

Mathematical and Empirical Analysis of Mobile Arpu Decline

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ABSTRACT

This paper focuses on seeking the underlying attributions for the decline of ARPU, and the impacts of this phenomenon on other operating indexes of the mobile operators, from both mathematical and empirical ways. There are two approaches adopted to explain the decline of ARPU, one of which is from the aspect of the relationship between revenue of operators and number of subscribers, and the other of which is from the aspect of the structure of mobile subscribers. The empirical data of several operating performance indexes fit well with the results of mathematical model, which offers a solid foundation for explanations proposed in this paper.

Keywords: ARPU, telecom revenue, post-paid subscriber, pre-paid subscriber

I. DEFINITION OF ARPU

According to the China Mobile Annual Report 2005^[1], ARPU stands for "average revenue per user per month (RMB yuan/User/Month)," which refers to the average telecom revenue receiving from each subscriber per month. In this paper, the calculation method adopts the one refers

in the Announcement^[3], which states that to calculate by "dividing the sum of cellular services revenue during the relevant period by the average of the number of subscribers on the first and last days of the period; and dividing the result by the number of months in the period." In this calculation method, the average number of subscribers, according to China Mobile^[1], refers to "the weighted average of the number of subscribers in each calendar month within that year." This definition is the foundation for the following analysis in this paper.

According to the Annual Report of China Mobile^[1, 2] and China Unicom^[4, 9], The Group's ARPU of China Mobile decreased from 299 yuan in 1999 to 90 yuan in 2005, and the ARPU for China Unicom's GSM business also fell down to 48.5 yuan in 2005 from 165.8 in 1999.

II. TWO ATTRIBUTIONS OF THE DECLINE OF ARPU

ARPU is related to the total revenue and the average number of subscribers, and it is also influenced by other factors, such as the tariff. The decline of ARPU is a collective consequence of all of those factors. This

paper presents two other approaches to explain this phenomenon: One focuses on the relationship between revenue of operators and number of subscribers, and the other the structure of mobile subscribers.

2.1 Revenue and average number of subscribers

Let R stand for the revenue of operators, N^A stand for the average number of subscribers, and $ARPU$ stand for the Group's ARPU, then we get the formula

$$ARPU = \frac{R}{N^A \times 12} \tag{1}$$

Do differential on equation (1), and get:

$$dARPU = \frac{\partial ARPU}{\partial R} dR + \frac{\partial ARPU}{\partial N^A} dN^A = \frac{1}{N^A} dR + (-\frac{1}{N^A} \times \frac{R}{N^A}) dN^A \tag{2}$$

From equation (2), we can conclude that ARPU is positively related to R , and negatively related to NA . When both R and NA change, the change direction of ARPU could be drawn by comparing dR and

$$\frac{dR}{R} - \frac{dN^A}{N^A} \tag{3}$$

From equation (3), it is clear that, when R and N^A change in the same proportion, $ARPU$ would remain constant. Therefore, there are three possibilities that would lead to the decline of $ARPU$: R keeps the same but NA increases, NA remains constant but R falls, and both R and NA change in the same direction with larger change proportion of the later one.

Next, let's consider what the empirical data reveal. Figure 1 and figure 2 illustrates the relationship between the revenue of operators and the average number of subscribers across 1999 to 2005, for both China Mobile and China Unicom. The real line represents revenue and its growth rate, while, the dashed line stands for the average number of sub-

scribers and its growth rate. All of the information presented in these two figures is cited directly from the Annual Report of these two carriers [1-2, 4-9].

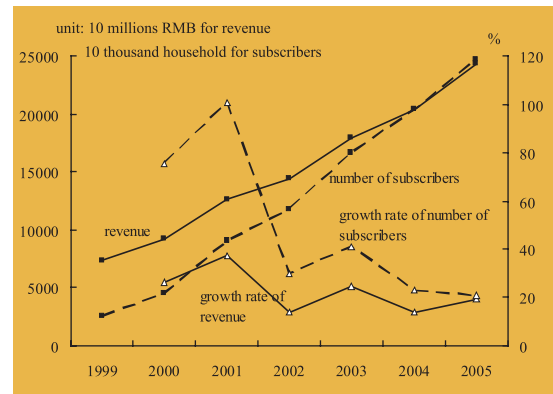


Fig.1 Revenue and number of subscribers of China Mobile from 1999 to 2005

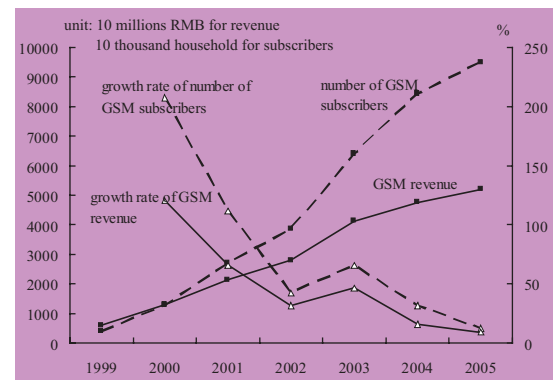


Fig.2 Revenue and number of GSM subscribers of China Unicom from 1999 to 2005

The conclusion drawn from these two figures are that, both the former two possibilities explaining the decline of ARPU do not reflect the reality of the Chinese mobile telecom market, and the fact is that, both R and N^A in the two figures are growing numerically, but the growth rate of revenue is always below that of average number of subscribers, which indicates that $\frac{dR}{R} - \frac{dN^A}{N^A} < 0$ in formula (2), and thus, get $dARPU < 0$, which results in the continuous decline of ARPU.

2.2 Post-paid subscribers and pre-paid subscribers

The rapid increase of subscribers in China mobile communication market benefits from the huge expansion of the post-paid subscribers, whose consumption

on mobile services is generally lower than that of the pre-paid ones. Therefore, only use the Group's ARPU could not expressly demonstrate the difference in the structure of consumption. For the reason that the revenue of operators are composed by earnings getting from both pre-paid subscribers and post-paid subscribers, the Group's ARPU should be calculated by both the ARPU of pre-paid and post-paid subscribers.

Let N_{post} be the number of post-paid subscribers, and its ARPU is $ARPU_{post}$; the number of pre-paid subscribers is N_{pre} , and its ARPU is $ARPU_{pre}$; α is the proportion of post-paid subscribers in the total subscribers, then,

there is $\alpha = \frac{N_{post}}{N_{post} + N_{pre}}$, with $\alpha \in (0,1)$, and

consequently $(1-\alpha)$ represents the proportion of pre-paid subscribers in the total subscribers. The Group's ARPU can be calculated by the equation:

$$ARPU = \alpha \times ARPU_{post} + (1-\alpha) \times ARPU_{pre}$$

$$ARPU_{post} > ARPU_{pre} \quad (4)$$

Do differentials on this equation, and get:

$$dARPU = \alpha dARPU_{post} + (1-\alpha) dARPU_{pre} + (ARPU_{post} - ARPU_{pre}) d\alpha \quad (5)$$

Because by definition there is $\alpha > 0, (1-\alpha) > 0$, and $ARPU_{post} - ARPU_{pre} > 0$, the Group's ARPU is positively related to $ARPU_{post}, ARPU_{pre},$ and α , and the various combination of changes on these three factors would lead to distinct interpretation on the decline of ARPU. Among those combinations of changes, only one combination would inevitably cause the decline of ARPU, that is, the fall of the three factors. Unfortunately, this is just what happened in China's mobile communication market, which is demonstrated in figure 3 and figure 4, namely the structure of ARPU of China Mobile and China Unicom during the past seven years. All of the information presented in these two figures are cited directly from the Annual Report of these two operators [1-2, 4-9].

Therefore, another attribution for the decline of ARPU in China mobile communication market is that, the three factors, or in other words, the ARPU of post-paid subscribers, the ARPU of pre-paid subscribers, and the proportion of post-paid subscribers in total subscribers, are collectively decreasing each year.

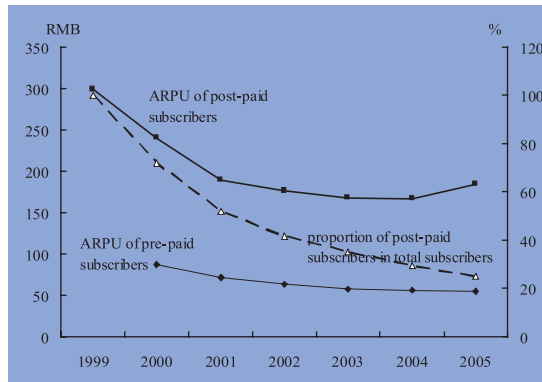


Fig.3 Structure of ARPU of China Mobile from 1999 to 2005

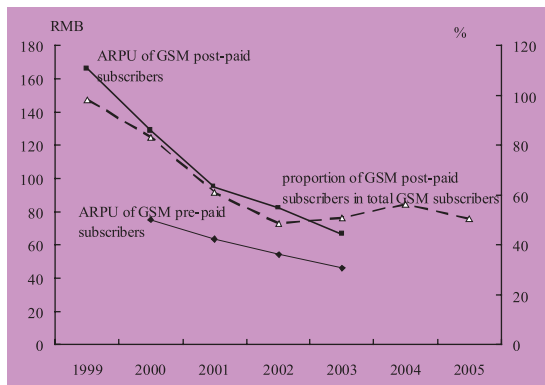


Fig.4 Structure of GSM ARPU of China Unicom from 1999 to 2005

III. IMPACTS OF ARPU DECLINE

Some scholars criticized that the decline of ARPU was the source of the shrinkage in revenue of operators. But in fact, ARPU is just an index reflecting the performance of operators from the perspective of income earning capacity, regardless of the expenditures spending on attracting subscribers. Therefore, the decline of ARPU should not be directly equaled with the movement of revenue. The following would clarify this idea with the introduction of operating expenditure indexes.

Let C stand for operating expenditures, π represent the profit of operators, and $AEPU$ refer to average expenditure per users, then, we could get the equation:

$$\pi = R - C = APPU \times N^A \times 12 - AEPU \times N^A \times 12 = (APPU - AEPU) \times N^A \times 12 \quad (6)$$

If and only if $ARPU > AEPU$, the operator is profitable.

For China Mobile, even though its ARPU is falling down, the AEPU is also descending, and the result is

a smooth enlargement of profit. See figure 5 for evidence. For China Unicom, its ARPU is also dropping, but due to the fact that the expenditure line is below the revenue line, the profit is still rising, as shown in figure 6. All of the information presented in figure 5 and figure 6 are cited directly from the Annual Report of these two operators^[1-2, 4-9].

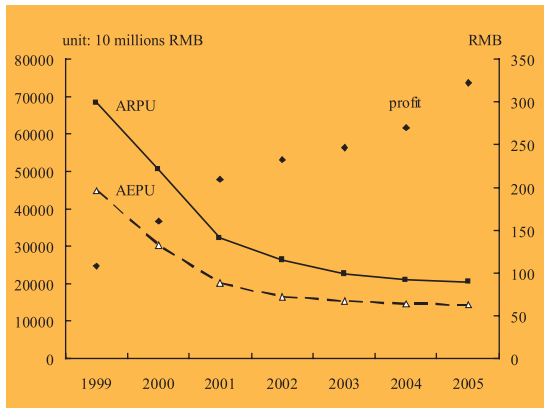


Fig.5 Payoff situation of China Mobile from 1999 to 2005

IV. SUGGESTIONS

Even though the ARPU is continuously descending, the mobile operators should be sober toward this phenomenon, because the decline of ARPU is not directly correlated with the movement of revenue. What's more, as an index reflecting the performance of operators from the perspec-

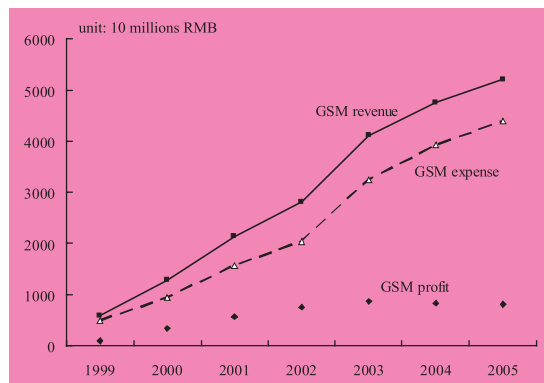


Fig.6 Payoff situation of GSM service of China Unicom from 1999 to 2005

tive of income earning capacity, ARPU must be consulted with regard of the expenditures spending on attracting

subscribers, when make judgement about the performance of a certain mobile operator.

Mobile operators should improve the factors that are positively related to ARPU, and meanwhile, be cautious to keep the expenditures at a reasonable level.

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