Analytic Demonstration of Effects of Network Externality on Telecom-Market Structure

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Abstract[1]

According to the economics analyses of Network externality (NE), we can see Network externality is the obvious nature of telecom-markets and it brings extra benefits to consumers and operators. But the analysis of the case in china demonstrates that if the benefits arising from NE are only occupied by the operator with the superiority in the development of telecom-network over others for it early start, which usually causes a winner-takes-all market pattern, that is, the strong gets stronger, while the weak gets weaker between telecom operators. Therefor, there is a lack of an effective competitive market structure and monopoly may appear. So the suggestion is that the benefits should be shared for reducing digital divide and increasing social welfare by the means of NE subsidy.

1. The Definition of Network Externality

1.1. The definition of Externality

Externality is a term which is often used in economics. An externality exists when a kind of consumption or production has an indirect effect on other consumption or production but this effect is not reflected in market prices directly.

1.2. The Definition of Network Externality

Network externality refers to an advantage for a user consuming a product; however this advantage was not offered by the product itself, but by other users consuming the same products. Katz and Shapiro gave a formal definition in 1985: A utility obtained by each user consuming a product or service changes when the number of the users consuming the same products or services changed. The economists, Farrell and Saloner, gave a clearer and more accurate definition: Direct network externality refers to a value of the product used by a consumer, which increases when another consumer buys the same or a compatible product. That is, the value of communication networks increases directly when the number of users increases. Communication networks such as telephone, fax-machine, online service and email are all typical examples of direct network externality.

1.3. Network Externalities in Telecom-Market

There are several reasons for network externalities occur in telecom-market obviously. For example, telecom-products have been characterized by path dependence. Once the telecom industry chooses a particular standard or development path for a technology, it cannot easily switch to another path. Network externality arises when a lot companies choices the same technology. Having made choices concerning a particular technology's development, companies generally consider it too costly and time-consuming to retrace the path back to the original choice point and take an alternative. New telecom-network development requires a large initial investment. On the other hand, the network interconnection is one of the important characteristic of telecom-industry so that no one like to choose a particular network technology only for a company itself other than network companies else in a telecom-market of the world. Network externality causes a emergence of the positive feedback mechanisms that encourage people to follow a chosen path.

2. The Effects of Network Externality on Consumers in Telecom-Markets

2.1. Metcalfe's Law for Telecom-Network

Markets follow the laws as "Scarcity of substance" and "Marginal benefit descending" in traditional economics but there is the mechanism of the operation telecommunication as "Metcalfe's Law" and "marginal benefit increasing" in the network economics. Bob Metcalfe indicated that the value of a network is equal to the square of the number of the nodes of the network.

$$I=EM2 \quad (1)$$

I ——the value of network ;

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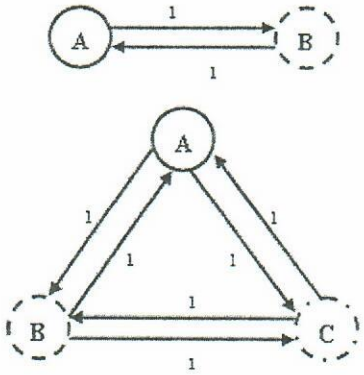
E——the constant ;

M——the number of nodes.

It shows the value of a telecom-network relates to the square of the number of its users and the value has been increasing exponential according as the number of users is increasing in the telecom-network. For example, if only one user(A) accesses to a telecom-network, and he(or she) can not communicate with others, so the network's utility to him(or her) is 0. If the other user(B) accesses to the network, the 2 persons can contact with each other. Total utility at this time is 2, and marginal utility is 2[see the top of Figure 1], that is, namely adding one user leads to 2 utility added. Than when the 3rd person(C) joins, the total utility adds up to 6 (marginal utility :4 [see the bottom of Figure 1]), so we can see total utility may increase more quickly as the users number increasing than the users number itself does.



(A、B、C are users)

Figure 1. Network Scale Effect[2]

2.2. Consumers' Utility Function under Network Externality

Under NE, changes take place in consumers' utility evaluation, and the activities of others' consuming the same product (or service) are looked as explanatory variable affecting the utility function. Here, valuation function of consumer(i) is:

$$Ui = Ui(X1 , X2 , \dots , Xn ; C1 , C2 , \dots , Cm) \quad (2)$$

Where, X1 , X2 , … , and Xn are the symbols separately representing the utilities of attributes of a product; and C1 , C2 , …, and Cm represent the activities of other consumers, which result in positive externality to consumers' utility. For example, in a telecom-network additional users can increase the new terminals for original users in the same telecom-network to communicate with, which heighten the consumers' evaluation of the telecom-network utility.

Consumers' utility function under NE analyzed above can be simplified further. The valuation function of the consumer i is the following.

$$Ui = Ui (X ; C) \quad (3)$$

Ui is the total value for a consumer i accesses a telecom-network and it is composed of both X and C. X can be seen as the value of the attributes of the telecom-network itself, and C can be seen as the value brought by other consumers activities accessing the telecom-network too, that is the value of network externality.

From the user's angle, the more users a telecom-network has, the more opportunities for communication with others, so people think the telecom-network with the most users has the highest value, even if many users have to endure a high price for it. Considering the network externality, the value of a telecom-network is no longer concentrated in the telecom-network's attributes itself, but gradually extends to the users number of the telecom-network. So consumer utility evaluation function is no longer based solely on the telecom-network itself, and the users number of the telecom-network will also be included. In such a premise, consumer choice is no longer just a telecom-network, but is also the user number of the telecom-network.

2.3. The Network Externality Effects on Demand in Telecom-Markets

To understand this better, there is the demand theory as the fulfilled expectations formulation of network externalities (Economides 1993b, 1996a), that is, the willingness to pay for the n^{th} unit of the product is $p(n; n^e)$, when n^e unit is expected to be sold.[3] With dynamic evolution of phases, one by one, the sort-term demand curve has been changed constantly along with the changes of consumer's expect for the market expansion of the product. So the market equilibrium gets more complex in long term, as the fulfilled expectations demand shows in Figure 2.

[2]Source: Jia Danhua. The public policies selection in the development of Internet. Beijing University of P & T Press, Dec, 2004.

[3]In this formulation n and n^e are normalized so that they represent market shares rather than absolute quantities.

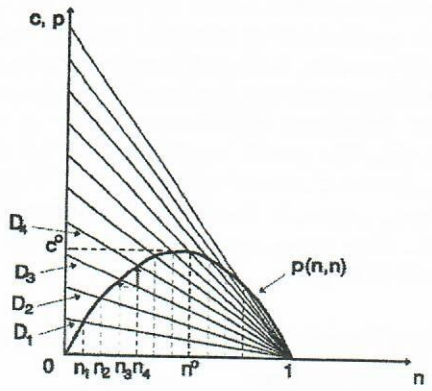


Figure 2. Long-Term Market Equilibrium[4]

Each curve Di, i = 1, 2, 3, ... shows the willingness to pay for a varying quantity n, given an expectation of users $n^e = n_i$. To understand it better here, all n^e, n_i represent relative telecom-market share, not the actual users number.

To each short-term demand curve, at $n = n_i$, expectations are fulfilled and the point belongs to p(n, n) as $p(n_i, n_i)$. Thus p(n, n) is constructed as a collection of points $p(n_i, n_i)$, which shows the fulfilled expectations demand curve. The effect of NE makes short-term market demand curve moves outside, and the moving degree is decided by consumer expectation, i.e. the expectation for network scale. Because consumer has certain expectation to future network scale and their decisions often rely on their expectation for users scale, the changes of consumer expectation have an important impact to market stability.

Taking into account the statement above, what a company should do is not only to create a telecom-network, but also to attract a number of users accessing its telecom-network for an increase in the value of its telecom-network, which is more important.

3. The Effects of Network Externality on Operators in Telecom-Markets

3.1. Telecom-Industry on Large Users Scale

The essence of NE is economies of scale during network enlarged, but different from traditional economies of scale arising from supply side in the market, it generates from the demand side. NE causes Marginal Cost (MC) descending and Marginal Benefit (MB) increasing, as Figure 3.

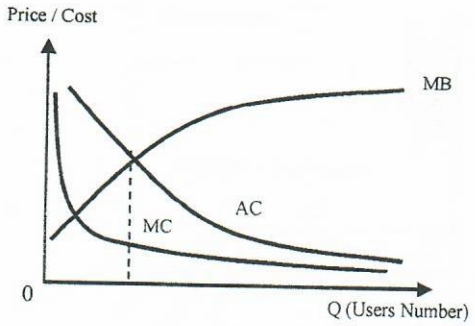


Figure 3. MB, AC & MC of a Telecom-Network with the Number of the Users Increasing

The costs of products or services supporting by a telecom-network consist of three major components: network construction cost, as fixed cost, transmission cost, and the cost of information collection, processing and production, as variable cost. Although the network construction cost was very high at the beginning, the telecom-network with certain capacity can be used for a long time since it was built. So its initial construction cost and transmission cost are not related to marginal users access to the network. Only the cost of information collection, processing and production is related to the number of network users but compared with the fixed cost it is negligible. So for a telecom-network with the increasing number of users, generally speaking, the marginal benefit (MB) is increasing and at the same time, the marginal cost (MC) is close to 0 and the total average cost (AC) is significantly decreasing. Therefore, this telecom-network's profitability will continue to increase during its expansion of users scale.

3.2. Multi-Equilibrium under NE in Telecom-Markets

In telecom-network market, single equilibrium phenomenon of traditional economy is broken, and is replaced by Multiple Equilibrium under Network Externality (NE). Let's find the NE effect on market equilibrium in telecom-network, basing on the demand analyses above.

For the sake of simplicity, here, we propose telecom enterprise set invariably single price (a little higher than average cost at certain time) and we can see it as the supply curve, a horizontal line which intersects the demand curve at A, B and C, as the three possible market equilibrium points shown in Figure 4.

[4]Source : Nicholas Economides, The Economics of Networks, International Journal of Industrial Organization vol. 14, no. 2 (March 1996).

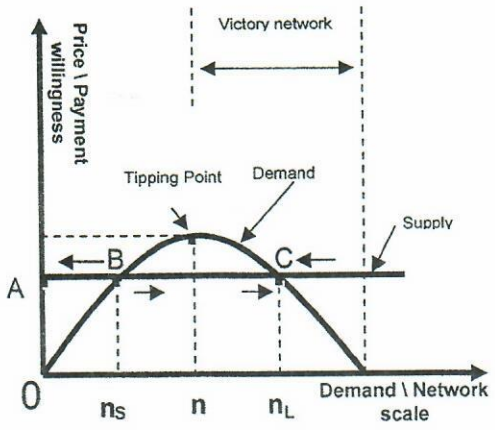


Figure 4. Multi-Equilibrium under NE

Point **A** is the market equilibrium under consumption n=0, because of no consumer, marginal user's payment willingness is 0, namely there is no person joining in the telecom-network. This point also is seen as Pessimistic Expectations.

Point **B** is the market equilibrium under small network ($n^*= n_S$). At the left of point B, payment willingness is lower than price; but at the right of B, payment willingness is higher than price. At this point B, marginal users think a telecom-network will not become so big, and will not purchase its service to access it, which may make the telecom-network worse. Contrarily, they think the network will certainly become bigger by new users coming quickly and will purchase its service to access it, which may lead the telecom-network to success. It means B is a key point to telecom-networks in telecom-markets. Whether an operator can pass B or not, which only depends on consumers anticipant demand. At point B, any marginal user's joining or leaving can break the market equilibrium. For example, marginal consumer leaving the network may make consumer's evaluation lower than price, and cause more users leaving this network until arriving at 0 equilibrium point, and then the network disappears. On the other, when marginal user chooses to join in the network, the enlarged scale of the network may make consumer's evaluation higher than price, and attract more consumers joining until arriving at next equilibrium—large network equilibrium.

Point **C** is the market equilibrium under large network ($n^*= n_L$). At the left of point C, payment willingness is higher than price; at the right of point C, payment willingness is lower than price. This point C is similar to the equilibrium point under traditional market. At the right of, especially the poor, they can't afford to the high price of service, even if network effect is very intense in this region. They expect someday the price will fall to the level that they can afford to, but unfortunately when a network is into this range, monopoly will happen.

Therefore we can see, point A and C are stable balance points, B is not. For the traditional economic region, the market equilibrium is unique and steady. But for NE, the market equilibrium is multiple, and its stability and instability coexist, Katz and Shapiro considered that the instability is caused by multi-equilibrium in competition. So the traditional Equilibrium theory is no longer applicable. The multi- equilibrium makes the market incline to one of two stable equilibrium—"0 equilibrium" or "large network equilibrium" ultimately, namely expelled from the market or a accepted by the market as standard widely.

4. Case Study: Effects of NE on Telecom-Market in China

4.1. The Achievement of Reform and Open in China Telecom-Markets

Table 1. Achievements of Reform and Open[5]

SERVICES	NUMBER OF USERS (million)	POSITION IN THE WORLD (2006)
Fixed telephone	367	No.1
Mobile telephone	461	No.1
Internet	137	No.2

Since the Reform and Open of domestic telecom-market, with the six major operators in competition, the telecommunication industry has been developing quickly and more and more people can access telecom-networks because the telecommunication tariff has been lower and lower in China. By the end of 2006 in China (Table 1), the telephone user number has exceeded 800 millions. The fixed phone user number adds up to 367.812 million and the mobile phone user number is up to 461.082 million. It is owed to the break of the monopoly in telecom-markets in China.

Though the Chinese government makes great efforts to support the new operators for the efficient competition in domestic market, there is a new dominative telecom-operator, as a market power, in China because of the competition under network externality in telecom-markets. It means the development of Chinese telecom-market is still in an unbalanced phase.

4.2. China Mobile Communication Market under NE

NE effect arises from convergence effect of consumers in telecom-market, which usually cause a winner-takes-all market pattern. There are obvious NE effects of telecom-market in China, and in this part we will choose the

[5] Data Source: Ministry of Information Industry of the People's Republic of China, http://www.mii.gov.cn/

Chinese domestic mobile communication market more representative to analyze the effects of NE. At the beginning of the market, China Mobile belonged to the China Telecom, as the unique operator, in a monopolized mobile market. In 1994, government broke monopoly and drew competition mechanism into telecom-market of China and then China Unicom appeared. Till now there are only two operators in Chinese mobile communication market, so they are bi-oligarch. China Mobile has the superiorities in the development of telecom-network and the users scale over China Unicom for their early start. The gap between them has been enlarged bigger and bigger during more than the decade, which shows on the following graphs.

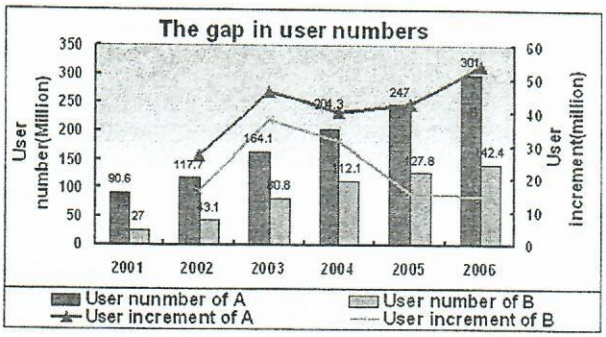


Figure 5. The Gap in User Numbers[6]

As is shown in Figure 5, China Mobile with telecom-network A has more advantages than China Unicom with telecom-network B. The user number of A was about 63.6 million more than that of B in 2001, and by the end of 2006, the user number of A adds up to 301 million with very high up increase rate, while the of user number of B is 142.2 million less 158.8 million than that of A. The distinct gap between the numbers of users is enlarged. Now A with the biggest users scale is the leader of mobile telecom-market in China.

From the Figure 6, we can see, overall, both of their main revenues have been rising, and the revenue increment of A increases faster, from 100.3(billion yuan) in 2001 to 295.4(billion yuan) in 2006. But the revenue increment of B has decreased since 2003 and became negative growth in 2006. Operator A has been occupying the dominant position in the market.

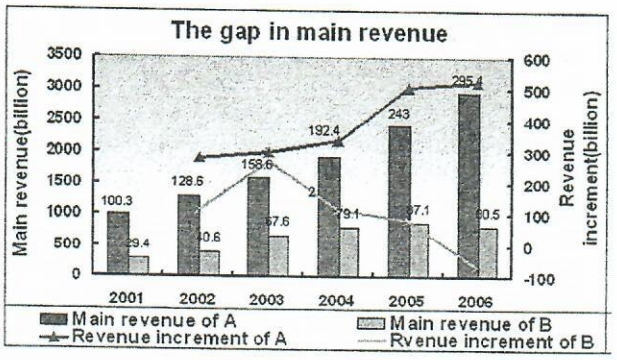


Figure 6. The Gap in Main Revenue

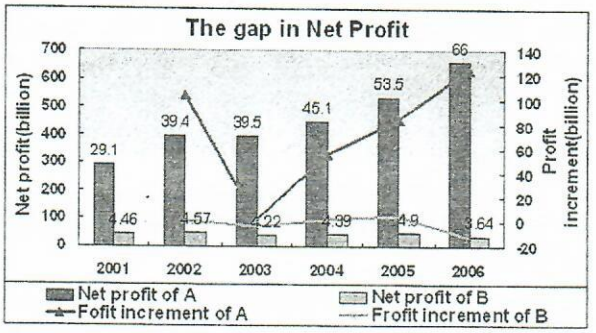


Figure 7. The Gap in Net Profit

From the Figure 7, the net profit of A reaches to 66 (billion yuan) in 2006 from 29.1 (billion yuan) in 2001, increasing 126%. It is obvious that B's net profit is far lower than that of A and the ratio of net profit between A and B in 2003, 2004, 2005 and 2006 are respectively 9.36, 10.26, 10.91 and 18.1. It's obvious that there is a descending trend in profit ability of B. Therefore the profit ability gap between A and B is enlarged notably.

5. Conclusion

Facts have proved that under the effects of NE, the strong gets stronger, while the weak gets weaker between telecom operators. There is not an effective competitive market structure, but one operator is the dominate force and another is follower. The development of Chinese telecom-market is still in an unbalanced phase, the dominate telecom-operator should take the responsibility to achieve universal access, and telecom-market regulation should be emphasized to ensure the fairness of market competition.

NE is a kind of positive externality and is the nature of telecom-markets. Network operator should not take up the benefits arising from NE only for themselves. Governments and international organizations in the world should take the responsibility to set up public policies and the primary goal of the policies making under the rule of NE is to increase the level of telecommunication service penetration, especially to those with low income and those in rural area. The key to NE usage efficiency is to use it as a form of aid to subsidize marginal users. To

[6] Data Source: Ministry of Information Industry of the People's Republic of China, http://www.mii.gov.cn/

do so, groups of low income population has to be identified and therefore low tariff should be provided to them.

NE subsidy should be provided to end users to internalize the benefits from NE, therefore reducing the individual access cost and increase net profits of telecom companies at the same time for reducing digital divide and increasing social welfare. International Telecommunication Union (ITU) is considering the issue of network externalities in relation to international settlement rates. The main purpose of this work is to explore the potential for the settlement rates of developed countries to include an element which could be used to help developing countries to expand their networks which leads to benefits both to the sending country and the recipient country.

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