Degregulation and the Theory of Regulation: An Application of the Core in the Game Theory*

Kuo-liang Wang

王 國 樑

（作者為本校經濟系兼任副教授，中華經濟研究院副研究員）

摘 要

此文試圖建立一個同時能解釋管制與解除管制的競局理論模型。假設政策變動需要此一競局裏全部參與者的同意，透過對核心解存在與否的檢定，我們發現對於解除管制的形成與否，需求的成長既不是充分，也不是必要條件；技術的進步是必要條件；但，唯有很顯著的技術進步才是充分必要條件。

ABSTRACT

This paper presents a game-theoretical model which seeks to account for both regulation and deregulation in a single model. By assuming that a policy change requires the unanimous consent of all players in the game and through checking the existence of the core, we conclude that an increase in demand is neither a necessary nor a sufficient condition for deregulation; an improvement in technology condition is a necessary condition for deregulation; however, only a significant improvement in technology condition is a necessary and sufficient condition for deregulation.

1. Introduction

Until the early 1960s the generally accepted view of why regulation comes into existence was the "public interest or market failure" theory, which assumed

* This paper is adapted from my Ph.D. thesis at Temple University. I thank the committee members, Drs. Erwin Blackstone, Woollcott Smith, Paul Seidenstat, and Edward Rosenthal for their constructive comments and suggestions. Any remaining errors are my own responsibility.

that regulation was a government response to public demands for the rectification of inefficient or inequitable practices by individuals and organizations. That is, regulation is the public administrative policing of a private activity with respect to a rule prescribed in the public interest. In economics, a necessary (but not sufficient) condition for government intervention in the private sector is market failure. In general, market failure means that markets fail to result in an equilibrium which is Pareto-optimal.[1] However, when government intervenes in the private sector, it may also lead to resource misallocation. Only when the resource misallocation caused by market failure dominates that caused by government intervention, then government intervention is justified.

Unfortunately, very few government policies, including regulatory policies, are Pareto-optimal in the real world. Usually, when there is a policy change, some people benefit and some others are harmed by it. Following a seminal article by Stigler (1971), a number of economists and political scientists have argued that regulation is a government response to demands for regulation by particular interest groups and segments of society that seek to advance their perceived self-interest, sometimes at the expense of others. This theory is called the "private interest or capture" theory of regulation. The capture theory is due originally to Stigler, was extended by Posner (1974) and was later formally modelled by Peltzman (1976). According to Stigler-Posner-Peltzman approach, regulation is itself an economic good which can be analyzed in a regulatory demand and supply framework. The demand for regulation comes from interest groups, or coalitions, that can achieve a more favorable outcome in a regulated market than in an unregulated market. The supply of regulation arises from politicians who want to increase the number of votes in order to win an election or reelection. As a result, the usual outcome is that regulation tends to be sought by an industry for its own protection and subsequently serves this purpose. The regulatory authorities do not control the regulated industry; they are controlled by it. That is, they do not serve the public interest, but promote special interests at the expense of the public.

Generally, the above two theories of regulation are able to provide plausible explanations of specific events in the history of regulated industries, but they have limited predictive power. Nevertheless, they also have their respective and common flaws as follows: (1) The public interest theory can be viewed as vague and indeterminate because there exists no single public interest conception and views of the public interest can be confliction; (2) regulation in the real world is often taken for both political and economic reasons, rather than just for the market failure reasons; (3) consumers seem to play no role at all in the political process of regulation in the capture theory of regulation; (4) there is no corresponding or equivalent measurement of political support for the politicians in the capture theory; (5) neither of the theories has given insight into decision making behavior by each interest group in the regulated industry; (6) neither has produced a useful framework for making predictions about what is likely to occur in the future in either currently regulated or unregulated industries.[2]

In this study we try to set up a new model of regulation that consists of elements of both the public interest theory and the private interest theory, but attempts to overcome the above defects of two existing theories of regulation. This model accepts the premise of the private interest theory that interest groups seek to use the process of regulation for their own benefit. We assume that the process of regulation is determined in the political market of regulation and all possible coalitions are actively competing in the market. In addition, we recognize that there may be several coalitions in any given industry, which could successfully determine the course of regulation. For instance, it is consistent with this model that at one time a regulatory agency is captured by producers in the industry, while at another time it is captured by consumer groups. However, the main focus of this study is not on predicting that which coalition can successfully manipulated the regulatory process. Instead, our main interest is in whether an exogenous shift in demand or a technological change will affect public policies for a given industry or not.

In the following section a game-theoretical model will be constructed. In section 3 we will use the model to investigate the relationship between changes in demand and/or technology conditions and the regulatory policy. Finally, section 4 will summarize the results of this study and indicate directions for further research.

2. The Game-theoretical Model

As Childs (1985) has written, the major dividend available from the study of regulation is the illumination of a shadow zone where public and private endeavors met and merged, where regulators and the regulated experienced a confusion of identity and assumed each other's roles. It is within this zone that interest groups compete one against another for governmental policies favorable to them. Examination of the shadowy zone demands an interdisciplinary approach. In this section, we try to set up a model of regulation that will borrow from such disciplines as economics, behavioral science, and political science. Economics allows us to assess the roles economic forces play in shaping policy responses; behavioral science and political science illustrate the regulatory processes within the society such as how behavioral ideologies develop and how they affect policy makings.

Following the simple definition given by Mitnick (1980), regulation in this study is defined as any attempt by the government to control the behavior of citizens, corporations, or subgovernments. In a sense, regulation is nothing more than the government's effort to limit the choices available to individuals within society. In general, regulation can take numerous forms as follows: Price regulation, entry regulation, regulation of standards, quota, and subsides or taxes. Since price regulation is most frequently used and entry regulation is most controversial in the history of the regulated industries, we will limit this study to these two types of old regulation although there are other types of regulation. In addition, regulation will be treated as an economic good, which indeed is a quasi-public good. Regulation is a quasi-public good in that it is a set of rules which everyone in society must abide by.[3] Meanwhile, there exists a political market (or a market with voting) for it, in which the demand for regulation or deregulation arises from interest groups or coalitions and the supply of regulation or deregulation comes from politicians who want to increase political support in order to win an election or reelection. However, this quasi-public good, regulation, does not have the general properties of economic goods such as perfect divisibility. This causes some problems in obtaining reasonable demand and supply curves in the political market of regulation. Therefore, we will use a cooperative game to model regulation and deregulation.

The regulatory game in this study consists of two essential components – the important features of the industry under study and a characteristic function which describes the opportunities available to each coalition. As to the former, we assume that there are two types of markets in the industry: profitable and unprofitable markets. The price in the unprofitable market must be less than or equal to the corresponding marginal cost; but in the profitable one, producers can set up whatever prices they want to maximize their own profit. We also assume that there initially exists entry regulation in the industry such that both markets are served by the original producers. Suppose that there exist new, potential producers who want to enter the profitable market only.[4] Then, there are four different interest groups or players in the model :nonsubsidized consumers in the profitable market, subsidized consumers in the unprofitable market, original producers, and new, potential producers.[5] In addition, for the purpose of simplicity we assume that both markets are characterized by constant returns to scale technologies such that marginal costs in both markets are constant, and that the costs of serving each market are independent so that no "economies of scope" exist. The last assumption eliminates the case of natural monopoly which justifies the existence of entry regulation on the basis of production efficiency. Finally, we assume that there is no free rider problem in determining how individuals in each interest group or interest groups organize for political advocacy.[6]

One of the major problems in applying game theory to social sciences is "how to measure payoff". In this study, we assume that payoffs can be represented by "social welfare" or "economic surplus" which, in turn, can be measured as a monotonic increasing function of a transferable commodity. Following the classical definition of social welfare or economic surplus in the welfare economics, we define social welfare as the sum of consumers' surplus and profits. Consumers' surplus, according to Marshall's definition, is the excess of what individuals are willing to pay for a commodity over the amount that they actually pay. Suppose that the price change is made in a series of small steps; consumers' surplus can be defined as the area under the demand curve and above the price line.[7] However, the definition of a measure of consumers' surplus has been one of the most controversial subjects in economics. Unlike the producer's case, where observable measures of well-being such as profit can be clearly determined, no equally appealing observable measure exists for a utility-maximizing consumer because utility is not observable. Theoretically, if prices and incomes change, there are both income effects and substitution effects between commodities over which the interested party holds preferences. When we want to measure changes in consumers' surplus, there may exist a path dependency problem. That is, we may have different measures of changes in consumers' surplus along different adjustment paths. In order to avoid the problem of path dependency, the demand curves mentioned in this study are presumed to be compensated demand curves. Finally, profits are defined as the excess of total revenues over total costs.

The cornerstone of the theory of n-person cooperative games is the characteristic function, a concept first formulated by John Von Neumann in 1928. The idea is to capture the potential worth of each coalition of players. Let $N = \{1, 2, \ldots, n\}$ be the set of all players. For an n-person game, the characteristic function is a real-valued function V defined on the subsets of N, which assigns to each subset $S \subseteq N$ the maximin value of the two-person game played between S and N-S,[8] assuming that these two coalitions form. That is, V(S) is the amount of payoff which the members of S can obtain from the game for sure, whatever the remaining players may do. Define market 1 as the profitable market; market 2 as the unprofitable market; P as price; MR as marginal revenue; MC as marginal cost; CS as consumers' surplus; π as profits; A as the original producers; B as the new, potential producers; C_1 as the nonsubsidized consumers in the profitable market; C_2 as the subsidized consumers in the unprofitable market. From the price regulation assumption in this section, we know that there exists price regulation in market 2 such that $0 \leqslant P_2 \leqslant MC_2$, where MC_2 is the marginal cost of production in the market 2. The original producers can set up their own prices in the market 1 such that $MC_1 \leqslant P_1 \leqslant P_1^0$, where MC_1 is the marginal cost of production in the market 1 and P_1^0 is the profit-maximizing price in the market 1. Suppose that the demand function in the market i, i = 1, 2, is given by $Q_i = f_i(P_i)$, i = 1, 2, where Q_i stands for the quantity demanded in the market i. By the definition of consumers' surplus and producers' profits, we know that $CS_i = \int_{P_i}^{\alpha} fi(s)\,ds$, where α is a positive constant and P_i is the market price in the market i, and $\pi_i = P_i f_i(P_i) - MC_i f_i(P_i)$. By applying the definition of the characteristic function to this study, the value of the characteristic function for a coalition S, denoted by V(S), can be interpreted as the maximum of the sum of consumers' surplus to consumers in the coalition S and profits to producers in the coalition S, subject to the constraints $MC_1 \leqslant P_1 \leqslant P_1^0$ and $0 \leqslant P_2 \leqslant MC_2$, i.e.,

$$V(S) = \text{MAX}\left(\sum_{i \in s} CS_i + \sum_{i \in s} \pi_i\right)$$

$$= \underset{P_1, P_2}{\text{MAX}} \left\{ \sum_{i \in s} \int_{P_i}^{\alpha} f_i(s)\,ds + \sum_{i \in s} [P_i f_i(P_i) - MC_i f_i(P_i)] \right\}$$

$$\text{s.t.} \quad MC_1 \leqslant P_1 \leqslant P_1^0, \qquad (1)$$

$$0 \leqslant P_2 \leqslant MC_2. \qquad (2)$$

In this study, we all realize that the relative political power of each player or coalition plays an important role in the distribution of payoffs among players and, therefore, is very crucial in the decision-making process of regulation. Accordingly, we will also take the players' capabilities to choose the course of regulation into account when we use the characteristic function to assign a payoff value to each possible coalition. To accomplish that, it is necessary to know two aspects of the regulated industry – the set of "winning coalitions" and the set of "feasible regulations". The winning coalitions are those coalitions which have the power to choose the course of regulation. The feasible regulations in this study are the control variables at the discretion of a winning coalition, which consist of the prices P_1 and P_2 in both markets and the issue of entry regulation or entry deregulation in the profitable market. However, in order to have a meaningful set of characteristic function values certain assumptions on the set of winning coalitions must be made as follows:

(A1) Every coalition is either winning or losing.

(A2) The empty set (i.e. there is no player in the coalition) is losing.

(A3) All trivial coalitions are losing.[9]

(A4) The grand coalition is winning.[10]

(A5) No losing coalition contains a winning coalition; on the other hand, a coalition containing a winning coalition must also be winning.

(A6) The complement of any winning coalition is losing.

(A7) Any coalition excluding both groups of producers or both groups of consumers is losing.

(A8) Any coalition containing both the original or new, potential producers and subsidized consumers is winning.

Suppose that the demand and marginal cost curves in both markets are illustrated in Figure 1 and Figure 2. For the purpose of simplicity, the demand curves are represented by straight lines. Because of the assumption of constant returns to scale, the marginal cost curves in both markets are horizonal. Define V_0 as CS to C_1 when $P_1 = P_1^0$; V_1 as π_1 when $P_1 = P_1^0$; V_2 as [CS to C_1 when $P_1 = MC_1$] minus $(V_0 + V_1)$; V_3 as CS to C_2 when $P_2 = MC_2$. Geometrically, when there is no new, potential producer, i.e., there are only three players: A, C_1 and C_2, then the values of the characteristic function are given by

$$V(\overline{C_1}) = V_0\,, \tag{3}$$

$$V(\overline{C_2}) = V_3\,, \tag{4}$$

$$V(\overline{A}) = 0\,, \tag{5}$$

$$V(\overline{AC_1}) = V_0 + V_1 + V_2\,, \tag{6}$$

$$V(\overline{AC_2}) = V_1 + V_3 , \tag{7}$$

$$V(\overline{C_1C_2}) = V_0 + V_3 , \tag{8}$$

$$V(\overline{AC_1C_2}) = V_0 + V_1 + V_2 + V_3 , \tag{9}$$

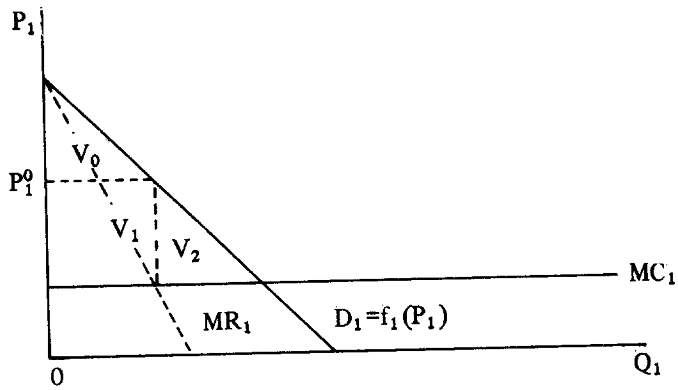

Figure 1
Profitable Market

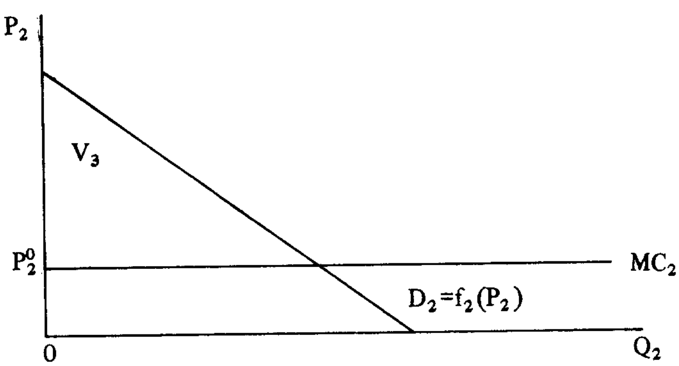

Figure 2
Unprofitable Market

where "—" represents coalitions. Because of assumptions (A3) and (A7), coalitions $\overline{C_1}$, $\overline{C_2}$, $\overline{A}$, and $\overline{C_1 C_2}$ are all losing. That is, they have no power at all to choose the course of regulation. Therefore, for each coalition the value of the characteristic function describes the best outcome for players in the coalition under the most adverse circumstances. In this case, the most adverse circumstance facing the nonsubsidized consumers (C_1) is $P_1 = P_1^0$ and the payoffs to them are V_0. Similarly, the worst situation facing the subsidized consumers (C_2) is $P_2 = MC_2$ and their payoffs are V_3; that facing the original producers (A) is $P_1 = MC_1$ and $P_2 = MC_2$, and there will be no profit enjoyed by them; that facing the coalition of C_1 and C_2 is $P_1 = P_1^0$ and $P_2 = MC_2$, and their joint payoffs are $(V_0 + V_3)$. If A and C_1 are to form a coalition, constraint (1) would disappear and the most adverse situation facing them will be $P_2 = MC_2$. Thus, this coalition can command joint payoffs of $(V_0 + V_1 + V_2)$. By assumption (A8), the coalition of A and C_2 is a winning coalition such that they can set up $P_1 = P_1^0$ in the profitable market to maximize their joint payoffs. Therefore, the joint payoffs to them are $(V_1 + V_3)$. Finally, if the grand coalition is to form, then both constraints (1) and (2) will become invalid and the joint payoffs to all three players will be $(V_0 + V_1 + V_2 + V_3)$.

3. Application of the Model

In this section we will use the concept of the core in the theory of n-person cooperative games to study the interaction of coalitions in a political marketplace where regulation is determined, and to analyze how changes in demand and technology conditions affect public policies in the regulated industry. In doing that, we will, first, show the existence of the core in the initially regulated industry and, then, conduct our study in four different cases: (a) when demands remain constant and the new, potential producers have the same technology as the original producers do; (b) when demand in the profitable market increases and the new, potential producers have the old technology; (c) when demands remain constant and the new, potential producers have a new technology which gives them lower operating costs than do the original producers in providing services in the profitable market; and (d) when demand in the profitable markets rises and the new, potential producers have a new technology in the production of services in the profitable market.

3.1 The Existence of the Core in the 3-player Case

Assume that the total political support for a politician is proportional to the sum of social welfare accruing to consumers and producers who support the politician. For the industry (composed of both markets) to exist, the grand coalition (composed of the original producers, nonsubsidized consumers, and subsidized consumers) must form. Furthermore, for the grand coalition to form the core in this game must be not empty, which in turn requires that all the conditions for individual rationality (no individual should get less than they can get by remaining independent), coalition rationality (no subset of players should get less than they can get by joining an intermediate coalition),[11] and group rationality (all players together share the joint payoffs to the grand coalition) be satisfied simultaneously.[12] Let X_A, X_{C_1} and X_{C_2} stand for allocations (i.e. distributions of payoffs among players) for A, C_1 and C_2, respectively. Given the values of the characteristic function by equations (3) to (9) in section 2, for the core to exist we have to find a payoff vector (X_A, X_{C_1}, X_{C_2}) which satisfies the following requirements:

$$X_A \geqslant 0, \tag{10}$$

$$X_{C_1} \geqslant V_0, \tag{11}$$

$$X_{C_2} \geqslant V_3, \tag{12}$$

$$X_A + X_{C_1} \geqslant V_0 + V_1 + V_2, \tag{13}$$

$$X_A + X_{C_2} \geqslant V_1 + V_3, \tag{14}$$

$$X_{C_1} + X_{C_2} \geqslant V_0 + V_3, \tag{15}$$

$$X_A + X_{C_1} + X_{C_2} = V_0 + V_1 + V_2 + V_3, \tag{16}$$

Inequalities (10) – (12) represent the conditions of individual rationality; inequalities (13) – (15) the conditions of coalition rationality; and equation (16) the condition of group rationality. By adding inequalities (10) – (12) together we have

$$(X_A + X_{C_1} + X_{C_2}) \geqslant V_0 + V_3,$$

which is consistent with equation (16). This property asserts that when all three disjoint trivial coalitions combine, they can get at least as much as the three could get separately. It is analogous to economies of scale in the absence of costs of organizations. It implies that there is an allocation of the grand total ($V_0 + V_1 + V_2 + V_3$) among three players, that will simultaneously meet the demands of all trivial coalitions. Hence, trivial coalitions can not form. Similarly, by adding (13) – (15) together we have

$$2(X_A + X_{C_1} + X_{C_2}) \geqslant (V_0 + V_1 + V_2 + V_3) + (V_0 + V_1 + V_3),$$

which is also consistent with equation (16). It implies that some allocation of the grand total among three players can satisfy the demands of all 2-element intermediate coalitions. Therefore, intermediate coalitions can not form, either. Only the grand coalition can form and it proves the existence of the core in the regulated industry. By intuition, it means that in the absence of new, potential entrants the original producers, nonsubsidized consumers, and subsidized consumers can live together harmoniously.

3.2 Constant Demands and Old Technology

Suppose that the new, potential producers (B) have the same technology as the original producers do and would like to serve the profitable market only. Now, there are four players in the game: A, B, C_1, C_2. For the similar story given in the case of three players, the values of the characteristic function are given by

$$V(\overline{C_1}) = V_0, \tag{17}$$

$$V(\overline{C_2}) = V_3, \tag{18}$$

$$V(\overline{A}) = 0, \tag{19}$$

$$V(\overline{B}) = 0, \tag{20}$$

$$V(\overline{AC_1}) = V_0 + V_1 + V_2, \tag{21}$$

$$V(\overline{AC_2}) = V_1 + V_3, \tag{22}$$

$$V(\overline{BC_1}) = V_0 + V_1 + V_2, \tag{23}$$

$$V(\overline{BC_2}) = V_1 + V_3 , \tag{24}$$

$$V(\overline{AB}) = 0 , \tag{25}$$

$$V(\overline{C_1C_2}) = V_0 + V_3 , \tag{26}$$

$$V(\overline{AC_1C_2}) = V_0 + V_1 + V_2 + V_3 , \tag{27}$$

$$V(\overline{BC_1C_2}) = V_0 + V_1 + V_2 + V_3 , \tag{28}$$

$$V(\overline{ABC_1}) = V_0 + V_1 + V_2 , \tag{29}$$

$$V(\overline{ABC_2}) = V_0 + V_3 , \tag{30}$$

$$V(\overline{ABC_1C_2}) = V_0 + V_1 + V_2 + V_3 , \tag{31}$$

In general, the new, potential producers can enter the profitable market either by making the initial three players all agree to deregulation or by enticing consumers to leave their original coalition (with the original producers) and to join a new winning coalition (with the new, potential producers). The latter will not be studied in this paper because it is very complicated and demands a more sophisticated research. For the purpose of simplicity, we assume that entry deregulation requires the unanimous consent of all players in the game.[13] That is, deregulation must be a Pareto improvement if it is to occur.[14] To find out whether deregulation occurs or not we can simply check the existence of the core in the 4-person game. If the core is not empty, then entry deregulation will occur; however, if the core is empty, entry regulation will still prevail. Given the values of the characteristic function by equation (17) – (31), the requirements for the non-empty core in this case are as follows:

$$X_A \geqslant 0 , \tag{32}$$

$$X_B \geqslant 0 , \tag{33}$$

$$X_{C_1} \geqslant V_0 , \tag{34}$$

$$X_{C_2} \geqslant V_3 , \tag{35}$$

$$X_A + X_{C_1} \geqslant V_0 + V_1 + V_2 , \tag{36}$$

$$X_A + X_{C_2} \geqslant V_1 + V_3 , \tag{37}$$

$$X_B + X_{C_1} \geqslant V_0 + V_1 + V_2 , \tag{38}$$

$$X_B + X_{C_2} \geqslant V_1 + V_3 , \tag{39}$$

$$X_A + X_B \geqslant 0 , \tag{40}$$

$$X_{C_1} + X_{C_2} \geqslant V_0 + V_3 , \tag{41}$$

$$X_A + X_{C_1} + X_{C_2} \geqslant V_0 + V_1 + V_2 + V_3 , \tag{42}$$

$$X_B + X_{C_1} + X_{C_2} \geqslant V_0 + V_1 + V_2 + V_3 , \tag{43}$$

$$X_A + X_B + X_{C_1} \geqslant V_0 + V_1 + V_2 , \tag{44}$$

$$X_A + X_B + X_{C_2} \geqslant V_1 + V_3 , \tag{45}$$

$$X_A + X_B + X_{C_1} + X_{C_2} = V_0 + V_1 + V_2 + V_3 . \tag{46}$$

Adding inequalities (42) – (45) together, we have

$$(X_A + X_B + X_{C_1} + X_{C_2}) \geqslant V_0 + V_1 + V_2 + V_3 + 1/3\, V_1 ,$$

which contradicts equation (46). It implies that any allocation of $(V_0 + V_1 + V_2 + V_3)$ among A, B, C_1 and C_2 will have to violate requirement (42) or (43) or (44) or (45). There is no allocation of the grand total that will simultaneously meet the demands of all three-element coalitions. Therefore, the core is empty so that deregulation does not occur. By intuition, although the number of the players in the game increases, the size of the pie, which is measured in terms of social welfare, remains constant. In other words, the new, potential producers do not make any contribution to the joint payoffs at all. If they were allowed to enter the profitable market, the pie of the same size would have to be shared by four players instead of three players, and obviously the three original players would be worse off than in the presence of regulation since their shares would all become smaller than before. That is why the new comer would not be welcomed by the three original players.

3.3 Increased Demand in the Profitable Market and Old Technology

Suppose that the demand in the profitable market increases and the new, potential producers have the same technology as the original producers do. Then, demand and marginal cost curves in both markets can be illustrated as in Figure 3 and Figure 4. Now, the demand curve in the profitable market shifts upward from D_1 to D'_1, and its corresponding marginal revenue curve also shifts outward. Under the new demand curve in the profitable market, we define V'_0 as CS to C_1 when $P_1 = P_1^1$; V'_1 as π_1 when $P_1 = P_1^1$; V'_2 as [CS to C_1 when $P_1 = MC_1$] minus $(V'_0 + V'_1)$. Other things being equal, the following requirements must

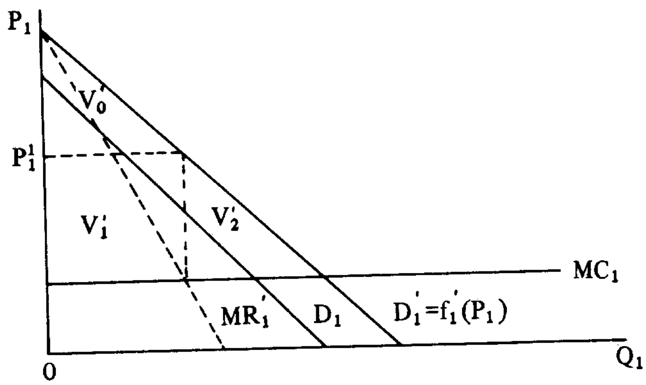

Figure 3
Profitable Market

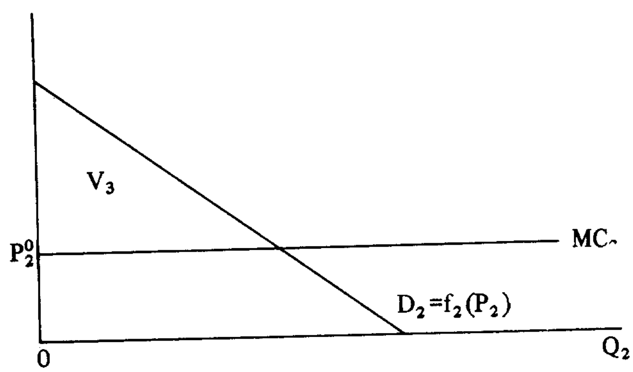

Figure 4
Unprofitable Market

be satisfied in order to guarantee the nonemptiness of the core:

$$X_A \geqslant 0, \tag{47}$$

$$X_B \geqslant 0, \tag{48}$$

$$X_{C_1} \geqslant V_0', \tag{49}$$

$$X_{C_2} \geqslant V_3, \tag{50}$$

$$X_A + X_{C_1} \geqslant V_0' + V_1' + V_2', \tag{51}$$

$$X_B + X_{C_1} \geqslant V_0' + V_1' + V_2', \tag{52}$$

$$X_A + X_{C_2} \geqslant V_1' + V_3, \tag{53}$$

$$X_B + X_{C_2} \geqslant V_1' + V_3, \tag{54}$$

$$X_A + X_B \geqslant 0, \tag{55}$$

$$X_{C_1} + X_{C_2} \geqslant V_0' + V_3, \tag{56}$$

$$X_A + X_{C_1} + X_{C_2} \geqslant V_0' + V_1' + V_2' + V_3, \tag{57}$$

$$X_B + X_{C_1} + X_{C_2} \geqslant V_0' + V_1' + V_2' + V_3, \tag{58}$$

$$X_A + X_B + X_{C_1} \geqslant V_0' + V_1' + V_2', \tag{59}$$

$$X_A + X_B + X_{C_2} \geqslant V_1' + V_3, \tag{60}$$

$$X_A + X_B + X_{C_1} + X_{C_2} = V_0' + V_1' + V_2' + V_3, \tag{61}$$

With the same mathematical operation as in the last section we can prove that the core is empty. Hence, deregulation will not occur, either. Since $(V_0' + V_1' + V_2' + V_3) > (V_0 + V_1 + V_2 + V_3)$, the size of the pie does increase in this case. However, the increase in the size of the pie comes from the increased demand in the profitable market, not from entry of the new, potential producers. The additional player does not make any contribution to the increased pie. Therefore, if the original producers have perfect information and are rational, they can prevent the new, potential producers from entering the industry by increasing the consumers' payoffs (or probably by means of predatory pricing).

3.4 Constant Demands and New Technology

Suppose that the new, potential producers have new technologies in physical equipment and/or management such that their marginal costs are lower than that of the original producers. Then, demand and marginal cost curves can be illustrated in Figure 5 and Figure 6. Now, there are two marginal cost curves in the profitable market: MC_1 represents that of the original producers, and

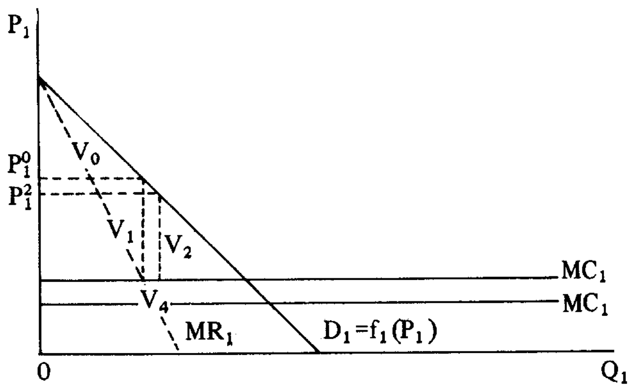

Figure 5
Profitable Market

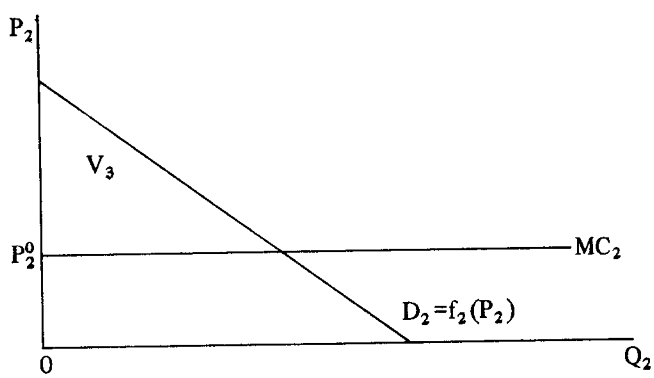

Figure 6
Unprofitable Market

MC_1' that of the new, potential producers. Define V_1'' as π_1 under the new marginal cost curve when $P_1 = P_1^2$; V_4 as [CS to C_1 when $P_1 = MC_1'$] minus $(V_0 + V_1 + V_2)$. Here, V_4 represents the effect of the lower cost technologies on the social welfare, which increases the characteristic function value for any coalition that contains both the new, potential producers (B) and the non-subsidized consumers (C_1). Other things being equal, to prove the existence of the core in this game, the following requirements must be satisfied:

$$X_A \geqslant 0, \tag{62}$$

$$X_B \geqslant 0, \tag{63}$$

$$X_{C_1} \geqslant V_0, \tag{64}$$

$$X_{C_2} \geqslant V_3, \tag{65}$$

$$X_A + X_{C_1} \geqslant V_0 + V_1 + V_2, \tag{66}$$

$$X_B + X_{C_1} \geqslant V_0 + V_1 + V_2 + V_4, \tag{67}$$

$$X_A + X_{C_2} \geqslant V_1 + V_3, \tag{68}$$

$$X_B + X_{C_2} \geqslant V_1'' + V_3, \tag{69}$$

$$X_A + X_B \geqslant 0, \tag{70}$$

$$X_{C_1} + X_{C_2} \geqslant V_0 + V_3, \tag{71}$$

$$X_A + X_{C_1} + X_{C_2} \geqslant V_0 + V_1 + V_2 + V_3, \tag{72}$$

$$X_B + X_{C_1} + X_{C_2} \geqslant V_0 + V_1 + V_2 + V_3 + V_4, \tag{73}$$

$$X_A + X_B + X_{C_1} \geqslant V_0 + V_1 + V_2 + V_4, \tag{74}$$

$$X_A + X_B + X_{C_2} \geqslant V_1'' + V_3, \tag{75}$$

$$X_A + X_B + X_{C_1} + X_{C_2} = V_0 + V_1 + V_2 + V_3 + V_4. \tag{76}$$

Adding inequalities (72) – (75) together, we have

$$3(X_A + X_B + X_{C_1} + X_{C_2}) \geqslant 2(V_0 + V_1 + V_2 + V_3 + V_4) + (V_0 + V_1 + V_2 + V_3 + V_1''). \tag{77}$$

Substituting equation (76) into inequality (77), we obtain

$$X_A + X_B + X_{C_1} + X_{C_2} \geqslant V_0 + V_1 + V_2 + V_3 + V_1'', \qquad (78)$$

or

$$V_0 + V_1 + V_2 + V_3 + V_4 \geqslant V_0 + V_1 + V_2 + V_3 + V_1'',$$

or

$$V_4 \geqslant V_1''.$$

That is, for any allocation of the grand total among four players to meet the demands of all 3-player coalitions simultaneously we require that the effect of the lower cost technologies brought by the new, potential producers be significant enough so that $V_4 \geqslant V_1''$. For condition (78) to hold there must be a significant improvement in the technologies of production in the profitable market. The existence of the core in this game implies that deregulation occurs. Intuitively, competing new technologies give the new, potential producers more bargaining power such that they can persuade both groups of consumers in favor of deregulation and force the original producers to share the profitable market with them.[15] Nevertheless, if the effect of the lower cost technologies is not significant enough so that $V_4 \leqslant V_1''$, then the core will be empty and regulation will still prevail. That is, although the new, potential producers can bring in a technological improvement in the profitable market, if it is not significant enough, consumers may still want to stick by the original producers.

3.5 Increased Demand in the Profitable Market and New Technology

Finally, suppose that demand in the profitable market rises, and that the new, potential producers have lower cost technologies in the production of goods and services in the profitable market. Similarly, demand and marginal cost curves in both markets can be illustrated in Figure 7 and Figure 8, where D_1' is the new demand curve and MC_1' the new marginal cost curve. Define V_1''' as π_1 under the new demand and marginal cost curves when $P_1 = P_1^3$; V_5 as [CS to C_1 under the new demand curve when $P_1 = MC_1'$] minus $(V_0' + V_1' + V_2' + V_4)$. Here, $(V_4 + V_5)$ stands for the effect of the lower cost technologies under the new demand curve, which increase the value of the characteristic function for any

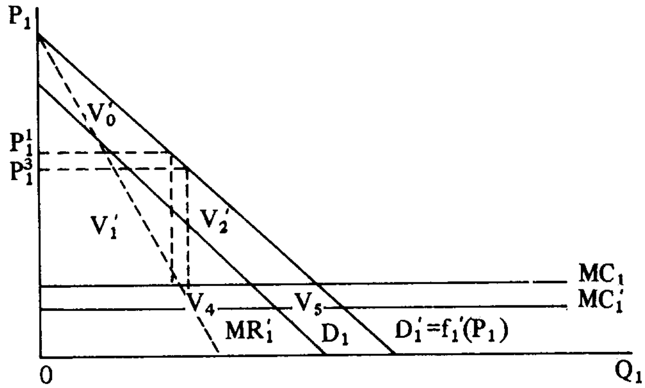

Figure 7
Profitable Market

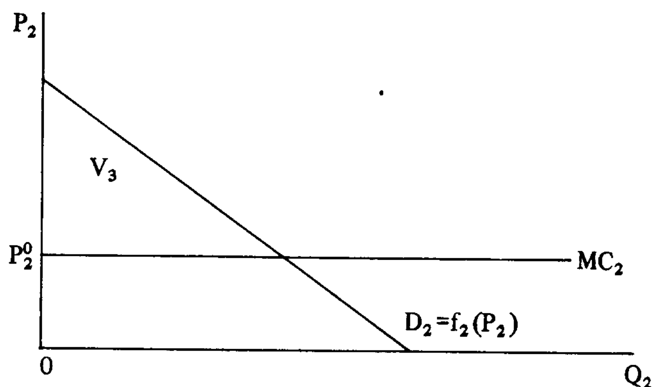

Figure 8
Unprofitable Market

coalition that includes both B and C_1. Other things being equal, for the original three players (A, C_1 and C_2) to agree to the entry of the new, potential producers, the following requirements for the nonempty core must be satisfied:

$$X_A \geqslant 0, \tag{79}$$

$$X_B \geqslant 0, \tag{80}$$

$$X_{C_1} \geqslant V_0 , \tag{81}$$

$$X_{C_2} \geqslant V_3 , \tag{82}$$

$$X_A + X_{C_1} \geqslant V'_0 + V'_1 + V'_2 , \tag{83}$$

$$X_B + X_{C_1} \geqslant V'_0 + V'_1 + V'_2 + V_4 + V_5 , \tag{84}$$

$$X_A + X_{C_2} \geqslant V'_1 + V_3 , \tag{85}$$

$$X_B + X_{C_3} \geqslant V'''_1 + V_3 , \tag{86}$$

$$X_A + X_B \geqslant 0 , \tag{87}$$

$$X_{C_1} + X_{C_2} \geqslant V'_0 + V_3 , \tag{88}$$

$$X_A + X_{C_1} + X_{C_2} \geqslant V'_0 + V'_1 + V'_2 + V_3 , \tag{89}$$

$$X_B + X_{C_1} + X_{C_2} \geqslant V'_0 + V'_1 + V'_2 + V_3 + V_4 + V_5 , \tag{90}$$

$$X_A + X_B + X_{C_1} \geqslant V'_0 + V'_1 + V'_2 + V_4 + V_5 , \tag{91}$$

$$X_A + X_B + X_{C_2} \geqslant V'''_1 + V_3 , \tag{92}$$

$$X_A + X_B + X_{C_1} + X_{C_2} = V'_0 + V'_1 + V'_2 + V_3 + V_4 + V_5 . \tag{93}$$

By adding inequalities (89) – (92) together, we have

$$3(X_A + X_B + X_{C_1} + X_{C_2}) \geqslant 2(V'_0 + V'_1 + V'_2 + V_3 + V_4 + V_5) + (V'_0 + V'_1 + V'_2 + V_3 + V'''_1). \tag{94}$$

Substituting equation (93) into inequality (94), we obtain

$$V_4 + V_5 \geqslant V'''_1 , \tag{95}$$

Similarly, inequality (95) implies that for deregulation to occur the effect of the lower cost technologies must be significant enough to ensure $(V_4 + V_5) \geqslant V'''_1$ Otherwise, deregulation will not occur. Compared with the condition for deregulation ($V_4 \geqslant V''_1$) in the last section, if $V''_1 \geqslant V'''_1$, the movement of deregulation in this case will be faster. On the other hand, if $V''_1 < V'''_1$, and if $V_5 > (V'''_1 - V''_1)$, the movement of deregulation in this case will still be faster;

and if $V_5 = (V_1''' - V_1'')$, the movement of deregulation will be the same; however, if $V_5 < (V_1''' - V_1'')$, the movement of deregulation in this case will be slower.

4. Conclusion and Suggestions for Further Research

In this paper we have developed a game-theoretical model of regulation, in which the politicians on the supply side of the political market of regulation are assumed to try to win an election or reelection and interest groups (such as the original producers, the potential entrants, nonsubsidized consumers, and subsidized consumers) on the demand side are assumed to pursue their own self-interest. By assuming that the political support for any politician from each interest group is proportional to social welfare accruing to the interest group, and that deregulation will occur only if there is the unanimous consent of all interest groups in the regulated industry, we have demonstrated the following results: (1) An increase in demand is neither a necessary nor a sufficient condition for deregulation; (2) an improvement in production technology is a necessary condition for deregulation, but may not be a sufficient condition for deregulation; (3) only a significant improvement in production technology is a necessary and sufficient condition for deregulation.

The research in this study could be extended in a number of ways. First, a general equilibrium analysis may be more relevant than a partial equilibrium one. This study is conducted in the partial equilibrium framework, and has ignored consideration of organized labor. Regulations make the trunking industry profitable so that it can afford to pay its workers high wages. Employees in the telecommunication and airline industries were also among the principal beneficiaries of anticompetitive regulation. With deregulation, profits would fall and wages would be reduced. As a result, it is not surprising that both firms and employees resist deregulation strenuously. Therefore, a general equilibrium framework consisting of a labor market may be superior to the partial equilibrium one in this study. Second, it is assumed in this study that the new, potential producers want to enter the profitable market only. However, in the history of regulated industries in the U.S., there were a few of cases in which the new, potential producers wanted to start their business in the unprofitable market. Therefore, they would ask for deregulation in the unprofitable market. This is also an interesting area where we can apply the game theory to investigate the relationship between the economic forces (changes in demand and technology conditions) and the issue of regulation. Finally, when we apply this model to a specific industry, an empirical study may be needed in order to convince policy makers. In doing that, we may have to estimate demand and cost functions in the relevant industry or, at least, have approximate measures of consumers' surplus and profits.

FOOTNOTES

1. A Pareto optimum is defined as a state of affairs such that no one can be made better off without at the same time making at least one other person worse off. In the context of the economy, an allocation of resources among uses is said to be Pareto-optimal if it is not possible to reallocate resources so as to improve the well-being of one person without making at least one other person worse off.
2. For example, Levine (1981) claims that neither of the two existing theories offers a satisfactory explanation of recent airline deregulation.
3. However, regulation may make some individuals worse off than they would be in the absence of regulation, whereas the public good is generally assumed to be valued by all individuals. That is why we view regulation as a quasi-public good.
4. This kind of behavior by the new, potential producers is referred to as fringe entry or creamskimming, reflecting the ideas that new entrants would enter the most profitable markets only, leaving the regulated monopolist to provide services in less profitable (and even unprofitable) areas.
5. Regulations often cause cross subsidies where profits on one set of activities are used to finance losses on another set of activities. In this case, consumers in major population centers pay higher freight rates in order to lower freight rates in small population centers. Other examples of cross subsidies occur in the post office (rural areas and magazines are subsidized) and, if AT&T can be believed, in the telephone industry.
6. Since regulation has the nonexcludability property of a public good in the sense that exclusion is not possible, there may be an incentive for individuals to hide their true preferences in order to get other people to foot the entire bill. This incentive to let other persons pay while an individual enjoys the benefits is known as the free rider problem.
7. Fundamental to the use of demand curve for the measurement of welfare change is the fact that prices can be interpreted as monetary measures of the marginal benefits of goods to consumers. This is because consumers allocate their incomes among the purchase of various goods in such a way that the marginal value in monetary terms equals the price for each good. This interpretation of price allows us to develop the notion of consumers' surplus. In addition, no distinction is drawn among consumers in each market. A dollar's worth of surplus to one consumer is treated as having the same weight as a dollar's worth to another, regardless of their income levels. That is, marginal utility of income is identical among all consumers. Thus, distributive or equity implications are disregarded entirely. In using the consumers' surplus as a measure of welfare change this should be borne in mind.
8. N-S is the complement of S relative to N, i.e., N-S is the set of elements which belong to N but not to S.
9. A trivial coalition is defined as a coalition in which there is only one player or interest

group.

10. The grand coalition is the coalition which is composed of all players in the game.
11. An intermediate coalition is a coalition which consists of more than one players, but only a subset of players in the game.
12. Please see Owen (1982) for the detailed description of the core.
13. Nevertheless, the conclusion derived in this paper will still be valid even if we replace the assumption of the unanimity rule by that of a majority rule.
14. A Pareto improvement is a situation where a policy change results in at least one person becoming better off without anyone else becoming worse off.
15. This is consistent with what Crew and Rowley (1970) expected that in the longer term, technological progress might help to erode the market power of those companies which initially escaped the full-impact of the anti-trust policy.

REFERENCES

Aumann, R. J., 1985, 'What is Game Theory Trying to Accomplish?' in K. J. Arrow and S. Honkapohja, ed., Frontiers of Economics (Basil Blackwell Inc., New York).

Boadway, R. W. and Bruce, N., 1984, Welfare Economics (Basil Blackwell Inc., Oxford).

Buchanan, J. M. and Tullock, G., 1962, The Calculus of Consent: Logical Foundations of Constitutional Democracy (The University of Michigan Press, Ann Arbor, Michigan).

Childs, W. R., 1985, Trucking and the Public Interest: The Emergence of Federal Regulation 1914-1940 (The University of Tennessee Press, Tennessee).

Coase, R. H., 1960, 'The Problem of Social Cost', Journal of Law and Economics, 3, 1 (October), pp. 1-44.

Crew, M. A. and Rowley, C. K., 1970, 'Anti-trust Policy: Economics versus Management Science', Moorgate and Wall Street, (Autumn 1970).

Dempsey, P. S. and William, E. T., 1986, Law and Economic Regulation in Transportation, (Greenwood Press Inc., Westport, Connecticut).

Friedman, J. W., 1986, Game Theory with Applications to Economics (Oxford University Press Inc., New York).

Hause, J. C., 1975, 'The Theory of Welfare Cost Measurement', Journal of Political Economy, 83, 6 (December), pp. 1145-83.

Hausman, J. A., 1981, 'Exact Consumer's Surplus and Deadweight Loss', American Economic Review, 71, 4 (September), pp. 662-76.

Jarrell, G. A., 1978, 'The Demand for State Regulation of the Electric Utility Industry', Journal of Law and Economics, 21, 2 (October), pp. 269-95.

Levine, M. E., 1981, 'Revisionism Revised? Airline Deregulation and the Public Interest', Law and Contemporary Problems, 44, (Winter), pp. 179-95.

Luce, R. D. and Raiffa, H., 1957, Games and Decisions (John Wiley and Sons, New York).

Meier, K. J., 1985, Regulation: Politics, Bureaucracy and Economics (St. Martin's Press, New York).

Meyer, J. R., Wilson, R. W., Baughcum, M. A., Burton, E. and Caouette, L., 1980, The Economics of Competition in the Telecommunications Industry (Oelgeschlager, Gunn & Hain, Publishers Inc., Cambridge, Mass.).

Mitnick, B. M., 1980, The Political Economy of Regulation: Creating, Designing and Removing

Regulatory Forms (Columbia University Press, New York).
Needham, D., 1983, The Economics and Politics of Regulation: A Behavioral Approach (Little, Brown and Company, Boston, Mass.).
Owen, G., 1982, Game, Theory (Academic Press, New York).
Peltzman, S., 1976, 'Toward a More General Theory of Regulation', Journal of Law and Economics, 19, 2 (August), pp. 211-40.
Posner, R. A., 1974, 'Theories of Economic Regulation', Bell Journal of Economics, 5, 2 (Autumn) pp. 335-58.
Raiffa, Howard, 1982, The Art and Science of Negotiation (Harvard University Press, Cambridge, Mass.).
Schwartz, T., 1986, The Logic of Collective Choice (Columbia University Press, New York).
Schotter, A. and Schwodiauer, G., 1980, 'Economics and Game Theory: A Survey', Journal of Economic Literature, 18, 2 (June), pp. 479-527.
Shapley, L. S., 1967, 'On Balanced Sets and Cores', Naval Research Logistics Quarterly, 14, 4 (December), pp. 453-62.
Shubik, M., 1982, Game Theory in the Social Sciences (Harvard University Press, Cambridge, Mass.).
Shubik, M., 1984, A Game-Theoretic Approach to Political Economy (MIT Press, Cambridge, Mass.).
Snow, M. S., 1986, Marketplace for Telecommunications: Regulation and Deregulation in Industrialized Democracies (Longman Inc., New York).
Stigler, G. J., 1971, 'The Theory of Economic Regulation', Bell Journal of Economics, 2, 1 (Spring), pp. 3-21.
Tunstall, J., 1986, Communications Deregulation: The Unleashing of America's Communications Industry (Basil Blackwell Inc., New York).
Wang, K. L., 1987, The Regulatory Game: A Cooperative Approach (Unpublished Ph.D. Thesis, Temple University).
Wilson, J. Q., 1980, The Politics of Regulation (Basic Books Inc., New York).