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Sir, I am resubmitting my research article for review and hopefully for publication. I appreciate the opportunity given to me to do this. Thank you. Onochie Jude Dieli

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Wireless Mobile Phone Technology, Deregulation Policy, Competition and Economic welfare in Nigeria's Telecom Industry: An Analytic model

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ABSTRACT

This analytic model is about the Nigerian telecom industry's structural change caused by the arrival of a new wireless mobile phone technology. Nigeria's telecom industry transformed from natural monopoly to competitive market as a result of deregulation that occurred in 1999. Under the price regulation using underground or above the ground cable telephone lines, it could run only with the help of government subsidies. This study argues that the arrival of a new telecom technology was the key to success of Nigeria's deregulation of its telecom industry. An analysis of a simple microeconomic model shows that with the new wireless technology, which requires much lower operation cost, the operator can now make a positive profit and therefore by deregulating the market, entries of new firms and competition takes place in the industry which lowers the final product price in the telecom market. The research, therefore, concludes that availability of wireless mobile phone technology led to deregulation of the industry which brought competition by increasing the number of firms in the industry that engendered fall in product price and increase in output. The study observed that the policy of deregulation is intended to usher in perfect competition but it is far from achieving that now for the industry displays behaviour similar to monopolistic competitive and oligopolistic industries. However, one thing is clear, it will never be a natural monopoly again.

Keywords: Natural Monopoly**,** Wireless Mobile Phone Technology, Deregulation Policy, Competition

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INTRODUCTION

This paper studies the deregulation of Nigeria telecom industry made possible by the availability of wireless mobile phone technology. The industry was fully deregulated in 1999. This study covers the period 1999 to 2015. This process began in 1992, marked by the establishment of NCC (Nigeria Communication Commission). The enabling law is Decree 75. After the implementation of deregulation policy in Nigeria's telecom industry, it is pertinent to investigate its impact on volume of output, number of carriers, and changes in product price in the sector. It is expected that the policy action will exert positive effects on competition (perfect competition) which is one of the hallmarks of market economy. Therefore, this paper is set to answer the research question: does deregulation policy implementation in Nigeria increase the number of firms (number of phone carriers), quantity of output and lower price of product in Nigeria's telecom industry?

Reviews of literature

Natural monopoly encourages regulation which is the heaviest handed of governing instrument options in public utility provision (Wilson, K. G. (1992). This scares away investors. As we all know private investment is driven by profit and where policies that guide participation in an industry is anti-competition, growth and expansion will be hindered thereby limiting consumer welfare. This creates the desire for deregulation by pro-growth governments because it will increase investment in the provision of essential products at a reduced price.
There are major articles that stress different patterns of investment namely, Ghemawat (1984), Kato (2009), Klepper (1996). Kato's model argues along with Ghemawat (1984). Both focus on the growth of investment efficiency as firms grow while others held similar points to Kato (2009) but offered incomplete explanations to the facts. Ghemawat (1984) claims that firms can acquire cost advantage by the process of learning that is based on cumulative gross investment. This has a cost advantage because the largest firms pre-empt all other firms to first invest and grow.

This model has an investment size that is exogenously determined and has only an investment stage. Kato (2009), identified investment as a variable where firms determine optimally at each date the size of their investment. Kato identifies increasing returns in the cost of growth whereby large firms can grow more easily. Kato identified multiple rest points as a result of strong increasing returns in the adjustment cost function. Klepper (1996) asserted that research helps create advantage of size through firm expansion. It is established that research helps in

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pushing down average costs. This advantage brings the opportunity of further research and innovation in large firms. This would in turn lead to decreased average cost and greater volume of output and fall in price. Deregulation liberalizes industries, removes bottlenecks to entry and assures competition which leads to growth and lowers product prize hence increases consumer welfare. This study is set to find if Nigeria telecom consumer products markets have been affected by the implementation of deregulation policy of 1999 in the direction of increasing number of firms(competition), volume of output and reducing of product price. According to Gupta (2013), deregulation increases consumer welfare in terms of products and services by reinforcing network and other externalities in a positive way. Deregulation, therefore, frees the market from regulation which attracts investment that increases output and lowers price.

THE ANALYTIC MODEL

Natural Monopoly, Technological change and Deregulation

A firm that is a sole supplier to the market is called a monopoly. It is at liberty to produce at any point of the market demand curve. In contrast, a natural monopoly holds economies of scale very important. It depicts a situation where only one firm can survive, or, in other words, where one firm can only produce and supply the market at a lower per unit-cost than when two or more firms operate in the industry. It can be concluded to be a situation on the cost-technology of an industry where operation of one firm is more efficient. There are numerous examples of natural monopolies, such as public utilities. The telephone, electric power and pipe borne water supply industries are examples of natural monopolies. More explicitly, the gas companies (multiple gas lines underground may not be desirable, hence one single provider); and telephone services rendered by Nigeria Telecommunications Company (NITEL) before deregulation in 1999, AT&T phone services before deregulation in USA in 1996 and electricity services provided by Power Holding Company of Nigeria (PHCN) are all examples of natural monopolies.

A firm is a natural monopoly when its cost function C (q) is **sub-additive** such that:

$$C\left(\sum_{i=0}^{N} q^{i}\right) < \sum_{i=0}^{N} C(q^{i}) \qquad (1.1)$$

for all quantities $q^1 \ldots q^N$ for which

$$\sum_{i=0}^{N} q^{i} = q.$$

.

The sub-additive average cost function represents economics of scale which is an essential property inherent in a natural monopoly. The implication is that production by one firm is socially less expensive when average costs are put into consideration. A firm that has a sub-additive cost function has the capability to produce at lower cost any given output than when the number of firms is more than one. The firm must have equal aggregate output capability with other firms. Therefore, sub-additivity guarantees the lowest total cost when there is only one supplier in the market. By all standards, the telecom industry in Nigeria was a natural monopoly before deregulation with NITEL as the incumbent firm. So, it is worthwhile to use a simple model to analyze the pricing options available to the natural monopoly under unregulated and regulated pricing systems. These graphical and mathematical analytics justify the implementation of Nigeria's deregulation policy. This model explains the NITEL's loss of monopoly power and subsidy from the government of Nigeria with the advent of wireless mobile technology.

It is further clarified in the texts that sub-additivity does not mean decreasing average cost (economies of scale), even though the latter exists in sub-additivity. This paper, in analyzing a regulated natural monopoly, made consumer surplus and profit a measure of welfare. It also assumed that the equality of price and marginal cost is a necessary condition for welfare maximization. However, the monopolist whose key interest is to maximize profit will not fix $p = mc$ in an unregulated natural monopoly. A monopoly firm would rather aspire to increase its profits by supplying the quantity q_m where marginal revenue equals marginal cost.

This is the likely option of output levels a profit maximizing firm would fix its quantity, and it is accompanied by huge deadweight loss.

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Option 1. 1 Unregulated Natural Monopoly/Pricing

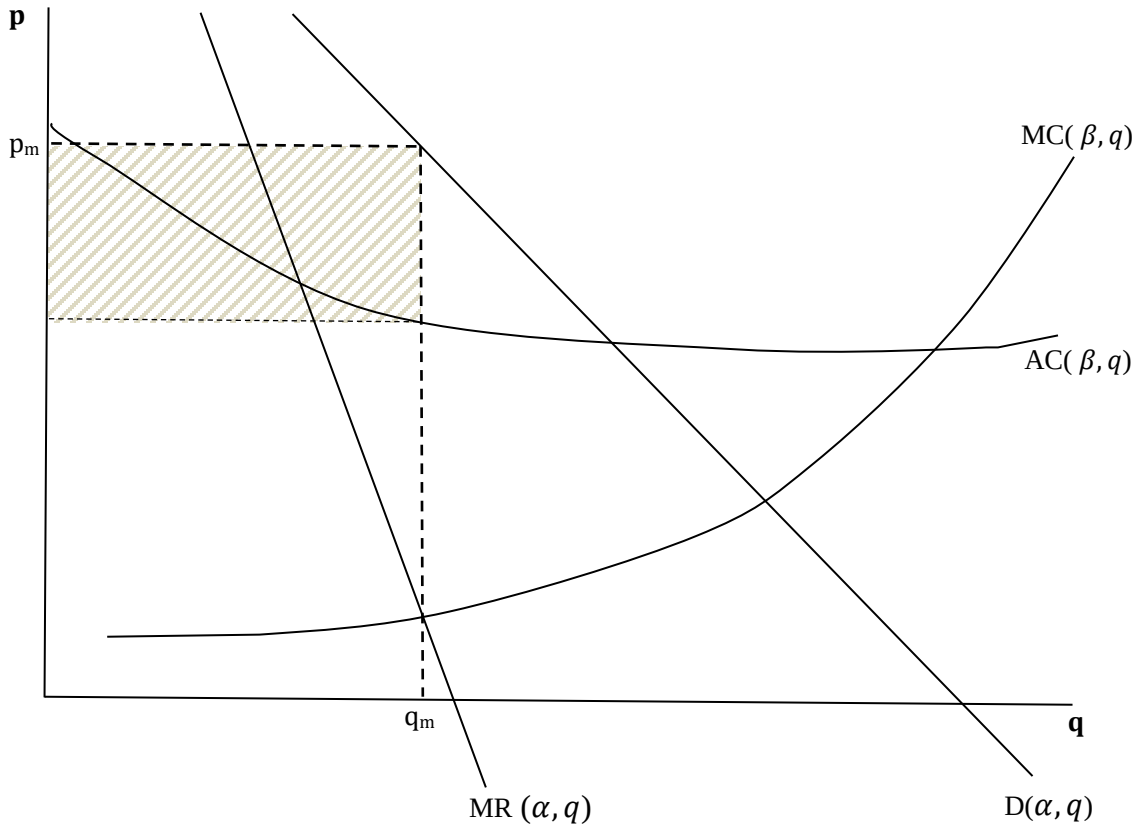

Figure 1.1 Unregulated Natural Monopoly

The figure 1.1 shows the demand curve D (α, q) the marginal revenue MR (α, q), and the average cost AC (β, q) where α and β are slopes of marginal revenue and average cost, respectively. The price is taken on the vertical axis and the quantity is taken on the horizontal axis. The monopolist in this market can only sell the quantity, q_m, where the monopoly price is set at p_m. Note, at this point, MR (α, q), is equal to the, MC (β, q). The monopolist makes a positive profit, $q_m\{p_m - AC(\beta, q_m)\} > 0$, as shown in Figure 1.1.

.

Regulation of Monopoly Pricing

Consider a firm that faces an inverse market demand function, p (αq). The firm's problem is to find a profit-maximizing production, q, as:

$$\max_{q} p(\alpha, q)q - C(\beta, q), \tag{1.2}$$

where
C (β, q) is the cost of producing quantity q

The first-order condition to this maximization problem is

$$\text{FOC:} \quad p(\alpha, q) + p_q(\alpha, q)q - C_q(\beta, q) = 0 \tag{1.3}$$

We may define the terms in eq. (1.3) as:

$$p(\alpha, q) + p_q(\alpha, q)q \equiv MR(\alpha, q) \tag{1.4}$$

and

$$C_q(\beta, q) \equiv MC(\beta, q) \tag{1.5}$$

Thus, the firm should produce at q which satisfies

$$MR(\alpha, q) = MC(\beta, q) \tag{1.6}$$

In the model above, q is the quantity while p is the market price. C (q) is the market cost of producing q. The constants α and β are the slopes of marginal revenue and marginal cost functions, respectively.

The profit maximizing/unregulated monopoly (monopoly firm or monopolist) will set the price (p_m) by going to where MR = MC.
The MR is the incremental money brought in by selling a unit more of the product while MC is the incremental cost incurred while producing and selling an additional unit.

An exchange is made when the money brought in is greater or equal to the additional cost incurred to produce and deliver the product to the consumer. By producing the profit maximizing quantity (q_m), the market would incur a deadweight loss as shown below in figure 1.2.

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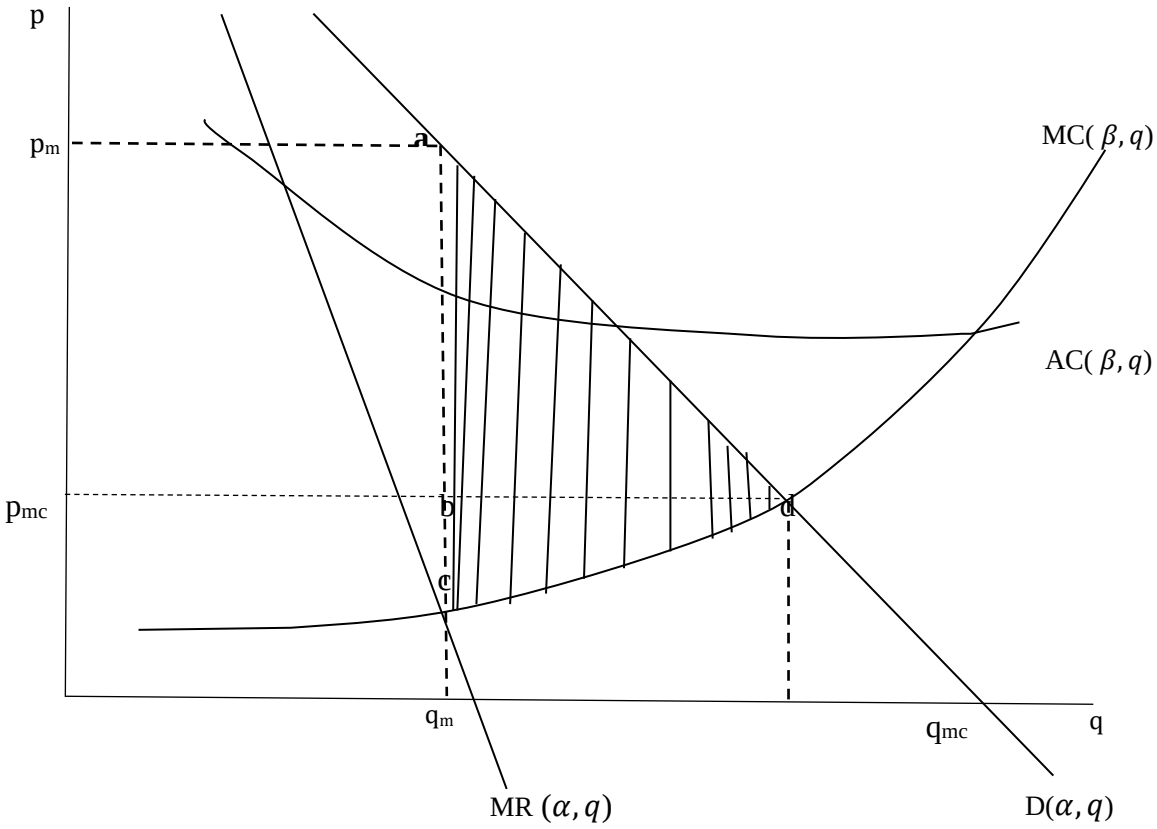

Figure 1.2 Natural Monopoly and Deadweight Loss

This is because the consumers are ready to buy at p_{mc} that is price is set where marginal cost intersects demand curve (MC= p) and the resultant quantity is q_{mc}. The **deadweight** loss is equal to the shaded area **(abcd)** that lies between the demand (DD) line and the marginal cost (MC) line, which represents the amount of underproduction. It is the integral of the area between inverse demand and marginal cost from the monopoly output (q_m) to the welfare-maximizing output (q_{mc}).

$$\text{Deadweight loss} = \int_{q_m}^{q_{mc}} \text{p}\ (\alpha, q) - MC(\beta, q)dq. \qquad (1.7)$$

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The deadweight loss that arises from an unregulated monopoly justifies the price regulation by a policymaker. In order to minimize this, a policymaker might consider these two types of price regulations below.

Option 1.2 Marginal-Cost-Pricing Regulation/Pricing

The second pricing option in a natural monopoly model is to produce the quantity where price equals marginal cost. Here, where p = MC is the **marginal-cost-pricing regulation** marked p_{mc} on the graph**.** This price option is the best for the consumer because the price is lower than the monopoly price and there is no deadweight loss as shown below.

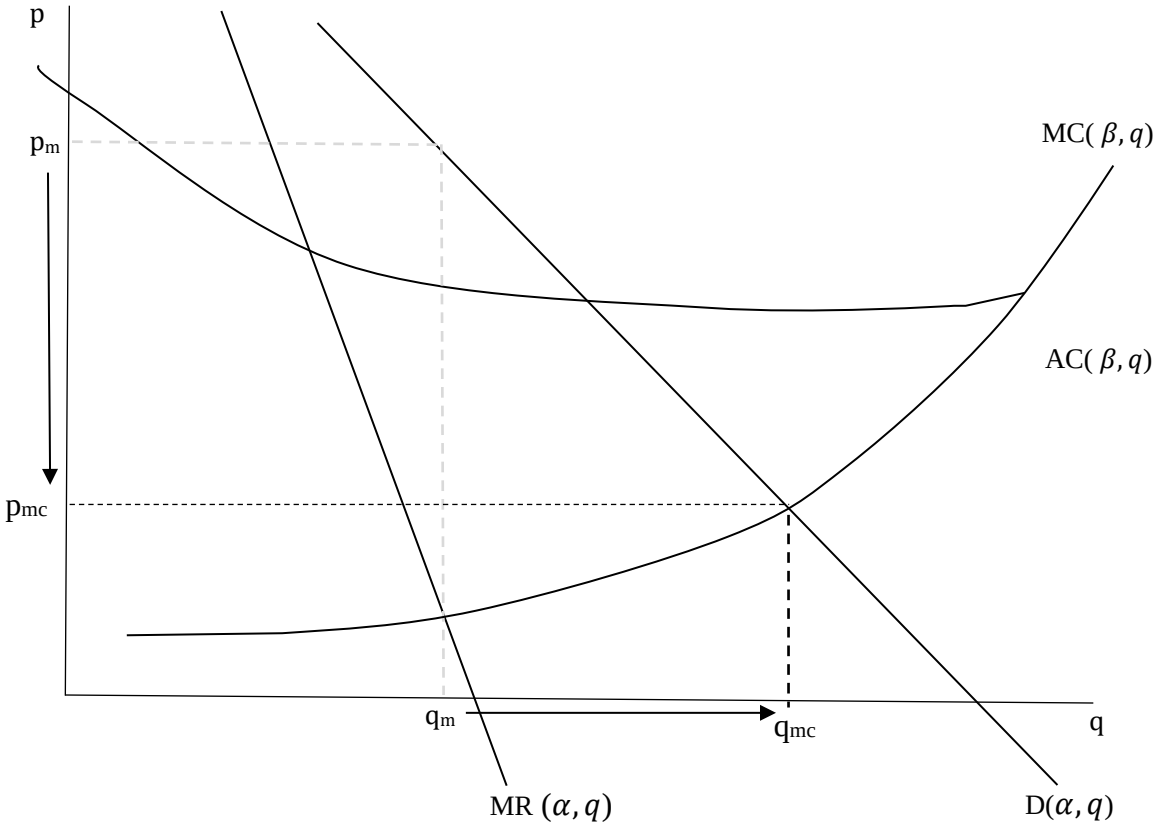

Figure 1.3 Regulated Natural Monopoly with Marginal-Cost-Pricing Regulation

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In figure 1.3, the monopolist produces the welfare-maximizing quantity (q_{mc}) that satisfies the following equation:

$$p(\alpha, q) = MC(\beta, q) \tag{1.8}$$

The arrow on the vertical axis (price axis) shows that there is a significant price fall from the price of the profit maximizing monopolist to the welfare maximizing monopolist. Moreover, there is also a noticeable increase in quantity as indicated by the arrows on the quantity axis. However, when price is set where **p = MC**, it is observed that the price p_{mc} is below the average cost (AC) at the quantity (q_{mc}). When average cost is above the price, it is crystal clear that the firm would earn a negative profit. The only way for the firm to survive is for the government to **subsidize** the monopolist.

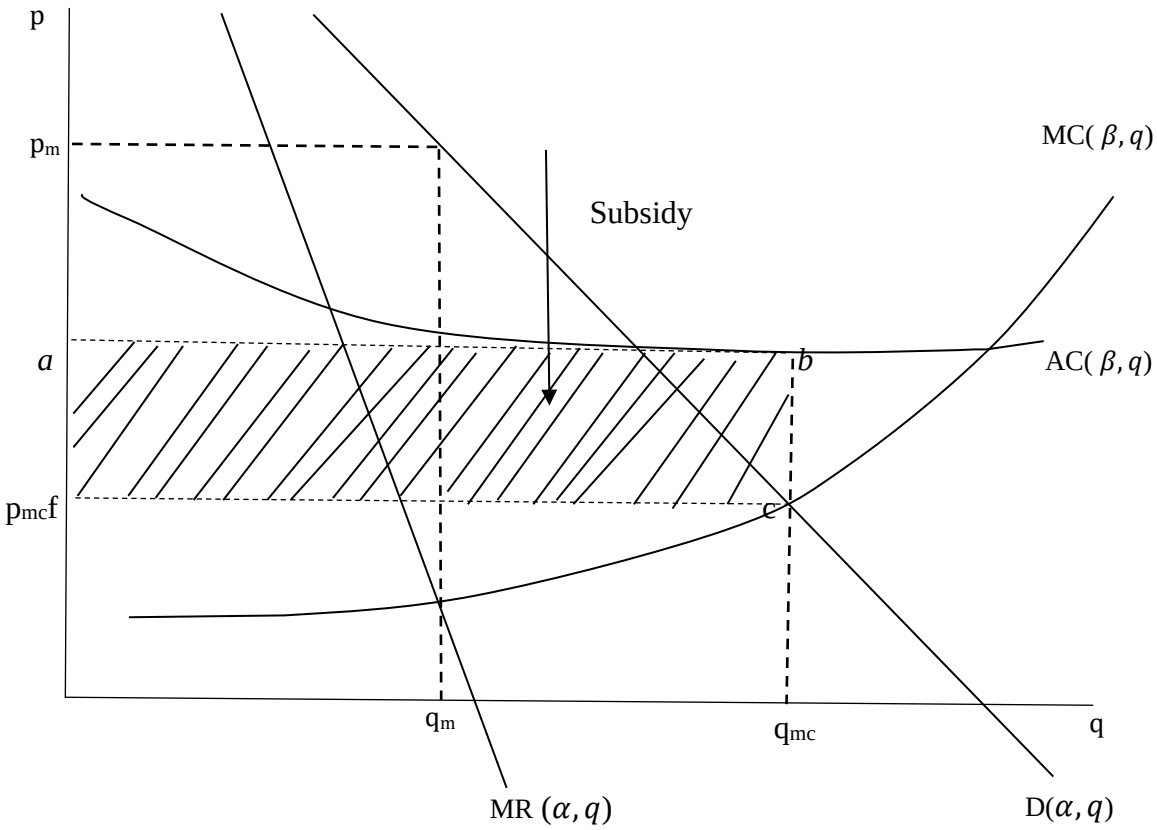

Figure 1.4 Government Subsidies under Marginal-Cost-Pricing Regulation

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The monopolist receives a subsidy

$$S = q_{mc}\{AC\ (\beta, q_{mc}) - MC(\beta, q_{mc})\} \quad (1.9)$$

such that its operation is at **breakeven point.** In figure 1.6, the amount of subsidy is **abcf**.

Furthermore, when the regulator fixes P = MC as solution to produce the welfare-maximizing quantity of output and MC $<$ AC then the monopolist firm is not financially viable because of economic loss and must receive subsidy. This issue of a subsidy is always controversial. In order to avert this issue, the policymaker regulates natural monopolies in such a way that they earn zero economic profit (normal rate of return). Next we discuss the average-cost-pricing option.

Option 1.3 Average Cost Pricing Regulation/ Pricing

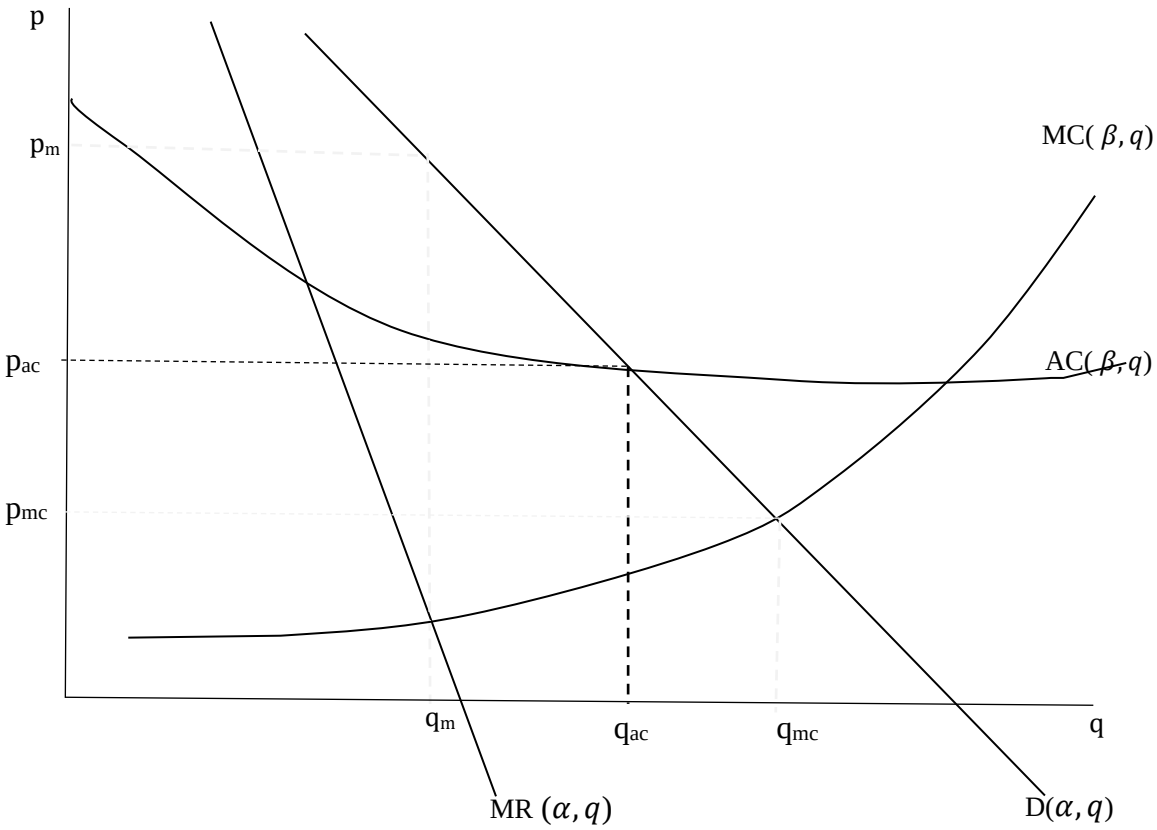

Figure 1.5: Average cost pricing

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When the average-cost-pricing regulation is imposed, the monopolist produces the quantity that earns zero profit, i.e.,

$$p(\alpha, q) = AC(\beta, q) \quad (1.10)$$

Thus subsidization is unnecessary in this case. If the price is set where the demand curve (D) and the average cost (AC) intersects, it provides a best of both world's solutions. Here, the price (p_{ac}) is lower than what it would be if the government left the industry unregulated and the dead weight loss is smaller though the quantity $\mathbf{q_{ac} < q_{mc}}$ **but** $\mathbf{q_{ac} > q_m}$**.** The government would not have to subsidize the company. The demerit is that the company lacks the incentive to keep cost low, and, as a result, average cost will simply rise and costs will subsequently be pushed to the consumers. Actually, the telecom industry in Nigeria as a natural monopoly was making **negative profit** without subsidies. This assertion can be confirmed by the records of the Bureau for Public Enterprises as cited by Okonjo-Iweala[2], 2012. It was found that for a period of 26 years (1973 to 1999), Nigeria invested over $100 billion (USD) in its public enterprises. NITEL, as a government corporation got on the average $3 billion (USD) per year in subsidies. It was against this background that the Federal government of Nigeria decided in 1999 to implement deregulation policy in the telecoms industry to seize the opportunity of the arrival of relatively cheap new wireless phone technology to reduce average costs and save the state from waste.

TECHNOLOGICAL CHANGE IN A MONOPOLY MARKET

The telecom markets worldwide experienced technological innovation through digital wireless mobile phones. The providers create networks via satellite technology. There are currently three providers namely Global Service for Mobile Communications, Code Division Multiple Access and Integrated Digital Enhanced Network. The mobile phone technology is far cheaper and less cumbersome to provide than the analog technology that uses cable lines laid underground. To cap it all, we have now numerous wireless networking capabilities. They are integrating as they are emerging. It can be deduced as well as expected, that based on the current trend, these technologies will produce faster-speed and longer-distance capabilities. An example of the one already in place is Wi-Fi, which is limited to buildings, Campuses and business premises.

[2] Ngozi Okonjo - Former Managing Director of the World Bank and the Coordinating/Finance Minister of Nigeria's Economy 2015.

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There exists also worldwide inter-operability for Microwave Access (WiMAX), which allows its wireless service everywhere.

In the USA, T-Mobile and Cingular[3] use GSM technology, Verizon and Sprint Wireless use Code Division Multiple Access technology (CDMA technology), Nextel uses iDEN. Nigeria's neighbor South Africa has been already enjoying this service before 1999 through their major phone companies, including MTN South Africa, which is GSM technology. Other West African countries such as Niger, Togo, Ivory Coast, Ghana and Benin also have access to these cheap wireless phone technologies. So after studying the cost effectiveness, capabilities and accessibility of wireless phone services, the government of Nigeria in a conscious effort to reduce government subsidies to corporations, encourages private participation to enhance efficiency. Nigeria deregulated the telecom industry in order to remove NITEL's drain from the State's treasury with the expectation of maximum utilization of its cost effectiveness for social welfare and economic growth.

When the Nigerian telecom industry experienced an introduction of new technology (Mobile phone technology), it witnessed a significant reduction in the production cost of its service. For example, it was costing NITEL over *one hundred million naira to lay underground telephone cables for an area of ten kilometers square radius* before, but now it costs mobile phone companies *ten million naira to install a satellite transmission station* that covers the same area (NCC,2012). This fall in the cost of production implies a decrease in product price. So, in applying the law of market forces, a fall in cost of production permits a rise in supply of the product. Therefore, the firm can now make *a positive profit***.** At this stage, Nigeria's telecom industry is no longer a natural monopoly because other firms can enter the industry and incur positive profit. It is economically wise to deregulate the industry as it will invite entries of additional firms to participate which engenders competition and its attendant benefits in the telecom industry

[3] There was a merger between Cingular and AT&T in 2004, and recently Sprint and Nextel joined to form a big organization

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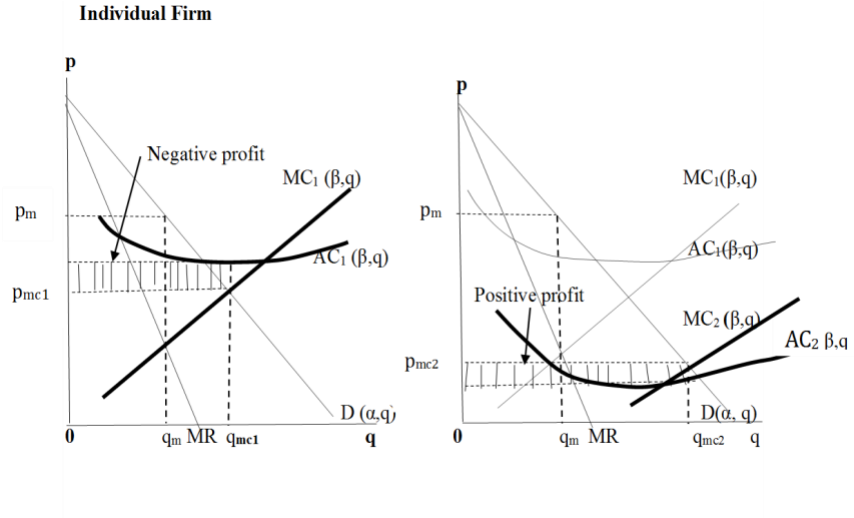

Figure 1.6a Effects of Technological Shock in a Natural Monopoly

The curves of marginal Cost (MC_1) and Average Cost (AC_1) represent the respective costs of the individual firm before the emergence of new technology while the curves of marginal cost (MC_2) and average cost (AC_2) denote the respective costs after the arrival of new technology. The latter set of curves show a decrease in cost of production as proposed by the model. The symbol P_m stands for monopoly price while P_{mc} depicts marginal cost pricing. The competitive price in figure 1.6b below is represented by P_c and MR stands for marginal revenue.

The figure1.6a (left –side graph) is a given representation of a natural monopoly (individual firm) before technology shock with monopoly price (p_m) and quantity (q_m). The price, p_m, and the quantity, q_m, are set in such a way to maximize profit, i.e. MR = MC, and it leads to deadweight loss. This pricing is not welfare friendly but with the imposition of marginal cost regulation where price is set to marginal cost (MC = P), the price falls, the quantity rises and therefore, welfare improves. However, the government has to **subsidize** the natural monopolist for it to **break even** because price is below average cost.

Furthermore, in figure 1.6a (left-side graph), the monopolist makes negative economic profit under marginal cost because price is below average cost. The shaded portion of the graph highlighted by the arrow is the **negative profit**. This actually inhibited entry as well as competition in the industry because firms in the industry are making a negative profit. This is the reason why there is no entry of new firms and competition in the industry before the technology shock.

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Suddenly, a new technology – wireless phone technology **shock** was experienced in the telecom industry which reduced the cost of production from AC_1 to AC_2 as shown in the right-side graph with new marginal cost MC_2. After the arrival of new technology in the industry, the monopolist firm does not need a subsidy to continue with marginal cost pricing as shown in figure 1.6a (right-side graph). At the right-side graph, the monopolist makes a positive profit under the marginal cost pricing represented by the shaded area with reduced cost of production. The government does not need to subsidize the industry with marginal cost pricing since the firm can make a profit as a result of new technology, which has reduced cost to AC_2 and moved down marginal cost price to a point lower than its former high position. This is possible because the cost of production has decreased from AC_1 to AC_2. At this point in time, it is advisable to deregulate the sector, so that other firms can enter and take advantage of the positive profit until it is zero. This is good for the industry and the economy because it will enhance availability of product at a considerable rate (price). It will also make possible the provision of efficient services.

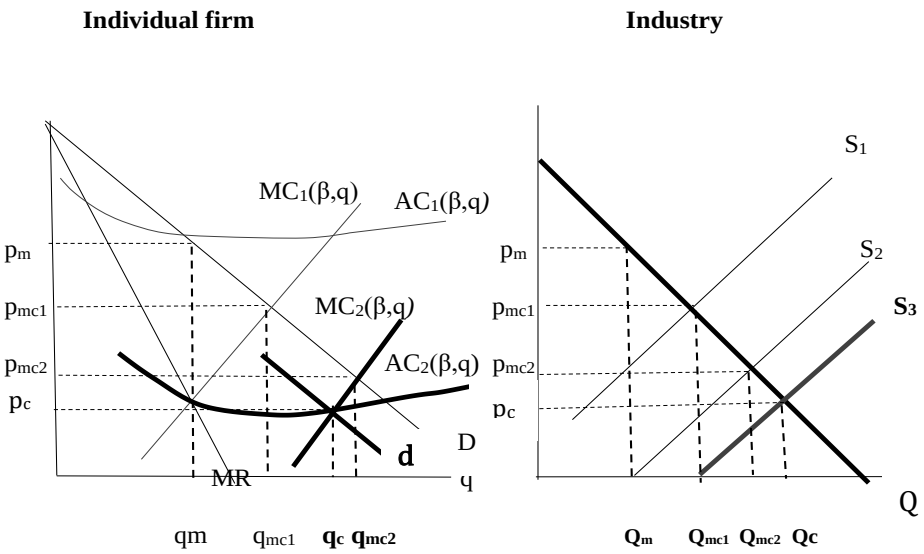

Figure 1.6b Effects of Deregulation on Individual firm and Industry

In figure 1.6 b (left-side and right–side graphs), it can be deduced from figure 1.6b (left-side graph); that the monopolist firm does need government financial intervention at the marginal pricing to remain in business. But with the new technology, the firm can run the industry with **profit** and not incur deadweight loss at any price where MC_2 equals demand (D). This is because the new technology has reduced the cost of production to AC_2 as shown by the left-side graph.

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Any price above p_c where MC_2 cuts **D** leaves the monopolist with a positive profit in a marginal cost pricing. Here, there is no deadweight loss, no negative profit and no allocative inefficiencies of monopoly that fix price above marginal cost. In addition, more quantity is produced at q_{mc} than at q_m. With the deregulation policy in effect, more firms enter the industries to take advantage of the profit which produces an inside shift of the demand curve (**d**) with increased competition.

It continues shifting until profit is zero. This increases availability of product to Q_c as shown above. In the figure 1.6b (right-side graph), it can be seen that if the industry remains a monopoly, it can continue supplying the telecom product at S_1 at price p_{mc1} with a subsidy covering cost and making negative profit. The fact is that there is only an individual monopolist firm in the industry so the industry–wide output should be equal to what a monopolist produces. Hence, the interactions of technology and market forces produce a new equilibrium where the average cost (AC_2) intersects marginal cost (MC_2) at price pmc_2 with positive profit at an increased quantity. The monopolist firm, therefore, gives the lowest price p_{mc2} and highest quantity oq_{mc2}. It is pertinent to state here that q_{mc2} is the total quantity supplied in the industry by a monopolist before deregulation. It has shown a significant decrease in price and increase in quantity at positive profit. More firms can now enter the industry as a result of deregulation and this produces the competitive price Pc which leads to an increase in industry aggregate supply as denoted by curve (S_3) with quantity Qc and inside shrinking of individual firm's demand curve to the left. As competition continues, the price falls to the lowest ebb p_c and lower quantity than oq_{mc2} to oq_c. It is pertinent to state here that q_{mc} is the total quantity supplied in the industry by a monopolist.

Thus, a **deregulation policy** can now trigger more entry of other firms since the average cost is low**.** As entry continues, an individual firm's demand curve shifts to d as shown in figure 1.6b (left-side graph). The process continues until an individual firm's profit becomes zero. This entry of new firms is represented by industry supply function S_3 and at a competitive offer price of p_c.

The industry-wide supply increases from Q_{mc2} to Q_c due to entry of firms as shown in 1.6b (right-side graph). It was, therefore, economically wise for the Nigerian government to remove barriers to competition in the telecom industry by deregulating the industry. This is because more entries of firms into the industry would engender competition, lower production cost, improve allocative efficiency and reduce product price. Entry should be encouraged to the extent that demand for the monopolist firm's product would decrease to the point where individual firm makes zero profit. This is depicted by point: p = mc = ac, in the left-side graph of 1.6b.

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In the alternative, it can be said that a technological shock reduces the marginal and average costs of production as follows:

$$AC_1(\beta, q) > AC_2(\beta, q) \quad (1.11)$$

and

$$MC_1(\beta, q) > MC_2(\beta, q) \quad (1.12)$$

and also, the cost function becomes **super-additive**

$$C(\sum_{i=1}^{N} q^i) > \sum_{i=1}^{N} C(q^i) \quad (1.13)$$

for all quantities $q^1, \ldots, q^N$ for which

$$\sum_{i=1}^{N} q^i = q. \quad (1.14)$$

Sub-additivity is a necessary and sufficient condition for natural monopoly, and now technological shock has led to super–additivity, which implies that more than one firm can operate in the industry, producing a proportion of the same product and still enjoy economies of scale. It is, then, economically advisable to open the industry to competition -- to liberalize or deregulate the industry as this will lead to competition, efficiency, a rise in output and affordable, low prices for the greater welfare of the society.

As noted above, deregulation of the industry becomes attractive as the cost function is super-additive rather than sub-additive; it is financially viable for more firms to operate in the industry. This is because the high average cost which made it difficult for more than one firm to produce has gone down drastically due to the arrival of wireless technology that has reduced the cost of doing business. If an industry is no longer in the state of natural monopoly due to technological progress, liberalizing the monopoly market becomes a good option for the government as this will reduce government involvement in the industry to a supervisory role rather than a player with invested capital/fund in the industry. The gain that is derivable from this deregulation of the telecom sector is that funds that should have gone out from the government through subsidy will be conserved and channeled towards other developmental projects. When a deregulation policy is implemented, competition subsequently emerges as more than one firm is allowed to operate in the industry.

An increase in the number of competitors (more firms entering the industry), and the opening up of the industry leads to an increase in output and a further fall in price. In summary, the above model predicts that technological shock can bring a change in the status of a natural monopoly to perfect competition.

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For example, if high total cost inhibits the development of competition in an industry, technology can reduce the cost of production on arrival, which makes it possible for more individual firms to enter the industry and invest as a result of low average costs which will lead to an increase in output and fall in price. This scenario is a good development for the consumer's welfare.

RESULTS

Impact of Deregulation Policy on Output, Carriers/Competition and Price

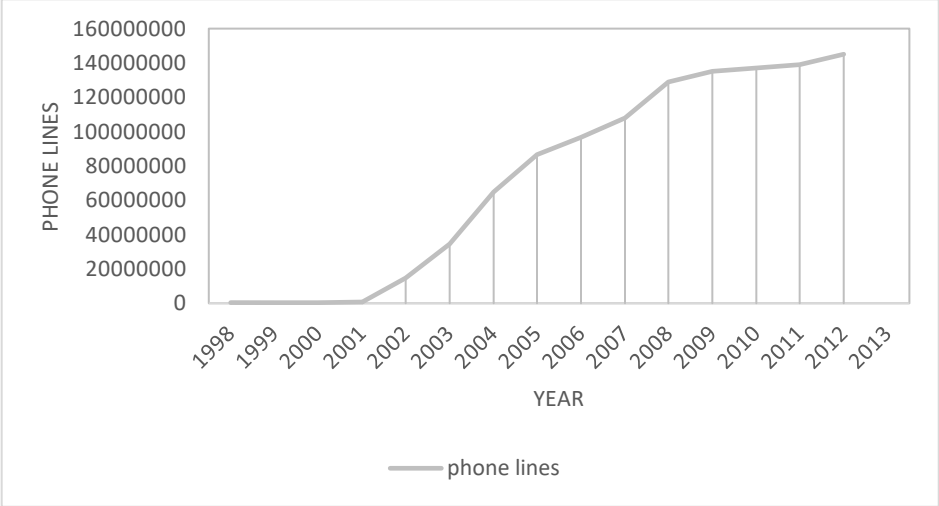

Figure 1.7 Number of Telephone Lines (Source of Data: NCC, 2015)

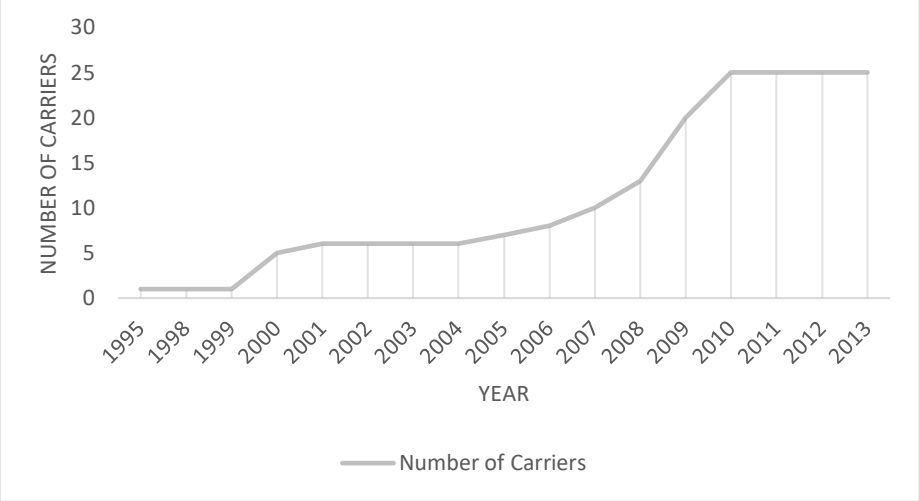

Figure 1.9 Phone Calls Billing (Source of Data: NCC, 2015)

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CONCLUSION

The Nigeria telecom industry prior to the implementation of the deregulation policy had only NITEL, a government monopoly, as the only firm operating in the industry which up till 1999 could give Nigeria, a country of about 200 million people, 450,000 telephone lines but with deregulation, Nigeria can boast of 130,760,406 million functional phone lines (NCC, 2015). Deregulation enhances competition. It brought private investors both domestic and international with enormous capital into the industry. The number of carriers goes up. The cost of production went down as a result of availability of mobile phone technology and more firms entered the industry. This fall in the cost of production led to fall in product price. With more firms' entry, competition ensued and this led to increase in the industry-wide supply. This hence reduces the product price. The Nigerian data showed that before the deregulation, it was costing about 25naira/min to make a domestic call within a city, 150naira/min inter-Nigerian states and 250naira/min or more internationally but post deregulation data showed a drastic reduction in the domestic and international billing rates. According to the data, it now costs less than 4naira/min for domestic calls and less than 20naira/min for international calls. In summary, the study answers the research question: "Does deregulation policy implementation as explained by analytic model increase the number of firms (number of phone carriers), quantity of output and lower price in Nigeria's telecom industry? Based on the Nigerian data analyzed above the answer is in the affirmative.
However, the Nigeria telecom industry is not a perfect competition rather tends to some form of competition similar to monopolistic and oligopolistic competitions. It will never be a natural monopoly.

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