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The Influences on the Frequency with Which Product Costs Are Used in Decision Making

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Abstract

This paper assesses the influence of the level of competition, product customization, importance of product costs in decision making and operating unit size on the frequency with which product costs are used in decision making. As the frequency of use is measured on a three-point ordinal scale of sometimes using, often using or using product costs all the time in decision making, the influence of the four constructs is tested using ordinal regression rather than ordinary least squares regression. Based on the questionnaire responses from 240 British management accountants, the results of the ordinal regressions show that the log odds of operating units sometimes using, or sometimes or often using product costs in decision making is negatively related to the importance of product costs in selling price decisions and operating unit size measured by the number of employees.

Keywords: Frequency of use of product costs, Importance of product costs, Ordinal regression, Questionnaire survey

1. Introduction

The product costing system should report accurate product costs to make decisions relating, for example, to the pricing, introduction, discontinuation and response to rival products (Cooper & Kaplan, 1987; Johnson & Kaplan, 1987). Although there are studies that have examined the extent to which product costs are used in decision making (e.g. Emore & Ness, 1991; Joshi, 1998), many surveys of product costing practice have not considered the frequency with which product costs are used in decision making (e.g. Joye & Blayney, 1990; Cohen & Paquette, 1991; Dean et al. 1991; Kellett & Sweeting, 1991; Clarke, 1992, 1997; Green & Amenkhienan, 1992; Drury et al., 1993; Lukka & Granlund, 1996). Furthermore, to the author's knowledge, prior research has not considered the factors influencing the frequency with which product costs are used in decision making, and hence there is a need to conduct exploratory research in this area. Consequently, this paper uses the results of a research study involving a questionnaire survey of management accountants working in British manufacturing industry to identify the factors influencing how frequently product costs are used in decision making.

In this research product costs were found to be used either sometimes, often or all the time in decision making. Given that it is difficult for a subjectively coded three-point scale to approximate an interval scale, it is not possible to apply ordinary least squares (OLS) regression analysis because OLS regression assumes that the dependent construct is coded on at least an interval scale, with equal intervals between the various points on the scale. Ordinally coded data assumes that there is a ranking between points on a scale, but it does not make any assumption about the distance between the points. Consequently, ordinally coded data, as in this research, should not be used as a dependent construct in OLS regression. This problem can be overcome by using ordinal regression, which does not make any assumption about the size of the intervals between points on ordinally coded data (see e.g., Bender & Benner, 2000; McCullagh, 1980; McCullagh & Nelder, 1989; Norusis, 2005). In addition, unlike OLS regression, ordinal regression does not require a constant variance in the residuals.

Unlike binary logistic regression, which considers the log odds of an individual event occurring when the dependent construct is binary coded, ordinal regression considers the log odds of an event occurring and all other events that are ordered before it. Hence, the objective of this paper is to use ordinal regression analysis to develop and test a model of the influences of the level of competition, product customization, importance of product costs in decision making and operating unit size on the frequency with which product costs are used in decision making. The results show that the importance of product costs in decision making and operating unit size, when measured by the number of employees, have a significant influence on the log odds of the frequency of use of product costs in decision making.

The remainder of the paper is structured into a further four sections. Section two proposes four hypotheses relating to the influence of the four factors on the use of product costs. Section three describes the research methods in terms of a questionnaire survey of management accountants working in British manufacturing industry and the data analysis using ordinal regression. Section four reports the results of the ordinal regression analysis. Section five concludes the research, and identifies its limitations and opportunities for future research.

2. Research hypotheses

Four constructs are examined as possible influences on the frequency with which product costs are used in decision making. The possible influence of each of these constructs is discussed below and because of the exploratory nature of this research. This results in a series of research propositions for each construct, rather than a list of hypotheses.

2.1 Competition

Prior research has identified a positive relationship between the level of competition in the marketplace and the use of management accounting systems (Khandwalla, 1972; Mia & Clarke, 1999). In relation to product costing, it can be argued that as the level of competition increases it is necessary that firms should make greater use of their management information systems to obtain the data necessary to make good quality decisions to compete effectively in competitive markets. To do this, there is a need to rely on a variety of different types of management information, including product cost information. If firms do not do this, then a competitor or competitors may take advantage of errors arising from decision making based on incomplete information. Consequently, it is expected that operating units facing a high level of competition would be likely to make more use of product costs in decision making. Hence:

P_1: As the level of competition increases, the frequency with which product costs are used in decision making increases.

2.2 Product customization

Customized products are produced in manufacturing processes that are non-repetitive manufacturing processes for which it is not possible to calculate standard production costs (Drury & Tayles, 2005)(Note 1). If a company is producing customized products, the variety of products produced will increase and each of these products is likely to have a different product cost, because it will have been produced differently and contain different components to other products. To ensure that appropriate product related decisions are made when a variety of customized products are produced, there is a need to use product cost information frequently in decision making. Hence:

P_2: As the level of product customization increases, the frequency with which product costs are used in decision making increases.

2.3 Importance of product cost in decision making

The higher the importance of product costs in decision making it is expected that the more likely they will be used more frequently in decision making. Hence:

P_3: As the level of importance of product costs increases, the frequency with which product costs are used in decision making increases.

2.4 Operating unit size

Larger operating units are likely to have access to more resources, have more contacts and communication channels than smaller operating units (Bjørnenak, 1997). In larger operating units, resources could take the form of the quantity and expertise of staff to analyse product cost information, which could lead to them using product cost information more frequently in decision making. Hence:

P_4: As the operating unit size increases, the frequency with which product costs are used in decision making increases.

3. Research method

3.1 Research questionnaire

Possible questionnaire respondents were obtained from a list of 854 members of the Chartered Institute of Management Accountants who were working in British manufacturing industry and had the job title of cost, management or manufacturing accountant. An introductory letter was posted to all possible respondents explaining the purpose of the research and that they would receive a questionnaire in two weeks time. Accompanying each questionnaire was a covering letter, which assured respondents of the confidentiality of their responses, and a stamped-addressed envelope. Non-respondents to the questionnaire were posted a follow-up letter two weeks later, and a further follow-up letter, questionnaire and stamped-addressed envelope were posted to non-respondents two weeks after that. After identifying possible respondents who worked in the same operating unit, had left their operating unit, operating units which had closed down, and possible respondents whose work did not involve manufacturing or product costing, the total possible respondents employed in independent operating units declined to 673. A total of 280 usable questionnaires were received (effective response rate = 41.6 percent) and, of these, 274 respondents indicated that they used product costs in decision making (Note 2).

The existence of non-response bias was tested by Mann-Whitney tests comparing respondents who had returned the questionnaire before the first reminder had been sent out (n = 131) and those who returned the questionnaire after the second reminder had been sent out (n = 51). This did not reveal any significant differences between these two types of respondent on any of the research constructs ($p > 0.05$)(Note 3). Hence, non-response bias may not be a problem.

3.2 The ordinal regression model

The ordinal regression model for a dependent construct defined as the frequency with which product costs are used in decision making is:

$\ln(\theta_{j=1,2}) = \alpha_{j=1,2} - \beta_1\text{COMP} - \beta_2\text{CUST} - \beta_3\text{IMPORT} - \beta_4\text{SIZE} + e$

Where:

$\ln(\theta_{j=1,2})$ = The link function that connects the independent constructs of the linear model. In this case, it is the natural logarithm of $\theta_{j=1,2}$, where j is the number of link functions. In this research there are two link functions (Note 4), that is $j = k - 1$, where:

k = The number of points on the ordinally coded scale of the dependent construct, in this case a three-point scale.

$\theta_{j=1,2}$ = The odds of an event occurring, that is $^{pk}/_{(1-pk)}$, where:

pk = The cumulative probability of an event or events occurring, and

$1 - p_k$ = the cumulative probability of that event or events not occurring.

In this case:

θ_1 = p(sometimes using product costs)/p(often using or using product costs all the time)

θ_2 = p(sometimes or often using product costs)/p(using product costs all the time)(Note 5)

$\alpha_{j=1,2}$ = A constant term for each of the link functions.

$\beta_{1\text{-}4}$ = The ordinal regression coefficients.

COMP = The level of competition.

CUST = The level of product customization.

IMPORT = The importance of product costs in selling price decisions.

SIZE = The operating unit size, measured by SALES = Annual sales revenue or EMPLOYEES = Number of employees.

e = Residual error term.

The ordinal regression model is a cumulative logit model, because it is based on the cumulative probabilities of an event occurring. Hence, θ_1 is the probability of operating units sometimes using product costs, relative to those that are often using or using them all the time, and θ_2 is based on the cumulative probability of operating units sometimes or often using product costs relative to those that are using them all the time. As ordinal regression is a form of logistic regression and its parameters are estimated using the maximum likelihood method, each logit has its own different constant term, but the same set of βs. Hence, the two ordinal regression equations are assumed to be parallel. This means that the four independent variables in the model have the same effect on the two logit functions. Thus, the two logit functions are:

$\ln(\theta_1) = \alpha_1 - \beta_1\text{COMP} - \beta_2\text{CUST} - \beta_3\text{IMPORT} - \beta_4\text{SIZE} + e$

$\ln(\theta_2) = \alpha_2 - \beta_1\text{COMP} - \beta_2\text{CUST} - \beta_3\text{IMPORT} - \beta_4\text{SIZE} + e$

Given that there are two size measures, there are two versions of each logit function depending upon whether size is measured by the annual sales revenue or the number of employees.

The model is written as subtracting the βs from the link function because of the form of the ordinal regression model. For example, although the level of competition is assumed to be related positively to the frequency with which product costs are used in decision making, the logit link is calculated so that it considers the log odds of operating units sometimes using product costs (code = 1), and operating units sometimes using or often using products costs (codes = 1 and 2 respectively). As these are the smaller valued codes on the scale measuring the frequency of use, the level of competition would be expected to be related negatively to the log odds of each of these events occurring.

3.3 Construct measurement

Respondents were asked to answer the questionnaire from the perspective of the operating unit in which they worked, such as the division of a divisionalized company, factory within a division or a non-divisionalized company. The extent to which operating units' used product costs in decision making (defined as selling price, make-or-buy, product mix, output level, cost reduction, product design etc., decisions) was obtained from a single question with responses of 1 = used all the time, 2 = often used, 3 = sometimes used, 4 = rarely used and 5 = never used, which were then reverse scored for data analysis.

The level of competition was measured by two questions developed by the researcher. The first question assessed the general level of current competition for the major products of the operating unit with responses on five-point Likert scale ranging from 1 = Very intense to 5 = Very slack. The second question asked for information about the level of expected competition over the next two years for the major products of the operating unit, with responses ranging from 1 = Very high and 5 = Very low. For data analysis, the scores on the two questions were reverse scored and initially summed and divided by 2 to provide a measure of the general level of competition on a nine-point scale from a low score of 1 to a high score of 5. Product customization was measured by two questions developed by the researcher. From these two questions, respondents identified the range of products produced by their operating unit on a five-point Likert type scale. For the first question responses ranged from 1 = Virtually all customized products, to 5 = Virtually all standardized products. For the second question responses ranged from 1 = At least 95% of products produced are unique and produced to satisfy individual customer's orders, to 5 = At least 95% of products are identical products produced in large quantities. The responses to both questions were initially reverse scored for data analysis and summed and divided by 2 to give a low score of 1 to a high score of 5 (Note 6).

The importance of product costs in decision making was assessed by its importance in selling price decisions, because it is an important decision that most organizations will have to undertake and, in which, product costs are likely have some role (e.g. Cooper & Kaplan, 1987; Drury et al., 1993). The importance of product costs in selling price decisions was assessed by responses on a six point scale ranging from 1 = Very important to 5 = Very unimportant and 6 = Do not make this type of decision. For the purpose of data analysis, only those operating units making selling price decisions were included, and the importance measure was reverse scored for analysis. Operating unit size was measured by annual sales revenue of and the number of employees employed by the operating unit. Respondents were asked to indicate the approximate annual sales revenue of their operating unit in the last financial year and the approximate number of employees in their operating unit.

4. Results

The ordinal regression analysis was applied using listwise deletion, which resulted in a sample of 241 respondents. All of these operating units made some use of product costs in decision making, but because only one operating unit rarely used product costs in decision making this was eliminated from the data analysis and the usable sample declined to 240 respondents. The results of ordinal regression analysis including the raw scored independent constructs revealed that, of the cells between the dependent construct and the independent constructs, 66.5 percent were empty when size was measured by annual sales revenue and 66.2 percent were empty when size was measured by the number of employees. The high level of empty cells meant that the goodness-of-fit statistics for the ordinal regression equations were unreliable (Norusis, 2005). To increase the dependability of these goodness-of-fit statistics it was necessary to reduce the number of empty cells between different values of the dependent construct and different values of the independent constructs, and the number of cells with small expected values on the points on the scales of each independent construct. This was achieved by rescaling the independent constructs, and, by trail and error, this led to the scales of the independent constructs being reduced to three-point ordinal scales.

There was no need to change the coding for the use of product costs measure because operating units either sometimes used (code = 1), often used (code= 2) or used product costs all the time (code = 3) in decision making. For the competition measure, as no operating units had a score of 1 or 1.5 and only one operating unit had a score of 2, the responses were reduced to a three-point scale with scores of 2, 2.5 and 3 being recoded 1, scores of 3.5 and 4 being recoded 2, and scores of 4.5 and 5 being recoded 3. The responses to the product customization measure were spread more evenly. Hence, the scale was reduced to a three-point scale with scores of 1, 1.5 and 2 being recoded 1, scores of 2.5, 3 and 3.5 being recoded 2, and scores of 4, 4.5 and 5 being recoded 3. The importance of product costs in decision making was recoded, with scores of 1 and 2 being recoded as 1, a score of 3 being recoded as 2, and scores of 4 and 5 being recoded as 3. The annual sales revenue measure was coded £0m to £20m = 1, greater than £20m to £100m = 2 and greater than £100m = 3. The number of employees was coded 0 to 100 employees = 1, 101 to 500 employees = 2 and greater than 500 employees = 3.

The distribution of responses for all of the constructs in the ordinal regression model is shown in Table 1. This table shows that most operating units use product costs at least often in decision making, face a high level of competition, have varying levels of product customization, regard product costs as being important in selling price decisions and are moderately sized.

Table 2 shows the Spearman Rank correlation coefficients between the six construct measures, and that the only significant correlations with the level of use of product costs was for the importance of product costs and for the number of employees. This indicates that these constructs may be related to the use of product costs in the ordinal regressions.

Unsurprisingly, the largest correlation was between the two size measures (r = 0.693), but this is of no importance because these two constructs do not appear in the same ordinal regression equations. The other significant correlation was between annual sales revenue and the level of competition, but the low correlations between the independent constructs indicates that multicollinearity is unlikely to be a problem in the ordinal regressions.

Table 3 shows the results of the ordinal regressions and reveals that the importance of product costs in selling price decisions and the number of employees were significantly related to the level of use of product costs. Hence, proposition 3 is accepted and proposition 4 is partly accepted, because the size effect for the annual sales revenue was not significant ($p \geq 0.05$). In addition, there were non-significant effects for competition and product customization, and, hence, propositions 1 and 2 were rejected. The ordinal regression equations for the frequency of use of product costs were, when size was measured by annual sales revenue were:

$\ln(^{p(\text{sometimes used})}/_{p(\text{often used or used all time})})$

= 1.488 + 0.085(COMP) – 0.190(CUST) – 1.028(IMPORT) – 0.388(SALES)

$\ln(^{p(\text{sometimes or often used})}/_{p(\text{used all the time})})$

= 3.515 + 0.085(COMP) – 0.190(CUST) – 1.028(IMPORT) – 0.388(SALES).

When size was measured by the number of employees the ordinal regression equations were:

$\ln(^{p(\text{sometimes used})}/_{p(\text{often used or used all time})})$

= 2.185 + 0.053(COMP) – 0.187(CUST) – 1.022(IMPORT) – 0.625(EMPLOYEES)

$\ln(^{p(\text{sometimes or often used})}/_{p(\text{used all the time})})$

= 4.243 + 0.053(COMP) – 0.187(CUST) – 1.022(IMPORT) – 0.625(EMPLOYEES).

This shows that the log odds of an operating unit either sometimes, and sometimes or often using product costs in decision making was related negatively to the importance of product costs in selling price decisions and to the number of employees. Alternatively, the log odds of an operating unit having used product costs all the time in decision making, or often used or used all the time was related positively to importance and the number of employees (Note 7).

It is necessary to test if the two regression lines are parallel, in other words that the relationship between the independent constructs and the two link functions is the same for each of the link functions. This test compares the model assuming that the two lines are parallel with the model assuming separate lines. A non-significant chi-square statistic indicates that the two lines are parallel and that the relationship between the independent constructs is the same for the different link functions of the dependent construct. If the chi-square statistic is significant then different models are required for the different link functions. The test for parallel lines when the ordinal regression model included size measured by annual sales revenue was chi-square = 2.900, p = 0.575 and when size was measured by the number of employees, chi-square = 2.647, p = 0.619. The non-significant chi-square indicates that the two lines are parallel.

If the model provides a good fit of the data, the observed and expected cell counts are similar, and there is no significant difference between them. When size was measured by annual sales revenue the goodness-of-fit statistics were:

Pearson: chi-square = 80.104, p = 0.476 and

Deviance: chi-square = 86.577, p = 0.288.

When size was measured by the number of employees, the goodness of fit statistics were:

Pearson: chi-square = 88.056, p = 0.204 and

Deviance: chi-square = 91.659, p = 0.138.

The non-significant goodness-of-fit statistics indicates that the model provided a good fit of the data, and the observed and expected cell counts were similar. In addition, the model fitting test compares the model with predictors to the model without predictions. A significant chi-square indicates that a model with predictors provides a better fit to the data. When size was measured by the annual sales revenue: chi-square = 16.547, p = 0.002, and when size was measured by the number of employees: chi-square = 22.097, p = 0.000. In both cases the models including predictors provided a better fit to the data than if they were not included.

Although the objective of the research was to develop a model of the factors influencing the use of product costs, measures of the strength of the association between the independent constructs and the dependent construct are reported for completeness. When size was measured by annual sales revenue, the strength of the associations were Cox and Snell pseudo R^2 = 0.067, Nagelkerke pseudo R^2 = 0.079 and McFadden pseudo R^2 = 0.038. When size was measured by the number of employees they were Cox and Snell pseudo R^2 = 0.088, Nagelkerke pseudo R^2 = 0.105 and McFadden pseudo R^2 = 0.050. Hence, the explanatory variance was low.

5. Conclusion

This paper has developed and tested an ordinal regression model of the factors influencing operating units' frequency of use of product costs in decision making. The model tested the influence of the level of competition, the level of product customization, the importance of product costs in selling price decisions and operating unit size as independent constructs. The results indicate that the log odds of an operating unit sometimes using, and the log odds of an operating unit sometimes or often using product costs is negatively related to the importance of product costs in selling price decisions and to the number of employees employed in the operating unit, or, alternatively, the importance of product costs and the number of employees is related positively to the frequency of usage, when this is defined as the log odds of an operating unit using product costs all the time, or often or all the time in decision making.

The level of competition, product customization and annual sales revenue do not impact on the frequency of use. Given that this is exploratory research these constructs need to be tested in future research. In particular, given that there is a significant effect for size when measured by the number of employees, the marginally non-significant effect for annual sales revenue needs to be confirmed in future research.

The pseudo R^2 in the ordinal regressions are low, which indicates that other constructs affect the level of use that have been omitted from the model. These constructs could include the quantity of staff in the accounting department, the quality of staff, the time available to use product costs in decision making and the level of accounting knowledge of non-accounting staff, senior management support for the use of product costs in decision making and having a person within the accounting department to promote the use product costs in decision making.

The main limitation of the research is the coding of the independent constructs on a three-point ordinal scale. This reduces the amount of data that is included in these constructs, and, hence, the discrimination between different levels of intensity of these constructs. Notwithstanding this limitation, the research illustrates the application of a research method that has been used rarely, namely ordinal regression. The method has the potential of overcoming the limitation of applying an ordinally coded dependent construct in OLS regression analysis. It is hoped that the technique described in this paper will encourage other researchers in this area to apply the ordinal regression method in future research.

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Notes

Note 1. Product customization is different to product diversity. The latter can be divided between volume diversity and support diversity. Volume diversity is similar to product customization, but support diversity is caused by products consuming resources in production departments in different proportions. As support diversity increases, then production process complexity increases and this can result in the production of customized products.

Note 2. A copy of the questionnaire is available on request.

Note 3. The results of the Mann Whitney tests are available from the author, on request. Unless stated otherwise, all statistical tests are two-tailed tests and all statistical significance levels are at the $p = 0.05$ level.

Note 4. There are various ways of defining the link function depending upon the distribution of the dependent construct. The results of the empirical research revealed that this link function was the best fitting of all the possible link functions. Examples of other forms of the link function are provided in Norusis (2005).

Note 5. There is no need to include the probability of sometimes using, often using or using product costs all the time because the probability of this event is 1.

Note 6. A factor analysis with a varimax rotation confirmed that the two, two-item measures of competition and product customization each loaded on to a single factor. The Cronbach's alphas for competition and product customization were 0.842 and 0.804 respectively, which indicated a satisfactory level of reliability.

Note 7. These results would have been obtained if the dependent construct had been reverse coded. In this case, the sign of the ordinal regression coefficients would reverse.

Table 1. Distribution of responses for the model constructs[a]

	Score 1	Score 2	Score 3	Total
	No. (%)	No. (%)	No. (%)	No. (%)
Frequency of use of product costs in decision making	24 (10.0)	79 (32.9)	137 (57.1)	240 (100)
Level of competition	13 (5.4)	95 (39.6)	132 (55.0)	240 (100)
Level of product customization	88 (36.7)	74 (30.8)	78 (32.5)	240 (100)
Importance of product costs	9 (3.8)	21 (8.8)	210 (87.5)	240 (100)
Annual sales revenue	78 (32.5)	122 (50.8)	40 (16.7)	240 (100)
Number of employees	29 (12.1)	127 (52.9)	84 (35.0)	240 (100)

[a] Scored on a three-point scale with low score = 1 and high score = 3.

Table 2. Spearman rank correlation coefficients[a]

	1	2	3	4	5	6
1. Frequency of use	1.000					
2. Level of competition	0.009	1.000				
3. Level of product customization	0.100	0.015	1.000			
4. Importance of product costs	0.241***	0.094	0.119	1.000		
5. Annual sales revenue	0.073	0.160*	–0.036	–0.122	1.000	
6. Number of employees	0.171**	0.004	–0.012	–0.080	0.693***	1.000

[a] * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 3. Ordinal regression analysis

	Regression coefficient	Standard error	Wald statistic	df	p
Panel A: Including annual sales revenue as the measure of operating unit size					
Constant (α_1)	1.488	1.028	2.086	1	0.148
Constant (α_2)	3.515	1.053	11.155	1	0.001
Level of competition	–0.085	0.218	0.152	1	0.696
Level of product customization	0.190	0.157	1.462	1	0.227
Importance of product costs	1.028	0.280	13.487	1	0.000
Annual sales revenue	0.388	0.198	3.857	1	0.050
Panel B: Including number of employees as the measure of operating unit size					
Constant (α_1)	2.185	1.081	4.088	1	0.043
Constant (α_2)	4.243	1.110	14.621	1	0.000
Level of competition	–0.053	0.216	0.060	1	0.807
Level of product customization	0.187	0.158	1.399	1	0.237
Importance of product costs	1.022	0.278	13.568	1	0.000
Number of employees	0.625	0.206	9.240	1	0.002