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Abstract

This study examines joint effects of stretch target costs and concurrent processes on cost reduction. There is no consensus in previous research about cost-reduction effects of their joint use. This study builds on the dynamic tension perspective, which has been developed in the management control literature. Specifically, this study assumes that concurrent processes enhance cost reduction through the structure of stretch target costs that act as a shared objective for managers. Furthermore, using stretch target costs under concurrent processes triggers new idea generation among managers who have different viewpoints. Their joint use is accompanied by tensions among multiple design targets or different departmental managers, and it enhances cost reduction if tensions are dynamic or creative. Multiple regression analysis for large

Japanese manufacturing firms is conducted, but no statistically meaningful relationship can be found. Further analysis, which divides the sample into assembly and process industries, shows that their joint use enhances cost reduction for firms belonging to process industries. Moreover, ad hoc analysis shows that concurrent processes enhance cost reduction when target costs have set stretch levels. These results are interpreted from several aspects. For example, the results reflect the characteristics of Japanese process industries that manufacture products of high quality and technology. This study extends previous research about the cost reduction-effects of the joint use of stretch target costs and concurrent processes by building on the dynamic tension perspective. In addition, this study extends the existing literature by providing the possibility of the effectiveness of target cost management in process industries.

Keywords
Target cost management, Dynamic tension perspective, Stretch target costs, Concurrent processes, Cost reduction, Cross-industry analysis

1. Introduction

Cost competitiveness is one way to gain competitive advantage (Porter, 1980). One means to achieve effective cost reduction is to manage costs in the product development stage. Larger profits can be gained by managing these costs at an early stage of product development, such as product planning or design, because most product costs are determined when specification of products are determined (Drury, 2012).

Japanese manufacturing firms manage costs under the product development stage by using target cost management (TCM) (Ansari et al., 2007; Hiromoto, 1988; Kato, 1993b; Tani et al., 1994). TCM refers to a system of profit planning and cost management at the earliest stages of product development. Given that the market determines product prices, TCM is used to gain larger profits by effective cost management at these stages (Sakurai, 1989). Since Toyota developed TCM in the 1960s, it has spread not only to assembly industries, such as transportation equipment and electrical machinery, but also to process-oriented industries (Ansari et al., 2007; Tani et al., 1994).

One characteristic of TCM in Japan is that stretch levels of target costs that are very difficult to achieve. Target costs are calculated from expected sales prices less target profit (Kato, 1993b). When price competition becomes intense, the market determines sales prices. In this situation, firms need to manage costs effectively to earn expected profits. Japanese manufacturing firms, especially those in assembly industries, have attempted to set target costs at levels that are very difficult to achieve in order to gain larger profits (Sakurai, 1989; Tani et al., 1994). Furthermore, these target costs that are very difficult to achieve contribute to drastic cost reduction in Japan (Kato, 1993a; Tani et al., 1993a).

Although setting stretch target costs is an important step for TCM, it is difficult to realize effective cost reduction without any support tools. Prior studies indicate that concurrent processes may play a role (Iwabuchi, 1992; Koga & Davila, 1999). Concurrent processes mean overlapping and parallel processes by which various departmental managers are involved in product development (Carter & Baker, 1992; Takeuchi & Nonaka, 1986). Concurrent processes contribute to effective new product development by significantly shortening the time to market and realizing high productivity in Japanese manufacturing firms (Clark & Fujimoto, 1991).

Previous research provides the possibility that joint use of stretch target costs and concurrent processes enhances cost reduction; however, empirical evidence to support this possibility is scarce and inconsistent. Specifically, the Japanese TCM literature suggests that their joint use enhances cost reduction (Iwabuchi, 1992; Koga & Davila, 1999). On the contrary, Gopalakrishnan et al.'s (2015) experimental study based on goal-setting theory suggests that their joint use is ineffective for cost reduction, because overlapping processes unexpectedly change product specifications or design readjustment. As a result, costs might increase.

Based on the abovementioned research, this study aims to examine the joint effects of stretch target costs and concurrent processes on cost reduction. In order to explain their joint effects, this study uses the dynamic tension perspective developed in the management control literature (Chenhall & Morris, 1995; Henri, 2006). This perspective is developed to explain why highly innovative firms combine organic processes with formal control systems, although prior research based on contingency theory assumes their combined use is inconsistent or paradoxical (Chenhall, 2006). The dynamic tension perspective assumes that formal control systems can support the translation of ideas that are generated from organic processes into effective innovation that is consistent with organizational objectives. Furthermore, new information, ideas, and strategies that are developed via organic processes can be monitored effectively by formal controls. Tensions accompany the joint use of formal control systems and organic processes, although they act complementarily and their interaction enhances organizational performance if tensions are dynamic or creative (Chenhall & Morris, 1995; Henri, 2006). Regarding the objective of this research, it can be assumed that the joint use of stretch target costs and concurrent processes is accompanied by tensions among multiple design targets or different departmental managers. However, it can be said that the tensions caused by joint use are dynamic or creative if they enhance cost reduction (Chenhall & Morris, 1995; Henri, 2006).

Using multiple regression analysis with survey data from large Japanese manufacturing firms, a statistically meaningful relationship between the joint effects and cost reduction cannot be found by the full sample analysis. However, the following sub-group analysis based on assembly and process-oriented industries shows that the joint effects enhance cost reduction for firms in process industries. Moreover, ad hoc analysis for firms in process industries indicates that concurrent processes enhance cost reduction when target costs are set at high stretch levels. These findings can be interpreted from several aspects. For example, the results reflect the characteristics of Japanese process industries that manufacture products of high quality and technology (Fujimoto & Kuwashima, 2009).

This study contributes to the growing body of TCM literature. The study theoretically explains how and why joint use of stretch target costs and concurrent processes enhances cost reduction. Contrary to Gopalakrishnan et al.’s (2015) study based on goal-setting theory, this study, using a dynamic tension perspective, assumes they have positive effects on cost reduction. The dynamic tension perspective used in this study is useful for explaining the dynamic nature of TCM activities that accompany tensions or conflicts on performance, which has not been examined sufficiently (Ansari et al., 2007).

In addition, the current study provides empirical evidence about their interaction effects, which are suggested mainly theoretically by prior studies. Contrary to the expectations of this study, a statistically meaningful relationship cannot be found using the full sample analysis. However, the expected results can be obtained using subgroup analysis along industry division. These results could indicate that different methods of cost reduction are needed by assembly and process industries because of maturation or sophistication of TCM, such as database or knowhow. The results of this study are important because the differences regarding TCM practices between these industries are not well known.

The remainder of this paper is structured as follows. Section 2 provides a theoretical model of dynamic tension for TCM and introduces the hypothesis. Section 3 presents the data collection and variable measurement. Section 4 presents the analyses and results. Section 5 interprets the results. Finally, section 6 provides the conclusions, limitations, and implications for future research.

2. Theory and hypothesis

This section presents a literature review of the development of the dynamic tension perspective, stretch target costs, concurrent processes. Subsequently, hypothesis about the effects of the joint use of stretch target costs and concurrent processes on cost reduction is developed.

2.1 Dynamic tension perspective

The dynamic tension perspective is useful for explaining the joint effects of stretch target costs and concurrent processes on cost reduction. This perspective has been developed as disproof against the perception of inconsistency among formal control systems and innovation.

Traditionally, formal control systems are characterized as mechanistic because they aim to measure deviations, focus on unfavorable variances, and implement corrective actions to achieve preset performance targets (Anthony, 1965). Behavior that pursues innovation is accompanied by uncertainty about the causal relationship between managers' efforts and performance. In this situation, formal control systems inhibit innovation because they force managers to focus on short-term performance targets and new idea generation that will contribute to future performance. Hence, it has been considered that formal control systems are inconsistent with innovation (Abernethy & Brownell, 1997; Rockness & Shields, 1984).

Contrary to traditional theory, Simons (1987) empirically finds that highly innovative firms use formal control systems more than conservative firms do. Although this result seems to be inconsistent with prior studies, he interprets this result from the viewpoint of types of controls. Later, he classifies two types of controls: diagnostic and interactive (Simons, 1995). Diagnostic control is similar to traditional mechanistic type of control that aims to measure deviations and to implement corrective actions to achieve preset performance targets. By contrast, interactive control is an organic type of control that enables employees to search for new opportunities, stimulate dialogue, and generate ideas for the enhancement of organizational learning or the emergence of new strategy (Simons, 1995). Interactive control is characterized as positive lever of control and is useful in a highly uncertain environment in which strategic change and innovation are highly needed (Abernethy & Brownell, 1999; Bisbe & Otley, 2004).

Since the use of control systems has been classified, empirical research has been undertaken to examine the performance effects of tensions created by joint use of opposing types of controls (Chenhall & Morris, 1995; Henri, 2006; Widener, 2007). The combined use of formal control systems and organic processes that pursue organizational learning or innovation seems to be inconsistent or paradoxical from a traditional view, as mentioned above. On the contrary, the dynamic tension perspective, developed based on Simons's (1987) study, assumes that their joint use brings benefits rather than disadvantages. Specifically, this perspective assumes that formal control systems can support the translation of ideas that are generated from organic processes into effective innovation that is consistent with organizational objectives. Furthermore, new information, ideas, and strategies that are developed by organic processes can be monitored effectively by formal (diagnostic) controls. As a result, joint use of formal control systems and organic processes stimulates dynamic or creative tensions that enhance innovation, organizational learning, and ultimately, organizational performance (Chenhall & Morris, 1995; Henri, 2006; Widener, 2007). In addition, later studies support the certainty of this perspective by confirming the positive effects of the joint use of opposing types of controls on product development or project performance (Bedford, 2015; Ylinen & Gullkvist, 2014). Based on this perspective, tensions that are created by the joint use of control systems are dynamic or creative if it enhances performance (Henri, 2006)[1].

2.2 Stretch target costs

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[1] Henri (2006, p.533) explains the notion that "dynamic tensions denote contradictory but interrelated elements." (Lewis, 2000) In addition, Henri (2006, p.534) points out that "the notion of dynamic tension is not necessarily new in the academic literature, and is related to other terms such as conflict, paradox, dilemma, and contrast." (English, 2001)

The formula to calculate target cost is “Target Cost = Expected Sales Price − Target Profit.” (Kato, 1993b) Theoretically, the expected sales price is driven by the marketplace and target profit is determined by organizational medium- or long-term profit planning (Kato, 1993b; Sakurai, 1989).

In calculating target costs from the expected sales price, one aspect of the characteristics of the equation reflects customer orientation (Cooper & Slagmulder, 1997). As the market environment becomes more competitive, the market comes to determine the price of products and thereby, firms have to set almost the same price as their competitors do. In this situation, Japanese manufacturing firms use a pricing method called “pricing by functions.” (Kato, 1993b, p.38) Specifically, products consist of many functions and the total values of each function come to determine the sales price (Kato, 1993b). In order to manage costs effectively, firms need to exclude excessive functions completely from the viewpoint of customer needs (Kato, 1993b; Sakurai, 1989).

The other aspect of the characteristics of the equation is the strong linkage between profit planning and target costs. Because of this linkage, target costs come to mean the commitment agreed upon by every person who participates in TCM activities (Kato, 1993b). At the beginning of TCM practices, when they are not mature, specific products are linked to profit planning. Later, as more TCM activities become mature, profit planning comes to be linked not only to specific products but also to all products. In other words, target costs are calculated from how much each product contributes to organizational profit (Kato, 1993b).

The level of target costs that are calculated via the abovementioned processes tends to be very difficult to achieve in Japan (Hiromoto, 1988; Kato, 1993b; Tani et al., 1994). Stretch target costs cannot be achieved using the current way of thinking or capabilities. It requires substantial effort to accompany the new way of thinking. A level that is very difficult to achieve seems to be inconsistent with goal-setting theory, which suggests that challenging but achievable goals are desirable to enhance goal commitment, which would contribute to desirable performance (Locke & Latham, 1990). However, prior studies suggest stretch target costs contribute to drastic cost reduction in Japan (Kato, 1993b; Koga & Davila, 1999; Tani et al., 1993a). For example, Tani et al. (1993a) find that tightness of target costs is positively correlated with their achievement. Similarly, Koga and Davila (1999) find that the more stretch target costs are difficult to achieve, the more actual costs are reduced.

2.3 Concurrent processes

The traditional approach to new product development is sequential engineering, known as “throwing it over the wall,” which focuses on developing a structured process with clearly defined and sequential phases (Takeuchi & Nonaka, 1986). Each department that participates in product development, such as product planning, development, design, production preparation, and manufacturing, acts independently. The sequential processes take a long time to develop and carry the risk of creating problems on cost or quality for the later stage of product development (Takeuchi & Nonaka, 1986).

Concurrent processes are completely different from the traditional approach. Concurrent processes, also called “rugby-style product development” or “simultaneous engineering,” are characterized by the involvement of the managers of each department as a cross-functional team in product development processes (Carter & Baker, 1992). The overlapping and parallel processes by which various functional managers are involved in the early stage of the project significantly shorten the time to market and contribute to high productivity and performance in Japanese manufacturing firms (Clark & Fujimoto, 1991; Takeuchi & Nonaka, 1986).

Previous research indicates that concurrent processes are a key component of TCM activities (Tani, 1996; Tani et al., 1993b). Tani et al. (1993b) provide two features of concurrent processes for TCM. The first is that drastic cost reduction cannot be realized without cooperation among cross-functional engineers. The second is that collaboration among cross-functional managers brings creative ideas into product development compared to interaction among members belonging to the same departments. The co-operation of various managers before drawing up a blueprint triggers many creative ideas, because there are many options for cost reduction. Furthermore, sharing different kinds of thoughts or ideas triggers new idea generation that will contribute to cost reduction. These suggestions are empirically supported by Yoshida (2003), who finds that interaction among managers from different departments is more effective for cost reduction than the performance effect of each tool used for TCM.

2.4 Joint effects of stretch target costs and concurrent processes on cost reduction

Some studies aim to explain cost-reduction effects caused by the joint use of stretch target costs and concurrent processes. Shimizu (1992a) focuses on the role of target cost information in TCM activities. Based on knowledge-creation theory

(Nonaka, 1990), Shimizu (1992a) theoretically explains how tightness of target costs encourages or discourages knowledge-creation activities for each individual. Shimizu (1992a) explains that as long as the tightness of a cost target is well managed, participants can understand existing solutions or previous experiences that contribute little to meet the target, and then, can begin to seek new solutions. Subsequently, Shimizu (1992b) attempts to extend his previous discussions about the role of target cost information at the individual level to the group level. He identifies the roles of target cost information as a catalyst for the transmission of knowledge and information. That is, as target cost information acts as commonly shared objectives for each individual or team, it becomes easier to drive team efforts, horizontal and vertical interaction, and cross-functional activities. As a result, existing solutions or previous experiences are rejected and new solutions are developed. Similarly, Iwabuchi (1992) focuses on the role of shared information among departments using a case study. He explains that shared information leads to cooperative efforts among different functions, and then, the collection of expertise and professional experience and knowledge turns into unique solutions. Furthermore, Koga and Davila (1999) provide the possibility that stretch target costs initiate intensive interactions between product and process engineers, as well as frequent monitoring of the gap between the target and cost estimate. Then, target costs act as a catalyst for organizational leaning among managers and contribute to good actual performance.

Contrary to the abovementioned studies, Gopalakrishnan et al.'s (2015) experimental study based on goal-setting theory explains that using specific goals under concurrent processes is less effective for cost reduction than doing so under sequential processes. The authors assume the effects of specific target costs that can tell managers how to achieve targets decrease under concurrent processes, because they enhance task uncertainty. Because of this task uncertainty, change or readjustment of design increases and ultimately enhances costs. However, their study ignores the dynamics in TCM activities that promote knowledge-creation by using specific target costs under concurrent processes.

Cost-reduction effects of joint use of stretch target costs and concurrent processes can be explained from the dynamic tension perspective. Building on this perspective, two notions—stretch target costs and concurrent processes—can be regarded as formal control systems and organic processes, respectively. Specifically, it can be assumed that concurrent processes enhance cost reduction through the structure of stretch target costs that act as a shared objective (Chenhall & Morris, 1995; Henri, 2006; Shimizu, 1992b; Widener, 2007). Furthermore, setting stretch target costs not only triggers new knowledge by creating a chaotic environment at the individual level but also enhances new idea generation at the group level through cooperation among individuals that have different viewpoints (Iwabuchi, 1992; Koga & Davila, 1999; Shimizu, 1992b). Based on this perspective, it can be assumed that joint use of stretch target costs and concurrent processes is accompanied by tensions among multiple design targets or different departmental managers. However, it can be said that the tensions caused by joint use are dynamic or creative if it enhances cost reduction (Chenhall & Morris, 1995; Henri, 2006). From the above, the following hypothesis is developed.

Hypothesis. The joint use of stretch target costs and concurrent processes enhances cost reduction.

3. Method

3.1 Data collection

A cross-sectional questionnaire survey was undertaken among large Japanese manufacturing firms. Japanese manufacturing firms are appropriate as respondents because the hypothesis of this study is developed based on Japanese TCM practices and literature. Questionnaires were mailed to executive officers or directors of firms' accounting departments. Accounting managers are appropriate as respondents because it can be assumed that they know TCM practices well. Specifically, previous research indicates that accounting managers in Japan frequently participate in cost meetings (Tani, 1995; Tani et al., 1994). Furthermore, there are many instances in which the TCM office is located within the accounting department (Kato, 1993a; Okano & Suzuki, 2007).

The questionnaire was sent to 847 manufacturing firms that are listed on the First Section of the Tokyo Stock Exchange in January 2014. The survey period lasted about two weeks. In total, 130 firms responded and the overall response rate was 15.3%. The final sample for analysis comprises 98 firms after removing those firms that do not use TCM and samples containing missing data. Table 1 shows the details of the response rate of the questionnaire survey.

Several tests to assess nonresponse bias were conducted. First, tests were undertaken to examine differences in sales and employment between responding and nonresponding firms. Although the mean of employment was larger for responding firms than for nonresponding firms (t= 2.005, p= .047), there were no statistically significant differences in sales (t= 1.453, p= .146). Next, tests were undertaken to compare early versus late respondents on organizational size. The results indicate no statistically significant differences in sales (t= .016, p= .987) and employees (t= −1.136, p= .258).

Finally, tests were undertaken to compare early versus late respondents on all variables used in this research. As a result, there are no significant differences in any variables (p> .10). Hence, it seems that there is no serious nonresponse bias.

Table 1. Sample characteristics

Industry	Sent	Valid response/rate (%)		Sample
Assembly industry				52
Machinery	120	12	10.0	10
Electrical/electronics	154	27	17.5	25
Transportation equipment	62	16	25.8	15
Precision equipment	28	2	7.1	2
Process industry				46
Food	69	13	18.8	10
Textile mill	41	4	9.8	4
Pulp/paper	11	2	18.2	2
Chemical	128	18	14.1	13
Pharmaceuticals	38	5	13.2	4
Oil/ coal	11	1	9.1	0
Rubber	11	2	18.2	1
Glass/ clay	33	4	12.1	3
Steel	32	4	12.5	3
Non-ferrous/non-fabricated metal	24	4	16.7	2
Fabricated metal	37	8	21.6	4
Other manufacturing	48	8	16.7	0
Total	847	130	15.3	98

3.2 Variable measurement

3.2.1 TCM usage, stretch target costs, concurrent processes, and cost reduction

First, respondents were asked whether their business unit uses TCM. It is possible that firms or business units use similar techniques to TCM, without realizing they are using TCM (Dekker & Smidt, 2003). In order to examine whether they use

TCM, a general idea of TCM should be provided (Dekker & Smidt, 2003). Specifically, respondents were asked whether their business units implement the setting or managing of target costs at product planning, development, and design stages of new product development (yes or no). Respondents who answered "yes" were required to answer other questions regarding TCM practices.

The survey constructs of stretch target costs and concurrent processes were composed of one instrument each, as follows. The question of stretch target costs (*STC*) relates to the extent of difficulty in achieving target costs, and is as follows: "Are target costs set at a challenging level that cannot be achieved easily at the starting point of product development processes?" The question of concurrent processes (*CP*) is as follows: "Are design engineers as well as many related cross-functional members involved in product development processes?" These two items were measured on Likert scales of 1–7, where 1 indicates "not at all" and 7 indicates "absolutely correct."

The joint use of stretch target costs and concurrent processes was measured by their product term. Prior to the formation of the product term, two independent variables were mean-centered because the product term is strongly correlated with each independent variable.

Cost reduction as a dependent variable was measured by the effectiveness of TCM activities in cost reduction. Respondents were asked to rate the effectiveness of TCM tools in cost reduction on a scale of 1–7, where 1 indicates "not effective" and 7 indicates "very effective."

3.2.2 Control variables

Environmental complexity and uncertainty moderate the relationship between TCM elements and performance (Yoshida, 2001). In order to measure the potential impact of TCM elements on cost reduction, the effects of these environmental factors should be controlled. Tani's (1995) items are used because they are suitable for examining business environments in Japan. The items for environmental complexity are degree of diversity of product market (*Diversity*), community of technology with competitors (*Community*), and variety of sales promotion (*Variety*). The items for environmental uncertainty are degree of competitiveness of product market (*Competitiveness*), frequency of developing new product and technology (*Frequency*), and inaccuracy of estimating customer demand (*Inaccuracy*). Respondents were asked to rate their perceived environmental complexity and uncertainty on a scale of 1–7, where 1 indicates "very predictable" and 7 indicates "very unpredictable."

In addition, organizational size (*Size*) is included. Organizational size is measured by the natural logarithm of sales in 2013.

4. Results

4.1 Descriptive statistics and variable correlation

The descriptive statistics of the survey constructs are presented in Table 2 and the correlation matrix is presented in Table 3. In this sample, 107 firms (82.7%) use TCM. Considering that the adoption rate of TCM in 1991 was about 60.6% (Tani, 1995), the results of this study suggest that TCM has spread widely to Japanese manufacturing firms in the last 25 years, as explained by Ansari et al. (2007). Variable correlation in Table 3 shows positive correlation coefficients of *STC* and *CP*, which are statistically significant (r= .257, p= .011). This result indicates they are used complementarily. Furthermore, both are positively correlated with cost reduction (r= .352, p= .000 and r= .344, p= .001, respectively). The positive correlation between *STC* and cost reduction is consistent with the results of Tani et al. (1993a), which show correlation between tightness of target costs and achievement of target costs. In addition, positive correlation between *CP* and cost reduction is consistent with the previous literature suggesting or confirming that interaction among various functional managers is effective for cost reduction (Tani et al., 1993b; Yoshida, 2003).

Table 2. Descriptive statistics of variables

		Mean	SD	Min	Max
1.	Stretch target costs (*STC*)	3.73	1.36	1	7
2.	Concurrent processes (*CP*)	5.23	1.28	2	7
3.	Diversity of product market (*Diversity*)	3.77	1.57	1	7
4.	Community of technology with competitors (*Community*)	3.51	1.22	1	6
5.	Variety of sales promotion (*Variety*)	3.85	1.41	1	7
6.	Competitiveness of product market (*Competitiveness*)	5.17	.91	2	7
7.	Frequency of developing new product and technology (*Frequency*)	4.69	1.33	2	7
8.	Inaccuracy of estimating customer demand (*Inaccuracy*)	3.86	1.14	2	6
9.	Organizational size (*Size*)	5.27	.63	3.93	6.99
10.	Cost reduction	5.17	1.18	2	7

Table 3. Variable correlation

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	*STC*	1									
2.	*CP*	.257*	1								
3.	*Diversity*	-.049	-.044	1							
4.	*Community*	-.036	-.058	.294**	1						
5.	*Variety*	.183†	-.037	.351***	.142	1					
6.	*Competitiveness*	.013	.134	.130	-.053	.069	1				
7.	*Frequency*	.006	.195†	.232*	.307**	.283**	.318**	1			
8.	*Inaccuracy*	-.011	-.048	.160	.016	.083	.203*	-.036	1		
9.	*Size*	.224*	.261**	.087	.030	.123	.226*	.391***	-.191†	1	
10.	*Cost reduction*	.352***	.344***	-.011	-.070	.091	.000	.173†	-.066	.246*	1

Notes: $^{\dagger}p<.1$, $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$ (two-sided test).

4.2 Hypothesis test

In order to examine the joint effects of stretch target costs and concurrent processes on cost reduction, multiple regression analysis is performed. In this study, two models are set. Specifically, model 1 includes the main effect of *STC* and *CP*. In addition, control variables are included. In model 2, the joint effect term of *STC* and *CP* is included.

It should be noted that small sample size reduces the statistical power of the tests. The sample size of 98 firms in this study is small relative to previous management accounting research (Van der Stede et al., 2005). Because of the small sample size, there is a greater possibility of a type-2 error occurring (this error occurs when the false null hypothesis is not rejected). In order to increase statistical power, this study follows Lindsay's (1993) recommendation to increase the significance level to .10. This approach is also adopted by a related study, Dekker and Smidt (2003).

Table 4 summarizes the estimation results of the multiple regression analysis. In model 1, a positive coefficient of *STC* and *CP* on cost reduction is found ($\beta= .313$, $p= .011$ and $\beta= .273$, $p= .025$, respectively). In model 2, which introduces the joint effects term of *STC* and *CP*, the coefficient is not statistically significant ($\beta= -.087$, $p= .487$). Furthermore, the change in the coefficient of determination (R^2) is not statistically significant ($\Delta R^2= .004$, $\Delta F^2= .488$, $p= .487$). This result indicates that the explanatory power might not change significantly when the joint effect term is not added. Hence, it cannot be said that the joint use of *STC* and *CP* enhances cost reduction by the full sample analysis.

Table 4. Estimation results of multiple regression analysis for full sample

	Model 1		Model 2	
	Coefficient	90% CI	Coefficient	90% CI
STC	.313*	[.11, .51]	.339**	[.13, .55]
CP	.273*	[.07, .47]	.252*	[.05, .46]
*STC*CP*			−.087	[−.29, .12]
Controls				
Diversity	.012	[−.20, .22]	.024	[−.19, .24]
Community	−.126	[−.33, .08]	−.145	[−.36, .07]
Variety	.020	[−.19, .23]	.019	[−.19, .23]
Competitiveness	−.139	[−.36, .08]	−.129	[−.35, .10]
Frequency	.182	[−.05, .42]	.161	[−.08, .40]
Inaccuracy	−.010	[−.20, .18]	−.023	[−.22, .17]
Size	.167	[−.17, .51]	.175	[−.17, .52]
Intercept	4.290***		4.268***	
R^2	.231		.235	
Adj. R^2	.152		.147	
ΔF			.488	

Estimated with ordinary least squares. CI means confidence interval. *P*-values are two-sided tested. Unstandardized. *$p<.05$, **$p<.01$, ***$p<.001$. VIF< 2.0.

4.3 Supplementary analysis

Next, subgroup analysis is performed. The whole sample is divided by industry: assembly and process industries. The reason that industry as a sub-group is selected is that differences in the maturation or sophistication of TCM between assembly and process industries seem to create differences in TCM elements on performance[2]. In

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[2] TCM was first developed in assembly industries, such as machinery, electric appliances, transportation equipment, and precision instruments (Monden & Hamada, 1991; Sakurai, 1989; Tanaka, 1995). These firms faced diversified customer needs and shorter product life cycles from the 1980s, and thus, they had to develop numerous

order to examine the cost-reduction effects of the joint use of *STC* and *CP*, samples are divided by classification table of industries developed by the Securities Identification Code Committee of the Japan Exchange Group[3].

Table 5 shows the descriptive statistics of variables in the assembly and process industries. The mean scores of variables for TCM practices (*STC*, *CP*, and *Cost reduction*) are higher for firms in assembly industries than for firms in process industries. In particular, the mean differences for *STC* and *Cost reduction* are statistically significant (t= 2.41, p= .018, t= 2.66, p= .009, respectively). Furthermore, *Frequency* is higher for firms in assembly industries (t= 2.33, p= .022). Hence, it can be said that firms in assembly industries are required to develop new products more frequently, use TCM tools more often, and achieve cost reduction more than are firms in process industries. Therefore, it can be said that TCM practices are matured for firms in assembly industries compared to firms in process industries, only with respect to *STC, CP,* and *Cost reduction*.

Table 6 shows the variable correlation in assembly industries (Panel A) and process industries (Panel B). The results show that correlation between *STC* and *CP* is not statistically significant in assembly industries (r= .186, p= .187); however, *STC* and *CP* are positively correlated in process industries (r= .308, p= .037). These results indicate the possibility that the relationship between *STC* and *CP* is complementary in firms in process industries.

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products with quite different characteristics (Sakurai, 1989). In order to simultaneously achieve low-cost, high-quality products that are introduced timeously in accordance with changing customer needs, it is necessary to manage costs in the early stages of product development processes. Therefore, TCM has matured in assembly firms but is only developing in processing firms (Okano & Suzuki, 2007).

[3] The test is conducted to examine differences in industry distribution in this sample and in the First Section of Tokyo Stock Exchange. The results indicate there are no statistically significant differences in industry distribution between respondents and firms belonging to the First Section of the Tokyo Stock Exchange (χ^2= 11.821, df= 15, p= .693). Hence, the industry distribution of the sample of this study is representative of the First Section of the Tokyo Stock Exchange.

Table 5. Descriptive statistics of variables for firms in assembly and process industries

		Firms in assembly industries				Firms in process industries				
		Mean	SD	Min	Max	Mean	SD	Min	Max	Mean differences
1.	*STC*	4.04	1.40	1	7	3.39	1.24	1	7	.65*
2.	*CP*	5.35	1.15	3	7	5.11	1.40	2	7	.24
3.	*Diversity*	3.73	1.74	1	7	3.80	1.38	2	7	-.07
4.	*Community*	3.56	1.24	1	6	3.46	1.21	2	6	.10
5.	*Variety*	3.96	1.55	1	7	3.72	1.24	1	6	.24
6.	*Competitiveness*	5.25	.95	3	7	5.09	.87	2	6	.16
7.	*Frequency*	4.98	1.31	2	7	4.37	1.29	2	6	.61*
8.	*Inaccuracy*	3.92	1.17	2	6	3.78	1.11	2	6	.14
9.	*Size*	5.46	.62	4.22	6.99	5.05	.57	3.93	6.20	.41***
10.	*Cost reduction*	5.46	1.15	2	7	4.85	1.14	2	7	.61**

Notes: *$p<.05$, **$p<.01$, ***$p<.001$ (two-sided test).

Table 6. Variable correlation for firms in assembly and process industries

Panel A: Firms in assembly industries

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	*STC*	1									
2.	*CP*	.186	1								
3.	*Diversity*	−.197	−.168	1							
4.	*Community*	−.182	−.165	.415**	1						
5.	*Variety*	.164	−.058	.324*	.348*	1					
6.	*Competitiveness*	−.022	−.045	.101	−.004	.100	1				
7.	*Frequency*	−.118	−.009	.274*	.405**	.320*	.480***	1			
8.	*Inaccuracy*	−.034	.122	.163	.098	.129	.248†	.179	1		
9.	*Size*	.180	.253†	.084	.036	.113	.185	.284*	−.155	1	
10.	*Cost reduction*	.453***	.278*	.123	−.157	.154	.000	.163	.144	.245†	1

Panel B: Firms in process industries

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	*STC*	1									
2.	*CP*	.308*	1								
3.	*Diversity*	.202	.103	1							
4.	*Community*	.131	.036	.122	1						
5.	*Variety*	.175	−.033	.409**	−.164	1					
6.	*Competitiveness*	.009	.304*	.183	−.124	.003	1				
7.	*Frequency*	.033	.359*	.205	.189	.206	.090	1			
8.	*Inaccuracy*	−.018	−.226	.160	−.090	.003	.135	−.330*	1		
9.	*Size*	.130	.243	.128	−.007	.081	.242	.418**	−.315*	1	
10.	*Cost reduction*	.122	.388**	−.190	.003	−.047	−.054	.070	−.361*	.087	1

Notes: $^{\dagger}p$<.1, *p<.05, **p<.01, ***p<.001 (two-sided test).

Multiple regression analysis is conducted in order to examine the cost-reduction effects of the joint use of *STC* and *CP*. Panel A in Table 7 presents the estimation results for firms in assembly industries. The estimation results for model 1a indicate that *STC* enhances *Cost reduction* significantly (β= .494, p= .001). On the contrary, the main effect of *CP* on *Cost reduction* is not statistically significant (β= .180, p= .282). Model 2a shows no statistically significant relationship between the joint effect term and *Cost reduction* (β= −.256, p= .103). Hence, the expected results are not achieved for firms in assembly industries.

Panel B of Table 7 shows the estimation results for firms in process industries. Model 1b indicates that *CP* enhances *Cost reduction* significantly (β= .437, p= .020). On the contrary, a statistically significant relationship between *STC* and *Cost reduction* cannot be found (β= .020, p= .921). Model 2b indicates that the joint effect term is positively associated with *Cost reduction* (β= .384, p= .077). Furthermore, model 2b has greater explanatory power than Model 1b does because the increase of R^2 is statistically significant (ΔR^2= .062, ΔF^2= 3.322, p= .077). These results suggest that the joint use of *STC* and *CP* enhances *Cost reduction* for firms in process industries.

Table 7. Estimation results for firms in assembly and process industries

	Panel A: Firms in assembly industries				Panel B: Firms in process industries			
	Model 1a		Model 2a		Model 1b		Model 2b	
	Coefficient	90% CI	Coefficient	90% CI	Coefficient	90% CI	Coefficient	90% CI
STC	.494**	[.25, .74]	.539***	[.30, .78]	.020	[−.31, .35]	−.234	[−.63, .17]
CP	.180	[−.10, .46]	.199	[−.07, .47]	.437*	[.14, .74]	.667**	[.30, 1.03]
*STC*CP*			−.256	[−.51, .00]			.384 †	[.03, .74]
Controls								
Diversity	.278 †	[.04, .52]	.301*	[.06, .54]	−.229	[−.60, .14]	−.330	[−.70, .04]
Community	-.355*	[−.63, -.08]	−.378*	[−.65, -.10]	.010	[−.29, .31]	.194	[−.15, .53]
Variety	.003	[−.24, .25]	.033	[−.21, .28]	.088	[−.28, .46]	.238	[−.15, .62]
Competitiveness	-.262	[−.55, .03]	−.227	[−.51, .06]	−.130	[−.48, .22]	−.219	[−.57, .13]
Frequency	.387*	[.07, .71]	.329 †	[.01, .65]	−.168	[−.53, .19]	−.131	[−.48, .22]
Inaccuracy	.153	[−.09, .40]	.102	[−.14, .35]	−.311	[−.63, .01]	−.205	[−.53, .12]
Size	.161	[−.26, .58]	.169	[−.24, .58]	−.006	[−.57, .56]	−.022	[−.57, .53]
Intercept	4.379**		4.388**		4.922**		4.851**	
Observations (n)	52		52		46		46	
R^2	.418		.455		.289		.351	
Adj. R^2	.293		.322		.111		.165	
ΔF			2.779				3.322 †	

Estimated with ordinary least squares. CI means confidence interval. *P*-values are two-sided tested. Unstandardized. $^{\dagger}p$<.1, *p<.05, **p<.01, VIF< 2.5.

In order to examine the content of interaction, simple slope analysis is performed. Following Aiken and West (1991), the regression line on *CP* is estimated when *STC* takes ±1 standard deviation (SD)[4]. Figure 1 highlights the regression line on cost reduction.

The estimation results shown in Figure 1 indicate that *CP* enhances *Cost reduction* when *STC* is high (+1SD) (β= .748, *p*= .007). The coefficient of *CP* when *STC* is low (−1SD) is not statistically significant (β= .247, *p*= .247). Hence, the results suggest that the complementary use of *STC* and *CP* enhances *Cost reduction* for firms in process industries.

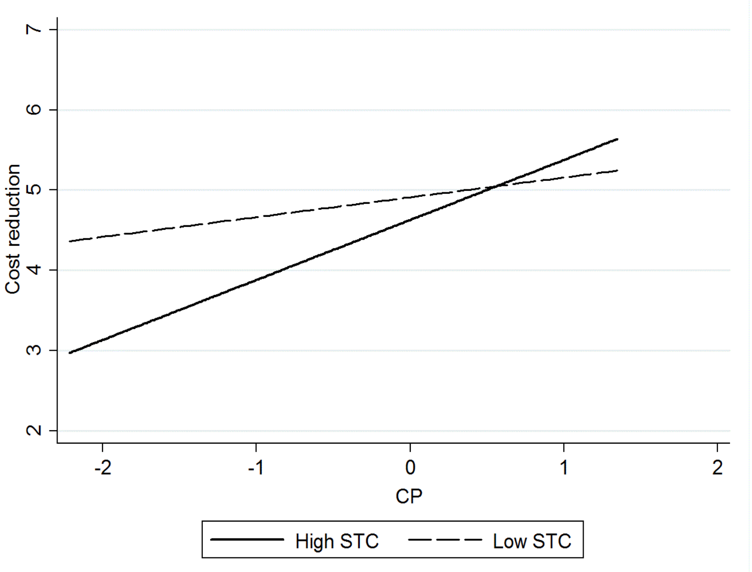

Figure 1. Interaction between *STC* and *CP* for firms in process industries

5. Discussion

The estimation results indicate that the joint use of stretch target costs and concurrent processes enhances cost reduction for firms in process industries. On the contrary, a statistically meaningful relationship cannot be found for the full sample and assembly firms. This section interprets these results.

In assembly industries, positive main effect of stretch target costs can be found; however, no significance can be found for concurrent processes and the interaction effect. These results can be explained by engineer's loss of autonomy or excess workload caused by excessive use of concurrent processes. An increase of meetings

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[4] This analysis chooses *STC* as the moderator variable, because it can be assumed that the cost-reduction effects of *CP* might be enhanced through the structure of *STC*, as Widener (2007) empirically shows.

caused by concurrent processes might result in excess workload and hamper autonomy. It is difficult for busy engineers to effectively use support tools for TCM, such as TCM-case studies or 3DCAD (three-dimensional computer-aided design), which are used mainly in assembly industries (Yoshida, 2003, 2007). As a result, effective ideas for cost reduction will not be developed. Because of the negative effects of tensions caused by excessive use of stretch target costs and concurrent processes, statistically meaningful relationships between concurrent processes or the interaction effect and performance cannot be found in assembly industries[5].

Furthermore, the estimation results in assembly industries can be explained by a recent advanced practice of TCM in assembly industries. Yoshida (2011) shows advanced TCM practices at Toyota from case research. Recently, target costs have been achieved when they were decomposed into parts at the beginning of product development processes. This means that target costs are mostly equal to estimated costs at that time because of maturation of TCM capabilities, such as databases or know-how accumulated through long time experience. In this case, collaboration between different departments is used to adapt to changes that occur afterward. These practices suggest that the cost-reduction effects of concurrent processes become smaller in assembly industries, although not to the same extent as in Toyota.

The estimation results about the positive performance effects of the joint effect term in process industries reflect the characteristics of Japanese process industries (Fujimoto & Kuwashima, 2009). According to Fujimoto and Kuwashima (2009), previous literature on product development indicates that fine-tuning product development between parts and functions is needed in assembly industries, such as automobiles, consumer electronics, and computers. In the case of the products of process industries, such factors as epoch-making inventions of process technology, investment, and amount of R&D expenses have been considered extremely important. On the contrary, the authors propose that firms in process industries in Japan, particularly firms that treat industry materials, also gain capabilities that achieve intended functions accurately by customers who propose extremely strict constraints on quality and costs. In order to meet these strict customer needs, firms in these industries have to realize total optimization in the steps of operation. Specifically, knowledge sharing with customers about product specifications might lead to reduction of development costs by avoiding excessive customization. Furthermore, collaboration with sales and development departments might lead to better and more

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[5] According to Lewis (2000), tensions act as a double-edged sword. That is, they might serve as a trigger for change or they might inhibit for change.

accurate understanding of customer needs and help avoid excessive customization. The results of this study indicate that concurrent processes are effective for cost reduction for firms in process industries. Hence, it is possible that stretch target costs, which are set to achieve strict customer needs, strengthen the cost-reduction effects of concurrent processes, as the results of simple slope analysis show.

6. Conclusion

This study aims to clarify the cost-reduction effects of the joint use of stretch target costs and concurrent processes. In order to examine their joint effects, this study builds on a dynamic tension perspective. Based on data from a questionnaire survey, no statistically meaningful relationship between the joint effects and cost reduction are found when analyzing the full sample. However, the results of sub-group analysis by assembly and process industries indicate that joint use enhances cost reduction for firms in process industries.

This study contributes to the growing body of TCM literature. This study theoretically explains how and why joint use of stretch target costs and concurrent processes enhances cost reduction. Contrary to Gopalakrishnan et al.'s (2015) study based on goal-setting theory, this study assumes positive effects of stretch target costs and concurrent processes on cost reduction. The dynamic tension perspective used in this study is useful for explaining the dynamic nature of TCM activities that accompany tensions or conflicts on performance, which has not been examined sufficiently (Ansari et al., 2007).

In addition, this study provides empirical evidence about their interaction effects, which are suggested mainly theoretically by prior studies. Contrary to the expectations of this study, statistically significant relationship cannot be found when analyzing the full sample. However, expected results are found by subgroup (industry) analysis. These results might indicate that differences in product development processes require different TCM practices, as Messner (2016) suggested. The results of this study are important because differences regarding TCM practices between these industries are not well known.

This study has several limitations. First, sample size and the number of survey instruments might not be sufficient. Specifically, the survey constructs of this study contain only one questionnaire item. In order to support content validity, it is preferable to use more items. Second, this study does not strictly consider the stages in which target costs are shown. As Shimizu (1992a) and Yoshida (2003) show, stretch target costs act as either a facilitator or constraint for knowledge-creation, depending on when target costs are shown. It is possible that statistically meaningful effects of the joint use of stretch target costs and concurrent processes on cost reduction will be found by considering different stages. Hence, it cannot be said strictly that joint use does not enhance cost reduction in assembly industries. Finally, the results of this study are limited to explaining cross-industry influence. Thus, this study cannot explain intra-industry differences in cost-reduction processes. It can be assumed that the effects of the joint use of stretch target costs and concurrent processes on cost reduction might vary with more micro factors, such as product architecture or capabilities of project teams. These overlooked factors might lower the validity of the findings, although some level of homogeneity in TCM practices within industries can be assumed, as Messner (2016) explains.

Future research should consider context variables that will moderate cost-reduction effects of the joint use of stretch target costs and concurrent processes. Yoshida (2001) empirically indicates that such elements as stretch target costs and concurrent processes do not always enhance cost reduction and their effect is different for such businesses as computers and air conditioning. This is because different business environments, such as those with novelty of technology and market dynamism, need different ways to reduce costs. Hence, it seems that the effectiveness of the joint use of stretch target costs and concurrent processes is determined in these contextual factors. Future research should explore and examine their effects. In addition, in order to accurately interpret the result that using stretch target costs and concurrent processes enhances cost reduction for firms in process industries, field investigation about TCM practices in these industries is needed. Unfortunately, there are few such investigations. Clarification of TCM activities in these industries might enhance knowledge about the current state of Japanese manufacturing industries and this enables understanding of why the use of stretch target costs and concurrent processes enhances cost reduction in process industries.

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