Influence of Technological Change on Pricing in Telecommunications

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Abstract
Most of the telecommunications service providers in India are experiencing higher marginal cost of production than marginal revenue. This paper is inspired by the unusual mismatch of these two parameters, which determine market equilibrium price. In the unregulated oligopolistic market where entry is costly, we experience oversupply of the product or services at price much lower than the market equilibrium price. New firm in the oligopoly market develops market power by lowering the price of the product to a level below the market price. The incumbent service providers initiate actions to improve their bottom line with business process reengineering, remodeling business processes, and introducing new technologies. The induction of new technology although it reduces cost of production, is not regarded as sole approach to lower the equilibrium price of the market and maximization of societal welfare. This paper examines technological change, which a firm takes up to improve quality of service as well as effect of it on pricing of the product.

Keywords: oligopoly; marginal cost; technology; societal welfare; regulation

1. Introduction
The inefficiency of the monopolist and technological change are some of the factors for reform of the market structure of the telecommunications network from monopoly to the free enterprise system. The Indian telecommunications market is experiencing hectic competition in price and technology thereby resulting to market distortion in short-run. The telecommunications service providers in the country have been on job in the past 5 years to minimize cost of production. The service providers have inducted new technologies in their networks with an aim to reduce cost of production and offer better and reliable services to the customers. New firms have entered into the market with normal prices or below marginal costs of production. Some service providers cannot sustain in the business environment and resultantly have exited from the market. The reserves & surplus fund of many firms are decreasing as the firms are sacrificing their short-run gain in their effort to sustain in the market considering the incentive of gain in the long-run. Many service providers take up initiatives to minimize cost of production and other business process reengineering to make their production function graphs steeper towards output line. Such initiatives can influence the cost of production; however, we have observed little or no change in pricing of the services.

2. Literature Review
The network industry started reformation in the price caps, sometime, in the mid-1980s. The price cap defines an average price level not to be exceeded by firms. The interest in research in reformation of the network industry started with the pioneering research of Laffont and Tirole (2001) and according to them, the prediction of theoretical analysis as confirmed in practice, many aspects are expected from the price cap revolution. The regulators’ imperfect information – when the regulators have imperfect information about the operator’s costs, there is an unavoidable trade-off between the provision of incentives and variations in profitability, the firms may receive large rents or may incur large losses. The inefficiencies of the monopolist and the other aspects of regulation reforms led to shifting of the monopoly market of the network industries to the free enterprise system, nevertheless, within the scope of competition and policy regulation. In the free enterprise system, the capitalist enterprises seek to maximize their profits to satisfy their shareholders and on the other hand, the regulator tries to maximize societal welfare in free market economy. It is often in the long-term interest of the firm to sacrifice short-run gains- for example, by respecting interests of employees, suppliers, or customers and by spending on equipment or maintenance- in order to reap profits in the long term (Tirole, 2016). The market demand, from perspective of economics, can be represented by a
downward sloping curve in the quantity-price axes. It represents a schedule of quantities of a product, which the customers will buy at different price levels in a given period.

2.1 Societal Welfare, Subsidy and Economic Growth

In the marketplace, both customers and producers seem to get a net benefit due to existence of market for that product. Customer benefit over and above the expenditure they incur on the product is called consumers’ surplus. On the other hand, the producer benefit over and above their marginal cost of producing and selling those many units is known as producers’ surplus.

The societal welfare is the sum of the consumers’ surplus and producers’ surplus, which has been generated due to existence of market for that product. In a free enterprise system, forces of demand and supply and competitive bidding by customers or produces leads to price discovery in the market (Deodhar, 2013). In the Figure 1, the market price of the product is represented as $P_2$ and its corresponding quantity is $Q_2$. The maximum societal welfare is represented by the sum of the shaded triangles which represent Consumer Surplus and Producer Surplus. The choice of any price other than the equilibrium price would lead to lower the level of societal welfare. The lowering of welfare at
price $P_3$ when the market price is at $P_2$ is represented by the triangle area ‘ade’ in Figure 2 and it is known as ‘dead weight loss’ (DWL). The dead weight loss is loss to the society due to wrong pricing other than equilibrium price. The non-equilibrium price affects the societal welfare, however sometimes government prefers to impose official price ceiling. In the Figure 3, $P_3$ is official price ceiling and $Q_2$ is quantity to be supplied at price $P_3$. This is the condition which government fixes lower price for customers, it also offer subsidy to producers so that they supply at least as much quantity as they have under the free market situation. The societal welfare in this condition remains same as it happened in the case of free enterprise system. Firm faces technological constraints imposed by nature, only certain combinations of inputs are feasible to produce a given amount of output and the firm must limit itself to technologically feasible production plans. The production function shows maximum output obtainable from any and all input combinations. Prices of the inputs and price of the output must be used with the production function to determine which of the many possible input combinations is best, given the firm’s objective. Firms can fail to organize or manage resources efficiently and produce less than the maximum output for given input rates. Economist use a variety of functional forms to describe production function. If the production function has the form $f(x_1, x_2)=A x_1^a x_2^b$, then it is Cobb-Douglas production function. The production function is a simple description of the mechanism of economic growth. An economic community achieves economic growth when there is increase in production. Economic growth is created by two factors so that it is appropriate to discuss about the components of growth. These components are an increase in production input and an increase in productivity. Economic growth process is illustrated in Figure 4.

3. Model Formulation

Economists have always praised the merits of competition in the markets wherever it is possible. However, competition is rarely perfect; markets have flaws, and market power – that is, a firm’s ability to set its prices substantially above its costs or to offer poor-quality services without losing many customers- has to be checked (Tirole, 2016). On the other hand, competition may affect the very purpose of the societal welfare – this has also to be checked. Competition is only an instrument in the service of society. If it leads to inefficiency or otherwise lowers the societal welfare, then it must be corrected. The obvious benefit of the competition is lower the prices for consumers. It is also not only reflected in lower prices but also encourages businesses to produce more efficiently or improve productivity. It promotes a diversity of approaches and experiments, giving rise to new technologies and business models (Tirole, 2016). The environment of the business does not remain constant due to intense competition and change in customers’ expectation (Meetei & Singh, 2013). In the free enterprise system, the firms try to lower their cost of production by improving their production system. Downsizing of employee strength, introduction of new technologies in the production system, and so forth are examples of internal business processes adopted by firms to improve their productivity. Even if such internal processes are in action, many firms fail to sustain in the market because of the poor industrial policy and regulation. For example, if the antitrust enforcer or the regulator does act on some other direction ignoring the societal welfare, there is high possibility of market failure.

3.1 Model for Entry in the Market

The large fixed costs, access to the same technology for producing the good and access to the same market to buy the inputs into production are some the characteristics of telecommunications network industry in India. In this paper, I assume that the products are of perfect substitutes. In such condition, the current and potential firms have same cost curves. Decision about entry and exit in a market of this type depend on the incentives facing by the owners of the existing firms and the entrepreneurs who could start new firms. Another peculiar characteristic of the market is the behavior of the customers. Unlike other sectors, the customers in the telecommunications sector prefer to associate with the service provider at which they have registered as subscribers, and this happens when the service offered by the other firms are of similar type. The new firm may enter the market if the price of the service exceeds the average total cost of production, that is, enter the market subject to $P>$
ATC, where P is price and ATC is average total cost. Due to large fixed costs, behavior of the customers and nature of similar type of products, the marginal cost of the new firm in the short-run is much higher than the marginal cost of the existing firms. Thus, the new firm will have to wait a long gestation period to reach the break-even point of the market equilibrium price. In order to shorten the gestation period the new firm may attempt to lower the price of its product from the market price in its effort to build a large pool of its own customers by adding new subscribers who have not yet registered with any service providers and by way of churning out subscribers from the existing firms. The new firm lowers the price in an effort to persuade the existing subscribers of the incumbent service providers migrate to the service offered by the new firm. In the economic theory of short-run decision, firm shuts down if the revenue that it would earn from producing is less than its variable costs of production, that is, if P<AVC then the firms shut down. Further, in long-run the firm exits the market if the revenue it would get from producing is less than its total costs, that is, if P<ATC then the firm exits. The criterion for entry is opposite of the exit, in such case, the firm enter if P> ATC.

3.2 Model Network and Technology Change

Because of the special character of telecom network such as large fixed costs, behavior of the customers and incentive of loss in short-run, the only incentive for entry into the market is the long-run gain at the expense of losses in short-run. New firm in the oligopoly market of the telecommunications network sector develops the market power by lowering the price of its product to a level below the market price. If the price goes much below the marginal cost of the products nevertheless with the supply that meets the demand, then in such condition there exists market distortion. The incumbent firms reciprocate it by lowering price at par with the price offered by the new firm and further initiate action for minimizing the cost of production. The incumbent firms initiate action for reducing costs of production by way of business process reengineering, downsizing of the staff strength, induction of new technologies, and so forth. In the telecommunications network, there are scopes for reducing production costs. The formulation of new network models, simulation, construction of production functions for the models and economic growth analysis are some of the management approaches being adopted in telecommunication network for improvement of productivity (Meetei & Singh, 2016). In this paper, I consider a business area of BSNL where the firm has changed its technology with an aim to provide reliable service as well as minimization of production cost. In this area, I choose 52 base transceiver stations (BTS) to construct a network model and examine impact of technological change on pricing. In the year 2013, BSNL was providing 2G and 3G services with BTSs of Nortel and Ericsson make. These equipments however have been replaced completely with ZTE make combo-type of BTSs in the area of the model network. The power consumption of the Ericsson/ Nortel BTS is much higher than the power consumption of ZTE BTS. The telecom industry at that time was facing acute grid energy shortage and at most, the grid supply was about 4 to 6 hours a day (Meetei & Singh, 2014) and therefore diesel was main source of energy at the base stations. In the subsequent years, the Government of Manipur took bold initiative to improve the supply of grid energy. The grid supply has improved considerably and now most of the base stations are working with 24 hours of grid energy supply. The change of technology and business environment in Manipur made the BSNL in comfort zone of business in the subsequent years. However, with the entry of new firm in the year 2016 with price much lower than the marginal cost, which is even lower than average total costs (ATC) of the service of the incumbent service providers, the industry is facing an unhealthy business environment, in other words, the market is distorted and lowers the societal welfare.

3.3 Production Cost and Market Price

The over dependence of energy on diesel fuel was one among the key factors of shifting the technology from Nortel/ Ericsson to ZTE in the backdrop of cost minimization and maximization of network traffic. In the year 2013, the average uptime of base stations was 14 hours in a day, i.e. 58% of the 24 hours. The traffic data at 58% was available; however, the expected traffic at 100% was predicted with help of simulation in a model network. In the model network (Meetei, 2015), the production function was constructed with three factors of production \( w_1, w_2, \) and \( w_3 \). It was intended to
produce an output, $y$ at the cheapest way. If $f(x_1, x_2, x_3)$ is production function, then we write the problem as,

$$\min_{x_1, x_2, x_3} \ w_1x_1 + w_2x_2 + w_3x_3$$

such that $f(x_1, x_2, x_3) = y$

where, $w_1$, $w_2$ and $w_3$ are grid energy, diesel fuel and uptime.

The production function of the firm is represented as $Q = 0.6711 \times K^{0.4143} \times L_1^{0.9401} \times L_2^{0.0721}$, where, $K$ is diesel energy, $L_1$ is grid energy and $L_2$ is uptime. The regression between $L_1$ and $L_2$ is $L_1 = 766 + 0.678 \ L_2$ while regression equation between $K$ and $L_2$ is $K = -85.1 + 0.716 \ L_2$.

<table>
<thead>
<tr>
<th>Network Size</th>
<th>Diesel Energy</th>
<th>Grid Energy</th>
<th>Uptime (Hour)</th>
<th>Operating Cost</th>
<th>Total Input Cost</th>
<th>Output Traffic (Erlangs)</th>
<th>Output Price (Rs.)</th>
<th>Total Factor Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K$</td>
<td>$L_1$</td>
<td>$L_2$</td>
<td>$rK$</td>
<td>$wl_1$</td>
<td>$yl_2$</td>
<td>$rK+wl_1+yl_2$</td>
<td>$Q$</td>
<td>$(MOU \times 55)/100$</td>
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<tr>
<td>51</td>
<td>272.33</td>
<td>1104.46</td>
<td>499.20</td>
<td>1316.36</td>
<td>2995.20</td>
<td>10982.40</td>
<td>27593.96</td>
<td>7781.36</td>
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<td>52</td>
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<td>1189.07</td>
<td>624.00</td>
<td>18084.20</td>
<td>3744.00</td>
<td>13728.00</td>
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<td>686.40</td>
<td>20318.12</td>
<td>4118.40</td>
<td>15100.80</td>
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<td>22559.20</td>
<td>4494.00</td>
<td>16478.00</td>
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<td>874.00</td>
<td>27034.20</td>
<td>5244.00</td>
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<td>7488.00</td>
<td>27456.00</td>
<td>75876.40</td>
<td>18618.70</td>
</tr>
</tbody>
</table>

*Source: Meetej (2013)*

Table 1: Input Cost and Output Price

The variable production cost of the network at 60 percent of the network uptime as illustrated in Table 1 is Rs. 45321 while the output, i.e. market price was Rs. 372702. If the network was brought at 100% uptime, then the input cost was Rs. 75367 and output price was Rs. 614417 in a day. These were the figures in the year 2013. The average uptime of the network, between the period October 2018 and March 2019 is at 98%. This means that the network is almost radiating with full reliability in terms of availability. The technology change and business environment make the production function graph steeper towards the output axis of the production function graph. The total input cost in a day, on average as per primary data of the organisation, for the 98% uptime of the network is Rs. 29000 while it was Rs. 75367 in the year 2013. With the induction of the new technology, the productivity has improved, in other words, production cost has been minimized. In terms of traffic, the network registers 6500 erlangs of voice traffic in a day while 18618 erlangs of voice traffic in a day was registered in the year 2013. The revenue for the 6500 erlangs of voice traffic including revenue from data service is Rs. 60000 while the revenue was Rs. 611447 as expected at 100% uptime and it was Rs. 372702 at 60% uptime of the network in the year 2013. The expected revenue for the 6500 erlangs of traffic at the prevailing market price of the year 2013 is Rs. (6500 x 60 x .055) = Rs. 214500, but the present price which is offered at par with price offered by the new firm is Rs. 60000. In other words, the market price for 6500 erlangs of traffic registered in the 52 BTSs in 1248 hours (in one day, i.e. 24 x52 ) is Rs. 60000, which means that market price of the model network for 1 hour is Rs. 48 while average variable cost per hour is Rs. 23 (i.e. Rs. 29000/ 1248).
The per hour market price of the model network was Rs. 498 (i.e., 372072/749) in the year 2013 and the network availability was only 60%, which means that the 52 BTSs radiated 749 hours of the 1248 hours of a day. The induction of new technology has reduced the market price at Rs. 172 (considering at market price of 2013) and yet the network radiates 24 hours (1248 hours by 52 BTSs) in a day. With the induction of the new technology, the cost of production has been minimized, price is reduced and accordingly new production function line comes up with market price of Rs. 172.

3.4 Market Price on Entry of the New Firm

The actual market price of the network, which is determined based on the price offered by the new firm is at Rs. 48 even though Rs. 172 is the price to be fixed for the network had the new firm not entered into the market. The Figure 5 illustrates that the average variable cost (AVC) is below price, \( P_F \) and however, this price, \( P_F \) is less than the average total cost (ATC) and marginal cost of production. This depicts, as per economic theory that the firms must exit from the market. However, considering similar type of market conditions in all the firms whether it is new firm or the incumbent firms, the firms prefer to provide services although there is distortion in pricing.

3.5 Influence of Technological Change on Pricing

The technological change shifts the supply curve from \( S_1 \) position to \( S_2 \) position (Fig. 6). In Figure 6, the price shifts from, \( P_0 \) to \( P^* \) by technological change. The price further shifts from \( P^* \) to \( P_F \) with the entry of the new firm. In total, the price reduces from \( P_0 \) to \( P_F \) under two factors of market behavior, viz. technological change and entry of new firm. The change of price from \( P_0 \) to \( P_F \) is normally considered as effect of competition in the market, in other words, it is benefit given to the society by competition. On the other hand, the change of price from \( P^* \) to \( P_F \) is considered as effect of improper regulation which ultimately creates distortion in pricing. The total expected loss to the model network with the entry of the new firm is \((P_0-P_F) x Q_0 \) and net loss to the model network through
3.6 Funding from Reserve and Surplus

In order to sustain in the market the firms irrespective of whether it is new firm or incumbent firms will have to raise price until the price reaches above level of the average total cost. Meantime, the loss, i.e. \((P^*-P_F) \times Q^*\) shown in Figure 6 is to be funded either from the reserve and surplus fund of the firm or through borrowings. If any firm in the market is unable to do funding the amount, \((P^*-P_F) \times Q^*\) then the firm will have to exit from the market.

3.4 Regulator

The regulator is concerned about the price cap in the free enterprise system and tries to ensure that the equilibrium price is below the price cap, nevertheless, keeping in mind that incentive in terms of the producers’ surplus is well protected. If the regulator is too harsh on the firm and does not adequately compensate the firm for its investments and efficiency improvements, then the economic model falls into the model of the subsidy or otherwise reduction of production quantity at the level promoted by the price cap. This reduces the societal welfare. When the losses equivalent to the subsidy amount is not compensated, the losses are accumulated and finally the firm exits from the market.

Therefore, the regulator or the anti-trust law enforcer must try to correct the distortion if such situation of distortion exists in the market. A good industrial policy can prevent market distortion.

4. Conclusion

The free enterprise system advocates competition and competition makes productivity. New firms prefer to enter into the market of network industry that involves large fixed costs by lowering price below the equilibrium market price, in other words, even below the marginal costs of the product. When new firm enters market at price below marginal cost, the incumbent service providers lower their prices to keep the price at par with the price offered by the new firm and this resultantly distorts the market and societal welfare in short-run. Meantime, firms initiate business process reengineering to improve productivity. The ultimate market equilibrium price is determined by the factors of productivity initiatives such as change of technology, business process reengineering, and minimization of cost by reducing employees strength, and so forth. When the price has fallen below the price of marginal cost, average variable cost and average total cost, market distortion occurs. In this paper, I chose a model network and impact technological change on pricing is examined and found that there is great influence of competition on pricing. The regulator role is very important in controlling the price particularly when there is distortion in the market price.

References


