Manufacturing Strategy, Broad Scope MAS Information and Information and Communication Technology: A Research Note

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Abstract

In today's global business environment, firms are under pressure to create competitive advantages. Among the ways to do so are offering a wide range of quality products at competitive price and being customer responsive. The pressure also acts as an impetus for firms to employ strategies suitable for creating competitive advantages. Just-in time manufacturing (JIT) is one such strategy. This study tested the proposition that the relationship between a firm's successful JIT application and its managers' use of information and communication technology (ICT) is (a) partly indirect via the managers' use of broad scope MAS information, and (b) partly direct. The participants were 76 general managers, each in charge of one business unit (BU) within their firms. The results support part (a), but not part (b) of the proposition. Specifically, the results reveal that JIT application is positively associated with managers' use of broad scope information provided by the management accounting system (henceforth, MAS information), which in turn, is positively associated with the use of ICT.

Keywords: JIT, broad scope MAS Information, ICT.

1. Introduction

Researchers have argued that organisations facing competitive business environment need to identify and meet customer desires, produce superior products at competitive costs and be market-orientated (Kohli and Jaworski, 1990; Senge, 1990; Day, 1991; DeGeus, 1988). These competitive pressures act as impetuses for firms to employ strategies suitable for the environment. The application of JIT is one such strategy as it provides capabilities to reduce costs and improve product quality, process flexibility, and supplier and customer relationships (Banker, et al 1993; Yasin et al, 1997; Cowton and Vail, 1994; Cobb, 1993; Sakakibara, et al., 1993). This study views JIT as a production system under which goods in one stage of the production-sales cycle are completed just prior to being needed in the next stage (Gordon, 2000).

The extant literature (Ansari, 1997; Yasin, et al., 1997; Cowton and Vail, 1994; Cobb, 1993) suggests that broad scope MAS information provides necessary feedback on operational aspects including cost, production, inventory, market share and sales.

Given that JIT application aims at improving such operational aspects, we posit that managers in JIT environments would make a greater use of the MAS information, which in turn, is positively associated with their use of ICT. This is because use of ICT makes information readily available and communication of the information instantaneous. JIT firms communicate closely with suppliers and customers to ensure timely delivery of orders (Fitzerald, 1999), and use of ICT makes the communication effective (Thomas and Staatz, 1995).

By providing empirical support for the relationships between (i) managers' use of MAS information and JIT application, and (ii) the use of ICT and MAS information, this study adds to the existing understanding of the above issues, and may encourage further research in the area.

2. Theory and hypotheses

2.1. JIT application and managers' use of broad scope MAS information.

Broad scope MAS information comprises internal and external, quantitative and qualitative, financial and non-financial, and historical and future-orientated data (Gordon, 2000; Ansari, 1997; Kaplan and Norton, 1996; Bromwich and Bhimani, 1994). Examples of such information are: cost, revenue, sales growth, capacity utilisation, wastage, customer satisfaction, product quality, and government policy.

We argue that managers' use of the MAS information is positively associated with JIT application. Because of its breadth the information can provide feedback on a range of factors like costs, slack resources, wastage, set up and movement time, customer satisfaction, and sales growth; thereby helps a firm achieve its objective of applying JIT (Balakrishnan et al., 1996). Previous researchers argue that managers use the MAS information as it enhances quality of their decisions, expedites learning processes, helps performance evaluation, and assists monitoring operating environment (Mia, 1993; Porter, 1985). Because of reduced (or eliminated) slack resources in JIT environments (Daniel and Reitsperger, 1991; Mia, 2000; Gordon, 2000), managers running JIT operations do not have a buffer against unexpected difficulties, and unforeseen situations. Also, tasks in JIT environments are highly interdependent (Selto et al., 1995). Due to reduced (or eliminated) slack resources and high task-interdependencies, production processes in JIT environments must operate in concert. Therefore, managers in JIT environments ought to instantly make operations-related decisions, requiring their use of more broad scope MAS

information (Mia, 1993; Chenhall and Morris, 1986). Hypothesis one summarises the discussion.

H₁: There is a positive association between JIT application and managers' use of broad scope MAS information.

2.2. Managers' use of the MAS information and their use of ICT.

ICT, in this study, comprises Intranet (i.e., computer networks for communication between employees, departments, and functions within an organisation) and Internet (i.e., computer networks for communication with stakeholders including customers, suppliers, creditors and other external parties).

The relevant literature suggests that managers' use of ICT (i) increases volume, speed, and capacity of their data handling; and (ii) improves information exchange and communication across functions, parties, geographical locations and time zones (Andersen, 2001; Forouzan, 2001). We contend that managers' use of the MAS information and ICT are positively associated, as ICT helps managers in effectively using the information (see, Brynjolfsson and Hitt, 1996; Powell and Dent-Mitcallef, 1997). Such effectiveness is particularly relevant for use of broad scope MAS information which is voluminous (Mia, 2000; Ansari, 1997; Chenhall and Morris, 1986). As an integrated computer network and data interface, ICT also provides managers capacity to instantaneously share real-time information that enables faster and better decision-making (Brynjolfsson and Hitt, 1996; Powell and Dent-Mitcallef, 1997; Andersen, 2001).

Following the above discussion, we argue that managers' use of the MAS information for decision-making is positively associated with their use of ICT as presented in (H₂) below.

H₂: There is a positive association between managers' use of broad scope MAS information and their use of ICT.

2.3. JIT application and managers' use of ICT.

Due to high task interdependency in JIT environments, managers running JIT operations cooperate closely with their peers and engage in collaborative decision-making. ICT-supported communication can make mutual cooperation effective and facilitate quick decision-making, which are important in a JIT environment (Horvarth and Fulk, 1994).

Furthermore, the extant literature (Fitzerald, 1999) indicates that a successful JIT operation depends on a well-managed supply-chain (Claycomb et al., 1999;

Langley et al., 1992) as the chain can help minimisation of total production and delivery costs (Persson, 1995; Pragman, 1996), thereby achievement of JIT application goals. For this purpose, all firms within the supply-chain need to communicate closely among themselves, and managers' use of ICT can facilitate such communications. For instance, ICT can help effective and on-time communication between manufacturers and suppliers, allowing suppliers to learn what the manufacturer needs, how much to deliver, and when to deliver (Thomas and Staatz, 1995). Atkinson (2001), for example, argues that Internet (where transactions and interactions can take place at lightning speed) significantly improves information flow between manufacturers and suppliers and customers (see also, Thomas and Staatz, 1995). Hypothesis three summarises the discussion and Figure 1 presents the model of the study.

H₃ There is a positive association between JIT application and managers' use of ICT.

Insert Figure 1 here

An extensive review of the relevant literature allows us to conclude that (i) firm size is an important contextual factor in the relationships between a firm's JIT application and outcomes, and (ii) no previous study investigates if JIT application is associated with managerial use of the MAS information and ICT, irrespective of firm size. The results of previous studies assessing the role of firm size in JIT application - outcomes relationships are inconclusive. While some authors (Callen, et al, 2000; Lee, 1997; Claycomb et al, 1999; Lawrence, and Hottestein, 1995; Mehra and Inman, 1992; Inman and Mehra, 1990; Finch, 1986) report that firm size is important in the JIT applications - outcomes relationships, others (Germain, and Cornelia, 1996; Clarke and Mia, 1993; Golhar, et al, 1990; and Miller and Cornelia, 1986) fail to support such results. In addition to the inconclusive results, no previous study investigated the role of firm size in the relationships between managers' use of the MAS information and JIT application, and ICT. We argue that firm size is important in the above relationships because small firms have less resources to set up infrastructure (like sophisticated information systems, IT facilities), and for employee training required for JIT application (see Claycomb et al (1999).

This study tested the argument. It was done by testing the proposed hypotheses controlling for size of business units (BUs) in the sample. A business unit within a

company was a profit centre carrying out the usual business activities including manufacturing and selling products (Mia, 2000).

3. Method

3.1. The sample.

The study used the Dunn and Bradstreet ‘Salescan’ database, to select 250 firms at random, from among the manufacturing firms operating in Australia and applying continuous (repetitive) production processes. The relevant literature indicates different relationships between JIT application and outcome variables in continuous production process and job shop industries (Lawrence and Hottestein, 1995). A senior executive of each selected firm was initially approached in writing, then by telephone, to nominate one business unit (BU) general manager who had been in charge of the unit for at least one year, to participate in the study.

In total, 160 BU general managers were nominated and subsequently approached to participate in the study. During first week of January 2004, we wrote a personal letter (and telephoned two weeks after posting the letter) to each of the nominated general managers seeking their participation, and explaining the study’s purpose and potential benefits. A self-addressed postage paid envelope was attached to the letter, for return of the completed questionnaire direct to the researchers. Altogether, 79 BU general managers completed and returned the questionnaire within nine weeks of mailing the questionnaire, yielding a response rate of about 50% of the managers nominated. Three of the questionnaires were incomplete, so discarded leaving 76 cases. The managers had held their current positions for 1 to 9 years (the average being 3.8 years) and had been with their current employers for 4 to 15 years (the average being 8 years). The sample represents a wide range of manufacturers in continuous production process industries, including automobile, electrical home appliance, building product, and fertiliser. Only manufacturing firms were selected because previous empirical research in JIT concentrates on manufacturing firms.

Two steps were taken to investigate the non-response bias in the sample. First, three BU general managers, randomly selected from among those who decided not to participate in the study, were encouraged on telephone to participate in the study. The reasons given by the managers for non-participation were “lack of time”, and “not interested”; none of the managers made any comment raising a concern for non-response bias. Second, the responses provided by 20% of the early and late

respondents were compared applying Mann-Whitney U statistic; no difference across the two sub-samples was noted.

3.2. *Measurement of variables.*

The JIT application. The literature suggests that JIT application comprises six ‘key’ aspects of manufacturing activities including (i) set-up time, (ii) manufacturing process flexibility, (iii) preventive maintenance, (iv) equipment layout flexibility, (v) supplier relationships, and (vi) kanban (Sakakibara et al., 1997; Yasin et al., 1997).

In the current study, JIT application was assessed using the six-item instrument (adapted from Sakakibara, et al., 1997) that includes items on each of the six ‘key’ aspects of JIT application. Each item was anchored at both ends of a 7-point Likert scale indicating 1 (very low) and 7 (very high). The BU general managers were provided with the definition of each of the six “key” aspects of JIT application and they were asked to indicate the extent to which their BUs implemented JIT under each of the aspects (see Appendix A, panel 1). Each manager’s score for JIT application was the average of the manager’s scores for the six items.

The JIT instrument including those for the MAS information and ICT were pilot-tested and refined before they were used in the study. A reliability test for the JIT instrument in this study produced a Cronbach (1951) alpha coefficient of 0.80, which was considered satisfactory. Also, a factor analysis of the scores of each of the instrument separately produced a single factor with an eigenvalue greater than 1 (see, Appendix B). Table 1 presents the variable’s mean and standard deviation.

Insert Table 1 here.

Managers’ use of the MAS information. Managerial use of the information was assessed using the 6-item instrument (adapted from Mia, 2000; Chenhall and Morris 1986). BU general managers were asked to indicate the extent to which they use the MAS information, on a 7-point Likert scale ranging from 1 (not at all) to 7 (to a great extent).

A reliability test for the measure (Appendix A, panel 2) in the study produced a Cronbach (1951) alpha coefficient of 0.83, which was considered satisfactory. A manager’s overall score for use of the MAS information was the average of the manager’s scores for the six items in the instrument. Table 1 presents the variable’s mean and standard deviation.

Managers' use of the information and communication technology (ICT). The 4-item instrument assessing managers' use of ICT was adapted from Andersen (2001). The BU general managers were asked to indicate, on a 7-point Likert-scale ranging from 1 (low use) to 7 (high use), the extent to which ICT was used for their decision-making. A manager's overall score for use of ICT was the average of the manager's scores for the four items in the instrument (Appendix A, panel 3).

A reliability check of the instrument for the study produced a Cronbach (1951) alpha coefficient of 0.65, which was considered satisfactory (Nunnally, 1967). Table 1 presents the variable's mean and standard deviation.

BU Size. Prior studies (Lawrence and Hottestein, 1995; Lee, 1997; Droge and Germain, 1998) have used number of full-time equivalent employees working within a firm as a proxy for the firm size. Lawrence and Hottestein (1995) for instance, categorised sample firms as small (number of employees less than 150) and as large (number of employees greater than 150). They also report that the relationship between JIT application and firm performance depends more on whether a firm is "large" or "small" than on how large or how small it is. Following Lawrence, and Hottestein (1995), the size of a business unit (BU) in the current study was measured in terms of the number of full-time equivalent employees working for the BU at the time of the study. Each participant BU general manager was asked to indicate if the number of full-time equivalent employees of their respective BU was (a) less than 150, or (b) 150 or more.

4. Results

The hypotheses were tested using path analysis which is technically multiple linear regression analysis (Pedhazur, 1982, p. 582). Therefore, following Coakes and Steed (2001), Tabachnick and Fidel (2001), and Pedhazur (1982), the assumptions for: adequate sample size, absence of outliers, absence of multicollinearity, normality, linearity, homoscedasticity, and independence of residuals of the variables in the model were tested using the data for the current study. The test results revealed that each of the assumptions was met (see, for instance, Table 1 for absence of multicollinearity).

4.1. Test of the hypotheses

The path analysis involved running two regression equations - one to test hypothesis one and the other to test hypotheses two and three. As mentioned earlier in the paper, each of these hypotheses was tested controlling for size of business units in the sample.

Hypothesis H_1 , which predicts that there is a positive relationship between JIT application and managers' use of the MAS information, was tested using the regression equation (1): $X_2 = a + \beta_1 X_1 + \beta_2 S + e$; where X_2 = managers' use of broad scope MAS information, X_1 = JIT application, S = business unit size, and e = the error term.

The results presented in Table 2 indicate a positive and significant ($\beta_1=0.29$, $p<0.01$) relationship between JIT application and managers' use of the MAS information, thereby providing support for hypothesis H_1 .

Insert Table 2 here

Hypothesis H_2 predicts that there is a positive relationship between Managers' use of the MAS information and ICT. Similarly, Hypothesis H_3 predicts that there is a positive relationship between JIT application and managers' use of the ICT. These hypotheses were tested using regression equation (2): $X_3 = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 S + e$; where X_3 = managers' use of ICT, X_2 = managers' use of broad scope MAS information, X_1 = JIT application, S = business unit size, and e = the error term.

The results in Table 3 indicate a positive and significant ($\beta_2=0.28$, $p<0.02$) relationship between managers' use of the MAS information and ICT providing support for hypothesis H_2 . However, the relationship between the JIT application and managerial use of ICT (Table 3) was not significant, thus hypothesis H_3 was not supported. The results also revealed that BU size had a significant and positive association ($\beta_3=0.22$, $p<0.04$) with managers' use of ICT. An explanation for the result is provided in the next section.

Insert Table 3 here

5. Discussion, limitations and conclusion

The significant and positive relationship between JIT application and managers' use of the MAS information supports the argument that managers in a JIT environment use broad scope MAS information for decision-making. The study

extends Mia (2000) by testing the relationship between JIT application and managers' use of the MAS information. Mia (2000) did not investigate the relationship between managers' use of the MAS information and JIT application.

An interpretation of the lack of association between business unit size and use of the MAS information (Table 2) is that managers' use of the information is driven by their information needs for decision-making, not by size of their organisations. We consider that JIT application acts as a precursor of such information needs. Selto et al (1995), and Mia (2000) suggest that managers in JIT environments are involved in on-the spot decision-making, so they have a greater need to use the MAS information.

The significant and positive MAS - ICT relationship (Table 3) supports the argument in the paper that in using the MAS information the managers need to use ICT. Since the MAS information is broad, managers using such information are faced with processing large volume of data; ICT assists managers in effectively handling the data and using the information for decision-making. Nevertheless, it is plausible that managers' use of the ICT might also prompt use of more MAS information. The study extends research on use of ICT to situations (e.g., JIT operation) where managers' use of the MAS information is warranted.

The significant and positive relationship between business unit size and managers' use of ICT (Table 3) supports the argument that large firms can afford the required investments for setting up infrastructure like sophisticated ICT facilities, and staff training (see Claycomb et al (1999)). Large firms, by providing managers with more sophisticated ICT facilities, may encourage managers' greater use of the facility. We consider that the findings improve current understanding of the importance of firm size in making decisions on setting up necessary infrastructure (e.g., ICT). However, the interpretation of the results is rather speculative; future research empirically investigating the matter would add to current understanding.

An interpretation of the lack of support for hypothesis H₃ is that the JIT application-ICT relationship flows through mediums (other variables) and managers' use of the MAS information is one of the mediums for the sample firms. Since the relationships between managers' use of the MAS information and JIT application (H₁) and between managers' use of the ICT and MAS information (H₂) were significant and positive, we argue that at least part of the relationship between JIT application and managers' use of ICT is indirect, existing via their use of the MAS information

(Bartol, 1983; Pedhazur, 1982). One explanation for the result is that JIT application is positively associated with managers' use of the MAS information, which in turn is positively associated with the use of ICT.

Just like other studies in field settings, the following limitations to this study are worth mentioning. First, the study was limited to the manufacturing industries. Given that JIT is also applicable in service organisations having different cost structures, future research investigating associations of JIT application with the use of MAS information, and ICT in service organisations would be beneficial. Second, although extensive care was taken in devising measures for the variables, there are rooms for improvement. For instance, in addition to assessing the JIT application under the six key aspects, data on the period for which the aspects had been in practice in the respective BUs prior to the study would have made the results more informative. Finally, while organisation size has been included as a control variable in testing the hypotheses, there are other possible missing variables such as level of competition that might account for greater use of the MAS information, and ICT in JIT environment. Future studies would benefit from including such variable(s).

Given the above limitations, the results of the study have implications for theory and practice. The study, by offering empirical support for theoretical inference on managerial use of the MAS information and ICT in JIT environments, makes a modest contribution towards improving understanding of the accounting and information technology interfaces. Granlund (2007) for instance argues that the accounting academia has in general a limited understanding of the current developments in the accounting and information technology interfaces. This knowledge gap has important implications for what should be studied in the area and how. The study provides empirical support for the view that organisations' manufacturing strategies (e.g., JIT application) stimulate needs for managers' use of the MAS information and that ICT can help the managers to make an effective use of the information. In other words, use of MAS and ICT in an organisation co-exist and complement each other. Indeed, Macintosh (1985, pp. 3-7) argues that like the plumbing system in a house, MAS provides hot and cold water while IT provides the pipes and plumbing. Macintosh's 'hot and cold water' can be interpreted as broad scope MAS information and 'pipes and plumbing' as hardware and software.

One implication for practice is that an organisation that plans to implement a manufacturing strategy like JIT may perform better if it concurrently upgrades or modifies its MAS and ICT facilities to meet its managers' information needs. Also, organisations that apply JIT, could appropriately design MAS and ICT to identify and meet managers' information needs as they emerge.

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Figure 1: The Model

Table 1
Descriptive Statistics and Correlation

Variables	Mean	Std.dev	Correlation		
			1	2	3
1. JIT application	5.20	1.02	1.00		
2. Use of the MAS information	5.29	1.56	0.29	1.00	
Use of ICT	4.50	1.13	0.17	0.30*	1.00

Table 2

The results of regressing managers' use of broad scope MAS information against JIT application (controlling for BU size)

Variables	Coefficient (β) Value	t-value	Signif.Level p <
BU size (β_2)	0.02	0.21	0.84
JIT application (β_1)	0.29	2.58	0.01
R. Square = 8.54%; Adjusted R. Square = 6.03%; $F_{2,73} = 3.41$; $P=0.04$			

Table 3

The results of regressing managers' use of ICT against their use of broad scope MAS information and JIT application (controlling for BU size).

Variables	Coefficient (β) Value	t-value	Signif.Level p <
BU size (β_3)	0.22	2.05	0.04
MAS informatn use (β_2)	0.28	2.44	0.02
JIT application (β_1)	0.11	0.94	0.35
R. Square = 14.60%; Adjusted R. Square = 11.05%; $F_{3,72} = 4.10$; $P=0.01$			

Appendix A

Panel 1: JIT application measure

The BU general managers were asked to assess the extent to which their BU applied JIT under each of the six items.

1. Set-up time is the time taken to prepare a machine or a manufacturing cell for production. In your opinion, the extent of set-up time reduction achieved within your business unit is (please cross one number on the scale below for your answer):							
Very low	1	2	3	4	5	6	7 very high.
2. Equipment layout flexibility is the ease of adjusting machines layout on factory floor to facilitate production to order. In your opinion, the equipment layout flexibility within your business unit is (please cross one number on the scale below for your answer):							
Very low	1	2	3	4	5	6	7 very high.
3. Preventive maintenance is scheduled maintenance to prevent, rather than fix, machine breakdowns. In your opinion, the extent of preventive maintenance procedures implemented by your business unit is (please cross one number on the scale below for your answer):							
Very low	1	2	3	4	5	6	7 very high.
4. Manufacturing flexibility is the capability of production facilities to manufacture goods to order (i.e., to suit customer needs such as volume, size, and cut). In your opinion, the flexibility of production facilities within your business unit is (please cross one number on the scale below for your answer):							
Very low	1	2	3	4	5	6	7 very high.
5. Supplier relationship is the development and maintenance of long-term relationships with suppliers involving them in the planning and quality improvement process. In your opinion, your business unit's supplier involvement in planning quality improvement is (please cross one number on the scale below for your answer):							
Very low	1	2	3	4	5	6	7 very high.
6. Kanban is an approach to pull production through the factory based on customers' demand for finished goods; it is a signal to authorise production when needed. The kanban may be a card, an empty container with attached card, a computer record or an empty vehicle. In your opinion, the extent of your business unit's use of kanban is (please cross one number on the scale below for your answer):							
Very low	1	2	3	4	5	6	7 very high.

Panel 2: Managers' use of broad scope MAS information measure

The BU general managers were asked to indicate using the scale the extent to which they used the MAS information for their work-related decision-making.

1. To what extent do you use the MAS information (provided by your organization's management accounting system) relating to your business unit's budgeted production, costs, wastage, defects, capacity utilization, sales, inventory levels, and profits? Please cross one number on the scale below for your answer.
Not at all. 1 2 3 4 5 6 7 to a great extent.
2. To what extent do you use the MAS information (provided by your organization's management accounting system) on achievement of your business unit's budgeted production, costs, wastage, defects, capacity utilization, market share, sales, inventory levels, and profits? Please cross one number on the scale below for your answer.
Not at all. 1 2 3 4 5 6 7 to a great extent..
3. To what extent do you use the MAS information (provided by your organization's management accounting system) related to your business unit's production activities such as output rates, scrap levels, machine efficiency? Please cross one number on the scale below for your answer.
Not at all. 1 2 3 4 5 6 7 to a great extent..
4. To what extent do you use the MAS information (provided by your organization's management accounting system) related to overall actual performance trend of your business unit and the industry? Please cross one number on the scale below for your answer.
Not at all. 1 2 3 4 5 6 7 to a great extent.
5. To what extent do you use the MAS information (provided by your organization's management accounting system) related to your business unit 's product markets such as customer preferences, market size, growth in market share, economic conditions, population growth, technological developments? Please cross one number on the scale below for your answer.
Not at all. 1 2 3 4 5 6 7 to a great extent..
6. To what extent do you use the MAS information (provided by your organization's management accounting system) related to your business unit's employee attitudes, labour relations, attitudes of government and consumer bodies, competitive threats? Please cross one number on the scale below for your answer.
Not at all. 1 2 3 4 5 6 7 to a great extent..

Panel 3: Managers' use of information and communication technology (ITC) measure
The BU general managers were asked to indicate using the scale the extent to which they used
the following information technology.

1. To what extent do you use e-mail to communicate or exchange work-related information with others within your firm? Not at all. 1 2 3 4 5 6 7 To a great extent.
2. To what extent do you use computer network to access work-related information and data from within your firm? Not at all 1 2 3 4 5 6 7 To a great extent.
3. To what extent do you use Internet (external networks) to communicate with suppliers, customers and other relevant entities that are external to your firm? Not at all 1 2 3 4 5 6 7 To a great extent.
4. To what extent do you use Internet to communicate or exchange information with parties (creditors, investors, gov't agencies) external to your firm? Not at all 1 2 3 4 5 6 7 To a great extent.

Appendix B

Items	JIT	MAS	ICT
	Factor Loadings	Factor Loadings	Factor Loadings
1	0.75	0.77	0.73
2	0.79	0.71	0.69
3	0.69	0.69	0.69
4	0.70	0.78	0.67
5	0.65	0.82	
6	0.69	0.83	
Eigen value (% of variance explained)	3.03 50.60	3.55 59.20	1.94 48.50