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Research On Pricing Strategy Of Mobile Communication Resale Service In China Based On Bertrand Model

Sun Xi, Kou Xiaoling, Zeng Lu[1]

Department of Business Administration (College of Mobile Telecommunications, Chongqing University of Posts and Telecommunications), Chongqing, 401520, China

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Abstract

Virtual operators play an important role in stabilizing the competition pattern of China's telecommunication market and promoting the development of mobile communication. The virtual operators could only obtain a little higher wholesale resale prices than the retail prices of basic operators due to the follow-up failure of the basic operators' retail prices adjustment, which brings virtual operators higher cost restricting their development seriously. This paper analyzes the pricing game between the basic operators and the virtual operators based on the Bertrand model. The result of collusion is that the price and the profit are all increase for both in comparison with make interests respectively. Basic operators have an incentive to maintain higher wholesale price, therefore government regulators must participate in the game. Based on the analysis results, the effective strategies for the development of mobile communication resale service in our country are put forward.

1 Introduction

The first 11 mobile virtual network operator (hereinafter referred to as virtual operator) licenses were issued in Dec 12th, 2013 following "Mobile Communications Resale Services Pilot Scheme" promulgated by MIIT (Ministry of Industry and Information Technology of the People's Republic China) dated January 8, 2013. A substantial first step has been made with private capital entering the telecoms industry for the first time. Virtual operator lists of the second batch to 5th batch has been released in succession with 42 private enterprises obtaining pilot approval from MIIT while MIIT finished project of examination and approval for pilot application of mobile communication resale by the end of December 18, 2014.

Virtual operators need reasonable price disparities between wholesale price and retail one to make profit at the beginning of operation and basic telecom operators (hereinafter referred to as basic operators) carry out vertical price squeeze strategy out of their own interests, namely they may well increase wholesale price for virtual operators and in the meanwhile maintain or reduce the retail price [2]. Most virtual operators struggle to survive with limited or even negative mark on which is the only resource the virtual operators can make money. Therefore, it is not difficult to imagine almost all virtual operators have been operating at a loss so far.

On January 6, 2016, MIIT issued the "MIIT's Guidance About Wholesale Prices Adjustment of Mobile Communication Resale Services", it made clear the benchmark, the adjustment frequency of wholesale price as well as normalized working mechanism, which aims at supporting and helping virtual operators by adjustment of wholesale price for mobile communication resale services. But it is afraid that the Guidance can't bring the majority of money-losing virtual operators into the black completely although the guidance improves the situation of limited or even negative mark on of virtual operators.

Pricing problems of mobile communication resale in China involves basic operators, virtual operators and government regulations bodies. It must inevitably impede the formation of effective competition in China telecom industry and reduce the efficiency if this problem can't solve suitably. There had been a lot of reforms and changes in the past twenty years, which have been analyzed by many scholars based on game theory. But most of them were based on traditional markets and game of basic operators instead of game research between basic operators and virtual ones [6]. This article will analyze pricing strategy of mobile communication resale in China and discuss the potentially effective strategy and methods for development of mobile communication resale based on game theory.

[1]Author: Sun Xi (1973-), Female, Associate professor at College of Mobile Telecommunications, Chongqing University of Posts and Telecommunications, Dean of the Department of Business Administration, Master, Research direction: Marketing management, Communication management.
Kou Xiaoling (1983-), Female, Lecturer at College of Mobile Telecommunications, Chongqing University of Posts and Telecommunications, Director of Teaching and Research Section, Research direction: Marketing management, Economics.
Zeng Lu (1978-), Female, Associate Professor at College of Mobile Telecommunications, Chongqing University of Posts and Telecommunications, Director of Teaching and Research Section, Research direction: Financial management, Financial market.

2 Current situation and problems of mobile communication resale services in China

2.1 Current situation of mobile communication resale services in China

Mobile communication resale service is the second category of basic telecommunications services. It refers to the service that the resale enterprises of mobile communication purchase the mobile communication service from the basic telecommunication operators owning mobile network operators and repackage them into their own brands and then sell them to the end users. According to the requirements of MIIT, the resale enterprises of mobile communication use mobile communication network infrastructure of basic telecommunication operators such as wireless network, core network, transmission network and so on instead of self-building. The resale enterprises of mobile communication service must self-build the customer service system. They can also build business support system such as integrated service management system, billing system and operating system as well if necessary. The virtual operators in this article refer in particularly to resale enterprises of mobile communication service, namely MVNO (Mobile Virtual Network Operator).

The relevant data of Qianzhan industry research institute showed the number of subscribers from virtual operators in China had reached 20.5 million by the end of 2015. 39 of 42 resale enterprises obtaining licenses for pilot approval have officially begun their own resale service with 7 of them having over a million of users. The number of users of top ten resale enterprises accounts for about 86% of the total number of users from virtual operators [10]. Virtual operators play an important and positive role in stabilizing competitive pattern of communications market in our country and promoting the development of mobile communication.

2.2 Problems and reasons of mobile communication resale services in China

The fixed cost of virtual operators is much lower than basic telecom operators due to unnecessary telecom network construction but they must pay heavy rental cost of telecom network, which leads to much higher variable cost part than basic telecom operators. The average cost of virtual operators is concerned with the number of end users. The virtual operators must acquire end users on a large scale as soon as possible to reach the break-even point in the early stage of operation [7]. Therefore, during this period of time virtual operators worked as competitors must introduce some tariff at a lower price to satisfy the customers' expectations and snatch customers. But the product prices are not as low as expected in the early stage of the operation. Some tariff from three basic telecom operators and several virtual operators with better development in are as below to be compared, especially in 50 to 60-yuan level. (note: "free card" of Snail provide mobile communications services through its own mobile game products, which wouldn't be compared in this article.)

Table Ⅰ: Tariff list of basic telecom operators

Operator	Package	Tariff (CNY)	Quantity of data flow in China	Minutes of calling part in China
China Mobile	4G SIM card for data flow	50	2GB	—
	4G package for data flow	50	1GB	—
	4G Feixiang package	58	500MB	100
China Telecom	4G package for data flow	50	1GB	—
	4G Lexiang package	59	500MB	100
	4G SIM card for data flow	49	3GB (only within the province)	100
	4G Changliao package for data flow	50	1GB (only within the province)	1000
China Unicom	package for data flow	60	1GB	—
	4G National package for data flow	56	500MB	100
	66 package of Chongqing wo	33	300MB+1GB (only within the province)	50
	60 package for wopai	60	2GB (only within the province)	200 (only for calling part within the province)

Table Ⅱ: Tariff list of virtual operators

Operator	Package	Tariff (CNY)	Quantity of data flow in China	Minutes of calling part in China
Ali Telecom	Qinxin number	37	185MB	—
			—	246
		77	425MB	—
			—	556
	Free transfer among voice, SMS and data, 1minute voice = 0.75M resource, 1SMS = 0.5M resource, 1M data = 1M resource, ￥7~37, per ￥1 = 5MB, ￥38~77, per ￥1 = 6MB, ￥78~127, per ￥1 = 7MB, over ￥127 元, per ￥1 = 8MB			
JD Mobile	Legou card	59	500MB	160
	Free journey and ￥5 card have no package. Free journey: ￥10/month, free 60 minutes voice in China, ￥0.15/minute in China, data flow in China ￥0.15/MB, SMS in China ￥0.1/piece. ￥5 card: ￥5/month, ￥0.15/minute in China, data flow in China ￥0.15/MB, SMS in China ￥0.1/piece.			
Suning Mobile	Zhixiang internet version	49	200MB	100
	Zhihe package	58	500MB	100
	Youwuji package	59	2GB	50
	Datangbao package of data flow	44.9	300MB	—
D.Phone	package of data flow	40	500MB	—
	11 levels of package from ￥19 to ￥579. Free combination of resources within package. ￥0.15/minute in China, data flow in China ￥0.0002/KB, SMS in China ￥0.1/piece.			
Telling Mobile	1707/1708/1709 package of data flow for number segments above	20	200MB	—
	package of data flow for number segment of 1705	20	150MB	—
		50	1GB	—
	Telling Mobile has no package. China Unicom version: ￥0.15/minute in China, data flow in China ￥0.20/MB, SMS in China ￥0.1/piece. China mobile version: ￥0.15/minute in China, data flow in China ￥0.29/MB, SMS in China ￥0.1/piece.			

As you can see that tariff of the virtual operators lack price advantage coupled with cheaper prices of local package of some basic telecom operators, which makes it difficult for virtual operators to attract customers. The wholesale prices given by basic telecom operators are still high although data traffic wholesale price dropped from ￥0.14/MB to ￥0.10/MB under the resale mode of resource pool. Therefore, it is not the advisable thing to do for the virtual

operators to obtain subscribers through low price strategy. Exaggerated publicity of cheap prices is bound to affect the long-term development of the virtual operators and even become the main reasons for users' complaints for the virtual operators.

The sales revenue of virtual operators includes the mark on between wholesale and retail prices of mobile business, value-added income of data flow application and datamation mark on of voice services, synergies with primary services. It's the first thing to have enough retail price difference if virtual operators want to make profit at the beginning of operation. Whereas the basic telecom operators would carry out the strategy of vertical price squeeze for their own interests due to the characteristics of the vertical integration of telecommunication, namely basic telecom operators who control the upstream of the mobile communication network (wholesale part) compete with virtual operators of in the downstream market (retail part) who rent the mobile network from basic operators in mobile voice, SMS, mobile data services [2]. The basic operators may increase wholesale price for virtual operators to squeeze the profits of competitors while keeping or reducing their own retail price in the market, which leads to the perplexing problem of limited or even negative mark on of virtual operators.

The three biggest operators have decreased the data low fee dramatically which leads to a huge change in retail price level due to the requirement of our country's " speed acceleration and lower fee" and deteriorated competition in 4G industry of basic telecom operators. The basic operators haven't changed the resale price accordingly although "MIIT's Guidance about wholesale prices adjustment of mobile communication resale services" already placed clear the benchmarking and adjustment frequency of wholesale price which leads to the slower adjustment speed of virtual operators than the descend speed of basic telecom operators.

The virtual operators operating costs will be higher with uneconomical business cost and the cost for billing system construction, maintenance and service if they can't find effective business mode of cross-subsidization which makes virtual operators lose profitability and severely restrict the development of the virtual operators and even worse [7].

3 Game analysis based on Bertrand Model

The market structure of oligopoly competition has changed from the competition among the three basic telecom operators to more complex competition after virtual operators entered the market. There are the competition between basic operators as a whole and virtual operators as a whole in addition to the competition among basic operators, the competition between basic operators and virtual operators as well as the competition between basic operators and virtual operators [4].

We would consider a state of competition that takes the three basic telecom operators as a whole and also all virtual operators as a whole to simplify the analysis. The pricing game between virtual operators and basic operators would be the research target based on Bertrand Model.

The assumption of Bertrand Model is: (1) the oligopoly firms compete with each other by selecting price; (2) the oligopoly firms have homogeneous products; (3) there is no formal or informal collusion behavior among oligopoly firms [3]. The competition situation of virtual operators and basic telecom operators basically conform to Bertrand model.

Products are difference in the price game to some extent, which means the difference of brand, quality, packaging, etc. for similar kinds of products from two monopolistic enterprises products. Virtual operators provide the same mobile communication products and services as basic operators do but there are differences in brand and quality that makes discrepancies between them. So there is high vicarism but not complete between the products of the virtual operator and basic operators. That is to say, the product of higher prices may still survive even if similar products with different prices.

Suppose that the price of basic operators is P_1 while the price of virtual operators is P_2, and their respective demand function is as below.

$$q_1 = q_1(P_1, P_2) = a_1 - b_1 P_1 + d_1 P_2$$
$$q_2 = q_2(P_1, P_2) = a_2 - b_2 P_2 + d_2 P_1$$

$a_1, a_2, b_1, b_2, d_1, d_2 > 0$, a_1 and a_2 show the consumers' actual and potential demands; b_1 and b_2 show level sensitivity of consumers towards prices; d_1 and d_2 show substitution coefficient of alternative products from two operators [8]. To simplify the question, we suppose that there are fixed cost for both basic operators and virtual operators (telecom operators in China seldom consider the fixed cost when decrease price.). We also suppose that the marginal cost for per increased unit output are C_1 and C_2 respectively [9]. Finally, suppose that basic operators and virtual operators make the decisions at the same time, namely only considering static game problem.

The two game players are basic operators and virtual operators in this game. Their respective strategy space is: $S_1 = [0, P_{1max}]$ and $S_2 = [0, P_{2max}]$. P_{1max} and P_{2max} are the highest price which can be sold on respectively by basic operators and virtual operators (i.e., the highest prices regulated by the government). The earnings for both players of the game income are their respective profits, denoted with u_1 and u_2 that are both price functions [9], namely:

$$u_1 = u_1(P_1, P_2) = P_1 q_1 - C_1 q_1 = (P_1 - C_1)(a_1 - b_1 P_1 + d_1 P_2)$$

$u_2 = u_2(P_1, P_2) = P_2 q_2 - C_2 q_2 = (P_2 - C_2)(a_2 - b_2 P_2 + d_2 P_1)$

Because both players realize they reduce the price but the other player keep the price, which can raise their own market share and gain additional benefit; whereas it would lower market share and lead to money loss for them. Therefore, both players would try to choose price drop strategy, it is easy to reach the Nash equilibrium [9]. The Nash equilibrium (P_1^*, P_2^*) is to solve the maximum of P_1^* and P_2^*. We can get the reaction function of virtual operators and basic operators as follows because there is the maximum value when the value of partial derivative for revenue function is 0.

$$P_1 = R_1(P_2) = \frac{1}{2b_1}(a_1 + b_1 C_1 + d_1 P_2)$$

$$P_2 = R_2(P_1) = \frac{1}{2b_2}(a_2 + b_2 C_2 + d_2 P_1)$$

The Nash equilibrium (P_1^*, P_2^*) must be the intersection of response function, namely:

$$\begin{cases} P_1^* = \dfrac{1}{2b_1}(a_1 + b_1 C_1 + d_1 P_2^*) \\ P_2^* = \dfrac{1}{2b_2}(a_2 + b_2 C_2 + d_2 P_1^*) \end{cases}$$

The solutions of equations are as follows:

$$P_1^* = \frac{d_1}{4b_1b_2 - d_1d_2}(a_2 + b_2 C_2) + \frac{2b_2}{4b_1b_2 - d_1d_2}(a_1 + b_1 C_1)$$

$$P_2^* = \frac{d_2}{4b_1b_2 - d_1d_2}(a_1 + b_1 C_1) + \frac{2b_1}{4b_1b_2 - d_1d_2}(a_2 + b_2 C_2)$$

(P_1^*, P_2^*) is the only Nash equilibrium for the game. We substitute P_1^* and P_2^* into revenue function and obtain the equilibrium income for basic operators and virtual operators.

Basic operators are market first-movers with strong strength while virtual operators are market late comers with weak strength. Consumers have different requirements towards their products, so $a_1 > a_2$. Basic operators and virtual operators adopt similar technology and they are just different in brand and product quality so that $b_1 = b_2$ and $d_1 = d_2$. The marginal cost of basic operators is very low (even zero) without considering fixed cost. But the marginal cost of virtual operators is very high without marginal benefit, namely $C_1 < C_2$. We can get P_1^*、P_2^* and u_1^*、u_2^* by substituting assumed figures.

Suppose that neither basic operators nor virtual operators cares about each other's interests, they just try to make benefit for themselves even if they wouldn't neglect the competitors' existence. It would make difference if consider the best result based on whole profit. We suppose the price that can make the maximum whole profit as P ($P = P_1 = P_2$), then whole profit is $U = PQ - CQ = (P - C)(q_1 + q_2) = (P - C)(a_1 - b_1 P_1 + d_1 P_2 + a_2 - b_2 P_2 + d_2 P_1)$. If we make the derivative of U equal to 0, then we can get the highest price P^* for the maximum whole profit and u_1^*、u_2^*.

Suppose $a_1 = 11$, $a_2 = 8$, $b_1 = b_2 = 1$, $d_1 = d_2 = 0.5$, we would get different results with different assumed C_1 and C_2. The calculated results are shown in table below.

Table III Equilibrium prices and profits under independent decision scenario and conspiracy scenario

	independent decision				conspiracy		
	P_1^*	P_2^*	u_1^*	u_2^*	P^*	u_1^*	u_2^*
$C_1=1$, $C_2=2$	7.7	6.9	45.23	24.26	10.25	54.34	23.72
$C_1=1$, $C_2=3$	7.9	7.5	47.27	20.03	10.5	54.63	20.63
$C_1=1$, $C_2=4$	8	8	49	16	10.75	54.84	17.72
$C_1=0$, $C_2=1$	7.1	5.7	47.93	27.50	9.75	59.72	27.34
$C_1=0$, $C_2=2$	7.2	6.8	51.84	23.04	10	60	24
$C_1=0$, $C_2=3$	7.3	7.3	53.66	18.71	10.25	60.22	20.84

For basic operators, conspiracy can raise prices and increase profits in any way from the above data. For virtual operators, conspiracy can raise prices and increase profits only when the cost difference between the basic operators and virtual operators is significant.

It is the reality that there is the gigantic cost gap between virtual operators at the early stage of operation and basic operators having run the business for many years. Therefore, the basic operators and virtual operators can make higher profits respectively if they can cooperate and jointly decide the price than they do business under independent decisions scenario.

Such cooperation is certainly not easy because pricing combination to achieve maximum profit is not a Nash equilibrium and both players realize the result that they would make higher profits if they decrease price while the other player keep the price and vice versa. Therefore, both players would choose to lower the price till it reachs a new Nash equilibrium. The Bertrand Model may well explain the price war of mobile communication market in China.

From the above data can be seen that the higher cost difference between the basic operators and virtual operators, the closer the prices, the greater the difference in profits. Therefore, the basic operators have motivation to maintain high wholesale prices which makes higher cost for virtual operators.

It's indispensable bringing regulator in game and increasing restraint and punishment for operators to curb the price war between basic operators and virtual operators, and competitive limitation behavior of basic operators, which can change the revenue function. For example, if $u_1 = u_1(P_1, P_2) - k \cdot f(P_1)$, k is the penalty factor which can show the intensity of punishment by regulator towards violation. Therefore, the government should establish corresponding laws and regulations, increase the intensity of punishment for the vicious violations of price competition and setting up competitive barriers to achieve cooperation to some extent in order to lead to benign development of coopetition.

4 The dvelopmental strategy of mobile communication resale service in China

4.1 Regulators and operators cooperate concertedly to curb the virulent price competition

Firstly, both the basic telecom operators and virtual operators should realize the dangers of vicious price competition and establish the rational management methodology. Under the market condition, the price competition has the obvious interaction, namely one part lower the prices and the other would also lower the prices to maintain the market share and a new cycle of depreciation would last accordingly that would ultimately lead to vicious competition of price-cutting spiral and loss at both sides as well as declined economic benefit continuously [9]. While price competition is the appearances of the competition, the fundamental competitiveness of enterprises should be the product competition. The operators can satisfy consumers' demand by focusing on products through business innovation and constant introduction of new services in the meanwhile by strengthening the enterprises' ability through management innovation, cost-down, and efficiency improvement [1].

Secondly, the corresponding laws and regulations should be established to improve the efficiency of regulation. The price is the most concerned factor for consumers due to the developmental level of productivity. So, the existing operators with strong strength also tend to push aside new entrants by lowering prices (even below cost). According to the analysis above, the more powerful regulatory penalties, the higher cost the enterprises have in violation of lowing the price and the smaller space for price-cut. Therefore, it's necessary to establish corresponding laws and regulations, reinforce the penalty intensity for the malignant price competition of vicious price-cut and vertical price squeeze in order to avoid chaotic price competition [9].

4.2 Basic operators should keep open-minded to promote the mobile communication resale service

Wholesale and retail price difference is the guarantee of the virtual operators' development. The long-term mechanism to solve the problem has not been established although the three basic operators cut the wholesale price through different ways to alleviate the dispute of negative mark on to some extent. The three basic operators should undertake more social responsibility, keep open-minded and think about the issue in a long-run as central state-owned companies. In the long run, basic operators should cooperate with virtual operators actively to establish a benign business environment both for their own interests and social interests. Finally basic operators and virtual operators should adjust from being driven by policy to promoting the development of mobile communication service spontaneously and voluntarily to promote the development of mobile communication resale service in order to realize the multi-win for basic operators, virtual operators and consumers.

4.3 Virtual operators should break away from low-price competition by innovation and being aggressive

Most virtual operators would adopt low price strategy inevitably in the early stage of development to attract users according to the analysis above. For now, it depends on wholesale prices provided by the basic operators whether the virtual operators can make profits to a large extent. The virtual operators may hardly make profits and would get into the infinite loop of vicious competition if they only rely on differences between wholesale and retail prices [11]. So, in the era of mobile Internet, virtual operators don't hope to profit directly from the mobile communication services but should focus on the deep management of the data flow, jump out of the thinking mode of low price competition with innovation and being enterprising. They can change traditional tariff mode of the basic operators and attract users with reasonable tariff policy and rich business portfolio. For example, they can provide more refined fee packages through the more thorough segmenting of market based on consumers' features [5]. They can also expand the scale and increase the value of data flow by innovative billing mode. And they can make various packages for different types of mobile terminals as traffic consumption ability and differences between the users of different types of mobile terminals [7]. They can also integrate a large

number of services types and grades to provide a richer business mix. And they can develop comprehensive service of voice, video, or data flow with lower price than products of basic operators. It's not necessary for virtual operators to make profit on the mobile communications services but do it with improvement of the attraction and competitiveness for the core business by using data flow as a means to combine their own core business and mobile services closely in order to ultimately make profits as a whole.

4.4 Both parties of mobile comunication resale services should negotiate further about resale price to realize actual price linkage

The price of mobile communication resale services is determined by both parties and relatively fixed in a certain period. This kind of price decision mechanism is lack of flexibility, especially when the basic telecom operators reduce retail price frequently. The wholesale price which virtual operators get is not actually lower than the retail price of basic operators, which makes the virtual operators losing price advantage and restricting their development. Simply rely on the monopoly price advantage wouldn't improve the competitive ability of basic operators. In a long term, it doesn't lead to the win-win situation if virtual operators can't develop [4]. Therefore, basic operators and virtual operators should make further negotiation to figure out the more flexible pricing mode.

There should be a certain gap between the wholesale prices of virtual operators and the retail prices of basic operators. The wholesale prices obtained by virtual operators should be adjusted accordingly while the retail prices of basic operators have changed dramatically that makes wholesale prices with real and dynamic adjustment mechanism. Therefore, negotiated prices can become floating prices to solve the problem of negative mark on.

5 Conclusion

Mobile communication resale services make private capital play an important role with the advantages of innovation and flexibility, satisfy the mobile users with the applicable requirement of diversification, individuation and differentiation. In the meanwhile, resale services also enhance the competitive level and service level of the mobile communication market, play a role in optimizing the market competition pattern. This article analyzes preliminarily pricing strategy of mobile communications resale service and co-cooperation modes between basic operators and virtual operators as well as governmental regulation based on Bertrand model. Of course, there are some problems we couldn't have the in-depth discussions. For example, in order to simplify the analysis, this article supposed that the consumers had the same level of sensitive to the prices and basic operators and virtual operators had the same coefficient of product substitution. In fact, b_1 and b_2, d_1 and d_2 may not be equal, which remains to be researched further in the future.

With the industrial policy and market environment, basic operators and virtual operators must be able to drive the industry innovation to co-create new situation of mobile communication market in China as long as they can stick to a relation of both competition and cooperation by means of the opportunity of mobile communication service.

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References

[1] Corrocher N, Zirulia L. "Me and you and everyonewe know: an empiric analysis of local network effects in mobile communications", Telecommu-nications Policy. 33, pp. 68-79, (2009).
[2] Hank Intven, Jeremy Oliver, Edgardo Sepulveda. Telecommunications regulations handbook, Washington: McCarthy Tetrault, (2000).
[3] Li Jing, Ren Jinluan, Li Bo. "Multiplayer gaming model in mobile services market", Journal of Communication University of China (Science and Technology). 21, pp. 62-68, (2014).
[4] Liu Xianglong. "Research on the cooperation strategy between virtual operators and traditional operators——Based on Game Theory", Journal of Ningde Normal University (Philosophy and Social Sciences). 2, pp. 39-43, (2015).
[5] Munnukka J. "Customers' purchase intentions as a reflection of price perception", Journal of Prod-uct & Brand Management. 17, pp. 188-196, (2008).
[6] MJ Osborne, A Rubinstein. A course in game theory, Massachusetts: MITPress, (1994).
[7] Qin Tao. "The development strategy of domestic virtual operators", Telecommunications Information. 10, pp. 17-21, (2014).
[8] Wang Cui, Ding Naipeng. "An oligopoly game analysis of China's telecommunications market", Contemporary Economics. 3, pp. 136-137, (2009).
[9] Wang Yu, Hu Liandong. "Game theory analysis of price competition in telecom market", Heilongjiang Communications Technology. 4, pp. 14-16, (2002).
[10] Xu Lidong. "Review and summary of the development of mobile communication resale services in China", Communications Management and Technology. 2, pp. 12-15, (2016).
[11] Zhou Daiwei, Gao Rui, Zhou Yu. "Discussions on business mode and operating experience of domestic and overseas mobile virtual network operators", Mobile Communications. 1, pp. 28-32, (2015).