Comparison of Broadband Internet Pricing System: 
flat rate tariff vs. usage-based tariff

Jee Hyung Lee

Address: 161 Kajong-Dong, Yusong-Gu, Taejon, 305-350, Korea
Phone: +82 (42) 860-5124
Email: leejeehy@etri.re.kr
Electronics and Telecommunications Research Institute

Abstract

This paper examines the properties of two Internet pricing systems – a flat rate and a usage-based pricing system – in terms of the social welfare, by generalizing the theory advocated by the scholars. This study contributes not only to the systematic generalization of the theory but also to the examination of the waste of resource innate in the flat rate tariff. We found that the superiority between the two charging systems with regard to the waste of resource is not decided by the generic features of the charging systems themselves but by the scarcity of network resource. In other words, the flat rate pricing is better when there is no limit in the supportable volume of network source. Otherwise, the usage-based pricing system is better in the respect of reducing the unnecessary waste of network resource.

*JEL classification:* E52; E58

*Keywords:* Broadband Internet, Flat rate pricing, Usage-based pricing.
I. Introduction

All over the world, the flat-rate tariff is the most common broadband Internet service charging system. But the tariff is regarded as a very inefficient charging system in Internet Economics. It is because a subscriber to the flat rate tariff can use the Internet service too much without any restriction of usage time, and waste the network resource from the perspective of social welfare.

This usage pattern gives rise to the congestion of network such as increased time access and waiting time and bad connection. Consequently, the delay or loss of the packet caused by this congestion brings about the loss of all the other network users and eventually leads to the congestion externality where additional cost is aroused. The congestion externality comes from the existence of differences between individual and social valuations. For example, let’s suppose the common pasture which many shepherds share to raise their sheep. If each shepherd continuously increases the number of his own sheep in the pasture, the total number of the sheep will exceed the accommodating capacity of the pasture at one point. Eventually, the lack of the grass by the excess will bring about the “tragedy of common,” - the worst situation where the sheep die from hunger.

Apart from the problem of congestion externality, the flat-rate tariff has some other practical problems. In particular, when the use of the Internet service reaches the limit of network capacity, the flat rate tariff system does not have the mechanism to induce the investment to enlarge the capacity. It does not have a mechanism to induce the dispersion of network use by sending the users a signal that informs a possibly dynamic change of charges, either. Moreover, on the part of users, the flat rate system cannot avoid the inequality of cost distribution where light users have to support the cost of heavy users because all users pay the same amount of charge regardless of their usage time.

Despite the generic problems of the flat rate tariff, why do many countries choose the charging system, instead of the usage-based tariff? According to Clark (1997), the flat rate tariff has some benefits. 1) The predicted rate reduces the user’s sense of danger or uncertainty and the ISP’s sense of danger with regard to investment. 2) The flat rate accelerates the demand of the service and enlarges the consumer’s satisfaction. If there is no marginal cost (0 marginal cost), then there is no burden on the side of ISP. 3) The flat rate system can also avoid the operational and accounting cost to gather the information for charging standards due to the introduction of usage-based
tariff. However, Clark does not explain any theoretical reasons that the flat rate tariff is better than the meter rate tariff.

Meanwhile, Gupta, Stahl and Whinston (1997) examined the effects of usage-based tariff using a simulation model. They advocated the relative effectiveness of usage-based tariff compared to the traditional flat rate tariff.

It is true that many scholars point out the merits and shortcoming of both flat rate and usage-based tariffs and claims the superiority of either of the two. But they do not reach the point of providing any theoretically backups based on the systematic framework of analysis.

On the contrary, Edell and Vraiya (1999) tried an analytical approach to the problems of the waste of resource in the flat rate tariff system of Internet service with regard to its social welfare. A problem with their approach is their implicit presupposition of the additionally increased burden of investment on ISP when flat-rate tariff subscribers use the Internet service more than the equilibrium point of the usage-based tariff within the limited state of network resource. Edell and Vraiya do not provide any explanation about the possible waste of resource in the usage-based tariff and any comparisons of the waste of resource between the two charging systems.

Therefore, this study attempts to analyze and compare the characteristics of the two charging systems and their problems with the waste of network resource in terms of their roles in social welfare. It is to elucidate the fact that the superiority between the flat rate and usage-based tariff tariffs is decided not by their innate features as charging system but by the scarcity of network resource, by using a simple theoretical model. In short, this study tries to illustrate that the flat rate tariff is better, if the physical development of communication technology provides the unlimited, supportable volume of network resource at a very low price. It also shows that the usage-based tariff is better by minimizing the waste of network resource in other cases. 3)

This study will examine the principle of maximum utility on the side of consumers first in Chapter II. It will be examined in both suppositions of limited and unlimited network resource in order to make an analytical comparison of the waste of the resource between flat rate and usage-based tariffs. Chapter III is the conclusion induced from the analysis of the previous chapter.
II. The Model

1. Consumer Utility Maximization

Let's assume that the Internet access service is sold at \( p \) per service unit. The service fee is calculated either on the basis of data volume transmitted or received (per megabyte) or on the basis of time used. Then we can make a utility function of a user: That is \( U = v(q) + y \). The budget calculating formula can be said as \( pq + y = m \). The maximized consumer utility can be expressed in the following equation.

\[
\text{Max } U(q, v) = v(q) + y
\]

\[\text{s.t. } pq + y = m \]  \hspace{1cm} (1)

which has first-order condition

\[
\frac{\Delta v(q)}{\Delta q} - p = 0
\]

\[
\frac{\Delta v(q)}{\Delta q} = p \]  \hspace{1cm} (Condition for Utility Maximization)

We could derive a demand function or \( D(p) \) from the utility maximization condition. It is because demand moved to lower right side as shown in Figure 1. The demand function means that depending on given price, consumers show the intention of purchasing Internet access service in the amount of \( D(p) \).

Let's take a look at changes in consumer surplus and usage of distributed resources with respect to an individual's usage of Internet service depending on service charging systems. Assume that there are two pricing system, flat rate and usage-based charging system. For the purpose of comparison, we need to presume that the individual will be charged of the same amount of fee both under the flat rate system and usage-based charging system.

2. In case of unlimited network resources

When network resources are unlimited, expense paid by ISP to add one more service unit is zero. In this case, the maximization of consumer surplus requires zero marginal charge, which will be imposed on consumer. Then the consumer should expand his/her consumption until his/her marginal utility becomes zero. The fact that the marginal charge incurred to consumer is zero refers to that the rate system should be flat.

In this case, consumer surplus is what is left after deducting \( P_f \) from the total utility or \( \int_0^\infty D(q) dq - P_f \) that the consumer obtained by spending \( q_f \). This can be expressed in the following equation (2).
Now, let's think about the shift of the Internet service charging system from the flat rate to the usage-based rate. On the condition that the user's fee remains unchanged after the change of the charging system, let's see if there is any difference in consumer surplus.

In case where ISP offers unlimited service and a user choose the usage-based payment system, his/her service consumption will be reduced compared with the flat-rate system. As such, the total utility will go down. In this case, consumer surplus is equal to what is left after deducting $p_u q_u$ from the total utility or $\int_0^{q_u} D(q)dq$, which the consumer obtained by spending $q_u$. This can be expressed in the equation (3) as below.

$$CS_{Usage-based} = \int_0^{q_u} D(q)dq - p_u q_u$$  

(3)
The comparison between the flat rate and the usage-based rate requires the assumption that a user pays the same level of fee both under the flat rate and the usage-based system. As such, the amount paid under the usage-based pricing, which is equivalent to the size of the striped triangle, can be displayed in Figure 3 after the utility under the flat rate was subtracted. We can see easily that consumer surplus under the flat rate is bigger than that under the usage-based tariff by comparing them seen in figure 2 and 3.

The deadweight loss, which is generated in the process of switching from the flat rate to the usage-based tariff, can be expressed in equation (4) as below.
\[ \text{Deadweight loss} = \text{CS}_{\text{Flat}} - \text{CS}_{\text{Usage-based}} \]

\[ = \int_{0}^{q_f} D(q) dq - P_f \int_{0}^{q_u} D(q) dq + p_u q_u \]

\[ = \int_{0}^{q_f} D(q) dq - \int_{0}^{q_u} D(q) dq \quad (\because P_f = p_u q_u) \quad (4) \]

Figure 4. Consumer surplus under the usage-based tariff in case of unlimited resources

The decreased utility is identical to lost consumer surplus amounting to the size of checked triangle in Figure 4. In conclusion, from a social welfare perspective, the usage-based rate is inferior to the flat rate. In other words, when network resources are provided without limits, the switch from the flat rate to the usage-based tariff would lead to shrink in social welfare.

3. In case of limited network resources

When the network resources have their limits, the additional service supply by ISP is no longer free-of-charge. Like the previous method, under the flat rate, in order to maximize consumer surplus, the utility should be increased up to zero until marginal utility becomes zero. As such, the same consumer utility as in Figure 1 can be obtained. In case of the usage-based tariff, consumer surplus as in Figure 2 can be achieved. As such, in cases where network resources are limited, if viewed from an individual perspective, consumer surplus under the flat rate is larger than under the usage-based tariff.

Meanwhile, in cases where additional service supply by ISP requires cost higher than zero, in order to maximize the surplus of the entire society, marginal fee paid by
consumer should be equal to supply cost. Then consumer should expand his/her service consumption until their marginal utility becomes marginal fee. The fact that the marginal fee paid by consumer is bigger than zero is related to the usage-based rate.

If consumers prefer maximizing personal utility to maximizing that of the entire society, consumers do not need to concern supply costs incurred to service supplier. Therefore, if consumers adopt the flat rate, they would desire to increase their service consumption until their marginal utility becomes marginal fee. In this case, consumer surplus is calculated by deducting \( P_f \) from total utility or \( \int_0^{q_f} D(q) dq \) earned after consuming \( q_f \). This can be illustrated in the following equation (5).

\[
CS_{\text{Flat rate}} = \int_0^{q_f} D(q) dq - P_f
\]  

Let's presume that the flat rate is changed to the usage-based tariff. On the condition that the change does not affect the service fee amount, we could see if there are any changes in consumer surplus with respect to such charging rate change.

If the usage-based tariff is adopted on the condition that ISP provides unlimited resources, users are limited by payment amount tied to their service usage. Therefore, their service consumption will decline and lead to drop in total utility. Reduced utility means consumer surplus loss equal to deadweight loss as in Figure 4. From the social welfare perspective, therefore, it is an inferior charging system.

In this case, consumer surplus can be measured by deducting \( p_u q_u \) from total utility or \( \int_0^{q_u} D(q) dq \) earned after consuming \( q_u \). This can be interpreted as in the following equation (6).

\[
CS_{\text{Usage-based}} = \int_0^{q_u} D(q) dq - p_u q_u
\]

![Figure 5. Consumer surplus under the flat rate in case of limited resources](image-url)
As a result, from an individual perspective, consumer surplus under the flat rate is larger than under the usage-based tariff.

$$\text{CS}_{\text{Flat}} - \text{CS}_{\text{Usage-based}} = \int_0^{q_f} D(q) dq - P_f - \int_0^{q_u} D(q) dq + p_u q_u$$

$$= \int_0^{q_f} D(q) dq - \int_0^{q_u} D(q) dq \quad (: P_f = p_u q_u)$$

$$= \Delta A q_u q_f > 0$$ \hspace{1cm} (7)

However, under the flat rate scheme, consumers tend to use service more by the extra amount of $$(q_f - q_u)$$. In cases where network resources are limited, ISP is required to spend more resources by the extra amount of $$p_u (q_f - q_u) = 2 \int_0^{q_f} D(q) dq$$.

This is well expressed in Figure 6.

![Figure 6. Required resources for the flat rate in case of limited resources](image)

Now let's think of the flat rate scheme from the social welfare perspective. An individual's consumer surplus under the flat rate system was larger than under the usage-based system. However, from an entire social perspective, the flat rate scheme demands twice as much as resources. As such, the society-wide welfare can be calculated by subtracting service payment and resources requirement from the total utility obtained by an individual. It can be shown in the following equation.
\[ SW_{\text{Flat}} = CS_{\text{Flat}} - \text{Required resources} \]  

\[ = \int_{0}^{q_f} D(q) dq - P_f - 2 \int_{0}^{q_f} D(q) dq \]

\[ = \int_{0}^{q_f} D(q) dq - P_f - \int_{q_u}^{q_f} D(q) dq \]

\[ < \int_{0}^{q_u} D(q) dq - p_u q_u = CS_{\text{Usage-based}} \]

The below Figure 7 demonstrates that the striped section refers to welfare level under the flat rate scheme in consideration for required resources on the condition that network resources are limited. As such, when the network resources are limited, social welfare level increases with the transition from the flat rate to the usage-based tariff.

![Figure 7. Social welfare effects created by the flat rate in case of limited resources](image)

Costs for additional service supply were subtracted from consumer surplus. Depending on additional supply costs, surplus could be either negative, zero or positive. The most important point is that the consumer surplus under the flat rate is poorer than under the usage-based rate.
III. Conclusion

This study compared and analyzed social welfare effects generated by the flat rate scheme and usage-based scheme for the high-speed Internet access service respectively. It was also viewed from the perspective of optimal resources distribution. It reached two main conclusions. First, when viewed from the entire social welfare perspective, the superiority between the two pricing systems would depend on scarcity of network resources. If the network resources have no limits, it would be wiser to encourage more individuals to use the Internet based on the flat rate in order to boost consumer surplus. To the contrary, on the condition that the network resources are limited, the usage-based pricing system is appropriate. It is because service consumption higher than optimal service consumption would lead to wasting resources in the society.

Second, this study elaborated factors determining the level of resources waste and the mechanism. If the ISP cost required for providing additional service becomes higher, the number of heavy service users increase and the price elasticity grows more resilient, the degree of resources waste becomes more severe.


