Game analysis on innovation and regulation of value-added telecommunication service

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Abstract: It is obvious for value-added telecommunication services in China to share strong similarity and lack innovation; this must be changed in the near future. From the aspects of innovation’s size effect, learning effect and externality model, this paper analyses the substitution effect of monopolization for operators’ innovation and the crowding—out effect for value-added service providers. In the following, on the foundation of Prisoners’ Dilemma and Boxed Pigs Model, it analyses and points out that the current regulation policy can’t encourage service innovation efficiently; the existent regulating policy for service innovation lacks efficient encouragement. This shows that government must establish effective game rules, further to smash up a monopoly, promote competition, normalize telecommunication operators’ leading role in value-added service value chain, meanwhile, service innovation should be encouraged and protected.

Keywords: Value-added Telecommunication Service; Service Innovation; Regulation; Game

1. INTRODUCTION

Nowadays, basic telecommunication service has been moving towards mature maturity and value-added telecommunication service will become the new economic increasing point. Along with 3 G’s approaching, value-added service, the most outstanding service of 3 G will become into the competition focus.

The competition of value-added telecommunication service in Chinese market becomes intense day by day, but the service content is simple, developing rate is low, and service innovation is scare. Only with amounts of innovation, can the value-added telecommunication market develop stronger and strengthen itself, and the entire value-added telecommunication service market develop stronger and strengthen itself.
industrial chain flourish together continuously. To promote effective competition, improve service innovation, the regulation on value-added service market must be strengthened.

2. THE SIZE EFFECT, LEARNING EFFECT AND EXTERNALITY MODEL OF VALUE-ADDED SERVICE INNOVATION

Innovation can be distinguished between service innovation and technology innovation. In reality, service innovation and technology innovation often interweave. Like other innovations, service innovation also has size effect, learning effect and external problems.

2.1 Size effect and learning effect of value-added service innovation

It is the phenomenon that during value-added service innovation, unit cost and total cost decreases with the enlargement and accumulation of the scale. The following reasons can explain it approximately: (1) during the initial period to innovate, a great number of costs for development and research are needed, whereas in batch processing, fixed costs don’t increase or just increase a little; (2) better organization and administration are more effective; (3) experience and lessons have reduced blindness and extravagance; (4) advertisements and demonstration effect, which is created by initial innovation products and its users, decreases the advertisement cost.

2.2 The externality model of value-added service innovation

The externality model refers to such a phenomenon that economic actions do influence other economic main body, while these influence aren’t included in the cost and price of market trade. In the aspect of cost, value-added service innovation has a high risk, and the obtain of investing profit are at random. The potent-obtainable value-added service innovation has the pre-empting effect, whereas potent-unobtainable or potent-to-obtain innovation shares the nature of public products. Telecommunication value-added service innovation has obvious positive externality model, any innovation carried out by any enterprise often offered available information for other enterprises with less cost or no cost.

3. THE INFLUENCE ON VALUE-ADDED SERVICE INNOVATION FROM MONOPOLY FACTOR

After a decade of telecommunication system reform, the monopoly of the telecommunication market of our country has been broken on certain level. The government administrates the telecommunications market especially the value-added telecommunication service market more and more loosely; plenty of medium and small enterprises and joint ventures participate in competition in telecommunication service market and become value-added service provider.

The monopoly of operators still has and plays a greater role, however. They possess core network and abundant capital. The great demand of telecommunication and powerful
monopoly advantages keep Chinese operators a high profit rate, part of which even keeps over 30%. It is easy to make sudden huge profits, so why to run the risk of innovation? Under this condition, the operators would rather choose monopoly to get profits, while value-added service providers can only rely on innovation to attract business. However, most of value-added service providers are medium and small enterprises, which have difficulties in realizing size effects and externality model of innovation because of scale restriction and whose innovation enthusiasm would be restrained. Such spontaneous and profit-tension service isn’t fit for telecommunication structure, and it has become an important reason to explain the lagging of Chinese telecommunication industry innovation that the operators innovate inadequately.

3.1 Monopoly has a substitution effect on operators’ value-added service innovation

For operators, provided that two ways were to be chosen to get profit: One is to strengthen monopoly vigorously, i.e., to squeeze out competitors to get monopoly profit; the other is to obtain profit through innovation. Whether the operators choose to monopolize or innovate is decided by the comparison of marginal revenue and marginal cost brought by monopoly and innovation. Service innovation cost mainly includes studying and developing expenses, sale cost and risk cost and opportunity cost. Because traditional business constitutes the major part in operating (as fixed net operators’ traditional voice service), the innovation cost (especially opportunity cost) is much more than that of value-added service providers. Operators have a huge scale and solid capital, and can inter-subsidize value-added service with the basic service profits under unsound condition, so operators’ daily marginal cost is low, which reduced operators’ monopoly cost, and as a result, innovation cost is so expensive relatively that operators would innovate less, and choose to enlarge monopoly scale. It is monopoly’s substitution effect on innovation that makes operator have inadequate innovating motive power, which can explain why operators are fond of pursuing the expansionism of original business when neglecting and disdain to innovate. Business price campaign in recent years can be a good example. Besides unsound regulation from administration department, perhaps regulation arrangements can be some internal reasons.

3.2 Monopoly offers the crowding—out effect on value-added service providers

Such state-owned operators as China Telecom and China Mobile lie in a leading position, and this kind of domination has got government’s approval and supports, so that the government endow them an important task of state-owned asset value-keeping and value-adding. In certain period, under a condition with un-sound supervision and administration system, the government and operators are likely to co-fix a price, which can exclude the latent non-state-owned competitive factors out of market. Further speaking, operators are facing lower marginal cost curve when providing value-added service, while lower marginal cost signifies that it can offer value-added service with lower price. By contrast, value-added service providers are faced with higher marginal cost, for only with a lower price than operators can it compete with operators, besides, in an uncompleted market, value-added service providers would spend more trade cost and information cost, for
operators have accumulated a great deal of customer information and market experience in the long course of managing basic telecommunications business.

As Fig.1 shows, provided that operators and value-added service providers are faced with identical market demands curve $D = AR$, such factors as huge customer resource and scale advantage, and self-possessed physical network resource would reduce the marginal cost to Curve $MC - P$, in which $P$ is saving brought by scale advantage, while value-added service providers are faced with higher Marginal Cost Curve $MC$; in this way, operators can offer value-added service with lower price $P_1$, which can Crowding out the market share of $Q_1 - Q_0$, which had a extrusion effect on the innovation of value-added service with latent profit.

![Fig.1 monopoly’s crowding out innovation](image)

**4. GAME ANALYSES OF VALUE-ADDED TELECOMMUNICATIONS SERVICE INNOVATION**

The course of value-added service innovation is also the course for different benefit corpus to chase for self-profit game balanced. When making policy on whether carrying out service innovation or not, the operators or value-added service providers will compare latent profit (loss) with cost expense (including opportunity cost), besides, they will consider the influence played by other’s innovation and the possible reaction others may have to their innovation. To make it more convenient to analyzing, some assumptions are given below: (1) Operators and value-added service providers both have a profit-pursuing trend, so under the same circumstance, they surely will choose most beneficial ways; (2) the development cost of service innovation is fixed, profit is the positive function of innovation scale; (3) imitation cost is smaller than innovation cost; imitation profit is larger than non-imitation profit; (4) the existence of imitation will reduce the innovation cost, because the innovators take the
externality influences into consideration: In the following, game analyses will be made on
value-added service innovation under monopoly, in the light of existing entry barriers and
non-existing entry barriers.

4.1 Value-added service innovation’s Prisoners’ Dilemma under the existence of entry
barriers (This often occurs between leading operator and new-developed operator)

To accord with the China Telecom market’s present condition and the convenience of
analysis, it is assumed that there are one leading operator and two new-developed operators.
When entry barriers exist, the leading operator needn’t worry about latent competitors
entering and dividing monopoly profits. On the contrary, under un-sound administration and
control, she can still create difficulties for competitors on inter-linking and
inter-communication. Then, the leading operator’s innovating opportunity cost becomes larger,
while strengthened monopoly has a relative advantage compared with innovation. Being
rational, operators are reluctant to innovate. As for new-developed operators, the innovation
size effect is quite small because of the restriction of business, in spite of innovation, leading
operators’ imitation and extrusion measures will also reduce new-developed operators’
innovation profits, because of which the new-developed operators will adopt imitation, not
innovation, as a rational choice.

Thus, Nash balance would appear in market eventually (imitation, re-imitation, re-imitation),
then the Prisoners’ Dilemma for service innovation will occur. Model is as follows: Doubt public
security doubts three persons have committed felony, but without irrefutable evidence, so they can only arrest the crimes with other reasons. When the court
will measure their penalty according to the crimes’ deposition. If all of the three won’t confess,
each will be sentenced 1 years; If all of them confess, each will be sentenced 5 years; If some
confess and some don’t, the one who confesses will be set free and others will be punished for
8 years. The court interrogates the criminals separately. This problem can be summed up as a
complete information static game model, \( G = \langle N, S_1, S_2, S_3, u_1, u_2, u_3 \rangle \), in which, the player
assemble \( N = \{1, 2, 3\} \), representing the three criminal respectively. Three players share
the identical tactics assemble: \( S_1 = S_2 = S_3 = \{C, D\} \), in which, \( C \) represents confession, \( D \)
represents the strategy of defying , \( r \) is strategy combination. \( s = (s_1, s_2, s_3), s_i \in S_i, i=1,2,3, \)the
pay function of the three players is as follows:

\[
u_1(s_1, s_2, s_3) =
\begin{cases}
-5 & s_1 = s_2 = s_3 = C \\
0 & s_1 = C, s_2, s_3, at least one is D \\
-8 & s_1 = D, s_2, s_3, at least one is D \\
-1 & s_1 = s_2 = s_3 = D
\end{cases}
\]

\[1\]

\[
u_2(s_1, s_2, s_3) =
\begin{cases}
-5 & s_1 = s_2 = s_3 = C \\
0 & s_2 = C, s_1, s_3, at least one is D \\
-8 & s_2 = D, s_1, s_3, at least one is D \\
-1 & s_1 = s_2 = s_3 = D
\end{cases}
\]

\[2\]

\[
u_3(s_1, s_2, s_3) =
\begin{cases}
-5 & s_1 = s_2 = s_3 = C \\
0 & s_3 = C, s_1, s_2, at least one is D \\
-8 & s_3 = D, s_1, s_2, at least one is D \\
-1 & s_1 = s_2 = s_3 = D
\end{cases}
\]

\[3\]
\[ u_3(s_1,s_2,s_3) = \]

So, we can include:

\[
\begin{align*}
    r_1(C,C,C) &= r_1(D,C,C) = \{C\} \\
    r_1(C,C,D) &= r_1(D,C,D) = \{C\} \\
    r_1(C,D,C) &= r_1(D,D,C) = \{C\} \\
    r_2(C,C,C) &= r_2(D,C,C) = \{C\} \\
    r_2(C,C,D) &= r_2(D,C,D) = \{C\} \\
    r_2(D,C,C) &= r_2(D,D,C) = \{C\} \\
    r_3(C,C,C) &= r_3(C,C,D) = \{C\} \\
    r_3(C,D,C) &= r_3(D,C,D) = \{C\} \\
    r_3(D,C,C) &= r_3(D,D,C) = \{C\} \\
    r_3(D,D,C) &= r_3(D,D,D) = \{C\}
\end{align*}
\]

With \((C, C, C) \in r_1(C, C, C) \times r_2(C, C, C) \times r_3(C, C, C)\), \((C, C, C)\) can be expressed as Nash balance. In this paper, for each side of the three operators, no matter how to choose, the individual’s best choice is to imitate, which will obstruct the springing up of telecommunications service innovation.

4.2 When entry barriers don’t exist, Boxed Pigs game analysis of value-added service innovation (It often occurs among the value-added service providers such as SP and CP)

When entry barriers exist, or has little obstacle when entering, numerous SPs and CPs participate in market competition.

To be convenient to describe, we just take such a game into consideration that both enterprises (enterprise 1 and enterprise 2) can carry out a service innovation independently. Since enterprises need researching cost to develop by themselves and may run the risk of bearing failure, we can suppose \(C\) represents direct cost put into for researching; for each enterprise, success probability is \(P\). And provided that researching success of any enterprise would bring enterprise 1 and enterprise 2 utility (or profit) \(v_1\) and \(v_2\) respectively. But if only one enterprise succeeding in researching, to share the research accomplishment, another enterprise must pay the successful enterprise certain applying fee \(d\) (We generally assume \(d < v_2, d < v_1\), i.e. the profit brought by sharing the researching accomplishment is larger than the fees paid for sharing. For example when enterprise 1 succeeds in researching, while enterprise 2 doesn’t participate the research (or fails in researching), enterprise 2 must pay enterprise 1 cost \(d\) to share research accomplishment. In this way, the net profit of enterprise 2 is \(v_2 - d\) (or \(v_2 - d - c\)), while the net profit of enterprise 1 is \(v_1 + d - c\).

Since every enterprise has two tactics options, including spontaneous innovation research (shortened as “innovation”) and waiting to imitate other enterprises’ research
accomplishment (shortened as “imitation”). So for two enterprises, there are four different tactics assemble, i.e. enterprise 1 innovation, enterprise 2 innovation enterprise 1 imitation, enterprise2 innovations; enterprise 1 and enterprise 2 innovation; enterprise 1 and enterprise 2 imitation.

(1) If both enterprise 1 and enterprise 2 do research, 4 kinds of phenomena will happen:
a. both enterprise 1 and 2 enterprise succeed, enterprise 1 gain advantage $v_1$, enterprise 2 gain advantage $v_2$;
b. enterprise 1 succeeds, enterprise 2 fails, then enterprise 1 gains advantage $v_1+d$, 2 gains advantage $v_2-d$;
c. enterprise 1 fails, enterprise 2 succeeds, then enterprise 1 gains advantage $v_1-d$, 2 gains advantage $v_2+d$;
d. both enterprise 1 and 2 do not succeed , each gains advantage 0.

Considering the direct cost, their payoff matrix is shown as follows:

<table>
<thead>
<tr>
<th></th>
<th>2 succeed</th>
<th>2 fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 succeed</td>
<td>$v_1-c,v_2-c$</td>
<td>$v_1+d-c,v_2-d-c$</td>
</tr>
<tr>
<td>1 fail</td>
<td>$v_1-d-c,v_2+d-c$</td>
<td>$-c,-c$</td>
</tr>
</tbody>
</table>

the corresponding probability matrix is:

<table>
<thead>
<tr>
<th></th>
<th>2 succeed</th>
<th>2 fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 succeed</td>
<td>$p^2$</td>
<td>$p(1-p)$</td>
</tr>
<tr>
<td>1 fail</td>
<td>$p(1-p)$</td>
<td>$(1-p)^2$</td>
</tr>
</tbody>
</table>

Supposing $U_1$, $U_2$ indicate the net profit of enterprise 1 and enterprise 2 respectively, if both enterprise 1 and enterprise 2 do research, then the conditional expectation profit of enterprise 1 is:

$$E\{U_1 \mid both\; enterprise\; 1\; and\; enterprise\; 2\; do\; research\} = v_1 (2p - p^2) - c$$ (7)

The conditional expectation profit of enterprise 2 is:

$$E\{U_2 \mid both\; enterprise\; 1\; and\; enterprise\; 2\; do\; research\} = v_2 (2p - p^2) - c$$ (8)

(2) If enterprise 1 does research, wile enterprise 2 does not, it can be divided into two conditions.
a. if enterprise 1 succeed, the net profit of enterprise 1 and enterprise 2 are:$v_1+d-c$, $v_2-d$.
b. if enterprise 1 fails, the net profit of enterprise 1 and enterprise 2 are different: $-c$, 0. So

$$E\{U_1 \mid enterprise\; 1\; research,\; enterprise\; 2\; not\}$$ (9)
\[ = p (v_1+|d-c|) -c (1-p)=p(v_1+|d|) -c \]

\[ E \{U_2 \mid \text{enterprise 1 research, enterprise 2 not} \} = p \langle v_2-|d| \rangle \]  

(10)

(3) If enterprise 2 does research, while enterprise 1 does not, it can also be divided into two conditions.

a. if enterprise 2 succeed, the net profit of enterprise 1 and enterprise 2 are: \(v_1-d, v_2+d-c\).

b. if enterprise 2 fails, the net profit of enterprise 1 and enterprise 2 are different: 0,\( -c\).

So

\[ E \{U_1 \mid \text{enterprise 2 research, enterprise 1 not} \} = p \langle v_1-|d| \rangle \]  

(11)

\[ E \{U_2 \mid \text{enterprise 2 research, enterprise 1 not} \} = p \langle v_2+|d-c| \rangle -c (1-p)=p(v_2+|d|) -c \]  

(12)

(4) If neither of enterprise 1 and 2 does research work, the result is:

\[ E\{U_1 \mid \text{neither of enterprise 1 and 2 does research} \} = E\{U_1 \mid \text{neither of enterprise 1 and 2 does research} \} = 0 \]  

To this, we can write out the payoff matrix of innovation behaviors about the two participators enterprise 1 and enterprise 2:

<table>
<thead>
<tr>
<th></th>
<th>innovation</th>
<th>imitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>enterprise 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>innovation</td>
<td>(v_1(2p-p^2)-c), (v_2(2p-p^2)-c)</td>
<td>p(v_1+</td>
</tr>
<tr>
<td>imitation</td>
<td>p(v_1-</td>
<td>d</td>
</tr>
</tbody>
</table>

It is easy to prove that if \(v_1 > (c/p) - d > v_2\), the famous Boxed Pigs game will be found. Its balance solution is: enterprise 1 (big pig) innovate, enterprise 2 (little pig) imitate. If \(v_2 < (c/p) - d\), it is obvious that

\[
\begin{align*}
p (v_2 + d) &< 0 \\
v_2 (2p - p^2) &< p (v_2 - d)
\end{align*}
\]  

(14)

For enterprise 1’s any tactics, it’s optimum for enterprise 2 to select imitation. Since enterprise 1 would only imitate, enterprise 2 only has one option to innovate when \(v_1 > (c/p) - d\). Because when given enterprise 2 to imitate, the utility for enterprise 1 to innovate is bigger than to innovate. \((p (v_1 + d) - c > 0\) can be easily got in condition of \(v_1 > (c/p) - d\). So, (enterprise 1 innovate, enterprise 2 imitate) is the preferential solution after recalling.

So, we can make a conclusion: If enterprise utility \(v_1\) and utility \(v_2\) locate in two different sides of the boundary \((c/p - d)\), then the enterprise with high utility will choose innovation and the enterprise with low utility imitation, which is a preferential strategy after recalling.
just like fig.2.

Fig.2 the equilibrium when \( v_1 > \frac{c}{p} - d > v_2 \)

When \( v_1 > \frac{c}{p} = d \), the strategy is: enterprise 1 innovates, and enterprise 2 imitate.

This is a typical issue that “the harder can’t get more, while the lazier may get more”, which will suppress enterprise’s enthusiasm to innovate, so as to delay the course of innovation.

In reality, we can punish imitate through protecting malicious through protection and innovation to promote innovation of small and weak value-added service providers. In this way, value-added service innovation can achieve Pareto Improvement.

5. BRIEF CONCLUSION AND POLICY SUGGESTION

The lagging of Chinese telecommunications value-added service innovation lies in lacking corresponding system arrangement. First, supervision falls backward, such as the independence of supervision and administration system, the present asymmetrical administration and control policy etc., which should be solved urgently; Second, monopolize has been restricting innovation; operators lack innovation power because of the obtaining of monopoly profit; the last but not the least, innovation is lack of protection and motivation. For medium and small enterprises such as some value-added service providers, their scale restricts them and their service innovation has a larger externality model, so they are used to imitating and waiting when lacking innovation protection and motivation.

To push forward Chinese telecommunications value-added service innovation, we must break the original route of luring system vicissitudes and choose a new service innovation route of obligatory system vicissitudes, all of which are to be compelled by the government. So at present, it is the telecom administration department and original system arrangement that should be innovated, rather than operators and value-added providers. It is China telecom’ innovation orientation to let systematic innovation promote market innovation. The telecommunications control reform has become an issue to be solved urgently, so as to further develop telecommunication industry.
Specific policies and measures are listed in the following:

(1) To further relax control and reduce allowable threshold, encourage market competition, for the prosperity of value-added service innovation can only be realized through competition. To relax control, we should follow two ways; one is to allow more value-added service operation corpus to participate into the market; the other is to reduce the controlling of operating enterprises, and the importance should be transformed to adjust the whole market structure and set up fair competing surroundings. Only after perfecting market structure of high monopoly, can it give the market participators pressure and power to solve efficiently such problem as insufficient innovation.

(2) To reform the property rights of the operators. The twist of property right is the deep-level drawback of operators. As the possessor of state-owned assets, the main shareholder and the final proprietor of the operators, the government can’t choose but plunging into the issues, so operators’ property rights must be reformed. The most realistic way is to improve operating enterprises’ administration structure by attracting nongovernmental business capital.

(3) To standardize operators’ role and the position in industrial value chain of value-added service and to restrict the behavior of value-added service providers such as SP, CP.

Basic telecommunications operators should integrate the resources, fulfill effectively service administration responsibility, normalize service all-round, bring coordination into full play, unite closely developed and underdeveloped -enterprises, and strengthen cohesive force of the industrial chain.

At the same time, we should pay attention to restraining the competing behavior of value-added service providers, punishing malignant price, to maintain a fair order.

(4) To set up system to motivate and protect service innovation. We can establish special telecommunications control department to establish innovation fund, encourage service innovation for telecommunications business. We can also adopt such measures as forcing to apply, granting special-permission right and patent. Besides, we should protect intellectual property right efficiently, prevent innovation accomplishment from being plagiarized and imitated to protect the benefit of new service developers feasibly.

REFERENCES: