Omega 115 (2023) 102777

Contents lists available at ScienceDirect

Omega

journal homepage: www.elsevier.com/locate/omega

A proprietary component manufacturer's global supply chain design: The impacts of tax and organizational structure☆

Sijing Deng[a], Jiayan Xu[b,*], Yonghui Han[c]

[a] School of Economics and Management, South China Normal University, Guangzhou 510006, China
[b] School of Business, Sun Yat-sen University, Guangzhou 510275, China
[c] Guangdong Institute for International Strategies, Guangdong University of Foreign Studies, Guangzhou 510420, China

ARTICLE INFO

Article history:
Received 20 October 2021
Accepted 28 September 2022
Available online 4 October 2022

Edited by: Prof. Hvattum

Keywords:
Proprietary component manufacturer
Global supply chain
Tax
Organizational structure
Transfer price

ABSTRACT

This paper studies the supply chain structure design for a proprietary component manufacturer (PCM) in a global environment. The PCM, producing component with patent protection and/or superior quality, chooses to enter into an overseas market to enhance revenue. There are three supply chain structures available to the PCM: (1) monopoly where the PCM establishes a downstream manufacturing subsidiary to produce and sell the end product, (2) component supplier where the PCM supplies component to a local original equipment manufacturer (OEM), and (3) dual distributor where the PCM supplies component to the OEM but also produces a competing end product. Our analysis suggests that two important features in a global environment, i.e., the global tax disparity and the organizational structure, have significant impacts on the PCM's supply chain structure design and profits. If the downstream has a tax advantage, it is optimal for the PCM to directly enter into the downstream market with the structure of monopoly. As the downstream tax rate increases, the other two structures, i.e., component supplier and dual distributor, become more attractive. We show that centralization makes the dual distributor and monopoly structures more desirable. However, the OEM may be driven out of the market and the dual distributor structure is infeasible when the downstream tax rate is high enough. Contrary to our traditional wisdom, decentralization may benefit the PCM under certain circumstances.

1. Introduction

Globalization makes it convenient for manufacturers to expand their market bases and sell products to overseas markets. One special type of manufacturer is called *proprietary component manufacturer* (PCM), which produces components with patent protection and/or superior quality. In order to cover the large amounts of R&D investment incurred on the components, the PCM usually enhances its revenue by entering into overseas markets. Due to the proprietary nature and high quality, the PCM is usually the sole source of a critical component (e.g., Pentium CPU) for end products (e.g., PCs). Therefore, the PCM is often able to shape the downstream supply chain structure when expanding to an overseas market. In practice, we observe three different supply chain structures among PCMs. Some PCMs produce and sell their own end products using the proprietary components, but don't share proprietary components with other original equipment manufacturers (OEMs). In such case, these PCMs adopt the *monopoly* structure. For example, Bose Corporation does not share its proprietary technology but uses it to produce high-quality speakers and sells directly to consumers. Alternatively, some PCMs refrain from the end-product market and instead supply their proprietary components to OEMs who produce end products. We call it *component supplier* strategy. For example, Intel supplies its CPUs to OEMs such as Dell and HP, but does not build PCs for sale in the end-product market. A third route that some PCMs have taken is to produce their own end products while supplying the components to other OEMs. The PCMs' and OEMs' products usually compete in the end-product market. We call it *dual distributor* strategy. For example, Panasonic produces advanced compressor which is a core component of refrigerator. It sells refrigerator in overseas markets but also supplies compressor to local competitors like Haier.

Moreover, a PCM's supply chain design is far from a permanent arrangement. We observe in many industries that PCMs change their supply chain structure choices. Palm, specialized in manufacturing personal digital assistants, used to sell handheld devices with its Palm OS operating system under monopoly structure. But

☆ Area - Supply Chain Management. This manuscript was processed by Associate Editor Prof. Benjamin Lev.

* Corresponding author.
E-mail address: xujiayan3@mail.sysu.edu.cn (J. Xu).

https://doi.org/10.1016/j.omega.2022.102777
0305-0483/

later on it also supplies the operating system to other handheld makers, and transforms to dual distributor structure [51]. After being the world largest operating system provider for decades, Microsoft also introduces its own PCs and sells to global markets. On the contrary, IBM transforms to be a pure service provider after selling its PC business. Understanding the drivers for such changes will help PCMs reshape their supply chain structures.

The extant literature, including Venkatesh et al. [46] and Xu et al. [51], study the optimal supply chain structure design of PCMs under different settings, and investigate the impacts of various factors, such as competition intensity, production capability, marketing investment, contractual agreement and consumer valuation. These researches show that each supply chain structure has its own advantages and drawbacks. However, these researches focus on issues and tradeoffs in a local supply chain. The problem of supply chain structure design for a PCM under a global supply chain environment has not been well investigated. However, the above mentioned companies, like Bose and Panasonic, are all multinational firms (MNFs) with operations in different countries. This motivates us to study a PCM's supply chain structure design when entering into a new overseas market, and consider important factors in the global environment, such as the tax rate disparity between the upstream and downstream countries and the organizational structure of the PCM.

MNFs have long realized that it is very important to align the supply chain management with global tax planning. For example, a global survey conducted by Ernst & Young found that 80% of US-based MNFs involve tax directors at the "concept or initiation phase" of business planning and that only 5% of MNFs reported that they do not [17]. Deloitte recommends in its "strategic tax vision" that, at the beginning of any new business project, MNFs should involve tax departments to assess supply-chain strategies that may lead to a reduced structural tax rate and, consequently, to improved after-tax profits [13]. Large MNFs, such as General Electric and Apple, saved billions of dollars in taxes through tax-efficient supply chain management [16,29]. If a MNF's upstream and downstream subsidiaries face different corporate income tax rates, this MNF will have strong incentives to shift profits from the high-tax country to the low-tax country by properly adjusting its transfer price, which is the transaction price between the MNF's different subsidiaries. As an example, consider a MNF that produces a product with a unit cost of \$1 in an upstream country and sells the product with a retail price of \$10 in a downstream country. Let's assume that the corporate income tax is 20% in the upstream country while 40% in the downstream country. If the MNF uses a transfer price at \$2, its total after-tax profit is $(2-1)*(1-0.2)+(10-2)*(1-0.4)=\$5.6$. However, if it uses a transfer price at \$9, its total after-tax profit increases to \$7 which implies a 25% improvement. This simple example illustrates the roles of transfer price in income shifting. Some supply chain literature have shown the significant impacts of global tax disparity and transfer price on MNFs' distribution channel strategy [22,44] and sourcing decisions Shunko et al. [43].

If a PCM chooses the monopoly or dual distributor structure when entering into an overseas country, it produces the component and end product in different countries. These two supply chain structures provide opportunities for the PCM to shift profits and improve global tax efficiency via transfer price decisions. However, the PCM's income shifting behavior is restricted by the famous arm's length principle (ALP), which is imposed by the Organisation for Economic Co-operation and Development (OECD) for international trade. For a MNF with global operations, the upstream country would prefer a high transfer price from the MNF to enlarge its tax base, but the downstream country would prefer a low transfer price from the MNF. The OECD imposes ALP restriction for MNF's transfer price to guarantee that each country could get a fair tax base from the MNF. The transaction price between the MNF and outside independent firms for the same product is an ideal benchmark for the internal transfer price. Therefore, ALP requires that the MNF's internal transfer price should be equal to the wholesale price at which the MNF sells to outside independent firms [40]. Hence, if the PCM adopts the dual distributor structure, the wholesale price offered to the downstream OEM will restrict the PCM's transfer price decision and global after-tax profits. Therefore, the impacts of international taxation and transfer price on the PCM's supply chain design are subtle, and need further exploration and study.

Another important issue about global supply chain design is the organizational structure of the multinational PCM. In reality, there are two commonly used organizational structures for MNFs: centralized structure and decentralized structure. Under centralized structure, headquarters of MNFs centrally make all decisions. Under decentralized structure, however, retailing and marketing decisions are delegated to local subsidiaries. The conventional belief, which is based on local operations, favors centralized structure since it can avoid the well-known double marginalization problem. In a global environment, however, it is not uncommon that retailing decisions are delegated to local subsidiaries which are closer to customers and have better market information than headquarters [5,20]. According to an empirical study by Robinson and Stocken [42], decentralized organizational structure is utilized for approximately three quarters of MNFs' subsidiaries, and there is an observable increasing trend towards decentralization among MNFs. The study also suggests that MNFs selling relatively standardized products (e.g., petroleum) are more likely to centralize most decisions, but those selling more customized products (e.g., electronic products, food, and services) have tendency to decentralize local decisions to subsidiaries. When entering into an overseas market, the PCM needs to consider whether to adopt the decentralized structure and delegate decision rights to the overseas subsidiary.

This paper builds a game-theoretical model to study a PCM's supply chain structure design in a global environment. The PCM in our model produces a proprietary component in an upstream country, and wants to enter into an overseas market by establishing a downstream manufacturing subsidiary and/or supplying component to a local OEM who focuses on product manufacturing and has cost advantage as compared to the PCM. Therefore, there are three available supply chain structures for the PCM: monopoly structure, component supplier structure, and dual distributor structure. We derive and compare the equilibrium outcomes of each supply chain structure under decentralization and centralization. We summarize the major findings as follows.

We find that the tax rate disparity between the upstream and downstream countries has fundamental impacts on the PCM's supply chain structure decisions. Under decentralized structure, when the downstream has a tax advantage, it is optimal for the PCM to enter into the market directly and adopt the monopoly structure, where the double marginalization problem is alleviated by the downstream tax advantage and low transfer price. When the downstream has a significant tax disadvantage, however, it is difficult for the PCM to balance between alleviating double marginalization and shifting profits. In such case, the structures of dual distributor and component supplier become more attractive for the PCM. It is optimal for the PCM to adopt the dual distributor structure when the OEM's cost advantage is insignificant, and remain in the component wholesale market with component supplier structure when the OEM's cost advantage is sufficiently large. Interestingly, since the ALP forces the PCM to lower the component wholesale price, the OEM may benefit from the PCM's encroachment. Centralization eliminates the double marginalization and makes it easier for the PCM to coordinate the component wholesale profit and product retail profit. Therefore, the component supplier struc-

ture becomes less attractive but the dual distributor structure becomes more attractive. However, when the downstream has a significant tax disadvantage and the OEM's cost advantage is not large, the OEM is driven out of the market and the optimal supply chain structure is reduced to monopoly.

We also compare the PCM's and OEM's equilibrium profits under decentralized and centralized organizational structures. Our analysis suggests that when the downstream tax disadvantage and the OEM's cost advantage are sufficiently large, decentralization may bring benefits, rather than burdens, to the PCM in a global supply chain setting. This finding contradicts with the conventional wisdom (which is based on a local environment) that centralization coordinates the supply chain and benefits the integrated firm. The underlying reason is that the aggressive encroachment from the centralized PCM may drive the OEM out of market, and the dual distributor structure cannot be sustained. Another interesting finding is that decentralization may lead to win-win, lose-lose and lose-win outcomes for the PCM and OEM.

Our paper contributes to the supply chain structure design literature by extending it to a global environment. We find that the global tax disparity and the organizational structure of the PCM have significant impacts on the supply chain decisions and profits. Moreover, we derive some results that are different from the traditional literature. For example, we show that under centralized structure, the PCM finds dual distributor structure attractive when the OEM's cost advantage is very significant and the global tax disparity is moderate. This contradicts with the traditional result that the PCM will choose dual distributor structure when the OEM's cost advantage is moderate. This difference shows that the PCM should consider both operations environment and tax environment in choosing the best supply chain structure.

The rest of this paper is organized as follows. Section 2 reviews the related literature and positions this study. Section 3 presents the model formulation. We analyze different supply chain structures and characterize the optimal supply chain design under decentralization in section 4. We analyze the centralized case in section 5, and compare centralized and decentralized structures in section 6. Section 7 concludes the paper and presents some future research directions. All the proofs are in the Appendix.

2. Literature review

This paper mainly relates to three streams of literature: tax-efficient supply chain management, global supply chain management, and supply chain structure design.

Due to globalization, nowadays the sourcing, manufacturing and distribution of various products are located in different countries/regions around the world. Tax-efficient supply chain management, which studies the impacts of international taxation on global supply chain management, has become a rapidly growing research stream in recent years. Cohen and Lee [10] and Cohen and Mallik [12] provide excellent reviews about early studies in this stream. Shunko et al. [44] compare three commonly-observed operations structures when a MNF's distribution division is located in a low-tax jurisdiction. Yang et al. [53] address a MNF's onshoring vs. backshoring decision, and investigate the impacts of production cost, tariff and market competition. Legislations and policies imposed by governments and organizations will significantly affect the tax liabilities and supply chain decisions of MNFs. Li et al. [34] study the impacts of local content requirement in international trade on MNFs' material sourcing strategies. Hsu and Zhu [23] and Xu et al. [52] investigate the impacts of China's export-oriented tax policies on MNFs' procurement, manufacturing, and distribution strategies. Based on the newsvendor model framework, Xiao et al. [50] and Hsu and Hu [21] analyze MNFs' global capacity and sourcing decisions under the tax cross-crediting policy.

Among the research stream of tax-efficient supply chain management, some papers specifically investigate how MNFs use transfer prices to improve tax efficiency and global after-tax profits. Huh and Park [26] and Wu and Lu [48] analyze and compare MNFs' decisions and profits under cost-plus and resale-price transfer price methods. Shunko et al. [43] investigate how a decentralized MNF aligns the transfer price decision and sourcing strategy to take advantage of the low foreign tax rate and low production cost. Hsu et al. [22] study a MNF's decision of selling to a downstream rival, considering the tax rate disparity and transfer price regulation. Lai et al. [31] study the impacts of information asymmetry and global tax disparity on a MNF's procurement outsourcing strategy under the territorial tax system.

Our paper enriches this stream of research by investigating a PCM's global supply chain design problem, and we further compare two commonly used organizational structures among MNFs: decentralized and centralized structures. Our analysis shows that international taxation and organizational structure have significant impacts on the PCM's global supply chain choice and profit.

The second stream of literature related to our study is the global supply chain management. Cohen and Lee [11] give an extensive review about this stream and point out some promising future research opportunities. Based on a global newsvendor model, Kouvelis and Gutierrez [30] propose a nonlinear pricing scheme to coordinate a MNF's production and inventory decisions in two markets. Lu and Van Mieghem [39] investigate the production decision of a common part which can be transported to serve two geographically separated markets. They mainly address the question of whether to centrally produce the common part in one market. Dong et al. [14] study a MNF's facility design decision, i.e., where to locate the production facility, considering uncertain exchange rate and responsive pricing. Boute and Van Mieghem [6] formulate a discrete-time inventory model to study a MNF's global sourcing problem, and analyze the impacts of capacity and lead times. Among this stream of literature, some papers consider MNFs' decisions about offshoring or reshoring, and study the impacts of production cost, market competition, demand information, supply dependence, and risk pooling [2,8,28,47,49]. Cohen et al. [9] give a comprehensive summary about literature in this area. We contribute to this stream of literature by studying a PCM's global supply chain structure design problem, which has not been addressed in the extant literature, and consider some important features in the global environment, such as international taxation and organizational structure.

Our paper is also related to the literature about supply chain structure design. To the best of our knowledge, our paper is most related to those by Venkatesh et al. [46] and Xu et al. [51]. They investigate a PCM's choice among the following three supply chain structures: component supplier, monopoly, and dual distributor. They also study the impacts of various factors, such as competition intensity, production capability, marketing investment, contractual agreement and consumer valuation, on the PCM's preference about different supply chain structures. Our paper is different from theirs in the following two aspects. First, they consider a local supply chain structure design problem, while we cast this problem into a global environment and investigate the impacts of tax rate disparity between the upstream and downstream countries. Second, we further compare two commonly observed organizational structures among MNFs (decentralized and centralized structures), and find that under certain circumstances, decentralization may benefit the multinational PCM. Furthermore, we also derive some results that are different from these papers. For example, Xu et al. [51] show that the PCM finds dual distributor structure most attractive when the OEM's cost advantage is moderate. However, our

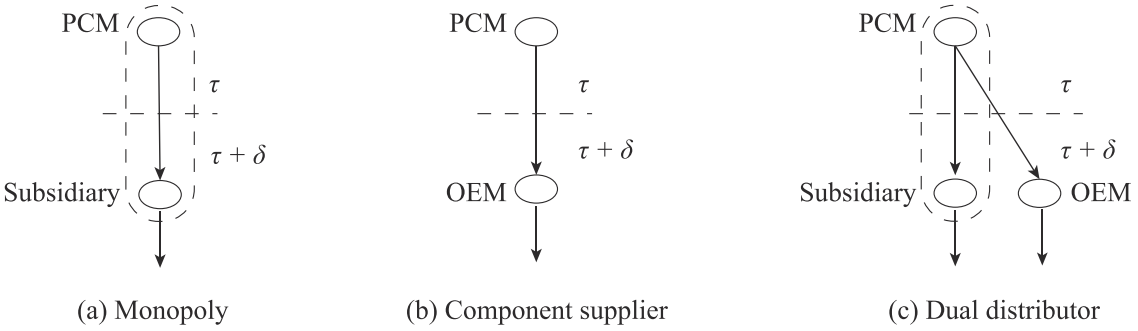


Fig. 1. Supply chain structures.

analysis of the centralized structure suggests that the dual distributor strategy will be chosen by the PCM only when the OEM's cost advantage is very significant. Literatures that study dual channel structure are also related, such as Duan et al. [15], Guo et al. [19], Huang et al. [25], Jiang et al. [27], Li et al. [33,35,37], Liu et al. [38], Yi et al. [54], and Song et al. [45].

Our paper is finally related to the literature that compares the centralized and decentralized organizational structures. It is well known in supply chain management that decentralization leads to double marginalization problem, and that centralization eliminates the double marginalization and benefits the integrated firm [24,32]. A large stream of supply chain literature study various supply chain contracts, including buyback contracts [41] and revenue sharing contracts Cachon and Lariviere [7], to restore supply chain efficiency and achieve supply chain coordination. Interestingly, some literature demonstrate, under certain supply chain settings and reasonable assumptions, the benefits of decentralization over centralization Alles and Datar [1], Arya and Mittendorf [3], Arya et al. [4], Göx [18], Li et al. [36]. For example, Alles and Datar [1] and Göx [18] examine the benefits of an integrated firm ceding control to its affiliates and the role of strategic transfer prices on downstream competition. Among this stream of literature, the paper by Arya et al. [4] is most related. They compare the centralized and decentralized structures of an integrated firm that supplies products to a downstream rival. They show that the integrated firm may benefit from decentralization under which the integrated firm is able to gain more wholesale profits from the downstream rival. Our paper differs from theirs in the following two aspects. First, we compare the centralized and decentralized structures in a global environment, and study the impacts of global tax disparity. Second, we further investigate the PCM's three options for its global supply chain design: monopoly, component supplier and dual distributor.

3. Model

Consider a PCM (she) who owns a leading innovation and produces a proprietary component of some end consumer products. The production of the proprietary component occurs in the home country, while the manufacturing and assembly capability for the end consumer products is widely available. We assume that end products are locally produced to better respond to market demands. When entering into an overseas country, there are three available supply chain structures for the PCM: (1) monopoly structure where the PCM directly enters into the end product market by establishing a downstream manufacturing subsidiary who manufactures and sells final product to the local market; (2) component supplier structure where the PCM remains in the component market and supplies the component to an outside OEM (he) who manufactures and sells final product; (3) dual distributor structure where the PCM enters into the end product market through a downstream manufacturing subsidiary and also supplies component to an external OEM. To facilitate our analysis, we use the subscripts m, d, and o to denote the PCM, the downstream manufacturing subsidiary, and the external OEM, respectively. The proprietary component is produced in the upstream country with corporate income tax rate τ, while the downstream manufacturing subsidiary and external OEM are located in the downstream country with tax rate $\tau+\delta$, where δ measures the tax rate disparity between the upstream and downstream countries, and could be either positive or negative. When $\delta \geq 0$, the downstream tax rate is higher than the upstream. When $\delta < 0$, however, the tax rate of the downstream country is lower. We assume that the tax rates are in the interval $[0, 1]$ in accordance with the reality, i.e., $0 \leq \tau, \tau+\delta \leq 1$. Fig. 1 depicts the three supply chain structures available to the PCM. In the following analysis, we use the superscripts M, S, and D to denote the monopoly structure, component supplier structure, and dual distributor structure, respectively.

The unit production cost for the proprietary component is c_m, and the unit manufacturing cost for the final product by the OEM is c_o. The OEM focuses on product manufacturing and usually enjoys a capability advantage in producing the end product. To this end, we assume that the unit manufacturing cost of the PCM's downstream subsidiary is $c_o + c_a$, where $c_a \geq 0$ denotes the OEM's cost advantage. The market price is determined by the total selling quantity. Under the monopoly and component supplier structures, the inverse demand functions are given by $p = a - q_m$ and $p = a - q_o$, where p is the market selling price, a is the market size, and q_m and q_o are the selling quantities of the PCM's downstream subsidiary and the OEM respectively. We assume Cournot competition between the OEM and the PCM's downstream subsidiary. Therefore, under the structure of dual distributor, the inverse demand function becomes $p = a - q_m - q_o$.

Under component supplier structure, we assume that the PCM supplies the component to the OEM through a wholesale price contract. Specifically, the PCM proposes a take-it-or-leave-it contract with wholesale price w, and the reservation profit of the OEM is assumed to be zero. Under monopoly and dual distributor structures, the PCM's component production and final product manufacturing reside in two countries with disparate tax rates. In such case, the PCM is motivated to set a preferable transfer price t, which is the transaction price between the PCM's upstream and downstream subsidiaries, to shift profits and improve tax efficiency. However, under dual distributor structure, ALP requires that the PCM's internal transfer price t and external wholesale price w should be the same [40]. That is, $t = w$.

In the following, we will study the PCM's supply chain structure design under two commonly observed organizational structures among MNFs: decentralized and centralized structures. Under decentralized structure, the downstream subsidiary independently determines the selling quantity to optimize its local profit. Under centralized structure, however, the PCM centrally makes the selling quantity decision to optimize her global after-tax profit. Before we

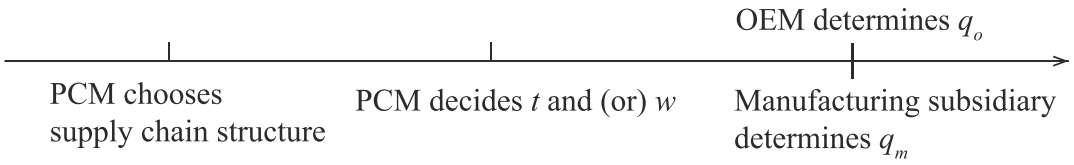


Fig. 2. Sequence of events under decentralized structure.

proceed to the analysis, we make some parameter transformations to facilitate analysis: $\alpha \equiv a - c_m - c_o$, $C \equiv c_a/\alpha$, and $\Delta \equiv \delta/(1-\tau)$. α could be viewed as the normalized market potential, and C represents the relative cost advantage of the external OEM. We assume $0 \le C \le 2/7$ to guarantee nonnegative selling quantities. To be consistent with realistic situations, we assume $-1/2 \le \Delta \le 1/2$. Similar assumption could be found in Hsu et al. [22].

4. Decentralized structure

In this section, we investigate and compare different supply chain structures of the PCM under decentralized organizational structure. The PCM is the Stackelberg-leader and the manufacturing subsidiary and OEM are the followers. The sequence of events is summarized as follows (illustrated in Fig. 2). First, the PCM determines the supply chain structure to optimize her global after-tax profits. Second, the PCM decides the transfer price for the downstream manufacturing subsidiary and/or the wholesale price for the external OEM under the corresponding supply chain structure. Third, the manufacturing subsidiary and/or the OEM determine the selling quantities (simultaneously). In the following, we first derive the subgame prefect equilibrium under each supply chain structure, and then analyze the optimal supply chain structure for the PCM.

4.1. Analysis of different supply chain structures

Monopoly: Under monopoly structure, the PCM enters into the overseas product market directly through the downstream manufacturing subsidiary. The PCM decides the transfer price t to maximize her global after-tax profit, which includes profits from upstream and downstream countries:

$$\Pi_m = (1-\tau)(t - c_m)q_m + (1-\tau-\delta)(a - q_m - t - c_o - c_a)q_m. \tag{1}$$

In this case, the PCM has no external wholesale price as reference, but the transfer price should not be lower than the component cost to avoid the negative upstream profit. Then, the downstream manufacturing subsidiary decides the selling quantity q_m to maximize its own after-tax profit:

$$\Pi_d = (1-\tau-\delta)(a - q_m - t - c_o - c_a)q_m. \tag{2}$$

Component supplier: Under component supplier structure, the PCM stays in the component market and supplies component to the external OEM. The PCM decides the wholesale price w to maximize her after-tax profit:

$$\Pi_m = (1-\tau)(w - c_m)q_o. \tag{3}$$

Then, the OEM determines the selling quantity q_o to maximize his after-tax profit:

$$\Pi_o = (1-\tau-\delta)(a - q_o - w - c_o)q_o. \tag{4}$$

Dual distributor: Under dual distributor structure, the PCM enters into the end product market through the downstream manufacturing subsidiary, and also supplies component to the external OEM. To this end, the dual distributor structure is a combination of monopoly and component supplier structures. The PCM determines the wholesale price w and transfer price t to optimize her global after-tax profit:

$$\begin{aligned}\Pi_m = {} & (1-\tau)[(t - c_m)q_m + (w - c_m)q_o] \\ & + (1-\tau-\delta)(a - q_o - q_m - t - c_o - c_a)q_m.\end{aligned} \tag{5}$$

The wholesale price and transfer price are subject to the ALP. Therefore, $t = w$. Then, the downstream manufacturing subsidiary and the external OEM determine the selling quantities simultaneously. The after-tax profit functions of the subsidiary and OEM are as follows:

$$\Pi_d = (1-\tau-\delta)(a - q_m - q_o - t - c_o - c_a)q_m, \tag{6}$$

$$\Pi_o = (1-\tau-\delta)(a - q_m - q_o - w - c_o)q_o. \tag{7}$$

Equilibrium results: The subgame perfect equilibrium of each supply chain structure could be derived by the standard backward induction. The detailed derivations are in the Appendix. We summarize the equilibrium results in Table 1.

The following corollary shows the impacts of δ and c_a on the PCM's and OEM's profits under different supply chain structures.

Corollary 1. *Under decentralized structure, we have the following results:*

(a) Π_m^M *and* Π_m^D *are decreasing in* δ *and* c_a*, and* Π_m^S *is independent of* δ *and* c_a*.*

(b) Π_o^S *and* Π_o^D *are decreasing in* δ*.* Π_o^S *is independent of* c_a*, and* Π_o^D *is increasing in* c_a*.*

The results in Corollary 1 are very intuitive. The increase of downstream tax rate hurts both the multinational PCM and the local OEM. Under component supplier structure, however, the PCM only produces the component in the upstream country and supplies to the local OEM. Therefore, the PCM's profit in this case is independent of the global tax disparity δ. The impacts of c_a are also obvious.

4.2. The optimal supply chain structure

Based on the equilibrium results in Table 1, this section aims to compare the PCM's profits under different structures. We'll first make pairwise comparisons, and then move to the comparison of three supply chain structures. The pairwise comparisons enable us to disentangle the tradeoffs in designing the optimal structure for the PCM.

The following lemma compares the PCM's profits under the structures of monopoly and component supplier.

Lemma 1. $\Pi_m^M > \Pi_m^S$ *if* $C < C_1(\Delta)$ *and* $\Pi_m^S \ge \Pi_m^M$ *otherwise, where*

$$C_1(\Delta) = \begin{cases} \frac{2}{7}, & \text{if } \Delta < 1/49, \\ (2 - \sqrt{2(1+\Delta)})/2, & \text{if } \Delta \ge 1/49. \end{cases}$$

Lemma 1 shows that as the downstream tax rate increases and the OEM's cost advantage widens, the PCM is more likely to prefer component supplier structure. The results are shown in Fig. 3, where the horizontal axis Δ measures the tax rate disparity between the upstream and downstream countries while the vertical

Table 1
Equilibrium results under decentralized structure.

Monopoly		Component supplier		Dual distributor	
t^M	$c_m + \frac{\delta(\alpha-c_a)}{1-\tau+\delta}(\delta \geq 0)$	w^S	$c_m + \frac{\alpha}{2}$	t^D	$c_m + \frac{2(2-2\tau+\delta)\alpha+(1-\tau-4\delta)c_a}{2(5-5\tau+\delta)}$
	$c_m\ (\delta < 0)$			w^D	$c_m + \frac{2(2-2\tau+\delta)\alpha+(1-\tau-4\delta)c_a}{2(5-5\tau+\delta)}$
q_m^M	$\frac{(1-\tau)(\alpha-c_a)}{2(1-\tau+\delta)}\ (\delta \geq 0)$	q_o^S	$\frac{\alpha}{4}$	q_o^D	$\frac{2(1-\tau)\alpha+(3-3\tau+2\delta)c_a}{2(5-5\tau+\delta)}$
	$\frac{\alpha-c_a}{2}\ (\delta < 0)$			q_m^D	$\frac{(1-\tau)(2\alpha-7c_a)}{2(5-5\tau+\delta)}$
Π_m^M	$\frac{(1-\tau)^2(\alpha-c_a)^2}{4(1-\tau+\delta)}\ (\delta \geq 0)$	Π_o^S	$\frac{(1-\tau-\delta)\alpha^2}{16}$	Π_o^D	$\frac{(1-\tau-\delta)(2(1-\tau)\alpha+(3-3\tau+2\delta)c_a)^2}{4(5-5\tau+\delta)^2}$
	$\frac{(1-\tau-\delta)(\alpha-c_a)^2}{4}(\delta < 0)$	Π_m^S	$\frac{(1-\tau)\alpha^2}{8}$	Π_m^D	$\frac{(1-\tau)(4(1-\tau)\alpha^2-4(2-2\tau-\delta)\alpha c_a+(9-9\tau-8\delta)c_a^2)}{4(5-5\tau+\delta)}$

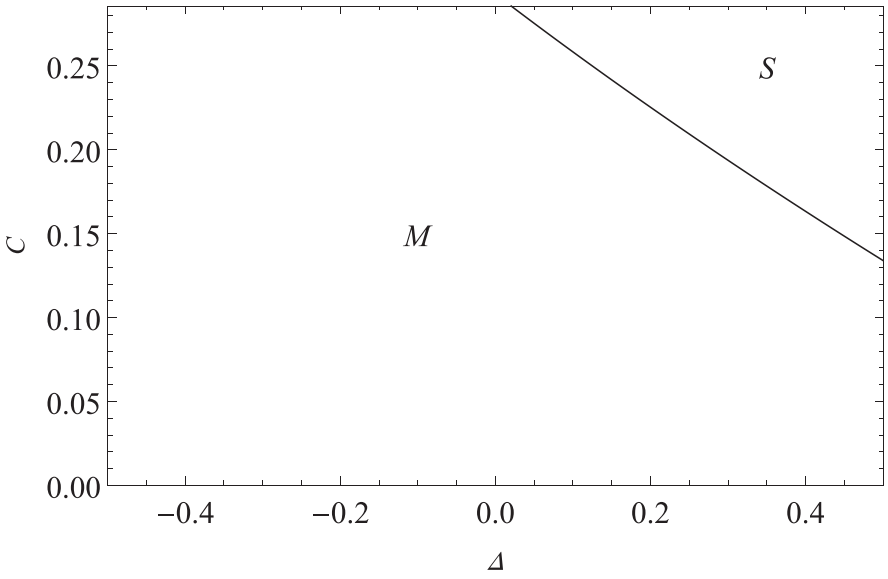


Fig. 3. Monopoly vs. component supplier under decentralization.

axis C measures the relative cost advantage of the OEM. We use "M" to denote the region where $\Pi_m^M > \Pi_m^S$, and "S" to denote the region where $\Pi_m^S \geq \Pi_m^M$. The advantage of the monopoly structure is that the PCM can earn some downstream retail profit. The disadvantage, however, is that the PCM's production efficiency is lower as compared to the OEM under component supplier structure. When the downstream tax rate is relatively low (i.e., $\Delta < 1/49$), then the downstream retail profit is relatively valuable, and the PCM always prefers monopoly structure. When the downstream tax rate is high enough (i.e., $\Delta \geq 1/49$), the downstream profit becomes less important, and whether monopoly structure outperforms the component supplier structure depends on the relative production efficiency: If the OEM's cost advantage is limited (i.e., $C < C_1(\Delta)$), the PCM still prefers to directly enter into the downstream market; if the OEM has a significant cost advantage (i.e., $C \geq C_1(\Delta)$), however, it is better for the PCM to act as a pure component supplier and refrain from the downstream market.

From another perspective, as the downstream tax rate increases, the PCM, which aims to maximize its global after-tax profit, will raise the transfer price to shift more profits to the upstream country under monopoly structure. However, under component supplier structure, the PCM only gains profit from the upstream country, and its transfer price decision is independent of the downstream tax rate. As a result, the double marginalization problem becomes more severe under monopoly structure, as compared to component supplier structure. That's another reason why the monopoly structure becomes less attractive as Δ increases.

Next, we compare the PCM's profits under monopoly and dual distributor structures. Lemma 2 shows the results.

Lemma 2. *(a) When* $\Delta < 1/24$, $\Pi_m^M > \Pi_m^D$;
(b) When $1/24 \leq \Delta \leq 1/3$, *there exists a threshold* $C_2(\Delta)$ *such that* $\Pi_m^M > \Pi_m^D$ *if* $C < C_2(\Delta)$; *otherwise,* $\Pi_m^D \geq \Pi_m^M$;
(c) When $\Delta > 1/3$, $\Pi_m^D \geq \Pi_m^M$.

Lemma 2 shows that as the downstream tax rate increases and the OEM's cost advantage widens, the PCM is more likely to prefer dual distributor structure. The results are shown in Fig. 4. We use "M" to denote the region where $\Pi_m^M > \Pi_m^D$, and "D" to denote the region where $\Pi_m^D \geq \Pi_m^M$. Introducing a downstream competitor into the market increases the PCM's component wholesale profit in the upstream, but intensifies the market competition and hurts the PCM's retail profit in the downstream. The PCM's tradeoff between wholesale and retail profits depends on the tax disparity between the upstream and downstream countries. When the downstream tax rate is very high (i.e., $\Delta > 1/3$), the upstream wholesale profit is very important. In such case, the PCM prefers dual distributor structure under which the wholesale profit is higher. When the downstream tax rate is very low (i.e., $\Delta < 1/24$), however, the downstream retail profit becomes very important. In such case, the PCM prefers monopoly structure under which the retail profit is higher. When the downstream tax rate is moderate (i.e., $1/24 \leq \Delta \leq 1/3$), the preference of the PCM depends on the relative production efficiency: If the OEM's cost advantage is limited (i.e., $C < C_2(\Delta)$), the PCM prefers not to supply component to the OEM and retains the monopoly power in the downstream market; if the OEM has a significant cost advantage (i.e., $C \geq C_2(\Delta)$), however, it is better for the PCM to sell component and keep the OEM in the downstream market.

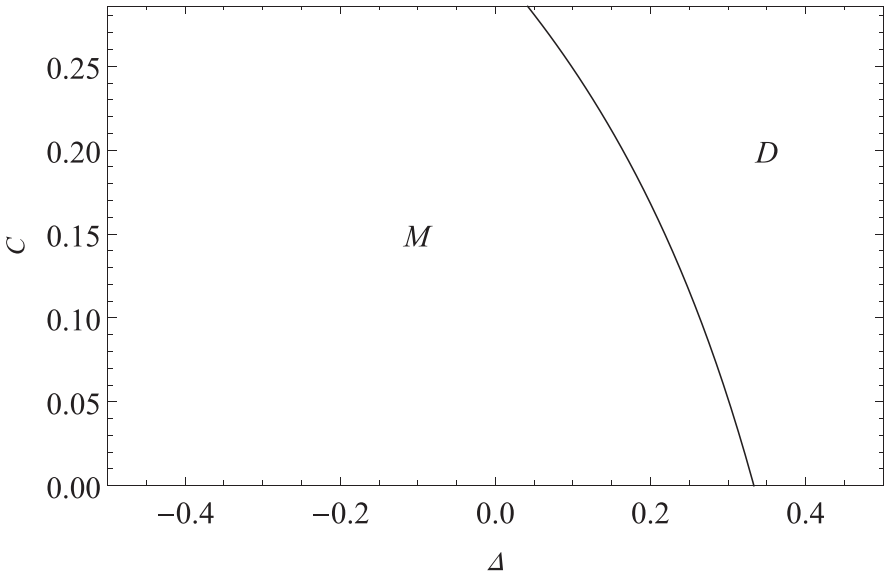


Fig. 4. Monopoly vs. dual distributor under decentralization.

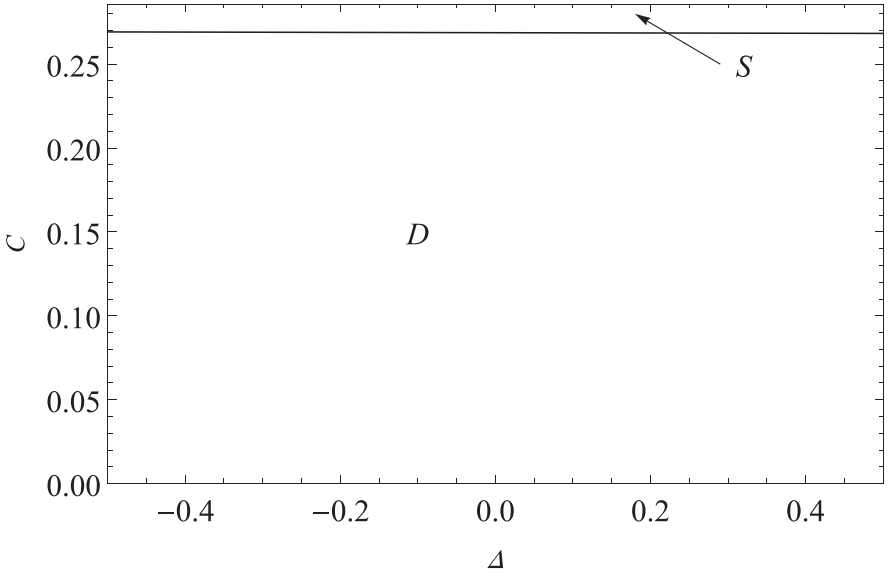


Fig. 5. Component supplier vs. dual distributor under decentralization.

From another perspective, as the downstream tax rate decreases, the PCM is motivated to set a lower transfer price to shift more profits to the downstream, which stimulates the downstream order quantity and alleviates the double marginalization problem under monopoly structure. Under dual distributor structure, the PCM will also lower the transfer price to shift profits. However, ALP requires that the PCM should offer the same wholesale price to the competing OEM. The lower wholesale price strengthens the competitive advantage of the OEM, which hurts the PCM's downstream retail profit. That's another reason why the dual distributor structure becomes less attractive to the PCM as Δ decreases.

Lemma 3 compares the PCM's profits under dual distributor and component supplier structures.

Lemma 3. $\Pi_m^D > \Pi_m^S$ *if* $C < C_3(\Delta) \equiv (4\Delta - 8 + \sqrt{2(5+\Delta)})/(2(8\Delta - 9))$*; otherwise,* $\Pi_m^S \geq \Pi_m^D$.

Lemma 3 shows that as the OEM's cost advantage becomes more significant, it is more likely for the PCM to choose the component supplier structure and stay in the component market. The results are shown in Fig. 5. We use "*D*" to denote the region where $\Pi_m^D > \Pi_m^S$, and "*S*" to denote the region where $\Pi_m^S \geq \Pi_m^D$. The dual distributor structure helps the PCM to seize retail profit in the downstream market, but the intensified competition reduces the OEM's order size for the proprietary component. When the OEM's relative cost advantage is sufficiently large, the PCM's component wholesale profit loss dominates her downstream retail profit gain. In such case, it is better for the PCM to refrain from the downstream market and act as a pure component supplier. Otherwise, the retail profit gain dominates and the PCM should encroach on the downstream market.

Combining the above analysis, we have the following proposition which characterizes the optimal supply chain structure for the PCM.

Proposition 1. *There exist a threshold* Δ_1 *such that:*

(a) When $\Delta < 1/49$, $\Pi_m^M \geq \max\{\Pi_m^S, \Pi_m^D\}$;

(b) When $1/49 \leq \Delta < \Delta_1$, $\Pi_m^M \geq \max\{\Pi_m^S, \Pi_m^D\}$ *if* $C < C_1(\Delta)$ *and* $\Pi_m^S \geq \max\{\Pi_m^M, \Pi_m^D\}$ *if* $C \geq C_1(\Delta)$;

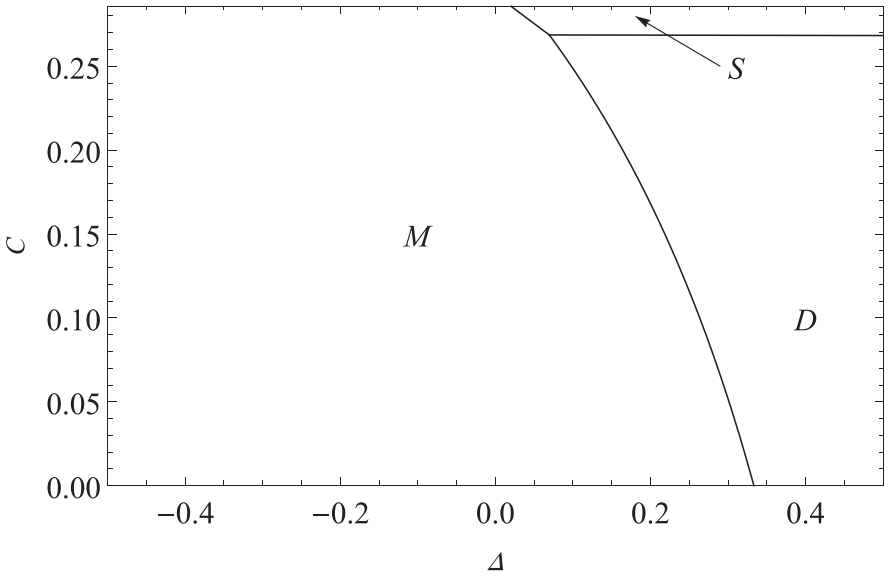


Fig. 6. The PCM's optimal supply chain structure under decentralization.

(c) When $\Delta_1 \le \Delta < 1/3$, $\Pi_m^M \ge \max\{\Pi_m^S, \Pi_m^D\}$ *if* $C < C_2(\Delta)$, $\Pi_m^D \ge \max\{\Pi_m^M, \Pi_m^S\}$ *if* $C_2(\Delta) \le C < C_3(\Delta)$ *and* $\Pi_m^S \ge \max\{\Pi_m^M, \Pi_m^D\}$ *if* $C \ge C_3(\Delta)$;

(d) When $\Delta \ge 1/3$, $\Pi_m^D \ge \max\{\Pi_m^M, \Pi_m^S\}$ *if* $C < C_3(\Delta)$ *and* $\Pi_m^S \ge \max\{\Pi_m^M, \Pi_m^D\}$ *if* $C \ge C_3(\Delta)$.

Proposition 1 shows that the PCM's global supply chain structure design depends on both the operations environment (measured by C) and the tax environment (measured by Δ), and that each of the three supply chain structures might be optimal for the PCM. When the downstream tax rate is low enough, the monopoly structure gives the PCM the highest global profits. As the downstream tax rate increases, then component supplier and dual distributor structures become more attractive for the PCM. In such case, the PCM should adopt the dual distributor structure if the OEM's cost advantage is insignificant, and component supplier structure otherwise. The results are shown in Fig. 6. We use "M" to denote the region where $\Pi_m^M \ge \max\{\Pi_m^S, \Pi_m^D\}$, "$D$" to denote the region where $\Pi_m^D \ge \max\{\Pi_m^M, \Pi_m^S\}$, and "$S$" to denote the region where $\Pi_m^S \ge \max\{\Pi_m^M, \Pi_m^D\}$.

When the tax rate of the downstream country is very low, the downstream retail profit is very valuable. Furthermore, in this case the PCM will charge a low transfer price to shift profit to the low-tax downstream, which alleviates the double marginalization. Therefore, it is profitable for the PCM to directly enter into the downstream market and enjoy the monopoly power. When the downstream tax rate is high enough, however, the upstream wholesale profit becomes more valuable, and the double marginalization under monopoly structure becomes more severe. In such case, it is better for the PCM to forgo the monopoly structure, and instead supply component to the OEM and earn some component revenue. The PCM earns a higher retail profit but a lower wholesale profit under dual distributor structure, as compared to the component supplier structure. Whether the PCM should encroach on the downstream market and adopt a dual distributor structure depends on the relative cost advantage of the OEM. If the OEM's cost advantage is very significant, the PCM's retail profit gain from encroaching is dominated by its wholesale profit loss, and the PCM should refrain from the downstream market and act as a pure component supplier; otherwise, if the OEM's cost advantage is insignificant, the PCM's retail profit gain dominates its wholesale profit loss, and the PCM should encroach on the downstream market and adopt the dual distributor structure.

Our analysis here indicates that for industries with large profit margins or insignificant manufacturing costs, such as high-end smartphones or luxury cars, the monopoly and dual distributor structures are more likely to be adopted by PCMs. The component supplier structure is only suitable for PCMs in industries with small profit margins or significant manufacturing costs, such as consumer products.

The results in Proposition 1 and Fig. 6 also suggest that the global tax disparity has significant impacts on the PCM's optimal supply chain structure. Without tax disparity (i.e., $\Delta = 0$), the PCM should adopt the monopoly structure. With the consideration of tax disparity and global after-tax profits, each of there supply chain structures could be optimal for the PCM. If the downstream tax rate is very low (i.e., $\Delta < 1/49$), the monopoly structure always dominates; if the downstream tax rate is moderately low (i.e., $1/49 \le \Delta < \Delta_1$), the PCM's optimal structure will change from monopoly to component supplier as the OEM's cost advantage widens; if the downstream tax rate is moderately high (i.e., $\Delta_1 \le \Delta < 1/3$), the optimal structure will change from monopoly to dual distributor and then to component supplier as the OEM's cost advantage widens; if the downstream tax rate is extremely high (i.e., $\Delta \ge 1/3$), the optimal structure will change from dual distributor to component supplier as the OEM's cost advantage widens.

From another perspective, when the OEM's cost advantage is small, the PCM's optimal structure will change from monopoly to dual distributor, as the downstream tax rate increases. When the OEM's cost advantage is very significant, however, the optimal structure will change from monopoly to component supplier, as the downstream tax rate increases. Proposition 1 implies that in determining the optimal supply chain structure when entering into an overseas market, the PCM ought not to simply examine its production efficiency (as compared to the competing OEM). The PCM should also consider the tax environment of the new overseas market.

Before we proceed to the analysis for the centralized case, we compare the OEM's profits under different supply chain structures. Since the OEM gets zero profit under the monopoly structure, we focus on the comparison between component supplier and dual distributor structures. The following proposition gives the result.

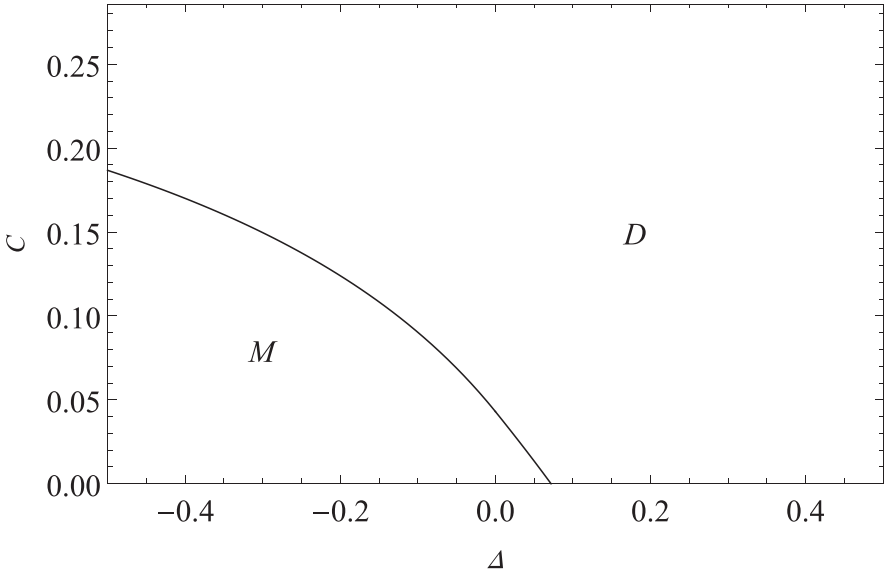


Fig. 7. The comparison of total profit under decentralization.

Proposition 2. *When* $C > \frac{1+\Delta}{6+4\Delta}$, $\Pi_o^D > \Pi_o^S$; *otherwise,* $\Pi_o^S \geq \Pi_o^D$.

Proposition 2 suggests that the OEM may benefit from the PCM's encroachment if his cost advantage is significant enough. Under dual distributor structure, the OEM faces the direct competition from the PCM. However, compared to the component supplier structure, the PCM under dual distributor is motivated to lower the transfer price (and wholesale price) to alleviate the double marginalization problem, which benefits the OEM. Therefore, under dual distributor structure, the OEM suffers from the intensified competition but enjoys the benefit of wholesale price reduction. When the OEM's cost advantage is very significant, the encroaching PCM doesn't gain a large market share. In such case, the OEM's loss of market share is dominated by the benefit of wholesale price reduction, and the dual distributor structure is better for the OEM. Otherwise, the loss of the market share dominates, and the OEM prefers the component supplier structure.

We are also interested in the overall supply chain efficiency. Fig. 7 compares the PCM and OEM's total profit under the three supply chain structures. We use "M" to denote the region where $\Pi_m^M + \Pi_o^M \geq \max\{\Pi_m^S + \Pi_o^S, \Pi_m^D + \Pi_o^D\}$, and "$D$" to denote the region where $\Pi_m^D + \Pi_o^D \geq \max\{\Pi_m^M + \Pi_o^M, \Pi_m^S + \Pi_o^S\}$. The total profit of the PCM and OEM under component supplier structure is always lower as compared to the other two structures, due to the severe double marginalization problem. The comparison between monopoly and dual distributor structures depends on the global tax disparity and the relative cost advantage of the OEM. When Δ is small, the PCM will charge a low transfer price to shift profits. In such case, the double marginalization is not severe, and the monopoly structure brings the highest total profit for the PCM and OEM when the OEM's cost advantage is not significant. Otherwise, the dual distributor structure brings the highest total profit.

5. Centralized structure

Section 4 analyzes and compares different supply chain structures when the PCM adopts decentralized organizational structure. In reality, some MNFs may centrally control all decisions, including the downstream retail decisions. In this section, we analyze the PCM's supply chain structure design under centralized structure. The sequence of events under centralized structure is similar to Fig. 2 for the decentralized case, except that the PCM, rather than the downstream manufacturing subsidiary, makes the order quantity decision. The profit functions are also the same as those for the decentralized case, and we omit the detailed discussions here. The subgame perfect equilibrium of each supply chain structure could be derived by the standard backward induction. The detailed derivations are in the Appendix. We summarize the equilibrium results in Table 2. We use "$\bar{\ }$" to differentiate from the equilibrium results under decentralized structure.

Note that under the monopoly structure, centralization improves the PCM's equilibrium profit when the downstream has tax disadvantage (i.e., $\Delta \geq 0$), as compared to the case of decentralization. However, the PCM's equilibrium profit doesn't change when the downstream has tax advantage (i.e., $\Delta < 0$). The reason is as follows. With downstream tax disadvantage (i.e., $\Delta \geq 0$), the PCM is motivated to charge a high transfer price to shift profit to the low-tax upstream, which aggravates the double marginalization under decentralization. Under centralization, however, the PCM centrally makes the ordering decision, and the double marginalization problem disappears. With downstream tax advantage (i.e., $\Delta < 0$), the PCM, under both centralization and decentralization, will set a marginal-cost transfer price, which eliminates the double marginalization. In such case, the PCM's global after-tax profit doesn't change.

Under the component supplier structure, intuitively, the PCM's equilibrium profits under both organizational structures are the same. Under the dual distributor structure, however, the comparison of PCM's profits under the two organizational structures is not intuitive. Note that under centralization, the feasible range for the dual distributor structure is: $-1/2 \leq \Delta < 0$ and $0 \leq C \leq 2/7$, or $0 \leq \Delta \leq (3\sqrt{73} - 23)/8$ and $3\Delta/(4 - \Delta - 2\Delta^2) \leq C \leq 2/7$. The reason is as follows. Under centralization, the PCM becomes more aggressive in the downstream competition. When the downstream has significant tax disadvantage (which leads to a high wholesale price from the PCM) and the cost advantage of the OEM is not sufficient, the OEM will be forced out of the market.

The following corollary shows the impacts of δ and c_a on the PCM's and OEM's profits under different supply chain structures.

Corollary 2. *Under centralized structure, we have the following results:*

(a) $\bar{\Pi}_m^M$ *is decreasing in* δ; $\bar{\Pi}_m^D$ *is decreasing in* δ *when* $-1/2 < \Delta < 0$ *and* $0 < C < \frac{\Delta}{-2+3\Delta}$, *and increasing in* δ *otherwise;* $\bar{\Pi}_m^S$ *is in-*

Table 2
Equilibrium results under centralized structure.

Monopoly		Component supplier		Dual distributor	
$\bar{t}^M$	$c_m + \frac{(1-\tau-\delta)(\alpha-c_a)}{2-2\tau-\delta}$ $(\delta \geq 0)$	$\bar{w}^S$	$c_m + \frac{\alpha}{2}$	$\bar{t}^D$	$c_m - \frac{(1-\tau-\delta)((5-5\tau+2\delta)\alpha-(1-\tau+4\delta)c_a)}{2(\delta^2+5(1-\tau)\delta-5(1-\tau)^2)}$
	c_m $(\delta < 0)$			$\bar{w}^D$	$c_m - \frac{(1-\tau-\delta)((5-5\tau+2\delta)\alpha-(1-\tau+4\delta)c_a)}{2(\delta^2+5(1-\tau)\delta-5(1-\tau)^2)}$
$\bar{q}_m^M$	$\frac{(1-\tau)(\alpha-c_a)}{2-2\tau-\delta}$ $(\delta \geq 0)$	$\bar{q}_o^S$	$\frac{\alpha}{4}$	$\bar{q}_o^D$	$\frac{3(1-\tau)\delta\alpha+(2\delta^2+\delta-\delta\tau-4(1-\tau)^2)c_a}{2(\delta^2+5(1-\tau)\delta-5(1-\tau)^2)}$
	$\frac{\alpha-c_a}{2}$ $(\delta < 0)$			$\bar{q}_m^D$	$\frac{(1-\tau)((7-7\tau-5\delta)c_a-(5-5\tau-\delta)\alpha)}{2(\delta^2+5(1-\tau)\delta-5(1-\tau)^2)}$
$\bar{\Pi}_m^M$	$\frac{(1-\tau-\delta)(1-\tau)^2(\alpha-c_a)^2}{(2-2\tau-\delta)^2}$ $(\delta \geq 0)$	$\bar{\Pi}_o^S$	$\frac{(1-\tau-\delta)\alpha^2}{16}$	$\bar{\Pi}_o^D$	$\frac{(1-\tau-\delta)(4c_a-(1+2\delta)\delta c_a-3(1-\tau)\delta\alpha-(8-\delta)\tau c_a+4\tau^2 c_a)^2}{4(\delta^2+5(1-\tau)\delta-5(1-\tau)^2)^2}$
	$\frac{(1-\tau-\delta)(\alpha-c_a)^2}{4}$ $(\delta < 0)$	$\bar{\Pi}_m^S$	$\frac{(1-\tau)\alpha^2}{8}$	$\bar{\Pi}_m^D$	$\frac{(1-\tau)(1-\tau-\delta)(-5(1-\tau)\alpha^2+2(5-5\tau-2\delta)\alpha c_a-(9-9\tau-8\delta)c_a^2)}{4(\delta^2+5(1-\tau)\delta-5(1-\tau)^2)}$

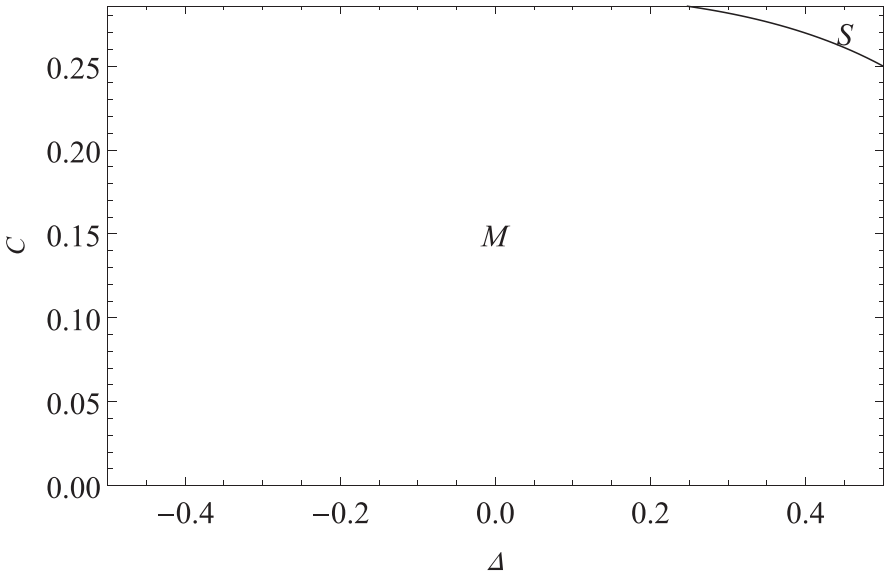


Fig. 8. Monopoly vs. component supplier under centralization.

dependent of δ. $\bar{\Pi}_m^M$ and $\bar{\Pi}_m^D$ are decreasing in c_a; $\bar{\Pi}_m^S$ is independent of c_a.

(b) $\bar{\Pi}_o^S$ and $\bar{\Pi}_o^D$ are decreasing in δ. $\bar{\Pi}_o^D$ is increasing in c_a; $\bar{\Pi}_o^S$ is independent of c_a.

In most scenarios, the increase of downstream tax rate hurts both the multinational PCM and the local OEM. Interestingly, according to Corollary 2, under certain conditions, the PCM's profit under dual distributor structure could be increasing in the tax disparity δ. The major reason is as follows. As δ increases, the PCM will raise the transfer price (and wholesale price) to shift more profits to the upstream country. Under centralized structure, the double marginalization problem within PCM disappears and the increase of the wholesale price would weaken the OEM's competitive advantage and benefit the PCM's downstream retail profit, especially when the OEM's cost advantage is very significant, i.e., when C is large enough. The impacts of c_a are similar to those under decentralized structure.

Based on the above results, we compare the PCM's profits under different supply chain structures. Similar to the decentralized case, we'll first make pairwise comparisons, and then move to the comparison of three supply chain structures. The following lemma shows the comparison between monopoly and component supplier structures.

Lemma 4. *(a) When $\Delta < 2(5\sqrt{2}-1)/49$, $\bar{\Pi}_m^M > \bar{\Pi}_m^S$;*

(b) When $\Delta \geq 2(5\sqrt{2}-1)/49$, there exists a threshold $C_4(\Delta)$ such that $\bar{\Pi}_m^M > \bar{\Pi}_m^S$ if $C < C_4(\Delta)$; otherwise, $\bar{\Pi}_m^S \geq \bar{\Pi}_m^M$.

The results are shown in Fig. 8. Similar to the decentralized case, when choosing whether to adopt the monopoly structure, the PCM faces a tradeoff between the loss of the production efficiency and the benefit of retail market share. Therefore, the results in Lemma 4 and Fig. 8 are similar to those for the decentralized case, except that the monopoly structure becomes more attractive under centralization. The main reason is as follows. The PCM' equilibrium profit under component supplier structure is the same as the decentralized case. Under the monopoly structure, centralization, which eliminates the double marginalization problem, improves the PCM's equilibrium profit when the downstream has tax disadvantage. As a result, the region where the PCM finds monopoly structure attractive becomes larger under centralization.

The comparison between dual distributor and monopoly structures is more intriguing since centralization alters the PCM's profits under both supply chain structures. The following lemma shows the results.

Lemma 5. *(a) When $\Delta < (3\sqrt{2289}-149)/50$, $\bar{\Pi}_m^M > \bar{\Pi}_m^D$;*

(b) When $(3\sqrt{2289}-149)/50 \leq \Delta < 0$, there exits a threshold $C_5(\Delta)$ such that $\bar{\Pi}_m^M > \bar{\Pi}_m^D$ if $C < C_5(\Delta)$; otherwise, $\bar{\Pi}_m^D \geq \bar{\Pi}_m^M$;

(c) When $0 \leq \Delta \leq (3\sqrt{73}-23)/8$, $\bar{\Pi}_m^M > \bar{\Pi}_m^D$ if $C < C_6(\Delta) \equiv 3\Delta/(4-\Delta-2\Delta^2)$; otherwise, $\bar{\Pi}_m^D \geq \bar{\Pi}_m^M$;

(d) When $\Delta > (3\sqrt{73}-23)/8$, $\bar{\Pi}_m^M > \bar{\Pi}_m^D$.

The results are shown in Fig. 9. Similar to the decentralized case, the PCM faces a tradeoff between component wholesale profit gain and downstream retail profit loss when choosing the dual distributor structure, and the tradeoff depends on the global tax disparity (i.e., the relative importance of the wholesale and retail profits) and relative cost advantage of the OEM. Recall under decentralized structure, the PCM under dual distributor is motivated to lower the transfer price (and wholesale price) to alleviate

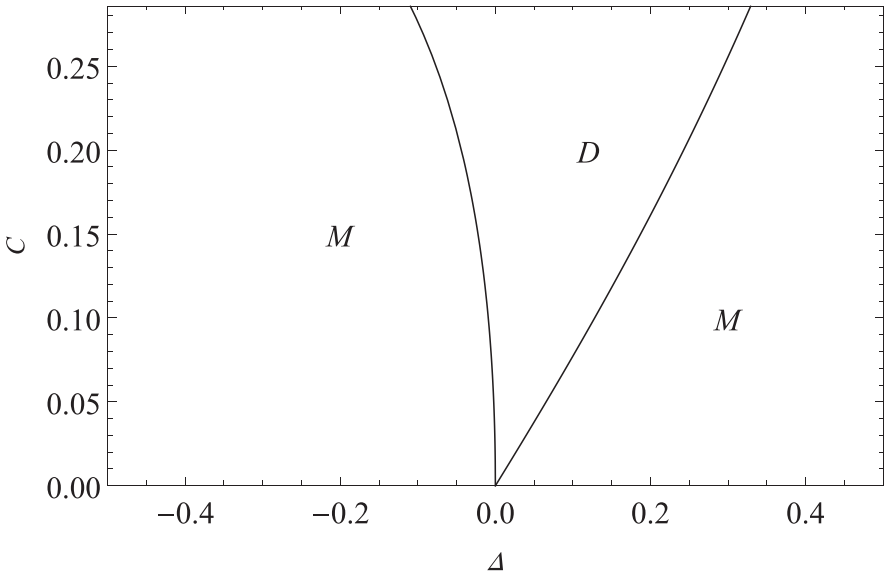


Fig. 9. Monopoly vs. dual distributor under centralization.

the double marginalization problem, which benefits the competing OEM. Under centralized structure, however, the PCM centrally controls the ordering decision and relies less on the transfer price reduction to mitigate the double marginalization. In such case, the PCM's component wholesale profit from the OEM is guaranteed. Therefore, the dual distributor structure becomes more attractive for the centralized PCM. This explains why the threshold $C_2(\Delta)$ under decentralization moves leftwards to $C_5(\Delta)$ under centralization (as shown in Figs. 4 and 9). However, as mentioned earlier, when the downstream has significant tax disadvantage (which leads to a high wholesale price from the PCM) and the cost advantage of the OEM is not sufficient, the OEM will be forced out of the market under centralization. In such case, the dual distributor structure is then reduced to the monopoly structure. $C_6(\Delta)$ in Lemma 5 and Fig. 9 defines the boundary of the feasible area for the dual distributor structure. To summarize, under centralization, although the dual distributor structure becomes more attractive, its feasible range shrinks.

Lemma 6 compares the PCM's profits under dual distributor and component supplier structures.

Lemma 6. *(a) When* $\Delta < 0$, $\bar{\Pi}_m^D > \bar{\Pi}_m^S$;
(b) When $0 \le \Delta \le (3\sqrt{73}-23)/8$, $\bar{\Pi}_m^S > \bar{\Pi}_m^D$ *if* $C < C_6(\Delta)$; *otherwise,* $\bar{\Pi}_m^D \ge \bar{\Pi}_m^S$;
(c) When $\Delta > (3\sqrt{73}-23)/8$, $\bar{\Pi}_m^S > \bar{\Pi}_m^D$.

The results are shown in Fig. 10. Under centralization where the double marginalization is eliminated, the PCM can better coordinate the component wholesale profit and downstream retail profit, and the attractiveness of dual distributor structure is improved. However, the PCM's profit from acting as a pure component supplier does not change. Therefore, the PCM has higher incentives to encroach on the downstream market and adopt the dual distributor structure under centralization. As shown in Fig. 10, the dual distributor structure, as long as feasible, is always preferable to the PCM as compared to the component supplier structure. $C_6(\Delta)$ in Lemma 6 and Fig. 10 defines the boundary of the feasible area for the dual distributor structure.

Based on the above analysis, we are ready to characterize the optimal supply chain structure for the PCM. The following proposition shows the results.

Proposition 3. *There exist a threshold* Δ_2 *such that:*

(a) When $\Delta < (3\sqrt{2289}-149)/50$, $\bar{\Pi}_m^M \ge \max\{\bar{\Pi}_m^S, \bar{\Pi}_m^D\}$;
(b) When $(3\sqrt{2289}-149)/50 \le \Delta < 0$, $\bar{\Pi}_m^M \ge \max\{\bar{\Pi}_m^S, \bar{\Pi}_m^D\}$ *if* $C < C_5(\Delta)$ *and* $\bar{\Pi}_m^D \ge \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^S\}$ *if* $C \ge C_5(\Delta)$;
(c) When $0 \le \Delta < \Delta_2$, $\bar{\Pi}_m^M \ge \max\{\bar{\Pi}_m^S, \bar{\Pi}_m^D\}$ *if* $C < C_6(\Delta)$ *and* $\bar{\Pi}_m^D \ge \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^S\}$ *if* $C \ge C_6(\Delta)$;
(d) When $\Delta_2 \le \Delta < (3\sqrt{73}-23)/8$, $\bar{\Pi}_m^M \ge \max\{\bar{\Pi}_m^S, \bar{\Pi}_m^D\}$ *if* $C < C_4(\Delta)$, $\bar{\Pi}_m^S \ge \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^D\}$ *if* $C_4(\Delta) \le C < C_6(\Delta)$, *and* $\bar{\Pi}_m^D \ge \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^S\}$ *if* $C \ge C_6(\Delta)$;
(e) When $\Delta \ge (3\sqrt{73}-23)/8$, $\bar{\Pi}_m^M \ge \max\{\bar{\Pi}_m^S, \bar{\Pi}_m^D\}$ *if* $C < C_4(\Delta)$ *and* $\bar{\Pi}_m^S \ge \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^D\}$ *if* $C \ge C_4(\Delta)$.

Similar to the case of decentralization, Proposition 3 shows that under centralization the PCM's global supply chain structure design depends on both the operations environment (measured by C) and the tax environment (measured by Δ), and that each of the three supply chain structures might be optimal for the PCM. When the downstream tax rate is very low, the centralized PCM should always adopt the monopoly structure. When the downstream tax rate is in a medium range, monopoly is the optimal supply chain structure for the PCM if the OEM doesn't have a significant cost advantage, and dual distributor is the optimal supply chain structure if the OEM's cost advantage is significant. When the downstream tax rate is extremely high, the monopoly structure is the best for the PCM if the OEM's cost advantage is insignificant, and component supplier structure is the best if the OEM has a significant cost advantage. The results are illustrated in Fig. 11.

As mentioned earlier, the centralized structure improves the PCM's profits under structures of monopoly and dual distributor, while her profit under component supplier structure doesn't change. Hence, the component supplier structure becomes less attractive for the centralized PCM, and is optimal only when the downstream tax disadvantage and the OEM's cost advantage are both sufficiently large. As regards to the comparison between the dual distributor and monopoly structures, when the downstream tax rate is in a medium range, it would be easier for the PCM to charge a moderate transfer price (and wholesale price) to coordinate the upstream wholesale profit and downstream retail profit. In such case, the PCM should adopt the dual distributor structure and keep the OEM in the downstream market to enlarge the component wholesale profit, if the OEM has a significant cost advantage in producing the end product. When the downstream tax rate is outside this range, it becomes difficult for the PCM to balance

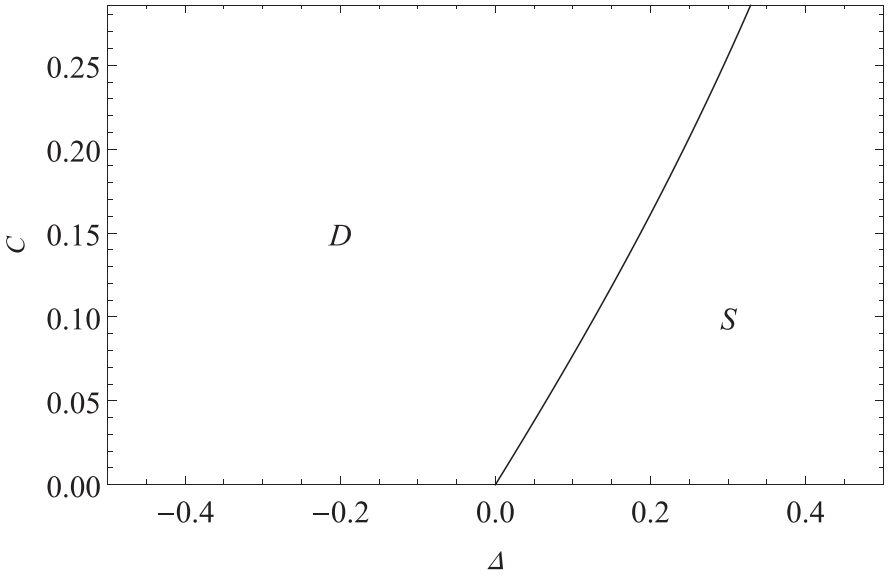


Fig. 10. Component supplier vs. dual distributor under centralization.

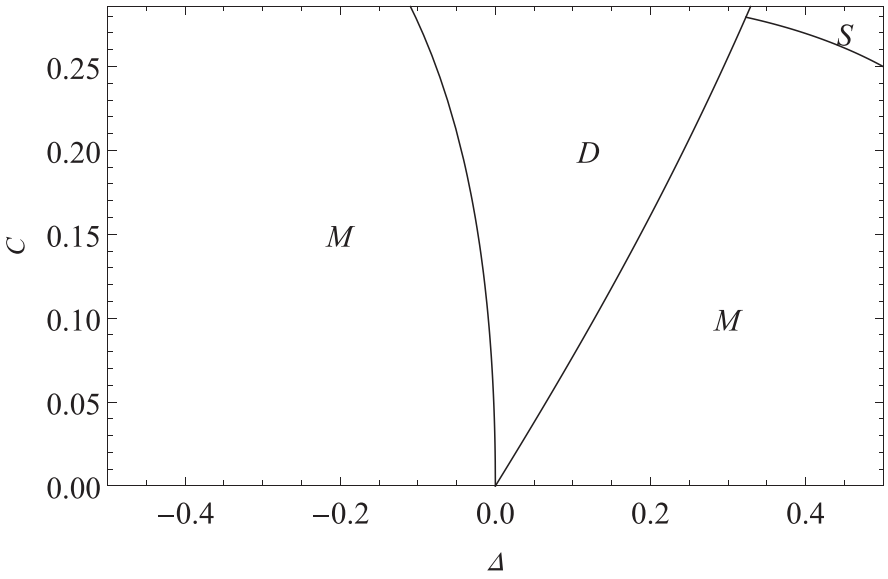


Fig. 11. The PCM's optimal supply chain structure under centralization.

the profits from different markets and the income-shifting benefit. With a significant downstream tax advantage, the PCM should charge a low transfer price (and wholesale price) to shift profits to the low-tax downstream. This low wholesale price would benefit the competing OEM. With a significant downstream tax disadvantage, however, the PCM should charge a high transfer price (and wholesale price) to shift profits to the low-tax upstream. This high wholesale price would force the OEM out of the downstream market. Therefore, whenever the downstream has a significant tax advantage or disadvantage, the PCM has a difficult tradeoff between the managerial and tax objectives. In such case, it is better for the PCM to use the monopoly structure to fully coordinate the whole supply chain.

Our results also imply that the global tax disparity has significant impacts on the PCM's global supply chain structure design. Without tax disparity, dual distributor is the optimal structure for the PCM. As the tax disparity widens, the other two structures, i.e., monopoly and component supplier, become more attractive for the PCM. From another perspective, when the OEM's cost advantage is small, the centralized PCM's optimal structure will change from monopoly to dual distributor and then back to monopoly, as the downstream tax disadvantage widens. When the OEM's cost advantage is very significant, however, the optimal structure may switch to component supplier, if the downstream tax rate is very high.

The results here are also consistent with some of our observations about MNFs' global supply chain design. Our analysis suggests that the monopoly structure allows the PCM to gain the highest profit when entering into a downstream country with a sufficiently low tax rate. In China, the corporate income tax rate is 25%. ZTE, a high-tech MNF based in China, chooses the monopoly structure when entering into Ireland, which has a very low tax rate of 12.5%. However, when entering into Indonesia, which has a tax rate of 22% (very close to the tax rate in China), ZTE chooses the dual distributor structure: ZTE supplies key components to Bolt, which produces and sells smartphone in Indonesia; at the same time, ZTE also sells smartphone with ZTE brand names in Indonesian market.

By comparing Figs. 6 and 11, we observe that the PCM's optimal supply chain structure shares some similarities under the two organizational structures. When the downstream tax rate is low

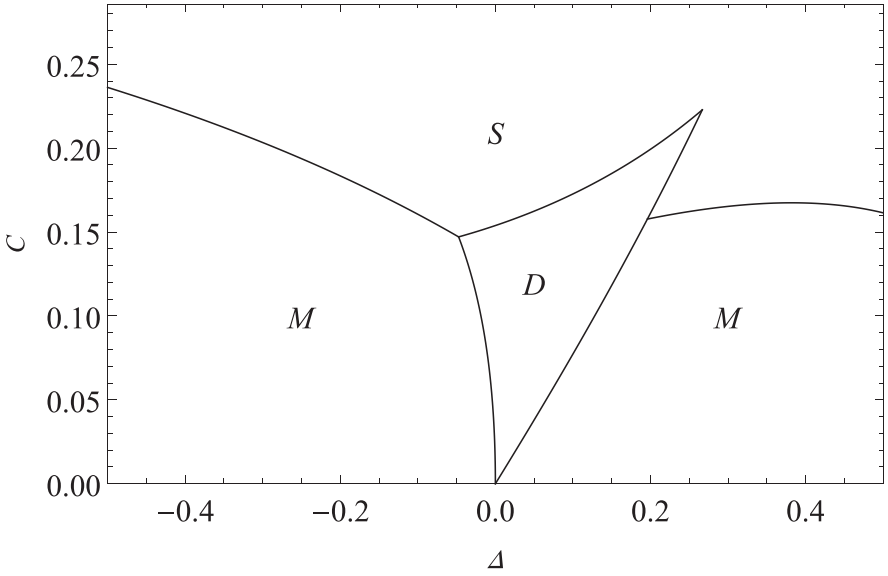


Fig. 12. The comparison of total profit under centralization.

enough, the monopoly structure always dominates. As the downstream tax rate increases, the dual distributor and component supplier structures become more attractive. The major difference is that under centralization, the dual distributor structure cannot be sustained when the downstream tax rate is high enough.

Next, we compare the OEM's profits under different supply chain structures. Since the OEM gets zero profit under the monopoly structure, we focus on the comparison between component supplier and dual distributor structures. The following proposition shows that the OEM always prefers the component supplier structure, since the centralized PCM would compete aggressively and seize a significant market share under the dual distributor structure. The results differ from those under decentralization where the OEM may find dual distributor structure attractive.

Proposition 4. *Whenever the dual distributor structure is feasible,* $\bar{\Pi}_o^D < \bar{\Pi}_o^S$.

We are also interested in the total profit of the PCM and OEM. Fig. 12 shows the comparison of the three supply chain structures in terms of total profit. The region "*D*", where the dual distributor structure brings the highest total profit, shrinks as compared to Fig. 7 under decentralization. The main reason is as follows. Under centralization, the aggressive retail arm of the PCM causes intense competition between the downstream subsidiary and OEM, and hurts the overall supply chain efficiency. When Δ is very large, the OEM will be forced out of the market and the dual distributor structure reduces to the monopoly structure. When C is very large, the OEM's cost advantage is very significant, and it is better for the PCM to act as a pure component supplier.

6. Decentralization vs. centralization

In Sections 4 and 5, we study the PCM's optimal supply chain structure design under decentralization and centralization, and find that the organizational structure has significant impacts on the PCM's structure choice. In this section, we further compare the PCM's equilibrium profits under the two organizational structures. Conventional wisdom, which is based on local operations, suggests that centralization eliminates the double marginalization and benefits the integrated firm. We want to examine whether this intuition still holds in a global supply chain environment. Π_m^* and $\bar{\Pi}_m^*$ denote the PCM's equilibrium profits under decentralization and centralization, respectively. Intuitively, we have $\Pi_m^* = \max\{\Pi_m^M, \Pi_m^S, \Pi_m^D\}$ and $\bar{\Pi}_m^* = \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^S, \bar{\Pi}_m^D\}$. The following proposition shows the comparison between Π_m^* and $\bar{\Pi}_m^*$.

Proposition 5. *There exist thresholds* Δ_3 *and* $C_7(\Delta)$ *such that:*

(a) When $\Delta < (3\sqrt{2289} - 149)/50$, $\bar{\Pi}_m^* = \Pi_m^*$;

(b) When $(3\sqrt{2289} - 149)/50 \le \Delta \le 0$, $\bar{\Pi}_m^* = \Pi_m^*$ *if* $C \le C_5(\Delta)$ *and* $\bar{\Pi}_m^* > \Pi_m^*$ *if* $C > C_5(\Delta)$;

(c) When $0 < \Delta < \Delta_2$, $\bar{\Pi}_m^* > \Pi_m^*$;

(d) When $\Delta_2 \le \Delta < (3\sqrt{73} - 23)/8$, $\bar{\Pi}_m^* > \Pi_m^*$ *if* $C < C_4(\Delta)$ *or* $C > C_6(\Delta)$ *and* $\bar{\Pi}_m^* = \Pi_m^*$ *if* $C_4(\Delta) \le C \le C_6(\Delta)$;

(e) When $(3\sqrt{73} - 23)/8 \le \Delta < \Delta_3$, $\bar{\Pi}_m^* > \Pi_m^*$ *if* $C < C_4(\Delta)$ *and* $\bar{\Pi}_m^* = \Pi_m^*$ *if* $C \ge C_4(\Delta)$;

(f) When $\Delta \ge \Delta_3$, $\bar{\Pi}_m^* \ge \Pi_m^*$ *if* $C \le C_7(\Delta)$, $\bar{\Pi}_m^* < \Pi_m^*$ *if* $C_7(\Delta) < C < C_3(\Delta)$ *and* $\bar{\Pi}_m^* = \Pi_m^*$ *if* $C \ge C_3(\Delta)$.

Proposition 5 shows that whether the PCM benefits from decentralization depends on both the operations environment (measured by C) and the tax environment (measured by Δ), and that the PCM's equilibrium profit under decentralization may be higher, lower, or the same, as compared to the centralized case. The results are shown in Fig. 13.

The most intriguing finding is that the PCM's profit under decentralized structure may be higher than the centralized structure, which contradicts with our traditional understanding. This counterintuitive result occurs when the downstream tax disadvantage and the OEM's cost advantage are sufficiently large. Note that the threshold $C_7(\Delta)$ is smaller than $C_4(\Delta)$. When the OEM's relative cost advantage, C, is between $C_7(\Delta)$ and $C_4(\Delta)$, the optimal supply chain structures under centralization and decentralization are monopoly and dual distributor, respectively. When C is between $C_4(\Delta)$ and $C_3(\Delta)$, the optimal supply chain structures under centralization and decentralization are component supplier and dual distributor, respectively. Under both cases, the PCM gets a higher global after-tax profit under decentralization where dual distributor is the equilibrium supply chain structure. Under centralization, however, the PCM's aggressive encroachment forces the OEM out of the market, and the dual distributor structure is infeasible.

When the downstream has a significant tax advantage or when the downstream has a little tax advantage and the OEM's cost advantage is small, monopoly is the equilibrium under both organizational structures, and the PCM's profits remain the same. When

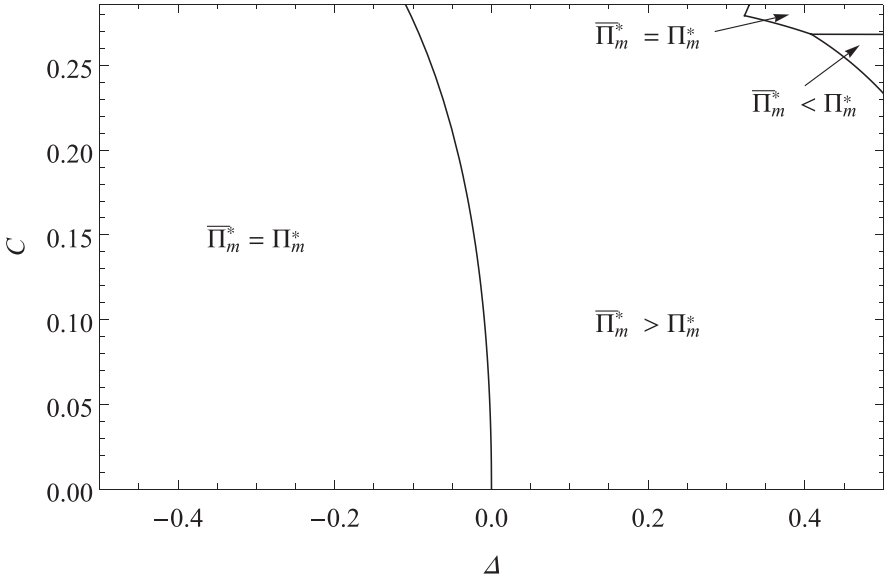
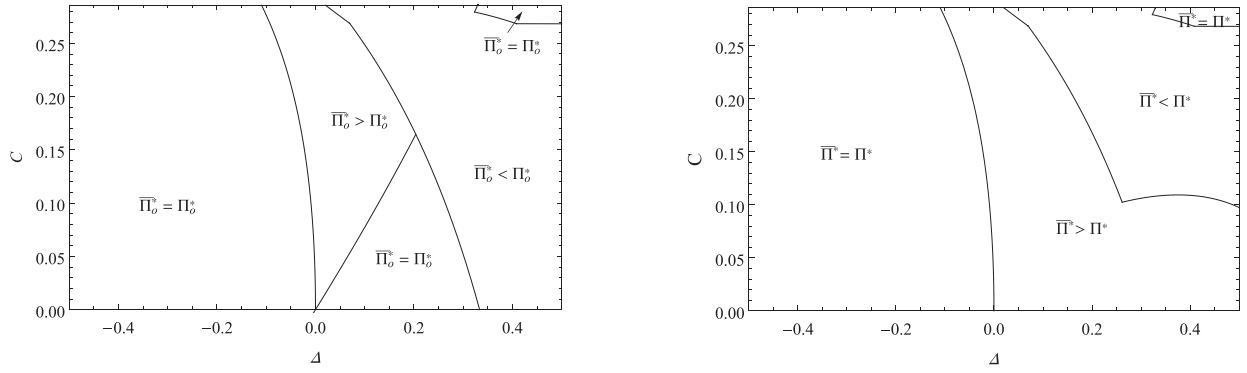


Fig. 13. The PCM's profits under the two organizational structures.



(a) The comparison of OEM's profit (b) The comparison of total profit

Fig. 14. The comparison of OEM's profit and total profit under the two organizational structures.

the downstream tax disadvantage and the OEM's cost advantage are extremely large, component supplier is the equilibrium under both organizational structures. Hence, the PCM gets the same profit under the two organizational structures in this case. In the remaining area, the PCM strictly prefers centralized structure.

Our analysis also suggests that the global tax disparity has fundamental impacts on the PCM's preference about two organizational structures. Without tax disparity, the PCM always prefers centralized structure, which is consistent with our intuition. With the consideration of tax disparity, however, decentralized structure may become attractive to the PCM, especially when the downstream tax rate is much higher than the upstream. In such case, the competing OEM is able to survive with a decentralized PCM, and the dual distributor structure is viable.

We next compare the OEM's equilibrium profits under the two organizational structures. Define $\Pi_o^* \equiv \{\Pi_o^j$, where $\Pi_m^j = \max\{\Pi_m^M, \Pi_m^S, \Pi_m^D\}\}$ and $\bar{\Pi}_o^* \equiv \{\bar{\Pi}_o^j$, where $\bar{\Pi}_m^j = \max\{\bar{\Pi}_m^M, \bar{\Pi}_m^S, \bar{\Pi}_m^D\}\}$. The former (or latter) is OEM's equilibrium profit (subject to the PCM's choice of supply chain structure) under decentralized (or centralized) structure. The comparison between Π_o^* and $\bar{\Pi}_o^*$ is shown in Fig. 14(a). It suggests that the PCM's decentralization could hurt the OEM if the downstream tax rate is in a medium range, where the equilibrium structures are monopoly and dual distributor under decentralization and centralization, respectively. In such case, decentralization leads to a lose-lose outcome for the PCM and OEM. This contradicts with our intuition that decentralization hurts the PCM but benefits the downstream OEM. When decentralization benefits the PCM, the OEM's equilibrium profit is also higher with a decentralized PCM. In this case, decentralization achieves a win-win outcome. We can also check that decentralization may bring a lose-win outcome, but never a win-lose outcome for the PCM and OEM.

We are also interested in the total profit of the PCM and OEM. Fig. 14(b), where $\Pi^* = \Pi_m^* + \Pi_o^*$ and $\bar{\Pi}^* = \bar{\Pi}_m^* + \bar{\Pi}_o^*$, compares the total profits under the decentralized and centralized structures. When the downstream country has tax advantage or when the downstream's tax disadvantage and the OEM's relative cost advantage are sufficiently large, the total profits are equal under the two organizational structures. When the downstream has tax disadvantage and the OEM's relative cost advantage is not significant, the total profit is higher under the centralized structure. When the OEM's relative cost advantage grows, the total profit is higher under the decentralized structure instead. Most of the comparisons directly follow from Figs. 13 and 14(a), and we omit the discussions here.

7. Concluding remarks

This paper studies the impacts of tax and organizational structure on a PCM's global supply chain structure design. When the

PCM decides entering into an overseas market, there are three options of supply chain structures: monopoly, component supplier and dual distributor. Some extant literatures investigate the optimal supply chain structure for a PCM, but in a local supply chain setting. Given the prevalence of globalization, we cast this problem into a global supply chain setting, and address some factors unique to the global environment, such as the tax rate disparity between the upstream and downstream countries, the transfer price regulations, and the organizational structure of the multinational PCM. We characterize and compare the equilibrium outcomes under the three supply chain structures, and find that the PCM's global supply chain structure design depends on both the operations environment and the tax environment, and that each of the three supply chain structures might be optimal for the PCM. Specifically, when the downstream tax rate is low enough, the PCM should adopt the monopoly structure to maximize her product retail profit. As the downstream tax rate increases, the advantage of monopoly deteriorates, and the PCM prefers to earn some component wholesale profits by choosing the dual distributor or component supplier structure. It is optimal for the PCM to adopt the dual distributor structure if the OEM's cost advantage is small, and component supplier structure if the OEM's cost advantage is very significant. We also compare the supply chain structure designs and profits under decentralization and centralization, and find that centralization improves the attractiveness of the monopoly and dual distributor structures. Interestingly, when the downstream tax disadvantage is very significant, decentralization may improve the global after-tax profit of the PCM. The results and insights in this paper are useful for the PCM's global supply chain design and the choice of organizational structure.

There are some limitations in this study. Our current model assumes symmetric information between the PCM and the downstream OEM. Future research could study models with asymmetric information, where the upstream PCM has less information about the consumer demand in the downstream country, and/or the downstream OEM doesn't have full information on the component production cost of the PCM. Another limitation of the current paper is that we assume no competition in the component market. In reality, there may be several PCMs competing with each other. It would be interesting to investigate the impacts of component competition on the PCM's global supply chain structure design. Finally, it would be interesting to study how demand uncertainty might influence the PCM's global supply chain design. With demand uncertainty, the profits of the OEM and downstream subsidiary may be negative, which leads to the issue of tax asymmetry [50]. Furthermore, with demand uncertainty, the OEM and downstream subsidiary need to consider the issue of inventory risk (inventory shortage and leftover). Extending our model to incorporate demand uncertainty in future research may generate new managerial insights, but will require a completely different analytical approach from that used in our current paper.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Sijing Deng: Conceptualization, Writing – review & editing. **Jiayan Xu:** Methodology, Writing – original draft. **Yonghui Han:** Writing – review & editing.

Acknowledgments

The authors are grateful to the editors and four anonymous referees for their valuable comments and suggestions that have greatly improved this article. This research was supported by the Humanities and Social Sciences Foundation of Ministry of Education of China (20YJC630013), the National Natural Science Foundation of China (71802197, 72102077), and the Guangdong Basic and Applied Basic Research Foundation (2021A1515011987, 2022B1515020081).

References

[1] Alles M, Datar S. Strategic transfer pricing. Management Science 1998;44(4):451–61.
[2] Allon G, Van Mieghem JA. Global dual sourcing: Tailored base-surge allocation to near- and offshore production. Management Science 2010;56(1):110–24.
[3] Arya A, Mittendorf B. Interacting supply chain distortions: The pricing of internal transfers and external procurement. The Accounting Review 2007;82(3):551–80.
[4] Arya A, Mittendorf B, Yoon D. Friction in related-party trade when a rival is also a customer. Management Science 2008;54(11):1850–60.
[5] Baldenius T, Reichelstein S. External and internal pricing in multidivisional firms. Journal of Accounting Research 2006;44(1):1–28.
[6] Boute RN, Van Mieghem JA. Global dual sourcing and order smoothing: The impact of capacity and lead times. Management Science 2015;61(9):2080–99.
[7] Cachon G, Lariviere M. Supply chain coordination with revenue-sharing contracts: Strengths and limitations. Management Science 2005;51(1):30–44.
[8] Chen L, Hu B. Is reshoring better than offshoring? the effect of offshore supply dependence. Manufacturing & Service Operations Management 2017;19(2):166–84.
[9] Cohen MA, Cui S, Ernst R, Huchzermeier A, Kouvelis P, Lee HL, Matsuo H, Steuber M, Tsay AA. OM forum-benchmarking global production sourcing decisions: Where and why firms offshore and reshore. Manufacturing & Service Operations Management 2018;20(3):389–402.
[10] Cohen MA, Lee H. Resource deployment analysis of global manufacturing and distribution networks. Journal of Manufacturing and Operations Management 1989;2(2):81–104.
[11] Cohen MA, Lee HL. Designing the right global supply chain network. Manufacturing & Service Operations Management 2020;22(1):15–24.
[12] Cohen MA, Mallik S. Global supply chains: Research and applications. Production and Operations Management 1997;6(3):193–210.
[13] Deloitte. The forest and the trees–how a tax-aligned supply chain can reduce your structural tax rate. Technical report, Deloitte 2008.
[14] Dong L, Kouvelis P, Su P. Global facility network design with transshipment and responsive pricing. Manufacturing & Service Operations Management 2010;12(2):278–98.
[15] Duan H, Deng S, Song H, Xu J. The impacts of sales efforts and mode of payment on the competition between agent and retailer. Omega - International Journal of Management Science 2021;103:102416.
[16] Duhigg C, Kocieniewski D. How apple sidesteps billions in taxes. The New York Times 2012. http://www.nytimes.com.
[17] Young Ea. Global transfer pricing surveys 2005-2006. Technical report, Ernst and Young 2007.
[18] Göx R. Strategic transfer pricing, absorption costing, and observability. Management Accounting Research 2000;11(3):327–48.
[19] Guo X, Kouvelis P, Turcic D. Pricing, quality, and stocking decisions in a manufacturer-centric dual channel. Manufacturing & Service Operations Management 2022;24(4):2116–33.
[20] Hiemann M, Reichelstein S. Transfer pricing in multinational corporations: An integrated management-and tax perspective. Fundamentals of International Transfer Pricing in Law and Economics 2012;1:3–18.
[21] Hsu VN, Hu Q. Global sourcing decisions for a multinational firm with foreign tax credit planning. IISE Transactions 2020;52(6):688–702.
[22] Hsu VN, Xiao W, Xu J. The impact of tax and transfer pricing on a multinational firm's strategic decision of selling to a rival. Production and Operations Management 2019;28(9):2279–90.
[23] Hsu VN, Zhu K. Tax-effective supply chain decisions under china's export-oriented tax policies. Manufacturing & Service Operations Management 2011;13(2):163–79.
[24] Hua G, Wang S, Cheng T. Price and lead time decisions in dual-channel supply chains. European Journal of Operational Research 2010;205(1):113–26.
[25] Huang S, Guan X, Chen Y. Retailer information sharing with supplier encroachment. Production and Operations Management 2018;27(6):1133–47.
[26] Huh WT, Park KS. Impact of transfer pricing methods for tax purposes on supply chain performance under demand uncertainty. Naval Research Logistics 2013;60(4):269–93.
[27] Jiang Z, Zhao J, Yi Z, Zhao Y. Inducing information transparency: The roles of gray market and dual-channel. Annals of Operations Research 2020. Forthcoming

[28] Jung S. Offshore versus onshore sourcing: Quick response, random yield, and competition. Production and Operations Management 2020;29(3):750–66.
[29] Kocieniewski D. G.e.'s strategies let it avoid taxes altogether. The New York Times 2011. http://www.nytimes.com
[30] Kouvelis P, Gutierrez G. The newsvendor problem in a global market: Optimal centralized and decentralized control policies for a two-market stochastic inventory system. Management Science 1997;43(5):571–85.
[31] Lai G, Liu Y, Xiao W. International taxation and production outsourcing. Production and Operations Management 2021;30(2):402–18.
[32] Lariviere M, Porteus E. Selling to the newsvendor: An analysis of price-only contracts. Manufacturing & Service Operations Management 2001;3(4):293–305.
[33] Li G, Li L, Sethi S, Guan X. Return strategy and pricing in a dual-channel supply chain. International Journal of Production Economics 2019;215:153-164.
[34] Li Y, Lim A, Rodrigues B. Global sourcing using local content tariff rules. IIE Transactions 2007;39(5):425–37.
[35] Li G, Wu H, Xiao S. Financing strategies for a capital-constrained manufacturer in a dual-channel supply chain. International Transactions in Operational Research 2020;27(5):2317–39.
[36] Li J, Yi L, Shi V, Chen X. Supplier encroachment strategy in the presence of retail strategic inventory: Centralization or decentralization? Omega - International Journal of Management Science 2021;98:102213.
[37] Li G, Zhang X, Chiu S, Liu M, Sethi S. Online market entry and channel sharing strategy with direct selling diseconomies in the sharing economy era. International Journal of Production Economics 2019;218:135-147.
[38] Liu B, Guan X, Wang H, Ma S. Channel configuration and pay-on-delivery service with the endogenous delivery lead time. Omega - International Journal of Management Science 2019;84:175–88.
[39] Lu LX, Van Mieghem JA. Multimarket facility network design with offshoring applications. Manufacturing & Service Operations Management 2009;11(1):90–108.
[40] OECD. OECD transfer pricing guidelines for multinational enterprises and tax administrations. OECD Publishing 2010. Paris
[41] Pasternack B. Optimal pricing and return policies for perishable commodities. Marketing Science 1985;4(2):166–76.
[42] Robinson L, Stocken P. Location of decision rights within multinational firms. Journal of Accounting Research 2013;51(5):1261–97.
[43] Shunko M, Debo L, Gavirneni S. Transfer pricing and sourcing strategies for multinational firms. Production and Operations Management 2014;23(12):2043–57.
[44] Shunko M, Do HT, Tsay AA. Supply chain strategies and international tax arbitrage. Production and Operations Management 2017;26(2):231–51.
[45] Song H, Duan H, Deng S, Xu J. Brand extension and channel structure: An analysis of the effects of social influence. Omega - International Journal of Management Science 2022;110:102626.
[46] Venkatesh R, Chintagunta P, Mahajan V. Research note- sole entrant, co-optor, or component supplier: Optimal end-product strategies for manufacturers of proprietary component brands. Management Science 2006;52(4):613–22.
[47] Wang T, Thomas D, Rudi N. The effect of competition on the efficient-responsive choice. Production and Operations Management 2014;23(5):829–46.
[48] Wu Z, Lu X. The effect of transfer pricing strategies on optimal control policies for a tax-efficient supply chain. Omega - International Journal of Management Science 2018;80:209–19.
[49] Wu X, Zhang F. Home or overseas? an analysis of sourcing strategies under competition. Management Science 2014;60(5):1223–40.
[50] Xiao W, Hsu VN, Hu Q. Manufacturing capacity decisions with demand uncertainty and tax cross-crediting. Manufacturing & Service Operations Management 2015;17(3):384–98.
[51] Xu Y, Gurnani H, Desiraju R. Strategic supply chain structure design for a proprietary component manufacturer. Production and Operations Management 2010;19(4):371–89.
[52] Xu J, Hsu VN, Niu B. The impacts of markets and tax on a multinational firm's procurement strategy in china. Production and Operations Management 2018;27(2):251–64.
[53] Yang H, Ou J, Chen X. Impact of tariffs and production cost on a multinational firm's incentive for backshoring under competition. Omega - International Journal of Management Science 2021;105:102500.
[54] Yi Z, Wang Y, Liu Y, Chen Y. The impact of consumer fairness seeking on distribution channel selection: Direct selling vs. agent selling. Production and Operations Management 2018;27(6):1148–67.