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PREFACE

Two years have passed and, once again, we are here with our international meeting of academics and professionals – the conference on Strategic Management and its Support by Information Systems (SMSIS). This year, the conference is held for the 13th consecutive year and, again, we are glad for the support from the dean of the Faculty of Economics, VŠB – Technical University of Ostrava, prof. Zdeněk Zmeškal.

The first SMSIS conference has been held in 1995 and, to this day, it continues as a traditionally bi-annual platform for professional discussions and exchange of experiences between research teams from various countries and institutions around the world, namely from the Czech Republic, Hungary, Iran, Spain, Slovakia and the United Kingdom. The conference focuses on a relatively broad scale of topics that are associated with:

- strategic management,
- quantitative methods and their applications in management issues,
- trends and issues in information systems design, management and security,
- and applications of new media and intelligent tools in the Digital Economy.

This year, several new hot topics are presented and discussed, namely, social dimension of strategic management, benchmarking in supply chain management, spatial econometrics, cybersecurity for industry 4.0, or artificial neural network and machine-learning with human-in-the-loop.

The SMSIS 2019 conference is organized in cooperation with the Czech Society for Systems Integration (CSSI) and three Czech universities: VŠB – Technical University of Ostrava (Faculty of Economics), University of Economics in Prague (Faculty of Informatics and Statistics) and Masaryk University in Brno (Faculty of Informatics).

The SMSIS conference proceedings usually contains about 50 carefully selected scholarly and professional papers, which are double-blind reviewed by members of the programme committee, who certainly deserve thanks for their devoted work. I would like to thank the members of the organizing committee as well, for their dedication and hard-work during the preparation and organization of the SMSIS 2019 conference event.

I wish all of us to be successful in the presentation of our work, our contributions to be beneficial to conference participants and that the event will meet everyone's expectations.

To a successful conference!

Jana Hančlová

May 2019

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A

STRATEGIC MANAGEMENT

Comparison of supply-chain coordinating contract types

Viktor Molnar[1], Tamas Faludi [2]

Abstract. Contract types as hard coordinating tools of supply chains have become an important focus point in the strategic issues of enterprises in recent decades. The market mechanisms connected to simple or even complex chains can be analyzed on the basis of mathematical formulation of coordination models This study, through a quantitative example, investigates how strong a coordinating power certain contract types (wholesale pricing and quantity discount) have; that is, among the applied contract types which can be considered as more profitable from a coordinating point of view. The aim of this study is comparing the basic wholesale pricing contracts in centralized and decentralized settings and the widely applied quantity discount type contract in order to get clear information about their advantages or disadvantages. Both the centralized and the quantity discount type is recommended to apply in supply chains where possible.

Keywords: Supply-Chain Coordination, Quantity discount; Wholesale Price; Contract Type.

JEL Classification: D21, L11, L14, M10

1 Introduction

Supply chain management appeared for the first time in the literature in the 1980s. In that period globalization was evolving and as a result supply chains were widening. The number of cooperating enterprises increased and the sudden development of information technology tools increasingly affected the operation of enterprises (Juhasz and Banyai, 2018a). This development process is still continuing nowadays. This is why supply chain management is one of the most important research areas today.

The chains have formed complicated networks in the 21st century. There are many suppliers, raw material manufacturers and distribution centers within the supply networks. They have to cooperate in an efficient manner in order that all of the customers' needs be satisfied (Tamas and Illes, 2017). These processes have to be operated in a way that the members of the network are able to earn profits. This is the reason for the increased scientific interest in the coordination of supply chains.Two groups of coordination possibilities can be distinguished. One is the group of soft factors, which attempt to increase coordinating efficiency through the behavioral aspect (Singh and Benyoucef, 2013). The other is the group of hard factors that facilitate coordination through financing. Many believe that the potentially best hard factor is the set of contract types (Gomez-Padilla and Mishina, 2009).

To analyze supply chain coordination mechanisms, the detailed study of basic elements or basic processes of production or providing service is necessary. In manufacturing, for example, one of the most elementary solutions, sufficiently accurate cutting tool management in mass

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production can result in a significant saving of cost annually (Vasvari et al., 1994; Mamalis, Kundrak and Horvath, 2005). In another example, the proper formation of surface topography of the produced parts can significantly influence the scrap rate and therefore the customers' satisfaction (Felho and Kundrak, 2012). However, these elements, which seem to be minor, have significant effects on costs, particularly if the development level of calculation procedures and systems at a given enterprise is high enough (Musinszki, 2014, 2016a).

In the time of Industry 4.0, the in-depth analysis of complex organizational systems requires relatively quick processing and analysis of great amounts of data (Musinszki, 2016b; Juhasz and Banyai, 2018b). The reason for success of cooperation between companies is not simply their bargaining power but also the elements determining the efficiency of activities defined within the basic processes of an organization. Another important issue is that a strategic step that may profitable in the short term does not necessarily lead to long-term success, and vice versa.

According to the state-of-the-art the aims of contract types are to ensure a legal framework for the cooperation of companies and determining responsibilities and rates of costs and profits (Coltman et al., 2009). These ensure clear rules, therefore conflicts can be avoided. Another definition points out that contracts are used mainly to increase the performance of supply chain. At the same time most of the contracts are applied on the basis of their coordinating capability and the resulting advantages (Wang, Wang and Su, 2013; Tilson, 2008).

There are many contract types in practice that are used by companies to make agreements. Researchers intensified their interest in this topic around the year 2000. There are traditional contracts, e.g. wholesale contracts, hybrid ones (Molnar, Musinszki and Faludi, 2018), and relatively new types as well, e.g. the trade credit type (Luo and Zhang, 2012). Choosing the most suitable contract type for a certain operation and contact system of a company could be a potential coordinating factor. The wholesale contract type can be used in both centralized and decentralized supply chains. In the latter case companies maximize their profits individually on the basis of previously determined prices. In a centralized setting there is a chain member who manages the rest of the members due to its bargaining power, and they all intend to maximize the profit of the whole supply chain. This means that the profit maximizing variable is the quantity to be sold (Chakraborty, Shauhan and Vidyarthi, 2015). The quantity discount type contract is also an option that can be applied in supply chains operating either in centralized or decentralized settings. The main goal of this type is that the seller motivates the customer to buy as great an amount of product as possible. Here the price and quantity sold are in inverse relationship, that is the larger the lot the customer buys, the greater discount it obtains.

In our study the above mentioned contract types are compared. The methodology of the analysis consists of a supply chain model formulation and an analysis through an illustrative mathematical example. The model consists of two supply chain members and it can be generalized to a sequential chain by several members.

2 Model formulation

The coordination powers of the two contract types (wholesale pricing and quantity discount) are demonstrated through a quantitative example when centralized and decentralized settings

are applied. The analysis is carried out with the use of a simple supply chain model with two members (Fig. 1).

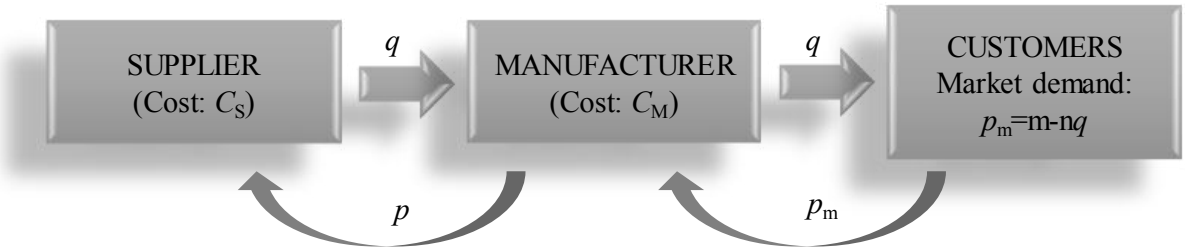

Figure 1 The supply chain structure of the model

The two members are the supplier and the manufacturer. They serve the market and therefore the customers. The notations applied in the model are summarized in Table 1.

Symbol	Description
S	supplier
M	manufacturer
p	supplier's price
p_m	market price
q_{DC}	quantity – decentralized setting
q_C	quantity – centralized setting
π_{DC}	profit – decentralized setting
π_C	profit – centralized setting
π_{QD}	profit – quantity discount
m; n	constants of market demand function
C	total cost of the SC members
α_M	manufacturer's revenue rate

Table 1 Notations applied in the model

3 Analysis

The objective of this case study is to demonstrate the difference between the centralized and decentralized settings of supply chains by emphasizing the applied prices, sold quantities, total profit of the chain and the individual profits of chain members. In the case study two contract types – wholesale pricing and quantity discount – are analyzed.

Parameter	pm	C_S	C_M	α_M
Value	100–1.5q	EUR 15	EUR 25	0.7

Table 2 Economic parameters

The simplified market demand function ($p_m(q)$) and the given process are valid in the case of durable consumer goods that are not strongly seasonal. Data necessary for calculations are summarized in Table 2.

In wholesale pricing when the decentralized setting is applied, profit values can be calculated by the formulas below. Eq. (1) is the supplier's profit, Eq. (2) is the manufacturer's profit. The

manufacturer maximizes its profit on the basis of the sold quantity, i.e. it choses q_{DC} on the basis of market demand. Therefore $\pi_{\mathrm{DC,M}}$ has to be partially derived by quantity. When this expression is equal to zero, quantity q_{DC} can be expressed (Eq. (3)).

$$\pi_{\mathrm{DC,S}} = (p - C_{\mathrm{S}})q_{\mathrm{DC}} \tag{1}$$

$$\pi_{\mathrm{DC,M}} = (p_{\mathrm{m}} - p - C_{\mathrm{M}})q_{\mathrm{DC}} \tag{2}$$

$$\frac{\partial \pi_{\mathrm{DC,M}}}{\partial q_{\mathrm{DC}}} = 0 \rightarrow q_{\mathrm{DC}}(p) = \frac{m - p - C_{\mathrm{M}}}{2n} \tag{3}$$

The supplier determines the price to be charged to the manufacturer (p) if it orders quantity q_{DC}. The supplier's profit and the supplier's price determined by the profit maximum criteria can be calculated by Eqs. (4) and (5).

$$\pi_{\mathrm{DC,S}} = (p - C_{\mathrm{S}})\frac{m - p - C_{\mathrm{M}}}{2n} \tag{4}$$

$$\frac{\partial \pi_{\mathrm{DC,S}}}{\partial p} = 0 \rightarrow p = \frac{m - C_{\mathrm{M}} + C_{\mathrm{S}}}{2} \tag{5}$$

The quantity q_{DC} (Eq. (6)) can be determined using Eqs. (3) and (5). Substituting this in the demand function provides the market price (Eq. (7)).

$$q_{\mathrm{DC}} = \frac{m - C}{4n} \tag{6}$$

$$p_{\mathrm{m}} = \frac{3m + C}{4} \tag{7}$$

Profits of the supply chain members and the whole chain are calculated by Eqs. (8)–(10). They incorporate only the known costs and constants that describe market demand.

$$\pi_{\mathrm{DC,S}} = \frac{(m - C)^2}{8n} \tag{8}$$

$$\pi_{\mathrm{DC,M}} = \frac{(m - C)^2}{16n} \tag{9}$$

$$\pi_{\mathrm{DC}} = \frac{3(m - C)^2}{16n} \tag{10}$$

In the centralized setting the chain members maximize the total profit of the supply chain (Eq. (11)) on the basis of the market demand q_{C} (Eq. (12)). Substituting q_{C} quantity in the marked demand function, the market price can be determined (Eq. (13)).

$$\pi_{\mathrm{C}} = (p_{\mathrm{m}} - C)q_{\mathrm{C}} \tag{11}$$

$$\frac{\partial \pi_{\mathrm{C}}}{\partial q_{\mathrm{C}}} = 0 \rightarrow q_{\mathrm{C}} = \frac{m - C}{2n} \tag{12}$$

$$p_{\mathrm{m}} = \frac{m + C}{2} \tag{13}$$

Profits of the supply chain members and the whole chain are calculated by Eqs. (14)–(16) They incorporate only the known costs, the constants that describe market demand and the price charged by the supplier. In the centralized setting the supplier's price, which splits the total profit of the chain equally, can be calculated (Eq. (17)).

$$\pi_{\mathrm{C,S}} = (p - C_{\mathrm{S}})\frac{m - C}{2n} \tag{14}$$

$$\pi_{\mathrm{C,M}} = (p_{\mathrm{m}} - p - C_{\mathrm{M}})\frac{m - C}{2n} \tag{15}$$

$$\pi_{\mathrm{C}} = \frac{(m - C)^2}{4n} \tag{16}$$

$$\pi_{\mathrm{C,S}} = \pi_{\mathrm{C,M}} \rightarrow p^* = \frac{m - C_{\mathrm{M}} + 3C_{\mathrm{S}}}{4} \tag{17}$$

In the case of a quantity discount type contract the supplier charges the manufacturer price $p(q_{\mathrm{C}})$, which depends on the quantity q_{C}. It is assumed that the price is the declining continuous function of the quantity. The profit of the manufacturer is the difference between its revenue ($R(q_{\mathrm{C}})$) and costs (Eq. (18)). In this contract type the centralized setting of the wholesale pricing contract is considered optimal. In such a situation the quantity is identical to q_{C} and by applying this quantity the profit of the whole chain is identical to the profit of the centralized setting. This means that the profit of the manufacturer is an α_{M} portion of the total profit (Eqs. (19) and (20)). The price $p(q_{\mathrm{C}})$ can be expressed from these (Eq. (21)). Using the resulting formulas, the profit of the supplier can be calculated by Eq. (22).

$$\pi_{\mathrm{QD,M}} = R(q_{\mathrm{C}}) - [p(q_{\mathrm{C}}) + C_{\mathrm{M}}]q_{\mathrm{C}} \tag{18}$$

$$\pi_{\mathrm{QD,M}} = \alpha_{\mathrm{M}}\pi_{\mathrm{C}} \tag{19}$$

$$R(q_{\mathrm{C}}) - [p(q_{\mathrm{C}}) + C_{\mathrm{M}}]q_{\mathrm{C}} = \alpha_{\mathrm{M}}[R(q_{\mathrm{C}}) - Cq_{\mathrm{C}}] \tag{20}$$

$$p(q_{\mathrm{C}}) = (1 - \alpha_{\mathrm{M}})\frac{R(q_{\mathrm{C}})}{q_{\mathrm{C}}} - C_{\mathrm{M}} + \alpha_{\mathrm{M}}C \tag{21}$$

$$\pi_{\mathrm{QD,S}} = [p(q_{\mathrm{C}}) - C_{\mathrm{S}}]q_{\mathrm{C}} = (1 - \alpha_{\mathrm{M}})\pi_{\mathrm{C}} \tag{22}$$

For the quantity discount type it was also analyzed how the studied economic parameters change when the quantity is lower or higher than the optimum sold quantity (q_{C}). The reason for this is to gain more realistic insight into the market and to simulate a situation where the quantity sold not always remains the optimum expected by the market. In the first case the sold quantity is identical to that of the centralized setting, in the second it is lower and in the third it is higher. Table 3 summarizes the results of applying the formulas above and the data of Table 2.

Parameter	Wholesale pricing		Quantity discount		
	decentralized	centralized	$q=q_C$	$q<q_C$	$q>q_C$
quantity, q [1000 pcs]	10	20	20	17	25
market price, p_m [EUR]	85	70	70	74.5	62.5
supplier's price, p [EUR]	45	30	24	25.35	21.75
supplier's profit, π_S [EUR 1000]	300	300	180	175.95	168.75
manufacturer's profit, π_M [1000 EUR]	150	300	420	410.55	393.75
total profit, π [1000 EUR]	450	600	600	586.5	562.5

Table 3 Results of the calculation

From the numerical results it can be stated that each company that applies wholesale pricing earns a higher profit in the centralized setting than in the decentralized setting. This means that the total profit of the whole supply chain is also higher. It is recommended to apply the centralized setting because this statement is valid not only in case of two but more members too.

In quantity discount any alteration in the optimal centralized quantity results in the decrease of profit values: in case of lower quantity the prices increase; in case of higher quantity the prices decrease but the marginal revenue decreases to a higher extent. Due to the share rate the share of profits between the members is relatively unequal. The reason for this is the preliminary given α_M rate, whose value in practice depends on the bargaining powers of the members. This value highlights the connection between the quantity discount type and the revenue sharing type: In the latter model the supplier always earns (1-α) part of the total profit of supply chain while when a quantity discount is applied, the profit of retailer depends on the p price determined by q_C quantity. Therefore, in an uncertain market situation the risk is borne completely by the retailer. If a quantity discount can be applied in the transactions between the members, the q_C quantity is worth to be bought because of the highest profit. Of course; it is not always possible because the quantity is determined by the market but endeavoring to that could be useful. However; the lower or higher quantities also result in higher profits than that in the decentralized setting of wholesale pricing.

4 Summary

One of the most important questions in supply chain management is how the operation efficiency and profitability of supply chains or networks can be increased. Supply chain coordination solutions can be considered as the greatest help in meeting this aim. Applying soft and hard coordinating factors, the operation of supply chains can become more efficient. Hard factors, namely the supply chain coordination by contracts, were the focus of this study. Two

relatively frequently applied contract types were compared in supply chains operating in either centralized or decentralized settings. The comparison was demonstrated in a case study. It was found that the centralized setting ensures more advantageous conditions with the wholesale pricing type of contract than the decentralized one. When quantity discount is applied, it is worth selling the same quantity of products as determined in centralized setting because this allows a maximum profit. The profitability of supply chains can be increased by altering the present contracts between the members to a more profitable one. In this paper it was demonstrated that the widely applied decentralized wholesale pricing contract can be substituted by more profitable ones. The most important step in this modification is the development of ability for a more efficient communication process and trust between the partners. It can be reached only by the change of attitude of managers. It is recommended to apply additional variables in order to make revenue sharing fairer. This issue can be a direction for further research.

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References

Chakraborty, T., Shauhan, S.S. and Vidyarthi, N. (2015). 'Coordination and competition in a common retailer channel: Wholesale price versus revenue-sharing mechanisms'. *International Journal of Production Economics*, 166, pp. 103–118.

Coltman, T., Bru, K., Perm-Ajchariyawong, N., Devinney, T. M. and Benito, G. R. (2009). 'Supply Chain Contract Evolution', GR, Supply Chain Contract Evolution. *European Management Journal*, pp. 1–30.

Felho, C. and Kundrak, J. (2012). 'Characterization of topography of cut surface based on theoretical roughness indexes'. *Key Engineering Materials*, 496, pp. 194–199.

Gomez-Padilla, A. and Mishina, T. (2009). 'Supply contract with options'. *International Journal of Production Economics*, 122 (1), pp. 312–318

Juhasz, J. and Banyai, T. (2018a). 'Last mile logistics: an integrated view'. *Proceeding of IOP Conference Series: Materials Science and Engineering*, Kecskemét, Hungary, pp. 448

Juhasz, J. and Banyai, T. (2018b). 'What industry 4.0 means for just-in-sequence supply in automotive industry?'. *Lecture Notes in Mechanical Engineering*, pp. 226–240.

Luo, J. and Zhang, Q. (2012). 'Trade credit: A new mechanism to coordinate supply chain'. *Operations Research Letters*, 40, pp. 378–384.

Mamalis, A.G., Kundrak, J. and Horvath, M. (2005). 'On a novel tool life relation for precision cutting tools'. *Journal of manufacturing science and engineering*, 127 (2), pp. 328–332.

Molnar, V., Musinszki, Z. and Faludi, T. (2018). 'Profit allocation in supply chains on the basis of revenue-sharing rates'. *International Journal of Economics and Management Systems*, 2, pp. 47–52.

Musinszki, Z. (2014). 'Cost to be a cost? Cost in the management accounting', *Controller Info Studies Budapest, Copy & Consulting Ltd*., pp. 134–138.

Musinszki, Z. (2016a). ‘Innovations and cost systems trends and ways in the cost accounting’. *Proceedings of Organizational and economic mechanisms of development of the financial system*, Riga, Latvia, pp. 209–219.

Musinszki, Z. (2016b). ‘Ipar 4.0 – költségrendszer 4.0?: Innovációk a költségrendszerekben’. *Controller Info*, 4 (3), pp. 2–9.

Singh, R.K. and Benyoucef, L. (2013). ’A consensus based group decision making methodology for strategic selection problems of supply chain coordination’. *Engineering Applications of Artificial Intelligence*, 26, pp. 122–134.

Tamas, P. and Illes, B. (2017). ‘Novel trends in improvement of warehouse management systems for manfacturing companies’. *Academic Journal of Manufacturing Engineering*, 15 (3), pp. 23–28.

Tilson, V. (2008). ’Monotonicity properties of wholesale price contracts’. *Mathematical Social Sciences*, 56 (1), pp. 127–143.

Vasvary, L., Ditroi, F., Takacs, S., Szabo ,Z., Szucs, J., Kundrak, J. and Mahunka, I. (1994). ‘Wear measurement of the cutting edge of superhard turning tools using TLA technique’. *Nuclear Inst. and Methods in Physics Research*, 85, pp. 255–259.

Wang, X., Wang, X. and Su, Y. (2013). ’Wholesale-price contract of supply chain with information gathering’. *Applied Mathematical Modelling*, 37 (6), pp. 3848–3860.