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# **Structural Inefficiency in the Early Twentieth Century:**

Studies in the Aluminum and  
Incandescent Lamp Markets

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## I. Abstract

The 1930s were tumultuous times for the global economy and especially the United States. A global depression, almost a decade in length, had a lasting effect on world markets. As the United States emerged from the recession of 1937, it appeared that an end to this economic disaster was in sight. However, as the economy lifted itself out of the malaise of the previous decade, prices did not fall as expected. Thus, it was feared that the demand that fueled this recovery might be squelched by the stagnant, inflated prices. Weeding out the market inefficiencies such as cartels or oligopolies that kept prices artificially inflated became a priority of the Department of Justice and the economic policy makers at the Federal Reserve and the Treasury Department.

Three areas must be examined when considering such market inefficiencies and their corrosive economic impact. First, each type of market inefficiency must be identified. Second, industries that may have been characterized by such market inefficiencies must be examined in light of the different theoretical models. Third, by applying theoretical models of market inefficiency to these industries, it must be determined whether they were actual sources of economic inefficiency.

Before the Department of Justice could actively use the Sherman and Clayton Antitrust Acts to attack such anti-competitive practices, it was vital to identify the exact nature of the inefficiency. Three types of structural inefficiency can exist in the market. Monopoly, monopolistic competition, and oligopoly are structural descriptions of any given industry. They are classified by their varying degrees of impact on pricing and output decisions in any given industry. Each different structure has various advantages and disadvantages; however, they all have one common characteristic. All three structural forms artificially inflate the price of a product and restrict its output, hence moving the production point to an economic and socially inefficient point.

### *1.A Perfect Competition*

The model of perfect competition is the model against which each form of inefficiency is measured. Each model of inefficiency differs in some specific aspect from perfect competition. A perfectly competitive industry exists when a number of structural conditions are met. First, no barriers to entry into the industry may exist. Any firm must be able to enter the industry at any time. Thus, an infinite number of firms may be present in a perfectly competitive industry, allowing the market to set the equilibrium point for production. It also discourages economic profit because as firms artificially inflate prices, new firms will enter the industry to restore the equilibrium price determined by the market. Secondly, no product differentiation is possible. The products in a perfectly competitive industry must be perfect substitutes. Thus, the product from one firm can be substituted for any product from any other firm in the industry. This condition means that only one demand/supply schedule is present for an industry, a demand/supply schedule determined by market forces. Third, no single firm can exercise any control over price/production decisions in a perfectly competitive industry. It must be kept in mind that perfect competition is an unrealistic, theoretical model of the most efficient mode of competition. Thus, no industry will ever meet all the conditions of perfect competition although it is possible to attain some.

### *1.B Monopoly*

Monopoly is the most commonly understood form of market inefficiency. A monopoly consists of a single firm that produces a product with no close substitute and the industry has significant barriers to entry which prevent other firms from entering. There are a number of market conditions that must exist for any industry for it to correspond to the model of a monopoly. The primary market condition of a monopoly is the significant difficulty firms face when entering the industry. In fact, the barrier to entry

is absolute. A solitary firm controls the market and no other firms may enter the industry and undercut the economic profits of the monopolist.

There are a number of practical barriers to entry that allow the monopolist to retain his absolute control over the market for a given product. Governments provide the first example of a barrier to entry resulting in a monopolistic industry. The government determines that certain industries, such as water, electricity, cable television, and local phone service, are most efficient when operated as monopolies. Thus, the government allows that these industries exist as monopolistically structured, while closely regulating their pricing practices.

Government often encourages another barrier to entry in any given industry. Patents, filed and approved at the government patent office, allow corporations to lay exclusive claim to a process or product. Despite the obvious intellectual property problems inherent in abandoning the patent system, it serves as a way for a monopolist to gain legitimacy for the control over pricing/production decisions in an industry. Because of the two competing interests of intellectual property and antitrust enforcement, licensing is often proposed as a solution. A corporation is allowed sole patent to a process or product; however, a corporation is also forced to license this process or product to outside firms, in order to promote competition in a given industry. In this fashion, the inefficiencies of monopoly would be curbed and the resulting price/production point would demonstrate a decrease in price and an increase in production. While this is not as efficient as perfect competition, licensing seems to provide a valid means to promote compromise between advocates of intellectual property rights and advocates of antitrust enforcement.

Economies of scale and the cost advantages of a monopoly structural also serve as a barrier to entry. If an industry favors a firm that can achieve high cost efficiency due to economies of scale, smaller firms face significant barriers to entry, for they do not

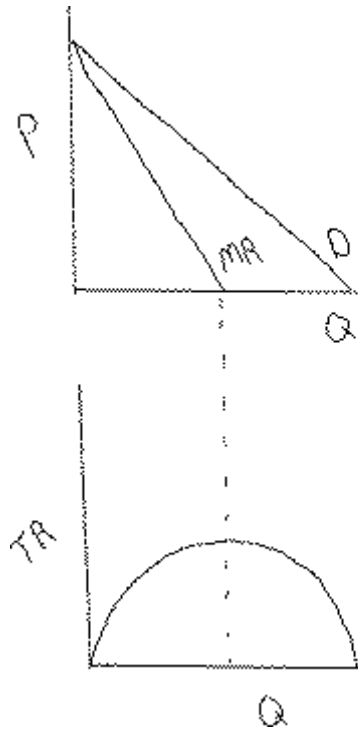
have the opportunity to develop such cost efficiency. Such economies of scale must be realized at a scale that is close to total demand in a market. This economy of scale is a significant barrier to entry in industries in which the variable costs are high, for firms will not risk entry without access to the opportunity to develop economies of scale.

The final and perhaps most historically significant barrier to entry in an industry is concentrated ownership of a scarce factor of production. If a single firm owns the majority of bauxite in the world, a key factor of production for aluminum, it will control the coal market. Thus, if a vertically integrated firm controls both the production of a product and the scarce factors of production for that product, it has erected insurmountable barriers to entry in its given industry.

The factor which distinguishes monopolies from individual firms in other forms of market inefficiency is that price is the fourth decision variable for the monopoly, whereas in other forms of market inefficiency, price is not solely controlled by the firm. In perfect competition, the firm has three decision variables. It decides how much of a product to produce. It also decides how to produce a given product. Finally, it decides how much to demand in the input markets. However, a firm in a perfectly competitive industry does not control the price that it charges for its product. Price is the fourth decision variable for a monopolistic firm because the market lacks the power to set prices. In perfect competition, the firm is a price-taker while in monopoly the firm is a price-maker.

This difference in pricing illustrates another crucial distinction between monopolistic and perfectly competitive industries. In perfect competition, two demand curves exist, one for the firm and one for the industry. In monopoly, only one demand curve exists and it represents not only the demand for the firm but also the demand for the entire industry.

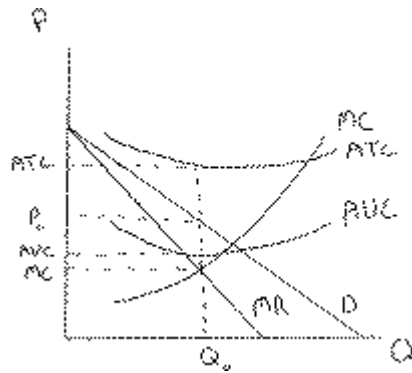
Graph 1.1 Output, Revenue, and Demand



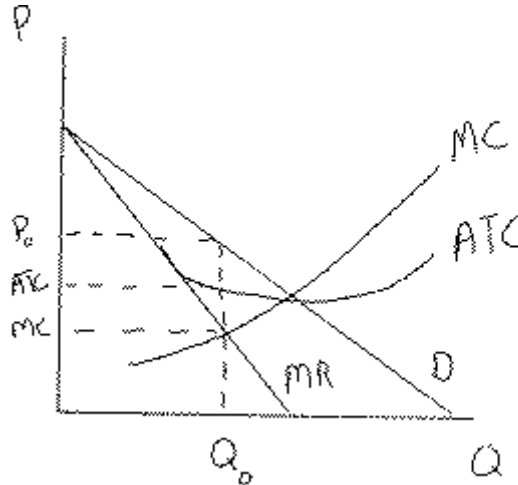
Profit-maximizing monopoly is the most prevalent model of monopoly. The profit-maximizing monopoly is a single firm that exercises significant control over the market conditions of a given product. Like any firm, the profit-maximizing monopoly seeks to maximize profit, even profit above and beyond the normal profit included in cost. This additional profit is called "economic" profit. In the course of operation, a monopolist faces a series of price and output choices that dictate the behavior of a monopoly firm.

Profit-maximizing monopolies produce at the point where the marginal cost of producing a unit of a product equals the marginal revenue, just as a perfectly competitive firm would. However, because the marginal revenue and demand curves are separate for a monopolistic industry, the monopolist is able to artificially inflate prices. This is important because this is the source of the economic profit which monopolies so jealously guard. Depending upon the cost curves, a firm behaving in this fashion can either accrue substantial economic profit or suffer significant losses.

Graph 1.2 Profit-Maximizing Monopoly Firm Operating at a Short Term Loss



Graph 1.3 Profit-Maximizing Monopoly Firm Operating at a Short-Term Loss

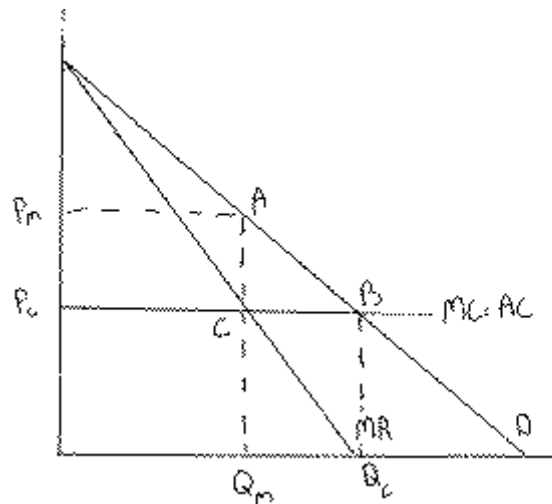


Despite the additional profit generated for individual firms within monopolistic industries, monopoly remains a socially and economically inefficient mode of production. This is due to the fact that monopoly generally results in an inefficient mix of pricing and output. Consumers are overcharged due to higher pricing and the output is restricted, thus opening the possibility that the monopolist may not meet the quantitative needs of the market.

The inefficient mix of pricing and output in a monopolistic industry results in economic profits. In the interests of profit-maximization, the monopolist will act to safeguard these economic profits, from either other firms or the government. This

behavior is termed "rent-seeking" behavior. As shown on graph 1.4, the monopolist seeks to protect a clearly defined wedge of profit that is represented by square  $P_mACP_c$ . Triangle ABC represents the net social loss or gain, depending upon the direction of prices and production. In a monopoly industry, this represents the net social loss along with square  $P_mACP_c$ .

*Graph 1.4 Social Inefficiency of Monopoly*



Often monopolists enlist the government, in opposition to a free and competitive market, in order to protect economic profits in a situation known as government failure. Government failure occurs when the government becomes the tool of the rent-seeking monopolist and the allocation of resources in the marketplace is actually made less efficient by government intervention.

### *1.C Monopolistic Competition*

Monopolistic competition is separate, distinct form of market inefficiency from the commonly understood monopoly model. Monopolistic competition requires a number of basic market conditions. First, there are a large number of firms in a monopolistically competitive industry. Second, no barriers to entry can exist, although in practice there is



an exception to this condition that I will examine later. Third, unlike the homogeneous products of a perfectly competitive or monopolistic industry, product differentiation exists in a monopolistically competitive industry. Fourth, each firm is relatively small with respect to the total market and therefore does not possess the same pricing power as a monopolist or oligopolist. Finally, despite product differentiation, products must be relatively good substitutes for each other.

Product differentiation is a crucial condition of a monopolistically competitive industry. Often increased product differentiation results in increased market vitality. For instance, the soft drink market is a good example of product differentiation in a monopolistically competitive industry. A number of different products, each slightly differentiated from the next, compete with each other in a cutthroat market. This differentiation has led to increased competition and vitality in the marketplace. A by-product of this increased level of competition is a level of efficiency and quality far superior to that of a monopoly.

However, there are also potential disadvantages to product differentiation. In order to create different identities for products in large markets, firms must spend a high percentage of their revenues in order to market and fashion such an identity. These advertising costs generally exceed what usually is assumed as a natural cost of doing business. It is also argued that these vast sums are spent in order to create separate public identities for products that are essentially the same. For instance, Pepsi and Coke have enormous advertising budgets in order to protect their respective market images. However, the actual differences between the products are minimal.

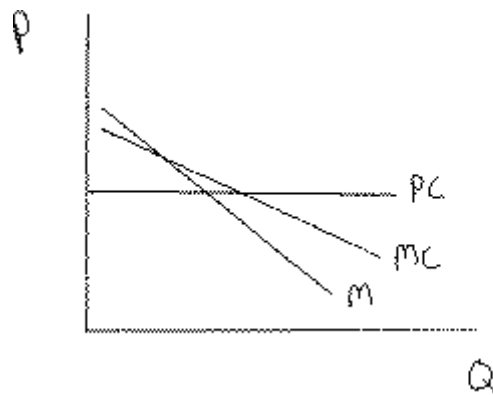
A monopolistically competitive industry generally has no barriers to entry. Advertising is the exception to this rule. In fact, given the modern cost of television, radio, and print, advertising has become a significant barrier to entry. If a firm cannot

support the high burden of advertising costs, it will not enter an industry. Thus, the myth of an industry free of industry barriers is simply a myth.

These barriers to entry do not represent the only detrimental effect of product differentiation. In fact, the primary cost of product differentiation is social in nature. The market spends an inordinate amount of time digesting advertisements. The firm spends a similar amount of time creating such advertisements. The opportunity cost of this wasteful activity is enormous. If the resources devoted to product differentiation were devoted to product development, productivity and efficiency would improve.

Price and output determination in a monopolistically competitive industry is significantly different from price and output determination in monopolistic or perfectly competitive industries. Price and output determination varies by industry due to the differences in demand curves for each respective industry.

*Graph 2.1 Varying Elasticities of Demand*

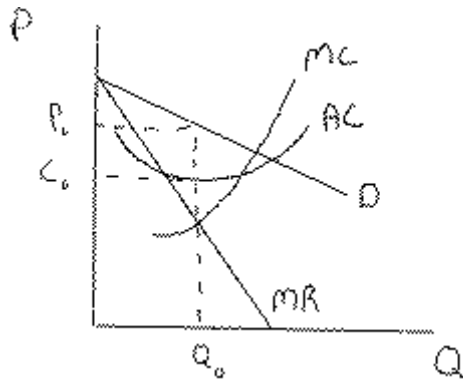


This graph illustrates how the elasticity of demand for a firm in each industry affects the respective demand curves and thus the determination of pricing and output. As this graph illustrates, demand for a firm in a perfectly competitive industry is the most elastic, due to the market conditions promoting efficiency. The demand curve for firm in a monopolistically competitive industry is somewhat elastic, for monopolistic competition

is more efficient than monopoly but is less efficient than perfect competition. The demand in a monopolistic industry is the most inelastic of demand curves due to the existence of only one firm in the industry. Therefore, the demand curve of the industry is the demand curve for the firm. Evaluating the various demand curves and their respective elasticities is necessary to evaluate the efficiency of a monopolistically competitive industry in comparison to other market models.

A firm in a monopolistically competitive industry operates under a similar profit-maximization model as a monopolist. However, because of differences in elasticity of demand, the monopolistically competitive firm facing a much slimmer profit margin. The following is a graph of a monopolistically competitive firm earning short-term economic profits.

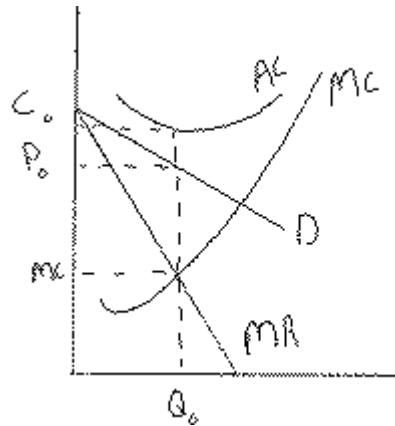
*Graph 2.2 Monopolistically Competitive Firm Operating at Short-Term Profit*



As evident, the firm sets output at the point at which marginal revenue equals marginal costs. Price is set a  $P_0$ , the corresponding price point to  $Q_0$  on the demand curve. Because  $P_0$  exceeds the average total cost represented by  $C_0$ , the firm earns economic profits. However, in contrast to a monopoly industry, firms are allowed to entry this industry without obstruction. Thus, firms will enter the industry in order to realize a portion of these economic profits.

A similar situation exists when a monopolistically competitive firm is incurring losses. A similar profit-maximization model exists, however average total cost exceeds price so the firm operates at a loss.

*Graph 2.3 Monopolistically Competitive Firm Operating at a Short-Term Loss*



However, price exceeds the average variable cost so that the firm is able to continue to operate. As a firm operates with such losses, it depreciates its capital stock and forces itself out of business. Inefficient firms are eliminated in this fashion.

A monopolistically competitive firm in long-term equilibrium will not earn any economic profits nor will it operate at a loss. The lack of barriers to entry in a monopolistically competitive industry means that firms will enter and exit depending on whether economic profits or losses are present. The primary condition for long-run equilibrium is that the demand curve is tangent to the average total cost curve. At this point, a firm is neither earning nor losing economic profit. In this fashion, a monopolistically competitive firm in long-run equilibrium is similar to a perfectly competitive firm.

Despite the social benefits of a monopolistically competitive industry, there are significant problems in economic efficiency and resource allocation. Despite the increased production levels, production is significantly reduced from perfectly

competitive levels. In addition, because a monopolistically competitive industry represents an economic compromise between monopoly and perfect competition, firms are not able to realize the full economies of scale and their subsequent contribution to efficiency that monopolies can. Hence, the monopolistically competitive industry is still a model of significant market inefficiency in comparison to perfect competition.

### *1.D Oligopoly*

The third model of market inefficiency is oligopoly. An oligopoly is an industry structured with a few large firms, large enough to influence market prices in concert but not individually. In contrast to other models of market inefficiency, products may be homogeneous or differentiated. In an oligopolistic industry, the behavior of individual firms influences the behavior of other firms. Hence, the study of the inter-relationships between firms comprises a large portion of the study of oligopoly. Five primary, distinct models of oligopoly have been developed, each with its own description of market structure within the aforementioned conditions.

#### *1.D.1 Collusion Model*

The first and most simple model of oligopoly is the collusion model. In the collusion model, a group of firms form a cartel for the purpose of setting joint price and output policy and generating economic profits. They set production at the point at which marginal revenue equals marginal cost. They set prices above the corresponding price point on the demand curve so that economic profits are generated. This cartel may be an explicit or tacit agreement to fix prices; the difference is irrelevant because no legal mechanism is available to enforce such price-fixing agreements.

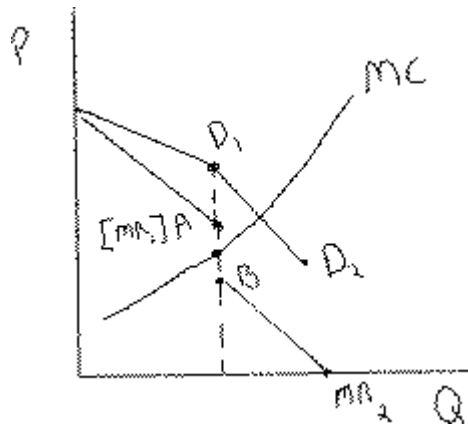
### *I.D.2 Cournot Model*

The second model of oligopoly is the Cournot model, developed by Augustin Cournot in his 1838 text, Researches into the Mathematical Principles of the Theory of Wealth. In Cournot oligopoly, there are only two firms in the industry. Output is taken as given; however, Cournot gave considerable treatment to the process which firms go through in order to reach an output point. He theorized each output decision of the two firms depended on static behavior by the other firm. Thus, static equilibrium in output is the result of such a decision-making process. In Cournot oligopoly, each firm attempts to maximize profits. Thus, the production and pricing levels in Cournot oligopoly fall somewhere between optimal pricing/production levels in perfect competition and the most inefficient pricing/production levels in monopoly.

### *I.D.3 Kinked Demand Curve Model*

The third model of oligopoly is the kinked demand curve model. In this model, the demand curve facing each individual firm has a "kink" in it. This "kink" follows the assumption that competing firms in a oligopoly structure will follow a firm in a price cut but will not follow a firm in a price increase. This discrepancy also leads to a vertical gap in the marginal revenue curve, as shown here. This graph also demonstrates how changes in marginal cost within the "MR" gap do not affect an oligopolist's pricing or output decisions. Because the oligopolist fears losing market share by raising prices and initiating a destructive price war, the oligopolist is content to allow profit to shift within this window without changing prices.

Graph 3.1 The Kinked Demand Curve



#### *1.D.4 Price Leadership Model*

The fourth model is the price leadership model. In this model, one dominant firm in the industry sets prices and all the smaller firms follow its pricing policies. Pricing and output in this model, like a number of other models of oligopoly, fall between the levels of perfect competition and monopoly.

#### *1.D.5 Contestable Market Model*

The fifth model of oligopoly is the contestable market model. Unlike the other models of oligopoly, the structure of the industry does not determine pricing and output decisions. Rather, firms make pricing and output decisions solely on the basis of the barriers to entry and exit in the industry. Price is determined solely on the basis of the barriers to entry and exit, not by the cost of production. However, the assumption is that the barriers to entry and exit in an industry really determine the cost of production. Therefore, price is really dependent upon the underlying basis for the cost of production.

It should be kept in mind that these five models do not represent every model of oligopolistic behavior. Economists specializing in market inefficiency

models such as Bertrand, Edgeworth, Stackelberg, and Chamberlin have all devised models to describe the behavior of participants (firms) in an oligopolistically structured industry. However, the five models examined previously summarize the different schools of thought regarding oligopolistic behavior without entering into a complicated examination of game theory and concentration ratios, the study of interactions between firms and how market power in an industry is concentrated. Without examining these two areas of oligopoly theory, it is difficult to understand the behavior of the participant firms in any of the preceding models.

#### *1.D.6 Game Theory*

Game theory is a complicated, mathematical body of theory regarding how participants in an industry will make decisions and respond to decisions by other firms. Strategic decision-making, a concept rooted in game theory, describes how firms take explicit account of a rival's expected response to a decision when making that decision. Strategic decision-making is particularly relevant to oligopolies because they engage in it when making pricing and output decisions. Monopolies and monopolistic competitors don't engage in strategic decision-making. This fact is important because of the role the "invisible handshake" plays in an oligopolist's decision making process. No legal mechanism exists to enforce the price-fixing agreements of oligopolists. Thus, oligopolies must consider their trust in the other market firms when making decisions.

#### *1.D.7 Concentration Ratios*



Concentration ratios also play a significant role in the decision-making process of oligopolies. They represent the fashion in which market power is concentrated in an industry. The Commerce Bureau in the United States generally publishes reports every year classifying and coding every industry in the country. Utilizing this information and market research, ratios can be developed that describe the way market power is distributed. For example, concentration ratios could indicate that three firms control 64 percent of the market share of an industry. However, they do not indicate how that 64 percent is distributed among the three firms. The distribution of market power can play a significant role in the decision-making of oligopolists because it can determine how the rest of an industry will respond to changes in price and output by a given firm. Concentration ratios can also be used to determine what model of oligopoly a given industry fits. For example, if one firm controlled 56 percent of market share, it would be logical to assume that industry followed the price leadership model.

## II. Case Studies

As the country emerged from the Great Depression and the specifically the Recession of 1937, it appeared that the economic malaise, which characterized life in the United States and much of the world for the past decade, was clearing. Glass-Steagall and emergency banking reforms of the early 1930s had restored confidence in the financial system. The industrial codes and close government regulation, although later ruled unconstitutional in Schechter Poultry vs. US (1936), had nursed business and industry back from the brink of bankruptcy. Restored economic confidence and the shrewd monetary policy of the Federal Reserve had acted to curb inflation. However, the prices and the cost of living remained artificially high.

Despite economic recovery in the industrial sector, market inefficiencies still existed in business across the industrial spectrum. The inefficient market structures often stretched across national borders, evading any national controlling legal entity. Sugar, rubber, steel, aluminum, magnesium, and incandescent lamps were all industries characterized by market inefficiency. Each of these industries had similar market structures and for the sake of brevity, I will examine only the aluminum and incandescent electric lamp industries. These two industries are both representative of the market inefficiencies in the other aforementioned industries.

While the nature of the industrial inefficiency in the late 1930s was primarily international, this examination will focus primarily on the conditions, effects, and implications of the inefficiency in the US economy.

### *II.A. The Aluminum Industry (ALCOA)*

Of any industry, commodities industries seem to be most susceptible to forms of concentrated control and market inefficiency. This susceptibility is due to the fact commodities are generally found in concentrated locations, due to physical location (metals, oil) or restrictions upon production location (wheat, grain, livestock). This condition alone makes such industries easily adaptable to concentrated control. Because of this natural susceptibility, it is not surprising that aluminum has been subject to concentrated control for its history as an industrially useful metal, both domestically and internationally.

In the late 19<sup>th</sup> century, processes were developed to strain bauxite, the only practical source of aluminum, from its natural impurities. Corporations rushed to patent their processes and began production of aluminum alloys and pure aluminum. In 1893, the Pittsburgh Reduction Company, with the financial backing of the Andrew Mellon, acquired sole patent rights over the domestic production of aluminum. In 1906, the

Pittsburgh Reduction Company became the Aluminum Company of America (ALCOA), which would retain domestic control over the production and sale of aluminum until 1945.

ALCOA maintained its domestic control over the supply of bauxite and aluminum through a variety of measures. It began an integration program in 1896 with the purchase of substantial bauxite deposits in Georgia. In 1905, it absorbed the General Bauxite Company, which held all the remaining, known, domestic bauxite reserves, including substantial deposits in Arkansas. It also began a process of vertical integration, through which it achieved dominance in the production and marketing of aluminum products domestically. In 1901, it established the United States Aluminum Company and the Aluminum Cooking Utensil Company to produce and market aluminum kitchenware. In 1906, it began the process of acquiring its own power supply by purchasing the St. Lawrence River Power Company and substantial interests in a number of southern hydropower companies.

By pursuing integration, both horizontally and vertically, ALCOA insulated itself from changes in the prices of the factors of production and solidified its position as the sole producer of aluminum and aluminum products. In this way, ALCOA developed control over both the cost of production and the revenue associated with the production and sale of aluminum and aluminum products. ALCOA was visionary in this regard, for other international aluminum companies would not begin to pursue such a policy until the beginning of the First World War.

When examining its control of the domestic aluminum markets, one must first understand the international nature of the inefficiency in the aluminum industry. From its inception, ALCOA maintained or sought to maintain agreements concerning prices and output with European aluminum manufacturers and exporters. These agreements

generally had two effects. They served not only to elevate the price of aluminum internationally but also to secure ALCOA's dominance in the domestic aluminum market.

The first comprehensive worldwide cartel in aluminum production was established in 1901 between Aluminum Industrie A.G., ALCOA, the British Aluminum Company, and two French concerns, Froges and d' Alais et Camargues. This agreement designated the home market of each producer as closed. The rest of world market, including Germany, "was designated as open." However, sales quotas between each participant in the cartel subsequently carved up this open market. ALCOA's share of the open market was 21 percent of all sales. The cartel eliminated price competition by establishing a committee, which set prices for the open market. This committee also dictated minimum prices in each closed market, in order to deter resellers from undercutting the cartel price in the open market.

### Graph 4.1 Aluminum Prices 1893-1940

ALCOA'S AVERAGE ANNUAL PRICES OF ALUMINUM INGOT, 1893-1940  
(In Cents Per Pound)

Year	Schedule Prices <sup>a</sup>	Year	Schedule Prices <sup>a</sup>	Net Realization Prices <sup>b</sup>
1893	75	1920	33.1	32.79
1894	61	1921	25.3	21.18
1895	54.4	1922	19.9	18.69
1896	47.8	1923	23.0	22.69
1897	36.1	1924	27.0	26.78
1898	33	1925	27.5	27.51
1899	35	1926	26.9	26.98
1900	33	1927	25.6	25.36
		1928	23.9	24.09
1901	35	1929	23.9	23.58
1902	33	1930	23.4	23.33
1903	33			
1904	33	1931	22.9	22.78
1905	33.1	1932	22.9	21.76
1906	36	1933	22.9	19.30
1907	38	1934	22.2	18.95
1908	29.3	1935	19.5	18.75
1909	24	1936	18.0	18.82
1910	22	1937	19.8	19.56
		1938	20.0	19.64
1911	20.3	1939	20.0	19.86
1912	20.2	1940	18.7	---
1913	21.2			
1914	18.8			
1915	24.5			
1916	35.3			
1917	37.5			
1918	33.5			
1919	32.8			

a. Computed from U.S. v. Aluminum Company of America, et al., in U.S. District Court for the Southern District of New York (1937), Inquiry No. 85-33 (reproduced below as USA3), Answers of Alcoa to interrogatories 27, 28, and from U.S. Bureau of Mines, *Alumina Yearbook*, Washington, 1938-1940. For the period prior to 1938, these prices differ somewhat from those shown in USA1, Exhibit 36, 1938, though at a rate only by fractions of a cent. All of the prices in Ex. 1638 are for 95 per cent ingot; whereas prices shown here are for 98.99 per cent ingot up to 1934, after which they price quotations on this grade of ingot were withdrawn.

b. Prices USA3, Exs. 1637, 1705, 1746. These are the average net prices realized by Alcoa after making allowance for the part of freight charges absorbed (i.e., paid) by it. (Not available before 1936.)

This cartel arrangement represented the basic arrangement between the world's aluminum producers for the next 50 years. Only a few shifts were made as industrial, political, and military concerns dictated. The cartel was suspended a number of times, in view of war or lack of cooperation between participants. However, for the majority of the first half of the twentieth century, a cartel arrangement similar to this original pact determined pricing and output for the world's aluminum industry.

The inefficiencies of this market structure were clearly evident within months of the agreement's signing. European aluminum prices were raised by over twenty percent in only a few months. By 1905, they had advanced to 200 percent of their 1901 levels.

Aluminum prices in the United States were slower to respond. Because ALCOA had been the sole producer of aluminum domestically, it made no alteration to its prices until 1906. ALCOA felt that its scheduled price of 33 cents per pound was the optimum price for maximizing revenue . Only in 1905, when the cartel mandated an increase, did ALCOA revise its price schedule.

During the term of the first cartel agreement, which lasted from 1901 to 1906, worldwide production capacity for aluminum grew by almost 100 percent. Given the pricing schedule, it is clear that this expansion did not serve to meet growing demand in the aluminum market, both in the United States and abroad. In a perfectly competitive system, pricing and output should have kept pace with the market demand for aluminum. Despite this inability to satisfy demand, ALCOA was making substantial and constantly increasing profits. As the chart indicates, ALCOA was enjoying substantial returns on shareholder equity during a time period in which it is clear that demand for aluminum was not being satisfied.

Graph 4.2 Capital and Income of ALCOA

CAPITAL AND INCOME OF ALCOA, 1890-1939

Average of 5-Year Period	Stockholders' Equity <sup>a</sup>	Net Earnings <sup>b</sup>	Rate of Earnings <sup>c</sup>
50-year average	\$71,312,490	\$8,605,292	12.03
1890-1894	925,914	34,519	3.72
1895-1899	1,289,717	36,709	5.95
1900-1904	2,724,879	437,839	16.07
1905-1909	5,242,810	2,742,842	29.36
1910-1914	26,405,810	4,704,458	17.82
1915-1919	73,144,840	12,372,863	26.49
1920-1924	106,521,424	4,320,215	4.04
1925-1929	158,222,029	21,332,858	13.48
1930-1934	166,832,477	4,689,319	2.82
1935-1939	170,514,800	28,351,296	16.61

a. Adapted from *U.S. v. Aluminum Company of America, et al.*, in U.S. District Court for the Southern District of New York (1937), Equity No. 83-75 (cited below as USAL), Exhibit No. 1709, col. D.

b. Before income taxes, but after deductions for all other taxes and for interest. From USAL, Ex. 1737, col. C.

c. Computed by division of net earnings by stockholders' equity.

In 1908, the cartel arrangement dissolved under the pressures of several new aluminum-producing enterprises and a general business slump. Due to an agreement

between AIAG and ALCOA, the United States did not realize an immediate competitive price. While prices in Europe dropped up to fifty percent in 1908, prices in the United States remained relatively stable. However, by 1909, the volume of aluminum imported into the United States from Europe reached such a level that ALCOA had no choice but to cut prices. In the next three years, prices dropped an average of eighteen percent per year, resulting in the lowest price of aluminum ever offered to American consumers. Domestic consumption increased from 31 million pounds to 47 million pounds between 1909 and 1910. This illustrated how ALCOA's price/production point was vastly different from the demanded price and output point.

*Graph 4.3 Worldwide Aluminum Production*

(In Thousands of Pounds)

Year	United States <sup>a</sup>	Canada <sup>b</sup>	World <sup>c</sup>	North American Percentage of World Total <sup>d</sup>
1893	216	---	---	---
1894	494	---	---	---
1895	501	---	---	---
1896	1,002	---	---	---
1897	2,371	---	---	---
1898	2,993	---	---	---
1899	3,262	---	---	---
1900	3,652	---	---	---
1901	5,738	---	---	---
1902	5,763	1,714	---	---
1903	6,636	1,673	---	---
1904	8,100	2,161	---	---
1905	10,810	2,456	---	---
1906	14,123	3,667	---	---
1907	16,323	5,928	---	---
1908	20,679	972	---	---
1909	29,081	6,083	---	---
1910	33,462	9,648	---	---
1911	38,396	9,679	---	---
1912	41,806	12,028	---	---
1913	47,279	14,063	---	---
1914	57,973	14,391	---	---
1915	90,504	18,568	---	---
1916	115,107	21,183	---	---
1917	129,861	24,087	---	---
1918	124,723	23,333	---	---
1919	128,477	21,582	---	---
1920	138,042	22,384	276,169	58
1921	54,532	6,335	153,681	37
1922	73,633	12,341	192,236	48
1923	126,658	23,334	307,637	49

In 1911, in order to reestablish cartel control over world aluminum production, A.V. Davis, President of ALCOA, began negotiations with AIAG and other European producers to revive the cartel agreements of the previous decade. Despite ongoing antitrust investigations into the operations of ALCOA, both domestically and internationally, Davis was successful in revitalizing a system that stymied the efficient production and sale of aluminum.

This process would continue for the next forty years, alternating between competition and cartel regulation. Participating firms would occasionally attempt to undercut the established price and production quotas, thus placing pressure on the cartel to dissolve. Reduced profits would subsequently drive producers to reactivate the cartel arrangement. Occasionally, suspensions were forced due to political (antitrust enforcement) or military (World Wars One and Two) considerations. However, this pattern of alternation between competition and stifled competition would continue until 1945, when ALCOA was effectively broken up by Judge Learned Hand's decision in the US vs. Aluminum Company of America, on the basis of violations of the Sherman and Clayton antitrust statutes.

### *II.B The Incandescent Electric Lamp Industry*

The incandescent electric lamp industry was structured in a substantially different fashion than the commodities industries. Because this industry produced electric lamps, a patented invention, it was centered primarily around patenting, licensing, and cross licensing. By concentrating control of patents and extending licensing agreements, corporations could exert considerable influence over the market for the product. However, like the commodities industries, the market inefficiency in the incandescent electric lamp market was present both domestically and internationally. In a similar



fashion to the aluminum industry, an international cartel, Phoebus, was created in 1924 to control the production and sale of incandescent electric lamps.

Control had been concentrated domestically in this industry well before the creation of Phoebus in 1924. General Electric Co., created by a merger of the Edison General Electric Company and the Thomson-Houston Company in 1892, held the Edison patent to the incandescent electric lamp. It quickly took steps to solidify its hold on the domestic market. It cross-licensed with Westinghouse Electric Company, its primary competitor, and created an industry association, the Incandescent Electric Lamp Manufacturers, consisting of the six producers of electric lamps at that time. This association served to fix prices, set output, and divide markets.

In addition to fixing prices and dividing markets, General Electric also signed exclusive pacts with producers of lamp manufacturing equipment to purchase their goods. These agreements also held that any sales to competitors of General Electric would be made at artificially inflated prices. In this fashion, General Electric managed to stifle competition by preventing the emergence of any competitors or rivals.

However, when such rivals did appear, General Electric used its market power to eliminate or acquire them. For instance, in 1901, General Electric Co. purchased a controlling interest in the National Electric Lamp Company. General Electric Co. proceeded to use National Electric Lamp Company as a front in order to purchase the other six lamp manufacturers in the Incandescent Electric Lamp Manufacturers Association. It continued to use National Electric Lamp as a front to purchase up to eighteen other rival competitors, until 1911 when a federal court held the arrangement to be in violation of the Sherman Antitrust Act. It forced General Electric and National Electric Lamp to consolidate their collective assets and liabilities under one corporation, General Electric Co. After this consolidation, the resulting corporation controlled eighty percent of domestic lamp output. While the federal court's decision was designed to

bolster competition, the result of the decision was merely a more powerful General Electric.

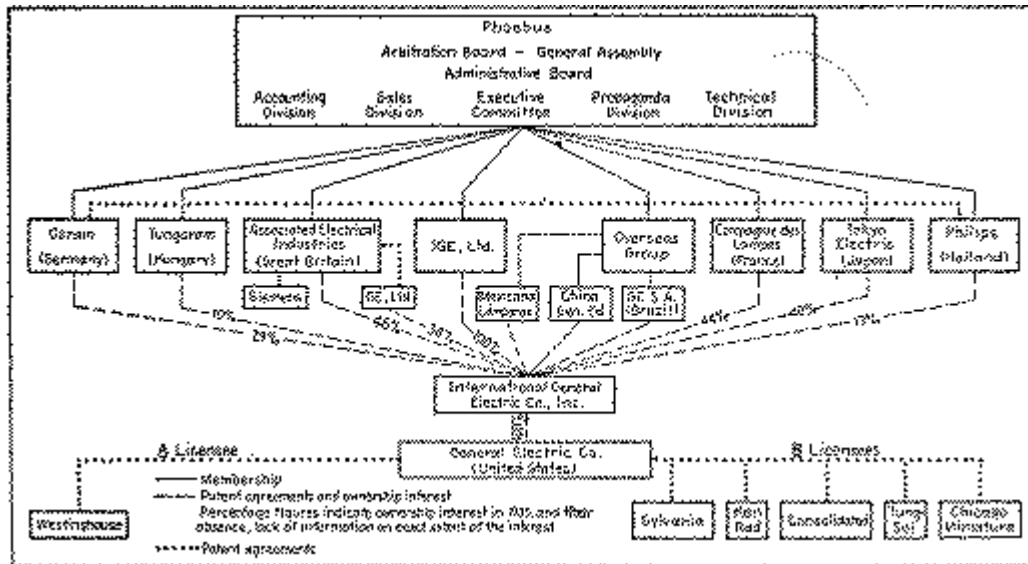
General Electric always feared the influence uncontrollable foreign lamp markets would have on its own domestic operations. Thus, like ALCOA and the aluminum industry, General Electric sought to organize an international organization to regulate prices, set output, and divide markets. It was seeking an international association similar to the Incandescent Electric Lamp Manufacturers Association. In the spring of 1921, the Internationale Gluhlampen Preisvereinigung, a price-fixing cartel, was formed. International General Electric, its foreign subsidiary, represented General Electric. In 1924, however, this agreement began to come apart as producers pursued separate pricing/production strategies.

The breakdown of Internationale Gluhlampen Preisvereinigung led to renewed negotiations between International General Electric and the major producers of incandescent electric lamps in Europe. After the intervention of J.M. Woodward, the president of International General Electric, an agreement was reached on December 23, 1924 to create Phoebus, a new international cartel controlling the production of incandescent lamps.

Phoebus was organized as a corporation in Switzerland under the name of Phoebus S.A. Compagnie Industrielle pour la Developpement de l'Eclairage. All of the world's leading manufacturers of incandescent electric lamps were part of the organization including Osram, Phillips, Tungsram, Associated Electrical Industries, Compagnie des Lampes, International General Electric, and the Overseas Group, which consisted of international subsidiaries of General Electric. These corporations subscribed to stock in Phoebus in proportion to the lamp sales of each corporation in comparison to total world lamp sales between July of 1922 and June of 1923. A General

Assembly was created, with ultimate authority in policy matters, in which each member could exercise the voting powers of their stock.

Graph 5.1 The Structure of the Phoebus Cartel



The purpose of Phoebus was multi-fold. First, it divided the world's lamp markets into three categories: home territories, British overseas territories, and common territory. Home territory was a country in which one of the member corporations had "important manufacturing facilities or sales." British overseas territory consisted of the British Empire excluding England and Canada. Associated Electrical Industries (The British Group), Osram, Phillips, and Tungsravn controlled it. Common territory represented the all the territory remaining in the world, excluding the home territory and the British overseas territory.

Phoebus subsequently ensured each member was allocated a proportion of sales within each market area in proportion to sales during the period of July of 1922 to June of 1923. In this fashion, a member was guaranteed a secure domestic position and a portion of the sales in each other area. Phoebus placed no limit on total sales; however, each member had to stay within its designated quotas for each distribution

area. If sales exceeded the allotted quota, the profits on the excess were penalized. The penalties were distributed to those corporations that didn't meet their quotas in proportion to difference between realized sales and the quota.

Through this system, Phoebus avoided the need to fix prices in each individual market. By guaranteeing sales quotas, Phoebus transferred the responsibility of fixing prices to National Assemblies, committees composed of each firm in a given market area. While Phoebus advised on pricing decisions, it left such decisions up to the individual market regions.

Despite the fact pricing responsibility was distributed to each individual market region, prices were nevertheless grossly inflated due to the concentrated control over the market. The following is taken from a Westinghouse internal corporate memorandum in February of 1937. It demonstrates how prices and not production are paramount to profit in a cartel arrangement.

*In all countries...where we do business in the Common Territory we invariably have a larger percentage of the market than our percentage in the Common Territory, consequently, if the growth of business is greater in those countries than in the Common Territory as a whole, the position becomes one more embarrassing for us as regards exceeding our permissible sales. Unless one can purchase units at a very reasonable figure—and it is not always easy to do this—it becomes most unprofitable to exceed one's permissible sales. The goal therefore to be aimed at is to make as much money as possible out of those units we are permitted to sell. In other words, it is much more advantageous for us to make a profit of 5 cents per unit on 4,000,000 units than 2.5 cents on 8,000,000 units.*

This artificial inflation of prices was not only evident when examining the relationships between firms in the Phoebus cartel but also when competition arose outside of the cartel.

In 1928, a Swedish corporation drew up plans for a lamp factory. Despite threats of market muscle and patent-infringement suits from Phoebus, the Swedes went ahead with laying the plant. A cooperative union, sponsored by smaller corporations in

Denmark, Sweden, and Norway, began production of incandescent lamps at this plant in 1931. It was able to produce and sales lamps at price levels substantially below those of the Phoebus cartel firm in that market area, demonstrating the artificially high level of Phoebus prices.

Graph 5.2 Japanese Production of Incandescent Lamps 1924-1935

JAPANESE PRODUCTION OF INCANDESCENT ELECTRIC LAMPS IN PLANTS EMPLOYING FIVE OR MORE WORKERS, 1924-1935

(In Thousands)

Year	Number	Value	
		Yen	U.S. Currency*
1924	35,323	17,277	\$7,116
1925	57,063	17,089	7,013
1926	63,633	17,225	7,174
1927	87,255	26,315	12,476
1928	97,550	24,327	11,290
1929	134,383	17,064	7,866
1930	114,812	35,192	7,503
1931	202,054	38,037	8,811
1932	286,653	39,683	9,534
1933	343,393	21,971	5,633
1934	318,750	19,998	5,942
1935	308,683	21,230	6,089

Source: U.S. Tariff Commission, Report No. 135, Ser. 11, *Incandescent Electric Lamps*, Washington, 1939, p. 64.

\* Yen converted to United States currency on basis of the annual average rates of exchange as shown in the *Foreign Exchange Bulletin*. The annual average value of the yen in United States currency varied from a high of 47.4313 cents in 1927 to a low of 23.646 cents in 1935. Because of such sharp fluctuations in exchange rates, the converted figures fail to show satisfactorily the actual changes in volume of business.

The principal evidence of inflated prices and restricted output in the United States economy was the influx of cheap lamps made by non-Phoebus foreign competitors. For example, the Japanese incandescent lamp industry flourished as Phoebus gained control over the incandescent lamp market in the United States. The Japanese were able to produce and export lamps at substantially reduced costs in comparison to Phoebus firms.

These exports were primarily directed to the markets in North America Japanese production surged by over 600% over the period of 1924-1935 and that this production was being directed to the North American markets, rather than being absorbed by domestic demand.

Phoebus also maintained quality control standards for all member firms. While the stated purpose of these standards was to "insure and sustain an equally high quality of lamps..." However, the program had two purposes not explicitly outlined in the cartel agreement creating Phoebus. First, it served to limit the life of lamps in order to increase sales and profits. Secondly, it served to standardize cartel products and eliminate quality competition between firms. Far from a quality control program, the standardization program was instituted primarily to curb competition and increase sales.

In fact, the purpose of the standardization program was stated concisely in a letter written by a General Electric engineer in 1932 and released in the discovery process during the antitrust action the Justice Department pursued against General Electric in 1937. The following is a selection from that letter.

*Two or three years ago we proposed a reduction in the life of flashlight lamps from the old basis on which one lamp was supposed to outlast three batteries, to the point where the life of the lamp and the life of the battery under service conditions would be approximately equal. Sometime ago, the battery manufacturers went part way with us on this and accepted lamps of two battery lives instead of three. This has worked out very satisfactorily.*

*We have been continuing our studies and efforts to bring about the use of one battery life lamps...If this were done, we estimate that it would result in increasing our flashlight business approximately 60 per cent. We can see no logical reason either from our standpoint or that of the battery manufacturer why such a change should not be made at this time.*

*Messrs. Parker and Johnson now have this matter up with the battery manufacturers and I would urge that every assistance be given them to put it over.*

In this letter, Mr. Porter clearly demonstrates the mindset that reducing the life and quality of the product would result in increased sales.

General Electric also utilized the standardization program to eliminate quality competition, particularly among its licensees (corporation to which licenses to GE lamp patents were granted). For instance, a General Electric executive, M.L. Sloan, described

the program in the following terms:

*Now that the licensees have come to the use of efficiencies and design lives which are the same as for Mazda (General Electric) lamps there will be much less likelihood of tests and test results being utilized in a commercial practice that was the case before. They have all agreed that tests should not form the basis for acceptability of a product except in a very general way.*

General Electric was also scolded on occasion by its licensees for engaging in quality competition with the electric lamp brands of competitors and licensees. An executive of Hygrade Sylvania wrote to Mr. Sloan in 1938 scolding him for sanctioning General Electric engagement in quality competition.

*I realize that it is difficult to control matters such as this 100% but because of other information I have as to claims by your salesman that GE lamps are at least 3% better than Hygrade lamps, I am a little bit confused as to whether you are still in favor of the policy of the four Government lamp contractors not engaging in a competitive way in proving detailed superiority of individual brands.*

Thus, General Electric was violating the very licensing requirements it imposed upon its licensees.

General Electric's participation in the Phoebus cartel through International General Electric and the Overseas Group ended in 1939 with US vs. General Electric, in which the Justice Department moved to break General Electric's control of the domestic incandescent lamp market and its participation in Phoebus.

### III. Analysis

It is clear that inefficiencies existed in the aluminum and incandescent electric lamp markets during the early half of the twentieth century. Each individual industry had a slightly different structure worthy of examination and analysis. Government intervention in these markets was the direct result of these market inefficiencies.

### *III.A Analysis of the Aluminum Industry*

The aluminum industry in the early half of the twentieth century was in fact characterized by two distinct inefficient market structures, one domestic in nature, the other international. Domestically, the Aluminum Company of America clearly represented a monopoly industrial concern. It met the conditions set forward for the existence of a monopoly. It was a single firm, producing a metal for which no close substitute existed. Barriers to entry in the aluminum industry were substantial, as ALCOA owned virtually 100 percent of known domestic bauxite reserves. It also held the patents to the processes necessary to strain the impurities from bauxite.

The quantitative evidence also seems to suggest ALCOA was a profit-maximizing monopolist. Prices were significantly above the equilibrium price in perfect competition, as demonstrated by the substantial decrease in the domestic price of aluminum ingot when the international aluminum cartel dissolved in 1908. Output was also substantially restricted, as evidenced by the substantial increase in aluminum consumption and importation when the international aluminum cartel collapsed in 1908. It was clear that ALCOA had not been meeting the domestic demand for aluminum in the previous decade. These conditions characterize the price/output levels in a monopoly industry. Price is inflated while output is severely restricted.

In addition, an examination of the price/output conditions in the first few years of the international aluminum cartel seems to indicate ALCOA was a monopoly. ALCOA doubled its domestic production capability yet was still unable to keep pace with increases in prices. This seems to indicate that ALCOA's production level was restricted and ALCOA was unable to satisfy domestic demand. This inability to satisfy real demand is a characteristic of a monopoly industry.



Internationally, ALCOA seemed to be a part of a large, international cartel that restricted prices and output worldwide. This cartel was clearly an oligopoly market structure, specifically defined by the collusion model of oligopoly. The international aluminum market consisted of several large firms, with enough market power to impact pricing and output decisions across an industry. These firms colluded to fix prices, divide markets, and set output quotas. The impact of such practices was to inflate prices above the equilibrium price in a perfectly competitive system and to depress output. The same pricing and output conditions that characterized the aluminum market in the United States and Canada from 1901-1906 also characterized the world. It was clear the market structure was not meeting the demand and prices were rising quickly. This situation, while characteristic of a monopoly domestically, was characteristic of an international oligopoly given the number of participating firms. Depressed output and inflated prices are both conditions of an oligopoly and a monopoly.

Repeated government intervention to regulate the ALCOA monopoly was directly due to the economically inefficient market structure. After pursuing a series of minor cases in which ALCOA was bound by limiting consent decrees, the Justice Department, under Attorney General Arnold Thurman, moved to break up the ALCOA monopoly in 1937. After the case spent years winding its way through the judicial system, federal Judge Learned Hand broke up the ALCOA monopoly in 1944.

As demonstrated when the domestic aluminum market was opened to competition in 1908, the absence of a domestic monopoly in the aluminum industry was beneficial to consumers. Output was increased and prices decreased drastically. The same situation existed in the long-term in 1944 when Judge Hand broke up the ALCOA monopoly. Despite the temporary disturbance in production due to the military demands of the Second World War, pricing and output in the long-term moved to more efficient

levels closer market equilibrium in perfect competition, due to the breakup of ALCOA by the Justice Department and Judge Hand.

### *III.B Analysis of the Incandescent Electric Lamp Industry*

From the beginnings of the incandescent lamp industry, free enterprise and competition have been stifled. Patents and patent licensing have suffocated competition at every turn. Rather than operating under the principle of each firm taking risks in a free market, the incandescent lamp industry has managed risk by colluding to fix prices, divide markets, and assign sales quotas. These anti-competitive practices became international in nature with the creation of Phoebus, an international cartel in incandescent electric lamp production.

The evidence detailing the operations of General Electric in the early half of the twentieth century seems to suggest it was an oligopoly, specifically a price leader in an oligopolistically structured industry. General Electric controlled the majority of the market, approximately eighty- percent, and the other firms followed its pricing and output decisions, either by fear or contractual obligations.

While the advancement of technology brought about improvements in quality and lower costs, it is not clear whether General Electric and other firms in the cartel were responsible for such technological advancements. Only when some competition developed in the lamp markets did cartel firms pass on the benefits of technology to consumers. In fact, the standardization program of GE and the Phoebus cartel indicates that quality was sacrificed for increased sales and quality competition was stifled. Thus, it appears that GE and Phoebus hindered the technological advancement of the incandescent lamp industry.

Phoebus also operated in an oligopolistic fashion by restricting output. In the decade of 1924-1935, Japanese incandescent lamps flooded the markets of North

America. Japanese production of incandescent lamps surged 600 percent in that decade. This increase in production was not absorbed by domestic demand in Japan. Most of this production capacity was directed towards the United States. This increase in production demonstrated that Phoebus was not satisfying the domestic demand for incandescent lamps.

General Electric and Phoebus also administered agreements to divide markets and establish sales quotas, which indirectly resulted in the fixing of prices. By denying the benefits of free enterprise system to public, the cartel and its firms have also blocked the efficient allocation of resources in lamp production. These policies resulted in higher prices and lower output. In short, it appears that the cartel has placed its own interests above those of the consumer and the public.

#### IV. Conclusions

Economic inefficiency in the early twentieth century was primarily oligopolistic in nature. Both the aluminum and incandescent lamp industries were characterized domestically by monopoly or price leadership oligopoly. These industries were classified internationally as colluding oligopolies. These forms of market structure were economically inefficient because they restricted output and inflated price. They were socially inefficient because they failed to pass on the benefits of technological improvements to the consumer and the public.

Government action against these industries was taken with the intention of restoring competition. Both industries were prosecuted and broken on the basis they had violated provisions of the Sherman and Clayton Antitrust Acts. Given the pricing and output data for the years in which cartel operation deteriorated or was voluntarily

suspended, it appears that dissolution of these cartel operations served to restore some modicum of efficiency and competition to the market.