The effect of innovative services on mobile network traffic

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Abstract: Although current mobile network traffic is usually believed to exhibit the price sensitivity, this might not be the case at the innovative mobile services since most mobile operators of today provided almost homogeneous services to their subscribers, based on a theoretical model of innovative services effect on mobile network traffic, we find frequent services innovations undoubtedly increase the traffic even in the conditions of price fluctuation, further analysis and empirical implementation show that mobile operators without innovative services will not be bound to increase their traffic or mobile services consumption even if they decline the tariff dramatically for attracting subscribers.

Keywords: innovative services, network traffic, MOU, price competition

1. INTRODUCTION

One of the most notable events in the telecom sector has been the remarkable growth of mobile subscribers due to technological changes and market competition, meanwhile, the monthly average revenue of per user (ARPU) of many mobile operators falls down year by year.

Traditionally, with the relaxation of telecom regulation, the incumbents surely complete against those entrants with low cost advantage in order to keep or strengthen their own market position, the price competition among those mobile operators becomes inevitable in providing consumers the homogeneous services, moreover, such competition will embody evidently in attracting potential customers in developing countries.

The problem associated with huge number of mobile subscribers is that the average mobile service consumption has been reducing yearly. In particular, more and more low-end users have entered the mobile network. According to ITU estimation, the period of 2G mobile system completely evolved into 3G system will at least need over ten years, but how to increase earning ability and service innovation for current mobile network seems to be a great task for those operators in coming years as numerous subscribers don’t bring about the corresponding high growth of revenue and profit.
There have been a number of analytical studies related to improve the mobile traffic and raise income per subscriber by economic views. Fu (2004) revealed the network traffic average mobile phone user originated was considerably various for discriminatory pricing and subscriber bandwagon. The paper by Rodimi el at. (2003), on the other hand, showed the substitutability of mobile services, income and age differences among subscribers could impact the mobile traffic significantly, the study also estimated cross price elasticity could be able to constrain or outplace the traffic. Tong (2003) conducted a analysis of the determinants of telephone traffic, it showed that the traffic changes were determined by those variables such as specific cost structure, network capacity, market concentration. Dessein (2004) has explored the network competition with homogeneous customers and calling patterns, he has shown customer’s different types substantially affected the nature of the calling patterns and unbalanced traffic.

Given the study on the mobile traffic, this paper attempts to shift the focus from consumer’s factor to the price and service innovation of mobile operators, the reason is because providing consumers abundant applications with low price certainly spurs the increase of usage of mobile services and the traffic.

The theoretical model used in this study is based on function analysis of traffic by major determinants, in other word, the mobile traffic in this paper is not only affected by mobile operators’ price divergence but also determined by different level of mobile services, in addition, the model allows for price competition and network traffic which are structured in comparison to services by the utility analysis, it is shown that traffic volume and imbalances are driven by asymmetries in specific cost structure, services innovation and market strategies.

The paper is structured in the following way, the theoretical model is presented in section 2, section 3 describes the sample and empirical implementation, the conclusion is given in section 4.

2. THE BASIC MOBILE

This section sets forth a theoretical model for assessing the services and tariff induced network effect on the general mobile subscription market. In common with precious studies, network traffic is undoubtedly inferred from price and favorite services, within this approach, the model assumes the competition between two horizontally differential mobile services without any substitutability, and given the innovative services offer subscribers additional utility relative to the general services and the corresponding traffic will increase for more subscription. Let \( u_i \) represents the innovative service value which also implies the utility derived from subscribing to the service for subscribers, while the \( u_c \) is for the conventional mobile service. the detail price of innovative mobile services by operator to any mobile subscriber is denoted as \( p_i \) while the \( p_c \) is for the conventional service. \( \delta \) measures the degree of subscriber’s preference to specific mobile service, the parameter \( \delta \ ( \delta > 0) \) is also supposed the utility of innovative service under condition of the \( u_i \) equals to one, the mobile traffic \( V_n \).
originated by the specific service n is assumed to be given by:

\[ V_n = \begin{cases} 0 & \delta u_n - p_n \leq 0 \\ f(u_n, p_n) = \delta u_n - p_n & \delta u_n - p_n > 0 \end{cases} \quad n = (1, 2, \ldots, k) \]

Where \( \delta \) is a stochastic variable which will reinforce the traffic if its value appears to increase, meanwhile, we assume the \( \delta \) distribution function and density function are denoted by \( F(\delta) \) and \( f(\delta) \) respectively.

For simplicity, if \( u_i > u_c \), the mobile subscriber then receive more utility from innovative service than that of conventional service in the mobile network, given \( 0 \leq u_i, u_c \leq u \), where \( u \) is the upper limit value of the service, and correspondingly, the \( p_i > p_c \).

For \( u_i / p_i \geq u_c / p_c \) and \( \delta u_c > p_c \), which means the effect of innovative service by unit on network traffic is not less than that of conventional service, the result of network traffic \( V_i \) is surely larger than the traffic \( V_c \) is given by:

\[ \Delta V = f(u_i, p_i) - f(u_c, p_c) = (\delta u_i - p_i) - (\delta u_c - p_c) = p_i (\delta u_i/p_i - 1) - p_c (\delta u_c/p_c - 1) \geq \Delta p (\delta u_c/p_c - 1) > 0 \quad (i \neq c) \quad (1) \]

Where \( \Delta P = p_i - p_c \), as for \( \Delta V = V_i - V_c \) is always positive which shows the traffic has increased by the innovative or advanced services with relative low price.

If the parameter \( \delta^* \) represents the indifferent subscriber preference between two specific mobile services and originated , so that \( V_i = V_c \), and equations are then:

\[ \delta^* u_i - p_i = \delta^* u_c - p_c, \quad \delta^* \Delta u = \Delta p \quad \text{or} \quad \delta^* = \frac{\Delta p}{\Delta u} \]

where \( \Delta u= u_i - u_c, \Delta p= p_i - p_c \).

From above analysis with respect to the innovative traffic increase, the essential condition is given by

\[ V_i > V_c, \text{and} \delta \geq \frac{p_i}{u_i}, \quad \delta > \delta^* = \frac{\Delta p}{\Delta u} \quad \text{and} \delta \geq \frac{p_i}{u_i} \quad (2) \]

On other hand, note that by given \( u_i / p_i \leq u_c / p_c \), the condition for innovative service can be written as \( \Delta p /\Delta u \geq p_i / u_i \), \( u_i \geq p_i / u_c \), due to \( \Delta p /\Delta u \geq p_i / u_i \), which can be translated into \( u_i \Delta p \geq p_i \Delta u \), that is \( u_i p_c \leq p_i u_c \) or is shown as \( u_i / p_i \leq u_c / p_c \), the traffic of innovative service is then given by

\[ P(\delta \geq \frac{p_i}{u_i}, \delta \geq \frac{p_i - p_c}{u_i - u_c}) = 1 - F(\frac{\Delta p}{\Delta u}) = V_i(p_i, p_c, u_i, u_c) \quad (3) \]

Similarly, if traffic of conventional mobile service is in excess of the innovative service, the prerequisite should be in consistent with \( V_i < V_c \) and \( \delta \geq p_i / u_c \), which also \( \delta \leq \Delta p /\Delta u \).
and \( \delta \geq \frac{p_i}{u_c} \), the traffic generated by conventional service are then

\[
P_i(\frac{p_i}{u_c} \leq \delta \leq \frac{\Delta p}{\Delta u}) = F(\frac{\Delta p}{\Delta u}) - F(\frac{p_i}{u_c}) = V_i(p_i, p_c, u_i, u_c)
\]

(4)

Such that traffic by the different mobile services can be written as

\[
V_i(p_i, p_c, u_i, u_c) = 1 - F(\frac{\Delta p}{\Delta u})
\]

(5)

\[
V_c(p_i, p_c, u_i, u_c) = F(\frac{\Delta p}{\Delta u}) - F(\frac{p_c}{u_c})
\]

(6)

Differentiating Eqs (5) and (6) with respect to price variable, the following first order conditions can be obtained

\[
\frac{\partial V_i}{\partial p_i} = f(\frac{\Delta p}{\Delta u})
\]

(7)

\[
\frac{\partial V_c}{\partial p_c} = f(\frac{\Delta p}{\Delta u}) - f(\frac{p_c}{u_c})
\]

(8)

In particular, for the \( \delta \) is drawn from a uniform distribution on the interval \([0,1]\), above equations are equal to

\[
V_i(p_i, p_c, u_i, u_c) = 1 - \frac{\Delta p}{\Delta u}
\]

(9)

\[
V_c(p_i, p_c, u_i, u_c) = \frac{\Delta p}{\Delta u} - \frac{p_c}{u_c}
\]

(10)

Eq (9) suggests when retail price of innovative mobile service begins to rise, the corresponding network traffic is bound to decline, but to soar by the increase tariff of competitive service, meanwhile, the traffic of innovative service will boost with its escalation of subscribers utility while the flow tends to decrease with competitors’ innovative services or simulation strategies under constant subscription charge.

Defining \( \frac{\partial V_i}{\partial p_i} = \frac{1}{\Delta u} \) as traffic sensitivity of new service developed by the operator in domestic mobile market, it indicates the less difference between innovative service and common service appears, the higher price elasticity of consumer subscription seems to be, therefore, the market can be characterized by that the more traffic will be generated by the new or innovative services,

\[
\frac{\partial V_c}{\partial p_c} = \frac{u_i}{\Delta uu_c}
\]

Similarly, \( \frac{\partial V_c}{\partial p_c} = \frac{u_i}{\Delta uu_c} \) is described as traffic sensitivity of conventional services,
which shows traffic is sure to rise with elimination of the gap (Δu) between two distinctive services, on the other hand, the traffic will reduce with various mobile services innovated continuously while it will raises for the rivals new services providing in market.

3. **THE EMPIRICAL IMPLEMENTATION**

The mobile communications sector in China has experienced a number of technological and regulatory development over the last decade, the number of mobile phone subscribers registered at tremendous growth, for instance, China Unicom, incorporated as the second mobile services provider in domestic market in 1994, has more than 100 million users in year 2004 and its annual growth is close to 105 percent in the past six years. However, from the analogue cellular technology abandoned in 2000 to current digital technology adopted, the majority of the revenue of China two mobile operators is generated from the conventional voice service, and their growth rate of average revenue of per user (ARPU) and minute of usage (MOU) have showed a slow-down in near years.

The statistics used in this study are from the semi-annual and annual report of China Unicom corporation (HK) from December 1999 to June 2004, the data are published to domestic and oversea investors and can be obtained by browsing the company’s homepage, it includes the most important finance data and statistic for its operation such as traffic, revenue, ARPU and MOU.

![Fig.1. The conventional voice service of China Unicom: the MOU and tariff](image)

As figure 1 illustrates, the average tariff, roughly estimated through the value of ARPU divided by MOU value as various and complicated pricing strategies of China Unicom carried out in regional markets, has declined by more than 60 percent, from around 0.88 yuan per minute to 0.27 yuan during the time period of 1999 to 2004. in contrast, the annual traffic generated by the subscribers, which can be measured by the MOU in the paper, has rise by less than 10 percent, the major reason of the non-equilibrium of the two indexes for the China...
Unicom is driven by the single cellular voice service aside from the reason of competition and rush of massive low-end users. Conversely, the number of its short message service (SMS) has grown from 9.1 billion in 2002 to 31.3 billion in 2003 at constant tariff, most mobile subscribers can enjoy a variety of value-added services such as voice SMS, super SMS and news broadcast.

Obviously, we can conclude that the variations in the network traffic between the common voice services and value-added services are well explained by the variables suggested by the above theoretical model, in particular, if the price elasticity of network traffic is denoted as

\[ \eta = \frac{\Delta v / v_i}{\Delta p / p_i} \]

the parameter of conventional voice service \( \eta \) seems to be around 36.3 in the past two years, the price competition between the mobile operators seems to have statistically insignificant impact on the revenue and traffic, the traffic are statistically significant for mobile operators in value-added services even if the tariff of conventional services keep constant.

4. CONCLUSION

In this paper, the effect of innovative services on mobile network traffic was analyzed, the research provided a theoretical model to assess the network traffic changes by two major variables price and innovative service utility. As shown earlier, the model assumed one mobile operator provided two different services to subscribers with corresponding prices. Interesting enough, the results presented here show that, although the fluctuation of the services tariff has a great impact on mobile traffic, the innovative services providing the additional utility to subscribers can also change the traffic volume significantly.

The model reveals the network traffic will decline in the case of the price of innovative service increases while it is bound to soar when other service tariff begins to rise, in fact, the emergence of more innovative services prompts the network traffic greatly under the conditions of relative constant tariff, the model also finds that innovative services will have significant effect on traffic as result of price sensitivity of traffic for the less substitution between innovative service and conventional service, conversely, the conventional services will dominate the large part traffic as the substitution become greater, at this time, the critical determinant to traffic change will attribute to the price, which has been partly illustrated in the empirical implementation of China Unicom from 1999 to June 2004.

In addition, the effect of innovative services on network traffic provides an important operation implication for the current mobile operators. As described previously, mobile operators in many countries were engaged in a cut-throat competition to increase their market share in terms of subscribers as quickly as possible, particularly via price competition, this resulted in huge financial losses and decline of competition advantage in the long run. The paper shows that continuous services innovations not only help the operators to generate more mobile service subscription but win the top market position.
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