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The effects of collaboration on build-to-order supply chains: with a comparison of BTO, MTO, and MTS

Ling Li · Li Zhang · Marzana Willamowska-Korsak

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Abstract The initiative of collaborative planning, forecasting and replenishment has generally provided rich options of strategies for build-to-order (BTO) supply chain members. In this study, we examined collaborative activities across BTO, make-to-order (MTO), and make-to-stock (MTS) supply chains. We draw upon the results from an empirical research from 126 manufacturing companies to illustrate what collaborative activities will enable companies to achieve better market performance, given their particular production circumstances. We have provided three major findings in this study: (1) identified a set of activities that are viewed as important for collaboration by business managers; (2) recognized various effects of collaboration on BTO, MTO, and MTS; and (3) illustrated the association between collaborative activities in BTO, MTO, and MTS supply chain and firm's market performance.

Keywords Supply chain · Collaboration · Build-to-order · CPFR · Market performance · E-business · Enterprise systems

L. Li
Old Dominion University, Norfolk, VA 23529, USA
e-mail: lli@odu.edu

L. Zhang (✉)
School of Economics and Management, Beijing Jiaotong University, Beijing 100044, China
e-mail: lzhang@bjtu.edu.cn

M. Willamowska-Korsak
Safety Engineering Department, College of Engineering, Warmia and Mazury University at Olsztyn, Olsztyn, Poland

1 Introduction

In the e-commerce age, customers expect firms to produce products with greater specificity to their needs [3, 12, 23–25, 30]. In order to provide customized products, many manufacturing producers have adopted the strategy of build-to-order (BTO) and have provided the customer what he/she wants, how he/she wants it, and when he/she wants it. Traditional production planning and inventory control method such planning bills developed by individual companies may not be as effective in this new environment as it was before.

In recent years, BTO has caught the attention from both practitioners and researchers. BTO is a manufacturing process that starts its production when the actual customer order is received. It is oriented from a one-of-a-kind paradigm, and can be utilized to manufacture variety of products using a cluster of components [2]. For example, Dell Computer has gained market share by building customized computers using the Internet as an order fulfillment vehicle. Dell assembles computers but outsources most of the parts and components it needs for production. Outsourcing has made collaborative planning, forecasting, and replenishment (CPFR) a vital vehicle to implementing BTO strategy in supply chain. The goal of collaboration in the supply chain is to create a transparent, visible demand pattern that paces the entire supply chain [5, 18, 20–22, 26, 27].

A majority of studies on the topic of BTO focus on the importance of BTO strategy [2], responding to short-term dynamics of schedule changes in BTO environment, the impact of BTO strategy on the upstream with suppliers and downstream with customers, and BTO products with short life-cycles. Very few studies have comprehensively examined CPFR for implementing BTO strategy; even fewer studies have explored the effects of CPFR on

manufacturing firms' performance in the production and operations management literature.

The research presented here attempts to fill the gap in the literature and is therefore aimed at rekindling academic initiatives focusing on implementing BTO strategy through collaboration. This study intends to explore the critical collaboration factors that contribute to BTO. Issues relate to the integration of material and information flows in a BTO supply chain with the objective of improving market performance will also be explored.

The key research questions addressed in this study are (1) what are the collaborative activities that affect BTO operations? (2) Will collaboration equally contribute to various production processes, such as BTO, make-to-order (MTO), and make-to-stock (MTS)? (3) Will supply chain collaboration contribute to better firm performance? We will empirically validate a list of collaboration issues and further investigate their simultaneous and synergistic effects on firm's market performance.

This paper is organized as follows. Section 2 presents literature review and hypotheses. Section 3 discusses methodology and the research plan. Results of the study and discussions are provided in Sects. 4 and 5 respectively. Conclusions and limitations are provided in Sect. 6.

2 Background

2.1 BTO, MTO and MTS

Strategies for manufacturing process differ because of firms' ability to use inventory and capacity [13]. Make-to-stock (MTS), BTO, and make-to-order (MTO) are three major approaches manufacturers adopt to satisfy customer needs. These three approaches require different ways to manage production, inventory, and capacity.

2.1.1 Make-to-stock manufacturing process

The MTS manufacturing approach involves holding items in stock for immediate delivery so as to minimize customer delivery times. This strategy is an applicable choice for standardized products, high volumes, less variety, and reasonable accurate forecasts, such as the products provided by Campbell Soup. The competitive priority is low cost manufacturing.

2.1.2 Build-to-order manufacturing process

The BTO manufacturing process can be defined as the configuration of departments and firms in the supply chain that creates the greatest degree of flexibility and responsiveness to changing customer requirements in a cost effective manner. BTO manufacturing is a manufacturing paradigm that focuses on smaller batches, modular production, responsive operations capability, and workers with adequate skills to deal with uncertain demand. In addition to focusing on managing inventory and other issues for reducing production cost, BTO emphasizes on outsourcing, supplier development, flexibility, and agility. Therefore, collaboration and strategic partnership become very important to BTO supply chain. BTO is similar to assemble-to-order to a certain degree. In this study, we define BTO as a manufacturing process that starts its production when the actual customer order is received. It can be utilized to manufacture a low volume of products of a predetermined high variety using a cluster of components. Outsourcing parts and components is a common practice to BTO [2].

2.1.3 Make-to-order manufacturing process

The MTO manufacturing process makes products to customer specifications in low volumes. Very often, MTO starts from scratch and includes both product design and production. Companies engage in MTO tend to be vertically integrated firms, such as Excelsior Co., which makes a tractor attachment for Deere & Co. MTO usually has a more complex manufacturing process than assembling a final product from standard parts and components, such as assembling a Dell computer to the customer order. Companies adopt MTO strategy tends to be vertically integrated within the firm.

2.2 Supply chain collaboration

The implementation of supply chain management (SCM) involves identifying the supply chain members with whom it is critical to link, what processes need to be linked to each of these key partners and what type or level of integration applies to production process [1, 29]. Coordination is particularly important when considering BTO supply chain networks, which passes the individual company's boundaries.

In recently years, many companies have established collaborative agreements with their supply chain partners and have achieved substantial results [6, 28]. For example, in the spring of 2001, Sears and Michelin (a French company) began discussions on collaboration. Later that year, they implemented a CPFR initiative. The mutual goal of the two companies was to improve order fill rate and reduce inventory at Sears distribution centers and Michelin's warehouses respectively. As a result of implementing CPFR, Sears distribution-centers-to-store fill rate increased by 10.7 %. The combined Michelin and Sears inventory

levels were reduced by 25 % [19]. This practice indicates that collaboration can offer companies the opportunities to transform and radically improve their supply chain performance. Such a transformation can have dramatic benefits and create competitive advantages.

The goal of collaboration is to optimize supply chain performance through improved production planning and demand forecasts, and to deliver the right product at the right time to the right location, with reduced inventories, avoidance of stock-outs, and improved customer service. The idea of CPFR was initiated at the annual Retail Systems Conference and Exposition in the mid 1990s. Later, the voluntary interindustry commerce standards (VICS) committee developed a nine-step process model as a guideline for CPFR implementation. CPFR has an on going planning, forecasting, and replenishment process in place among supply chain partners, and leads to smaller order sizes and more frequent order replenishment. The result is a smoother flow of orders that manufacturers are able to handle more efficiently.

The major activities of CPFR described in the literature are planning, forecasting, and replenishment. Planning includes a contract that details the responsibilities of the companies that are collaborating with each other with a joint business plan regarding demand management and production planning. Forecasting comprises of estimating customer demand for all the participating firms, identifying and resolving any differences in demand among participating firms, and developing a feasible sales forecast to all firms in the supply chain. Replenishment consists of developing an efficient production and delivery schedule, and fulfilling actual orders to meet customer demand. Companies implementing CPFR tend to share point of sales data with all the partners in their respective supply chains and to share inventory data with each other [5, 17, 19]. It is also reported that information sharing provides a basis for each company to make decisions that will yield better efficiencies and profits for itself and for the supply chain as a whole [17].

Companies that are able to establish collaborative supply chains will have a significant competitive edge over their competitors, no matter what production process they select to implement. Prominent companies such as Wal-Mart (a retailer), Dell (a BTO company), and Proctor & Gamble (a MTS company) are already beginning to lead the way. For example, Procter & Gamble Co. was one of the earliest adopters of CPFR who conducted collaborative planning with hundreds retailers and achieved remarkable results. The hypothesis related to manufacturing process types and collaboration is:

Hypothesis 1 Collaboration is a critical endeavor to all three types of manufacturing processes—BTO, MTO and MTS in e-business environment.

The BTO manufacturing process tends to outsource or purchase many parts and subassembly components that are used for configuring customized products. Therefore, collaboration among the trading partners becomes particularly important to BTO manufacturers. For example, Dell Computer implements a "direct model" which builds customized computers based on customer orders. It collaborates with many of its suppliers and applies the Internet technology. The advantage that Dell gets from collaboration is difficult to be imitated by other computer makers such as HP, Gateway, and Compaq. The hypothesis related to BTO and collaboration is:

Hypothesis 2 Collaboration is a more critical factor to implement BTO than to implement MTO and MTS.

2.3 Market performance

Previous research on performance focuses more on cost and financial performance. We agree that a company's financial performance is vital to a company's existence. However, in today's customer-driven market, customer base is a key to achieve good financial performance [8, 15, 16]. The central theme of market performance is to satisfy customer needs and improve customer relations, which is also the goal of BTO. A customer-driven BTO supply chain focuses on promoting high quality products, retaining existing customers, and expanding to new markets. To a BTO focused company, winning customer trust and being competitive on the market place are the keys to win orders.

Literature concerning marketing and supply chain/manufacturing interface shows that one of the keys to develop a firm's competencies is to understand what the customer wants and how to provide it better than the competitor does [4]. Emphasizing responsiveness, meeting the customer's needs through providing unique and quality products are indicators of good market performance. Advances in collaboration are enabling firms to critically reevaluate their market-focused performance. A better understanding of the benefits of supply chain collaboration fosters the idea of customer satisfaction. The effects of collaboration on manufacturers' market performance reflect in a number of dimensions: (1) fast delivery; (2) broad range of products; (3) customized products; (4) competitive pricing; (5) new markets development; (6) improved competitiveness [8, 19].

We assume that above the average market performance of BTO, MTO, and MTS companies is associated with above the average emphasis on supply chain collaboration. The measures of market performance of this study include winning market share through product variety, fast delivery, competitive pricing, and improved competitiveness. The performance data are self-reported in the above-mentioned

areas. Hypotheses three to five consider the relationship between collaboration and market performance. The related hypotheses are as follows:

Hypothesis 3 Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect **BTO** firm's market performance.

Hypothesis 3a Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's **fast delivery** performance.

Hypothesis 3b Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's performance on **providing broad range of products**.

Hypothesis 3c Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's performance on **providing customized products**.

Hypothesis 3d Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's performance on **competitive pricing**.

Hypothesis 3e Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's performance on **new markets development**.

Hypothesis 3f Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's **market competitiveness**.

Hypothesis 4 Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect **MTO** firm's market performance.

Hypothesis 4a Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTO firm's **fast delivery** performance.

Hypothesis 4b Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTO firm's performance on **providing broad range of products**.

Hypothesis 4c Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTO firm's performance on **providing customized products**.

Hypothesis 4d Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTO firm's performance on **competitive pricing**.

Hypothesis 4e Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTO firm's performance on **new markets development**.

Hypothesis 4f Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTO firm's **market competitiveness**.

Hypothesis 5 Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect **MTS** firm's market performance.

Hypothesis 5a Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTS firm's **fast delivery** performance.

Hypothesis 5b Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTS firm's performance on **providing broad range of products**.

Hypothesis 5c Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTS firm's performance on **providing customized products**.

Hypothesis 5d Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTS firm's performance on **competitive pricing**.

Hypothesis 5e Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTS firm's performance on **new markets development**.

Hypothesis 5f Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect MTS firm's **market competitiveness**.

3 Research methodology

3.1 Data

Today, a significant amount of parts and subcomponents is purchased or sourced from countries outside United States,

such as China, India and Mexico. Thus, supply chain managers need to not only understand the differences within supply chains, but also have to be aware of the collaborative initiatives in other countries [7, 9–11, 14]. Many Chinese companies are supply chain partners of US companies. For example, Limited Brands partnerships with its fabric and garment supplier, Li & Fung in Hong Kong. Limited Brands provides point-of-sale information to Li & Fung. Li & Fung, an upstream company in the supply chain, delivers the shipments to Limited Brands' stores. Due to the extensive collaboration between Chinese firms and manufacturers in Europe and US, we surveyed Chinese manufacturing companies on the issue of collaboration related to BTO, MTO, and MTS.

A sample of 800 Chinese companies was contacted. One hundred ninety-seven companies responded. The response rate was 24.6 %. There are 68 companies that provide services only. Therefore, these companies are dropped from this study. Among the remaining 131 manufacturing companies, 5 companies did not respond to all the questions we have used in this study, so they are not included in the analysis. Table 1 shows the breakdown of the respondents categorized by the industry type and manufacturing process type which includes BTO, MTO, and MTS. About twenty percent of respondents engage in textile industry (Table 1), fifteen percent engage in electronic and electronic equipment, ten percent in chemical and allied industry, about nine percent in transportation equipment, and eight percent in machine and computer equipment. The results from Chi square tests indicate that there are no significant differences between respondents and non-respondents in terms of industry types and manufacturing process types.

Based upon the literature in collaborative planning, forecasting, and replenishment, a list of seven items was selected in accordance with the literature [5, 14, 17] and the results of personal interviews with Chinese managers. The seven items (see Table 2) are viewed by manufacturing managers as potential collaborative activities that a firm would like to adopt with the objective of improving market performance. Given the wide variation in definitions and usage of the concept in the literature, the collaborative activities suggested in this study are just one of many ways that can be applied to capture the overall thrust of supply chain collaboration.

3.2 Survey questions, variables and validity

Questions related to collaborative activities and performance are based on a seven-point Likert scale (Table 2). The plant managers were asked to rate the importance of each item with end points from "no emphasis" (equals 1) to "extreme emphasis" (equals 7). Market performance items are ranked from "strongly disagree" (equals 1) to "strongly agree" (equals 7).

Table 1 Participates' information

	N	Percent
Industry type		
Agriculture products	1	0.79
Coal mining	1	0.79
Heavy construction	1	0.79
Construction	1	0.79
Food and kindred products	8	6.35
Tobacco products	2	1.59
Apparel and fabrics products	24	19.05
Furniture and fixture	1	0.79
Paper and allied products	2	1.59
Printing, publishing and allied industry	3	2.38
Chemicals and allied industry	13	10.32
Petroleum refining and related industry	7	5.56
Rubber and miscellaneous plastics products	1	0.79
Leather and leather products	1	0.79
Stone, clay, glass, and concrete products	5	3.97
Primary metal industry	2	1.59
Fabricated metal products	4	3.17
Machinery and computer equipment	10	7.94
Electronic and electronic equipment	19	15.08
Transportation equipment	11	8.73
Electric gas	3	2.38
Wholesale	1	0.79
Building material	1	0.79
Home furniture	1	0.79
Health service	1	0.79
Information not provided	2	1.59
Total	126	100
Types of manufacturing process		
Build-to-order	40	19.79
Make-to-order	32	21.98
Make-to-stock	54	47.25
Total	126	100

The independent variables are concerned with collaborative activities that supply chain members adopt. Table 2 presents both independent and dependent variables used in the study. Independent variables include supply chain member cooperation, communication, joint forecasting demand, planning production, and managing inventories. These items are expected to affect firms' supply chain market performance.

The dependent variables represent various market performance indicators. Literature suggests that fast delivery, broad product range, competitive pricing, new market development, etc. are all indicators of market performance [2, 4, 8]. These dependent variables reflect the effects of

Table 2 Questions

	No emphasis	Extreme emphasis
Collaborative activities		
X_1. Emphasizing on supply chain cooperation	1…2…3…4…5…6…7	
X_2. Sales forecasting is developed through supply chain coordination	1…2…3…4…5…6…7	
X_3. Planning information and data are shared by supply chain members	1…2…3…4…5…6…7	
X_4. Fostering communication and cooperation among members	1…2…3…4…5…6…7	
X_5. Conducting supply chain-wide performance evaluation	1…2…3…4…5…6…7	
X_6. Using market information for business decision making	1…2…3…4…5…6…7	
X_7. Conducting supply chain-wide analysis before making inventory decisions	1…2…3…4…5…6…7	
Market performance		
Y_1. Providing fast delivery	1…2…3…4…5…6…7	
Y_2. Providing a broad range of products	1…2…3…4…5…6…7	
Y_3. Providing customized product	1…2…3…4…5…6…7	
Y_4. Developing competitive pricing	1…2…3…4…5…6…7	
Y_5. New markets have been developed	1…2…3…4…5…6…7	
Y_6. Market competitiveness has improved	1…2…3…4…5…6…7	

supply chain collaboration on firm's supply chain performance.

Content validity, which specifies that the research instrument reflect the domain of the research area, was established through several personal interviews with manufacturing managers on site. Additionally, each research questions in the conceptual model was validated through a comprehensive literature review. The survey instrument was revised according to the suggestions of the practicing managers. This process validated the survey items in an objective manner.

3.3 Analysis

The analysis includes three phases. First, the results from descriptive statistics are analyzed to illustrate the importance of collaborative activities. Then, the effects of collaborative activities on the three manufacturing process types are analyzed using ANOVA method. Finally, the correlation between market performance and collaborative activity are tested using regression analysis.

ANOVA is performed to determine which dependent variables differed across the three manufacturing process types in the research design. As a consequence, hypotheses 1 and 2 are tested. For the market performance indicators, the technique of least squares is used to estimate the regression coefficient (b_i) in an equation of the form:

Table 3 Rank order by means

	Means
Rank order by collaborative activities	
X_1. The channel emphasizes supply chain cooperation	5.60
X_4. The channel fosters communication and cooperation among members	5.53
X_2. Sales forecasting is developed through supply chain coordination	5.39
X_6. Use market information for business decision making	5.35
X_3. Planning information and data are shared by channel members	5.25
X_7. Conduct channel-wide analysis before making inventory decisions	5.14
X_5. Conduct channel performance evaluation	5.03
Rank order by performance	
Y_3. Providing customized product	5.80
Y_4. Developing competitive pricing	5.66
Y_1. Providing fast delivery	5.58
Y_2. Providing a broad range of products	5.19
Y_6. Market competitiveness has improved	5.14
Y_5. New markets have been developed	4.65

$$\text{Performance} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + u \quad (1)$$

where u denotes a random disturbance term. The regression coefficient (b_i) represents the expected change in the market performance indicator associated with one-unit change in the *i*th independent variable, i.e. cooperation, communication, collaborative planning, forecasting, and inventory management. Multiple regression was run for each performance indicator. Therefore, six multiple regressions were run for BTO, six for MTO, and six for MTS. A total of 18 multiple regression models were executed.

4 Results

4.1 Rank order of collaborative activities

The collaborative activities are described in seven areas. The means and rank order for the seven collaborative items are given in Table 3. There is a considerable degree of consensus in the sample concerning the importance of the seven collaborative decisions.

The most important collaborative item rated by the managers is "the channel emphasizes supply chain cooperation," witch has a mean 5.6 (Table 3). The next highest ranked item is "fostering communication and cooperation

Table 4 ANOVA summary table

	Between-group		Within-group		F value
	Mean square	d.f.	Mean square	d.f.	
Collaborative activities					
X_1. Emphasizing on supply chain cooperation	4.91	2	1.49	123	3.3**
X_2. Sales forecasting is developed through supply chain coordination	0.90	2	1.30	123	0.69
X_3. Planning information and data are shared by channel members	2.1	2	1.66	123	1.26
X_4. Channel fosters communication and cooperation among members	6.50	2	1.56	123	4.16**
X_5. Conduct supply chain-wide performance evaluation	5.48	2	2.50	123	2.19
X_6. Use market information for business decision making	7.89	2	1.64	123	4.80***
X_7. Conduct supply chain-wide analysis before making inventory decisions	7.76	2	2.33	123	3.33**

* The model is significant at .10; ** the model is significant at .05; *** the model is significant at .01

among members," with a mean of 5.53. The mean for sales forecasting is 5.39, the mean for planning data and information shared by channel members is 5.25, and the mean for channel-wide inventory decision is 5.14. The least emphasized items is conducting channel performance evaluation, which has a mean of 5.03. The result indicates that cooperation and communication are viewed by managers as the most important factors that will affect collaborative planning, forecasting, and replenishment.

4.2 Results from ANOVA analysis

Table 4 shows the results of the ANOVA for the first hypothesis. Since a significant overall main effect is found for cooperation, communication, using market information for decision making, and supply-chain inventory decisions (at $p < 0.05$ or better), Hypothesis 1 can be accepted. We, therefore, conclude that collaboration is a critical endeavor to all three types of manufacturing processes—BTO, MTO and MTS.

Table 5 shows the results of ANOVA post hoc analysis, which determines which process type differs from others. As illustrated in Table 5, sales forecasting developed through supply chain cooperation is important to BTO but is not emphasized by MTS companies. Comparing BTO and MTS companies, "fostering communication and cooperation" is significantly different between the two types of companies. Post hoc analysis also shows that there is significant difference between BTO and MTS supply chain in using market information for business decisions. According to the results from post hoc analysis, Hypothesis 2, collaboration is a more critical factor to implement BTO than implement MTO and MTS, is accepted.

Table 5 ANOVA post hoc analysis

	Pair-wised comparison
Collaborative activities	
X_1. Emphasizing on supply chain cooperation	BTO–MTS**
X_2. Sales forecasting is developed through supply chain coordination	
X_3. Planning information and data are shared by channel members	
X_4. Channel fosters communication and cooperation among members	BTO–MTS**
X_5. Conduct supply chain-wide performance evaluation	
X_6. Use market information for business decision making	BTO–MTS**
X_7. Conduct supply chain-wide analysis before making inventory decisions	BTO–MTS*, MTO–MTS*

* The model is significant at .10; ** the model is significant at .05

4.3 Results from regression analysis

Multiple regression models were run for each process type. The results of multiple linear regressions reported in Table 6 use cooperation (X_1), forecasting (X_2), collaborative planning (X_3), communication (X_4), channel-wide performance evaluation (X_5), using market information for decision making (X_6), and inventory management (X_7) as independent variables and market performance as the dependent variable. The multiple linear regression model was run with each of the six market performance dependent variables, fast delivery (Y_1), range of product (Y_2), customized products (Y_3), competitive pricing (Y_4), new markets development (Y_5), and competitiveness (Y_6). Table 6 lists the model R^2, the model p value, the parameters (betas) for the independent variables and the intercept.

The result of the multiple regression for BTO (Table 6) shows that cooperation (X_1), forecasting (X_2), collaborative planning (X_3), communication (X_4), channel-wide performance evaluation (X_5), using market information for decision making (X_6), and inventory management (X_7) jointly affect BTO performance in fast delivery (Y_1), broad range of products (Y_2), customized products (Y_3), and new market development (Y_5), with a p value of $p < 0.05$

Table 6 BTO—Multiple Regression Analysis Results

	Model R^2	Intercept	β_i for						
			X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y_1. Providing fast delivery	0.39**	0.22	0.11	0.15	0.42*	0.02	0.06	0.21	0.03
Y_2. Providing broad range of products	0.38**	2.13**	0.04	0.02	0.23	0.10	0.27*	0.26	0.22
Y_3. Providing customized product	0.37**	1.32	0.28	0.46**	0.01	0.28	0.09	0.27	0.03
Y_4. Developing competitive price	0.17	6.20***	0.60**	0.36	0.23	0.17	0.27	0.14	0.09
Y_5. New markets have been developed	0.34**	3.03***	0.24	0.08	0.04	0.27*	0.10	0.25*	0.06
Y_6. Market competitiveness has improved	0.30*	2.53**	0.22	0.30	0.04	0.43**	0.10	0.28*	0.10

Description for independent variables X_i is given in Table 2

* The model is significant at .10; ** the model is significant at .05; *** the model is significant at .01

(Table 6). The seven independent variables positively associate with the dependent variable, market competitiveness (Y_6), but are not strong predictors. The correlation between the seven predictors and market competitiveness is marginally significant at $p < 0.10$ (Table 6). Judging from the outcome of six multiple regressions, we can conclude that that the empirical results support hypotheses 3a, 3b, 3c, 3e, and 3f. Collaborative activities, such as cooperation, communication, planning, forecasting, and inventory management, jointly affect BTO firm's market performance. Additionally, competitive pricing is not significantly associated with the independent variables. Therefore, hypothesis 3d is not supported by the empirical data.

The result of the multiple regression for MTO (Table 7) shows that cooperation (X_1), forecasting (X_2), collaborative planning (X_3), communication (X_4), channel-wide performance evaluation (X_5), using market information for decision making (X_6), and inventory management (X_7) are not significant predictors for MTO performance on fast delivery (Y_1), broad range of products (Y_2), customized products (Y_3), competitive pricing (Y_4), new market development (Y_5) and market competitiveness (Y_6). Therefore, we conclude hypothesis 4a, hypothesis 4b, hypothesis 4c, hypothesis 4d, hypothesis 4e, and hypothesis 4f are not supported by the empirical data.

The result of the multiple regression for MTS (Table 8) shows that cooperation (X_1), forecasting (X_2), collaborative planning (X_3), communication (X_4), channel-wide performance evaluation (X_5), using market information for decision making (X_6), and inventory management (X_7) are not important predictors for MTS performance in fast delivery (Y1), broad range of products (Y_2), customization (Y_3), and new market development (Y_5). However, communication, collaboration in planning, forecasting and inventory management has some significant impact on competitive pricing (Y_4), which is a competitive advantage that MTS companies tend to focus. Observing the result of regression analysis in general, we conclude hypothesis 5a, hypothesis 5b, hypothesis 5c, hypothesis 5e, and hypothesis 5f are not supported by the empirical data. Hypothesis 5d is supported at the $p < 0.10$ level.

More information about BTO can be discovered by examining the multiple regression result for each market performance indicator (Table 6). Sharing planning information with channel members (X_3) has a positive impact on fast delivery performance indicator (Y_1), with a p-value of $p < 0.10$. However, this association is marginally significant. Coordinated forecasting (X_2), on the other hand, is a significant predictor for providing customized products (Y_3) with a p-value of $p < 0.05$. Channel member communication (X_4) and using market information for decision making (X_6) are significant predictors for new markets development (Y_5) and market competitiveness (Y_6), with p values at $p < 0.05$. These results indicate that cooperation and communication within the BTO supply chain can significantly affect companies' market performance. Thus, cooperation (X_1), forecasting (X_2), collaborative planning (X_3), communication (X_4), channel-wide performance evaluation (X_5), using market information for decision making (X_6), and channel-wide inventory management (X_7) are recognized as important predictors of market performance for BTO companies. This result not only supports the predictive validity of our operational definition of market performance, but also is consistent with the literature cited earlier [4, 8, 14, 17].

In summary, eight out of twenty hypotheses have been supported by the results of the statistical analysis, with *p value* ranges from 0.10 to 0.01. Examining the eight regression models of market performance as a set, a couple of conclusions can tentatively be drawn. First, cooperation (X_1), forecasting (X_2), collaborative planning (X_3), communication (X_4), channel-wide performance evaluation (X_5), using market information for decision making (X_6),

Table 7 MTO—multiple regression analysis results

	Model R^2	Intercept	β_i for						
			X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y_1. Providing fast delivery	0.30	6.03***	0.46**	0.39	0.31	0.23	0.14	0.25	0.13
Y_2. Providing broad range of products	0.34	3.17*	0.17	0.30	0.21	0.38	0.41*	0.03	0.14
Y_3. Providing customized product	0.21	4.26***	0.11	0.27	0.12	0.03	0.05	0.03	0.39
Y_4. Developing competitive price	0.27	4.52***	0.01	0.25	0.10	0.21	0.15	0.34	0.11
Y_5. New markets have been developed	0.30	2.85**	0.23	0.12	0.12	0.03	0.36	0.10	0.31
Y_6. Market competitiveness has improved	0.16	4.65***	0.15	0.02	0.48*	0.29	0.13	0.30	0.08

* The model is significant at .10; ** the model is significant at .05; *** the model is significant at .01

Table 8 MTS—multiple regression analysis results

	Model R^2	Intercept	β_i for						
			X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y_1. Providing fast delivery	0.11	4.56***	0.02	0.09	0.19	0.27	0.21	0.12	0.08
Y_2. Providing broad range of products	0.13	2.47*	0.37	0.30	0.11	0.35	0.01	0.14	0.01
Y_3. Providing customized product	0.17	3.72***	0.22	0.04	0.18	0.29	0.12	0.06	0.07
Y_4. Developing competitive price	0.22*	3.71***	0.06	0.18	0.07	0.06	0.05	0.14	0.09
Y_5. New markets have been developed	0.04	4.91***	0.29	0.01	0.24	0.18	0.08	0.08	0.06
Y_6. Market competitiveness has improved	0.18	5.65***	0.48*	0.12	0.08	0.51*	0.23*	0.02	0.28

* The model is significant at .10; ** the model is significant at .05; *** the model is significant at .01

and inventory management (X_7) have played significant roles in determining BTO supply chain market performance. Second, collaborative activities do not affect the three production types equally; collaborative activities do not significantly associate with MTO and MTS firm's market performance. Additionally, we have identified the key collaborative activities that affect BTO operations.

5 Discussion

5.1 Collaborative activities for manufacturing firms

The results from multiple linear regression analysis indicate that cooperation, forecasting, collaborative planning, communication, channel-wide performance evaluation, using market information for decision making, and inventory management are important BTO supply chain collaborative activities. In recent years, many innovative manufacturers and retailers are forging partnerships to advance CPFR. This initiative is particularly pertinent to BTO companies. For example, Compaq is working with 850 of its trading partners to conduct purchasing planning over the Internet. Thomson Electronics is doing CPFR with 50 of its retailers. New Balance and Timberland are setting the pace in the shoe industry with selected retailers. Mitsubishi Motors is collaborating with its dealers to reduce customer lead time to 2 weeks. The results of our study not only provide a better understanding of the benefits of supply chain collaboration, but also suggest a set of applicable collaboration approaches for BTO supply chains.

5.2 Association between collaborative activities and market performance

Due to the vital role of customer relations to a company, we focus on the effects of collaborative activities on market performance in this study. The results of the study clearly indicate that collaborations affect the performance of BTO, MTO, and MTS firms differently. Collaborative activities have significant effects on the performance of BTO manufacturing companies but show no significant effect on the performance of neither MTO nor MTS companies.

Collaboration in demand forecasting, production planning, and inventory replenishment brings a number of

benefits to BTO supply chain. First, fast delivery is made possible because all companies in the BTO supply chain have access to sales data and share sales forecasts. This allows every player in the same supply chain to develop a better production plan, ideal inventory levels, and realistic delivery schedules. Rise and decline in customer demand is shared to everyone in the BTO supply chain. Adjustment to the previously planned production levels is made accordingly. Next, successful companies are not only able to maintain exiting customers by providing variety of customized products, but also are able to attract new customers through a set of capabilities created by BTO supply chain collaboration.

Collaboration is not easy to implement and it will take time to become more common in business. It is still a challenging process to integrate a disconnected forecasting and planning agenda in the entire supply chain. Additionally, more internal collaborations are need for firms to adopt CPFR applications.

Another interesting finding of the study is competitive pricing. For a BTO supply chain, competitive pricing is not significantly affected by collaborative activities; while for a MTS company, competitive pricing is positively affected by collaborative activities. This result confirms that low cost/low pricing is a powerful competitive advantage of MTS manufacturing companies; while customized products and fast delivery are more important competitiveness to BTO supply chains.

6 Conclusions and limitations

The study considers important collaborative activities that affect the market performance of BTO, MTO, and MTS manufacturing companies. We draw upon an empirical research from 126 manufacturing companies to illustrate what collaborative activities will enable companies to achieve better market performance, given their particular production circumstances. We have provided three major contributions in this study: (1) identified a set of activities that are viewed as important for collaboration by business managers; (2) recognized various effects of collaboration on BTO, MTO, and MTS; and (3) illustrated the association between collaborative activities in BTO supply chain and firm's market performance. The result of the study indicates that better collaboration does affect market performance of BTO companies.

There is a number of avenues to that this research can be extended. For example, further research on providing detailed insights into the theory and applications of BTO supply chain can be conducted. Research topics regarding collaboration of BTO supply chain may include risk assessment of collaboration, optimal point of product-differentiation in a BTO supply chain, selection of trading partners, the effects vertical collaboration, horizontal collaboration, and spatial collaboration on performance. In this study, we focus on the collaborative activities among BTO supply chain members. BTO is characterized by erratic and often discontinuous demand at the end item level. Future studies may consider the lumpy and deterministic dynamic-demand at the component level, and short finite planning horizons within the company.

There are some limitations that should be taken into consideration for future research. One limitation is that market performance ratings (Table 2) are self-reported. The answers from two different respondents from the same organization may vary and this may affect the results. Future research may consider integrate some performance indicators rated by third-party, as well as financial data. The second limitation of the study is using single item for collaborative activities. Future research may consider use multiple items for each collaborative activity to provide multiple perspectives.

Finally, caution should be taken when readers try to interpret the results of this study. The sample is collected from Chinese manufacturing firms that exist in a unique business environment. Manufacturing firms in other countries may collaborate in different manners. Additionally, the collaborative activities suggested in this study are just one of many ways that can be applied to capture the overall thrust of collaboration in BTO supply chain.

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