Business Competition with Mobile Virtual Network Operators

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ABSTRACT

This study examines the competition environment and welfare effect in MVNO(Mobile Virtual Network Operator) business in mobile telecommunications market. We review the service characteristics of MVNO business and analyze welfare effects of MVNO business. Using the vertical product differentiation model, we compare the competition patterns and measure the welfare effect depending on the entrance forms of MVNOs

I. INTRODUCTION

In mobile telecommunications market, Mobile Virtual Network Operators (MVNOs) add value such as brand appeal, distribution channels, and other affinities to the resale of mobile services. Conceptually, MVNO is a carrier providing users with mobile services without its own airtime and government-issued licenses. Thus, the introduction of MVNO can contribute to more competitive dynamics in the mobile telecommunications industry since this policy can add the number of service providers available and thus enhance competition within a market as well.

There are a growing number of MVNO that are most prolific throughout the world including UK, Europe, USA, Australia, Japan, Singapore and Hong Kong. Virgin Mobile is the most well known and successful MVNO with more than 5 million subscribers worldwide. Although the MVNO concept is relatively new, many experts foresee an explosive outlook for this business model. They may offer services that previously didn't exist, or at a lower costs more accessible for specific segments.

In this paper, we examine the competition environments and economic welfare effect of MVNO business, and suggest useful policy implications on the mobile telecommunications market. Especially, in case MVNOs are introduced to the monopolistic MNO market, the corresponding social welfare benefits are evaluated if the MVNO enters as the key communications provider Full-MVNO in a simultaneous competition situation, and if it enters as the reseller SP-MVNO in a sequential competition situation.

II. BASIC ASUMMPTION

The suppliers of 2G service requiring analysis include MNO, full MVNO, and SP-MVNO. The service quality of these suppliers is defined as s_i, i.e., s_I for MNO, s_F for Full-MVNO, and

s_S for SP-MVNO. It is assumed that there is a quality difference between MNO and MVNO services. Specifically, the service quality is assumed as $\delta_F = s_I - s_F > 0$ and $\delta_S = s_I - s_S > 0$. It is also assumed that the MNO has better service quality than the MVNO since MNO has its own networks in proving mobile services. The price offered by these operators is defined as p_i (here, $i = I, F, S$). On production side, each operator's production cost and fixed cost are set as 0 for the convenience's sake.

Finally, consumer preference is defined as $U(\theta) = \theta s_i - p_i$. Here, s_i indicates each operator's service quality and θ_i indicates consumers' evaluation of the value of quality. Then, the uniform distribution is assumed as $\theta_i \in [\theta - 1, \theta]$ where $1 < \theta < 2$ and each consumer purchases one unit.

III. MODEL ANAYLSIS

This section evaluates social welfare in case that MVNOs enter the market and compete with the MNO. The game situation is when the MNO and Full MVNOs play the game simultaneously on an equal footing, and when the MNO and SP MVNO play the game sequentially under asymmetrical circumstances.

Full MVNO with symmetric competition

The first case presents the existing monopolistic mobile operator I and a Full-MVNO entrant F. The Full-MVNO can provide voice and additional services all through its service platform. However, since the MVNO uses the call between the MNO's base stations, it should adopt the cost-plus method as a service fee system which is based on inter-connectivity criteria. The cost-plus method charges prescribed access charges only for what the MVNO uses, thus determining a somewhat profitable price in connection with the capital. The MNO provides its networks and receives access charges from the MVNO.

Then, the indiscriminate consumer preference is expressed as in the equation of $\theta_i s_I - p_I = \theta_i s_F - p_F$. Using this equation, the existing operator I and the entrant F can calculate their respective market demand through the vertical products differentiation model as follows.

$$q_I = \theta - \frac{p_I - p_F}{s_I - s_F} = \theta - \frac{p_I - p_F}{\delta_F} \quad \text{and} \quad q_F = \frac{p_I - p_F}{s_I - s_F} - \theta + 1 = \frac{p_I - p_F}{\delta_F} - \theta + 1.$$

Where q_I is I 's mobile quantity, q_F is the entrant's mobile quantity, and $\delta_F = s_I - s_F > 0$. From this, operators' returns functions are defined as follows.

$$\Pi_I = p_I q_I + \alpha q_F \quad \text{and} \quad \Pi_F = (p_F - \alpha) q_F .$$

The existing operator's returns function is comprised of sales amount and access charge in return for allowing its networks to be used. Here, the access charge α is paid by the Full-MVNO to MNO. With the entry of the key communications provider, Full-MVNO, the inter-access charge is paid. Also, the entrant Full-MVNO's returns function is defined as sales minus the access charge paid for using the network.

To analyze the equilibrium of the simultaneous game, a case is reviewed where each operator's price is determined independently of the other. Thus, to calculate each operator's response function, the first order condition for returns maximization is arranged to calculate the equilibrium price as follows.

$$p_I^* = \frac{3\alpha + (1+\theta)\delta_F}{3} = \alpha + \frac{(1+\theta)\delta_F}{3} \quad \text{and} \quad p_F^* = \frac{3\alpha + (2-\theta)\delta_F}{3} = \alpha + \frac{(2-\theta)\delta_F}{3} .$$

Then, if $1 < \theta < 2$, then $p_I^* > p_F^* > \alpha$. Using equilibrium price p_I^* and p_F^*, the optimum mobile quantity q_I^* and q_F^* are calculated as $q_I^* = \frac{1+\theta}{3}$ and $q_F^* = \frac{2-\theta}{3}$. Here, the assumption of $1 < \theta < 2$ produces $q_I^* > q_F^* > 0$. Also, from the equilibrium of $q_I^* + q_F^* = 1$, it is learned that the entire market is covered.

Using $p_I^*, p_F^*, q_I^*, q_F^*$, each operator's returns are calculated as follows.

$$\Pi_I^* = \frac{9\alpha + (1+\theta)^2 \delta_F}{9} = \alpha + \frac{(1+\theta)^2 \delta_F}{9} \quad \text{and} \quad \Pi_F^* = \frac{(2-\theta)^2 \delta_F}{9} .$$

Here, the assumption that $1 < \theta < 2$ and $\alpha \geq 0$ produces $\Pi_I^* > \Pi_F^* > 0$. Therefore, as indicated in the vertical products differentiation model, the MNO and the Full-MVNO each can gain more than normal returns from the price competition equilibrium in the simultaneous game.

In addition, in case the entrant Full-MVNO enters the mobile market where the only MNO operates, to compare changes in social welfare, consumers' welfare should first be obtained. Each operator's consumer welfare can be calculated as follows.

$$CS_I = \int_{\frac{2\theta-1}{3}}^{\theta} (\hat{\theta} s_I - \frac{3\alpha + (1+\theta)\delta_F}{3}) d\hat{\theta} = \frac{(5\theta^2 + 4\theta - 1)s_I - 6\alpha(1+\theta) - 2(1+\theta)^2 \delta_F}{18} \text{ and}$$

$$CS_F = \int_{\theta-1}^{\frac{2\theta-1}{3}} (\hat{\theta} s_F - \frac{3\alpha + (2-\theta)\delta_F}{3}) d\hat{\theta} = \frac{(-5\theta^2 + 14\theta - 8)s_F - 6\alpha(2-\theta) - 2(2-\theta)^2 \delta_F}{18}$$

Finally, since the social welfare is $W = \Pi_I + \Pi_F + CS_I + CS_F$, it is as

$$W = \frac{(4\theta - 1)s_I + (14\theta - 8)s_F + 5\theta^2 \delta_F}{18}$$

SP MVNO with asymmetric competition

This section analyzes a market where the existing mobile operator I and the reseller entrant SP-MVNO, S , exist. Since the SP-MVNO rents a particular gross mobile quantity from the MNO at discount prices and resell it, it sets a retail-minus price excluding a prescribed discount compared to the existing operator.

Then, the indiscriminate consumer can likewise be calculated as in the equation of $\theta_i s_I - p_I = \theta_i s_S - p_S$. Using the mentioned analysis method, the market demand can be obtained as follows.

$$q_I = \theta - \frac{p_I - p_S}{s_I - s_S} = \theta - \frac{p_I - p_S}{\delta_S} \text{ and } q_F = \frac{p_I - p_S}{s_I - s_S} - \theta + 1 = \frac{p_I - p_S}{\delta_S} - \delta + 1 .$$

Here, $\delta_S = s_I - s_S > 0$. And, each operator's returns function is as follows.

$$\Pi_I = p_I q_I + p_D \text{ and } \Pi_S = p_S q_S - p_D$$

Here, p_I is defined as I 's mobile fee, and q_I as I 's mobile quantity, the monopolistic mobile operator's returns are expressed as Π_I . Also p_S is the entrant SP-MVNO's mobile fee, q_S is the entrant SP-MVNO's mobile quantity, and p_D is the volume discount purchased from the existing operator I . Likewise, the reseller entrant SP-MVNO's returns are expressed as Π_S .

The SP-MVNO will pay only the volume discount price of p_D for the particular gross supply.

Meanwhile, p_D, a discounted price from the existing operator, does not directly impact the equilibrium price, but it affects the absolute size of returns.

Since it influences the entrant's decision in entering the market as with the fixed cost, we consider the two operators competing in the market equilibrium by analyzing only the segment that determines the establishment of $p_D < p_S q_S$ (under the resale price regulation by the government, for example).

For the equilibrium analysis of sequential game where the price of reseller entrant SP-MVNO depends on the monopolistic operator's prices, incumbent should calculate SP-MVNO's response function when it decides its optimal prices p_I and p_D. Given these prices of incumbent, the SP-MVNO chooses its optimal resale price to maximize its revenue returns. Specifically, using the entrant's price response function of $p_S = R_S(p_I) = \frac{p_I + (1-\theta)\delta_S}{2}$ and substituting this response function into Π_I to produce the existing operator's optimum price yields the following equilibrium prices.

$p_I^* = \frac{(1+\theta)\delta_S}{2}$ and $p_S^* = \frac{(3-\theta)\delta_S}{4}$.

Thus, $p_I^* > p_S^*$. Using p_I^* and p_S^*, optimum mobile quantity q_I^* and q_S^* can be calculated as $q_I^* = \frac{1+\theta}{4}$ and $q_I^* = \frac{3-\theta}{4}$. Similarly, it is $q_I^* > q_F^* > 0$. Also, from the equilibrium of $q_I^* + q_S^* = 1$, it is learned that the entire market can be covered.

Here, using $p_I^*, p_S^*, q_I^*, q_S^*$, each operator's returns can be calculated as follows.

$$\Pi_I^* = \frac{(1+\theta)^2\delta_S}{8} + p_D \text{ and } \Pi_S^* = \frac{(3-\theta)^2\delta_S}{16} - p_D$$

Meanwhile, in determining the discount price of p_D, the existing operator must consider a survival guaranteed segment for the entrant in the equilibrium. Then, the equilibrium must determine the condition for $p_D < \frac{(3-\theta)^2\delta_S}{16}$. Then, $\Pi_I^* > \Pi_S^* > 0$. Also, since the unit price of $\frac{p_D}{q_S^*} = p_S^*$ is smaller than p_I^*, the SP-MVNO's unit discount rate of $\frac{p_S^*}{p_I^*} = \frac{3-\theta}{2(1+\theta)}$ is at

the level of $0 < \frac{2-\theta}{1+\theta} < \frac{1}{2}$. As a result, as with the Full-MVNO in a situation of simultaneous game, the vertical products differentiation model produces more than normal returns for the two operators in the price competition equilibrium of sequential game.

With these conditions met, in case the reseller entrant SP-MVNO enters the monopolistic mobile market, to compare social welfare, each operator's consumer welfare can be calculated as follows.

$$CS_I = \int_{\frac{3\theta-1}{4}}^{\theta} (\hat{\theta} s_I - \frac{2\alpha + (1+\theta)\delta_S}{2}) d\hat{\theta} = \frac{(7\theta^2 + 6\theta - 1)s_I - 4(1+\theta)^2 \delta_S}{32} \quad \text{and}$$

$$CS_S = \int_{\theta-1}^{\frac{3\theta-1}{4}} (\hat{\theta} s_S - \frac{4\alpha + (3-\theta)\delta_S}{4}) d\hat{\theta} = \frac{(-7\theta^2 + 26\theta - 15)s_S - 2(3-\theta)^2 \delta_S}{32}$$

Thus, the social welfare of $W = \Pi_I + \Pi_S + CS_I + CS_S$ produces the following.

$$W = \frac{(6\theta - 1)s_I + (26\theta - 15)s_S + 7\theta^2 \delta_S}{32}$$

IV. COMPARISON

<Table 1> shows the similarity and the difference between the Full-MVNO entrant and the SP-MVNO entrant in the games. It indicates that the result of MVNO competition varies depending on the Full-MVNO's access charge α, the quality difference between MNO and MVNO (δ_F and δ_S), and the consumers' evaluation on quality, θ.

<Table 1> Comparison of Equilibrium of Games

	Full MVNO entrant with Simultaneous Game	SP MVNO entrant with Sequential Game
p_I	$\alpha + \frac{(1+\theta)\delta_F}{3}$	$\frac{(1+\theta)\delta_S}{2}$
p_F , p_S	$\alpha + \frac{(2-\theta)\delta_F}{3}$	$\frac{(3-\theta)\delta_S}{4}$
q_I	$\frac{(1+\theta)}{3}$	$\frac{(1+\theta)}{4}$

q_F , q_S	$\frac{(2-\theta)}{3}$	$\frac{(3-\theta)}{4}$
Π_I	$\alpha+\frac{(1+\theta)^2\delta_F}{3}$	$\frac{(1+\theta)^2\delta_S}{8}+p_D$
Π_F , Π_S	$\frac{(2-\theta)^2\delta_F}{9}$	$\frac{(3-\theta)^2\delta_S}{16}-p_D$
CS_I	$\frac{(5\theta^2+4\theta-1)s_I-6\alpha(1+\theta)-2(1+\theta)^2\delta_F}{18}$	$\frac{(7\theta^2+6\theta-1)s_I-4(1+\theta)^2\delta_S}{32}$
CS_F , CS_S	$\frac{(-5\theta^2+14\theta-8)s_F-6\alpha(2-\theta)-2(2-\theta)^2\delta_F}{18}$	$\frac{(-7\theta^2+26\theta-15)s_S-2(3-\theta)^2\delta_S}{32}$
W	$\frac{(4\theta-1)s_I+(14\theta-8)s_F+5\theta^2\delta_F}{18}$	$\frac{(6\theta-1)s_I+(26\theta-15)s_S+7\theta^2\delta_S}{32}$

It is noteworthy that the equilibrium prices of the MNO and MVNO under the competition with Full-MVNO are smaller than those with SP-MVNO. This is so because the MNO can keep the monopolistic power under the sequential competition with SP-MVNO compared with the simultaneous competition with Full-MVNO. Consequently, the market size of the MNO under the competition with Full-MVNO is greater than that with SP-MVNO, but the market size of the Full-MVNO is smaller than that of SP-MVNO. Therefore, the consumer surplus and the social welfare benefits will be determined by the service quality difference between the two MVNOs and consumers' quality preference. Specifically, as follows is the condition for the social welfare with the entry of the Full-MVNO being bigger than the social welfare with the entry of the SP-MVNO.

$$\frac{(4\theta-1+5\theta^2)s_I+(14\theta-8-5\theta^2)s_F}{18}>\frac{(6\theta-1+7\theta^2)s_I+(26\theta-15-7\theta^2)s_S}{32}$$

V. CONCLUSION

In this paper, in case MVNOs are introduced to the mobile market, the corresponding social welfare has been evaluated if the MVNO enters as the key communications provider Full-MVNO, and if it enters as the reseller SP-MVNO. Also, the vertical product differentiation model has been examined to compare social welfare and analyzed its economic effects.

In conclusion, in any case the MVNO is introduced to the market, the MVNO's type, the competition pattern between the MVNO and the MNO, the size of consumers' evaluation of the service quality of MVNO, and the service quality difference between the Full-MVNO and the SP-

MVNO are the crucial variables in determining social welfare.

Finally, in case the government introduces competitors with diverse value-added services based on 3G to expand effective competitive means in the mobile market in years to come, competition will diversify due to a wide variety of service quality and service types, and thus social welfare effects should be reevaluated. Therefore, since the MNOs stand to benefit less than others, MVNOs might not appear as a viable strategy until facilitating regulatory safeguard and appropriate operating conditions have been established. In this sense, future research needs to be carried out to explore the relevance of our theoretical model against a practical business environment for MNOs and MVNOs.

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