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The Potential of Partial Least Squares Structural Equation Modeling (PLS-SEM) with a Formative Approach in Accounting Research

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Abstract

Accounting research faces methodological challenges when investigating complex phenomena, often modeled by interrelated latent variables. In this context, Partial Least Squares Structural Equation Modeling (PLS-SEM) emerges as a robust alternative to multiple regression, particularly for modeling formative constructs. Unlike traditional methods, PLS-SEM allows for the simultaneous estimation of direct, indirect (mediated), and moderated relationships, making it especially useful for analyzing documentary and secondary data, which are commonly used in financial accounting. Therefore, this editorial explores the potential of the PLS-SEM formative approach in accounting research, highlighting applications in corporate governance, audit quality, organizational sustainability, and operational efficiency. The use of second-order constructs is discussed as a solution for capturing the complexity of these phenomena. Additionally, the relevance of PLS-SEM is underscored in the analysis of mediating and moderating effects, which are challenging to assess through traditional regression methods. By enabling more comprehensive and detailed analyses, PLS-SEM provides statistically robust models and greater precision in interpreting results. This article contributes to the literature by demonstrating the technique's applicability and encouraging its adoption in accounting research.

Keywords: Structural Equations. Formative Approach. Accounting Research.

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1 Introduction

Research in the social sciences, including Accounting, faces significant challenges related to the complexity of studying latent phenomena and controlling variables that systematically influence the relationships under investigation. In recent years, there has been growing interest in understanding phenomena such as perceptions, judgments, attitudes, and organizational cultures, as well as measuring their influence on learning, satisfaction, and corporate performance (e.g., stock prices), particularly in Behavioral Accounting studies (Nascimento & Macedo, 2016; Smith & Langfield-Smith, 2004; Bisbe, Batista-Fogueta & Chenhall, 2007; Henri, 2007; Mason & Levy, 2001). Recent studies reinforce this trend by highlighting the role of organizational culture in enhancing the quality of accounting and financial information (Qatawneh, 2023) and examining the influence of behavioral aspects, such as perceptions and emotions, on the implementation of accounting systems (Fitriana et al., 2022). From this perspective, it is crucial to employ robust methodologies that enable the simultaneous analysis of multiple relationships between constructs, thereby contributing to a more accurate understanding of accounting phenomena.

Structural Equation Modeling (SEM) is a powerful tool for addressing such analytical demands. The SEM technique has gained widespread use due to its ability to overcome the limitations of first-generation multivariate techniques, such as Ordinary Least Squares (OLS) regressions. Although OLS regression remains prevalent in empirical accounting literature, it presents significant limitations, especially in research designs where the dependent (endogenous) variable or construct assumes an explanatory role in subsequent relationships (Hair Jr., Black, Babin, Anderson, & Tatham, 2009). In such cases, the use of simultaneous equations, like the two-stage least squares (2SLS) method, may result in inconsistent estimators when explanatory variables are correlated with the equation's error term, a problem known as "simultaneous equations bias" (Gujarati & Porter, 2011).

The SEM technique encompasses two approaches: CB-SEM, based on the Covariance Matrix, and PLS-SEM, based on Partial Least Squares. The choice between these approaches fundamentally depends on the research objective. When the aim is to test theories and confirm hypotheses, the CB-SEM method is more suitable. Conversely, PLS-SEM becomes the preferred option when the objective is theoretical development and exploring new theoretical models (Hair, Ringle & Sarstedt, 2011).

Conceptually, PLS-SEM, the focus of this editorial, is similar to multiple regression analysis, as it aims to maximize the explained variance in dependent constructs while assessing data quality based on the characteristics of the measurement model. By combining aspects of factor analysis and multiple regression, the PLS-SEM approach represents a significant evolution of SEM, enabling the simultaneous estimation of multiple relationships and intermediate dependent variables. This approach offers flexibility in assumptions and supports the use of latent variables, the analysis of non-normal data, the modeling of error terms, and the modeling of mediating and moderating relationships. Furthermore, it allows for testing complex models with multiple equations within a single global adjustment, making it particularly valuable for investigating multifaceted relationships (Hair, Ringle & Sarstedt, 2011; Lee, Fayard & Robinson, 2011).

The PLS-SEM technique encompasses two specific measurement perspectives: reflective and formative. The most common approach, the reflective perspective, typically relies on primary data collected through questionnaires, often employing Likert-type scales, where the items (observed indicators) reflect the latent construct under investigation. In contrast, the formative approach, which is the focus of this editorial, generally uses documentary and secondary data, considering the indicators as formative components of the latent construct. This approach holds particular promise in the financial accounting literature, as it facilitates the modeling of complex relationships using information from financial statements, financial ratios, and other metrics derived from corporate reports (Hair, Ringle & Sarstedt, 2011).

It is essential to emphasize that selecting indicators from formative measurement scales that capture all relevant facets of a construct—or at least the most important ones—is crucial to ensuring its content is adequately represented (Diamantopoulos & Winklhofer, 2001). The quality of a formative construct depends on the inclusion of multiple interchangeable variables, with each indicator contributing to capturing a specific and unique aspect of the concept under investigation (Rodgers, 1999). Therefore, adopting proxies widely established in the literature is important to ensure that the indicators reflect the construct's central dimensions and enhance the reliability and validity of the analyses.

In this context, based on the understanding that PLS-SEM enhances the statistical precision of analyses and enriches theoretical interpretation, it proves particularly useful in situations where "causal" relationships are complex and data normality assumptions are difficult to meet. This editorial aims to discuss the potential of PLS-SEM for accounting research, focusing on its application in the formative approach.

2 The potential of the PLS-SEM formative approach in accounting research

As previously discussed, the PLS-SEM technique holds substantial potential for accounting research, particularly in analyzing documentary data and developing theoretical models based on formative approaches. This technique is especially valuable in contexts where observable indicators (such as free float, listing segment, ROE, ROA, ROIC, EBITDA margin, etc.) form complex latent constructs, such as corporate governance, financial performance, audit quality, or organizational transparency. By leveraging PLS-SEM, researchers can explore accounting phenomena robustly and innovatively.

Within the scope of the formative approach, PLS-SEM enables the modeling of relationships based on documentary data from financial reports, accounting statements, corporate reports, and economic indices. For example, a construct could be modeled in a study on corporate governance using variables such as board independence, adequacy of board size in line with IBGC recommendations, member diversity, listing segment, free float percentage, and specialized committees, among others. This construct would allow for the analysis of its influence on financial performance (measured, for instance, by ROE, ROA, operating cash flow weighted by total assets, asset turnover, EBITDA margin, etc.), market value (price multiplied by the number of shares in circulation), risk (beta or share volatility), and debt (current liabilities/total assets), while controlling for the systematic effect of size (natural logarithm of assets) and year (control variables), as proposed by Nascimento, Angotti, Macedo, and Bortolon (2018).

Alternatively, corporate governance could be modeled as a second-order construct with three dimensions: a) board structure, which includes indicators such as board independence, adequacy of board size, and member diversity; b) market practices, represented by variables such as listing segment and free float percentage; and c) oversight mechanisms, incorporating the existence of specialized committees and the frequency of their meetings.

This second-order modeling enables a more comprehensive representation of corporate governance as a broad and multifaceted concept. In second-order modeling, a primary latent construct comprises multiple first-order latent dimensions, each capturing a specific aspect of the phenomenon under analysis. In the case of corporate governance, for example, the construct could encompass dimensions such as Board Structure, Market Practices, and Oversight Mechanisms, as previously discussed. This hierarchical structure allows for more robust analyses of the influence of corporate governance on dependent variables, such as financial performance or market value, by integrating multiple indicators and better capturing the interrelationships between dimensions.

Another example of formative application occurs in the modeling of audit quality, using indicators such as the audit firm's size, the experience and qualification of its team, sector specialization, and reputation (captured by specific rankings), in addition to auditor turnover. This construct can be employed to investigate its relationship with the credibility of financial reports and its impact on the decisions of investors and creditors. For instance, Shahzad, Rehman, Hanif, Asim, and Baig (2019) analyzed the impact of audit quality (modeled by a dummy variable that takes the value of 1 if the audit was performed by one of the Big Four and 0 otherwise) and financial reports on the investment efficiency of companies listed on the Pakistan Stock Exchange. They applied multiple regression and found that firms audited by the Big Four exhibited greater investment efficiency, which was attributed to reduced information asymmetry and moral hazards.

The PLS-SEM approach enables the modeling of "audit quality" as a formative construct, integrating variables that potentially reflect the scope of audit service quality, such as audit firm size, team experience and qualifications, sector specialization, and reputation (captured by specific rankings). This approach allows for the simultaneous exploration of the direct effects of audit quality on investment efficiency and its indirect impacts mediated by the quality of financial reports. While using dummy variables simplifies data collection, employing PLS-SEM can significantly enhance the depth of the investigation by incorporating multiple indicators and examining how different dimensions of audit quality interact to influence outcomes. Furthermore, the PLS-SEM approach facilitates the inclusion of moderators, such as the industry's level of regulation, thereby improving the understanding of the conditions under which audit quality exerts significant influence.

Additionally, audit quality could be modeled as a second-order construct comprising two dimensions: "Technical Capability" (including audit firm size and the team's experience and qualifications) and "Reputation" (encompassing sector specialization and reputation captured by specific rankings). This modeling approach allows for the exploration of both the aggregate effects of audit quality on variables such as the credibility of financial reports and investor decisions and the specific contributions of each dimension. Adopting second-order constructs in PLS-SEM results in a more sophisticated model, offering a granular and comprehensive view of complex phenomena and enabling researchers to capture interrelationships between dimensions that might otherwise obscure their full impact on organizational performance or financial outcomes when investigated individually.

The construct "organizational sustainability" can be modeled using formative variables in research involving Environmental, Social, and Governance (ESG) practices, such as indicators of carbon emissions, investment in social projects, diversity policies, and ethical practices. For instance, Zhou et al. (2022) investigated the impact of ESG performance (measured through the indicator published by SynTao Green Finance) on companies' market value, with financial performance as a mediator. PLS-SEM in such contexts can offer greater flexibility and analytical depth than regression. PLS-SEM enables modeling "organizational sustainability" as a formative construct by integrating ESG metrics from multiple dimensions rather than relying on a single indicator that may not capture the construct's full scope (ESG performance). This approach allows for the simultaneous analysis of the relationships between organizational sustainability, financial performance, and market value, facilitating the exploration of both direct and indirect effects (mediation) in an integrated manner. Moreover, it supports the assessment of model quality through criteria such as the goodness of fit of the structural model.

Furthermore, in addition to incorporating control variables such as company size or sector of activity, this technique enables the inclusion of moderators, such as the level of maturity in ESG practices or the degree of exposure to environmental regulations. These moderators can be employed to investigate whether the impact of ESG performance on companies' market value is more pronounced in firms operating in highly regulated sectors or those with stricter compliance standards. This analytical strategy allows for a more nuanced examination of the conditions under which organizational sustainability exerts significant influence, offering valuable insights for managers and policymakers.

Similar to the approach taken by Suseno *et al.* (2023) in the context of management accounting, PLS-SEM can be applied to model operational efficiency. They analyzed how production efficiency, product innovation, and customer satisfaction influence financial performance in manufacturing companies. They utilized PLS-SEM to model the interrelationships between these factors and assess their collective impact. If this study had been conducted using traditional regression instead of the PLS-SEM technique, each hypothetical relationship between the variables would have to be analyzed separately, making it challenging to assess multiple interdependencies simultaneously. On the other hand, PLS-SEM enabled the analysis of how the construct influences performance metrics, such as profit margin and return on investment, while also incorporating mediating and moderating variables. This was achieved by modeling the "operational efficiency" construct in a formative manner, using indicators such as production costs, technological innovation, supply chain flexibility, and productivity.

For instance, PLS-SEM can facilitate the investigation of how "operational efficiency" (encompassing reduced costs and increased productivity) directly affects return on investment (ROI), mediated by metrics such as product innovation and customer satisfaction. Unlike traditional regression, where variables like company size or level of automation might be included as independent variables, PLS-SEM enables these factors to be modeled as control variables. This approach allows for assessing the specific effect of operational efficiency on ROI without these external factors systematically interfering with the analyzed relationship. Such a model can ensure a more nuanced understanding of how these factors influence outcomes, isolating the actual impact of the operational efficiency construct.

Thus, PLS-SEM can expand the analysis by providing a more holistic perspective and enabling more robust assessments of the models' validity and reliability. This approach can be particularly valuable in studies aiming to understand the factors that drive financial performance based on managerial and operational practices.

Substantial literature in Financial Accounting investigates the relationship between earnings management and the relevance of accounting information. For example, Habib (2004) investigated how earnings management practices impact the relevance of accounting information in the Japanese context. Using regression models based on the methodologies of Jones (1991) and Modified Jones (1995), the study presented empirical evidence that smoothing and accrual management practices reduce the relevance of accounting information by compromising its reliability.

Although the regression approach helps analyze direct relationships, it may limit the understanding of complex interrelationships between variables and latent constructs. If the previous study were conducted using PLS-SEM, it would be possible to model the "relevance of accounting information" as a formative construct, integrating indicators such as earnings relevance (Ohlson model, 1995) and operating cash flow (Burke & Wieland, 2017). Simultaneously, "earnings management" could be modeled using metrics such as discretionary accruals, operating activities, and smoothing practices. PLS-SEM would enable the analysis of how these constructs interact and impact companies' market value while also integrating mediating effects, such as the quality of corporate governance.

Putra, Anita, and Helmy (2023) conducted a survey and used multiple regression as a data analysis technique to investigate the impact of accountability, transparency, and public participation on the performance of public service organizations in Indonesia. They found significant relationships between accountability and transparency in organizational performance. However, if the PLS-SEM approach had been employed, they could have modeled transparency as a formative construct comprising variables such as report readability, disclosure frequency, and data accessibility. This technique would also enable the simultaneous analysis of direct and indirect effects, incorporating mediators such as public trust and moderators like organization size or digitalization level. Thus, PLS-SEM would enrich the study's conclusions, providing a more detailed and integrated analysis of the investigated variables.

Furthermore, the technique is helpful for studies aiming to identify mediating and moderating effects in complex relationships. In traditional regression, identifying mediating effects requires estimating multiple separate equations and applying specific tests, such as the Sobel test or the bootstrapping approach, making the analysis more fragmented and prone to statistical limitations. In PLS-SEM, mediation modeling is performed directly and simultaneously, allowing the assessment of direct, indirect, and total effects within a single structural model, using robust statistical criteria to measure the significance of mediating paths.

For example, when studying the relationship between disclosure practices and financial performance, PLS-SEM can model organizational transparency as a formative construct comprising financial report clarity, detailed explanatory notes, and disclosure frequency. The impact of transparency can then be analyzed in relation to financial performance while testing for potential mediating effects, such as investor perception or reduced information asymmetry. PLS-SEM allows for the assessment of the direct relationship between transparency and performance and an understanding of the intermediate mechanisms that explain this relationship. Additionally, the technique includes moderating variables, such as company size or industry, facilitating exploring conditions under which these effects become more or less pronounced.

With its ability to incorporate multiple documentary variables and model complex relationships, PLS-SEM offers accounting researchers a powerful tool to investigate dynamic and multifaceted phenomena. This technique not only enhances statistical accuracy but also enriches theoretical interpretation, making it indispensable for advancing the understanding of critical issues in the accounting field.

Therefore, the formative approach of the PLS-SEM technique is an indispensable tool for contemporary accounting research. Its ability to integrate multiple indicators, model complex relationships, and capture the full scope of abstract concepts such as corporate governance, audit quality, and organizational sustainability provides robust and detailed insights. With its analytical flexibility and theoretical rigor, PLS-SEM not only enhances the validity and reliability of research models but also lays a solid foundation for significant advances in understanding accounting phenomena.

3 Final Considerations

The PLS-SEM technique has established itself as an essential methodological tool for accounting research, particularly in modeling formative constructs. Unlike traditional approaches, such as multiple regression, PLS-SEM allows for the simultaneous estimation of multiple relationships, considering direct, indirect, mediating, and moderating effects concurrently. This flexibility is crucial for analyzing complex phenomena in accounting, such as corporate governance, audit quality, organizational transparency, and corporate sustainability, whose dimensions are often captured by formative indicators derived from documentary and secondary data.

In this editorial, we discuss the potential of the formative PLS-SEM approach in accounting research and highlight its applications across different domains. We illustrate how this approach enables the modeling of second-order constructs, the exploration of mediations, and the testing of indirect relationships that would be challenging to capture using traditional methods. Furthermore, we emphasize the importance of carefully selecting the indicators that constitute the constructs to ensure that the modeling comprehensively represents the phenomena under study.

Despite its advantages, the use of PLS-SEM still requires continuous refinement in its application to accounting research. Issues such as appropriate sample size determination, validation of formative constructs, and interpretation of structural coefficients demand careful attention to ensure robust analyses. Future research could compare the results obtained through PLS-SEM with those generated by other statistical approaches, thereby deepening the understanding of this technique's applicability in various accounting contexts.

Despite its advantages, PLS-SEM still requires continuous refinement in its application to accounting research. Issues such as determining an adequate sample size, validating formative constructs, and interpreting structural coefficients demand careful attention to ensure robust analyses. Future research could compare the results obtained through PLS-SEM with those generated by other statistical approaches, thereby deepening the understanding of this technique's applicability in various accounting contexts.

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