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A Study on China Digital Music Channel Mode and Channel Coordination

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ABSTRACT

Content providers, service providers and telecom operators in China digital music market compete expanding to upstream and downstream channel resource. The fierce channel competition between participants has impede user service level and the development of digital music market. This paper researches into two questions. The first one is how the participants compete in four different competitive channel modes, in which revenue and service level are influenced. The second one is how participants can optimize revenue in coordination rather than competition.

To answer to first question, firstly the participants, digital music service modes and channel modes are analyzed. Then considering the service level provided by telecom operator and service provider, two-partite and three-partite Stackelberg models are constructed to explore the four competitive modes, which are High Price without Service Provider (SP) Mode, "Low Price+Shared Revenue" without SP Mode, High Price with SP participation Mode and "Low Price+Shared Revenue" with SP participation Mode. Besides, optimal strategies in four modes are calculated and numerical analysis approach is adopted to explore the influence of different factors on the equilibrium results, which are digital music service production cost coefficient, revenue sharing ratio, user price sensitive factor and user service level sensitive factor.

To find out solution to the second question, cooperative channel without SP participation mode and cooperative channel with SP participation mode are built to maximum the revenue of digital music channel participants. Finally two-partite and three-partite revenue sharing mechanisms basing on the participants' bargaining power are explored to achieve the optimal channel system revenue.

This study finds that in the four competitive digital music channel modes, the participants

competing with each other leads to revenue loss. Whether SP participates, digital music channel participants revenue and system revenue in High Price Mode are better than those in “Low Price+Shared Revenue” Mode. The optimal competitive mode is High Price without SP Participation Mode. To achieve channel coordination, if without SP participating, Telecom Operator (OP) and Content Provider (CP) formulate contract according to proportion $\kappa = \frac{1}{4} + \frac{\varepsilon}{4}$ to share revenue, otherwise CP, SP and OP share revenue according to proportion κ, υ.

Key words: digital music, channel modes, competition, channel coordination

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

SP Service Providers

CP Content Providers

OP Telecom Operators

1 INTRODUCTION

1.1 Background

Music was at music sheet stage at 19th century and moved to records stage in the middle of 20th century. As the Internet technology progresses and home computer popularizes, music industry came to the digital age at the beginning of 21st century. Now the music industry is marked with both traditional physical records sales market and digital sales market. In the recording industry, the main property that is created and traded are compositions, recordings and media (such as CDs or MP3s). Performances, reproduction, synchronization and distribution are the main revenue sources for music publishers. Recordings are produced by the artists and owned by record companies, who are responsible for manufacturing, marketing and promoting. Media like CDs and MP3s is delivered by the distributors from manufacturers to retailers and money flows from retailers to distributors and then to recording companies.

With the rapid progress of Internet and digital technology, great changes have taken place in the value chain and business model of music industry. Online music downloads cause a rapid decrease in physical records. Consumers tend to buy their favorite singles instead of the whole album. Digital single sales replacing bundling sales is impacting physical music industry. In 2007 the global recording industry's physical music revenue accounted to $17.3 billion with a sharp drop of 46% in the next 5 years, while digital music is penetrating the music market from $3.2 billion to $5.8 billion with a compound annual growth rate of 12.6%. In 2012, the global digital music reached $16.5 billion with more than 500 authorized digital music service providers providing 30 million songs (IFPI, 2013, pp.6). In Chinese music market, digital music revenue exceeded physical recording revenue in 2008, and soared into $75.8 million in 2012 while physical music revenue reached $16.6 million. Chinese digital music revenue increased 103% while physical

music dropped 62% from 2007 to 2012. The traditional music recording sales mode is gradually replaced by digital music business model. The boundary between different players in the music industry, such as artist, publisher, record company, distributor, retail and consumer electronics, has blurred. There are artists launching their own music studio to generate, distribute their own music, and big publishing companies also play the role of distributor and retailer.

Compared with the United States and Japan, China has much bigger music listeners market, whereas music sales are not comparable with the music market. In 2012, Chinese recording industry's digital music revenue, which came from music downloads, master ringtone, ringback and advertising, reached $92 million, ranking 20th of the world music market. According to 2012 China's Online Music Market Annual Report issued by China Ministry of Culture, in 2012 Chinese digital music user scale reached 454 million and mobile music utilization rate accounted to 50.9% among mobile users. The authoritative digital music enterprises reached 575. In 2012 Chinese digital music service providers revenue achieved 4.54 billion RMB, among which online music revenue arrived at 1.82 billion RMB and mobile music reached 2.72 billion RMB. However, Chinese mobile music total revenue achieved 31.72 billion RMB in 2012, among which telecom operators attained 29 billion RMB, accounting to 91% of the whole mobile music market (China Ministry of Culture, 2012, pp.9). Among mobile music users, 53.7% of them got access to China Mobile, 26.7% got access to China Unicom and the rest 19.6% got access to China Telecom. According to 2012 Digital Music Report issued by International Federation of the Phonographic Industry (IFPI), digital music piracy rate was as high as 99% in Chinese market (pp.23). Lots of problems need to be settled down in Chinese music market, such as several recording companies and telecom operators' monopoly, intense competition among music channels and severe piracy which leads to the user habit of getting free music resource.

The main participants in digital music channels contain music content providers (CP), service providers (SP) and telecom operators (OP). The global music industry market sales are increasing, but competition between different digital music channel participants has hindered the development of music market seriously. In the music channel, SP cooperates with big recording companies by adopting “guaranteed + revenue sharing” copyright payment mode or copyright buyout mode. In the "guaranteed + is divided into" copyright payment mode, big recording company impose a relatively low guaranteed fee from SP according to the business plan and SP share the digital music revenue with recording company. However, in copyright buyout mode, SP buys the copyright from recording company at a relatively high price but not shares revenue. Due to the leading role of big recording companies in the channel, most profits are often attributed to big recording companies and experienced service providers with strong marketing and promotion capability corner the digital music service market. However, small indie recording labels often get very little profit because of its weak channel influence. Small CP with excellent music products, such as individual artists and studio, only positioning niche market because they lack money to publicity and marketing. Some artists have to give up music copyright to enable their music to enter market by service providers. In mobile music market, telecom operator dominates the music channels and acquires more than 90% of the channel revenue, whereas service providers cannot survive in the market for a long time, being not able to pay royalties to CP by sharing digital music sales. The intense channel conflicts and unreasonable channel profit sharing mechanism contribute to deformed development of music market. In view of the above analysis, four different channel competition modes and optimal strategies in two cooperative channel modes are explored and channel system revenue loss is discovered by comparing different channel modes. Channel coordination mechanism is designed to enable channel participants’ and channel system’s revenue to achieve optimal basing on participants’ bargaining power.

1.2 Research Problems and Questions

China digital music has a huge market potential. However, the digital music sales revenue is held down and participants compete channel control with each other to expand to the upstream and downstream resources. In the game, content provider has a great power over content resources, besides telecom operator offers mobile music interface and online music website access with large number of mobile user resource. With the expanding of mobile music market, telecom operators are seeking direct cooperation with content providers to acquire and produce music content. Service providers with excellent digital music service capability are gradually squeezed out by content providers, whereas telecom operators' service capability is not able to satisfy the huge potential digital music demand, leading to negative impact on user service level and the development of digital music market. With the growing service demand from digital music users, China digital music market is in desperate need of new channel coordination strategies. Therefore, it's with great practical significance to explore digital music channel modes and the coordination strategy.

Now there are few researches on digital music channel competition and coordination. There is still no study on four digital music channel competition modes and the impact of service level and price on participants' strategies. Specifically, the research gaps are found to lie in three aspects shown as below.

(1) In the former research of digital music channel mode structures, recording companies and digital music providers are the key research objects and the channel structure usually comes to be "recording companies- service providers- users" with three level channel length. However, telecom operators as the most important participants in the mobile digital music channel are seldom studied.

(2) Lots of literatures have explored the channel competition causes and channel

competition strategies in physic channel by using descriptive methods and quantitative methods, whereas game theory model is seldom adopted to research the channel competition and channel coordination strategy in digital music channel. Game theory model as an important means of scientific research can theoretically verify channel choosing and channel coordination strategy.

(3) The existing quantitative research on digital music channel focus on channel pricing strategy and contract coordination in service provider and content provider's advertising revenue sharing mode, service provider's single charge mode and bundling charge mode. However in Chinese music market, High price mode and "Low Price+Shared Revenue" mode are usually adopted between content providers and service providers or content providers and telecom operators, which is not yet focused to analyze.

In view of these, two questions will be answered in this paper. How the participants compete in four different competitive channel modes, in which revenue and service level are influenced. How can participants optimize revenue in coordination rather than competition? The results will provide with theoretical basis for digital music channel competition and channel coordination. Reasonable channel cooperation modes and development route are explored to enhance the understanding of the digital music market and promote channel participants to develop optimal contracts.

1.3 Research Innovation

Compared with the huge potential of digital music market demand and the high expectations to the service level of listeners, digital music channel competition has seriously hindered the development of digital music market. Considering the characteristics of China digital music channel, this paper analyzes digital music channel

modes and explores the optimal strategy of participants in different channel competitive modes. Channel coordination mechanism is finally put forward to reduce the channel revenue loss in competitive situation.

The purpose and innovation of this paper are as the following:

(1) On the basis of lots of reports and papers reading, this paper explores four different digital music channel competition modes. By constructing bipartite Stackelberg game model (Zhang Weiying, 1996, pp. 107-137) between CP and OP and tripartite Stackelberg game model between CP, SP and OP, participants' optimal action strategies are analyzed. Numerical analysis is employed to explore the impact of different parameters' change on the revenue, pricing and service level of channel participants. Through comparing the equilibrium results of four kinds of channel modes, a series of practical conclusions are drawn, which provides thought on the optimal action strategies of digital music channel participants in competitive situations to achieve optimal revenue in different modes.

(2) On the basis of reviewing the previous studies on game model of physical products and information goods, and considering the impact of service providers' and telecom operators' service level difference, the optimal service level is explored in different channel modes to offer participants the possibilities of improving service level.

(3) To motivate participants' cooperation in digital music channel to eliminate competition revenue loss, this paper considers the characteristics of digital music channel comparing with previous studies on physical products channel coordination and designs bipartite and tripartite revenue sharing mechanisms on the basis of CP's, SP's and OP's bargaining power in channels, which provides a thinking on digital music channel coordination in different channel modes.

1.4 Definitions

(1) Digital music

Digital music refers to music products such as songs, music or MV with music etc., which are spread in the form of online broadcast or Internet downloads via communication network like Internet, mobile Internet, and fixed communication network[2]. Digital music can be categorized into online music and mobile music.

(2) Online music

Online music, which is also known as Internet music, refers to the music provided by service providers to download or play on the personal computers via Internet. Mobile music, known as wireless music, is the music downloaded or played on the mobile phone via mobile Internet.

(3) Content Providers (CP)

Content providers are the main players who provide the music resource in the music market. Content providers consist of music production companies and copyright agency.

(4) Service Providers (SP)

Digital music service providers process the physical music format into digital format, market, promote and distribute digital music. Service providers provide music service by operating digital music websites, and develop APP to provide mobile music service when having sizable user base.

(5) Telecom operators (OP)

Telecom operators provide fixed telephone, mobile phone, internet access and other communications services. In the digital music industry, as the vital players, telecom operators not only provide Internet access service and mobile Internet services, but also

act as technology platform and charging channels.

1.5 Structure of Study

This section describes the structure arrangement.
Chapter 1 is introduction, which introduces the selected topic background, purpose and significance, and elaborates the innovation of this paper.

Chapter 2 is literature review, in which digital music channel modes, channel competition and conflicts, channel coordination are reviewed. The research gaps are also explained in this chapter.

Chapter 3 describes the research methodology and framework, which guide the whole analysis to achieve research goal.

Chapter 4 analyzes the digital music channel modes in details. Participants, including content providers, service providers and telecom operators are firstly analyzed, and then five digital music service modes are explored. Finally, two different channel modes and their characteristics of online music and mobile music are elaborated.

Chapter 5 constructs and analyzes four kinds of digital music competition channel models. Stackelberg game model is employed to analyze the four competition modes and their equilibrium solutions. Through the numerical analysis, the impact of parameter change on the equilibrium solutions is illustrated. Finally the optimal channel mode in competitive situation is proposed by comparative analysis.

Chapter 6 constructs and analyzes two cooperative channel models and channel coordination mechanisms. In this chapter, optimal revenue, service level and pricing in

cooperative digital music channel with SP and without SP are explored. Then revenue sharing mechanism basing on the bargaining power of participants is constructed to gain mutual cooperation and achieve optimal channel system revenue.

Chapter 7 explains the conclusion and research prospects. This part mainly aims at summarizing the results of previous chapters and discussing the future research prospects. Uncertain user demand and more coordination mechanisms are worthy of future research.

2 LITERATURE REVIEW ON DIGITAL MUSIC CHANNEL AND COORDINATION

2.1 Literature Review on Digital Music Channel Mode

In this paper, digital music channel can be interpreted as digital music marketing channel. Marketing channel refers to the pathway that digital music is spread from producers to end-users. Digital music channel covers different areas, including music content creation, digital music service production, marketing and distribution. Research on digital music channel mode can be summarized into three aspects：research on digital music channel structure, research on participants' channel behavior and research on channel relationships.

Channel structure has three dimensions: channel length, channel width and channel breadth. Channel length structure is defined by the levels of channel participants involved, such as two-tier, three-tier and multi-tier. Premkumar (2003, pp 89-95) concluded six different music channel structures: record label-retailer-customer (RLRC), record label-customer, record label- intermediary-customer (RLIC), artist- customer (AC), artist-intermediary-customer (AIC), and audio-on-demand. The traditional RLRC remains as the main marketing channel structure, whereas RLIC is more and more popular in which customers buy digital music from intermediary like iTunes and intermediary pay record label for copyright. Channel width is defined by the number of participants in each level, such as intensive channel, exclusive channel, and etc. Channel breadth is defined by the number of channels, such as single channel, double channel and multiple channels. Feng et al.(2009, pp.241-270) investigated into the optimal channel structure and corresponding service and pricing strategies when introducing C2C channel alongside with B2C channel, with the result of that improving service could bring dual channel's pricing flexibility, reduce B2C channel's independence and allow buyers to tolerant

higher C2C channel redistribution costs.

Channel behavior research focus on channel participants' channel control power, channel conflicts and channel cooperation. Most of the researches are investigated from pricing strategies, profit model and piracy.

Some researchers explore participants' pricing strategy by qualitative and quantitative approaches. Bockstedt et al. (2006, pp.9) analyzed the industry structure, value chain and different stakeholders' strategy of both traditional and digital music. Single purchase pricing and subscription service as the two main digital music pricing strategies are proposed. In USA, digital single is priced at $0.99 and a digital album is priced at $10, meanwhile digital music subscription is set at $15 on average. However, digital music service providers cannot make profit by pricing at $0.99, of which content providers get $0.7-$0.75 for royalties or commissions and credit card companies receive $0.27 per transaction. Basically service provider obtains a $0.02 loss to $0.03 profit. Service provider is aimed at encouraging the digital music market to pursue long-term profit maximization, instead of making profits in the early stage. Shapiro & Varian(1999,pp) proposed three different information goods pricing strategies: versioning pricing, bundling pricing and fixed fee contract pricing, of which fixed fee contract is suitable for digital audio service and creator's album or service provider's collection usually adopt bundling pricing, whereas versioning pricing is often adopted by service providers to differentiate digital music with different quality by pricing. Khouja & Park (2007, pp. 109-141) analyzed physical album pricing and digital singles' linear and nonlinear pricing aiming at different customer segments. The influence of digital experience goods channel on participants' revenue and behavior was also explored.

Some researchers investigate into channel profit model. Chen (2006, pp.20-35) explored

the causes of Chinese music industry's difficult progress and proposed centralized profit model by analyzing music industry chain and value chain[11]. Bhattacharjee etc. pointed out digital music distributors could maximize their profits by providing mixed channel with both single purchase and subscription. Shan (2010, pp. 220-221) argued online music industry chain was not promoted simply by record companies, but was driven by all the participants like record companies, individual creators, online music website and copyright providers to achieve a win-win solution. In the mobile music industry chain, telecom operator takes the leading role. Digital music profit models can be categorized into five modes: digital single sales, a way out of bundling sales, enabling users to choose the singles they like to purchase freely; Direct sales, by which major record companies cooperate with terminal equipment manufacturers to set up their own online music store and make profit by the digital music downloads or terminal equipment's sales; Value-added digital music service, which has been made to be the vital part of 3G operator telecom's value-add service by 3G's and music phone's development, and more high quality digital music value-added service is in need to appeal to customers; Terminal equipment pre-packaged, by which record companies make profit by providing music copyright for digital music terminal equipment manufacturers such as MP3 player and music phone manufacturers as preset music; Digital album advertising, digital album contains all the songs included in the album, MV, modeling photos, introduction information and artists' teaser, of which revenue comes from advertising. Papies & Eggers (2006, pp.777-794) considered free advertising model's effect on business models, and also researched the influence of alternatives between free advertising and pay model on customers' choice. Bakos and Brynjolfsson (1999, 1613-1630) expanded two-product bundling research into multiple-product bundling research.

The biggest obstacle of digital music's development is piracy. Considering preferences of different customer segments on piracy, Khouja & Park (2007, pp. 109-141) found that

incorporation of different customer segments makes manufacturers charge lower prices in order to spread authorized products. They analyzed different producer pricing policies' effect on creators and the results showed that royalty system could not solve double marginalization problem and creator's expected price lower than producer's optimal pricing allowed creator's copyright price to increase.

Gayer and Shy (2006, pp.374-384) put forward a simple model to explain that digital music legal action will cause profit conflict between artists and record companies, not only considering the vertical difference between digital copies and original version, but also taking the sampling effect into account. Contrary to most researches that found digital music piracy weakened seller's profit, Mortimer et al. (2012, pp.3-14) examined file-sharing's positive impact on complementary music products from a different angle. Data was collected to empirically analyze file-sharing's impact on the profits of recorded music and live concert performances among different artists segments. Results showed that digital channel accelerated the increase of live performance. Chaney (2012, pp.42-52) stated piracy brings two positive effects: increasing the demand for legal products; promoting consumers to buy legal products with higher quality. From the perspective of artists, grown popularity brought by piracy can improve the income of other aspects, such as live concert and affiliate products (mobile phone ring tones, T-shirt, hats and etc.). Therefore, artists and record companies play strategic game in the unified market of recording and live performance. A two-stage game model between artists and recording companies is built from the point of piracy's positive role, followed by a revenue sharing contract basing on recording sales and performance. In this game model, artist is assumed to be the channel leader and recording sales fall into recording companies' pockets, whereas artists and recording companies share the revenue of live performance. Consumer's willingness to pay for live performance is proportional to the willingness to pay for recording music, which has a linear relationship with distance and quality of the

artists' live performances.

Channel relationship researches focus on channel participants' relations and aliments, and by improving the trust and cooperation, the opportunism behaviors among the participants are reduced. Galbreth et al. (2012, pp. 603-620) explored social sharing profits and pricing from two aspects, which were customer social network structure and group decisions. However, few studies research digital music channel incentive mechanism. In this paper, digital music coordination mechanism is constructed to promote channel participants forming alliance.

Digitalization brings great impact on music industry. Massive piracy brings great pressure on legal products and digital music sampling effect leads to an increase on listeners demand. Digitalization also reduces producer's distribution, marketing and promotion costs. McLean et al. (2010, pp. 1365-1377) adopted critical social theory approach to examine digitalization's impact on music industry. Cosain & Lee (2001, pp. 140-145) concluded five differences between physical recording channel and digital music channel: (1) music is released from physical music carriers and turns into digital content; (2) digital music is apt to debundling and rebundling; (3) it's easier to control customer experience and dynamic pricing by digital music; (4) in digital channel physical distribution and facilities such as physical stores are losing their influence; (5) value-added information and information processing support has played a more and more important role.

On the creation and production, new technology enables channel participants such as creators and service providers to cooperate remotely. Amateur creators can get direct access to listeners through platforms like social networks, which makes the outstanding songs soon recognized and bings creators more opportunities to participate into channels, thus enriching the diversity of the creation and production area[6]. User involvement in the

creation and production area makes music cater to users' preferences.

On the distribution and marketing, there appear two new trends in digital music channel compared with physical channel. One is Internet service providers' and mobile operators' involvement, resulting in weakened dominance of record companies in the music channels and enhanced channel power of service providers and mobile operators. Another is the possibility of individual artists and creators reaching listeners and selling digital music through Internet (Benjamin & Wigand, 1995, pp.62-72). Direct contacts shorten the music channel and help record companies and copyright agencies discover new potential creators, from whom copyrights are bought from Internet quickly. Net radiation effect of the social network enables songs to spread rapidly. Digital music channel has become the most effective and efficient way of promotion and distribution.

On the consuming, the process of consuming has changed with the popularity of digital music. On one hand, digital music turns album sales into single sales and listeners can purchase singles instead of the whole album. Elberse collected data of digital track, digital album and physical album released by 200 artists from January 2005 to April 2005, and establishes regression models of both album sales and single sales. The empirical study finds that digital downloads reduce revenue from albums sales and the negative effect will decrease only if there is a popular song in the album (Elberse, 2010, 107-123). On the other hand, customers' channel control power has enhanced and music channel has turned from the recording companies' "push" marketing into "pull" marketing focused on the preferences of listeners. All the players in the music market are striving to innovate their business models. Customers become the most important participant in the chain of songs creation, marketing and promotion. Sun (2008, pp. 19-49) explored the impact of digital technology on customer behavior, customer habits, traditional value chain and stakeholders' interests, from the perspective of dynamic relation between enterprise,

market and technology. In addition, through iTunes Store case, digital music business model is explored, including value proposition, target customers, customer relationship and partners.

On the music channel process and costs, traditional music channel is no longer applicable to digital music. In the digitalized market, players' role has changed with marketing and promotion replaced by digital technology, such as home-recording, downloads and file-sharing (Nguyen, 2003) There is no process of storage and logistics in digital music channel, resulting in not only costs saving on storage and logistics in a shortened channel, but also costs saving on supply-demand mismatch and stockout. Internet service providers, user labels, telecom operators, copyright liquidation agencies and online billing companies appear in the digital music market. Ahn & Yoon (2009, pp. 306-325) adopted comparative static analysis approach to establish evaluation framework of digital music distribution channel's influence. By establishing a model to compare digital channels and traditional channels, producers' profits were found to decrease in digitalization whereas consumer surplus and social surplus were likely to increase. This is because digitalization reduces the fixed distribution costs and increases extra income from other complementary products, such as live performance.

2.2 Research on Channel Competition and Conflicts

There are three different types of channel competition, which are static competition, dynamic competition and competition with foresight. In static competition, existing competitors' action strategies are not affected by the actions of new competitors, who are aware of the existing competitors' actions strategies before making their own strategies (Farahani et al. 2014, pp. 92-118). Mathematical models are often employed to research facilities capability, products quality, waiting time and etc. in static competition (Aboolian et al. 2007, pp.40-62; Bernstein & Federgruen, 2007, pp. 242-262). In dynamic

competition, existing competitors' action strategies are affected by entrant competitors' entrance, in which condition Nash game equilibrium is often employed to analyze competitors' pricing and service level (Tsay & Agrawal, 2000, pp. 372-391; Chun et al. 2011, pp. 812-825). Whereas in competition with foresight, leader's decisions are based on follower's probable action strategies, and follower makes decisions according to leader's optimal action strategies. Stackelberg game model (Zhang Weiying, 1996, pp. 107-137) is applicable to solve problems in competition with foresight.

Channels can be categorized into single channel and multi-channel by channel structure. In single channel, participants compete with upstream players and downstream players vertically in a channel, whereas in multi-channel participants are faced with horizontal competition between different channels.

Table 1 Different types of channel competition

Competition Type	**Characteristics**	**Research Method**
Static competition	Existing competitors' action strategies are not affected by the actions of new competitors	Mathematical models
Dynamic competition	Existing competitors' action strategies are affected by entrant competitors' entrance	Nash game model
Competition with foresight	Leader's decisions are based on follower's and follower makes decisions according to leader's optimal action strategies	Stackelberg game model

Pricing strategies of participants are often explored in channel competition researches. Bernstein et al. (2008, pp. 671-690) analyzed retailers' pricing game equilibrium in the

situation that multiple retailers participated into digital retail channel or physical retail channel. The results show that launching digital retail channel in many cases is a kind of strategic demand, but not necessarily can bring profits for the retailers. Furthermore, if retailers are not capable of launching digital channels but to cooperate with professional digital retailers, prisoner's dilemma will occur. Chiang et al. (2003, pp.1-20) explored the game between retailers and manufacturers by the different degree of customers accepting direct sales. Suo & Jin (2003, 546-550) examined two kinds of Stackelberg games (Zhang Weiying, 1996, pp.107-137), which were supplier-dominant and retailer-dominant respectively, by considering that retailer makes pricing decision and quantity decision simultaneously. Huang & Swaminathan (2009, pp. 258-279) proposed the optimal pricing strategy when retailer retailed in both digital channel and physical channel. Xu (2009) explored the impact of customer purchase costs and acceptance level to direct channel on pricing equilibrium in dual-channel. Ingene & Parry (1995, pp. 360-377) examined the impact of wholesale price strategy, quantity discount strategy and dual pricing strategy on manufacturers' and retailers' revenue in the condition of one manufacturer and two competing retailers. Results show that manufacturers should employ different pricing strategies in different situations.

Channel competitions result in channel conflicts. Coughlan et al. (2001) proposed a standard definition of channel conflict in 1996: channel conflict refers to the situation that one or several members in the channel prevent or interfere with others to achieve goals. Causes of channel conflicts include different goals, conflicting areas and different understanding of the situation. To reduce channel conflicts, Chun et al. (2011, pp.812-825) discussed channel conflict resolution strategy from the perspective of customer heterogeneity and retail service. It turns out that manufacturers adding direct channel is beneficial to both themselves and retailers. Direct channel enables manufacturers to reach not only customers who are sensitive to price but also those sensitive to service, thus

enlarging market coverage and enabling retailers to benefit from getting lower wholesale price. Tsay & Agrawal (2004a, pp. 93-110) and Cattani et al. (2004) conducted a systematic review of literature on channel conflict and channel coordination, in which some quantitative modeling methods were explored to solve channel conflicts. Webb (2002, pp. 95-102) stated channel conflicts resolution strategy qualitatively. Tsay and Agrawel (2004b) concluded that wholesale price reduction, retailers compensation and providing retailers with complete demand information could reduce the conflicts between physical channel and online direct channel.

2.3 Research on Channel Coordination

To eliminate channel competition, lots of channel coordination research is conducted. In this paper, channel coordination is similar with supply chain coordination. Supply chain coordination research pioneer Tsay et al. (1999) concluded that supply chain contract is a kind of action coordination mechanism that motive all the participants in the decentralized supply chain to behave like in an integrated supply chain. Cachon (2003) argued that supply chain contract can make the participants reach Nash equilibrium by fixing contract terms, such as quantity, price, quality and delivery time, and finally achieving optimal overall supply chain, minimizing inventory costs and realizing risk-sharing goal.

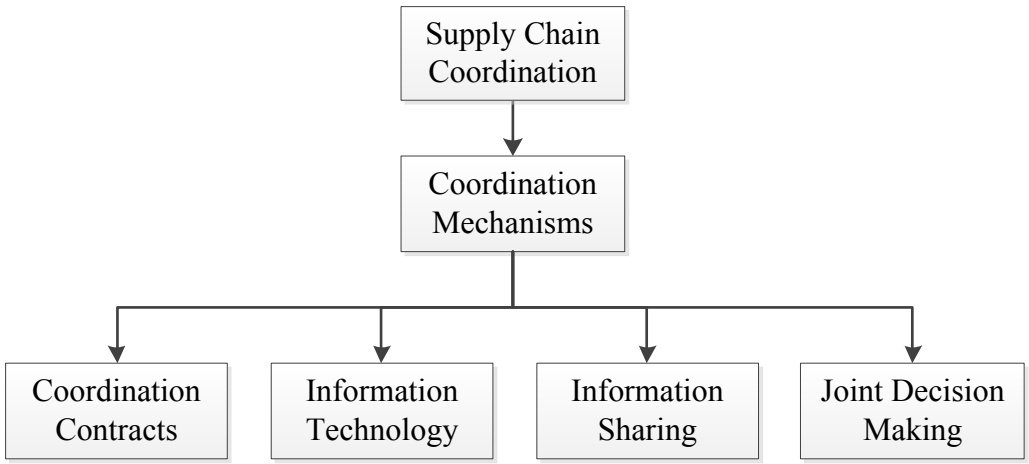

Figure 1 A classification scheme of coordination; Source Govindan et al. (2003, pp. 320)

Arshiner & Deshnukh (2008, pp.316-335) suggested coordination mechanism was summarized into four categories: contracts, information technology, information sharing and joint decision making, as shown in Figure 1. Contracts can motivate members of a decentralized setting to participate in the optimization of the whole system. Coordinating contracts can achieve optimization of the whole supply chain profit and fair risk sharing between the members. When designing coordination mechanism by contracts, elements should be considered to contain structure, coordinating incentive, theory approach, demand approach and time horizon. Structure can be categorized into two-echelon and multi-echelon by the sets of participants. For example, in two-echelon structure, participants may contain suppliers and manufacturers or producers and retailers, whereas in multi-echelon structure, participants may contain three or more of suppliers, manufacturers, distributors, retailers and etc. To be more detailed, two-echelon structure is classified into 1-1, 1-n, n-1, n-n by the number of participants in each echelon. The incentives for participants to coordinate are quantity discounts, price discounts, quantity flexibility, lead-time and information sharing on storage level and sales forecast. The most common approach to study coordinating contracts is game theory. Some researchers approach it by using fuzzy theory, mathematics method, simulation approach and graph theoretical model. Demand approach can be divided into stochastic and deterministic by the characteristics.

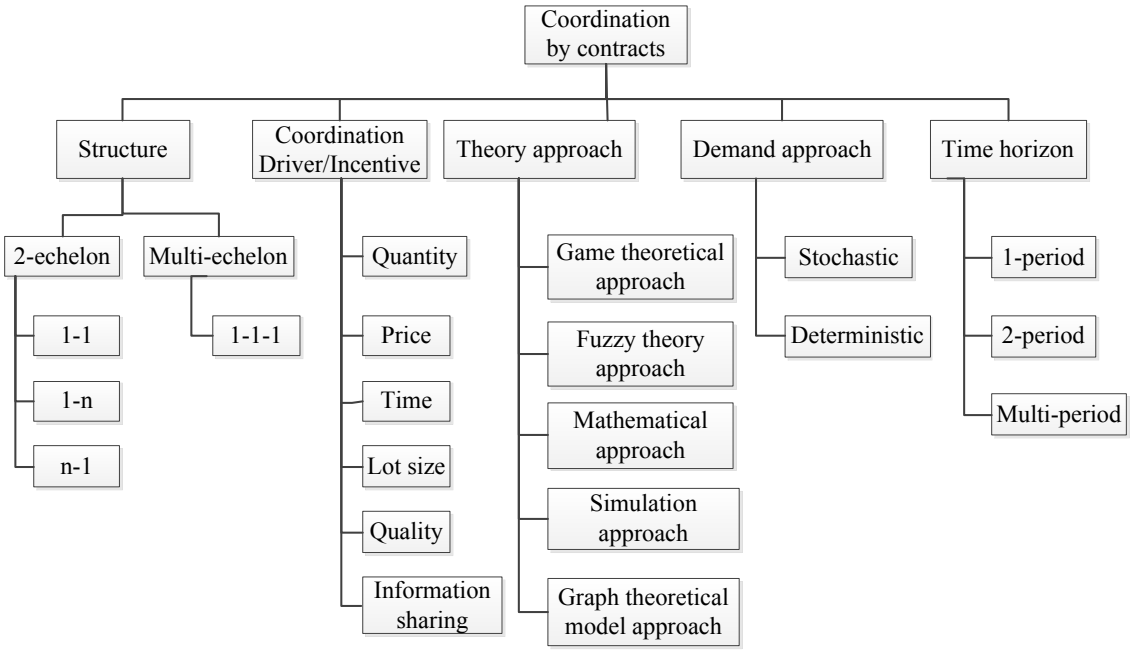

Figure 2 Studies on supply chain coordination; Source Govindan et al. (2003, pp.327)

Channel coordination makes it possible for participants to cooperate to realize win-win solutions. Some researchers explore the channel performance in both cooperated and incooperated channels. Chen(2010) examined muti-channel coordination in both centralized strategy and decentralized strategy from various angles of single product, multiple products, digital channels based on information intermediary and service cooperation. Gong et al. (2008, pp. 26-30) researched the pricing strategy of three-echelon channel system comprised of manufacture, retailer and third-party logistics service provider, in both centralized and decentralized strategy. Li & Wang (2007, pp. 1-16) argued that channel system profits in cooperated were bigger than those in incooperated, as well as the buyer's optimal order quantity. However, seller's wholesale pricing in cooperated channel was smaller than that in incooperated channel.

As an important channel coordination mechanism, revenue sharing contract has been explored in many literature researches. Yan (2011, pp. 636-642) studied the strategic role of differentiation brand strategy and profit sharing strategy in multi-channel production-

retail supply chain, and found that differentiation brand strategy was not able to achieve full channel coordination but effectively reduced the channel competition and conflicts, and a new kind coordination mechanism-profit sharing mechanism was in demand. Cachon & Lariviere (2005, pp. 30-44) analyzed the advantages and limitations of revenue sharing contract in supply chain coordination and argued that revenue sharing strategy not only coordinated supply chain with single retailers but also coordinated that with multiple retailers competing sales. Guo et al.(2011, pp. 433-440) explored two-stage revenue sharing contract in dynamic market environment by discussing retailer's twice-ordering behavior using a two-stage Newsboy model. Cai (2010, pp. 22-36) considered supplier's and retailer's negotiation ability in different supply chain structures, and explored supplier's and retailer's strategies in single retailer mode, supplier direct sales mode, supplier direct sales combining with retailer mode and two retailers mode. Chen(2011, pp 293-300) explored supplier's and retailer's buyback prices in profit sharing strategy in a single manufacturer and single retailer decentralized decision making supply chain.

There are few literatures on digital music channel coordination. Traditional physical supply chain coordination strategy like buyback contract and return policy is no longer suitable for digital music products (Ramnath & Shivendu, 2005, pp. 400-417). Yang (2009) constructed models to research supply chain contracts of single charge mode and advertising charge mode in online music supply chain, and found the incomplete coordination problems in both of this two modes. He argued that advertising charge modes was superior to single charge mode, and advertising charge mode could achieve channel coordination under certain conditions by introducing revenue sharing contract. Jeong et al. (2012, pp. 590-603) considered fixed fee contract and single contract. In fixed fee contract, no matter how many songs that listeners download from retailer's website, recording companies charge a fixed fee for the album, whereas in single contract which

is more common in the digital music industry, recording companies and retailers charge for every downloaded songs. Contract type and different piracy risk cost's impact on supply chain pricing, profits and supply chain coordination was explored. The result shows that both of the piracy risk cost and contract type influence supply chain profits, and fixed fee transfer contract can realize supply chain coordination. The profitability of the fixed fee contract increases with the enlarging of online market scale.

3. METHODOLOGY AND FRAMEWORK

3.1 Research Methodology

This chart clarifies the research methods and techniques used for the research. The goal of this research is to firstly find out the digital music channel modes in Chinese markets, and secondly to identify how different participants compete in different channel modes. The third goal is to discover how the participants cooperate in different channel to achieve channel coordination by revenue sharing. The objectives are reached by literature review, descriptive approach and Stackelberg game model (Zhang Weiying, 1996, pp.107-137).

The study is started by exploring into literature review on digital music channel mode, and then moves to literature review on channel competition and conflicts. Finally literature review on channel coordination is studied, following the research gaps are drawn on the basis of literature review. Literature review is firmly serving the whole research on digital music channel in Chinese market. In order to define the digital music channel modes in Chinese market, lots of website information, data and published paper are collected to elaborate the Chinese music market overview, participants, service modes, physical music and digital music channel mode. This lay the basis of the further analysis of the competitive and cooperative relationship between different participants.

Due to the obvious strategy adoption between CP, SP and OP in different channel structure, this formulates typical Stackelberg game model (Zhang Weiying, 1996, pp. 107-137). Game refers to the process that individuals, groups or organizations choose and implement simultaneously or successively, once or many times from their possible actions or strategies set to reach the corresponding results or profits respectively by relying on the information that they grasp under certain environmental conditions and constraints. In economics, game theory is usually adopted to research the decision-making and

equilibrium problem when a certain economic agent's strategy can not only influence but also be impacted by other economic agents' strategies. Stackelberg model, which was put forward by Stackelberg in 1934, depicts a two companies complete information dynamic game in which one company with dominant position acts first to select the yield or price and another company with subordinate position selects the yield or price following the dominant company's strategies. Thus, Stackelberg game model is employed to analyze the competitive strategy in different mode depending on if SP participate into channel. Then comparative analysis is employed to analyze the differences and similarities between different modes.

Basing on the competitive channel mode, digital music channel cooperative equilibrium is explored by taking derivative with respect to parameters to compare the revenue loss in competitive mode. Finally digital music channel coordination mechanisms is constructed by revenue sharing, which could eliminate the competitive mode revenue loss and achieve win-win solution for participants.

3.2 Research Content and Framework

In view of the unbalanced development of the digital music market and the channel competition problems, digital music channel participants, service modes and channel modes in Chinese market are analyzed. And then according to the four channel competition modes, Stackelberg game model model (Zhang Weiying, 1996, pp. 107-137) are established and numerical analysis is employed to explore the impact of parameters, such as service level and service price and etc., on game equilibrium solution, followed by comparative analysis to seek the optimal channel mode in competitive situations. Finally, channel game equilibrium in cooperative situation is explored to seek the channel revenue loss in competitive situation, and the channel achieves coordination by constructing revenue sharing mechanism basing on participants' bargaining power.

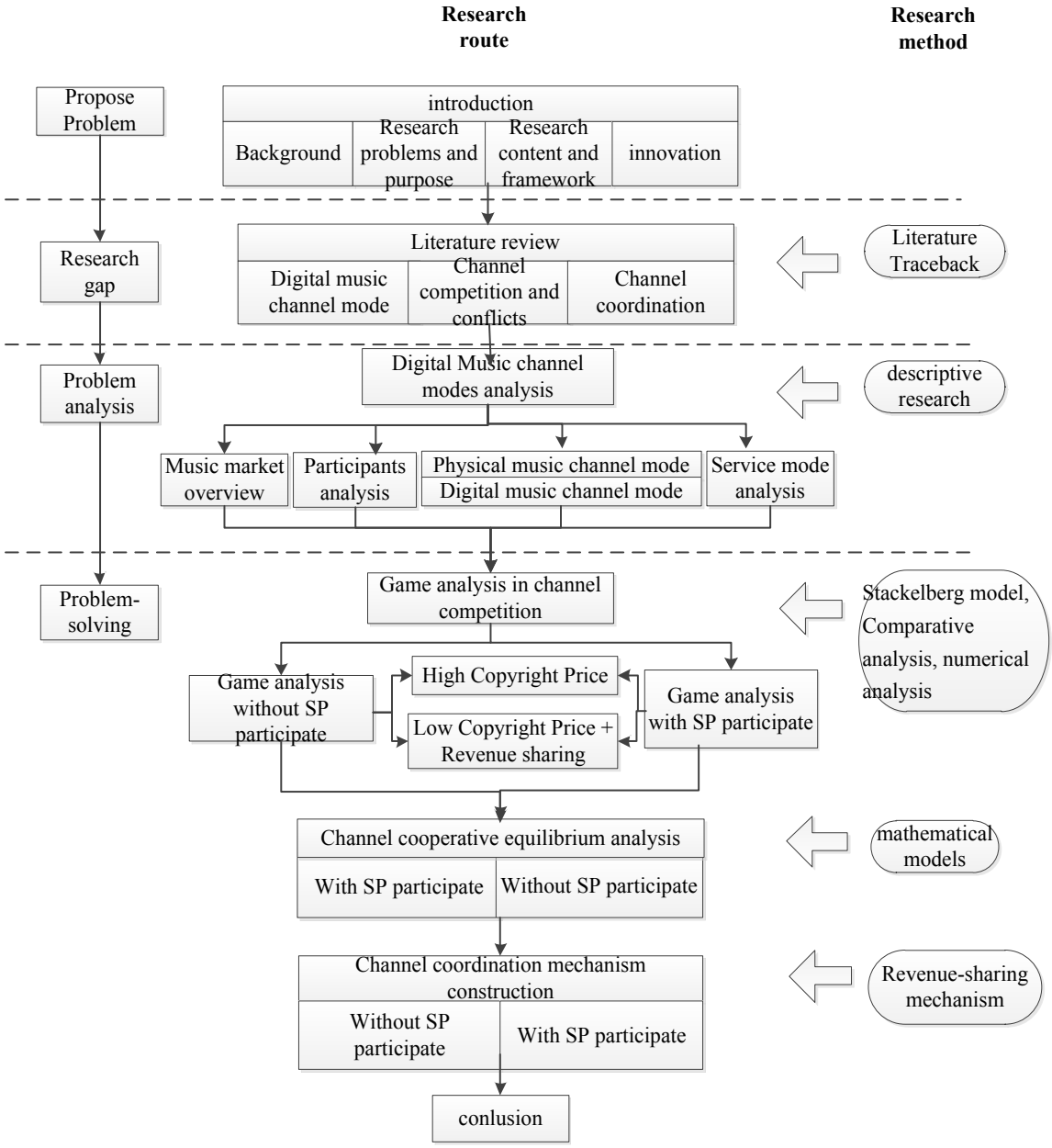

Figure 3 Research framework and methodology

4 DIGITAL MUSIC CHANNEL MODES IN CHINESE MARKET

Music was distributed in physical music carriers (music sheets, tapes or CD) by physical retailers before digital music spread. With the prosperity of digital music, music industry is experiencing the transition from product-oriented market to service-oriented market.

In this chapter, firstly specific data is introduced to analyze the development of global and Chinese music industry. In both of the global and Chinese markets, digital music market is expanding year by year, while physical music market is shrinking. Digital music begins to gradually replace physical music as the main consumption way. Due to channel competition and piracy, China digital music market share lags far behind the USA and Japan, though with a large digital music market potential. The vast majority of the Chinese digital music income comes from the mobile music sector. Telecom operators occupy more than 90% of the whole profit in the mobile music sector, whereas the service provider cannot survive and telecom operator's service capability cannot meet the users' demand. China's vast digital music market potential has yet to play out. Then the development status, profit model and channel status of the main participants including content providers, service providers and telecom operators are explored. The participants are found to seek the upstream and downstream resources to enhance its channel control. Five digital music service modes, which are download store, subscription service, music stream service, internet radio, social network, are further analyzed, followed by an exploration into the new characteristics of digital music supply chain from the perspective of creation & production, distribution & marketing, consumption and supply chain costs. Lastly piracy, which impedes the development of digital music market, is analyzed from the angles of present situation, forming reasons and solutions.

4.1 Global Music Market Overview

Music revenue mainly comes from physical recording, digital music, live performance and synchronization. As seen from Table 4, global recording industry revenue is decreasing due to the pitfall of physical records revenue. Whereas revenue in digital music, live performance and synchronization is increasing year by year, but not enough to make up for the physical records sales drop loss. Piracy is the root cause of the sharp decline in music sales. Single sales rather than bundling album sales are impacting the music industry. Listeners tend to buy their favorite single songs instead of the whole album.

As shown in Figure 4 and Table 2, physical music revenue in 2007 was $17.3 billion, and in the following 5 years it dropped 46%. Whereas digital music revenue increased by 81%, from $3.2 billion in 2007 to $5.8 billion in 2012, and the compound annual growth rate reached 12.6%. Data shows that global physical music consumption has gradually shift to digital music consumption and in the next few years digital music is likely to exceed physical music to become the main consumption format. According to IFPI, at the beginning of 2011 digital music service providers provided international service in 23countries, while in 2013 more than 100 countries were covered. Now there are more than 500 authorized digital music service providers in the world, providing 30 million tracks. Digital music consumption gradually becomes the mainstream.

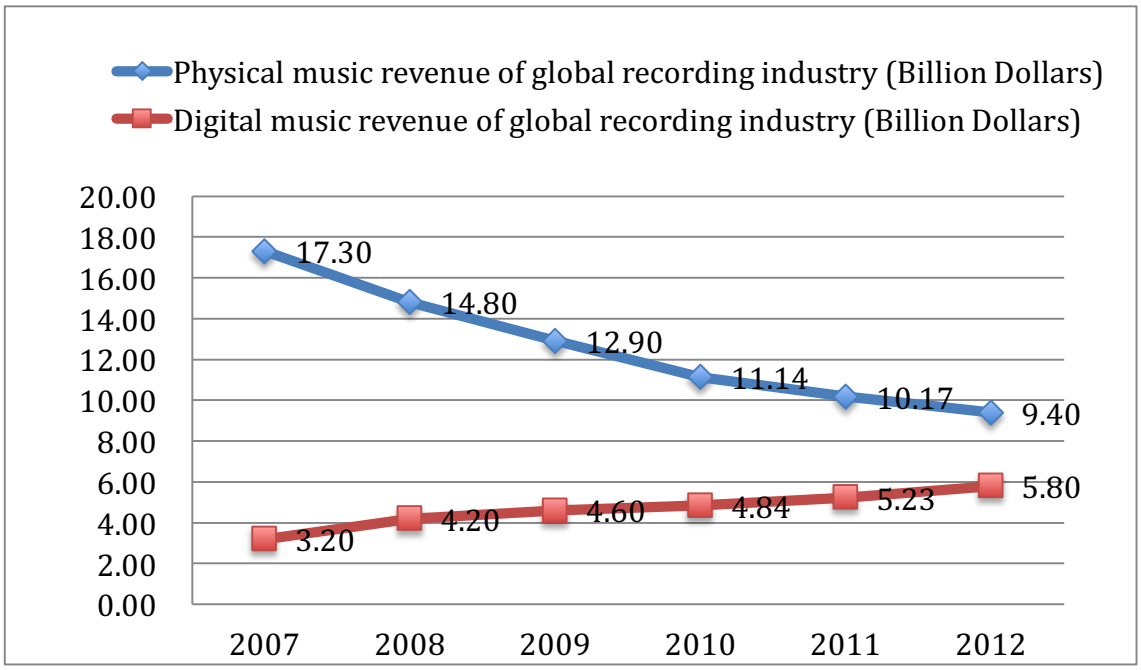

Figure 4 Annual revenues of physical recording and digital music in global recording industry; Source IFPI (2011) & RIAJ (2013, pp 2)

Table 2 Annual revenues of global recording industry by music categories（Billion Dollars); Source IFPI (2011) & RIAJ (2013, pp 29)

	Physical recording	**Digital music**	**Live performance**	**Synchronization**	**Total**
2007	17.3	3.2	0.7	0	21.2
2008	14.8	4.2	0.8	0	19.8
2009	12.9	4.6	0.8	0	18.3
2010	11.1	4.8	0.9	0.3	17.2
2011	10.2	5.2	0.9	0.3	16.6
2012	9.4	5.8	0.9	0.3	16.5

4.2 Chinese Music Market Overview

As shown in Figure 5, Chinese physical music and digital music sales trends kept the same with the global ones from 2007 to 2012. Chinese digital music sales exceeded physical music sales in 2008 and the digital music market share reached 82% in 2012. In

the five years, digital music revenue grew by 103% while physical music revenue fell by 62%. In 2012, China's recording industry revenue reached $92.4 million, ranking 20 for the first time in the global music market. According the IFPI Digital Music Report, China's music piracy rate reached 99%. Listeners have formed the habit of getting music for free. The music industry is facing with the great challenges of changing the listeners' habits.

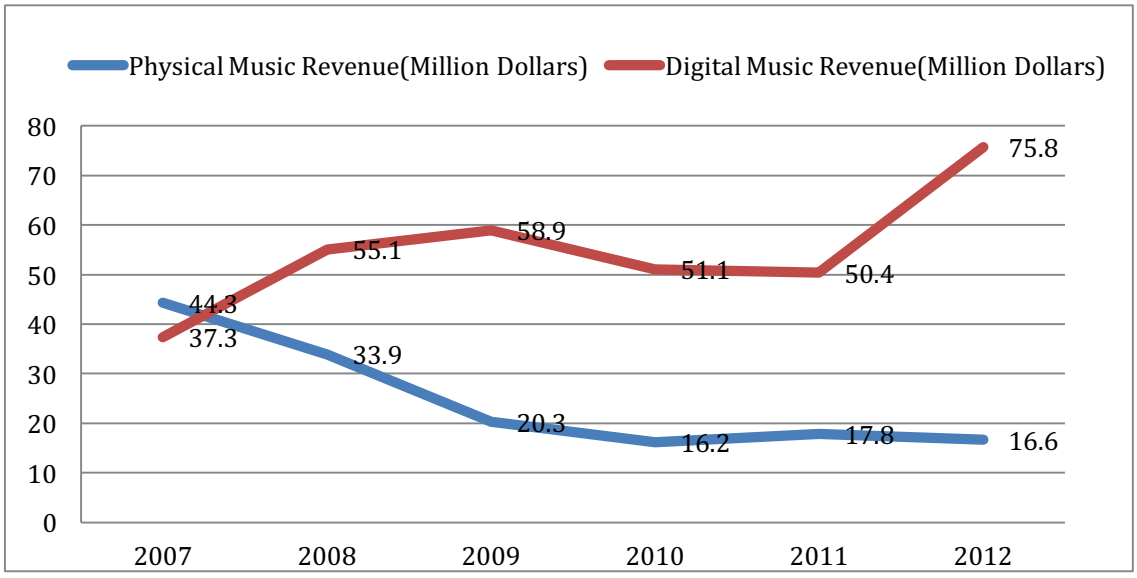

Figure 5 Annual revenues of digital music and physical recording in Chinese market from 2007 to 2012; Source IFPI (2011) & RIAJ (2013, pp 29)

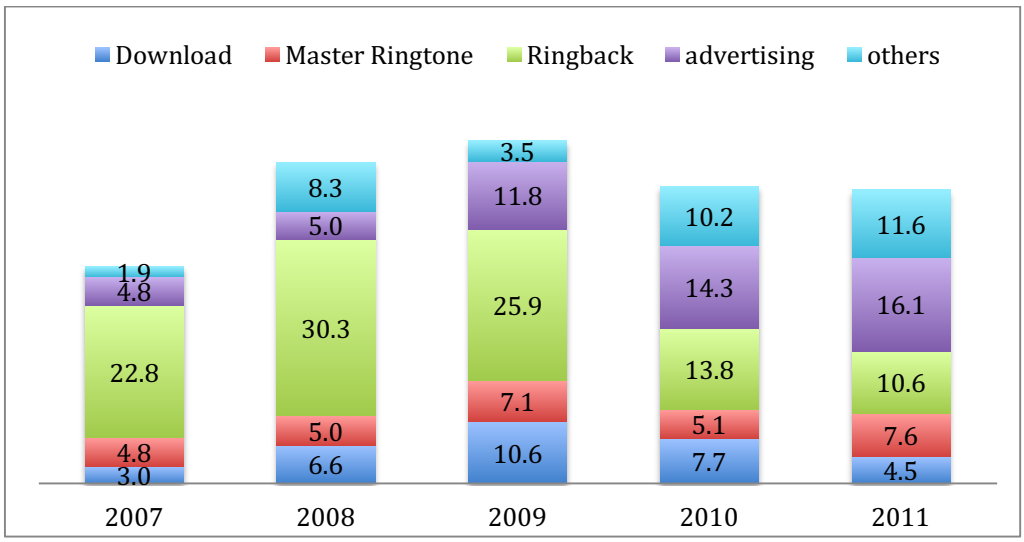

Figure 6 Chinese digital music revenues by categories from 2007 to 2011; Source IFPI (2011)

China's digital music sales come from downloads, master ringtones, ringback tunes and advertising, as shown in Figure 6. Master ringtones and ringback tunes are the main source of sales. Ringback tunes sales accounted for $30.3 million in 2008, but decreasing in the following years. The proportion of advertising accounting for the digital music is increasing.

According to "2011 China's Digital Music Market Annual Report (Abstract)", mobile music market size accounted for 86.3% of the digital music market size[55]. According to "2012 China's Online Music Market Annual Report" issued by China Culture Ministry, in 2012, Chinese Internet users reached 564 million within which 420 million are the mobile Internet users, and mobile phone replaced PC as the biggest Internet terminals. Chinese digital music user scale reached 436 million in 2012 and more than 50.9% of mobile Internet users listened to mobile music. Authorized music enterprises reached 575 in 2012. China's mobile music total revenue achieved 31.72 billion RMB, of which 29 billion RMB belonged to telecom operators while content providers got only 2.72 billion RMB. Within mobile music users, 53.7% get access to China mobile, and 26.7% get access to China Unicom, and 19.6% remaining get access to China Telecom[2].

4.3 Participants in Digital Music Channels

In the digital music channels, there are content providers, service providers, telecom operators, terminal manufacturers and users. Chart 3.2 shows the participants' role, core resources, revenue stream and the typical representatives in Chinese market.

Table 3 Main participants in digital music channel

Participants	**Role**	**Core resources**	**Revenue stream**	**Typical representatives in Chinese market**
Content Providers(CP)	recording companies, reators	Copyright, artists resource	Royalties, physical recording sales	China Record Corporation, Taihe Rye Music, Warner Music, Rock Records
service providers (SP)	Search Engine, Portal Websites, Professional Music Company	marketing, service providers branding	Subscription service, advertising, gaming, software, revenue sharing with OP	Sina Music, aigo MUSIC, Baidu Music, A8 MusicC, China Mobile Wireless Music Portal
telecom operators (OP)	Communicatio n service companies	Channel resources	Channel fee (band width), mobile music service	China Mobile, China Telecom, China Unicom
terminal manufacturers	Phone manufacturers	Music promotion terminals	terminals sales, music software and content promotion revenue sharing	HUAWEI, ZTE

4.3.1 Content Providers (CP)

Content providers consist of music production companies and copyright agency. As the most important role in music production, recording companies sign singers, produce music and promote with its powerful marketing and distribution channels. Copyright agency buy copyright from individuals or recording companies, and then sell to service providers to take the advantage of price differences. However, with shortened and transparent digital music supply chain, copyright agency is facing more and more challenges.

The recording market consists of several big international recording companies and varieties of small and medium-sized independent recording companies. The world biggest recording company, Universal Music with headquarter in USA which is owned by the French Vivendi, bought recording segment from EMI Music in 2011, and Sony Music bought EMI's copyright segment. The "big three" Universal Music, Sony Music and Warner Music account for about 70% of the world music recording and publishing market, and own large numbers of labels, distribution and promotion channels. They are engaged in most activities of the value chain, including recording, production, marketing and distributing, forming vertical integration in the value chain in which major recording companies own and control the production and distribution network[57]. With the decreasing in the recording sales, recording companies turn to provide copyright to digital music market players.

With the development of digital production and distributing channels, more and more independent producers and small firms join the music market to produce, distribute and promote digital music. These independent producers and small music publishers focus on niche market with great flexibility and innovation. However, it's difficult for them to raise funds by royalty, resulting in lack of human and financial resources in response to

technology innovation. High marketing and promoting costs make it difficult to distribute worldwide. Many indie labels cooperate with big recording companies to distribute. In some case recording companies sign contract to buy the label and even the whole firm if they see potential or success in the artists.

In Chinese market, the leading recording companies Taihe Rye Music, Ocean Butterflies and Wonderful Music, with shorter development history and less resource of songs and artists, can neither compete with the big international recording companies, nor follow them to cooperate with digital music service providers by charging high royalties. As content providers' core competence comes from copyright resources, they are engaged in producing music with their own labels and buying copyrights. Some of them start to produce and provide digital music service as service providers to shorten the channels and gain more channel control.

4.3.2 Service Providers (SP)

In China digital music market, the leading authorized music service providers include Baidu, China Mobile, Duomi, Kugou, Kuwo, Tencent and Xiami, as shown in Table 4. They transform the physical music format into digital format, market, promote and distribute digital music.

At the initial of mobile music service development, subject to the channel and users, mobile music service providers seek cooperation with telecom operators, who help deliver music service to listeners with their scalable users and developed settlement platform. However, with the development of 3G network and the popularity of smart phones, mobile service providers can reach the users by mobile Internet access. Users download and enjoy music by the installed mobile music APP or mobile Internet websites.

The main costs of digital music service providing come from royalties and bandwidth costs. Take Kugo as an instance, every thousand times stream listening, 2.5 RMB royalties is paid to content providers and 1.6 RMB bandwidth fee is paid to telecom operators, thus 4.1 RMB is spent in total on every thousand times stream listening[58]. Service providers continuously explore new business models to seek stable profits. Kugou and Kuwo provide online games with music, enabling users play games while listening to music, and service providers and game developers share gaming revenues together according to a certain proportion. Advertising, games combined, third-party software and subscription services become the main revenue stream for service providers. For Kuwo, 40% revenue comes from games and the remaining 60% comes from advertising.

Brand influence and promotion capability is the core competence for service providers. To secure the channel control and shorten digital music value chain, on one hand, service providers seek to explore artists to grasp the upstream content resource and digital copyright technology. On the other hand, they cooperate with downstream telecom operators to provide service bundles. In France, service provider Deezer collaborate with telecom operator Orange, and in Dutch Spotify cooperates with KPN. In China, China Unicom launches an 8 RMB music package which is free of data traffic with Duomi, and users can get access to music by Duomi APP on the mobile phone.

Table 4 Typical digital music service providers in Chinese market

Type	Representatives	Strengths	Weakness
Music search websites	Baidu Music	Powerful music search capability, high brand awareness and advertising attraction	Lacking Music information
Comprehensive portal websites	Sina Music, Tencent Music, Netease Music Channel, Sohu Music	High brand awareness and advertising attraction, rich music information,	Lacking music search function
Professional music websites	1ting Music, 520 Music, Haoting Music, 9Sky Music	Comprehensive music service to cater for different users, various revenue streams	Weak brand awareness and advertising attraction

4.3.3 The Big Three Telecom Operators in Chinese Market

The three big telecom operators dominate mobile music channel with large user base, strong marketing capability and developed payment channels. They control the content resource and marketing channels by launching central music platforms or music bases to stretch their business to upstream and downstream. Telecom operators' revenue accounts for 95% of Chinese overall mobile music market. They provide Internet access service and mobile Internet services, and act as technology platform and charging channels. The mobile music service refers to the value-added music service through SMS, MMS, WAP, wireless voice value-added service, including wireless music club, music downloads and ringback service. Value-added music service provided by service providers helps telecom

providers increase user engagement.

(1) China Mobile

As the largest communications service provider, China Mobile's revenue reached 560.4 billion RMB with 710 million users in 2012. China Mobile Wireless Music Base, which was launched in 2005, integrates six systems including operation analysis, customer service support, business review, channel management, copyright management and work order management, providing value-added music service through WWW, WAP, SMS, IVR, mobile APP, PC client and Migu Magazine.

Now China Mobile Wireless Music Base is the largest licensed music wireless publishing platform, trading platform and music membership interacting platform with 1.7 million licensed songs and 100 million monthly music sales. China Mobile Wireless Music Club founded in 2006 provides one-stop digital music service like ringtones, music downloads, privilege of getting concert tickets and attending events. Now the membership number grows into 60 million. China Mobile cooperates with mobile terminal manufacturers to customize mobile phones which have special music play button and a built-in China Mobile Wireless Music website links.

Music downloads on China Mobile Central Music Platform reached 4.3 billion times in 2012 and its revenue with more than 20 billion accounted for 83% of the whole wireless music market in China. China Mobile sought upstream and downstream cooperation with over 1000 partners, including Universal Music, Sony Music, Columbia Records, Sohu Wireless Music, Rolling Stones and etc. China mobile signs an exclusive contract with many recording companies that the content resource cannot be provided to other telecom operators.

(2) China Telecom

China Telecom, as the second largest communication service provider, has more than 100 million broadband Internet access subscribers, 160 million mobile users and 163 million fixed telephone households by the end of 2012. China Mobile launched “Love Music” mobile music service to provide ringtones, music downloads and music club membership service with Warner Music, Taihe Rye Music, EMI, Universal Music, Rolling Stones in 2007. In 2009, China Telecom Digital Music Operation Center is founded to integrate content resource, value chain cooperation, customer consumption data management, marketing and channel management. The Love Music Club provides integrated music products and services (ringtones, downloads, music box, music magazines, etc.) as a music experiencing and sharing platform.

China Telecom’s digital music service target users are cell phone users and part of the fixed phone and Internet users. China Telecom is leading in the fixed phone and broadband user scale but lag behind in the cell phone user scale. The main revenue stream of China telecom digital music service comes from ringtones sector, adopting revenue sharing mechanism with content providers. Although being late in launching digital music service, in 2012 China Telecom initiated Love Music Honeycomb Plan to develop integrated music APP production, publish, distribution, payment and settlement platform.

(3) China Unicom

As the third largest telecom operator, China Unicom provides comprehensive music services including music information, ringtones, music (single, ringing, MV) downloads, online listening, club memberships etc. through its central music platform and mobile music club. China Unicom keeps mining users’ music preference to push music with the similar style according to their subscription or collection records. Users can put acquired music in the cloud and enjoy from different terminals, such as PC, tablet computers,

mobile phone and automotive audio.

4.4 Digital Music Service Modes

Digital music service modes refer to the ways users acquire licensed digital music products and service. In this section, five digital music service modes are studied, including download store, subscription, music stream, internet radio and social network. In the digital music market, business models are keeping innovating and digital music service modes are varying in different markets. As Mr Wells of universal music said: "all of our market is not a single road of development, each country is unique", "in every country, consumers interacting with music differ in thousands ways. Each country has different economic conditions, different levels of broadband penetration and level of development of digital technology and equipment".

Table 5 Typical service provider representatives of different digital music service modes

	Global service provider representatives	**Chinese service provider representatives**
Download store	iTunes, AmazonMP3, 7digital,	Jingdong, Amazon China, Taobao
Subscription	Spotify, Deezer	QQ Music, Douban FM Pro
Music stream	Youtube	Youku
Internet radio	Pandora, lastfm, TDC, WiMP,FASTWEB, MusicHub	Kuwo Music, Baidu Music, Kugou Music, Duomi Music, Xiami Music, Douban Music, QQ Music
Telecom operators	Vodafone, CuboMusica,	China Mobile, China Telecom, China Unicom

4.4.1 Download Store

As the main revenue stream of digital music, single downloads grow steadily, and over 500 authorized service providers provide 18 million songs available for download. Global download store sales volume reached 4.3 billion in 2012 and its revenue reached $5.6 billion, which accounted for 70% of the digital music market. The success of download store can be attributed to three factors: payment ways are verified to be convenient and secure; download stores safeguard the legitimacy of acquiring digital music; users trust the brands of download stores.

Download store mode began with Cductive selling MP3 format music online for $0.99 per song for the first time in 1996. After that a group of music download stores appeared like MP3.com. In 2000, as a major recording company, Sony Music first time set up download store “The Store”. Major recording companies gave up authorization on MP3.com and Cductive and started to collaborate to launch their own online music stores. AOL, RealNetworks, EMI and BMG founded the joint venture AOL MusicNet, and Sony and EMI jointly founded Sony’s Pressplay, followed by Apple, Google, Amazon and Microsoft joining the market.

In 2003, Apple launched iTunes store to provide digital music downloads, including singles, music video, ringtones, and other services such as audio books, TV programs, movies and games. iTunes turned to be extremely popular in the first year and its turnover exceeded Musicnet and Pressplay. iTunes’s success lies in adopting the unified pricing model of 99 cents per song and making downloaded music available to play in different terminals. In November 2011, Apple and Google launched iTunes match for the ios platform and Google Music service for the android platform respectively, which enabled users to pay an annual fee of $24.99 to get access to their music library through different terminals by cloud service.

In China, the big download stores, including Jingdong, Amazon China and Taobao, provide high quality music download. Generally in American digital music market, each single is priced at $0.99 by online music service providers and $0.65 by content providers. In 2012, the revenue of iTunes music store reached $4.3 billion but $3.4 billion royalties were paid to content providers[2]. Content providers tend to set high price for the royalties, because online music sales reduce the physical music sales and users have the freedom to buy only one or two songs online instead of the whole album. Basically if taking away royalties and credit card companies trading fees, digital music service providers cannot make money by setting price at $0.99 but they'd like to encourage users to buy digital music in download store to seek profits in the long term[61].

4.4.2 Subscription Service

Usually digital music service providers adopt "free value-added" business models, in which users can listen to music for free but have the limitations of listening time every week, number of songs and commercial advertisement intercut. Free service attracts users to experience the music service and gradually turn them into premium service users with higher quality music service. In the premium service, users are able to listen to high quality music offline without the limitations of listening time and commercial advertisement intercut. In the subscription service, by tracking listeners' listening records, digital music service providers can dig out listeners' preferences and recommend other songs with the similar style, making it easier for users to find new music. Users don't need to buy songs separately and the free service helps improve user experience.

Improvement of user experience, integration of social networks and different pricing strategies contribute to a rapid growth of subscription service. In 2012, Global digital music subscriber reached 20 million. Microsoft offers Xbox Music at a monthly

subscription fee of $9.99[3]. Spotify and Deezer spread quickly and become internationally renowned digital music service brands with 5 million and 3 million premium users respectively. Spotify succeeds in transiting free music service users to premium service users at a conversion rate of 15%[2].

In China, Douban FM provides online music listening for over 10 million users. In January 2013, Douban launched FM Pro, and users can enjoy high quality music without commercial advertisements by paying a monthly fee of 10 RMB or 50 RMB for half year. Baidu introduces a common VIP service, a 5 RMB monthly subscription package with free download and high quality songs online listening. If users want to download high quality songs without any advertisements, the common VIP service can be upgraded to platinum VIP service by paying 10 RMB monthly. Tencent QQ Music provides users with "Green Diamond" music service, which contains high quality songs download and the privileges of access to games and concerts.

In the subscription service mode, digital music service providers reward content providers by two ways: when users download the songs, royalties are paid to content providers; and when users listen to music online, royalties is paid by every play.

4.4.3 Music Stream Service

YouTube is the world's biggest online video site, with more than 800 million active users worldwide. And the integration of social networks such as YouTube and Facebook, makes music quickly spread in social networks. Free listening to the music and the ability to discover new music promoted the users to use music video streaming service. The monthly music video playback volume of VEVO, the most popular professional music channel in YouTube, exceeds 4 billion times. Now VEVO is expanding investment and constructing multiple devices and platforms. The music video profits come from its vast

online advertising business with more than 550 advertisers.

In China, the largest video streaming service provider Youku, which was founded in December of 2006, covers PC, TV and mobile terminals. From the second quarter of 2012, mobile Internet traffic soared in the Youku, and by November of 2013 it surges into 300 million's playback.

4.4.4 Internet Radio Stations

Internet radio stations create different playlists according to different genre of songs, themes or artists, making audience enjoy casual experience as broadcast. American most popular Internet radio service Pandora accounts for 8% of all American radio traffic, as many as 66 million active users.

1Ting Music, Chinese largest online music website, integrates the original music, Internet radio and original song platform. It has the original song show platform Coke Channel and radio show.

4.5 Physical Music Channel Mode and Digital Music Channel Mode

4.5.1 Physical Music Channel Mode

In the physical recording industry, music market consists of content providers, music products manufacturers, channel agents, distributors and users. Recording companies play a vital role in the whole music value chain. They sign artists to record and also sign the copyright agreements. Then the recorded music works are sent to music products manufacturers to largely compressed into disks, tapes, which are distributed by distribution department of the recording companies or the professional distribution companies. The revenue stream of physical music channel comes from records or other

music products sales.

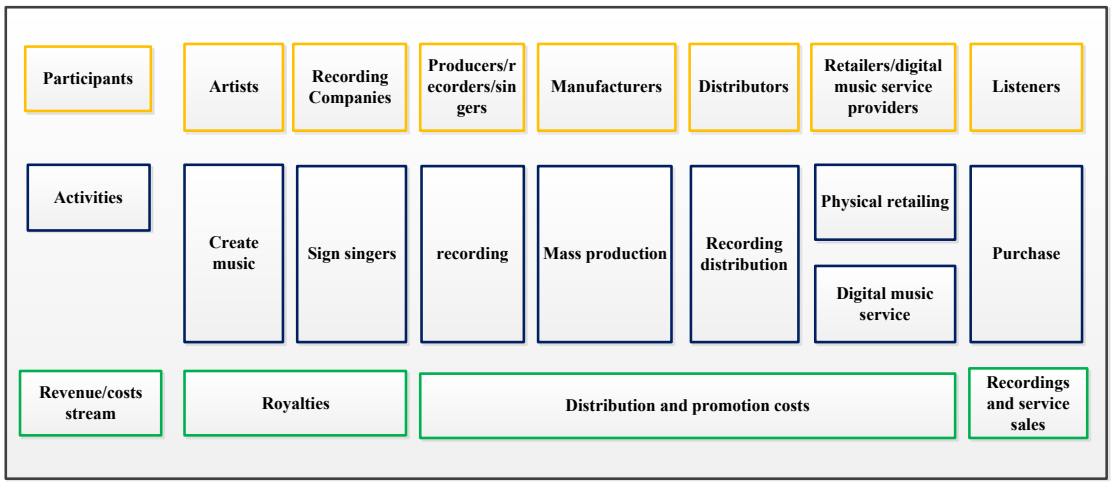

Figure 7 Physical recording channel mode

4.5.2 Digital Music Channel Mode

Digital music can be categorized into online music and mobile music, which have different channel modes. In the online music channel, service providers, terminal equipment providers and telecom operators acquire music contents from content companies. Service providers offer digital music through websites after turning the music contents into digital ones. Telecom operators offer online music through their music base or platforms. Terminal manufacturers, mainly PC manufactures, cooperate with service providers to embed music contents or music player software into terminals. Service providers and telecom operators get revenue from advertising, gaming and user purchase. Advertisers and gaming developers purchase music contents from contents providers to implant into advertising and gaming.

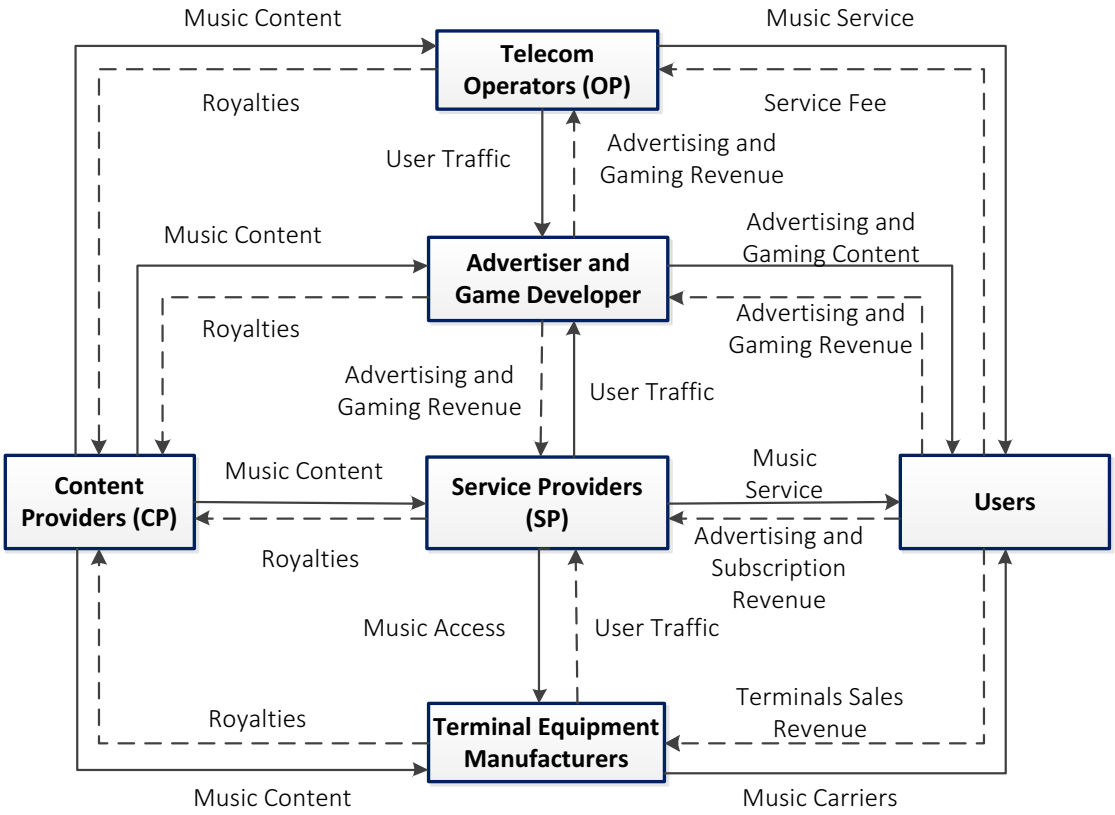

Figure 8 Online music channel mode

Different from online music channel, mobile music channel is usually longer. Service provider purchase copyright from content providers and sell digital music after producing to telecom operators, who act as the user interface. Users afford service fee to telecom operators, who will share revenue with service providers. Furthermore, service providers and telecom operators get part revenue from embedded advertising and gaming. In China digital music market, China Mobile initially shared revenue with service providers according to a percent of 15:85, while service providers and content providers share revenue according to their contracts. After the establishment of mobile music base, China Mobile cooperate with content providers directly and carry on a revenue sharing of 5:5. China Unicom share revenue with service providers in accordance with 3:7, and service providers give half revenue to content providers.

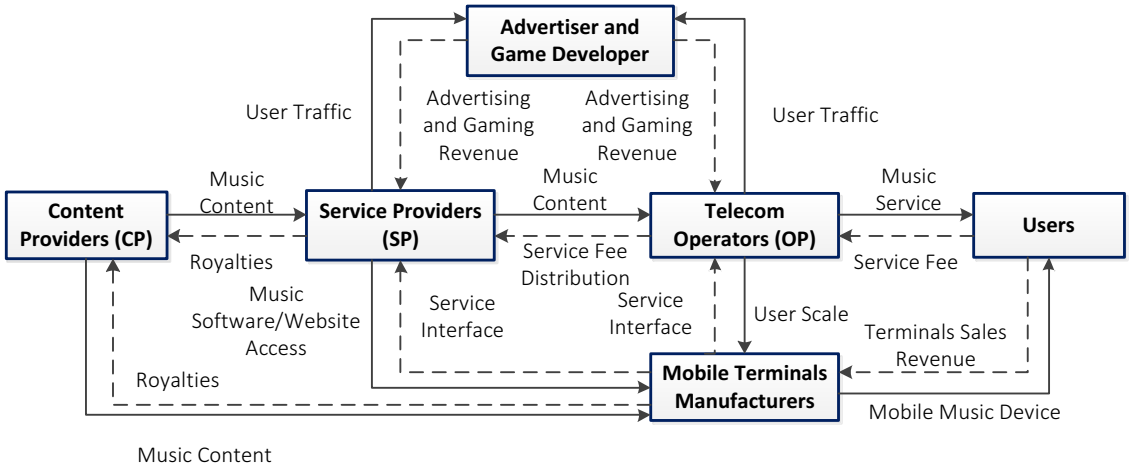

Figure 9 Online music channel mode

As shown in Figure 10, a channel cooperation mode is employed to simplify the channel modes of both online music and mobile music.

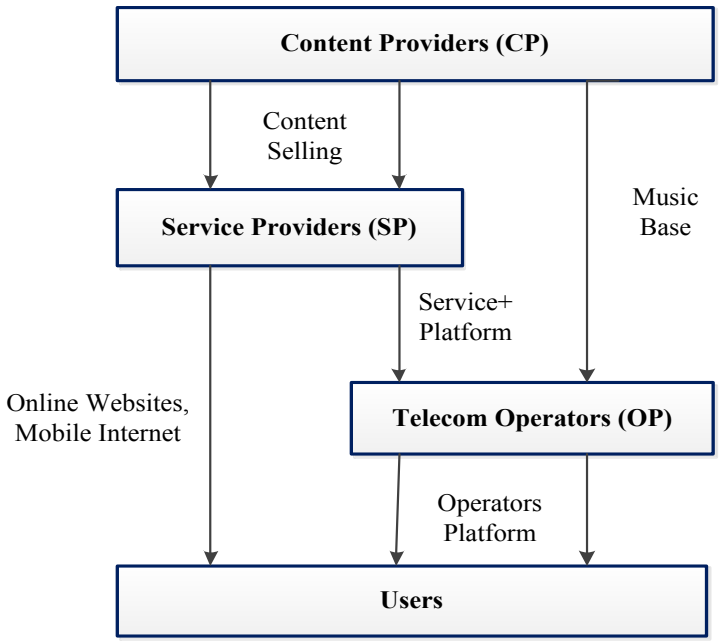

Figure 10 Simplified digital music channel mode

5 THE GAME ANALYSIS OF DIGITAL MUSIC CHANNEL IN COMPETITION

In the digital music channels, content providers (CP), service providers (SP), telecom operator (OP) compete with each other to acquire optimal profits. To study the optimal pricing, service strategies and revenues of CP, SP and OP in different competing channels, four competing channel modes are analyzed which are High Price without SP Mode, "Low Price+Shared Revenue" without SP Mode, High Price with SP participation Mode and "Low Price+Shared Revenue" with SP participation Mode. In this chapter, the participants' optimal revenue, optimal pricing and service level are firstly explored, and then numerical analysis is adopted to study the influence of service cost coefficient, revenue sharing ratio, user price sensitive factor and user service level sensitive factor on the results of game equilibrium. At last, by comparing the four competing channel modes, optimal channel selection strategy is found.

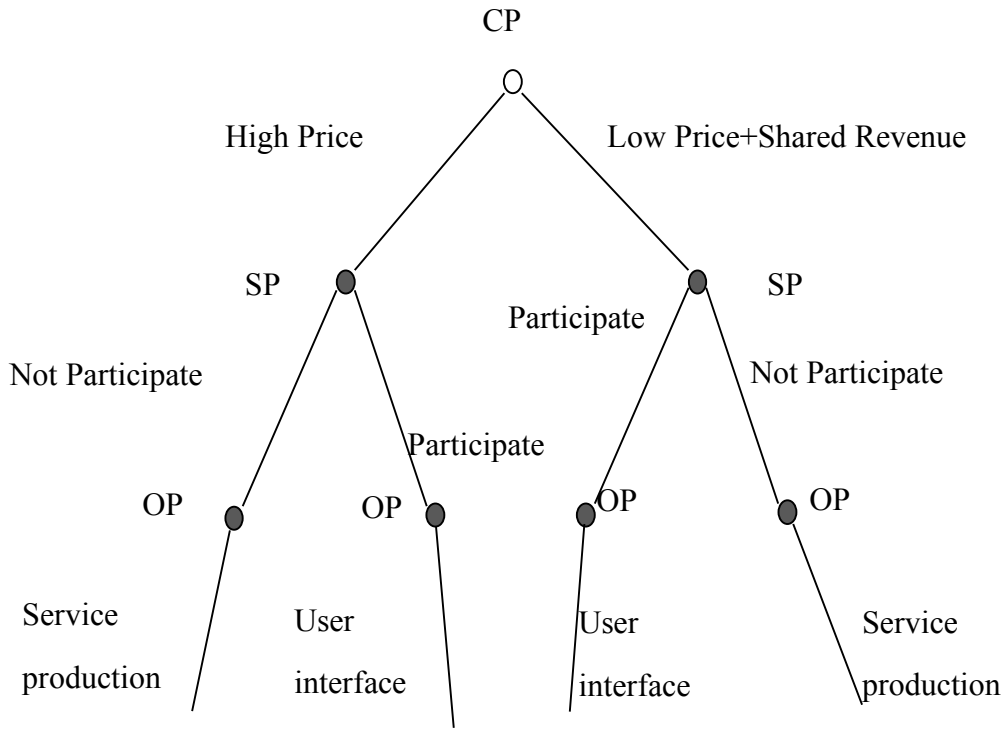

Figure 11 Tri-partite gaming of CP, SP, OP

As shown in Figure 11, according to the fact that whether SP participate in the channels,

there are two channel structures: CP cooperate with OP directly without SP, OP take the role of SP and provide service for users; SP buy the music copyright from CP and provide digital music service for users through the OP's access. In the cooperation situation of CP and OP, there are two different contract modes: OP buy the copyright at a high price; OP buy the copyright at a low price and share the revenue with CP. SP master a greater digital content production and marketing capability compared with OP, which means a higher music service level of SP that influence music pricing and sales volume. When SP participate, channels are lengthened and CP, SP and OP compete with each other. In this situation, two different channel modes are considered: SP buy music copyright at a high price and sell the digital music content to OP at a relatively high price; SP buys music copyright at a low price and sell digital music content at a low price to OP, then OP share the revenue with SP and CP together.

In this chapter, considering service level's influence on user demand, Stackelberg game model (Zhang Weiying, 1996, pp. 107-137) is introduced to analyze the competing digital music channels game equilibrium and then numerical analysis and comparative analysis are adopted to reach a series of conclusions.

5.1 Model Assumption and Parameter Settings

In the digital music channel, CP, SP and OP are assumed to be risk neutral and perfectly rational. To eliminate the unnecessary factors' influence on the results, costs unrelated to service level are not considered. Due to the fact that content providers dominate channels in Chinese markets, in the following analysis CP are assumed to take the leading role in the game.

Table 6 Parameters set and explanations in the model

CP	p_c	Copyright price of every single
	c_c	Copyright cost of every single
	Π_c	Revenue of CP
OP	p_o	Digital music service Price provided for users
	d_o	Digital music service Demand
	Π_o	Revenue of OP
	c_o	Digital music service cost of OP
	s_o	Digital music service level that OP provide
SP	p_s	Digital music service price that SP sell to OP
	Π_s	Revenue of SP
	c_s	Digital music service cost of SP
	s_s	Digital music service level that SP provide
	Π	Revenue of the whole channel

5.2 Game Analysis on Digital Music Channels in the Situation that CP and OP participate

In the digital music market, to obtain greater channel control power, OP strive to expand their business scope to upstream and cooperate with CP to buy the copyright directly, replacing SP to produce digital music contents and provide users with digital music service through their own platforms. In the situation of CP and OP participating into channels without SP, CP with copyright resources and OP with user scale and digital music production capability compete in the channels. As “content is the king”, content providers have the dominating power over the channels. In this section, considering the

dynamic game relation between OP and CP, CP decide the copyright price, and then OP decide the offering price and service level to users by considering users' service and price acceptation ability. As CP act first and then SP take action according to CP's strategy, a two-stage Stackelberg game model (Zhang Weiying, 1996, pp. 107-137) analysis is adopted to explore the game equilibrium solution, namely OP and CP's optimal strategies in the competition.

In the absence of SP in the channel, CP and SP adopt two kinds of cooperation modes. One is CP sell music copyright to OP at a high price and OP take all the risks of digital music service. However, to reduce of the risks, OP tend to buy music copyright at a low price and share revenue with CP according to a contract signed before. Now China Mobile music base adopt a five-to-five revenue sharing scheme with CP.

In this section, CP and SP's game equilibrium strategies and different parameters' influence on the equilibrium results are explored in both High Price SP Mode and "Low Price+Shared Revenue" without SP Mode. Finally, a series of conclusions are achieved by comparative analysis.

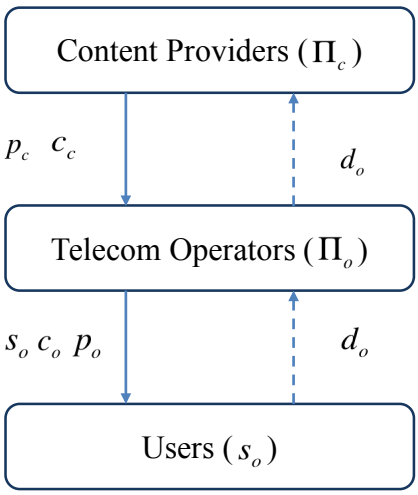

Figure 12 Channel structure diagram of CP and OP participating into channel

5.2.1 High Copyright Price without SP Mode

Consumers are sensitive to both price and service level. Here digital music service demand function is defined as a function of a leaner relationship with price and service level. Let d_B denote the basic user demand of digital music. Let α and β denote the effect parameter of price and service. So user demand is defined as below:

$$d_o = d_B + \beta * s_o - \alpha * p_o \tag{5.1}$$

OP's service cost is related to its service level. Iyer (1998, pp. 338-355), Tsay et al. (2000, pp. 372-391, Mukhopadhyay et al. (2008, pp. 950-958), Feng et al (2009, pp. 241-270) assume service cost to be the convex function of service level. This paper argues that OP's service cost and service level are in line with the function: $c_o = \eta \frac{s_o^2}{2}$, wherein η is a known constant that is shared by all the participants in the channel. Feng et al assume $\eta = 1$ in their research and Mukhopadhyay et al think that η conforms to a random distribution $f(\eta)$.

CP takes the leading role in digital music channel and determine copyright price first, and then OP choose the user service level and price after observing CP's action. That is to say that CP's copyright price affects OP's digital music service level and price offered to users. Below Stackelberg game model (Zhang Weiying, 1996, pp. 107-137) is established between CP and OP, and backward induction approach is used to solve the Nash equilibrium solution. OP's revenue is its sales revenue minus copyright cost and digital music content production cost, namely:

$$\Pi_o = (p_o - p_c) * d_o - c_o \tag{5.2}$$

OP's goal is to maximum its revenue by choosing proper music service level and price in the condition of $p_o > p_c$, namely:

$$\max_{p_o > p_c} \Pi_o(p_o, s_o) \tag{5.3}$$

Above formula is taken derivative with respect to p_o and s_o to obtain two simultaneous equations, which can be solved to achieve OP's optimal price and service level:

$$p_o^* = \frac{\eta d_B + \alpha\eta p_c - \beta^2 p_c}{2\alpha\eta - \beta^2}, \quad s_o^* = \frac{\beta(d_B - \alpha p_c)}{2\alpha\eta - \beta^2} \tag{5.4}$$

Then the above optimal price p_o^* is substituted into demand function d_o to get the optimal sales volume:

$$d_o^* = \frac{\alpha\eta(d_B - \alpha p_c)}{2\alpha\eta - \beta^2} \tag{5.5}$$

CP's revenue function is:

$$\Pi_c = (p_c - c_c) * d_o \tag{5.6}$$

CP's goal is to maximum its revenue by choosing proper music copyright price in the condition of $p_o > c_c$, namely:

$$\max_{p_c > c_c} \Pi_c(p_c) \tag{5.7}$$

d_o^* is substituted into Π_c, followed by taking derivative for Π_c to obtain the optimal copyright price:

$$p_c^* = \frac{d_B + \alpha c_c}{2\alpha} \tag{5.8}$$

Channel system's revenue is:

$$\prod = \Pi_o + \prod_c \tag{5.9}$$

Through the above calculation, the following equilibrium table can be drawn:

Table 7 Equilibrium results in High Copyright Price without SP Mode

p_c^*	$\frac{d_B + \alpha c_c}{2\alpha}$
p_o^*	$\frac{c_c}{2} + \frac{d_B}{2\alpha} + \frac{\eta d_B - \alpha\eta c_c}{2(2\alpha\eta - \beta^2)}$
d_o^*	$\frac{\alpha\eta(d_B - \alpha c_c)}{2(2\alpha\eta - \beta^2)}$
s_o^*	$\frac{\beta(d_B - \alpha c_c)}{2(2\alpha\eta - \beta^2)}$
Π_o^*	$\frac{\eta(d_B - \alpha c_c)^2}{8(2\alpha\eta - \beta^2)}$
Π_c^*	$\frac{\eta(d_B - \alpha c_c)^2}{4(2\alpha\eta - \beta^2)}$
Π^*	$\frac{3\eta(d_B - \alpha c_c)^2}{8(2\alpha\eta - \beta^2)}$

It can be seen from the above game equilibrium that CP's copyright pricing is related to user price sensitive coefficient, but has nothing to do with the service level sensitive coefficient. If users are more sensitive of music service level, OP's service pricing, service level and user demand will be higher accordingly, as well as all participants in the channels. CP is taking the leading role in the channel, with almost twice the revenue of OP. If OP's digital music service cost coefficient η increases, its pricing, service level, user demand and all the participants' revenue will decrease.

To explore OP's service cost coefficient η's influence on the results of game equilibrium, set $d_B = 20000, c_c = 1000, \alpha = 10, \beta = 15$ for numerical analysis.

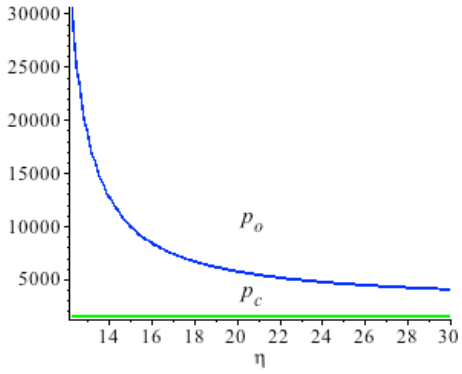

Figure 13 Influence of η on CP's and OP's pricing in High Copyright Price without SP Mode

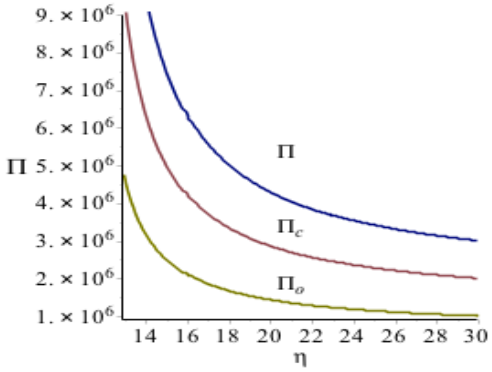

Figure 14 Influence of η on participants' and channel system's revenues in High Copyright Price without SP Mode

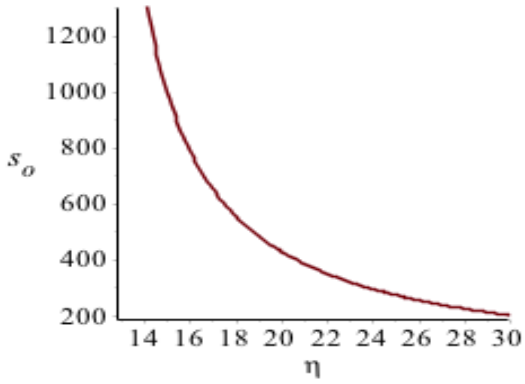

Figure 15 Influence of η on OP's service level in High Copyright Price without SP Mode

From the above figures, CP's copyright pricing is not influenced by OP's service cost coefficient η. OP's music service pricing p_o, OP's and SP's revenues and channel system's revenue increase with a decreasing speed as η grows. Therefore, to maximum all the participants' revenues, η's value should be reduced as much as possible. From the service level curve, the bigger OP's service cost coefficient η is, the lower its service level is.

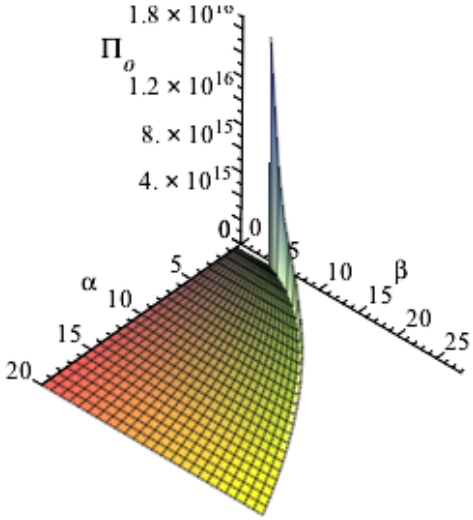

Figure 16 Influence of α , β on OP's revenue

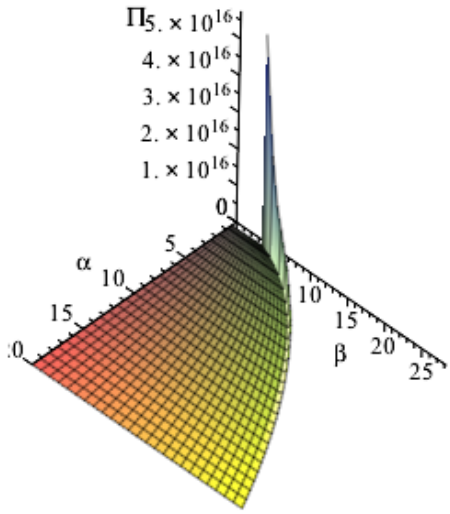

Figure 17 Influence of α , β on channel system's revenue

To explore user price effect parameter α and service effect parameter β 's influence on the participants' revenues, set $d_B = 20000$, $c_c = 1000$, $\alpha = 10$, $\beta = 15$ for numerical analysis. As CP's revenue is twice as much as OP's revenue, CP's three-dimensional figure has the same trend with that of OP. From the above figures, it can be drawn that channel participants' revenues increase with the growth of user service effect parameter β . Therefore, innovating business model and improving user experience will bring a geometric growth to all the participants in the channels. User price effect parameter α 's increase will lead to a decrease in all the participants' revenues.

Conclusion1: In a competitive High Copyright Price without SP Mode,

- CP is taking the leading role in the channel, with almost twice the revenue of OP.
- If OP's digital music service cost coefficient η increases, its pricing, service level, user demand and all the participants' revenue will decrease. However, η doesn't affect CP's pricing.

- It's user price effect parameter α not user service effect parameter β that influences CP's pricing. If users are sensitive to digital music service level but not sensitive to digital music service price, participants' and channel system's revenues will all grow. Innovating business model and improving user experience will bring a geometric growth to all the participants in the channels.

5.2.2 "Low Copyright Price + Revenue sharing" without SP Mode

In this mode, CP sells its copyright at a relatively low price and then OP produce digital music service content for users. In the revenue obtained, OP distributes $1-\gamma$ of the revenue to CP according to a contract concluded in advance. In this case, CP will be faced with OP's service level and user scale risks. Here, γ is assumed to be a known constant. Similar with High Copyright Price without SP Mode, the demand function is defined as：

$$d_o = d_B + \beta * s_o - \alpha * p_o \tag{5.10}$$

Wherein d_B denotes the basic user demand of digital music, and α, β denote the effect parameter of price and service.

OP's revenue is γ of its sales revenue minus copyright cost and digital music content production cost, namely:

$$\Pi_o = \gamma p_o d_o - p_c d_o - c_o \tag{5.11}$$

Same with High Copyright Price without SP Mode, OP's service cost is defined as:

$$c_o = \eta \frac{{s_o}^2}{2} \tag{5.12}$$

OP's goal is to maximum its revenue by choosing proper music service level and price in the condition of $p_o > p_c$, namely:

$$\max_{p_o > p_c} \Pi_o(p_o, s_o) \tag{5.13}$$

Above formula is taken derivative with respect to p_o and s_o to obtain two simultaneous equations, which can be solved to achieve OP's optimal price and service level:

$$p_o^* = \frac{\eta d_B + \alpha\eta p_c - p_c\beta^2}{2\alpha\eta - \beta^2}, \quad s_o^* = \frac{d_B\beta - \alpha\beta p_c}{2\alpha\eta - \beta^2} \tag{5.14}$$

Then the above optimal price p_o^* is substituted into demand function d_o to get the optimal sales volume:

$$d_o^* = \frac{\alpha\eta(d_B - \alpha p_c)}{2\alpha\eta - \beta^2} \tag{5.15}$$

CP's revenue function is its copyright revenue plus revenue sharing minus copyright cost:

$$\Pi_c = (p_c - c_c) * d_o + (1-\gamma) p_o d_o \tag{5.16}$$

CP's goal is to maximum its revenue by choosing proper music copyright price in the condition of $p_o > c_c$, namely:

$$\max_{p_c > c_c} \Pi_c(p_c) \tag{5.17}$$

p_o^*, d_o^* are substituted into Π_c, followed by taking derivative for Π_c to obtain the optimal copyright price:

$$p_c^* = \frac{\gamma(2c_c\alpha^2\eta + 2\alpha\gamma\eta d_B - \alpha c_c\gamma\beta^2 - \gamma d_B\beta^2)}{2\alpha(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)} \tag{5.18}$$

Channel system's revenue is:

$$\prod = \Pi_o + \prod_c \tag{5.19}$$

Through the above calculation, the following equilibrium table can be drawn:

Table 8 Equilibrium results in "Low Copyright Price + Revenue sharing" without SP Mode

p_c^*	$\frac{\gamma(2c_c\alpha^2\eta + 2\alpha\gamma\eta d_B - \alpha c_c\gamma\beta^2 - \gamma d_B\beta^2)}{2\alpha(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)}$
p_o^*	$\frac{\gamma(\alpha\eta d_B + c_c\alpha^2\eta + 2\alpha\gamma\eta d_B - \alpha c_c\gamma\beta^2 - \gamma d_B\beta^2)}{2\alpha(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)}$
d_o^*	$\frac{\alpha\eta(d_B - \alpha c_c)}{2(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)}$
s_o^*	$\frac{\gamma\beta(d_B - \alpha c_c)}{2(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)}$
Π_o^*	$\frac{\gamma\eta(d_B - \alpha c_c)(2\alpha\eta d_B - 2c_c\alpha^2\eta + \alpha c_c\gamma\beta^2 - \gamma d_B\beta^2)}{8(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)^2}$
Π_c^*	$\frac{\eta(d_B - \alpha c_c)^2}{4(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)}$
Π^*	$\frac{\eta(d_B - \alpha c_c)(4\alpha\gamma\eta d_B - 2\gamma\beta^2 d_B + 2\alpha\eta d_B - 4c_c\alpha^2\eta\gamma + 2\alpha c_c\gamma\beta^2 - 2c_c\alpha^2\eta - \gamma^2 d_B\beta^2 + \alpha c_c\gamma^2\beta^2)}{8(\gamma\alpha\eta - \gamma\beta^2 + \alpha\eta)^2}$

From Table 8, in "Low Copyright Price + Revenue sharing" without SP Mode, CP's copyright pricing is related to both user price sensitive coefficient and service level sensitive coefficient.

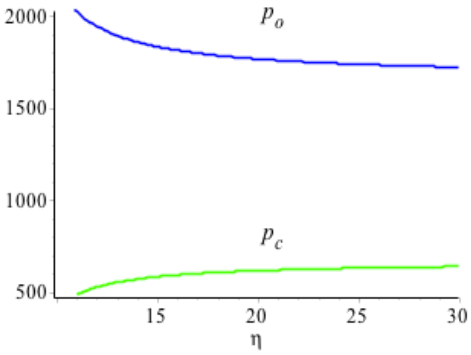

Figure 18 Influence of η on CP's and OP's pricing in"Low Copyright Price + Revenue sharing" without SP Mode

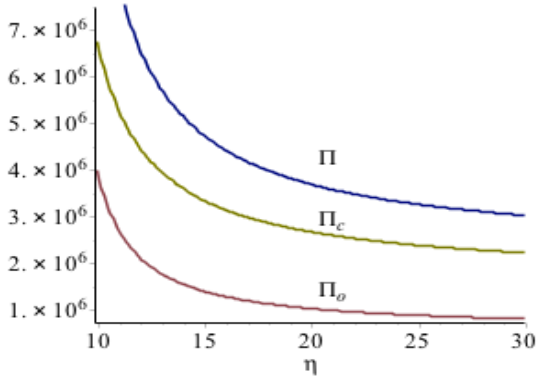

Figure 19 Influence of η on participants' and channel system's revenues in "Low Copyright Price + Revenue sharing" without SP Mode

To explore OP's service cost coefficient η's influence on the results of game equilibrium, set $d_B = 20000$, $c_c = 1000$, $\alpha = 10$, $\beta = 15$, $\gamma = 0.5$ for numerical analysis. In "Low Copyright Price + Revenue sharing" without SP Mode, if η grows, OP's music service pricing p_o, service level, participants' revenue and channel system's revenue will all decrease at a slowing down speed, whereas CP's copyright pricing will increase.

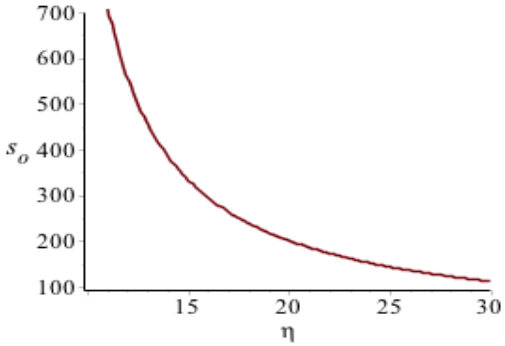

Figure 20 Influence of η on OP's service level in "Low Copyright Price + Revenue sharing" without SP Mode

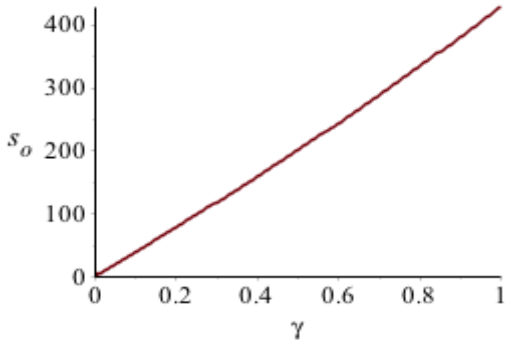

Figure 21 Influence of γ on OP's service level in "Low Copyright Price + Revenue sharing" without SP Mode

To explore revenue sharing ratio γ's influence on the results of game equilibrium, set

$d_B = 20000$, $c_c = 1000$, $\alpha = 10$, $\beta = 15$, $\eta = 20$ for numerical analysis. The results show, with the revenue sharing ratio γ's growth, OP's service level, CP's and OP's pricing and revenue increase. Although most revenue is attributed to CP, OP is gaining its power in the channel with γ's growth. When $\gamma = 1$ which means if CP and OP don't share revenue, all the participants in the channels will maximum their revenue. This can explain the phenomenon that CP tends to price its copyright on high level and the revenue sharing part accounts for only a small part of its income. Another reason that CP prefers High Copyright Price without SP Mode is that in the revenue sharing mode, CP cannot know OP's real sales because of the asymmetric information between CP and OP, resulting in OP's moral hazard. Therefore, there is a need to design an incentive cooperation mechanism to motive both CP and OP to cooperate to achieve a win-win situation.

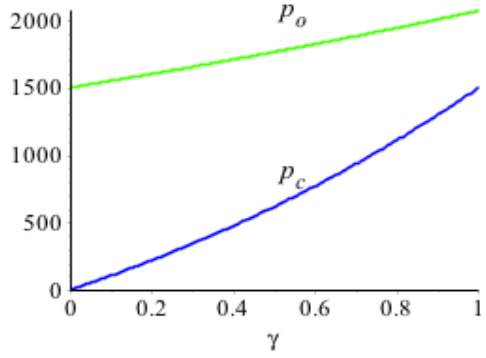

Figure 22 Influence of γ on CP's and OP's pricing in "Low Copyright Price + Revenue sharing" without SP Mode

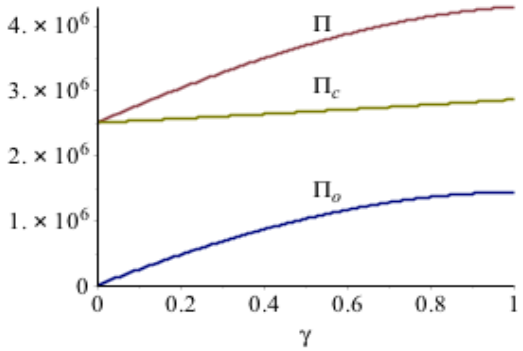

Figure 23 Influence of γ on participants' and channel system's revenues in "Low Copyright Price + Revenue sharing" without SP Mode

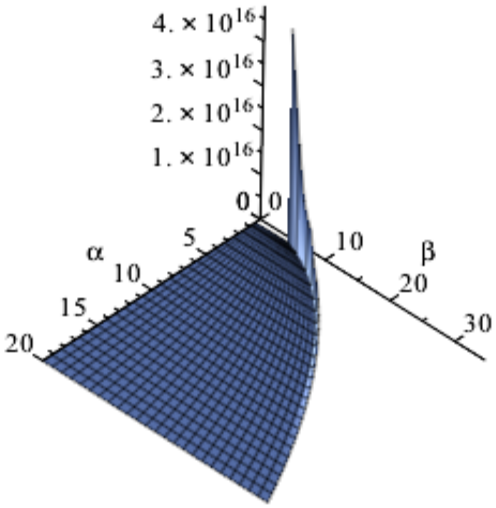

Figure 24 Influence of α , β on OP's revenue in "Low Copyright Price + Revenue sharing" without SP Mode

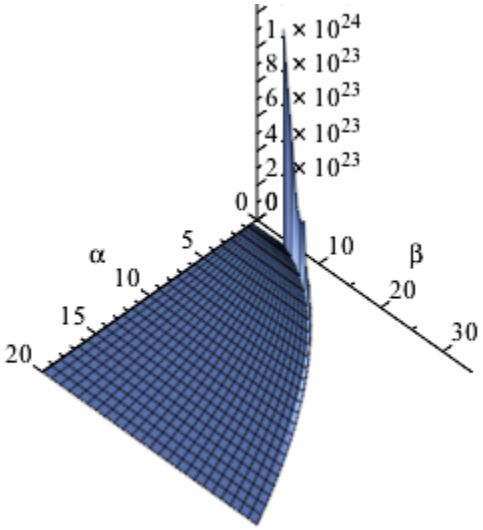

Figure 25 Influence of α , β on channel system's revenue in "Low Copyright Price + Revenue sharing" without SP Mode

To explore user price effect parameter α and service effect parameter β 's influence on the participants' revenues, set $d_B = 20000$, $c_c = 1000$, $\eta = 20$, $\gamma = 0.5$ for numerical analysis. It can be seen from Figure 24 and Figure 25 that, if CP and OP share revenue using split 50-50, CP will account for nearly all the revenue in the channel. Participants' revenues increase with the growth of user service effect parameter β , whereas user price effect parameter α 's increase will lead to a decrease in all the participants' revenues.

Conclusion2: In a competitive "Low Copyright Price + Revenue sharing" without SP Mode,

- If OP's digital music service cost coefficient η increases, its pricing, service level, user demand and all the participants' revenue will decrease, whereas CP's pricing will increase on the contrary.

- If CP and OP's revenue sharing ratio γ grows, OP's service level, CP's and OP's pricing and revenue will all increase. CP's revenue percentage in the channel system's

revenue drops, whereas OP gains its power in the channel with γ's growth. When $\gamma = 1$ which means if CP and OP don't share revenue, CP gets twice the revenue of OP and all the participants in the channels can maximum their revenue.

- Participants' revenues increase with the growth of user service effect parameter β, whereas user price effect parameter α's increase will lead to a decrease in all the participants' revenues. If users are sensitive to digital music service level but not sensitive to digital music service price, participants' and channel system's revenues will all grow.

5.2.3 Comparative Analysis of High Copyright Price without SP Mode and "Low Copyright Price + Revenue sharing" without SP Mode

To help stakeholders in the digital music channels to gain a clear perspective about which mode to choose in the competitive situation, the similarities and differences are drawn to after comparative analysis in the table 9 below:

Table 9 Comparative analysis of High Copyright Price without SP Mode and "Low Copyright Price + Revenue sharing" without SP Mode

Differences	High Copyright Price without SP Mode	"Low Copyright Price + Revenue sharing" without SP Mode
	η doesn't affect CP's pricing .	CP's pricing p_c increases with η's growth
	CP gets twice the revenue of OP	If γ grows, CP's revenue percentage in the channel system's revenue drops; When $\gamma = 1$, CP gets twice the revenue of OP
	β doesn't affect CP's pricing .	β affects CP's pricing
		If CP and OP's revenue sharing ratio γ grows, OP's service level, CP's and OP's pricing and revenue will all increase.
Similarities	If OP's digital music service cost coefficient η increases, its pricing, service level, user demand and all the participants' revenue will decrease.	
	If users are sensitive to digital music service level but not sensitive to digital music service price, participants' and channel system's revenues will all grow.	

5.3 Game Analysis on Digital Music Channels with SP's Participation

From the point of the whole digital music market, SP with a sensitive market sense and

professional digital music content production and marketing capability, has a more powerful ability to meet users demand compared with OP. Therefore, in this paper when SP participate into digital music channel, its service level is supposed to surpass OP's service level, that is to say $s_s > s_o$. If SP participate into the channel, OP serve as user service interface and SP produce digital music content and service whose service level affects user demand directly. In this section, considering SP's service level and service cost, tripartite game equilibrium strategies are explored among CP, SP and OP. In the tripartite game, CP decide the music copyright price and then SP decide the service level and price selling to OP. After observing SP's action, OP decide its pricing depending on user price and service effect parameter to achieve maximal profit. With SP's participation, a tripartite dynamic game relation is formed in the channel and High Copyright Price with SP Mode and "Low Copyright Price + Revenue sharing" with SP Mode are explored in this section.

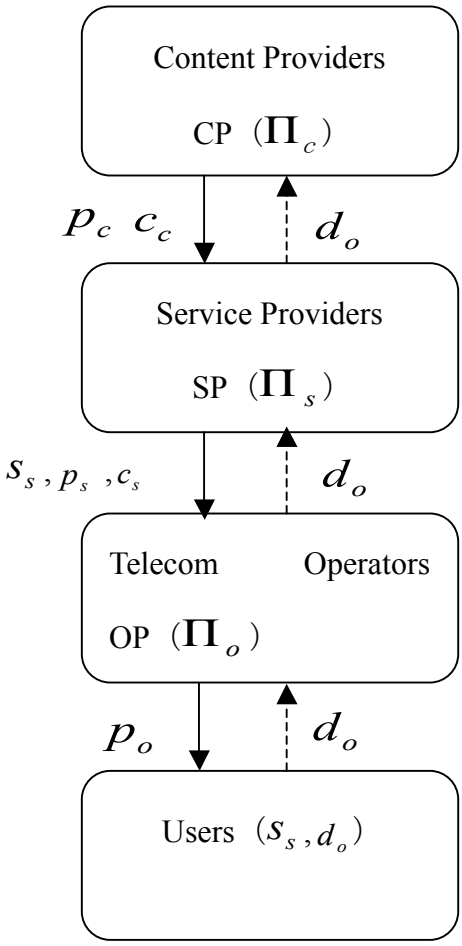

Figure 26 Channel Structure Diagram of CP, SP and OP participating into channel

5.3.1 High Copyright Price with SP Mode

In High Copyright Price with SP Mode, CP sell music copyright to SP at a high price and then SP choose the service level and service pricing selling to OP basing on user service level affect parameter and copyright price. OP deliver the digital music service at a price which is affected by user price affect parameter. In this section, a three-stage Stackelberg game model (Zhang Weiying, 1996, pp. 107-137) is established and backward induction approach is used to solve the Nash equilibrium solution.

As High Copyright Price without SP Mode, digital music service demand function is defined as a function of a leaner relationship with price and service level. So user demand

is defined as below:

$$d_o = d_B + \beta * s_s - \alpha * p_o \tag{5.20}$$

OP's revenue is its sales revenue minus digital music content cost bought from SP, namely:

$$\Pi_o = (p_o - p_s) * d_o \tag{5.21}$$

OP's goal is to maximum its revenue by choosing proper music service price in the condition of $p_o > p_s$, namely:

$$\max_{p_o > p_s} \Pi_o(p_o) \tag{5.22}$$

Above formula is taken derivative with respect to p_o to obtain a simultaneous equation, which can be solved to achieve OP's optimal price:

$$p_o^* = \frac{d_B + \alpha p_s + \beta s_s}{2\alpha} \tag{5.23}$$

Then the above optimal price p_o^* is substituted into demand function d_o to get the optimal sales volume:

$$d_o^* = \frac{1}{2}(d_B + \beta s_s - \alpha p_s) \tag{5.24}$$

SP's revenue function is sales revenue minus copyright cost and digital music production cost:

$$\Pi_s = (p_s - p_c) d_o - c_s \tag{5.25}$$

σ, as a known constant, is assumed as SP's digital music production costs affect parameter. SP's service cost and service level are in line with the function:

$$c_s = \sigma \frac{{s_s}^2}{2} \tag{5.26}$$

SP's goal is to maximum its revenue by choosing proper digital music service level and price selling to OP in the condition of $p_s > p_o$

$$\max_{p_s > p_c} \Pi_s(p_s, s_s) \tag{5.27}$$

d_o^* is substituted into Π_s, followed by taking derivative for Π_s to obtain the optimal digital music content selling price and service level:

$$p_s^* = \frac{2\alpha\sigma p_c + 2\sigma d_B - p_c\beta^2}{4\alpha\sigma - \beta^2}, \quad s_s^* = \frac{\beta(d_B - \alpha p_c)}{4\alpha\sigma - \beta^2} \tag{5.28}$$

Above formula are substituted into d_o^*:

$$d_o^* = \frac{\alpha\sigma(d_B - \alpha p_c)}{4\alpha\sigma - \beta^2} \tag{5.29}$$

CP's revenue function is:

$$\Pi_c = (p_c - c_c)d_o \tag{5.30}$$

CP's goal is to maximum its revenue by choosing proper music copyright price in the condition of $p_o > c_c$, namely:

$$\max_{p_c > c_c} \Pi_c(p_c) \tag{5.31}$$

d_o^* is substituted into Π_c, followed by taking derivative to obtain the optimal copyright price:

$$p_c^* = \frac{d_B + \alpha c_c}{2\alpha} \tag{5.32}$$

Channel system's revenue is:

$$\Pi = \Pi_c + \Pi_s + \Pi_o \tag{5.33}$$

Through the above calculation, the following equilibrium table can be drawn:

Table 5.5 Equilibrium Results in High Copyright Price with SP Mode

p_c^*	$\frac{d_B + \alpha c_c}{2\alpha}$
p_s^*	$\frac{2\alpha^2\sigma c_c + 6\alpha\sigma d_B - \alpha c_c\beta^2 - \beta^2 d_B}{2\alpha(4\alpha\sigma - \beta^2)}$
p_o^*	$\frac{\alpha^2\sigma c_c + 7\alpha\sigma d_B - \alpha c_c\beta^2 - \beta^2 d_B}{2\alpha(4\alpha\sigma - \beta^2)}$
d_o^*	$\frac{\alpha\sigma(d_B - \alpha c_c)}{2(4\alpha\sigma - \beta^2)}$
s_s^*	$\frac{\beta(d_B - \alpha c_c)}{2(4\alpha\sigma - \beta^2)}$
Π_c^*	$\frac{\sigma(d_B - \alpha c_c)^2}{4(4\alpha\sigma - \beta^2)}$
Π_s^*	$\frac{\sigma(d_B - \alpha c_c)^2}{8(4\alpha\sigma - \beta^2)}$
Π_o^*	$\frac{\alpha\sigma^2(d_B - \alpha c_c)^2}{4(4\alpha\sigma - \beta^2)^2}$
Π^*	$\frac{\sigma(d_B - \alpha c_c)^2(14\alpha\sigma - 3\beta^2)}{8(4\alpha\sigma - \beta^2)^2}$

From the equilibrium results in Table 5.5, SP's digital music service cost coefficient and user service effect parameter β cannot affect CP's pricing. CP gets twice the revenue of OP.

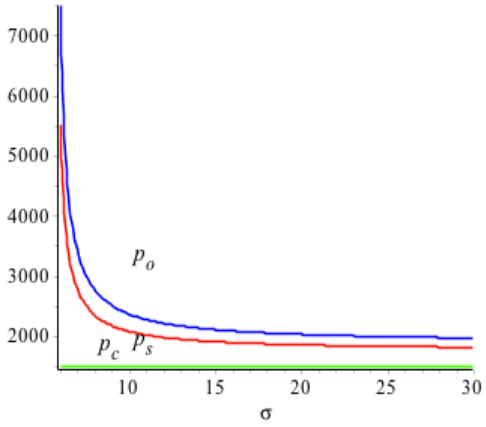

Figure 27 Influence of σ on CP's, SP's and OP's pricing in High Copyright Price with SP Mode

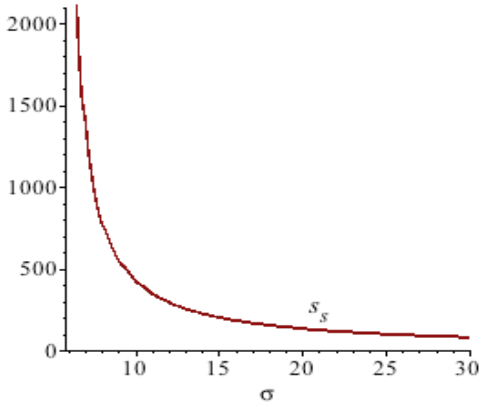

Figure 28 Influence of σ on OP's service level in High Copyright Price with SP Mode

To explore SP's service cost coefficient σ's influence on the results of game equilibrium, set $d_B = 20000, c_c = 1000, \alpha = 10, \beta = 15$ for numerical analysis. If SP's digital music service cost coefficient σ increases, its pricing, service level s_s, OP's pricing, user demand and all the participants' revenue will decrease, whereas σ doesn't affect CP's pricing. When σ gets a small value, p_c is far less than p_o and p_s, and OP takes most of all the revenue in the channel. OP's revenue drops rapidly, becoming the least revenue gainer in the channel with σ's growth, whereas CP gets most revenue.

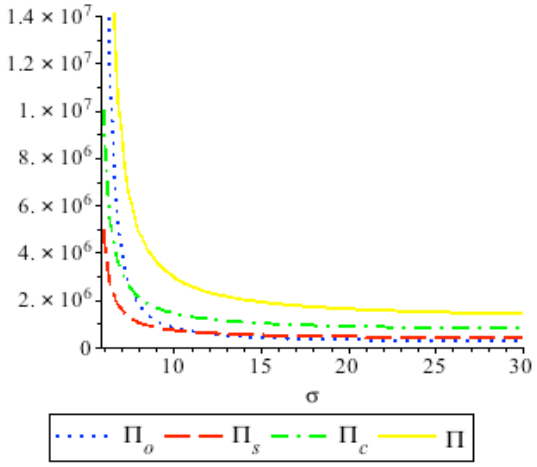

Figure 29 Influence of σ on participants' and channel system's revenues in High Copyright Price with SP Mode

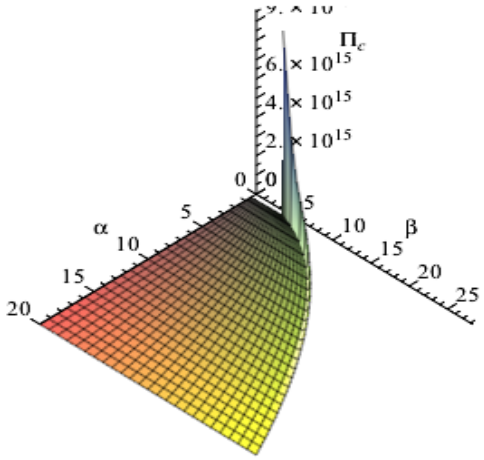

Figure 30 Influence of α , β on CP's revenue in High Copyright Price with SP Mode

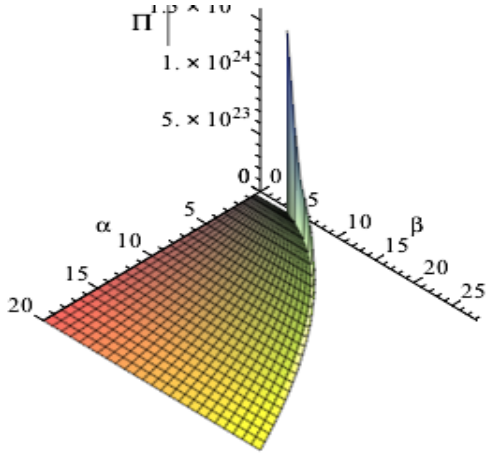

Figure 31 Influence of α , β on channel system's revenue in High Copyright Price with SP Mode

To explore user price effect parameter α and service effect parameter β 's influence on the results of game equilibrium, set $d_B = 20000$, $c_c = 1000$, $\sigma = 10$ for numerical analysis. Consistent with High Copyright Price without SP Mode, if users are sensitive to digital music service level but not sensitive to digital music service price, participants' and channel system's revenues will all grow.

Conclusion3: In a competitive High Copyright Price with SP Mode,

- CP is taking the leading role in the channel, with twice the revenue of OP. σ and β doesn't affect CP's pricing.

- If SP's digital music service cost coefficient σ increases, its pricing, service level s_s , OP's pricing, user demand and all the participants' revenue will decrease. OP's revenue drops rapidly, becoming the least revenue gainer in the channel with σ 's growth, whereas CP gets most revenue.

- If users are sensitive to digital music service level but not sensitive to digital music

service price, participants' and channel system's revenues will all grow.

5.3.2 "Low Copyright Price + Revenue sharing" with SP Mode

In "Low Copyright Price + Revenue sharing" with SP Mode, CP sell the copyright to SP at a relatively low price, and then SP choose service level and service pricing selling to OP basing on user service level affect parameter and copyright price. OP deliver the digital music service at a price affected by user price affect parameter. OP get δ of the revenue obtained and distribute μ of it to SP while $1-\delta-\mu$ to CP according to a contract concluded in advance. Here, δ and μ are assumed to be known constants, and the demand function is defined as：

$$d_o = d_B + \beta * s_s - \alpha * p_o \tag{5.34}$$

OP's revenue is δ of its sales revenue minus digital music content cost, namely:

$$\Pi_o = \delta(p_o - p_s) * d_o \tag{5.35}$$

SP's revenue is sum of revenue of digital music content selling to OP and μ of the revenue obtained minus copyright cost and digital music content production cost, namely:

$$\Pi_s = (p_s - p_c)d_o - c_s + \mu(p_o - p_s)d_o \tag{5.36}$$

SP's service cost is defined as:

$$c_s = \sigma \frac{{s_s}^2}{2} \tag{5.37}$$

CP's revenue function is its copyright revenue plus revenue sharing minus copyright cost:

$$\Pi_c = (p_c - c_c)d_o + (1-\delta-\mu)(p_o - p_s)d_o \tag{5.38}$$

Similar with Stackelberg game analysis without SP's participation, CP's optimal copyright price:

$$p_c^* = \frac{4\alpha^2\sigma c_c + 2\alpha\sigma d_B - \alpha c_c\beta^2 - 2\alpha^2\sigma\mu c_c - \beta^2 d_B}{2\alpha(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)} \tag{5.39}$$

Channel system's revenue is:

$$\Pi = \Pi_c + \Pi_s + \Pi_o \tag{5.40}$$

Through the above calculation, following equilibrium table can be drawn:

Table 10 Equilibrium results in"Low Copyright Price + Revenue sharing" without SP Mode

p_c^*	$\frac{4\alpha^2\sigma c_c + 2\alpha\sigma d_B + 2\alpha\sigma d_B - \alpha c_c\beta^2 - 2\alpha^2\sigma\mu c_c - \beta^2 d_B}{2\alpha(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)}$
p_s^*	$\frac{2\alpha^2\sigma c_c + 2\alpha\sigma\delta d_B + 4d_B\alpha\sigma - \alpha c_c\beta^2 - 2\alpha\sigma\mu d_B - \beta^2 d_B}{2\alpha(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)}$
p_o^*	$\frac{\alpha^2\sigma c_c + 2\alpha\sigma\delta d_B + 5d_B\alpha\sigma - \alpha c_c\beta^2 - 2\alpha\sigma\mu d_B - \beta^2 d_B}{2\alpha(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)}$
d_o^*	$\frac{\alpha\sigma(d_B - \alpha c_c)}{2(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)}$
s_s^*	$\frac{\beta(d_B - \alpha c_c)}{2(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)}$
Π_c^*	$\frac{\sigma(\alpha c_c - d_B)^2}{4(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)}$
Π_s^*	$\frac{\sigma(\alpha c_c - d_B)(-\alpha c_c\beta^2 - 2\mu\sigma c_c\alpha^2 + 4\alpha^2\sigma c_c - 4\alpha\sigma d_B + d_B\beta^2 + 2d_B\alpha\sigma\mu)}{8(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)^2}$
Π_o^*	$\frac{\alpha\delta\sigma^2(\alpha c_c - d_B)^2}{4(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)^2}$
Π^*	$\frac{\sigma(\alpha c_c - d_B)(-3\alpha c_c\beta^2 - 4\mu\sigma c_c\alpha^2 + 10\alpha^2\sigma c_c + 4\alpha^2\sigma c_c\delta + 4\alpha\sigma\mu d_B + 3d_B\beta^2 - 10\alpha\sigma d_B - 4d_B\alpha\sigma\delta)}{8(3\alpha\sigma + \alpha\sigma\delta - \alpha\mu\sigma - \beta^2)^2}$

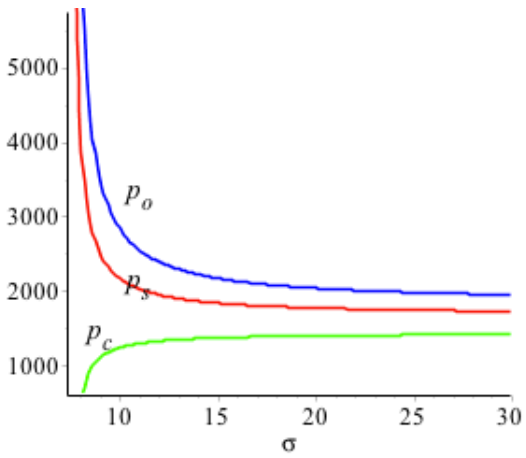

Figure 32 Influence of σ on CP's, SP's and OP's pricing in"Low Copyright Price + Revenue sharing" with SP Mode

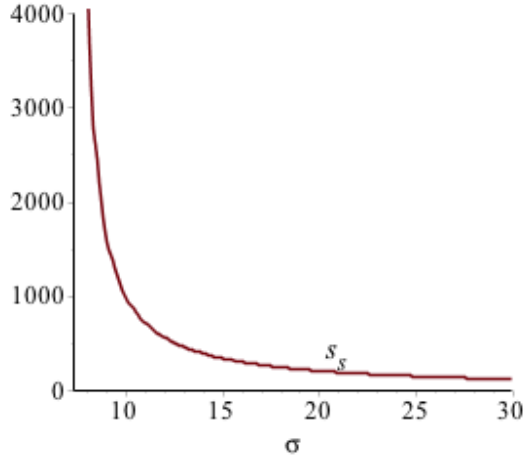

Figure 33 Influence of σ on SP's service level in"Low Copyright Price + Revenue sharing" with SP Mode

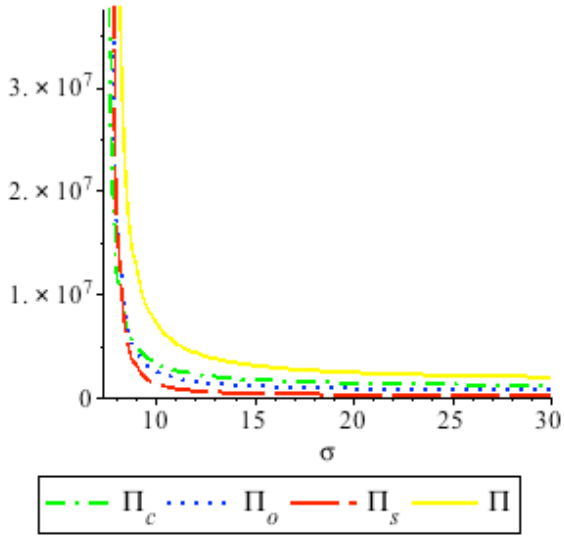

Figure 34 Influence of σ on participants' and channel system's revenues in"Low Copyright Price + Revenue sharing" with SP Mode

To explore SP's service cost coefficient σ's influence on the results of game equilibrium, set $d_B = 20000, c_c = 1000, \alpha = 10, \beta = 15, \delta = 0.3, \mu = 0.3$ for numerical analysis. In "Low Copyright Price + Revenue sharing" with SP Mode, if σ grows, SP's and OP's music service pricing, service level, participants' revenue and channel system's revenue

will all decrease at a slowing down speed, whereas CP's copyright pricing will increase and gradually level off. Consistent with the High Copyright Price with SP Mode, when σ gets a small value, p_c is far less than p_o and p_s, and OP take most of all the revenue in the channel. OP's revenue drops rapidly, becoming the least revenue gainer in the channel with σ's growth, whereas CP get most revenue. The quantitative outcomes are in conformity with China digital music market situation—— CP and OP dominate the channel and SP is losing its channel power.

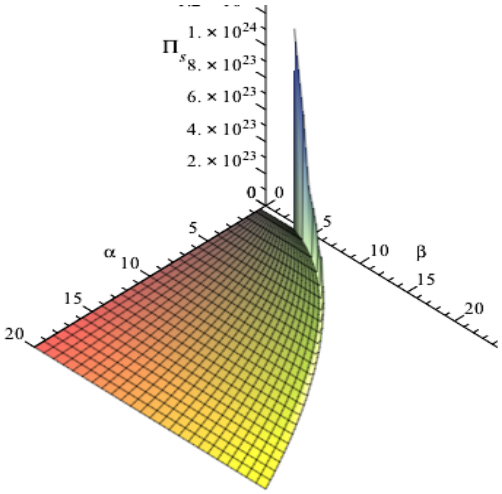

Figure 35 Influence of α, β on OP's revenue in "Low Copyright Price + Revenue sharing" with SP Mode

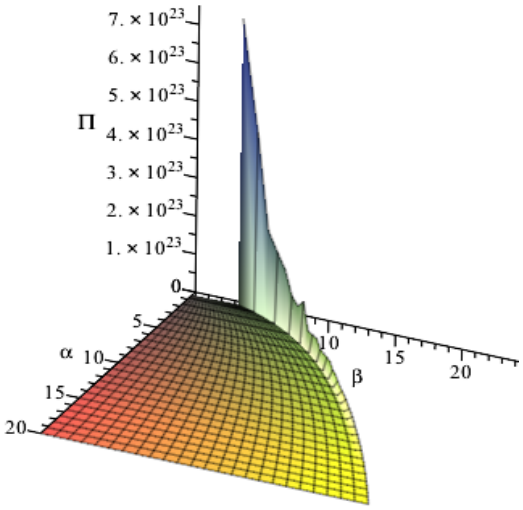

Figure 36 Influence of α, β on channel system's revenue in "Low Copyright Price + Revenue sharing" with SP Mode

To explore user price effect parameter α and service effect parameter β's influence on the participants' revenues, set $d_B = 20000$, $c_c = 1000$, $\sigma = 10$, $\delta = 0.3$, $\mu = 0.3$ for numerical analysis. It can be seen that CP will account for the nearly all the revenue in the channel. Participants' revenues increase with the growth of user service effect parameter β, whereas user price effect parameter α's increase will lead to a decrease in all the participants' revenues.

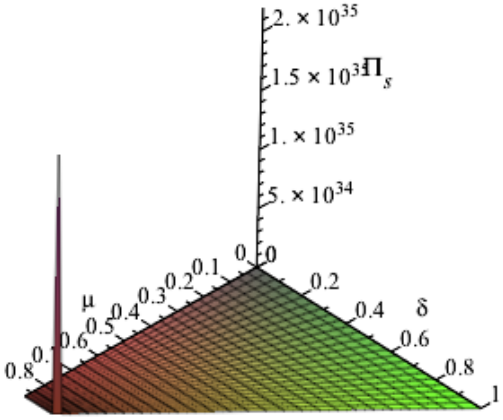

Figure 37 Influence of δ , μ on SP's revenue in "Low Copyright Price + Revenue sharing" with SP Mode

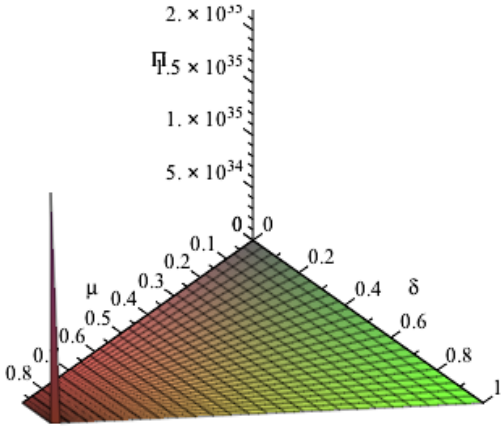

Figure 38 Influence of δ , μ on channel system's revenue in "Low Copyright Price + Revenue sharing" with SP Mode

To explore revenue sharing ratio's influence on the results of game equilibrium, set $d_B = 20000, c_c = 1000, \alpha = 10, \beta = 15, \sigma = 10$ for numerical analysis. From Figure 37 and Figure 38, SP's revenue ratio accounts for the largest part, followed by OP's revenue ratio. If CP doesn't participate into revenue sharing, which mean $\delta + \mu = 1$, all the participants in the channels will maximum their revenue.

Conclusion4: In a competitive "Low Copyright Price + Revenue sharing" with SP Mode,

- If SP's digital music service cost coefficient σ increases, its pricing, service level s_s, OP's pricing, user demand and all the participants' revenue will decrease, expect CP. OP's revenue drops rapidly, becoming the least revenue gainer in the channel with σ's growth, whereas CP gets most revenue.

- If users are sensitive to digital music service level but not sensitive to digital music service price, participants' and channel system's revenues will all grow.

- If SP's revenue ratio μ accounts for the largest part, and CP don't participate into revenue sharing, which means $\delta + \mu = 1$, all the participants in the channels will

maximum their revenue.

5.3.3 Comparative Analysis of High Copyright Price with SP Mode and "Low Copyright Price + Revenue sharing" with SP Mode

To help stakeholders in the digital music channels to gain a clear perspective about which mode to choose in the competitive situation, the similarities and differences are drawn to after comparative analysis in table 11.

Table 11 Comparative analysis of High Copyright Price with SP Mode and "Low Copyright Price + Revenue sharing" with SP Mode

	High Copyright Price with SP Mode	**"Low Copyright Price + Revenue sharing" with SP Mode**
Differences	σ doesn't affect CP's pricing p_c.	CP's pricing p_c increases with σ 's growth
	CP get twice the revenue of OP	If σ grows, CP's revenue ratio in the channel system's revenue drops.
	β doesn't affect CP's pricing p_c.	β affects CP's pricing p_c.
		If μ gets a big value and CP don't participate into revenue sharing, which means $\delta + \mu = 1$, all the participants in the channels will maximum their revenue.
Similarities	If SP's digital music service cost coefficient σ increases, its pricing, service level, and OP's pricing, user demand and all the participants'	

	revenue will decrease.
	If users are sensitive to digital music service level but not sensitive to digital music service price, participants' and channel system's revenues will all grow.

5.4 Comparative Analysis of Four Competitive Digital Music Channel Mode

It can be seen from the comparison of the four competitive channel modes that, if SP don't join digital music channel, users can get higher service level in High Copyright Price mode than that in "Low Copyright Price + Revenue sharing" mode. On the contrary, if SP join digital music channel, service level is higher in "Low Copyright Price + Revenue sharing" mode than in High Copyright Price mode. Whether SP participates, all the participants' revenue and channel system's revenue is bigger in High Copyright Price mode than "Low Copyright Price + Revenue sharing" mode, which means it's more profitable without participants' revenue sharing.

If SP's service level and OP's are not much different, which means OP's service cost coefficient η and SP's service cost coefficient σ are not much different, all the participants' revenue and channel system's revenue in the mode with SP are smaller than those without SP. If σ is far less than η, all the participants' revenue and channel system's revenue in the mode with SP are bigger than those without SP. Therefore, if η and σ are not much different, OP and CP adopting High Copyright Price mode without SP is the optimal strategy, otherwise if σ is far less than η, CP, SP and OP adopting High Copyright Price mode is the optimal strategy in the competitive channel. No matter whether SP participate into the channel, OP's optimal pricing stays stable in High Copyright Price mode.

In sum, in the competitive digital music channel, if OP's service cost coefficient η is around SP's service cost coefficient σ, OP buying music copyright from CP and producing digital music content can shorten channel length, which means less channel competition but lower service level than that in the mode with SP. Otherwise if σ is far less than η, SP should participate into the channel and produce digital music content with higher service level.

6 DIGITAL MUSIC CHANNEL COOPERATIVE EQUILIBRIUM AND COORDINATION MECHANISM CONSTRUCTION

As in competitive situations, channel participants CP, SP and OP compete with each other, resulting in channel revenue loss. To design a reasonable channel coordination mechanism, game equilibrium is explored in cooperative digital music channel. There are two cooperative modes— with SP's participation and without SP's participation.

Considering digital music service production cost and service level, cooperative models are constructed to explore OP's pricing, service level and channel system's revenue. By comparing channel system revenue in cooperative modes and that in competitive modes, channel system's revenue increase significantly in cooperation situation. Then a revenue sharing mechanism based on participants' bargaining power is constructed in both of these two cooperative modes to achieve channel coordination in which channel participants' revenue achieve optimization.

6.1 Equilibrium of Cooperative Digital Music Channel Mode

In cooperative situation, CP, SP and OP make joint decisions to achieve optimal channel system revenue. To find out the revenue loss in competitive digital music channel, equilibrium results in cooperative channel modes are explored. By comparing the competitive modes and cooperative modes, a reasonable channel coordination mechanism is in necessary to make all the participants achieve optimal revenue.

6.1.1 Equilibrium in Cooperative Digital Music Channel without SP

In both High Price without SP Mode and "Low Price+Shared Revenue" without SP Mode, CP and OP cooperate with each other to achieve optimal channel system revenue. Parameter settings in this chapter are consistent with those in last chapter. In cooperative situation without SP, channel system revenue is the sum of CP's and OP's revenue. Let

c_c denote CP's music copyright unit cost. Let p_o denote the digital music service pricing set by both CP and OP selling to users. d_o is set to be digital music service demand and c_o is OP's cost by providing digital music service. So channel system revenue is:

$$\prod = \Pi_o + \prod_c = (p_o - c_c) * d_o - c_o \tag{6.1}$$

Consistent with last chapter, digital music service demand function is defined as a function of a linear relationship with price and service level. Let d_B denote the basic user demand of digital music. Let α and β denote the effect parameter of price and service. So user demand is defined as below:

$$d_o = d_B + \beta * s_o - \alpha * p_o \tag{6.2}$$

OP's service cost and service level are in line with the following function:

$$c_o = \eta \frac{{s_o}^2}{2} \tag{6.3}$$

Wherein η is a known constant that is shared by all the participants in the channel. OP and CP cooperate together to choose proper digital music service pricing p_o and service level s_o for users. Their goal is to maximize channel system revenue, namely:

$$\max \Pi(p_o, s_o) \tag{6.4}$$

Above formula is taken derivative with respect to p_o and s_o to obtain two simultaneous equations, which can be solved to achieve their optimal price and service level:

$${p_o}^* = \frac{\eta d_B + \alpha\eta c_c - c_c\beta^2}{2\alpha\eta - \beta^2}, \quad {s_o}^* = \frac{d_B\beta - \alpha\beta c_c}{2\alpha\eta - \beta^2}$$

Through the above calculation, the following equilibrium table can be drawn:

Table 12 Equilibrium results in cooperative digital music channel without SP

p_o^*	$\frac{\eta d_B + \alpha\eta c_c - c_c\beta^2}{2\alpha\eta - \beta^2}$
d_o^*	$\frac{\alpha\eta(d_B - \alpha c_c)}{2\alpha\eta - \beta^2}$
s_o^*	$\frac{d_B\beta - \alpha\beta c_c}{2\alpha\eta - \beta^2}$
Π^*	$\frac{\eta(d_B - \alpha c_c)^2}{2(2\alpha\eta - \beta^2)}$

As in competitive digital music channel, revenue in high price mode is bigger than that in "Low Price+Shared Revenue" mode, here channel system revenue comparison is made between cooperative channel without SP mode and high price mode without SP. Let C denote cooperative channel and let N denote competitive channel. Therefore, in competitive situation, channel system revenue loss is:

$$\Delta\Pi = \Pi^{C*} - \Pi^{N*} = \frac{\eta(d_B - \alpha c_c)^2}{8(2\alpha\eta - \beta^2)}$$

6.1.2 Equilibrium in Cooperative Digital Music Channel with SP

In the situation that SP participates into digital music channel, let c_s denote OP's music copyright unit cost. Channel system revenue is the sum of CP's, SP's and OP's revenue:

$$\prod = \Pi_o + \prod_c + \Pi_s = (p_o - c_c) * d_o - c_s \tag{6.5}$$

Similarly, digital music service demand function is defined as a function of a linear relationship with price and service level. Let d_B denote the basic user demand of digital music. Let α and β denote the effect parameter of price and service. So user demand is defined as below:

$$d_o = d_B + \beta * s_o - \alpha * p_o \tag{6.6}$$

SP's service cost and service level are in line with the following function:

$$c_s = \sigma \frac{s_s^{\ 2}}{2} \tag{6.7}$$

Wherein σ is a known constant that is shared by all the participants in the channel. SP, OP and CP cooperate together to choose proper digital music service pricing p_o and service level s_s for users. Their goal is to maximize channel system revenue, namely:

$$\max \Pi(p_o, s_o) \tag{6.8}$$

Above formula is taken derivative with respect to p_o and s_o to obtain two simultaneous equations, which can be solved to achieve their optimal price and service level:

$$p_o^{\ *} = \frac{\sigma d_B + \alpha\sigma c_c - c_c\beta^2}{2\alpha\sigma - \beta^2}, \quad s_s^{\ *} = \frac{d_B\beta - \alpha\beta c_c}{2\alpha\sigma - \beta^2}$$

Through the above calculation, the following equilibrium table can be drawn:

Table 13 Equilibrium results in cooperative digital music channel with SP

$p_o^{\ *}$	$\frac{\sigma d_B + \alpha\sigma c_c - c_c\beta^2}{2\alpha\sigma - \beta^2}$
$d_o^{\ *}$	$\frac{\alpha\sigma(d_B - \alpha c_c)}{2\alpha\sigma - \beta^2}$
$s_o^{\ *}$	$\frac{d_B\beta - \alpha\beta c_c}{2\alpha\sigma - \beta^2}$
Π^*	$\frac{\sigma(d_B - \alpha c_c)^2}{2(2\alpha\sigma - \beta^2)}$

With SP's participating, here channel system revenue comparison is made between cooperative channel with SP mode and high price mode with SP. In competitive situation,

channel system revenue loss is:

$$\Delta\Pi = \Pi^{C*} - \Pi^{N*} = \frac{\sigma(d_B - \alpha c_c)^2}{8(2\alpha\sigma - \beta^2)}$$

Comparing he equilibrium results in cooperative digital music channel without SP and those in cooperative digital music channel with SP, if OP's service cost parameter is the same as SP's, which means $\eta = \sigma$, channel system revenue, digital music service level, digital music service pricing and demand are similar. However, in fact SP gets a more professional digital music service capability and OP gets a higher digital music service cost parameter, which means $\eta > \sigma$. Therefore, with SP's participating, users are able to acquire higher service level and channel system revenue is higher compared with the situation without SP's participating.

6.2 Construction of Digital Music Channel Coordination Mechanism

Channel system gets bigger revenue in cooperative situation than that in competitive situation. However, because of asymmetric information, CP, SP and OP compete with each other to maximum their own revenue. Coordination mechanism can motivate CP, OP and SP to adopt cooperative strategies and achieve optimal channel revenue. In this section, digital music channel coordination mechanism is constructed basing on participant's bargaining power to enable participants to formulate revenue sharing contracts to achieve channel coordination.

From last chapter, in competitive situation, channel revenue in high price mode is bigger than that in "Low Price+Shared Revenue" mode. Therefore, in this section competitive high price mode is set as benchmark to consider the channel system revenue loss between competitive situation and cooperative situation. Let C denote cooperative channel and let

N denote competitive channel.

6.2.1 Construction of Digital Music Channel Coordination Mechanism without SP

In cooperative digital music channel without SP, CP and OP formula revenue sharing contract to share channel system revenue according to a ratio. As CP and OP have different channel control power, CP's and OP's bargaining power is set to measure their control power, which finally determines their revenue sharing ratio in the channel.

In revenue sharing mechanism, Π^C is cooperative channel system revenue. Let κ denote OP and CP's revenue sharing ratio. $\Pi_c{}^C$ and $\Pi_o{}^C$ are CP's and OP's sharing revenue in the framework of revenue sharing mechanism. OP's and CP's revenue are as follows:

$$\Pi_o{}^C = \kappa\Pi^C \tag{6.9}$$

$$\Pi_c{}^C = (1-\kappa)\Pi^C \tag{6.10}$$

To motivate CP and OP, CP's and OP's revenue should get bigger in revenue sharing than that without revenue sharing:

$$\Pi_o{}^C > \Pi_o{}^N, \Pi_c{}^C > \Pi_c{}^N$$

The sum of CP's and OP's bargaining power is assumed to quantify as 1. Let ε ($0 < \varepsilon < 1$) denote OP's bargaining power and let $(1-\varepsilon)$ denote CP's bargaining power.

A Nash bargaining model is constructed as follows:

$$\max u_1 u_2 = (\Pi_o^C - \Pi_o^N)^{\varepsilon} (\Pi_c^C - \Pi_c^N)^{(1-\varepsilon)} \tag{6.11}$$

Above formula is taken derivative with respect to κ to achieve OP and CP's optimal revenue sharing ration:

$$\kappa = \frac{\varepsilon(\Pi^C - \Pi^N) + \Pi_o^N}{\Pi^C}$$

Channel system revenue both in coordinate and non-coordinate situations is substituted into above formula:

$$\kappa = \frac{1}{4} + \frac{\varepsilon}{4}$$

The ratio shows that, CP and OP's revenue sharing ratio only has relation with CP's and OP's bargaining power. OP can get a bigger revenue sharing ratio with bigger bargaining power.

To conclude, in the digital music channel without SP's participation, if OP and CP formula revenue sharing contract according to a ratio of $\kappa = \frac{1}{4} + \frac{\varepsilon}{4}$, both CP and OP will get optimal revenue.

6.2.1 Construction of Digital Music Channel Coordination Mechanism with SP

If SP participate into cooperative digital music channel, CP, SP and OP formula revenue sharing contract to share channel system revenue according to a ratio. Similarly, as CP, SP and OP have different channel control power, their bargaining power are set to measure their control power, which finally determines their revenue sharing ratio in the channel.

In tripartite revenue sharing mechanism, let κ and υ denote the revenue sharing ratio between OP, SP and CP. OP's, SP's and CP's revenue are as follows:

$$\Pi_o^C = \kappa\Pi^C \tag{6.12}$$

$$\Pi_s^C = \upsilon\Pi^C \tag{6.13}$$

$$\Pi_c^{\ C} = (1-\kappa-\upsilon)\Pi^{\ C} \tag{6.14}$$

To motivate all the participants, CP's, SP's and OP's revenue should get bigger in revenue sharing than that without revenue sharing:

$$\Pi_o^{\ C} > \Pi_o^{\ N},\ \Pi_s^{\ C} > \Pi_s^{\ N},\ \Pi_c^{\ C} > \Pi_c^{\ N}$$

The sum of CP's, SP's and OP's bargaining power is assumed to quantify as 1. Let ε ($0 < \varepsilon < 1$) denote OP's bargaining power and let θ denote SP's bargaining power. So CP's bargaining power is $(1-\varepsilon-\theta)$. A Nash bargaining model is constructed as follows:

$$\max u_1 u_2 u_3 = (\Pi_o^C - \Pi_o^N)^{\varepsilon} (\Pi_s^C - \Pi_s^N)^{\theta} (\Pi_c^C - \Pi_c^N)^{(1-\varepsilon-\theta)} \tag{6.15}$$

Above formula is taken derivative with respect to κ and υ respectively to achieve OP, SP's and CP's optimal revenue sharing ration:

$$\kappa = \frac{\varepsilon(\Pi^C - \Pi^N)}{(2-2\theta-\varepsilon)\Pi^C} + \frac{\Pi_o^N}{\Pi^C}$$

$$\nu = \frac{(1-\varepsilon)(\Pi^C - \Pi_c^{\ N}) + (1-\theta)(\Pi_s^N - \Pi_c^N - \Pi_o^N) - \theta\Pi^C}{\Pi^C(2-2\theta-\varepsilon)}$$

Then channel system revenue both in coordinate and non-coordinate situations are substituted into above formula.

To conclude, in the digital music channel with SP's participation, if OP, SP and CP formula revenue sharing contract according to a ratio of κ and υ, they will all get optimal revenue, wherein:

$$\kappa = \frac{\varepsilon\beta^4 - 10\varepsilon\beta^2\alpha\sigma + 32\varepsilon\alpha^2\sigma^2 + 4\theta\alpha\sigma\beta^2 - 8\theta\alpha^2\sigma^2 - 4\beta^2\alpha\sigma + 8\alpha^2\sigma^2}{4(2-\varepsilon-2\theta)(4\alpha\sigma-\beta^2)^2}$$

$$\upsilon = \frac{-2\varepsilon\beta^4 + 18\varepsilon\beta^2\alpha\sigma - 44\varepsilon\alpha^2\sigma^2 + 24\theta\alpha\sigma\beta^2 - 52\theta\alpha^2\sigma^2 - 24\beta^2\alpha\sigma + 52\alpha^2\sigma^2 + 3\beta^4 - 3\beta^4\theta}{4(2-\varepsilon-2\theta)(4\alpha\sigma-\beta^2)^2}$$

7 CONCLUSION AND FURTHER RESEARCH

7.1 Conclusion

This study sets out two questions. The first one is how the participants compete in four different competitive channel modes, in which revenue and service level are influenced. To answer this question, four competitive channel game models are constructed to seek the equilibrium in competitive situations after qualitatively analyzing participants, service modes and channel modes in digital music market. The conclusions are drawn that whether SP participates or not, all the participants' revenue and channel system's revenue is bigger in High Copyright Price mode than "Low Copyright Price + Revenue sharing" mode, which means it's more profitable without participants' revenue sharing in competitive mode. But the service level varies a lot in different modes. If SP don't join digital music channel, users can get higher service level in High Copyright Price mode than that in "Low Copyright Price + Revenue sharing" mode. On the contrary, if SP join digital music channel, service level is higher in "Low Copyright Price + Revenue sharing" mode than in High Copyright Price mode.

The second question is how participants can optimize revenue in coordination rather than competition. To study channel coordination mechanism, equilibrium in two cooperative channel models are explored and revenue sharing mechanism is constructed basing on participants' bargainning power. In the digital music channel without SP's participation, if OP and CP formula revenue sharing contract according to a ratio of $\kappa = \frac{1}{4} + \frac{\varepsilon}{4}$, both CP and OP will get optimal revenue. In the digital music channel with SP's participation, if OP, SP and CP formula revenue sharing contract according to a ratio of κ and υ, they will all get optimal revenue, wherein:

$$\kappa = \frac{\varepsilon\beta^4 - 10\varepsilon\beta^2\alpha\sigma + 32\varepsilon\alpha^2\sigma^2 + 4\theta\alpha\sigma\beta^2 - 8\theta\alpha^2\sigma^2 - 4\beta^2\alpha\sigma + 8\alpha^2\sigma^2}{4(2-\varepsilon-2\theta)(4\alpha\sigma-\beta^2)^2}$$

$$\upsilon = \frac{-2\varepsilon\beta^4 + 18\varepsilon\beta^2\alpha\sigma - 44\varepsilon\alpha^2\sigma^2 + 24\theta\alpha\sigma\beta^2 - 52\theta\alpha^2\sigma^2 - 24\beta^2\alpha\sigma + 52\alpha^2\sigma^2 + 3\beta^4 - 3\beta^4\theta}{4(2-\varepsilon-2\theta)(4\alpha\sigma-\beta^2)^2}$$

7.2 Limitations and future research

With the fast progressing of digital music business model innovation, new cooperative mode is continously in developing. There are still some limitations of this study, which need further research.

(1)The uncertainty of user demand function

In this paper, the demand function, which is linear to digital music service price and service level, is constructed basing on the demand characteristics of physical goods. The influence of uncertain demand on channel equilibrium is worthy studying.

(2)More channel coordination mechanisim basing on different business models

Revenue sharing mechanism is constructed basing on participants' bargaining power in this paper. While with the business model innovation of participants, the channel control power among different participants is changing. Thus more proper channel coordination mechanisim is in necessary to research into to promote the digital music market development.

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