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## Economic Analysis and Recommendation of Mobile Virtual Operation Market in China

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# Economic Analysis and Recommendation of Mobile Virtual Operation Market in China

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**Abstract:** With the continuous development and iteration of telecommunication technology, the users' requirements of the quality and service have increased dogmatically. In order to meet the diverse and personalized consumer demands, virtual network operators came into being. In 2013, China officially launched mobile wholesale business pilot which symbolized the arrival of virtual operation in China market. This paper explores the economic effect of China virtual operation from the perspective of consumer surplus and social welfare according to the data of data service from three years after the introduction of virtual operation. The results show that, after introducing virtual operators into China market, consumer surplus and social welfare have both enhanced. Moreover, comparing with the wholesale mode, simple virtual operation mode could provide greater consumer surplus and social welfare. At the same time, MVNO will get more profits. In the early stage, MVNO is in a weak position, but the policy of simple virtual operation mode reflects strong government support. Finally, this paper puts forward some recommendations based on the result of the mathematical model and China's national conditions.

**Keywords:** Virtual Operation; Mobile Wholesale; Consumer Surplus; Social Welfare

## 1. Introduction

In December 26, 2013, when China officially launched mobile wholesale business pilot, the arrival of the era of China's virtual operation was witnessed. By the end of 2016, China's mobile wholesale business pilot has entered its fourth year with more than 40 mobile virtual network operators (MVNO).— The number of mobile wholesale users have exceeded 43 million, which accounting for nearly 3% of the country's whole mobile users. However, the mobile wholesale official license which should be released after the end of two-year pilot is still stagnant to release. Meanwhile, the mobile virtual operation pilot has failed achieved its desired results because the mobile virtual network operators' performance is unsatisfactory. The mobile virtual network operators are plagued by many problems, such as the rampant telecommunications fraud (mostly caused from the code of virtual operators), the lack of the code number resources and the fuzzy profit model.

In contrast, since Sense company(Norway) carried out the virtual operations business in 1990 for the first time, virtual operation has been generally recognized and implemented in Europe countries, such as the United Kingdom, Sweden, Switzerland, Norway and so on. The British Virgin Mobile and many other well-known virtual operators were set up at that time. Same foreign governments have adopted forcing Mobile Network Operators (MNO) to open their network to Mobile Virtual Network Operator (MVNO), such as Korea, Norway and Sweden. While others have chosen to force MNO and MVNO to set up joint ventures, such as the United Kingdom. These two ways have both promoted the telecommunications market open to virtual operators. Thus, virtual operators can leverage their own advantages to provide a more varied information products and services to further meet users' demands.

The intention of China's mobile wholesale pilot is to learn from the successful experience of open virtual operations in the Western developed countries, and through the introduction of virtual operators to stimulate the competitiveness of the telecommunications industry, and further improve the quality of information products and services. But after three years' operation, pilot did not achieve the desired results. In view of the current situation, the domestic research mostly aimed at the policy, market, feasibility and even the key technology of virtual operation. Junhao Yang (2010) analyzed the maturity and feasibility of domestic virtual operation market through the comparison of the development process of foreign virtual operation market, and ultimately recommended that China's virtual operation market is mature. What's more, he assumed that the government needs to legislate to protect the market and strengthen the state-owned capital control and so on[1]. According to the analysis of the current situation of China's telecommunication industry, Shi Pu (2003) pointed out the necessity of introducing virtual operation, and thought that the cooperation between virtual operators and basic operators was the best choice [2]. Danyan Fang (2013) introduced three main modes of MVNO and two typical models MOCN and GWCN in the full virtual operation mode, and thus analyzed development strategy of MVNO. Finally, he proposed several recommendations on the sub-billing, number assignment, International roaming and other key technical issues [3].

There is no analysis of the cost-effectiveness after the introduction of virtual operations in China, but the analysis of virtual operations abroad is widely used. Livio Cricelli (2012) provided an economic analysis by establishing a competitive model between MNO and MVNO, and concluded that a reduction in mobile terminal rates would lead to competition among operators, force each operator to lower retail prices and improve consumer welfare. At the same time, the cooperation strategy of MVNO and FNO not only can reduce the retail price, but also can weaken the MNO [4]. Byung Woon Kim (2007) predicted the effect of introducing virtual operations from the perspective of consumer surplus and social welfare by constructing a demand-price model. Then he proposed that if the access fee is costly or incremental, no matter what type of introduction policy, the introduction of virtual operators would bring positive social benefits [5]. Duk Hee Lee (2006) estimated the consumer surplus of the Korean mobile phone service market by building a model, and he assumed that facility-based competition policy and the reduction of access fees such as terminal subsidies could effectively promote the popularization of mobile communication services in Korea [6].

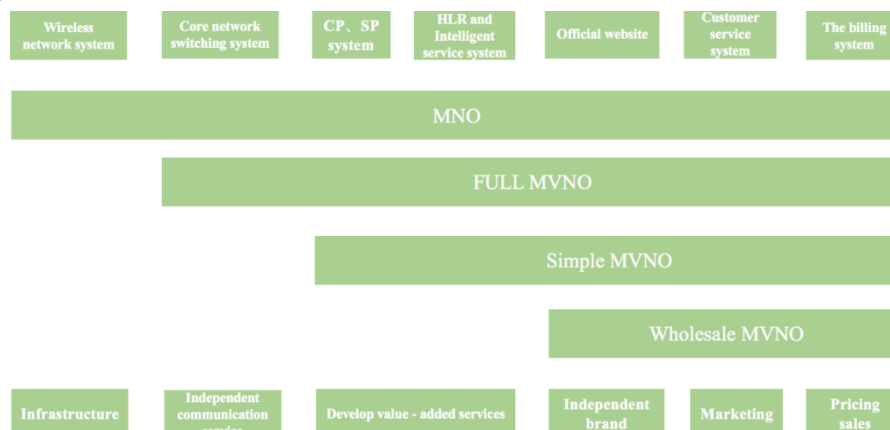
Based on the comparison of before and after the introduction of virtual operations, this paper builds a demand-price model and carries out an economic analysis according to the network operator's data service data on the telecommunications market (network operator's data shows that data services and other non-linguistic business income has more than voice business income, The traditional voice call market is gradually shrinking).Through the economic analysis, the change of cost and profit of each operator are estimated. The authors find out the crux of the virtual operation market in China and put forward the corresponding policy suggestions.

## 2. Overview of Virtual Operation

### 2.1 Virtual Operation

The telecommunication regulatory agency in the UK defines MVNO as “an organization which provides mobile telephone service to its customers, but does not have an allocation of spectrum.” The International Telecommunications Union (ITU) defines it as “a service provider that provides mobile network services to users without their own frequency and government-issued licenses”. Moreover, MVNO is generally defined in China as “a service provider that provides diversified and personalized telecommunications services through renting network lines and other hardware resources from traditional telecommunication operators, according to the demand of the market and the user”.

According to the definition of MVNO, the degree of dependence on MNO and their own resources to operate mobile networks, MVNO can generally be divided into three categories which are wholesale MVNO, simple MVNO and FULL MVNO, as shown in Figure 1.



**Figure 1: Classification of virtual operators**

Wholesale MVNO refers to the most basic virtual operators who wholesale code number resources and communications services from the MNO, establish independent brands, marketing channels and customer service system, and provide services for consumers through personalized information products and services. Wholesale MVNO relies on MNO to provide code number resources and SIM cards, and the wholesale price also depends on the MNO, so its ability to provide differentiated services is relatively weak. But meanwhile, the access threshold to it is relatively lower, which means that Wholesale MVNO is suitable for the new entrants from other industries. At present, MVNO in China are generally wholesale MVNO, and foreign representative companies of wholesale MVNO is the French Carrefour.

Simple MVNO has its own telecommunication line equipment (switching equipment) and SIM card on the basis of wholesale MVNO, so simple MVNO can independently allocate number and provide personalized value-added telecommunication services based on its own service platform. But on the other hand, simple MVNO still need to rely on mobile operators to provide communications and data services. Compared to the wholesale MVNO, the autonomy and providing differentiated service capabilities of simple MVNO has improved. The representative company of simple MVNO is the British Virgin.

Full MVNO has the greatest independence in all three MVNO Modes. Full MVNO only rents the basic network from MNO. It owns SIM card and code number resources, and it can provides independent communication and data services through self-built exchange equipment and transmission equipment. So full MVNO has a high degree of autonomy in pricing, service development and profitability. Full MVNO has all the communication data of its users. Thus full MVNO has enough capacity to provide differentiated, personalized service and form an effective competition with the MNO. However, there is higher access threshold to it. Full virtual operation mode has higher requirements in the enterprise's capital, technical level, telecommunications experience and other aspects, which means that full MVNO is suitable for enterprises with experience in telecommunication operations. The representative company is Italy Post Mobile.

Therefore, according to the above classification of the MVNO, the open mode of the virtual operation market can also be divided into three categories: wholesale mode, simple virtual operation mode and full virtual operation mode.

## 2.2 The Development of Virtual Operation in China

On November 10, 2001, China formally joined the WTO organization. Meanwhile, the Chinese government promised to gradually open the domestic telecommunications market. On December 26, 2013, because of the requirements of the State Council "Several opinions on encouraging and guiding the healthy development of private investment", and in order to further open the telecommunications market, promote private capital to enter and promote the vitality competitiveness of the telecommunications market, the Ministry of Industry and Information Technology gave the 11 enterprises the approval of first batch of mobile communications resale business pilot. By the end of 2016, China's mobile wholesale business pilot has entered its fourth year, with more than 40 MVNO, and the number of users of MVNO have exceeded 43 million, which accounting for nearly 3% of the country's whole mobile users. In these 42 companies, there are 11 companies have more than 100 million users, of which the largest enterprises have more than 8 million users.

But MVNO have also exposed a lot of problems, such as the rampant telecommunications fraud (mostly caused from the code of virtual operators), the lack of the code resources and the fuzzy profit mode. MVNO generally difficult to achieve profitability (except for the Huajishijie, mi mobile, Ali mobile and other six, which recently announced to achieve profitability). What's more, the mobile wholesale official license which should be released after the end of two-year pilot is still stagnant to release.

## 3. Model and Result

### 3.1 Model

With the start of the virtual operation pilot in 2013, MVNO entered the telecommunications market with taking price competition strategy for getting users from the three dominate network operators, which became one of the important reasons for the decline of the telecommunications market information products prices. However, as China took the most basic wholesale model to open virtual operation market, the MVNO in the market became both the customer and the competitor of the MNO. In a word,

MVNO in wholesale mode not only is subject to the constraints of MNO, such as criticizing zero to hang upside down and other issues, but also not have the sufficient ability to provide differentiated services. In contrast, if the government taking the simple virtual operation model, the constraints of the MVNO could be further released, the MVNO could set up joint ventures with operators, and then could change the relationship of both the customer and the competitors with MNO. Thus, the MVNO could have a greater space for price cuts, and provide differentiated services and value-added services, which will be more conducive to promoting the competitiveness of the telecommunications market. Moreover, it also can avoid the information security and other risks under the full virtual operation mode. So, this paper sets implement simple virtual operation mode as comparative policy; to compare the effects of wholesale mode. After entering the telecommunication market, the MVNO improve consumer surplus for consumers by cutting the price of data service. Thus the effectiveness of mobile virtual operation pilot policy can be assessed by consumer surplus.

**Table 1: Policy and mode**

Policy	Policy 1 (being implemented)	Policy 2
Mode	wholesale mode	simple virtual operation mode
Typical operating mode	Wholesale	Set up a joint venture

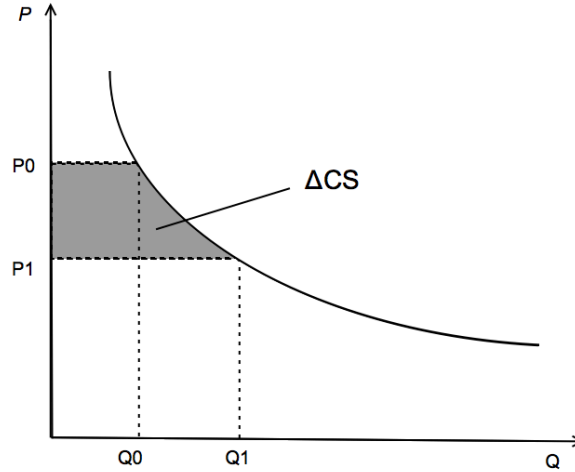
According to the data from National Bureau of Statistics, the cost of voice calls has declined from 0.3 to 0.15 yuan per minute, but the total mobile voice calls has declined from 2898.77 billion minutes to 284.999 billion minutes from 2013 to 2016, which indicating that there is a weak replacement relationship between the emerging data services and voice call services in the current telecommunications market. With the development of data services, voice call market is gradually shrinking. Therefore, this paper mainly from the perspective of data services to calculated the consumer surplus of the telecommunications industry, and for convenience and simplicity of estimation procedure, the assumption was made that the market demand function of data service is an ordinary demand curve with a log-linear form which is affected by call charge (p), and the size of the network (N).

$$Q = ep^{\alpha_1} N^{\alpha_2} \quad (1)$$

Where e is the demand-price factor.

The consumer surplus is the area of the shaded part of the price from  $p_0$  to  $p_1$ , as shown in Figure 2. So it can be calculated by the formula (2).

$$\begin{aligned}
 \Delta CS &= \int_{p_1}^{p_0} Q(p) dp \\
 &= \int_{p_1}^{p_0} ep^{\alpha_1} N^{\alpha_2} dp \\
 &= \int_{p_1}^{p_0} \frac{eN^{\alpha_2}}{\alpha_1} p^{\alpha_1+1} dp \\
 &= \frac{eN^{\alpha_2}}{\alpha_1} (p_0^{\alpha_1+1} - p_1^{\alpha_1+1})
 \end{aligned} \quad (2)$$



**Figure 2 consumer surplus model**

As for policy 2, since the MVNO have room for further price reduction, this paper assumed that the operator's price is  $p_n$ , then the price of the virtual operator is  $p_m = (1 - r_i)p_n$ , then the average price of the data service market is:

$$p_1 = s_i p_n + (1 - s_i) p_m \quad (3)$$

Where  $s_i$  is the market share of MVNO under the simple virtual operation mode.

After the introduction of the MVNO, the profit (profit-cost) change of the MNO and the MVNO is given by the formula (4) (5) respectively. If  $\Delta PS_i > 0$ , it means that the base operator's revenue increases after the introduction of the virtual operator. If

$\Delta PS_{vi} > 0$ , then means that the MVNO entering the telecommunications market could be profitable. The MNO in China have most of the telecommunications infrastructure, and as for the rest of infrastructure that rented from the tower company, MNO paid it according to the number of tower and not associated with business volume. Therefore, this paper assumed that after the introduction of virtual operations, the MNO's basic network access costs has not changed.

$$\begin{aligned}\Delta PS_i &= \Delta TR - \Delta TC \\ &= -s_i EN + (1-s_i)P_i Q_i - P_0 Q_0 + R_{vn} - (\Delta C_{ni} + \Delta C_{vni})\end{aligned}\quad (4)$$

Where E is the users average monthly rent of the MNO; N is the size of the mobile user;  $R_{vn}$  is the benefits of MNO from MVNO;  $\Delta C_{ni}$  referring to the operator's interconnection cost change value;  $\Delta C_{vni}$  is the market sales and other cost changes of MNO.

$$\begin{aligned}\Delta PS_{vi} &= R - C \\ &= s_i EN + s_i P_i Q_i - C_{vn} - C_{vni}\end{aligned}\quad (5)$$

Where  $C_{vn}$  is the network access cost of MVNO;  $C_{vni}$  is the market, sales, operating sites and other expenses of MVNO.

In the current policy (policy 1) of wholesale mode, the MVNO directly distributes the telecommunication product from the MNO, and then  $\Delta PS_i$  could be given directly by the formula (4').

$$\begin{aligned}\Delta PS_i^1 &= \Delta TR - \Delta TC \\ &= -(s_i EN + (1-a)s_i P_i Q_i) + (1-s_i)P_i Q_i - P_0 Q_0 - \Delta C_{vni}\end{aligned}\quad (4')$$

$$\begin{aligned}\Delta PS_{vi}^1 &= R - C \\ &= s_i EN + a s_i P_i Q_i - C_{vni}\end{aligned}\quad (5')$$

Where a is the wholesale discount based on the retail price.

Therefore, after the introduction of the MVNO, the change in the total social welfare is derived from the formula (6).

$$\Delta W = \Delta CS + \Delta PS_i + \Delta PS_{vi}\quad (6)$$

### 3.2 Data

#### 3.2.1 Data Traffic Price

Before virtual operation pilot implemented in 2013, data traffic price of the three major MNO was generally 0.31 Yuan each MB. After three years later of the implementation of policy 1 pilot, data traffic price of the three major MNO is seen in Table 2. This paper assumed that China Mobile, China Unicom and China Telecom ratio of 5: 3: 2, China Mobile internal price ratio of 7: 2: 1, China Unicom internal price ratio of 7: 3, and China Telecom internal price ratio of 8: 2.

**Table 2: Data traffic price of MNO (Yuan/MB)**

China Mobile			China Unicom		China Telecom	
0-100MB	>100MB	>1GB	0-37MB	>37MB	0-100MB	>100MB
0.29	0.1	0.06	0.27	0.1	0.3	0.06

Data source: official website of each MNO.

In December 2016, data traffic price of the main MVNO are seen in Table 3. Snail mobile, D.mobile this two MVNO's users have broken 5 million, both of which rank in the top.

**Table 3: Data traffic price of main MVNO (Yuan/MB)**

MVNO	Type	Charge	Ratio
Snail	Mian card	0.1	2
	60 Mian card	0.12	
	4G enjoyed card	0.2	
D.mobile	-	0.3	2
Ali Telecom	0-37yuan	0.2	1
	38-77yuan	0.17	
	78-127yuan	0.15	
	>127yuan	0.13	
Great Wall Mobile	-	0.25	1
G Mobile	-	0.3	1
Telling Mobile	-	0.29	1
JD Mobile	-	0.15	1
Suning Mobile	-	0.15	1

Data source: official website of each MVNO

As for the policy 2, the MVNO have more space and means to lower prices to attract users and provide differentiated services, so compared to the policy 1, the MVNO's price of data traffic is lower, and the MNO in order to retain users will reduce the price accordingly. Kim (2007) assumed that the price of the MVNO is reduced by 10%. This paper also assumed that the data traffic price of the MNO is  $P_n^2 = (1-r_i) P_n^1$ ; the data traffic price of the MVNO is  $P_{vn}^2 = (1-r_i) P_n^2$ , where  $r_i$  is 10%.

#### 3.2.2 User Scale

According to the data released by the Ministry of Industry and Information Technology, at the end of 2013, China's mobile

phone users was  $N_0=1.229 \times 10^9$ , and at the end of 2016 the number of mobile phone users in China was  $N_1=1.306 \times 10^9$ . Mobile phone penetration rate reached 95.5 / 100, which means incremental market of it is close to saturation.

### 3.3.3 Coefficient

For the sake of simplicity, this paper assumed that  $\alpha_2 = 1$ . The Ministry of Industry and Information Technology announced the 2013 and 2015 market size (mobile users size) was  $N_0=1.229 \times 10^9$ ,  $N_1=1.306 \times 10^9$  respectively, and the data access flow was  $Q_0=1.35 \times 10^{12}$ MB,  $Q_1=4.29 \times 10^{12}$ MB respectively. So,  $\alpha_1$  and  $e$  can be calculated by the formula (7) and (8).

$$\alpha_1 = \log_{\frac{P_0}{P_1}} \frac{Q_0 N_1}{Q_1 N_0} \quad (7)$$

$$e = Q_0 / (N_0 P_0^{\log_{\frac{P_0}{P_1}} \frac{Q_0 N_1}{Q_1 N_0}}) \quad (8)$$

Finally,  $\alpha_1 = -4.09$ ,  $e = 8.60$ .

### 3.3.4 Market Share

At the end of December 2016, under the policy 1 model, the number of the user of MVNO has reached 43 million (data source: Ministry of Industry and Communications Development Division), and the market shares of MVNO reached 3%. If implementing the policy 2, as the MVNO have greater room to lower price, MVNO will further increase the size of the user. According to foreign experience, Virgin Mobile as a typical simple MVNO, in 1999 after the establishment of two years, the market shares of it reached 3.22% (Virgin Mobile, 2002[9]). The British Telecommunications Authority has announced that the number of virtual operators has 7% of the total number of mobile subscribers (Ofcom, 2001[10]). Therefore, this paper assumes that if policy 2 is implemented, the market share of MVNO is  $S_i = 5\%$ .

### 3.3.5 Network Access and Marketing Cost

The cost of MVNO mainly include the network access cost, as well as self-built site operating costs and market costs and so on. "Mobile communications resale business pilot program" clearly stipulates that in terms of price, the wholesale price level that MNO set should be lower than minimum retail price level in its local public market. But the specific discount amount was decided by the MNO and MVNO together. This paper assumes that the discount amount  $m = 60\%$ . China Mobile's sales and marketing costs was accounted for 9% of operating income, China Unicom accounted for 15%, and China Telecom accounted for 14.4%. Therefore, this paper assumed that the MVNO's market cost is accounts for 14% of the operating income, and other costs include website operations, customer service and other costs is accounted for 6% of operating income.

### 3.4 Result

The consumer surplus, producer surplus and social welfare under the two policies was calculated, as shown in Table 4 below.

**Table 4: Consumer surplus (Hundred million yuan)**

Policy	Consumer surplus	Profit change of MNO	Profit change of MVNO	Producer surplus	Social welfare
Policy 1	1543.04	5291.69	107.34	5399.03	6942.07
Policy 2	1741.08	4814.38	398.91	5213.29	6954.37

Table 4 shows that, after three years of the implementation of policy 1, consumer surplus reached 154.304 billion yuan, and social welfare reached 694.20 billion yuan, indicating that the introduction of MVNO is both beneficial for consumers and the community. While the MVNO's profit changing value is 10.734 billion yuan, indicating that the MVNO could be profitable and would have a better earnings prospects. The result of the comparison policy showed that under the implementation of policy 2, the consumer surplus compared to under the policy 1 increased 19.84 billion yuan. MVNO profit change was raised to 39.891 billion yuan, and social welfare had a small increase too. The results showed that, after the introduction of virtual operators, consumer surplus and social welfare are both enhanced, and compared to the wholesale mode, simple virtual operation mode can bring greater consumer surplus and social welfare. At the same time, MVNO can get more profits. In the early stage, MVNO are in a weak position, and the policy of simple virtual operation mode reflect the strong support of the government to the MVNO, and it's more conducive to lower the price, increase the speed and the competitive vigor, promote the upgrading and development of the telecommunications industry in transition, which will be more conducive to the early development of virtual operators.

It should be noted that the profitability change of the MNO under both policies is positive, indicating that after the introduction of MVNO, the operator's profit is increased. This is mainly because the data service is emerging services, incremental market of it is still very large. Lower prices will bring a substantial increase in the use, so as to bring positive profit changes to the MNO. But in fact, due to the substitution of data services for voice services, the increase in data traffic revenue at the same time will reduce the MNO's voice business revenue, and excessive data traffic usage will also cause network congestion, and thereby all of it will increase the MNO's investment and operating costs. So in the absence of competition, MNO don't have much motion to take the initiative to reduce the data flow price, which do not conflict with the results of this model.

## 4. Summary and Conclusion

As for three modes of open virtual operation market, wholesale mode is relatively conservative. The MVNO is equivalent to the wholesale agents, which have many limitations in the development process. Compared to wholesale mode, simple virtual operation mode could increase the vitality and potential of MVNO, as the degree of openness has increased. MVNO under full virtual operation mode could be seen as the MNO without any infrastructure, which have the biggest initiative. But under this mode, MVNO have all communication data and would be difficult to guarantee the safety of national telecommunications.

In simple virtual operation mode, data and core resources of basic network is are still controlled by dominant network

operators, which could avoid the security problem of telecommunication data, reduce restriction and promote the vitality of MVNO. Finally, this paper puts forward some recommendations based on the results of the mode and China's national conditions.

For government, it should further loosen control in the telecommunication industry. Government should open mobile virtual operation market with simple virtual operation mode, and encourage the MVNO to set up a joint venture company with MNO, in order to carry out a variety of innovative telecommunications value-added services and promote the telecommunications industry competition. At the same time, simple virtual operation model is also down compatible. As there is only three MNO in China, a few joint ventures company will be set up, so, many of MVNO still need to take the wholesale mode. Therefore, the government needs to carry out the regulation or legislation of the virtual operators' qualification, sublease fees and other issues in detail. In terms of MVNO's qualification, government can take way to gradually open: first open to private capital, so as to accumulate experience; and then gradually open to Hong Kong, Macao and Taiwan capital; finally consider opening to foreign capital, until the virtual operation market is fully mature and the relevant laws and regulations are perfect.

Under the simple virtual operation mode, the domestic MVNO can take strategy of establishing a joint venture company with the infrastructure network operators to carry out the benefits of bundling, thus MVNO could avoid that it's both customers and competitors of MNO in the mobile wholesale mode. Virgin Mobile is the world's most famous and most successful MVNO which founded in 1999. It was a joint venture with T-mobile (Deutsche Telekom), and continued to use its strategy to set up a joint venture company with local infrastructure network operators to ensure localization and complementary market segments. MVNO as new entrant of the telecommunications industry, need to take good advantage of their own advantages to provide personalized services and focus on market segments. Each operator of three dominant network operators has more than one hundred million users, and it is difficult for them to focus on a specific market segment and provide special services. That is exactly what the advantages of MVNO, in allusion to this huge segment market, MVNO could provide special services for subdivision crowd and do accurate and personalized marketing.

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