



# Channel coordination through subsidy contract design in the mobile phone industry



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## ABSTRACTS

This paper examines the feasibility of employing subsidy contracts as a control mechanism to optimise the mobile phone sales channel. We investigate a dual-channel that consists of a telecommunication service operator (TSO) and a mobile phone manufacturer (MPM). The MPM's optimal production quantity and optimal retail price and the TSO's optimal service capacity and optimal service price are derived in both the decentralised and centralised MPSC models. The modelling results show that the coordinated MPSC leads to profit increase for the MPSC as a whole. More importantly, our analysis demonstrates that a properly designed subsidy contract can achieve the channel coordination in the MPSC. However, such channel coordination through subsidy contract is subject to certain conditions in which Pareto improvement can be achieved.

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## 1. Introduction

Over the past two decades, the mobile telecommunication sector has witnessed a rapid growth in both developed and developing economies. The increase in the number of mobile phone users has led to the significant growth of mobile service. According to recent forecast, global mobile service revenue will reach the height of 1137 billion U.S. dollars in 2015 (Informa Telecoms and Media, 2013). However, the increase of global mobile service revenue does not guarantee that each member within the mobile phone supply chain (MPSC) will gain more profit. In fact, intense competitiveness has already escalated the complexity of the strategic interactions among members within the MPSC. We have already seen many high profile winners and, of course, casualties in the mobile telecommunication sector. To meet the challenges, members in the MPSC can no longer compete as independent members. Instead, they must coordinate with each other and work towards a unified system to improve their supply chain performance.

It is well known from the existing literature that channel coordination can improve the overall supply chain performance (Boyaci and Gallego, 2004; Kanda and Deshmukh, 2008). However, the main assumption ignores the competitive environment in which

supply chain members operate. More importantly, MPSC is different from either traditional manufacturing supply chains or pure service supply chains. As a result, traditional supply chain theories may not be applicable. It is characterised in the following four aspects. (1) The main participating entities in the MPSC are telecommunication service operators (TSO), who provide the mobile telecommunication service, and mobile phone manufacturers (MPM), who produce mobile phones and product service. (2) In addition to the price and quality of mobile phones, both price and quality of telecommunication service complement each other and are essential to meet end customers' needs. (3) There exists a dual-channel in the MPSC, in which consumers can buy their mobile phones and telecommunication services from either the MPM or the TSO directly. For example, consumers can buy iPhones and service packages from Apple stores or from different TSOs. (4) The MPM and the TSO can either compete with each other for market share or alternatively coordinate with each other in setting up the prices and then negotiate with each other in distributing profit through subsidy contact (Chen and Wang, 2015).

Given the inherent differences between the MPSC and the conventional manufacturing or service supply chains, we develop a model that links product and service prices to market demand and subsidy policies in a competitive market environment. More specifically, we consider the channel coordination problem in a MPSC that consists of an MPM and a TSO. The MPM can sell mobile phones to customers and the TSO can sell telecommunication service to customers respectively in a conventional supply chain or alternatively they can sell product and service bundled package to

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customers in a coordinated MPSC. Several questions are addressed in this paper. They are listed as follows:

- (1) What are the MPM's optimal production quantity and retail pricing policies and the TSO's optimal service capacity and pricing policies in a decentralised or centralised MPSC respectively?
- (2) How to achieve supply chain coordination through subsidy contract and what is the effect of subsidy contract on MPSC decisions and its performance?
- (3) How to design a subsidy contract? For instance, what is the optimal subsidy and who are the provider and the receiver of the subsidy?
- (4) Under what conditions channel coordination through subsidy contract can achieve a win–win situation that MPSC members obtain a profit margin higher than they would do without contract?

Although there is a considerable amount of research in the literature on different aspects of channel coordination, very few studies have focused on coordination in the service supply chain (Tsay and Agrawal, 2000; Boyaci and Gallego, 2004; Chan and Chan, 2010; Liu et al., 2013; Chen et al., 2015). Even fewer studies have made use of the mobile telecommunication sector as a case, which has distinctive supply chain characteristics as discussed earlier. It is important that the production economics research stream addresses the research gap through specifically designed modelling efforts. This paper aims at fulfilling this objective by modelling the channel coordination in the MPSC using the game theoretical approach. Generally speaking, in the game theory models, players make decisions to maximise their own utility, while taking into account that others are doing the same and that decisions made by players affect each other's performance (Nagarajan and Sošić, 2008). The main contributions of our work are summarised as follows:

- (1) We develop MPSC models with an MPM and a TSO in both decentralised and centralised supply chain structures, in which, both the MPM and the TSO directly deal with the end customers and their demand is influenced by the pricing policies of both the mobile phone product and telecommunication service. Our paper extends the traditional supply chain that consists of sequential upstream manufacturer and downstream retailer that mainly considers product or service only.
- (2) Through examining the feasibility of using subsidy contract as a control mechanism to coordinate the MPSC, our research extends the exiting literature by demonstrating how such an approach can be employed practically to obtain a win–win outcome for the MPSC members.
- (3) Through studying the channel coordination in the MPSC, we analyse the effect of channel coordination, pricing policies, and subsidy contract on the MPSC performance. The analysis results will support firms in the mobile telecommunication industry to adopt the proper strategies in order to improve their competitiveness.

To the best of our knowledge, this paper represents the first attempt to study the channel coordination problem of the MPSC, in which, both the MPM and the TSO use price and subsidy to compete and cooperate with each other to maximise their own profits. The remainder of this paper is organised as follows. After a brief review of relevant literature in Section 2, modelling formulations and assumptions are provided in Section 3. In Sections 4 and 5 the optimal production quantity, optimal service capacity and pricing policies in a decentralised MPSC model and in a centralised MPSC model are presented respectively. In Section 6, we focus on how to

achieve channel coordination through subsidy contract for the MPSC. In Section 7, some critical issues of channel coordination through subsidy contract are discussed. Finally, we discuss the managerial implications of our study and future work in Section 8.

## 2. Literature review

Channel coordination is an important issue in marketing and supply chain management. Relevant studies on the coordination problem have been well reported in the literature. Other terms e.g. integration, collaboration, and cooperation are also used in the studies on channel coordination problems. These terms are complementary to each other and when used in the supply chain context can easily be considered as a part of supply chain channel coordination (Kanda and Deshmukh, 2008). To highlight our contributions, only the literature that is representative and particularly relevant to our study is reviewed.

The mobile phone industry has witnessed significant growth over the past two decades. Despite the importance to the economy and its unique features, studies on the MPSC are still rare in the operations and supply chain management literature. Among them, Catalan and Kotzab (2003) analysed the performance efficiency in the Danish MPSC and found its responsiveness was low. Their research emphasised the importance of the responsiveness and also suggested that collaboration between supply chain parties was crucial to improve the supply chain responsiveness. Eng (2006) provided some insights into the qualitative nature of mobile supply chain management but the research did not discuss the problems of the mobile phone industry. In addition, Eng (2006) mainly focused on the implications of mobile technology for supply chain management. Dedrick et al. (2011) analysed the distribution of value in the MPSC based on product-level data, and found that carriers and handset makers captured the most profit from each handset. Among the studies using quantitative approaches, Jiang et al. (2010) proposed an agent-based simulation approach to study the competitive and collaborative mechanisms for mobile service chains. Cricelli et al. (2011) examined the competition among mobile network operators in the telecommunication supply chain focusing on different value chain components, the resulting competitive advantages and the appropriate value strategies. More recently, Chen and Wang (2015) investigated the free and bundled channels in the MPSC. Their research mainly focused on assessing the impact of supply chain power dynamics on the channel selection problem. Different to above mentioned studies, this research aims to derive optimal operations solutions for the MPSC members in both decentralised and centralised scenarios, and seeks a feasible mechanism to achieve the MPSC coordination which leads to our next wave of enquiry.

Effective management of supply chains requires coordination among various channel members. According to Jeuland and Shugan (1983), channel coordination was defined as the setting of all manufacturer and retailer-related decisions at the levels that would maximise total channel profits. The literature on supply chain coordination is rich including the studies on coordinating manufacturing supply chains (Jeuland and Shugan, 1983; Ingene and Parry, 1995; Weng, 1995; Iyer, 1998; Tsay and Agrawal 2004; Raju and Zhang, 2005; Cai, 2010) and the supply chain scenarios where service is considered (Ernst and Cohen, 1992; Tsay and Arrawal, 2000; Boyaci and Gallego, 2004; Li et al., 2011; Chen and Shen, 2012; Liu et al., 2013). Different coordination mechanisms including quantity discount (Jeuland and Shugan, 1983; Weng, 1995; Raju and Zhang, 2005), two-part tariff pricing policies (Ingene and Parry, 1995; Raju and Zhang, 2005; Swami and Shah, 2013), pricing discount (Li et al., 2011), revenue sharing (Giannoccaro and Pontrandolfo, 2004; Cachon and Lariviere, 2005;

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