argues that an econometric definition of endogeneity clarifies its meaning in empirical research. A series of basic issues that concern endogeneity and theory construction are presented. These include omitted variables, simultaneity, equilibrium conditions and issues concerning choice variables. Finally, possible approaches for dealing with endogeneity are presented.

Introduction

There has developed a tradition of periodic reviews of progress and problems related to theory-based empirical research in management accounting. These reviews have attempted to clarify theories, reflect on findings and method resulting in evaluations of the extant literature (e.g. most recently Hartmann and Moers, 1999; Hartmann, 2000; Ittner and Larcker, 2001; Chenhall, 2003; Luft and Shields, 2003). These have been, in the main, constructive and arguably have assisted in focusing the research agenda. While some commentators are impatient with the lack of progress in addressing identified problems, it can be contended that there has been heightened concern with issues related to theory development, data collection and analysis.
A current concern is the issue of endogeneity. This has emerged, in part, as a consequence of management accounting researchers responding to more rigorous peer-group review that is requiring closer consideration of the assumptions underlying the econometric techniques being applied to test hypothesized relationships. It is interesting to reflect on why issues of endogeneity have only been posed recently as an issue of importance in management accounting when the potential problems are well established in basic econometrics and are often explicitly recognized in applied economics (e.g. Engle et al., 1983). It should be noted that the potential problems derived from endogeneity have also only been identified recently in financial accounting (e.g. Core, 2001; Fields et al., 2001). Perhaps the identification of endogeneity issues is part of an evolution to more rigorous research being advocated by a constant stream of review papers in (management) accounting. Also, in management accounting, as the field has evolved, more complex relationships have been investigated, some of which have posed issues of endogeneity. Notwithstanding the reasons for endogeneity issues surfacing as a recent concern in theory-based quantitative management accounting research, it would seem useful to clarify the issues associated with endogeneity and examine how these concerns can be addressed.

A current trend in the accounting literature seems to be a belief that endogeneity occurs as a consequence of explaining how a choice variable affects a desired outcome. That is, endogeneity is likely to be apparent when studies place a choice variable on the right-hand side of an equation that is specified to test whether the choice variable is associated with a specified outcome. Consequently, the validity of this type of research is questioned. Although concern with issues of endogeneity is important, this view of endogeneity is inappropriate as it represents only a partial understanding of notions of endogeneity.

In this paper, we argue that the key to understanding endogeneity lies in its meaning as an econometric problem. We therefore focus on the econometric definition of endogeneity in discussing the issue. In essence, endogeneity leads to biased and inconsistent estimators within equations used to test theoretical propositions, which makes inferences problematic and consequently reduces the confidence we have in drawing conclusions from research. While we examine both the sources of endogeneity and suggest various approaches for tackling this problem, the primary aim of this paper is to stimulate debate in this area. Progress in theory-based quantitative research in accounting will be enhanced if researchers can engage in a serious discussion about how endogeneity affects accounting research, drawing on basic ideas from econometrics and the treatment of endogeneity in other disciplines.

We argue that there is not a single empirical paper that does not have endogeneity issues. That is, endogeneity, as defined econometrically, is bound to be present in any empirical analysis. This does not, however, imply that we should stop doing empirical research. On the contrary! Our point is that researchers should explicitly address endogeneity issues and use theory and logic to argue why endogeneity is or is not a problem in their particular study. The paradox in
all this is that econometrics is crucial in understanding the issue, but econometrics cannot solve it.

We refrain from critically reviewing past management accounting papers and evaluating the extent of the endogeneity problem in these studies. We believe that this is not helpful in stimulating the debate for the following reason. As noted above, all empirical papers have endogeneity issues and a focus on past management accounting papers would make it wrongly appear that it is a problem unique to management accounting problem. Our purpose is to look forward and discuss ways to tackle a general problem in a specific research area, being management accounting. We also refrain from discussing complex econometric tools because it is important to first have a solid understanding of the underlying problem before these issues can be addressed in depth. Furthermore, we are skeptical about the extent to which simply using more advanced econometrics is going to resolve endogeneity problems. It often merely gives the researcher an unjustified feeling of assurance that a technical treatment can fully resolve endogeneity concerns.

We offer the following areas to direct the discussion and these areas also reflect the structure of the remainder of this paper.

- What is endogeneity?
- How important is the endogeneity assumption in theory construction?
- What is the link between endogeneity and choice variables?
- Can we deal with endogeneity?
- Is it a (management) accounting problem?

**What is Endogeneity?**

This paper is concerned with theory-based quantitative empirical research and, given this focus, we make use of the predictive validity framework (Runkel and McGrath, 1972) to discuss and explain endogeneity and to position it in the broader context of theory-based empirical research (see Figure 1 for the predictive validity framework). Specifically, we consider research that develops mathematical representations of theory that show the relationship between a set of defined variables. These relationships are based on theories drawn from a wide variety of disciplines including economics, behavioral and organization sciences, and information sciences. Data are used to test these theories by way of statistical analysis. The purpose of the theory is to develop a model, at the conceptual level, that identifies one or more variables of interest, such as the usefulness of budgets, and other variables, such as timeliness of budgets, that are expected to be associated with the behavior of the variable of interest. These variables are often referred to as dependent or explained variables and independent or explanatory variables, respectively.

In theory-based quantitative research, the theory is formalized by the so-called structural equation (link 1 in the predictive validity framework).
For example,

\[ Y = \beta_0 + \beta_1 X_1 + u \]  

where \( Y \) is the explained variable, \( X_1 \) is the explanatory variable and \( u \) is the residual that contains all factors affecting \( Y \) other than \( X_1 \). The coefficient \( \beta_1 \) represents the sign and magnitude of the impact of \( X_1 \) on \( Y \). The coefficient \( \beta_0 \) is the intercept that signifies the value of \( Y \) when \( X_1 = 0 \).

Figure 1 shows that the relationship between explained and explanatory variables, and the underlying theory, is examined at the operational level. That is, data are gathered on observable variables that are used to operationalize the concepts in the structural equation (links 2 and 3), and the relationship between the operationalized explanatory and operationalized explained variable is assessed (link 4). A popular statistical technique to assess this relationship is regression analysis, where the most common type of regression is the linear form employing the ordinary least square (OLS) estimation method. This method will be used to discuss issues related to endogeneity. The simple linear regression equation related to the structural equation is

\[ Y = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \epsilon \]  

where \( Y \) is the operationalized explained variable, \( X_1 \) is the operationalized explanatory variable and \( \epsilon \) is the OLS error term. The coefficient \( \hat{\beta}_1 \) represents the estimated sign and magnitude of the relationship between \( Y \) and \( X_1 \) based on the data gathered (link 4). The critical issue concerning \( \hat{\beta}_1 \) is whether it is an unbiased and consistent estimate of \( \beta_1 \). The estimator \( \hat{\beta}_1 \) will be unbiased if operational estimates are equally dispersed around the conceptual or true estimator \( \beta_1 \) when a large number (infinite) of estimates are made, that is, the expected value is
equal to the true value. Consistency indicates that the distribution of the estimator \( \hat{\beta}_1 \) becomes concentrated on the true value \( \beta_1 \) as the size of the sample used to estimate \( \hat{\beta}_1 \) increases. We are concerned with unbiasedness and consistency because this reflects the extent to which link 4 in the predictive validity framework tells us something about link 1.\(^4\) The role of the error term in the regression equation is crucial in answering this question and is central to understanding the issue of endogeneity.

There is some variation in the meaning of endogenous and exogenous variables. In general usage, a distinction between exogenous and endogenous variables may be made that relates the origins of the variables to be either ‘inside’ or ‘outside’ the structural equation. A variable is endogenous if it is determined within the context of the model, while an exogenous variable is a variable that affects the values of endogenous variables, but whose values are determined outside the model. To clarify this somewhat vague statement, we refer back to equation (1), that is,

\[
Y = \beta_0 + \beta_1 X_1 + u. 
\]

Now assume that \( X_1 \) is also determined by a number of factors and, more specifically, assume that the following structural equation applies:

\[
X_1 = \gamma_0 + \gamma_1 Z_1 + v. \tag{3} 
\]

Equation (3) indicates that the variable \( X_1 \) is endogenous, as it is the explained variable. The main question, however, is whether it is endogenous in equation (1). The variable \( X_1 \) is endogenous in equation (1) if it is correlated with the structural error term, that is, \( \text{Cov}(X_1, u) \neq 0 \). If \( X_1 \) is correlated with the structural error term, then \( X_1 \) is determined inside the model (equation (1)), because the presence of this correlation is either due to \( \text{Cov}(Z_1, u) \neq 0 \) or due to \( \text{Cov}(v, u) \neq 0 \). That is, (some of) the factors that affect \( X_1 \) also affect \( Y \) and as a result equations (1) and (3) are parts of the same model. If \( X_1 \) is not correlated with the structural error term of equation (1), then it must hold that both \( \text{Cov}(Z_1, u) = 0 \) and \( \text{Cov}(v, u) = 0 \), and \( X_1 \) is thus determined outside the model and not endogenous. In sum, the explained variable is, by definition, endogenous because it is always correlated with the structural error term.\(^5\) An explanatory variable may or may not be an endogenous variable.

Endogeneity exists when the model includes an endogenous explanatory variable. The potential for endogeneity exists in virtually all studies involving accounting, finance and economic variables. We draw on a variety of areas including economics (labor economics), management accounting (performance measurement) and financial accounting (corporate governance) to illustrate how endogeneity relates to a cross section of empirical research. Growing recognition of the problems caused by endogeneity, including faulty conclusions about
theoretical propositions, has promoted recent reviews of endogeneity in strategic management (Hamilton and Nickerson, 2003) and marketing (Shugan, 2004).

The treatment of endogeneity has been explicitly included in quantitative studies in economics for some time and particularly helpful approaches can be found in industrial and labor economics (Ashenfelter and Card, 2001). A simple labor economics example relates to an examination of whether trade union density is associated with employment levels. As is commonly the case in labor economics, where there are often important institutional, industry and economic forces, the potential for union density to be endogenous in this relationship is high. For example, the existence of institutional wage bargaining may encourage both union density by providing unions with a valuable advocacy role for their members and a decline in unemployment as sustainable ratios between wage rates and employment levels are determined. High industry productivity may increase union density as workers perceive unions to be beneficial as they can offer a stronger bargaining position, and high productivity leads to higher performing companies that can provide more employment opportunities. Numerous articles that recognize possible endogeneity in labor economics and attempt to manage its effects can be found in specialist journals in labor economics such as Journal of Labor Economics, Journal of Human Resources and Industrial and Labor Relations.

An important topic in recent management accounting research has been the effectiveness of non-financial performance measures (Ittner and Larcker, 1998). Evidence of a direct association between the application of non-financial performance measures and performance is at best mixed with most studies failing to provide evidence of positive associations (Chenhall, 2003). In contemporary manufacturing settings a potentially important variable implicated in the association between non-financial performance measurement systems and performance is the extent to which Advanced Manufacturing, such as TQM, is employed. In a study by Ittner and Larcker (1995) non-financial performance measures were associated with improved performance in settings of low TQM but not in advanced TQM. A potential source of endogeneity in this study is the role of process controls that may accompany the development of TQM. Process controls are those controls that become embedded within the ‘process design’ of a manufacturing process. These controls provide a ‘measurement architecture’ built into the process design that immediately informs workers as to how well they are performing their specific tasks (Hammer, 1996, p. 79). In situations of low TQM, it is likely that process controls are introduced and provide essential information for the formal non-financial performance measurement system. Importantly, the process controls may provide immediate performance benefits as engineers identify the more obvious areas for improvements. In this setting there are potential endogeneity problems in the relationship between performance and non-financial measurement systems from process controls as they are associated with both non-financial performance measures and performance. However, in settings of high TQM, it may be that process controls have been
well developed and we may not see an association between process controls and the non-financial performance measurement system. With the processes under control the non-financial measures adopt a role of focusing on customers, strategies, benchmarking and engaging in redesign and re-engineering. Thus, while advanced TQM may generate situations in which process controls still enhance performance (although this may not be the case because early ‘obvious’ improvements have been gained), there will be no endogeneity if process controls are not associated with non-financial performance measures.

In the case of low TQM, as ‘process controls’ are not included explicitly as an explanatory variable in the equation, it will be part of the structural error term \( u \) (i.e. it will be included along with all other factors that affect performance, other than the non-financial performance measures) and it is also correlated with ‘non-financial performance measures’. As a result, \( \text{Cov}(X_1, u) \neq 0 \) and the analysis is thus subject to endogeneity.

An area of contemporary interest in financial accounting and finance is corporate governance. Corporate governance refers to the mechanisms that help align the decisions of managers with the interests of shareholders and other stakeholders. There is a broad array of corporate governance mechanisms. The composition and size of the board of directors has been identified as important in providing corporate governance. Perhaps the most fundamental issue concerning the role of the board is whether more board members provide enhanced governance and as a consequence improved performance. However, there is a view that large boards are more ineffective at governance as they become more symbolic and less concerned with the process of management (Lipton and Lorsch, 1992; Jensen, 1993). These views have received some empirical support with studies showing board size and firm value being negatively associated (Yermack, 1996; Eisenberg et al., 1998). Reflecting on why this relationship should hold raises the potential for endogeneity problems. Successful and dominant CEOs may be able to limit the size of their company’s board, in an attempt to decrease the board’s influence. If there is also a significant association between the successful track record of the CEO and performance then the role of the CEO creates endogeneity.

Ideally, in regression analysis, the explained variable is significantly associated with the explanatory variables (link 4), which provides support for a theoretically proposed causal relationship between the variables (link 1). However, if endogeneity exists, we can no longer be confident that the results from the regression support the causality implied in the structural equation. To see why this is so, we need to compare the structural equation (equation (1)) to the OLS regression equation (equation (2)). The OLS estimation method leads, by construction, to no correlation between the explanatory variable \( X_1 \) and the OLS error term \( \varepsilon \), that is, the explanatory variables and the OLS error term are always orthogonal. This implies that, if the explanatory variable \( X_1 \) is correlated with the structural error term \( u \), then OLS will ensure that this correlation is eliminated at the operational level by adjusting the coefficient \( \hat{\beta}_1 \). Intuitively, \( X_1 \) will ‘pick up’ all the
factors in \( u \) that are correlated with \( X_1 \). As a result, \( \hat{\beta}_1 \) is a biased estimate of \( \beta_1 \) and we cannot be sure that link 4 says something about link 1. From a theory testing point of view, this can be a serious problem. For example, when we find a positive (negative) empirical association between ‘performance’ and ‘non-financial performance measures’ (or ‘firm value’ and ‘size of the board’), we cannot be sure that this really exists if there is a third variable such as ‘process controls’ (or a ‘successful CEO’), that affects both dependent and independent variables but is omitted from the analysis (Type I error).

**Importance of Endogeneity Assumption in Theory Construction**

In developing and testing a theoretical model it becomes important to understand the extent to which the theory and data comply with the specification of the model, including assumptions implied by the separation of variables into exogenous and endogenous. As the theoretical model is developed, researchers will derive causal relationships between explained variables of interest and explanatory variables, carefully construct definitions of variables and derive measures for these variables. In each of these areas there are issues to consider that concern the potential for endogeneity problems. We consider each of the following issues: ‘omitted variables’, ‘simultaneity’ and ‘equilibrium conditions’.

**Omitted Variables**

In theory-based quantitative research, the aim is to test a causal relationship between explained and explanatory variables. In this case, the empirical model will provide an estimate for prediction but the focus is on how well the explained variable is influenced by the explanatory variables. Thus, it is the regression coefficients that are important and the residuals are interpreted as summing the influence of causal variables not included in the model. In selecting which variables to include in the model, the researcher is guided by the theory that supports the relationships within the model. Inevitably, there will be secondary, omitted variables that may be important within the model. If these variables merely add additional predictive power, they may be seen as complementary to the prediction. For example, in examining the usefulness of balanced scorecards, findings of significant relationships with size and industry would support a theory of size and industry effects. The introduction of another variable, say strategic orientation may be justified on theoretical grounds and when introduced into the regression may be significantly associated with balanced scorecard usefulness and add to the \( R^2 \)-square. Thus, strategy is complementary and adds to the predictive power of the model.

Of concern in testing causal relationships is the possibility that an explanatory variable modeled as exogenous, will in fact be endogenous because of omitted variables (link 5). That is, there will be some systematic relationship between the explanatory variable of interest, modeled as an exogenous variable, and an
omitted variable not included in the model that is associated with both the explanatory variable and the explained variable. As noted in earlier examples, the omitted variable of ‘process controls’ in the relationship between non-financial performance measures and performance; and the role of a ‘successful CEO’ in the relationship between board size and performance illustrate how omitted variables can cause endogeneity problems. In the balanced scorecard example, decentralized structures might be associated with both size and usefulness of balanced scorecards. Decentralized structure is an omitted variable that can cause endogeneity problems. In these cases, the models are seen as being under-specified as an important variable that is associated with both the explained and the explanatory variable is excluded from the analysis. The degree to which this is a problem, that is, leads to a substantial bias in $\hat{b}_1$, can be illustrated as follows. Assume that the structural equation is given by

$$ Y = \beta_0 + \beta_1 X_1 + \beta_2 Z_1 + u. $$

(4)

The method of OLS provides the Best Linear Unbiased Estimate (BLUE) if all explanatory variables in the regression are exogenous. So, if we want to use OLS, we need to write $Y$ as a function of exogenous variables only, that is, we want to know the reduced form equation for $Y$. The reduced form for $Y$ is in this case identical to the structural equation. Assume that instead of estimating equation (4), we estimate equation (2). Using the method of OLS for estimating equation (2) (see, e.g. Wooldridge, 2000, p. 89), the expected value of the OLS estimate for $X_1(\hat{b}_1)$ can then formally be written as

$$ E[\hat{b}_1] = \beta_1 + \beta_2 \frac{\text{Cov}(X_1,Z_1)}{\text{Var}(X_1)}. $$

(5)

and bias is thus equal to

$$ E[\hat{b}_1] - \beta_1 = \beta_2 \frac{\text{Cov}(X_1,Z_1)}{\text{Var}(X_1)}. $$

(6)

In the above equations, $\beta_2$ reflects the sign and magnitude of the impact of $Z_1$ on $Y$ and $\text{Cov}(X_1, Z_1)$ reflects the strength of the relationship between $X_1$ and $Z_1$. The implications of the above equations are relatively simple when considering the importance of omitted variables. *Ceteris paribus*, the bigger the impact of $Z_1$ on $Y$ the larger the bias, and the stronger the relationship between $X_1$ and $Z_1$ the larger the bias. If $\beta_2$ and/or $\text{Cov}(X_1, Z_1)$ are ‘sufficiently’ small, then endogeneity is not a serious problem because the bias is small. More importantly, if either $\beta_2$ or $\text{Cov}(X_1, Z_1)$ equals zero, then there is no endogeneity. In other words, if the purpose is to test whether a theoretically proposed relationship between $Y$ and $X_1$ exists, then we are not concerned about omitted variables that are not correlated with $X_1$, nor do we need to be troubled about correlated variables that
do not affect $Y$. We are only concerned about variables that are correlated with both the explained and explanatory variable.

This observation is important given that causes of omitted variables are mainly due to the necessity to *ex ante* limit the research model to a theoretically manageable number of variables. The key is thus to carefully identify the variables to be included in the model following the arguments outlined above. That is, based on theory and previous empirical evidence, one should identify those variables that are likely to have a major impact on both the explained and explanatory variable and are thus most likely to potentially affect the results if excluded from the analysis. To do this, one should articulate the structural model that gives rise to the reduced form model.

**Simultaneity**

Another important cause of endogeneity related to theory construction is simultaneity. Simultaneity arises when one or more of the explanatory variables are jointly determined with the explained variable. In this case, the causal relationship between an explained and an explanatory variable runs both ways (link 1 is reciprocal). For example, it may be proposed that ‘usefulness of budgets’ will occur as a consequence of employing budget information that is timely. This relationship holds if ‘timeliness of information’ is exogenously determined. However, ‘timeliness of information’ will not be exogenous if there is a reciprocal relationship between ‘usefulness of budgets’ and ‘timeliness of information’. That is, as the budgets become more useful, the usefulness causes data to be collected in a more timely way. If simultaneity exists, then the structural error term is by definition correlated with the explanatory variable. To illustrate this, assume we have the following two-equation structural model:

\[
Y_1 = \beta_0 + \beta_1 Y_2 + \beta_2 Z_1 + u_1 \tag{7}
\]

\[
Y_2 = \delta_0 + \delta_1 Y_1 + \delta_2 Z_2 + u_2 \tag{8}
\]

where $Z_1$ and $Z_2$ are assumed to be exogenous and we want to estimate the first equation, that is, equation (7). To show that $Y_2$ is endogenous in equation (7), we rewrite $Y_2$ by replacing $Y_1$ in equation (8) by equation (7). This leads to

\[
Y_2 = \frac{\delta_0 + \delta_1 \beta_0}{1 - \delta_1 \beta_1} + \frac{\delta_1 \beta_2}{1 - \delta_1 \beta_1} Z_1 + \frac{\delta_2}{1 - \delta_1 \beta_1} Z_2 + \frac{\delta_1}{1 - \delta_1 \beta_1} u_1 + \frac{1}{1 - \delta_1 \beta_1} u_2. \tag{9}
\]

Equation (9) is the reduced form equation for $Y_2$, that is, the endogenous variable is written as a function of exogenous variables. As can be seen from this equation, $Y_2$ is a function of $u_1$ and $Y_2$ is thus endogenous in equation (7). In general, if $\delta_1 \neq 0$, then there exists endogeneity due to simultaneity. Intuitively, given that the structural error term contains all ‘other’ factors that affect the
explained variable, and the explained variable in turn affects the explanatory variable (simultaneity), the structural error is also correlated with the explanatory variable. The OLS method does not take this simultaneity into account and thus leads to biased estimators (simultaneity bias).\textsuperscript{11} Even if $\delta_1 = 0$, there can be endogeneity if $u_1$ and $u_2$ are correlated, but this is identical to the omitted variable bias discussed above.

**Equilibrium Conditions**

Consideration of endogeneity helps focus attention on an important issue in management accounting research that relates to the assumption that firms operate in equilibrium conditions. The most important question in this respect concerns whether organizational performance can be used as the explained variable when studying the effectiveness of management accounting systems. It is argued that if equilibrium conditions are assumed, then all firms are performing optimally, given their circumstances, and it is therefore inappropriate to examine organizational performance. The management accounting system is a choice variable and, in equilibrium, firms make optimal choices. That is, there is no relationship between organizational performance and the management accounting system after controlling for all exogenous factors that affect firms’ accounting choices (e.g. Demsetz and Lehn, 1985; Ittner and Larcker, 2001; Larcker, 2003). For example, following the Demsetz and Lehn (1985) argument, there should be no association between performance and the extent to which non-financial performance measures are used. Every firm will at any time make optimal decisions and for some firms it is optimal to emphasize non-financial measures, while for others it is optimal to emphasize financial measures. Since both types of firms make optimal decisions, there are no differences in economic profit between these firms, even though there are differences in the extent to which they use non-financial performance measures.

It is beyond the scope of this paper to fully examine whether or not there is variation in the performance of surviving firms and whether such variation can be associated with different types of management accounting systems. While systems may evolve towards equilibrium, there is substantial discourse as to how the dynamics of this takes place, if it is ever achieved given continual shocks to the systems, and if systems have a propensity to move away from equilibrium or sustain long periods of chaos.\textsuperscript{12} However, if equilibrium conditions are assumed, then any empirical association between organizational performance and attributes of management accounting systems must be due to model misspecification (endogeneity), as no such relationship exists in equilibrium.

**Endogeneity and Choice Variables**

There are several questions that are derived from issues explored in management accounting research that concern endogeneity, the relationship between choice
variables and equilibrium conditions. These questions are central to the criticism that models investigating the outcomes of the choice of management accounting systems are flawed, as the models will suffer from endogeneity. We identify three questions. First, is it always problematic to put a choice variable on the right-hand side of the regression equation, that is, does it always lead to (severe) endogeneity? Second, is the problem solved when we put the choice variable on the left-hand side of the regression equation? Finally, are choice variables the only potential endogenous explanatory variables? We consider each of these questions in turn.

**Choice Variable on the Right-Hand Side of the Regression Equation**

As noted above, if equilibrium conditions are assumed then examining the consequences of a choice variable, like management accounting, on organizational performance is problematic. However, this should not lead to the generalization that endogeneity is inherently present in all studies that examine the effects of a choice variable, no matter what these effects are. The assumption that ‘all firms are optimizing all the time’ implies that different management accounting systems do not have different organizational performance consequences. If this were to be generalized to all consequences, it would be impossible for management accounting systems to have any effect, since everything would be driven by ‘exogenous determinants’. In this situation the question could be asked ‘what is the use in studying the effects of management accounting systems’? That is, if this were true, then variation in management accounting systems would not be observed in equilibrium and research into the effects of management accounting systems would therefore be useless. Fortunately, this assumption is not very realistic.

As described above, an explanatory variable is endogenous if it is correlated with the structural error term. What are the implications of this when we consider a variable like management accounting systems as a choice variable in models that focus on the effects of these systems? That is, will treating management accounting practices as choice variables cause endogeneity problems when they are determined by some other variables? Consider the following: the ‘incentive use of financial performance measures’, which is a choice variable, is often considered to lead to ‘short-term oriented managerial behavior’. This type of behavior can be functional or dysfunctional, depending on the ‘strategy’ of the firm. For example, if the firm’s strategy involves ‘harvesting’ cash from existing markets, then the incentive use of financial performance measures would be appropriate, whereas if it is aiming to build long-term market share, such an orientation would likely be dysfunctional. If firms make optimal choices, then in equilibrium there should be cross-sectional variation in ‘short-term oriented behavior’ related to these different ‘strategies’. In equilibrium, strategy should affect the ‘incentive use of financial performance measures’ for the reason mentioned above, which results in cross-sectional variation in management
accounting systems. The question is raised, in this three-variable world, as to whether using ‘short-term oriented managerial behavior’ as the explained variable and the ‘incentive use of financial performance measures’ as the explanatory variable (i.e. putting a choice variable on the right-hand side), leads to an endogeneity problem because of the role of strategy. To answer this question, we need to articulate the structural model. The main theoretical prediction to be tested in this setting is whether incentives affect behavior and we want to ensure that whatever we find empirically in this relationship is not driven by any other variables; in this case, strategy. That is, we want to know whether the structural equation includes strategy. To determine this we need to theorize why strategy has or has no effect on short-term oriented behavior. Our argument would be that, although theory predicts that strategy affects the incentive use of financial performance measures thereby creating intentional effects, there is no theory that predicts that strategy by itself has an effect on short-term oriented managerial behavior. In essence, incentives drive behavior, not the reasons for providing these incentives. As a result, strategy is not part of the structural error term and the mere fact that incentives are a choice variable causes no endogeneity concerns. This is not to say that putting a choice variable on the right-hand side never leads to endogeneity problems. Our point here is to state, simply, that because the choice variable is determined by some set of determinants does not make this variable endogenous.

Choice Variable on Left-Hand Side of the Regression Equation

Given the concern of some that examining the association between choice variables and outcomes, such as short-term oriented behavior, involves the possibility of endogeneity, will research that switches choice variables from an explanatory (right-hand side variable) to an explained variable (left-hand side variable) overcome potential endogeneity problems? Consider the above example that examined how incentives and strategy are involved in influencing short-term oriented behavior, with the following (ad hoc) adjustments. Assume we put the choice variable ‘incentive use of financial performance measures’ on the left-hand side of the equation and explain variation in this variable by the influence of ‘environmental uncertainty’ (i.e. include environmental uncertainty on the right-hand side of the equation), but exclude strategy. In this setting, ‘environmental uncertainty’ will be an endogenous explanatory variable if the omitted variable ‘strategy’ is correlated with both the ‘incentive use of financial performance measures’ and ‘environmental uncertainty’. In this example we can see that endogeneity may still be apparent in studies that attempt to explain the nature of management accounting systems. That is, putting a choice variable on the left-hand side of the equation does not rule out the existence of endogeneity. The critical issue involves articulating the structural model and carefully examining if omitted variables, strategy in this case, are correlated with both the explanatory and explained variables.
'Other’ Variables on the Right-Hand Side of the Regression Equation

A remaining concern involves the relationship between endogenous and exogenous variables on the right-hand side of the equation. Specifically, is it possible to overcome endogeneity related to a primary management accounting choice variable by substituting it with an exogenous secondary management accounting variable that is associated with the primary management accounting variable?

Assume that ‘digitization of IT systems’ is a preexisting situation that can be considered as ‘truly exogenous’. Further assume that, in actuality, ‘digitization of IT systems’ affects ‘timeliness of information’, which subsequently affects ‘usefulness of budgets’. Would endogeneity be absent if we substitute ‘digitization of IT systems’ for ‘timeliness of information’ as the explanatory variable in explaining ‘usefulness of budgets’? The answer is no! The variable ‘timeliness of information’ would then become a correlated omitted variable and the ‘digitization of IT systems’ thus an endogenous explanatory variable. That is, despite the fact that ‘digitization of IT systems’ is ‘truly exogenous’ (i.e. in this case it is ‘historically predetermined’), this does not rule out the existence of endogeneity.

In sum, the previous discussion indicates that the presence of endogeneity depends on the specification of the model, not on whether a variable is a choice variable or historically predetermined. More specifically, the discussion indicates that putting a choice variable on the right-hand side of the equation does not by itself imply endogeneity, nor does putting a choice variable on the left-hand side imply the absence of such. Within the predictive validity framework, the econometric definition of an endogenous variable provides the basis to determine the existence of an endogeneity problem, not whether something is believed to be ‘truly exogenous’.

Econometric Approaches for Dealing with Endogeneity

In this section, we address some possible solutions to endogeneity problems. One approach to control for endogeneity is to test the theory by using experimental methods. In experiments, the causal dependence between the explained variable and the explanatory variables are established within the experiment. The effects of uncontrolled variables are neutralized by randomization thereby ensuring that their influence enters as disturbance, which is uncorrelated with the controlled variables. While experiments assist in providing control there can still be endogeneity problems. Consider a situation in which the effects of social training on effective use of participative budgeting is studied by providing one group with social training and a control group without training and examining differences between groups in the extent of participation in a budgeting exercise. It may be that training affects feeling of self-esteem, which then affects efforts to engage in participation. The endogeneity is caused by the treatment of social training resulting in an unanticipated improvement in esteem that is the cause of more extensive participation.
But even if experiments are completely free from endogeneity issues, they have their own problems (external validity) and are unlikely to provide all the answers. There is often a need for quasi-experimental research. In quasi-experimental research, like survey and archival research, the researcher can generally not determine the stimuli and achieve experimental control. In this case, other ways of controlling for endogeneity become relevant. We discuss these below in relation to the causes of endogeneity that we identified, that is, omitted variables and simultaneity. For each of the two causes, we indicate (i) the ‘textbook’ solutions and (ii) their shortcomings.

Omitted Variables

(i) If the omitted variable problem needs to be solved, then there are basically two standard ways to do this. First, if we believe there is an omitted variable but we are unable to include it because of data unavailability, we can include a proxy variable in the analysis. A proxy variable is a variable that is related to the unobserved omitted variable. For example, consider the relationship between an explained variable, ‘usefulness of budgets’, and an explanatory variable, ‘timeliness of information’, and we believe that ‘knowledge of accounting’ is an important omitted variable but we are unable to obtain data on this omitted variable. In this case, data on ‘tertiary education in accounting’ is available and if we believe that this is related to ‘knowledge of accounting’, it can be used as a proxy for ‘knowledge in accounting’. By including this variable, we control for the impact of the omitted variable on the explained variable and thus make the explanatory variable exogenous.19 This solution is called the ‘plug-in solution to the omitted variables problem’. Second, if a suitable proxy variable is not available we can use the method of instrumental variables. Instrumental variables are variables that are correlated with the explanatory variable and uncorrelated with the omitted variables (structural error term). In our example, ‘digitization of IT systems’ can be used as an instrument for ‘timeliness of information’. Intuitively, we can use the instrumental variable to predict the explanatory variable and use this prediction to estimate the impact of the explanatory variable on the explained variable. Under the instrumental variable assumptions stated above, the prediction is uncorrelated with the omitted variable and the endogeneity problem is thus ‘solved’. That is, in our example, ‘digitization of IT systems’ could be used as the Instrumental Variable as it is correlated with ‘timeliness of information’ but not with ‘knowledge of accounting’. The resulting estimator is called the Instrumental Variable (IV) estimator and, in the case of multiple instruments, sometimes the Two Stage Least Squares (2SLS) estimator. This estimator is, under the above-mentioned assumptions, consistent, though generally never unbiased. It is important to note that the use of instrumental variables as an approach to
omitted variables has some special conditions (see, Wooldridge, 2002, pp. 105–107).

(ii) The shortcomings of the ‘plug-in solution’ relate to typical measurement issues such as validity and we therefore refrain from discussing these in detail. Of more importance to this paper is to discuss the shortcomings of the IV estimator. In the previous example, we stated that the use of ‘digitization of IT systems’ as an instrument solves the endogeneity problem. Unfortunately, such a solution rarely happens in empirical research, since it is difficult, if not impossible, to find variables that satisfy the requirements of an instrumental variable (Ittner and Larcker, 2001; Larcker, 2003). The least problematic requirement is the relevance of the instrument, that is, the extent to which the instrument and the explanatory variable are correlated. To illustrate, we return to equations (1) and (3) without the intercepts, that is,

\[ Y = \beta_1 X_1 + u = \beta_1 \gamma_1 Z_1 + u^* \]  
\[ X_1 = \gamma_1 Z_1 + v. \]

Assume that \( \text{Cov}(X_1, u) \neq 0 \) and we want to use the IV estimator to correct for this endogeneity. If \( \text{Cov}(Z_1, u) = 0 \), that is, \( Z_1 \) is exogenous in equation (1), and \( \text{Cov}(X_1, Z_1) \neq 0 \), that is, \( X_1 \) and \( Z_1 \) are correlated (\( Z_1 \) is relevant), then the consistency of the IV estimator can be seen from the probability limit \( (p \lim) \) of the estimator, that is,

\[ p \lim \beta_{1IV} = \beta_1 + \frac{\text{Cov}(Z_1, u)}{\text{Cov}(Z_1, X_1)} \]  

where the second term is asymptotically zero. Thus, under these assumptions, the IV estimator is consistent, irrespective of the relevance of \( Z_1 \). However, the IV estimator is not unbiased. Intuitively, in finite samples, the IV estimator is biased because we need to estimate the impact of the instrumental variable on the explanatory variable, since we do not observe the ‘true’ relationship (e.g. Bound et al., 1995; Hahn and Hausman, 2002). Hahn and Hausman (2002) provide an approximation of the bias in the IV estimator, which can be roughly characterized by

\[ E[\beta_{1IV}] = \beta_1 \approx \frac{\text{Cov}(u, v)}{R^2_{X_1}}. \]  

This equation shows that bias increases with decreases in the first-stage \( R^2 \)-square \( (R^2_{X_1}) \), that is, the lower the relevance of the instrument the greater the bias in the IV estimator. Although Hahn and Hausman (2002) indicate that the
bias in the IV estimator is lower than the bias in the OLS estimator, the situation is more complicated when the instrument is not exogenous in the structural equation, that is, $\text{Cov}(Z_1, u) \neq 0$. If $\text{Cov}(Z_1, u) \neq 0$, then both the OLS estimator and the IV estimator are biased and inconsistent. Larcker and Rusticus (2005) show that in these circumstances IV estimators are unlikely to be preferred over OLS estimators. In sum, the major shortcoming of IV estimation is that this ‘textbook’ solution to the endogeneity problem is worse than the problem itself if the instrument is weak (low relevance) and endogenous.

**Simultaneity**

(i) Simultaneity can be taken into account by using simultaneous equation models. The technique of Two Stage Least Squares can be used to test simultaneity if a number of conditions are satisfied (see, e.g. Wooldridge, 2000). The necessary condition for the system to be identified is the order condition, while the sufficient condition is the rank condition. In a two-equation setting, the order condition states that for identifying the first (second) equation, at least one exogenous variable should be excluded from the first (second) equation. The rank condition additionally requires that at least one of the exogenous variables excluded from the first (second) equation has a nonzero (population) coefficient in the second (first) equation.

(ii) The shortcomings of the 2SLS estimator have been discussed above. These shortcomings are even more severe in the simultaneous equation setting, since we now have to have valid instruments for two equations instead of one (rank condition).

**Alternative Approaches for Dealing with Endogeneity**

In the previous sections, we explained what endogeneity is, what its drivers are, what its consequences are and identified the common ‘textbook’ solutions to endogeneity. Basically, we state that omitted variables and simultaneity lead to endogeneity and thus biased OLS estimators, but that the ‘textbook’ solution to this problem (IV estimation) is questionable in finite samples. Given that it is not at all clear whether IV estimation reduces or exacerbates the endogeneity problem in small samples, it might be more efficacious to examine whether the problem is worth correcting. That is, what is the expected bias and is this bias problematic?

To answer this question, we first analyze the omitted variable bias and simultaneity bias in its simplest form. As noted earlier, the omitted variable bias in its simplest form equals (see equation (5) above)

$$E[\hat{\beta}_1] - \beta_1 = \beta_2 \frac{\text{Cov}(X_1, X_2)}{\text{Var}(X_1)}.$$
If the researcher hypothesizes that $\beta_1$ is expected to be positive (negative) and the omitted variable bias is also positive (negative), then there is a higher likelihood of incorrectly rejecting the null hypothesis, that is, a higher likelihood of a Type I error. If, on the other hand, the expected direction of $\beta_1$ is opposite to that of the bias, then there is a higher likelihood of incorrectly failing to reject the null hypothesis, that is, a higher likelihood of a Type II error.

In a similar vein we can analyze the simultaneity bias. In its simplest form the simultaneity bias equals (e.g. Wooldridge, 2000, p. 507)

\[ E[\hat{\beta}_1] - \beta_1 = \frac{\delta_1}{1 - \delta_1 \beta_1} \mathrm{Var}(\epsilon_1). \]  

(12)

Given that $\mathrm{Var}(\epsilon_1) > 0$, the sign of the bias is given by $\delta_1/(1 - \delta_1 \beta_1)$. If opposite effects are expected (see, e.g. Nagar, 2002), that is, $\beta_1 > 0$ and $\delta_1 < 0$, then there exists an attenuation bias (potential Type II error). If both $\beta_1 > 0$ ($\beta_1 < 0$) and $\delta_1 > 0$ ($\delta_1 < 0$), then the sign of the bias depends on whether $\beta_1 \delta_1$ is lower or greater than 1.

In general, the issue is whether the bias works in favor or against the hypothesized relationship. However, establishing the direction of the bias becomes (almost) impossible when the model has multiple endogenous explanatory variables. Thus, in a ‘real-life’ context, that is, actual empirical research, it is difficult to predict the bias in OLS estimators. In addition, the paradox in this analysis is that the sign and the magnitude of the bias is unknown ex ante, since it requires knowledge of the true parameters that the researcher is trying to estimate in the first place (Moers, 2006). Finally, the 2SLS solution is questionable in small samples, which characterizes most management accounting studies. So, the issue remains as to what can be done to address the potential for this bias?

In general, the ‘only’ thing we can do is articulate the structural model of interest, deduct the reduced form equation and develop an empirical model based on this. To the extent that the empirical model differs from the reduced form equation, because of, for example, empirical restrictions, we need to analyze this difference using the above simple procedures. If these simple procedures indicate that bias is unlikely (likely) to be a major problem, then we are better off using OLS (OLS and 2SLS). Obviously this recommendation is too general to help researchers tackle the endogeneity issue. Below we provide some more specific recommendations for different types of studies.

- **Choice variable on the right-hand side (RHS) of the equation:** it is important to conceptualize the decision-making process and analyze what other choices are made in conjunction with the choice variable of interest. The next question is: do these other choices also (potentially) affect the explained variable of interest? The basic issue here is that we should be less concerned with the fact that the effect might be driven by the determinants of the choice variable and much
more concerned with the possibility that the effect might be driven by other choice variables. Consider the example where we are interested in the impact of non-financial performance measures on managerial short-term orientation. Given that the underlying idea relies on motivational (incentive) effects, the question is: what other motivational (incentive) mechanisms are chosen by the ‘firm’ in conjunction with the use of non-financial performance measures and what effects do these other mechanisms have on managerial short-term orientation? By spending more effort on articulating the structural model, these questions can be answered and used to improve the empirical model.

- **Choice variable on the left-hand side (LHS) of the equation**: this usually involves a typical analysis of correlated omitted variables. The basic question here is whether the proposed determinant on the RHS really is the determinant, or is there some ‘indirect’ effect (path)? Thus, in this case the focus is on the relationship between the determinants!

- **Choice variables on RHS and LHS**: in this case, we suggest that researchers follow both of the above two points, in addition to establishing the simultaneity bias using the ‘simple’ rule above.

In all of the above cases, it is theory and logic that needs to be used as a first step in addressing the endogeneity issue. That is, researchers first need to build better arguments as a prelude to building econometric models. Empirical researchers should be more careful to tell the reader something about their thinking about developing the structural model and (more importantly) identify which variables are assumed to be endogenous and exogenous in whatever economic model they have in mind. This would enable the reader to judge the reasonableness of the assumptions about the variables and perhaps the degree to which endogeneity is a problem.

In addition to the above recommendations, we provide the following final recommendations:

- If a decision is made to use 2SLS, then we recommend that the procedures discussed by Larcker and Rusticus (2005) are followed. Most, if not all, studies in accounting that apply 2SLS provide (almost) no assurance that the use of this method is actually valid. The Durbin–Wu–Hausman test that is typically reported to substantiate the use of 2SLS is useless if 2SLS is itself not valid. In essence, for this method to be valid, the instruments used must be (1) relevant and (2) exogenous. Larcker and Rusticus (2005) state that, in addition to providing some theoretical argument for why the instruments are expected to be relevant and exogenous, specification tests need to be performed to corroborate this argument. The specification tests for relevance are the first-stage exclusion restriction and the partial $R^2$-square, which examine whether the instruments are significantly related to the endogenous explanatory variable and how much variance is explained by the instruments, respectively. The specification test for exogeneity is the overidentifying restriction, which can only be used if the number of instruments exceeds the number of endogenous
variables (overidentification). A complementary analysis to determine exogeneity in this case is to use what Larcker and Rusticus (2005) label the ‘unconstrained second-stage’. For more details about these procedures, we refer to Bound et al. (1995), Wooldridge (2002) and Larcker and Rusticus (2005). For an actual application of these procedures in an empirical accounting study, we refer to Moers (2006).

- If it is decided to examine the performance effects of a choice variable, then we recommend the use of ‘residual analysis’. That is, assume that on average there is an equilibrium, but that in a cross section, some firms are (temporarily) off-equilibrium; model the decision-making process (choice variable on LHS) and use the residuals as a measure of the extent to which a ‘firm’ is removed from the optimum; subsequently regress ‘performance’ on the absolute values of the residuals (and control variables). The residuals should be negatively related to performance, that is, the further removed from the optimum the lower the performance. In addition, since there might be a difference between ‘overinvestments’ and ‘underinvestments’, it is necessary to split the residuals in positive and negative values and analyze the effects of each of these (see, e.g. Ittner et al., 2002).22

Conclusion

In this paper, we have provided an overview and discussion of endogeneity. The issue of endogeneity warrants discussion because we believe that some ‘readers’ of papers have overestimated the potential problems of endogeneity, while some ‘writers’ of papers have underestimated the potential problems. Restricting the problem of endogeneity to studies that examine the effects of choice variables, as appears to be the case in accounting, is an unsubstantiated restriction and an overgeneralization. Much can be gained by examining the econometric definition and treatments for endogeneity.

We have indicated that endogeneity has as much to do with putting a choice variable, such as a management accounting system, on the right-hand side as with putting a choice variable on the left-hand side. Importantly, we have indicated that endogeneity has nothing to do with putting a choice variable on the right-hand side. In other words, any attempt to define endogeneity in terms of what type of variable is put on what side of the equation is likely to be unhelpful. It is suggested that clarification is achieved if we focus on a single all-inclusive definition of endogeneity derived from the econometric definition, that is, endogeneity is present when an explanatory variable is correlated with the structural error term.

We have discussed the different causes of endogeneity and possible solutions to the problem. At a practical level, it is unlikely that any single study is completely free of endogeneity issues and we therefore argue that the initial consideration should be sought in careful theory construction. By providing an explanation of what endogeneity actually is and what its consequences are, we hope that researchers will be encouraged to appreciate more explicitly the extent to
which there may or may not be problems associated with endogeneity. As indicated at the outset, the main aim of this paper is to assist in promoting debate about endogeneity among management accounting researchers undertaking theory-based quantitative research.

Notes

1 See Libby et al. (2002) for an application of the predictive validity framework to experimental research in financial accounting.
2 In the literature, \( u \) is labeled the ‘structural residual’, ‘structural error term’ or ‘structural disturbance’.
3 Link 5 in Figure 1 refers to controls. This is where ‘other potentially influential’ variables besides the explanatory variables are controlled (Libby et al., 2002, p. 800). In, for example, experimental research, this is possible by holding these variables constant or through randomization.
4 Unbiasedness is a feature of an estimator for a given sample size (finite sample property), while consistency is a feature of the estimator when the sample size gets large (asymptotic property). The assumptions needed to assure unbiasedness of the OLS estimator also assure its consistency, although the opposite does not apply. That is, consistency does not necessarily imply unbiasedness. However, when we state that the estimator is unbiased (biased) we also mean it is consistent (inconsistent), unless we explicitly state otherwise. Consistency, sometimes called asymptotic unbiasedness, is a minimal requirement for an estimator.
5 This follows as the structural error term reflects all factors that affect the explained variable other than the included explanatory variables.
6 One explanation for this finding is that all firms are operating in equilibrium. We address this issue later in the paper.
7 Other mechanisms of corporate governance include the provision of financial accounting information to provide corporate transparency, executive compensation to align manager’s actions with those of shareholders and direct monitoring by outside parties with a dominant shareholding.
8 This is why one needs to be careful of characterizing endogeneity as a correlation between the explanatory variable and ‘the error term’ (see Greene, 2000, pp. 656–657). It is the correlation with the ‘structural error term’ that is of importance, since the model can always be rewritten to have no correlation with the error term, as is the case with OLS.
9 In a strict sense, ‘functional misspecification’ (link 1 vs. link 4) and ‘measurement error’ (links 2 and 3) can cause the explanatory variable(s) to be correlated with the structural error term and can thus lead to endogeneity. Given that these two types of problems deviate from the core issue that we address, we refrain from discussing these problems.
10 Another common example of endogeneity that is caused by an omitted variable is self-selection (Heckman, 1979). For example, the explained variable of ‘usefulness of sophisticated capital budgeting’ may be theoretically associated with ‘tertiary education in accounting’. However, there may be an unobserved variable of ‘ability’ that relates to how useful managers find ‘sophisticated capital budgeting’ which is also associated with ‘tertiary education in accounting’. This is caused by individuals with high ‘ability’ self-selecting into higher ‘tertiary education in accounting’. As a result, there is a correlation between ‘tertiary education in accounting’ and the structural error term thereby generating endogeneity. Although the econometric ‘solution’ to the self-selection problem is specific (see Heckman, 1979), the essence of the problem is identical to the omitted variable problem discussed and we therefore refrain from addressing self-selection in more detail.
11 Note that the OLS method causes no concerns when estimating equation (9), which is the reduced form equation.
12 Milgrom and Roberts (1992) argue that it is unlikely that everybody optimizes at the same time and there should therefore be cross-sectional variation around the optimal choice (see also Ittner and Larcker, 2001; Larcker, 2003).
It is important when considering choice variables to clarify if the managers, who are being considered in the theory, can in fact take decisions influencing the choice variables of interest. There may be a theoretical relationship between strategy, incentive use of financial measures and short-term decision orientation. However, the divisional manager may only have autonomy over the division’s strategy with the incentive use of financial measures being determined and fixed by senior managers. In this case, the incentive use of financial measures is not a choice variable at the divisional level.

These types of direct and indirect effects underlie most path analyses and structural equation models, where antecedents lead to choices and then to consequences (see, e.g. Van der Stede, 2000).

This logic is not only based on economics, it also forms the basis for Kerr’s (1975) oft-cited behavioral paper ‘On the Folly of Rewarding A while Hoping for B’. Only if we assume that there is simultaneity between effects and choice variables will putting a choice variable on the right-hand side always lead to endogeneity. However, this is not only an unrealistic assumption, it is also not the assumption underlying the arguments made in the accounting literature that drives this theory about incentives, strategy and short-term oriented behavior.

Note that it would also not be a very relevant analysis if we were ultimately interested in knowing the impact of ‘timeliness of information’ on ‘usefulness of budgets’.

A similar example can be found in the area of international accounting research, which often uses the variable ‘legal origin’ (common law vs. code law). In these types of studies, the legal origin of a country is predetermined and can, to some extent, be considered theoretically exogenous. However, if legal origin influences other institutions, and these other institutions are not controlled for, then we still face endogeneity issues due to correlated omitted variables.

Note that, if we are able to observe and measure the omitted variable, we would obviously use this measure in the analysis instead of the proxy variable.

This is not a problem when the sample size gets ‘very large’ (law of large numbers), which means that there is ‘asymptotic unbiasedness’, that is, the estimator is consistent.

Note that this is a rough characterization of the bias, not consistency, which is represented by the probability limit (see equation (10)). Conventional asymptotics ($n \to \infty$) ignores the influence of $\text{Cov}(u, \nu)$ and $R^2_f$.

It is important to note that an implicit assumption underlying this method is that a residual of ‘zero’ represents the optimum. This requires that firms are equally likely to overshoot the optimum as they are to undershoot the optimum.

References


Endogeneity within Theory-Based Accounting Research
