2020

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Journal of Global Information Management
Volume 28 • Issue 1 • January-March 2020

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ABSTRACT

Cloud innovation has become increasingly important to supply chain innovation and performance. User involvement is a crucial part of cloud innovation. However, the effect of user involvement in supply chain cloud innovation has not been thoroughly studied, particularly its effect on product cost and optimal price. In this paper, the authors attempted to bridge this major gap in the literature. The authors reviewed the relevant literature to define cloud innovation and user involvement in supply chain cloud innovation. Then the authors developed a game model based on the Bertrand model. Analysis of the model showed that user involvement affects product cost and optimal pricing in an interesting way. The authors also presented a real-life example of how user innovation takes place at Tailg electric vehicle company.

KEYWORDS

Bertrand Model, Cloud Innovation, Game Theoretical Model, User Involvement

INTRODUCTION

Firms today operate in a highly competitive global market. Supply chain performance excellence is crucial to business success. No wonder firms are always interested in methods that can lead to reduced cost and response time, and improved service level. Among all choices, innovation has proven its effectiveness in improving supply chain performance. Innovation leads to creative new products, or more efficient production processes. Through innovation, firms can establish and maintain a formidable competitive advantage. Therefore, it is not surprising that firms are highly interested in mechanisms that enables effective innovation.

Advancement of modern technologies has significantly changed how the innovation game is played. In the past, innovation was largely an intra-enterprise matter because information sharing across organizational boundaries was not easy and expensive (Guo et al 2012; Xu 2007, 2016). The advancement of technology, particularly the Internet and communications technologies, has completely changed the competitive landscape. Modern technologies enable ubiquitous and pervasive access to computing resources across geographical boundaries. Collaboration among supply chain players is no longer a difficult endeavor. Many studies have proven that technology advancement is positively associated with substantial supply chain performance improvement (Peruzzini & Stjepandić, 2017; Estorilio, Rodrigues, Canciglieri, & Hatakeyama, 2017; Achi, Salinesi, & Viscusi, 2016).

DOI: 10.4018/JGIM.2020010102

Recently, new technology such as cloud computing has contributed to the success of cloud innovation. Through cloud computing, multiple parties of a supply chain can easily work with each other on innovation projects. Ideas, information, and resources are seamlessly shared on a cloud computing platform. Compared to traditional innovation activities, information exchange in cloud innovation is much faster and direct. Therefore, innovation efforts will be directed more toward customer needs but not wasted on ideas that are not supported by customers. In short, cloud innovation increases the success rate of innovation.

User innovation is a term that specifically refers to end users' involvement in supply chain cloud innovation. As cloud computing technologies gain popularity, user innovation has increasingly become the main content of cloud innovation. Through cloud computing platforms, massive number of end users can be easily recruited to engage in innovation. A massive involvement of end users means exposing many hidden improvement opportunities in a supply chain (Nikander 2017; Alyahya et al 2016; Wei et al 2017). For example, through a user community, end users can directly provide feedback to a product manufacturer. In many cases, they can even directly offer numerous innovation ideas such as what product features are needed. Reaching a large number of users to collect feedback used to be a daunting task. Moreover, such innovation ideas are not limited to products, but also extend to processes. Directed innovation effort undoubtedly will lead to better satisfied customers and more efficient supply chain operations.

While the literature has recognized the positive impact cloud innovation has on supply chain performance, surprisingly, the effect of user involvement in supply chain cloud innovation has not been carefully quantified. In this research, we attempt to bridge this major gap in the literature. Specifically, we adopt a game theoretical modeling approach to quantify the effect of user involvement on product cost and optimal price (price that leads to maximum profit). To the best of our knowledge, this is one of the first quantitative studies. Results from this study hence potentially can make a significant contribution to the literature and practices.

This paper is organized as follows. The next section provides the background of cloud innovation as well as reviews the literature on user involvement in supply chain cloud innovation. Then we develop and analyze game models based on the Bertrand model. We conclude the paper with a discussion of the results obtained. We also suggest some future research directions.

CLOUD INNOVATION: BACKGROUND AND LITERATURE

Cloud Innovation: Concept and Examples

Cloud innovation originates but differs from cloud computing. Cloud computing means ubiquitous access to shared pools of configurable computing resources, while cloud innovation is about leveraging cloud computing to engage multiple parties in innovation. Cloud innovation is based on a variety of Internet technologies, including Internet of Things (IoT), cloud computing, and e-commerce. Utilizing these technologies, cloud innovation can quickly absorb, gather, and accumulate both internal and external resources, knowledge, and technological achievements for innovation (Cai et al. 2014; Li et al. 2013; Xiao et al. 2014; Xu et al, 2014). Integration of resources many times lead to great innovations. In a supply chain setting, cloud innovation means users can integrate both upstream and downstream resources and collaborate on innovation activities throughout supply chain nodes. As a result, innovation performance of the whole supply chain can be significantly improved.

Cloud innovation becomes increasingly popular in recent years, owing much to the fast development of cloud computing technologies. Advancement of cloud computing technologies has facilitated efficient communications and collaboration across companies (Bendre and Thool 2016; Jiang et al 2014; Tao et al 2014a,b; Xu 2011; Xu et al 2014; Zheng et al 2014a, 2014b). IBM's "jam" program, launched in 2006, is probably the earliest successful example of cloud innovation. Apple's App Store is another example of cloud innovation, through which Apple and third-party developers communicate and collaborate effectively. The Chinese telecommunications giant, Huawei, has developed three cloud computing platforms to improve its supply chain. The first effort is 28 joint innovation centers co-established by Huawei and telecom providers from all over the world, for instance, “Mobile Innovation Center” by Huawei and Vodafone. The second effort is “MBB Open Internet Industry Base,” which provides cutting edge cloud solutions to telecom providers, and business and individual users. The third effort is “Huawei Fans Club,” an electronic community for end users and third-party software developers.

User Involvement in Supply Chain Cloud Innovation

User Innovation

User involvement is crucial to innovation success. The role users play in innovation has long been recognized in the literature. Enos (1962) studied the relationship between refining processes and equipment innovation. He found that users of refining processes and equipment are the major innovators, who generated significant inventions and improvements. Subsequent studies showed that user involvement in innovation exists widely in many industries (Freeman, 1968; Knight, 1963; Rosenberg, 1976; Urban & von Hippel, 1998; Franke & Shah, 2003; Lüthje, Herstatt, & von Hippel, 2005; Hyysalo, 2009).

The concept of user innovation was first proposed by Urban and von Hippel (1988). Based on the innovation theory, they found that users are one of the most critical sources of innovation. When users are involved in cloud innovation, Brook et al (2014) found that it leads to not only technological innovations, but also business process innovations. Buchanan (2012) showed how cloud is used as an environment to improve innovation performance. In another study, Wu (2015) revealed that cloud-based design is an important aspect of cloud innovation, which can lead to a new paradigm of digital manufacturing and design innovation. Clohessy and Acton (2013) advocate that cloud computing is an important way to realize open innovation.

In a supply chain setting, Seth et al. (2017) emphasized the importance of an effective cloud computing platform to facilitate communications with upstream suppliers and downstream customers. With high quality and timely information collected, decisions can be made with much better quality on inventory replenishment, capacity activation, and material flow synchronization. Hung et al. (2016) identified top factors for inventory cost reduction and distribution optimization, which include excellent project management, organizational fit, information sharing, trialability, and top management commitment. What is common among all these studies is user involvement in cloud computing platforms. Other studies reached similar conclusion. For example, Khatwani and Srivastava (2017) developed an optimization model for mapping consumer preferences to product features in an online platform. He and Wang (2015) proposed a model explaining the adoption of cloud computing across multinational firms.

Types of User Involvement in Supply Chain Cloud Innovation

In a supply chain setting, firms can have two types of collaborators. One type of collaboration involves production activities, hence called producer collaborators. The other type is end users, often called consumer collaborators. Each type has different involvement in supply chain cloud innovation.

Producer collaborators are typically firms in a supply chain. They often possess professional R&D capabilities and can easily participate in innovation activities. They may be involved in: (1) upstream business R&D activities by directly assigning R&D personnel teams to upstream companies, or indirectly through a cloud platform; (2) joint innovation activities such as establishing joint research and development centers, or building joint cloud platforms for sharing benefits and risks; and (3) setting up supply chain innovation alliance based on a cloud platform, so that information sharing and knowledge exchange can take place easily.

Consumer collaborators, on the other side, may (1) participate in new product experiencing activities through a cloud platform or in a field, (2) customize their own innovative products on a cloud platform associated with E-commerce, (3) join product design, process improvement and other activities through a cloud platform or even at a firm's R&D department, and (4) crowdfund to raise capital for R&D activities that are related to expected or desired products.

Elements of User Involvement in Supply Chain Cloud Innovation

Cloud innovation is a complex process that spans from opportunity identification, ideas screening, feasibility analysis, risk analysis, plan selection, program refinement, risk plan, implement feedback, to optimization. User involvement means that users are engaged in some or even all these activities. User involvement may happen throughout the whole cycle of innovation design and development. User involvement in supply chain is often an open cloud innovation process. Since cloud innovation exceeds traditional enterprise boundaries, risk management becomes essentially important. Firms must carefully evaluate risks and effectively mitigate risks in cloud innovation.

User involvement in supply chain cloud innovation has five elements (Figure 1). First, there must be a cloud computing platform that provides hardware, software, and technical support, without which users cannot participate in supply chain cloud innovation. Second, user involvement can only happen when there is a supply chain alliance that consists of members from both upstream and downstream. The third element is external crowdsourcing R&D groups. Consumer communities are the fourth element. Last, but not the least, is an e-commerce platform on which activities of crowdfunding, customization, and purchasing are conducted.

Effect of User Innovation on Product Cost and Optimal Price

Despite abundant literature on cloud innovation, there is a dearth of studies on quantifying the effect of user innovation, particularly, on product cost and optimal price. A few studies have examined relevant issues. Wu (2013) studied the bargaining equilibrium of an industry with two competing supply chains. He used a downward-sloping linear function to model both the price and promotional effort. In another study, Wu, Baron, and Berman (2009) examined a similar equilibrium in the presence of demand uncertainty.

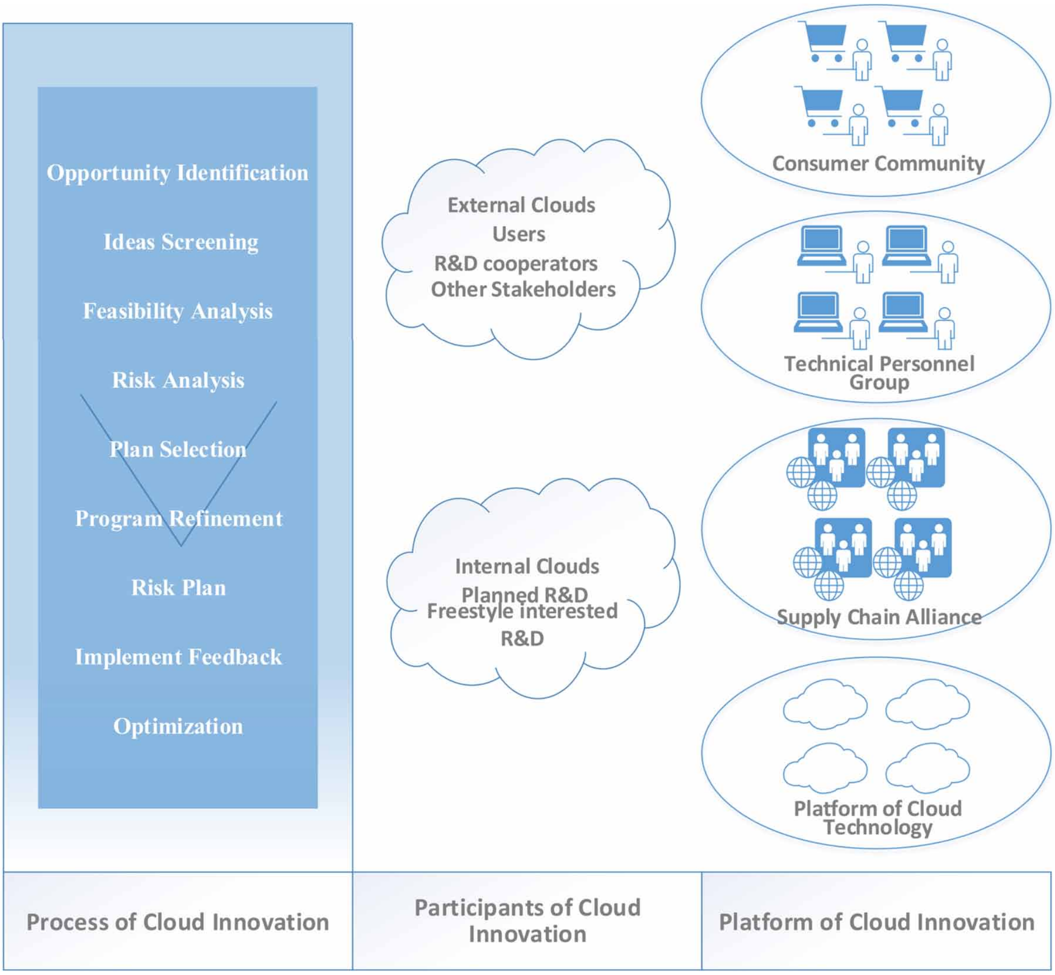
In past studies, Cournot model has been used to study the relationship between market and innovation (Loury, 1979). Sen and Tauman (2007) examined a cost reduction technology in a Cournot oligopoly setting. Another model, the Stackelberg model by Goel (1990), examines the relationship among innovation, welfare and market structure. Scholars have used the model to study technology transfer, diffusion, and licensing. For examples, De Cesare and Di (2001) set up a Stackelberg game of innovation diffusion to maximize profits from new product or technology sales. Kamien, Oren, and Tauman (1992) analyzed licensing of a cost reduction innovation to an oligopolistic industry in the form of a non-cooperative game.

As can be seen from the above, the effect of user involvement in supply chain cloud innovation has not been carefully quantified. Questions such as whether user involvement leads to lower or higher product cost remain unanswered. There is also a lack of information on how to set the optimal price for profit maximization. Therefore, the goal of this study is to quantify the effect. We follow the literature to use the game theoretical perspective. In the next section, we develop and analyze the models.

MODELING USER INVOLVEMENT IN SUPPLY CHAIN CLOUD INNOVATION

In this section, we develop a model to study the effect of user involvement in supply chain cloud innovation. Our model development effort is based on Bertrand model proposed by Bonanno and Haworth (1998). To quantify the effect of user involvement in supply chain cloud innovation, we compare two cases: one with user involvement (open innovation) and one without (closed innovation).

Figure 1. Elements of user involvement in supply chain cloud innovation



Bertrand Model

Bonanno and Haworth (1998) proposed the Bertrand model to study innovation and R&D. They used the model to compare product innovation to process innovation. Several scholars have used a similar modeling approach to study the behavior of technology licensing. For example, Muto (1993) set up a multi-stage non-cooperative game (Bertrand competition) that involves an external patentee and two firms, each producing a differentiated good. Wang and Yang (1999) found that royalty licensing is superior to fee licensing for an innovating firm, regardless the nature of an innovation being drastic or not. Other scholars have conducted comparative studies on innovation or R&D using both the Bertrand and Cournot models. For example, Aghion, Harris, and Vickers (1997) analyzed the relationship between product market competition and growth with step-by-step innovations. In short, the Bertrand model has been frequently used to study innovation.

The basic Bertrand model is presented as follows. The model assumes a duopoly market, where there are only two firms, A and B. The demand and price to firm A's product is denoted as Q_A and P_A respectively. The demand and price to firm B's product is denoted as Q_B and P_B respectively. The demand function of firms A and B is presented as:

$$Q_A = a + bP_A + cP_B$$
$$Q_B = d + eP_B + fP_A$$

The parameters *a, b, c, d, e,* and *f* satisfy:

$b, e < 0; a, d, c, f > 0$

The cost functions C_A and C_B of firms A and B is given by:

$$C_A(Q_A) = C_AQ_A$$
$$C_B(Q_B) = C_BQ_B$$

In the equations above, C_A and C_B are cost variables per unit for firms A and B, respectively. Therefore, the profit function π_A and π_B is derived as:

$$\pi_A = P_AQ_A - C_AQ_A = (P_A - C_A)(a + bP_A + cP_B)$$
$$\pi_B = P_BQ_B - C_BQ_B = (P_B - C_B)(d + eP_B + fP_A)$$

To obtain the maximum profit for firms A and B, we take the derivative and set it to zero:

$$\frac{\partial \pi_A}{\partial P_A} = a + 2bP_A + cP_B - bC_A = 0$$
$$\frac{\partial \pi_B}{\partial P_B} = d + 2eP_B + fP_A - eC_B = 0$$

Solving the equations, we have:

$$P_A = \frac{bC_A - a}{2b} - \frac{c}{2b}P_B$$
$$P_B = \frac{eC_B - d}{2e} - \frac{f}{2e}P_A$$

The Nash equilibrium solution to the problem is given by equation (1) below:

$$P_A = \frac{2e(bC_A - a) + c\left(d - eC_B\right)}{4be - cf}$$
$$P_B = \frac{2b(eC_B - d) + f\left(a - bC_A\right)}{4be - cf}$$

Quantifying the Effect of User Involvement on Product Cost and Optimal Price

Next, we apply the above Bertrand model to quantify the effect of user involvement in a supply chain setting. We still examine the two firms A and B in the duopoly market, but they will be evaluated in the supply chains. To develop the model, we assume that firms A and B each has its own supply chain, and both supply chains have three segments. Using the machinery manufacturing industry as an example, the first segment (upstream) is parts machining, the second segment is whole machine assembly, and the third segment (downstream) is end users. We further assume that product transfer between the segments is complete, that is, products manufactured by an earlier segment are all passed onto the next segment. With these assumptions, we can treat multiple firms in the first segment (i.e., multiple vendors) as one virtual firm. Products manufactured by these firms are all passed onto the machine assembly firm in the second segment, and finally to end users in the last segment. Obviously, output levels at all three segments remain the same in a given supply chain. We use Q_A to represent the production output level of supply chain A, and Q_B for supply chain B.

In supply chain A, parts manufacturers belonging to the first segment altogether sell Q_A units of parts at the price of P_{A1} to whole machine producers in the second segment. Then the whole machine producers in turn sell Q_A units of products at the price of P_{A2} to end users in the third segment. Similarly, Q_B represents the quantity of products sold from the first to the second and then the third segment in supply chain B, with price P_{B1} and P_{B2} respectively.

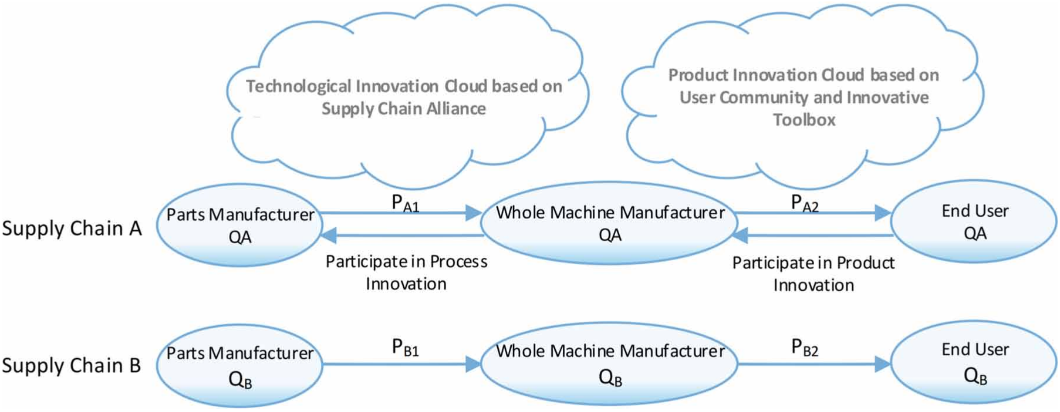
Now we consider the case of cloud innovation. If there is cloud innovation, then each manufacturer in the supply chain may benefit from user involvement so that they can plan production activities more efficiently. In general, the business process between the first and second segments of the supply chain is of a business-to-business (B2B) nature, while the business process between the second and third segments of the supply chain is more of a business-to-consumer (B2C) nature. In this B2C process, the whole machine assembly manufacturer must provide simplified toolbox for innovation to customers as well as training for the use of innovation techniques, because most customers are not professionals in innovation. Figure 2 visually presents the relationship.

Expanding the basic Bertrand model in the previous section, we have the following two demand functions for supply chains A and B, from the first to the second segment:

$$Q_A = a_1 + b_1 P_{A1} + c_1 P_{B1}$$
$$Q_B = d_1 + e_1 P_{B1} + f_1 P_{A1}$$

The parameters a_1, b_1, c_1, d_1, e_1, and f_1 satisfy:

Figure 2. The schematic diagram of innovation in supply chains A and B



$a_1, d_1, c_1, f_1 > 0; b_1, e_1 < 0;$

The cost functions of supply chains A and B, from the first to the second segment are then:

$$C_A(Q_A) = C_{A1}Q_A$$
$$C_B(Q_B) = C_{B1}Q_B$$

In which C_{A1} and C_{B1} represent marginal cost of supply chains A and B, respectively.

Following the same logic, the demand functions for supply chains A and B, from the second to the third segment are then:

$$q_A = a_2 + b_2p_A + c_2p_B$$
$$q_B = d_2 + e_2p_B + f_2p_A$$

The parameters a_2, b_2, c_2, d_2, e_2, and f_2 satisfy:

$a_2, d_2, c_2, f_2 > 0; b_2, e_2 < 0;$

The cost functions of supply chains A and B, from the second to the third segment are:

$$C_A(q_A) = C_{A2}Q_A$$
$$C_B(q_B) = C_{B2}Q_B$$

In which C_{A2} and C_{B2} represent marginal cost of supply chains A and B, from the second to the third segment, respectively.

To quantify the effect of user involvement in cloud innovation, we assume that supply chain A adopts user involved cloud innovation, but supply chain B only adopts closed innovation. In supply chain A, end users are involved in production innovation of the whole machine assembly manufacturer, and the whole machine assembly manufacturer is involved in product innovation of parts manufacturers. We can further separate users' participation in cloud innovation into two types: product versus process. Users' involvement in product innovation activities often lead to a higher level of satisfaction to the products. Price elasticity of demand tends to decrease, too. However, such involvement will likely increase production cost. In contrast, user participation in process innovation often leads to a streamlined e-commerce process, which reduces production cost.

Model Analysis

Given the above, the problem of finding the optimal price to maximize the profit can be simplified into a two-stage dynamic game as described by the Bertrand model. Such a problem can be solved by backward induction. Let P_{A1} and P_{B1} denote the product price of part manufacturers as well as the purchase cost to the whole machine assembly manufacturer in supply chains A and B. We derive the solution of P_{A1} and P_{B1} as in equation (2) below:

$$P_{A1} = \frac{2e_1(b_1C_{A1} - a_1) + c_1\left(d_1 - e_1C_{B1}\right)}{4b_1e_1 - c_1f_1}$$
$$P_{B1} = \frac{2b_1(e_1C_{B1} - d_1) + f_1\left(a_1 - b_1C_{A1}\right)}{4b_1e_1 - c_1f_1}$$

Following the same logic, we derive the solution to p_{A2} and p_{B2} in equation (3). p_{A2} and p_{B2} represent the product price of the whole machine assembly manufacture as well as cost to end users in supply chains A and B.

$$p_{A2} = \frac{2e_2(b_2P_{A1} - a_2) + c_2\left(d_2 - e_2P_{B1}\right)}{4b_2e_2 - c_2f_2}$$

$$p_{B2} = \frac{2b_2(e_2P_{B1} - d_2) + f_2\left(a_2 - b_2P_{A1}\right)}{4b_2e_2 - c_2f_2}$$

Once P_{A1} and P_{B1} are solved in equation (2), the final price p_{A2} and p_{B2} of the whole machines sold to end-users can be easily solved in equation (3).

Next, we analyze how characteristics and changes in parameter values affect product prices. We quantified the effect in a comparative context. We first look at the context when the demand functions of supply chains A and B are identical. We assume that in supply chain A, firms adopt user involved cloud innovation between all three segments of the supply chain; and in contrast, there is no user involved cloud innovation in supply chain B. The cost of parts manufacturing in supply chain A will be lower than that of supply chain B. If there is a sufficiently large absolute-slope-value of demand versus parts prices, the price of whole machines sold to end users in supply chain A will be lower than that of supply chain B.

The above can be expressed mathematically as follows. First, identical demand functions mean: $a_1 = d_1$, $b_1 = e_1$, and $c_1 = f_1$. Then we have $C_{A1} < C_{B1}$ for the lower marginal cost of supply chain A than that of supply chain B. The price difference between supply chains A and B is expressed as equation (4) below:

$$\begin{aligned} P_{A1} - P_{B1} &= \frac{2e_1(b_1C_{A1} - a_1) + c_1\left(d_1 - e_1C_{B1}\right)}{4b_1e_1 - c_1f_1} - \frac{2b_1(e_1C_{B1} - d_1) + f_1\left(a_1 - b_1C_{A1}\right)}{4b_1e_1 - c_1f_1} \\ &= \frac{2b_1(b_1C_{A1} - a_1) + c_1\left(a_1 - b_1C_{B1}\right) - 2b_1(b_1C_{B1} - a_1) - c_1\left(a_1 - b_1C_{A1}\right)}{4b_1^2 - c_1^2} \\ &= \frac{b_1(C_{A1} - C_{B1})}{2b_1 + c_1} \\ &= \frac{C_{A1} - C_{B1}}{2 + \frac{c_1}{b_1}} \end{aligned}$$

Since $C_{A1} - C_{B1} < 0$, and $2 + \frac{c_1}{b_1} > 0$ when $\left|b_1\right| > \frac{c_1}{2}$, so $P_{A1} - P_{B1} < 0$.

We follow the same logic to examine the price difference between the second and the third segment. We have $a_2 = d_2$, $b_2 = e_2$, and $c_2 = f_2$. We can get a result that is similar to equation (4):

$$p_{A2} - p_{B2} = \frac{P_{A1} - P_{B1}}{2 + \frac{c_2}{b_2}}$$

Clearly, when $\left|b_2\right| > \frac{c_2}{2}$, $p_{A2} - p_{B2} < 0$.

We also consider another context in which end users of supply chain A are more concerned about product quality, appearance, and performance in user involved cloud innovation. In other words, $b_2 > e_2$, or $|b_2| < |e_2|$. When $b_2 > e_2$, the cost functions of supply chains A and B are identical, and other parameters of the demand functions are the same, the price of whole machines sold to end users in supply chain A will be higher than that of supply chain B, if there is a sufficiently large absolute-slope-value of demand versus the whole machine price. Mathematical proof of the above statement is as follows:

First, based on the assumptions, $a_1 = d_1$, $b_1 = e_1$, $c_1 = f_1$, and $C_{A1} = C_{B1}$, we have $P_{A1} = P_{B1}$. In addition, $a_2 = d_2$, $c_2 = f_2$, and $C_{A2} = C_{B2.}$ We have:

$$\begin{aligned} P_{A2} - P_{B2} &= \frac{2e_2(b_2P_{A1} - a_2) + c_2\left(d_2 - e_2P_{B1}\right)}{4b_2e_2 - c_2f_2} - \frac{2b_2(e_2P_{B1} - d_2) + f_2\left(a_2 - b_2P_{A1}\right)}{4b_2e_2 - c_2f_2} \\ &= \frac{2e_2(b_2P_{A1} - a_2) + c_2\left(a_2 - e_2P_{A1}\right) - 2b_2(e_2P_{A1} - a_2) - c_2\left(a_2 - b_2P_{A1}\right)}{4b_2^2 - c_2^2} \\ &= \frac{(b_2 - e_2)c_2P_{A1} + 2a_2(b_2 - e_2)}{4b_2^2 - c_2^2} \end{aligned}$$

It is clear that in the formula above, the nominator is non-negative. Therefore, when $\left|b_2\right| > \frac{c_2}{2}$, $p_{A2} - p_{B2} > 0$.

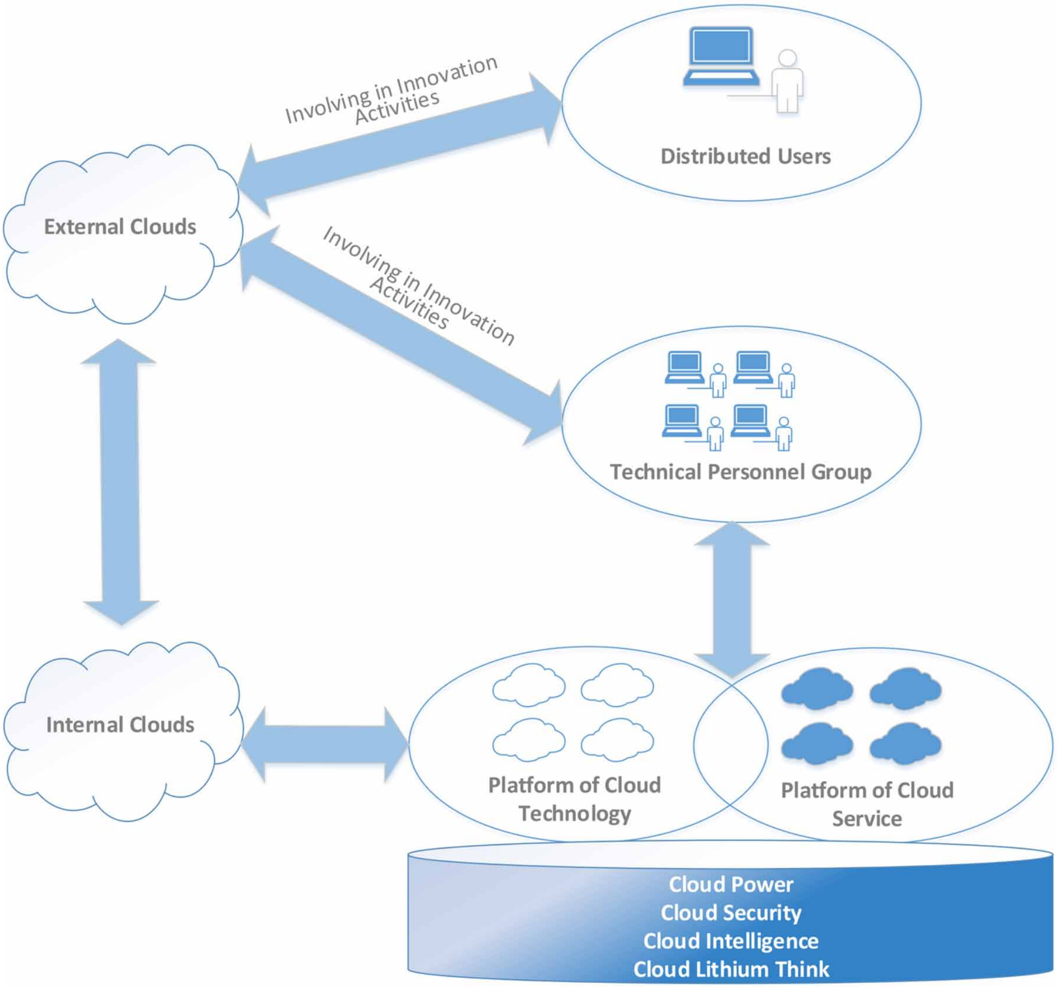
In summary, the two cases show that, user involved cloud innovation will lead to an enhanced cost position and price advantage, but it will also weaken the demand price elasticity. In other words, with the same demand, the product price will be higher when there is user involved cloud innovation in a supply chain.

A USER INNOVATION EXAMPLE: SHENZHEN TAILG ELECTRIC VEHICLE GROUP

Tailg Electric Vehicle Group provides a good site for reality check of user involved cloud innovation. Located in Shenzhen, China, the company is actively involved in supply chain cloud innovation. The company proposed several new product concepts including "cloud electric vehicle." Through user involvement in supply chain cloud innovation, Tailg develops a concept car that integrates multiple cutting-edge technologies. These technologies include future chip design, mobile control system, wireless charging, a postmodern lithium trams equipped with calories analyzer, and a 4G mobile data analysis system.

User involvement in supply chain cloud innovation at Tailg is conducted through a "cloud technology" system and a "cloud service" system. The "cloud technology" system contains four elements: cloud power, cloud security, cloud intelligence, and cloud lithium. Cloud power provides

Figure 3. Process of user involvement in supply chain cloud innovation at Tailg



consumers with choices in two dimensions: mileage and climbing power. Cloud security supplies choices in the central prevention and control module, which is a strong shift from passive security to active anti-theft prevention and control. This shift utilizes multiple security control mechanisms of electric vehicles. Cloud intelligence is an intelligent control module to provide users with a smart life experience. Cloud lithium is based on contemporary 4G communications technology, including a riding mode, a power mode, an electric mode, and a fitness mode. The “cloud service” system is an innovative integration of e-commerce and traditional service systems to provide more interactive users experiences. The cloud service platform has the ability to real-time track a user’s product usage pattern, enabling Tailg to provide services such as automatic detection, dynamic analysis, vector report, remote repair, and riding suggestions.

User involvement in supply chain cloud innovation at Tailg includes user experiences, user involvement in design, user do-it-yourself (DIY), user customization, and technology extension services. Together they serve the purpose of better meeting users’ needs. Figure 3 describes the process of user involvement in supply chain cloud innovation at Tailg.

While impressive, there is little doubt that many more opportunities for improvement exist. It has been suggested that crowdsourcing and crowdfunding should be included in the supply chain cloud innovation system. Such a mechanism enables users to specify certain R&D tasks and allocate financial resources toward them, which might be more direct and effective than the traditional R&D resource allocation process. It has also been suggested that user communities should be established to allow different market segments to participate. The third suggestion is to incorporate a cloud-based incentive mechanism such as membership upgrade, user project funding, and post-award funding. Figure 4 depicts an optimized supply chain cloud innovation process with these suggestions.

CONCLUSIONS

Cloud innovation has become increasingly important to supply chain innovation and performance. User involvement is a crucial part of cloud innovation. However, the effect of user involvement in supply chain cloud innovation has not been thoroughly studied, particularly, its effect on product cost and optimal price. In this paper, we attempted to bridge this major gap in the literature. We reviewed the relevant literature to define cloud innovation and user involvement in supply chain cloud innovation. Then we developed a game model based on the Bertrand model. Analysis of the model showed that user involvement affects product cost and optimal pricing in an interesting way. We also presented a real life example of how user innovation takes place at Tailg electric vehicle company.

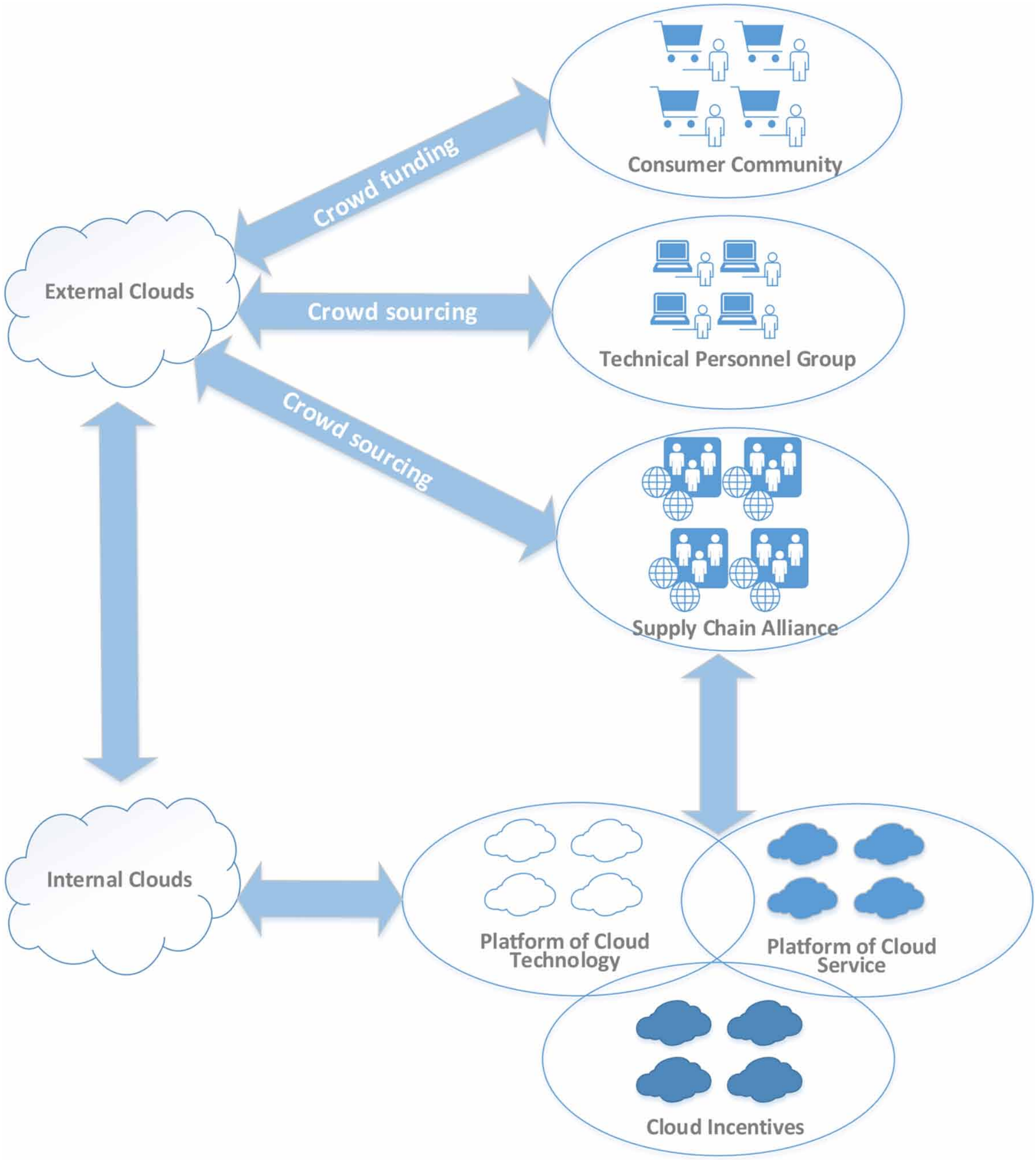
This paper potentially contributes to the literature. As stated above, this is one of the first studies that attempted to quantify the effect of user involvement in supply chain cloud innovation. Insights help develop a more in-depth understanding of the effect. They also provide guidance for practicing managers.

This study can be further extended in multiple ways. It is a plausible idea to empirically test the effect presented by our model. It is also a promising direction to look deep into the incentive mechanism of user innovation as well as toolbox provided. A closer examination of such mechanisms will very likely lead to new knowledge.

ACKNOWLEDGMENT

This work was supported by National Social Science Foundation of China (Grant No. 17BGL230).

Figure 4. Optimized process of user involvement in supply chain cloud innovation at Tailg



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