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CONTROL VARIABLES IN ENTREPRENEURSHIP RESEARCH: A SIX-YEAR REVIEW

Leon Schjoedt
University of Central Florida, leonschjoedt@ymail.com

Krittaya Sangboon
Mahasarakham University, Thailand

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Leon Schjoedt, Mahasarakham University, Thailand
Krittaya Sangboon, Mahasarakham University, Thailand

ABSTRACT

The use of control variables holds potential to enhance, or hinder, advancement of the entrepreneurship literature. This is because control variables impact research findings and their validity. We examined the use of control variables in the 1,197 works published in 2009-2015 in four leading entrepreneurship journals—ETP, JBV, JSBM, and SEJ. The results indicate that control variables are many times used appropriately; yet, there is room for improvement. The findings indicate a need for researchers to be more diligent and to follow more of the best practices for the use of control variables in future entrepreneurship research.

INTRODUCTION

Entrepreneurship, as a field of inquiry, is coming of age, evident in the growth of the research literature in recent years. This coming of age is reflected in both measurement and substantive developments (Schwab, 1980). Measurement developments refer to operationalization of concepts, such as scale development (cf. Schjoedt & Craig, 2017; Schjoedt & Shaver, 2012; Schjoedt, Renko, & Shaver, 2014). Substantive developments refer to research that examine the nature of relationships among constructs (cf. Bird & Schjoedt, 2009; Bird, Schjoedt & Baum, 2012; Bird, Schjoedt, & Hanke, 2014). Research findings, and their advancement of the literature, are only as strong as the methods employed in research studies (e.g., research design, sample, measurement, data analysis, and interpretation of results).

Scanning the expanding entrepreneurship research literature reveals certain characteristics. The majority of empirical research is based on non-experimental design, widespread use of regression analysis, and little consideration of control variables (Schjoedt & Bird, 2014; Schjoedt & Sangboon, 2015). This is similar to the management literature (Atinc, Simmering, & Kroll, 2012; Becker, 2005; Breaugh, 2006, 2008; Carlson & Wu, 2011; Spector & Brannick, 2011). The limited consideration of control variables is troublesome because control variables are, in fact, independent variables and their inclusion in research is, at times, less than fruitful in generating valid research findings (Atinc et al., 2012; Becker, 2005; Breaugh, 2006, 2008; Carlson & Wu, 2012; Schjoedt & Bird, 2014; Schjoedt & Sangboon, 2015; Spector & Brannick, 2011). Because the use of control variables has implications for the validity of research findings and, in turn, the substantial developments of the field of entrepreneurship, it is pertinent to explore the use of control variables to determine if researchers employ control variables appropriately as they seek to advance the entrepreneurship literature.

CONTROL VARIABLES

Control variables refer to variables extraneous to the relationship among variables of interest in a study. The role of variables in statistical control depends on the intentions of the study. Statistical control has been used in three ways (Schjoedt & Bird, 2014). First, prediction of unique variance in a dependent variable caused by the other variables of interest, the independent variables. With the control variables entered as the first set of variables, providing a base line, and one or more independent variables as a second, or later, set of variables in a regression analysis, the primary interest in this approach is whether the addition of independent variables provides a meaningful increase in the variance accounted for in

the dependent variable. This approach brings forth two challenges. One, identify all meaningful variables predicting the dependent variable. If a meaningful control variable is left out, it will limit the explanatory value of the included independent variables. In contrast, adding a large number of control variables will also affect the amount of unique variance explained by the independent variables (Becker, 2005). Two, control variables are not all equal. When meaningful control variables are correlated with the independent variables, the regression results may not provide evidence of unique contributions. Further, many control variables are included based on theoretical considerations of their association with the dependent variable. Whereas other control variables are included as artifacts of research design or sample characteristics (e.g., measurements, organizational characteristics) that covary with the dependent variable but do not explain the relationship of interest among the independent and dependent variables.

Second, many times a measurement problem is (implicitly) assumed by researchers. The variable assessed does not represent the constructs of interest, neither independent nor dependent variables but is rather a "contaminant". By removing this containment by partialling, the true relationship among variables of interest may be observed. This process is referred to as purification (Spector & Brannick, 2011). To control the contaminant requires that a control variable covaries perfectly with the contaminant but is unrelated with the variables or relationships of interest. Here partialling, or even semi-partialling, the correlations is an appropriate statistical control (Carlson & Wu, 2012). The challenge in purification is to identify the appropriate control variable or control variables as many times a control variable only captures part of the contaminant. Such control variables may also share variance with a variable of interest resulting in partialling removing variance in the dependent or independent variables of interest (Spector, Zapf, Chen, & Frese, 2000). In regression analysis this means that when a control variable is entered first, statistical control is applied to the independent variables but not the dependent variable (Breaugh, 2006, 2008; Spector & Brannick, 2011). Consequently, when nuisance variance exists in the dependent variable only or in the dependent and independent variables, the regression coefficient does not capture the intended relationship.

Third, researchers may want to assess the unique contribution of the independent variables in the presence of extraneous variables or rule out alternative explanations (Becker, 2005; Breaugh, 2008; Meehl, 1970, 1971; Spector et al., 2000). Partialling out the effects of a control variable in an independent variable, especially when they are correlated, is profoundly problematic because effects are removed from variables that cannot be removed in real life (Breaugh, 2008; Meehl, 1970, 1971). When this occurs, the sample will consist of 'fictional people assigned fictional scores' (Meehl, 1970, p. 401). Results based on these 'fictional people' do not generalize beyond the sample, and the findings cannot advance the field of entrepreneurship (Hunter and Schmidt, 2004; Meehl, 1970). This issue becomes even more problematic as the magnitude of the correlations between the independent and control variables increase (Breaugh, 2008; Schjoedt & Bird, 2014). As this shows, employing control variables that are correlated with the independent variable can result in regression coefficients that are not equivalent to the original unpartialled variable; phrased differently, partialling changes the meaning of the regression coefficients.

Two Points of View

There appears to be two points of view regarding the use of control variables. One point of view is to be conservative with the use of control variables. Carlson and Wu (2012) provide a rule of thumb: "When in doubt, leave them out" (p. 413). These scholars observe that without clear evidence supporting the inclusion and validity of control variables, the control variables should not be used. The other point of view is more liberal. It is based on a generous use of control variables and is apparent in the copious use of control variables in research publications (e.g., Atinc et al., 2012; Becker, 2005; Carlson & Wu, 2012; Schjoedt & Sangboon, 2015).

Best Practices

Irrespective of one's view on control variables or the purpose of using control variables, the best practices in employing control variables may be grouped into two: the appropriateness and reporting of control variables. Methodologists (Becker, 2005; Becker, Atinc, Breaugh, Carlson, Edwards, & Spector, 2016; Breaugh, 2008; Meehl, 1970, 1971; Schjoedt & Bird, 2014; Schjoedt & Sangboon, 2015; Schwab, 2005; Spector & Brannick, 2011) recommend researchers to provide theoretical arguments for the need and relevance of all control variables employed as part of a study. These methodologists also point out that control variables should only be employed with justification to illustrate the control variables' appropriateness by appreciating theoretical considerations and empirical evidence of the relationship between the control variables and the dependent variable (Breaugh, 2008; Schwab, 2005). In turn, this means that considerations of control variables should be part of the hypothesis development or literature review, hypotheses, methods, results and discussion since control variables may profoundly alter the relationships among the independent and dependent variables (Breaugh, 2006, 2008; Carlson & Wu, 2012; Meehl, 1970, 1971). Reporting of control variables is expanded upon in the discussion.

METHODS

Sample

For our exploration of the use of control variables in entrepreneurship research, we coded all 1,197 articles published in 2009-2015 in four leading entrepreneurship journals—Entrepreneurship Theory and Practice (ETP), Journal of Business Venturing (JBV), Journal of Small Business Management (JSBM), and Strategic Entrepreneurship Journal (SEJ)—as shown in Table 1. Because control variables are only relevant in empirical research, we focused our assessment on correlational research, which reduced the sample to 726 articles. To maintain consistency among the publications, the sample for our exploration is based on publications with regression analysis only. This reduced the sample to 578 articles, which is 80 percent of the correlational studies published in the four leading entrepreneurship journals in 2009-2015. Since the issue is the use of control variables, our main focus is the 532 studies with one or more control variables.

Table 1: Number of Publications (2009-2015)

	ETP	JBV	JSBM	SEJ	Total
Publications	465	307	285	140	1,197
Correlational Research	217	209	213	87	726
Regression Analysis	159	178	167	74	578
One or more CV	146	172	141	73	532

Measures

For our exploration, we identified items used in other assessments of use of control variables (Atinc et al., 2012; Becker, 2005; Carlson & Wu, 2012). We used the same coding protocol as employed in a previous one-year assessment of control variables use in accounting and entrepreneurship research (cf. Schjoedt & Sangboon, 2015). This included a variety of data on the type of study; type of analysis; contents of discussion, and control variables. Space limitations prevent description of all the variables coded; thus, only one variable is described here for illustrative purposes:

Relevance described. We coded 1 or 0 when the relevance of at least one control variable was/was not described (Atinc et al., 2012; Becker, 2005; Carlson & Wu, 2012; Schjoedt & Sangboon, 2015).

RESULTS

Table 2 shows the means, standard deviations, and ranges of the number of control variables used in the publications considered. These results show a few surprises. For ETP, the number of control variables ranged from zero to 23 with a mean of 7.5 and 54 percent of the publications employed seven or less control variables. Publications in JBV used between zero and 92 control variables with a mean of 9.9. Two publications were outliers as 64 and 92 control variables were employed. Forty-five percent of the JBV publications employed seven control variables or less. The number of control variables employed in JSBM publications averaged 5.2 and ranged from zero to 22. Seventy-seven percent of the JSBM publications used seven control variables of less. Among the SEJ publications the number of control variables ranged from zero to 17 with an average of 7.2 and 77 percent employed seven or less control variables. It is noteworthy that 13 (8.2%) ETP, 6 (3.4%) JBV, 26 (15.6%) JSBM, and 1 (1.4%) SEJ publications did not include any control variables.

Table 2: Mean, standard deviation, range of number of control variables by journal and in total*

Journal	n*	Mean	*s.d.*	Range
ETP	159	7.5	5.0	0-23
JBV	178	9.9	9.6	0-92
JSBM	167	5.2	4.5	0-22
SEJ	74	7.2	3.4	0-17
All	578	7.6	6.8	0-92

* Publications describing research based on regression analysis.

Table 3 presents the results of our exploration of the use of control variables in published entrepreneurship research. It contains the number and percentage of publications for each journal and for all four journals regarding research published that is based on regression analysis with one or more control variables.

Table 3: Number and percentages of publications employing one of more control variables

Journal and publications describing research using regression analysis with one or more control variables:	ETP n = 146		JBV n = 172		JSBM n = 141		SEJ n = 73		All n = 532	
Variable*	#	%	#	%	#	%	#	%	#	%
CV described	145	99	166	97	131	93	82	99	514	97
CV relevance described	130	89	87	51	92	65	24	33	333	63
CV measurement described	116	80	113	66	101	72	19	26	349	66
Provided psychometric properties for CV	22	15	17	10	15	11	15	21	69	13
Provided Cronbach's Alpha for CV	15	10	6	4	7	5	6	8	34	6
CV supported by citation	126	86	158	92	112	79	63	86	459	86
DV-CV relationship described	61	42	62	36	55	39	16	22	194	37
IV-CV relationship described	17	12	16	9	26	18	9	12	68	13
CV included in hypotheses	1	1	4	2	0	0	5	7	10	2
All CV in descriptive stats reported	136	93	159	92	115	82	69	95	479	90
CV-DV correlation addressed in Results	59	40	42	24	62	44	12	16	175	33
CV addressed in the Discussion	29	20	43	25	41	29	17	23	130	24
CV-DV addressed in the Discussion	11	8	14	8	25	18	8	11	58	11
IV-CV addressed in the Discussion	3	2	8	5	11	8	8	11	30	6

* CV refers to control variables; IV refers to independent variables; DV refers to dependent variable.

Consistently across the four journals, most publications include descriptions of the control variables. Relevance of the control variables in the research is only addressed in about two-thirds of the publications, ranging from 33 to 89 percent. While control variable measurement is described in more than two-thirds of the publications, it is noteworthy that it is the case in only 26 percent of the publications in SEJ. Even though control variables may be measured with single-items or objective data, consideration of psychometric properties, including Cronbach's Alpha, is low for all the journals. It appears that in more than 80 percent of the publications control variables are supported by references to other published works, a pattern that is consistent across the four journals. In a little more than one-third of the publications, with a high of 42 percent (ETP) and low of 22 percent (SEJ), the relationship among the control and dependent variables are addressed in the text of the results section. In only 13 percent of the publications are the relationships among the independent and control variables considered in the text of the results section. Very few publications include control variables in the stated hypotheses. Most publications include all the control variables in the descriptive statistics, with a low of 82 percent (JSBM) and high of 95 percent (SEJ). Control variables are addressed in the discussions in only one-quarter of the publications with a low of 20 percent (ETP) and high of 29 percent (SEJ). Less attention is given to the relationships among the control and dependent variables and among the independent and control variables in the discussions.

DISCUSSION

We set out to explore the use of control variables in entrepreneurship research publications because control variables influence the validity of research findings and, in turn, the substantial advancement of the entrepreneurship literature (Schwab, 1980). Our exploration of the use of control variables in published entrepreneurship research extends research on the use of control variables in the accounting and management literatures, specifically in Academy of Management Journal, Administrative Science Quarterly, Journal of Applied Psychology, Journal of Management, Personnel Psychology, and Strategic

Management Journal (Atinc et al., 2012; Becker, 2005; Bernerth & Aguinis, 2016; Carlson & Wu, 2012), and Journal of Accounting and Economics (Schjoedt & Sangboon, 2015). Our exploration also shed lights on the use of control variables in entrepreneurship research. Overall, our study shows that the use of control variables in entrepreneurship research has some positive characteristics while there is still room for improvement.

Methodologists recommend a two-fold best practice for the use of control variables (Becker, 2005; Becker et al, 2016; Carlson & Wu, 2012; Spector & Brannick, 2011; Schjoedt & Bird, 2014; Schjoedt & Sangboon, 2015). Therefore, we structure the remainder of this discussion around these two: appropriateness of control variables and reporting of control variables.

On average entrepreneurship researchers employ less control variables than researchers in accounting (M = 9.3, *s.d.* = 5.8; Schjoedt & Sangboon, 2015) and management (M = 17.7, *s.d.* = 64.4; Carlson & Wu, 2012). Many consider that relationships among the independent and dependent variables are spurious or artificially inflated resulting a common, although often unsubstantiated, belief that the inclusion of control variables purifies results and uncovers the "true" relationships (Atinc et al., 2012; Bernerth & Aguinis, 2016; Carlson & Wu, 2012; Schjoedt & Bird, 2014; Spector & Brannick, 2011). Therefore, methodologists (Carlson & Wu, 2012; Meehl, 1970, 1971; Schjoedt & Bird, 2014) recommend a conservative approach for the inclusion of control variables. As the results show, entrepreneurship researchers are more conservative in their approach to include control variables indicating that entrepreneurship research may potentially be less affected by purification of results than the general management literature, a best practice (Becker, 2005; Becker et al., 2016; Carlson & Wu, 2012; Schjoedt & Bird, 2014).

While 86 percent of published entrepreneurship research use references to support, at least, some control variables, this percentage is 74 for the management literature; the reason(s) for inclusion of control variables is only provided in 63 percent of the entrepreneurship publications. In the management literature, about 20 percent of the publications did not provide a justification for inclusion of any control variables (Atinc et al., 2012; Becker, 2005; Carlson & Wu, 2012). This indicates that there is room for improvement for entrepreneurship researchers in future research by going beyond merely using references to justify inclusion of control variables, a best practice (Becker, 2005; Becker et al., 2016; Carlson & Wu, 2012; Schjoedt & Bird, 2014).

Becker (2005; Becker et al., 2016) recommends that descriptive statistics (i.e., means, standard deviations, and correlations) are reported. Omission of any of the descriptive statistics means the reporting of results is incomplete and readers of the publications cannot assess the potential impact of control variables (Aguinis & Vandenberg, 2014; Becker, 2005; Schjoedt & Bird, 2014). Our results show that 90 percent of publications in the entrepreneurship literature included descriptive statistics for all control variables. This is more than the approximately 80 percent in the accounting (Schjoedt & Sangboon, 2015) and management literatures (Atinc et al. 2012; Becker, 2005; Carlson & Wu, 2012). However, only one-third of the entrepreneurship publications included considerations of the control variables in the text of the results section. As these results show there are positive features in the reporting of control variables in entrepreneurship research while there is also room for improvement for entrepreneurship researchers to be more diligent in reporting and considering control variables for the purpose of illustrating the control variables' potential impact on the research findings, a best practice (Atinc et al., 2012; Becker, 2005; Becker et al., 2016; Bernerth & Aguinis, 2016; Carlson & Wu, 2012; Schjoedt & Bird, 2014).

CONTACT: Leon Schjoedt, leonschjoedt@ymail.com, (T):+66816827501 Mahasarakham University, Thailand.