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The relationship between product diversity, usage of advanced manufacturing technologies and activity-based costing adoption

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ABSTRACT

This paper examines the associations between product diversity, usage of advanced manufacturing technologies (AMT) and activity-based costing (ABC) adoption. Theory strongly suggests that product diversity is a major determinant of the demand for ABC systems. To date, the results of empirical research on the relationship between product diversity and ABC adoption have generally been inconclusive, however, suggesting that there either may be no strong relationship, or that methodological issues may have prevented researchers from consistently finding it. Using a dataset of survey responses from 191 Dutch, medium-sized manufacturing firms, this paper re-examines the relationship between product diversity and ABC adoption. Improving upon the measurement of product diversity and distinguishing between ABC adoption and use, it examines whether the relationship is curvilinear (inverted U-shaped) and/or moderated by usage of AMT. The paper contributes to the literature by showing that, consistent with the underlying theory, product diversity, on average, is positively related to both ABC adoption and ABC use, but also that these relationships are indeed inverted U-shaped and that the relationship with ABC use is negatively moderated by usage of AMT.

1. Introduction

It is widely recognized that in order to be optimal, costing practices should be closely related to the fundamental work processes in a firm. That is, more complex work processes require more complex cost systems (in terms of the applied overhead absorption procedures) to capture them. Accordingly, from a rational economic theoretical perspective, firms' adoption of activity-based costing (ABC) should be mainly driven by technological factors, of which especially product diversity is strongly suggested to be a major determinant of the demand for ABC systems (Abernethy, Lillis, Brownell, & Carter, 2001; Al-Omiri & Drury, 2007). Product diversity refers to conditions in which products place different demands on a firm's activities or activities place different demands on its resources, and is generally considered to be the most important cause of distorted product costs by traditional (non-activity-based) cost systems (e.g., Cooper, 1988; Kaplan & Cooper, 1998).

Since its introduction in the literature in the late 1980s, several streams of empirical research on ABC have developed, of which research on the determinants of ABC adoption is a major one (e.g., Gosselin, 1997; Krumwiede, 1998). The results of this research, in which the influence of many potential determinants has been studied, are generally inconclusive. This has led researchers into arguing that more research in this area is necessary (e.g., Abernethy et al., 2001; Drury & Tayles, 2005), since the source of the inconclusive results may not only be substantial, but may also be methodological (Al-Omiri & Drury, 2007).

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Most studies to date have, for example, used inconsistent definitions of and measurement instruments for both ABC adoption and its (proposed) determinants, and some have used rather simple, bivariate statistics. More importantly, no study has yet explored effects other than linear, additive ones for any of the potential determinants of ABC adoption, although the results of qualitative field research suggest such effects may exist in practice (e.g., Abernethy et al., 2001). Despite its strong theoretical foundation, similar to the other studied (potential) determinants, the results of empirical research on the relationship between product diversity and ABC adoption have also generally been inconclusive, suggesting that there either may be no strong relationship, or that methodological issues may have prevented researchers from consistently finding it.

The purpose of this paper is to re-examine the relationship between product diversity and ABC adoption, using a dataset of survey responses from 191 Dutch, medium-sized manufacturing firms. Improving upon the measurement of product diversity and distinguishing between ABC adoption (defined as either using or implementing ABC) and use (defined as using ABC), it examines whether the relationship is curvilinear (inverted U-shaped) and/or moderated by usage of advanced manufacturing technologies (AMT).

This paper contributes to the literature on the determinants of ABC adoption in at least three ways. First, previous survey research has been criticized for adopting a rather simplistic approach to the notion of product diversity (Abernethy et al., 2001). In these studies, it has either been measured as the number of products (or product variants) produced in a firm, or by using a composite multi-item scale with respect to the complexity (diversity) of manufacturing and costing in a firm. Both types of measures seem to insufficiently capture the exact nature of product diversity. This study therefore develops and uses a new, more comprehensive measure of product diversity, that essentially combines the main underlying elements of both previously used types of measures. Second, previous survey research (e.g., Al-Omiri & Drury, 2007; Krumwiede, 1998) has implicitly assumed that the relationship between product diversity and ABC adoption is linear; the assumption has been that increased product diversity leads to corresponding increases in firms' likelihood of adopting ABC. Positing a linear relationship ignores the possibility that there may be nonlinear effects of product diversity on firms' likelihood of adopting ABC. The results of this study show that, consistent with the underlying theory, product diversity, on average, is positively related to both ABC adoption and ABC use, but also that these relationships are inverted U-shaped; i.e., that they are positive up to a point and then begin to decline. From a practical perspective, this latter finding means that firms are more likely to adopt and use ABC at moderate levels of product diversity than at high levels of product diversity. Third, previous survey research (e.g., Al-Omiri & Drury, 2007; Krumwiede, 1998) has also implicitly assumed that the relationship between product diversity and ABC adoption is additive; the assumption has been that product diversity does not have a joint (or interactive) effect with other contextual factors on firms' likelihood of adopting ABC. In their field study, however, Abernethy et al. (2001) find evidence that the relationship between product diversity and ABC adoption may be moderated by usage of AMT, and argue that this moderation effect requires extensive testing. This study provides such testing and shows that the relationship with ABC use (but not with ABC adoption) is negatively moderated by usage of AMT. From a practical perspective, this finding means that the effect of product diversity on firms' likelihood of using ABC is stronger when the level of usage of AMT is relatively low than when this level is relatively high. Overall, the results of this study indicate that the inconclusive results of previous survey research on the relationship between product diversity and ABC adoption at least partially seem to have been caused by methodological issues.

The remainder of this paper is structured as follows. Section 2 reviews the literature and develops the hypotheses. Section 3 describes the research methods used. Section 4 presents and discusses the results. Section 5 summarizes and concludes.

2. Literature review

The main focus of this study is on the nature (form) of the relationship between product diversity and ABC adoption. Product diversity refers to "conditions in which [products] place different demands on [a firm's] activities or activities place different demands on [its] resources. This situation arises, for example, when there is a difference in mix or volume of products that causes an uneven assignment of costs" (CAM-I, 1992). Different types of diversity include: physical size, complexity and batch size (Cooper, 1988; Miller, 1996). Product diversity is generally considered to be the most important cause of distorted product costs by traditional cost systems that use responsibility-based cost pools and only volume-based cost allocation bases (e.g., Cooper, 1988; Kaplan & Cooper, 1998). When products consume indirect and support resources in different proportions (i.e., in levels disproportionate to their production volumes), an activity-based cost system that uses activity-based cost pools and hierarchical (e.g., batch-level, product-sustaining and facility-related) cost allocation bases better (more accurately) captures the variation in resource consumption by different products (e.g., Cooper, 1988; Kaplan & Cooper, 1998). Theory thus strongly suggests that product diversity is a major determinant of the demand for ABC systems.

A number of survey studies have previously studied the relationship between product diversity and ABC adoption, but overall they have found inconclusive results, with studies showing either a positive relationship (e.g., Malmi, 1999), no relationship (e.g., Al-Omiri & Drury, 2007), or even a negative relationship (e.g., Bjørnenak, 1997) (see Table 1). As also shown in Table 1, however, these studies have used a variety of research method choices. In particular, these studies have used inconsistent definitions of and measurement instruments for both ABC adoption and product diversity, and some have used rather simple, bivariate statistics, which suggests that the source of the inconsistent results may not only be substantial, but may also be methodological (Al-Omiri & Drury, 2007).

This study therefore develops and uses a new measure of product diversity, which (as will be explained in greater detail in the Research method section) is more comprehensive than existing measures and better captures the exact nature of product diversity. In addition, this study distinguishes between ABC adoption (defined as either using or implementing ABC) and use