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Title: LIABILITY RULES, TRANSACTIONS COSTS AND OPTIMUM EXTERNALITY

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Economic theorists have proposed that the problems created by a Pareto-relevant externality may be solved by market transactions between the involved parties. These market transactions would allow realization of the potential gains from trade which characterize a Pareto-relevant externality. After all potential gains from trade had been realized, a Pareto-efficient solution would have been achieved.

From the literature which has developed in the field, it is possible to distill two propositions which are here called the Weak and the Strong Coasian Hypotheses on Optimum Externality. These Hypotheses require certain assumptions: perfect competition in the markets for all factors and commodities; perfect information in a context of static certainty; secure and well defined property rights for all factors and commodities; and a well defined set of liability rules to serve as a starting point, or _status quo_ point, for negotiations. The Weak

Hypothesis states that "(m)arket transactions between individuals or firms involved in an externality situation will result in achievement of a Pareto-efficient solution, regardless of the initial liability rule." The Strong Hypothesis includes the Weak Hypothesis and adds that "(e)xactly the same equilibrium output of externality will be produced, regardless of the status quo liability rule."

These Hypotheses are deductively tested, with the aid of simple mathematical models, for several different types of externality situations involving: producers only, consumers only and both producers and consumers; transactions costs equal to zero, and transactions costs greater than zero. For this deductive testing, the static perfect competition framework used in the original papers is retained.

It is found that the Strong Hypothesis must be rejected for all cases except that where no consumers are involved in the externality situation and variable transactions costs are zero. It is argued that situations meeting these criteria are most uncommon in practice, and so the Strong Hypothesis must be rejected for most practical situations. The Weak Hypothesis is not rejected, provided that all of the assumptions (including the crucial assumption of perfect competition in all relevant markets) are met.

In situations where the Strong Hypothesis is rejected but the Weak Hypothesis is not, the equilibrium output of externality is different, under each different status quo liability rule. In this case, the selection of a *status quo* point can greatly affect the equilibrium output of externality, the distribution of income among involved parties and, if the *status quo* rule has wide application throughout the economy, the values of many other variables such as relative and absolute prices, aggregate consumption, production and investment and real income.

Attention is drawn to the role of transactions costs in determining whether a solution can be obtained through market transactions between the involved parties. As the amount of variable transactions costs increases, the disparity between the solutions achieved under different *status quo* rules increases.

Transactions costs are also likely to be greater than zero when some extra-market institutional framework is used to handle externality situations. It is argued that the size and shape of the transactions cost curve under different institutions is an important variable to consider in institutional choice. Some directions for empirical research into the transactions cost curves are suggested.

Liability Rules, Transactions Costs and Optimum Externality

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I. INTRODUCTION

Much of the current public policy debate concerns selection of institutional arrangements to handle those problems in the organization of production and consumption which do not seem to be efficiently handled by laissez-faire markets. Those problems which would keep a purely competitive economy from attaining complete Pareto-efficiency are usually called externalities. The more recent contributions to externality theory are subjected to cursory examination below. Two propositions are distilled from these writings. These propositions can, with the aid of simple microeconomic models, be subjected to deductive tests. This procedure allows the clarification of issues which have seemed to remain confused despite the substantial volume of writings on the subject. The results of this deductive and purely theoretical exercise are shown to have some relevance to the policy debate and to offer help in the generation of hypotheses which could be empirically tested, given adequately ingenious research.

In the remainder of this chapter the term, externality, is rigorously defined, some relevant literature is briefly reviewed, and two propositions are stated. These propositions become the hypotheses to be tested with deductive models.

Externality Defined

The term "externality" has suffered from the confusion generated by a large number of attempts to define it, each differently. In what follows here, the definitions proposed by Buchanan and Stubblebine (1962) will be accepted. An externality is said to exist whenever

$$U_j = U_j(X_{1j}, X_{2j}, \ldots, X_{nj}, X_{bm}), \quad j \neq m$$

where

X_i $(i = 1, 2, \ldots, n)$ are activities

and $j = 1, 2, \ldots, k$ refers to people

that is, whenever the utility of an individual, j, is dependent on the activities, X_{ij}, which are exclusively under his control, and also upon an activity, X_{bm}, which is under the control of another individual, m. In this definition, the activity X_i may be any distinguishable human activity, including production, consumption, income redistribution, and anything else a human may be motivated to do.

A <u>relevant externality</u> exists when the performance of the activity, X_{bm}, generates any desire on the part of the externally benefited or damaged party, j, to modify the behavior of the party empowered to take action, m, through trade, persuasion, collective action, litigation, etc. A <u>Pareto-relevant externality</u> exists when the activity, X_{bm}, may be modified in such a way as to make the externally affected party, j, better off without making the acting party, m, worse off. A Pareto-relevant externality is characterized by the existence of potential gains from trade between the affected and the acting parties. In what follows, the term "externality" may (unless otherwise specified) be taken to mean Pareto-relevant externality.

Coase's Attack on the Pigovian Tradition

According to Coase (1960), economists and citizens in general have long followed a tradition which was derived originally from the "rather confusing writings of Pigou" (Coase's phrase). In this tradition, the overwhelming concern has been with external diseconomies, where one person inflicts a harmful side effect on others. The overwhelming thrust of proposals dealing with external diseconomies has been toward punishing the wicked, the creators of the diseconomy. The "producer" of the external diseconomy should be fined or taxed, and it is suggested that he be fined or taxed until the externality disappears completely.

Coase (1960) delineated a new approach to externality theory. He insisted that the harm resulting from an external diseconomy is reciprocal. The smoke emitted by a factory operating under *laissez-faire* conditions may inconvenience nearby residents but they, if able to force the factory to reduce smoke output, would thus inconvenience the factory owners. Coase suggested that this argument has both positive and normative implications. First, the positive implication is that, given secure property rights and no impediments to negotiation, at least one of the parties involved will have an incentive to induce a change in smoke output regardless of the extant liability rules. If the factory has the legal right to emit unlimited smoke the residents, if they are inconvenienced, have an incentive to offer the factory owners a "bribe" to induce them to reduce smoke output. If the law specifies that smoke output may not exceed that amount which the residents will permit, the factory owners have an incentive to offer compensation to induce the residents to accept a smoke output greater than zero. (It is assumed that a factory only emits smoke under laissez-faire conditions because smoke reduction raises costs and, quite possibly, complete smoke abatement would drive the firm out of business.) Under each set of liability rules, one of the parties has an incentive to induce a change in smoke output.

The normative implication is more subtle and oblique. This is that neither party has a monopoly in evil-doing or harm-causing and, therefore, adherence to moral principles does not necessarily mean that the factory should be required to cease its offensive omissions (or, for that matter, that the residents should cease their complaints).

Coase examined external diseconomy situations where the acting and affected parties were firms involved in production. He demonstrated that whenever the cost of market transactions can be neglected the damaging agent will make the same calculation of the marginal cost, whether charged with the responsibility for damages or not. Assignment of property rights or liability for damages has no effect on the allocation of resources (although product distribution will usually be affected). Under perfect competition and <u>any</u> assignment of property rights, market transactions between firms "producing" a nuisance and firms "consuming" it will bring about the same composition of output and the same output of externality as would have been determined by a single firm engaged in both activities. This analysis assumes that the interested parties will be legally able and willing to engage in bargaining, and that the bargaining process and subsequent enforcement of the bargain will be free of transactions costs.[1]

The contributions of Coase to the theory of social cost and externalities have been summarized by Stigler (1966) as follows: "... under perfect competition, private and social costs will be equal"; and by Calabresi (1968) as follows:

> ... all externalities can be internalized, and all misallocations (even those created by legal structures) can be remedied by the market, except to the extent that

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[1] In our present context, transactions costs include the costs of collecting information, making private decisions, making group decisions (by private bargaining, legal or administrative decision, or any other method), and enforcing the decisions made.

transactions cost money, and the structure itself creates some impediments to bargaining.

This line of reasoning has led Demsetz (1964) to formulate the hypothesis that the absence of an observable market for any commodity or discommodity does not indicate "market failure." Rather, a market may not exist precisely because the benefits from such a market are inadequate to compensate for the costs of organizing and using that market. The absence of an observable market is, in itself, a market solution. This type of argument seems to lead naturally to the conclusion that the appearance of what has traditionally been called "market failure" may often really be an optimal market solution. Thus, "market failure" is a wholly inadequate excuse for legislative or administrative intervention in an externality situation.

But does this mean that governments have no place in economic matters? Calabresi (1960) rejects this extreme view by focusing upon the question of transactions costs. Even if transactions costs are so high that it is unprofitable for private individuals and firms to establish a market for a commodity or discommodity, legal or administrative institutions may be able to operate with much lower transactions costs. Then, society may be better off with "imperfect" non-market solutions obtained at low cost than with either "Pareto-optimal" solutions obtainable at prohibitive cost or no solution.

Why do traffic regulations exist? A plausible answer is that the costs of making and enforcing traffic laws are very much lower than the costs of organizing market transactions between a large number of rapidly converging automobiles. In the absence of any kind of transactions costs, "rule-of-thumb" traffic laws lead to apparent inefficiencies. However, the real calculation should be based on a comparison of benefits minus costs minus transactions costs. On the basis of such a calculation, "rule-of-thumb" traffic laws may well be the optimal solution to the externality problems inherent in the use of highway facilities by individual drivers.

This brief summary of Coase's paper (1960) and several which followed it is not intended as a literature survey. Rather, its purpose is to suggest the revolutionary impact which the Coase theorem promised to have on the theory and practice of externality problems. The doctrine of punishing the creators of an externality until the externality disappears, had been put to rest. The very idea of market failure was questioned. Coase had planted the seeds of the idea that transactions costs may be an important factor in deciding both whether anything should be done about an externality, and what to do about it.

Hypotheses

The implications of Coase's article seem so important that a detailed examination of the subject is justified. It is possible to distill from the literature since 1960 two propositions, which will be referred to as the Strong and the Weak Coasian Hypothesis on Optimum Externality.[2] These Hypotheses require the following assumptions: the usual pure competition assumptions (consumers aim to maximize utility and producers aim to maximize profits, no firm or individual can perceptibly influence factor or product prices, perfect knowledge, rationality); secure and well defined property rights for all factors or commodities; and no artificial barriers to market transactions among individuals and firms.

The Weak Coasian Hypothesis of Optimum Externality states that, given the above assumptions, "(m)arket transactions between individuals or firms involved in an externality situation will result in achievement of a Pareto-efficient solution, regardless of the initial liability rules."

The Strong Coasian Hypothesis on Optimum Externality includes the Weak Hypothesis and adds that "(e)xactly the same equilibrium output of externality will be produced, regardless of the initial liability rules."

Both Hypotheses would imply that, given the essential

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[2]The term, "Coasian Hypothesis" is used in order to acknowledge Coase's seminal contribution to the literature from which these hypotheses are distilled. The term, "Coase's Hypothesis" or "anyone-else's Hypothesis" is not used; to use such a term would distract attention toward debate about who said what and away from the prime purpose of this exercise which is the deductive examination of these hypotheses.

assumptions, the market can be relied upon to achieve Pareto-efficient solutions to problems which had been called "market failure" by earlier writers. The Strong Hypothesis would imply that there is no reason on efficiency grounds alone to favor any particular liability rule; output of both externality and market goods will be unaffected by the choice of liability rules. The Weak Hypothesis would also imply that there is no reason on efficiency grounds alone to favor any particular liability rule, so long as any Pareto-optimal solution is acceptable and, prima facie, any Pareto-optimal solution is as good as any other. Clearly the Strong Hypothesis is a statement which would allow policy-makers more confidence in market solutions to externality problems. If market solutions are rejected and administered bribes or charges are used as shadow prices, the Strong Hypothesis suggests that as long as the correct shadow prices are used, the choice between bribes and charges can be made on income distribution grounds; the output of externality would be the same at equilibrium. In situations in which the Weak Hypothesis holds but the Strong Hypothesis does not (i.e., cases where each different liability rule leads to a different equilibrium solution which is Pareto-efficient), there is clearly a choice to be made between liability rules which lead to different equilibrium outputs of externality. Efficiency considerations are not helpful in making the choice, since all of the alternatives lead to efficient solutions.

Neither hypothesis offers any information on income distribution issues. It is immediately clear that different liability rules will lead to different equilibrium income distributions, when either hypothesis holds. However, the hard choice of who shall be allowed to grow richer and who to grow poorer cannot be made on efficiency grounds.

Procedure

The Strong Hypothesis and the Weak Hypothesis are both taken as null hypotheses. Alternative hypotheses are generated by inserting the word "not" following "will" in both hypotheses. These hypotheses are tested using simple deductive mathematical models. Situations are examined in which

(i) the acting and affected parties are both consumers (Chapter 3),

(ii) the acting and affected parties are both producers (Chapter 4),

(iii) both producers and consumers are involved in the externality situation (Chapter 4).

All of these situations are examined under two sets of assumptions: (a) transactions costs are zero and (b) transactions costs are greater than zero and constant per unit of externality modification.

The procedure of deductive hypothesis testing using simple theoretical models allows acceptance or rejection of the hypothesis.

Given the assumptions (premises), the hypothesis (conclusion) either does or does not follow logically. Deductive testing, then, at the very least allows elimination of the inconsistent and is therefore an efficient step in the development of hypotheses for empirical testing.

II. TRANSACTIONS COSTS IN PURE EXCHANGE

The "Coase theorem on social cost"[3] contains a very strong assumption about transactions costs: they are assumed to be zero.

Casual observation that a large number of people are able to earn adequate and sometimes generous incomes as agents, dealers, wholesalers and retailers, lawyers who draw up contracts and law enforcement officers and judges who enforce them, all of whom are engaged wholly or partly in arranging and enforcing transactions, suggests that transactions costs in a modern society are likely to be much greater than zero.

The inaccuracy of the assumption that transactions costs are zero is relevant to an evaluation of Coasian and post-Coasian contributions to externality theory only if a relaxation of the assumption would invalidate the results obtained using it. For this reason, the deductive testing of the Weak and Strong Hypotheses is performed both with and without the assumption that transactions costs are zero. As the Hypothesis in both its strong and weak forms states that market solutions to externality problems will be Pareto-efficient, it is necessary to determine whether the introduction of transactions costs greater than zero violates the requirements for Pareto-efficiency.

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[3]Nutter's phrase (1968, p. 503).

A simple exchange model is first presented in the usual form and then transactions costs are explicitly introduced.

Exchange when Transactions Costs are Zero

A two-person[4], closed society exchange model can be simply developed. There are two goods, both available in fixed quantities.

$$q_1^0 = q_{11} + q_{12} \tag{2.1}$$

$$q_2^0 = q_{21} + q_{22} \tag{2.2}$$

where

q_{ij} = the amount of the good i held by Mr. j.

At the start, $q_1^0 = q_{11}$ and $q_2^0 = q_{22}$, that is, Mr. 1 holds all of q_1 and Mr. 2 holds all of q_2.

Each person has a well-behaved utility function (enabling us to dispense with the constraint that goods cannot be held in negative quantities).[5]

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[4] It may be helpful, to remove all thought of bilateral monopoly problems, to consider two groups of people, each containing a large number of people all with the same utility function and the same budget constraint.

[5] Utility is defined in ordinal terms and for a single time period. It is necessary that the utility functions be continuous within the relevant range and have continuous first- and second-order partial derivatives. The second-order condition for utility maximization requires that the indifference curves must be convex from the origin. For the remainder of this study, utility functions are assumed to satisfy these conditions. Having made this assumption, we can concern ourselves with first-order conditions when considering questions of Pareto-optimality.

$$U_1 = U_1(q_{11}, q_{21}) \quad (2.3)$$

$$U_2 = U_2(q_{12}, q_{22}) \quad (2.4)$$

Each has a budget contraint:

for Mr. 1, $p_1(q_1^0 - q_{11}) - p_2 q_{21} = 0;$ (2.5)

for Mr. 2, $p_2(q_2^0 - q_{22}) - p_1 q_{12} = 0;$ (2.6)

where p_i = price of the good i.

Let each person maximize his utility subject to his budget constraint. Solution by the method of Lagrangian multipliers yields three equations for each person (the first-order conditions for utility maximization). When the two market clearing equations (2.1 and 2.2) are included, the eight equations, seven of which are independent, can be solved simultaneously[6] to yield equilibrium values of the seven unknowns $(q_{11}, q_{12}, q_{21}, q_{22}, \lambda_1, \lambda_2,$ and $p_1/p_2)$.

At all points on the resultant contract curve (and therefore at the equilibrium solution),

$$\frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial q_{21}} = \frac{\partial U_2/\partial q_{12}}{\partial U_2/\partial q_{22}} = \frac{p_1}{p_2} \quad (2.7)$$

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[6] The same problem can be solved geometrically, using the familiar Edgeworth box. A contract curve is found and efficient exchange may take place. Using offer curves, which are the loci of the points of tangency of the individuals' budget constraints at various prices with the individuals' indifference curves, a unique solution may be found (Newman, 1965, Chapters 3 and 4).

The condition (2.7) assures Pareto-efficiency in exchange.

Exchange when Transactions Costs are Greater than Zero

In order to allow communication between Mr. 1 and Mr. 2 and to strike a bargain between them, to make contractual arrangements and to enforce physical delivery of the goods exchanged, costs may be incurred in practice. One way to introduce these costs into a simple exchange model is to introduce a third person (a commission agent, for example) who performs the required services in return for an income. Each of the three members of society has a utility function.

$$U_1 = U_1(q_{11}, q_{21}) \tag{2.8}$$

$$U_2 = U_2(q_{12}, q_{22}) \tag{2.9}$$

$$U_3 = U_3[q_{13}, q_{23}, f(q_{12}, q_{21}, q_{13}, q_{23})] \tag{2.10}$$

where

$$q_1^0 = q_{11} + q_{12} + q_{13} \tag{2.11}$$

$$q_2^0 = q_{21} + q_{22} + q_{23} \tag{2.12}$$

$$x_3 = f(q_{12}, q_{21}, q_{13}, q_{23}) = \text{the work performed by Mr. 3 in arranging transactions.}^{7} \tag{2.13}$$

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[7] Throughout this study, it is assumed that production functions satisfy the second-order conditions for maximization or minimization, as required. Again, we may concern ourselves with first-order conditions when considering questions of Pareto-optimality.

This model assumes that transactions can be arranged only by Mr. 3, and that work is the only input in the production of transactions. In order to earn an income from his work, Mr. 3 extracts a price differential (e.g., a commission) on the goods which pass through his hands. His income is

$$(p_1^b - p_1^s)q_{12} + (p_2^b - p_2^s)q_{21}$$

where

p_i^s = price received for good i by the original holder of stocks

p_i^b = price paid (e.g., price paid by Mr. 1 for good 2).

It is clear that the buying prices, p_i^b, are composites made up of the prices of the goods, q_i, plus the prices of the transactions services which accompany the goods.

Let

$$p_i^b = p_i^s + c_i$$

where

c_i = the unit transactions cost, or the price of transactions services associated with the exchange of one unit of the good i.

Budget constraints are

$$\text{for Mr. 1,} \quad p_1^s(q_1^0 - q_{11}) - (p_2^s + c_2)q_{21} = 0, \tag{2.14}$$

for Mr. 2, $p_2^s(q_2^0 - q_{22}) - (p_1^s + c_1)q_{12} = 0,$ and (2.15)

for Mr. 3, $c_1 q_{12} + c_2 q_{21} - p_1^s q_{13} - p_2^s q_{23} = 0.$ (2.16)

For simplicity, it is assumed that Mr. 3 performs those transactions involved in arranging sales of q_{13} and q_{23} to himself free of charge. This is not unreasonable, since it is assumed that the buyer pays any transactions costs.

Let each of the three individuals separately maximize his utility subject to his budget constraint. Solution by the method of Lagrangian multipliers yields three equations each for Mr. 1 and Mr. 2 and five equations for Mr. 3, (the first-order conditions for utility maximization). When Equations (2.11, 2.12 and 2.13) are included, the 14 equations, 13 of which are independent, can be solved simultaneously to yield equilibrium values of the 13 unknowns $(q_{11}, q_{12}, q_{13}, q_{21}, q_{22}, q_{23}, \lambda_1, \lambda_2, \lambda_3, x_3, c_1/p_1^s, c_2/p_1^s, p_2^s/p_1^s)$.

The following results are obtained at equilibrium.

$$\frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial q_{21}} = \frac{p_1^s}{p_2^s + c_2} \neq \frac{\partial U_2/\partial q_{12}}{\partial U_2/\partial q_{22}} = \frac{p_1^s + c_1}{p_2^s} \neq \frac{\partial U_3/\partial q_{13}}{\partial U_3/\partial q_{23}} = \frac{p_1^s}{p_2^s}. \quad (2.17)$$

$$\frac{\dfrac{\partial U_3}{\partial f} \cdot \dfrac{\partial f}{\partial q_{12}}}{\dfrac{\partial U_3}{\partial f} \cdot \dfrac{\partial f}{\partial q_{21}}} = \frac{\partial f/\partial q_{12}}{\partial f/\partial q_{21}} = \frac{c_1}{c_2}. \quad (2.18)$$

Each of the three consumers equates his rate of commodity substitution between the two goods with the price ratio facing him. Each consumes efficiently. But, as the price ratios facing each consumer are different, the rates of commodity substitution of the three consumers are not equated. In this respect, it would appear that Pareto-efficiency has not been achieved. We will return to this question. The professional transactor equates his rate of product transformation (between production of transactions enabling Mr. 2 to purchase good 1 and transactions enabling Mr. 1 to purchase good 2) with the ratio of the rewards obtained per unit of each good exchanged. The first-order conditions for efficiency in production of transactions are satisfied..

Figure 1 is an Edgeworth box diagram which shows the conditions (2.17) for efficiency in consumption. The starting point, $q_1^0 = q_{11}$ and $q_2^0 = q_{22}$ is represented by the point A. Mr. 1 would refuse any trade at price ratios less favorable or as favorable as P_1^0A. Similarly, Mr. 2 would refuse any trade at price ratios less favorable or as favorable as P_2^0A. At price ratios more favorable than P_1^0A and P_2^0A, trade will take place even when $P_1^1A \neq P_2^1A$. In this instance, $q_{13} + q_{23}$ (Mr. 3's income expressed in quantities of goods paid to him) can be regarded from the viewpoints of Mr. 1 and Mr. 2 as the transactions costs spent to allow exchange to take place. Even though the combined holdings of Mr. 1 and Mr. 2 have been

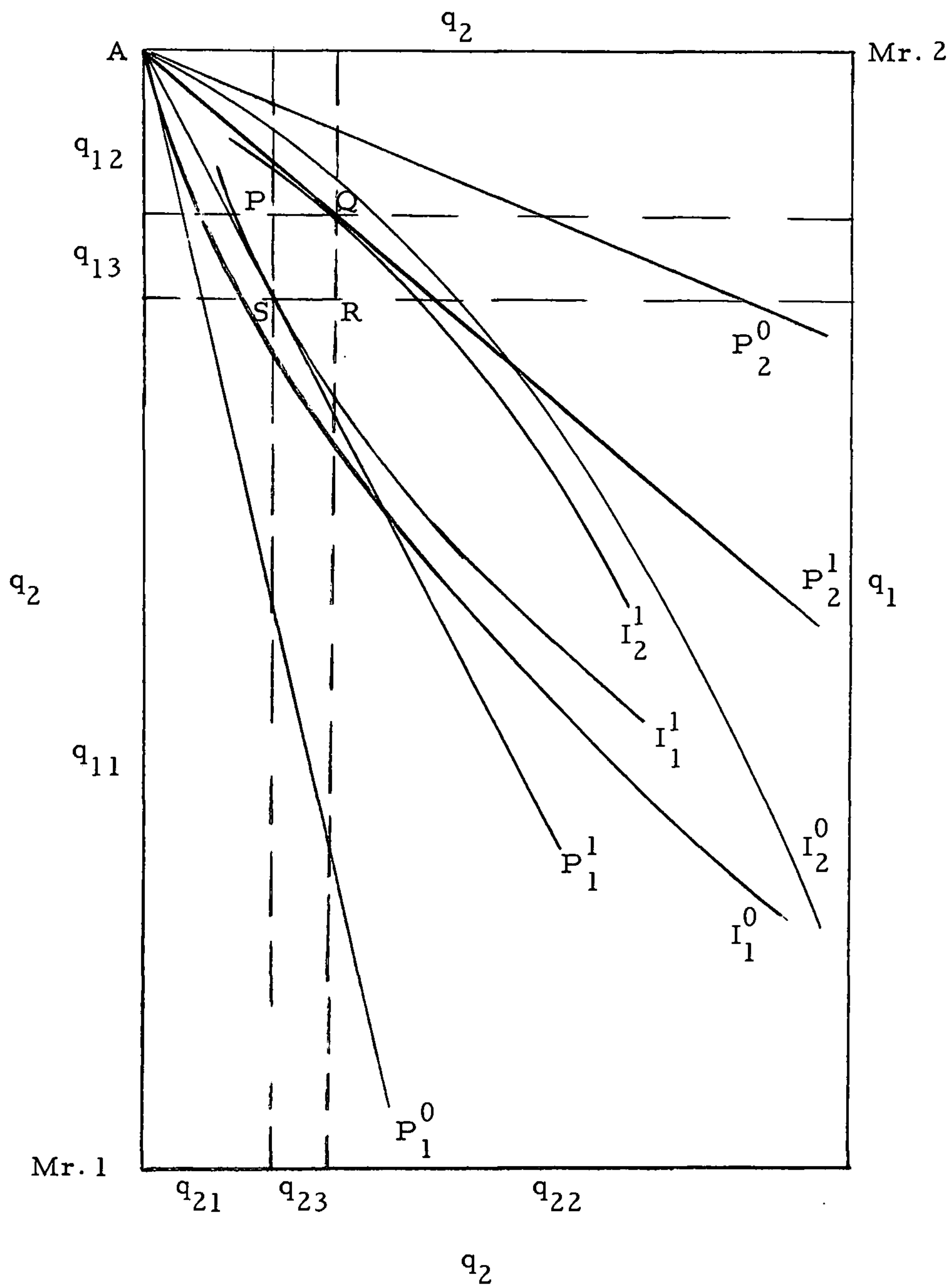

Figure 1. Efficiency in consumption, when transactions costs are greater than zero.

reduced from $(q_1^0 + q_2^0)$ to $(q_{11} + q_{21} + q_{12} + q_{22})$ both Mr. 1 and Mr. 2 are better off after trading and paying the necessary transactions costs.

It must be pointed out that the Edgeworth box in Figure 1 is insufficient to determine Mr. 3's economic position, because the efficiency condition for production of transactions (2.18) cannot be shown. However, we can see that if any trade takes place Mr. 3 is better off, too: his income has risen from zero to $q_{13} + q_{23}$. We know that Mr. 3 will not continue to arrange transactions past the point where the marginal utility of income equals that of leisure.

Pareto-efficiency in Exchange when Transactions Costs are Greater than Zero

The simple model presented above leaves unanswered questions about the Pareto-efficiency of exchange when transactions costs are greater than zero. Questions about the fulfillment of the efficiency conditions for both production and consumption remain.

Equation (2.18) assures us that the professional transactor equates his rate of product transformation with the ratio of rewards obtained per unit of each type of transaction performed. If it is assumed that Mr. 3 stands for a large group of people, each with the same utility function and the same production function for transactions, each of these professional transactors will equate his rate of product transformation with the price ratio, c_1/c_2. The transactions industry will be in competitive equilibrium.

There remains the problem that rates of commodity substitution between goods 1 and 2 are not equal for all consumers (Equation 2.17). It is clear that, if

$$\frac{\partial U_1/\partial q_2}{\partial U_1/\partial q_{21}} = \frac{p_2^s}{p_2^s+c_2}, \qquad (2.19)$$

then

$$\frac{\dfrac{\partial U_1/\partial q_1}{\partial U_1/\partial q_{21}}}{\dfrac{\partial U_1/\partial q_2}{\partial U_1/\partial q_{21}}} = \frac{\dfrac{p_1^s}{p_2^s+c_2}}{\dfrac{p_2^s}{p_2^s+c_2}}$$

and therefore

$$\frac{\partial U_1/\partial q_1}{\partial U_1/\partial q_2} = \frac{p_1^s}{p_2^s}. \qquad (2.20)$$

Similarly, if

$$\frac{\partial U_2/\partial q_1}{\partial U_2/\partial q_{12}} = \frac{p_1^s}{p_1^s+c_1},$$

then

$$\frac{\partial U_2/\partial q_1}{\partial U_2/\partial q_2} = \frac{p_1^s}{p_2^s}$$

and the rates of commodity substitution between all three consumers would be equated.

Examination of Equation (2. 19) reveals an interesting situation. We have assumed that the good 2 is available to Mr. 1 only in the form q_{21}; that is, Mr. 1 cannot obtain good 2 directly but, rather, a transaction must be performed at some effort by a professional transactor so that Mr. 1 may obtain the good 2 in the form q_{21}.

In Figure 2, Mr. 1's budget constraint between the goods 2 and 21 is shown as a broken line, AB. Both p_2^s and $(p_2^s+c_2)$ exist and so the slope of this broken line is known. But only the point A and all points on the line segment 0A are attainable (since only the good 21 is available to Mr. 1).

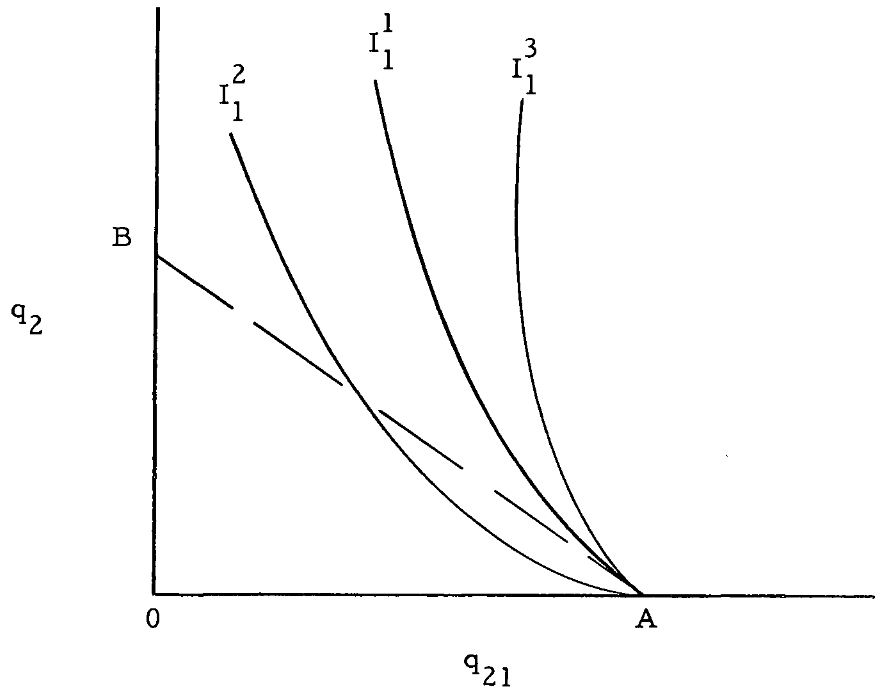

Figure 2. Mr. 1's choice between goods 2 and 21, assuming three different shapes for the indifference curves.

If, by coincidence, Mr. 1 has an indifference curve such as I_1^1 tangent to AB at the point A, then the condition (2.19) will hold and complete Pareto-optimality will be achieved. If Mr. 1 has no indifference curve tangent to the line AB at the point A, a solution maximizing Mr. 1's utility can be achieved, but it will be a second-best solution.

Now, the assumption that the two consumers initially involved in the exchange situation must pay for the professional performance of transactions services is relaxed. The assumptions that transactions services are required and that they require effort are retained. Mr. 1 is allowed to perform the work required in the exchange of good 2 from Mr. 2 to Mr. 1 himself should he so desire; similarly, Mr. 2 may perform the work required to allow him to obtain the good 1.

Where

q_{ijk} = the amount of good i sold to Mr. j with the help of transactions services provided by Mr. k

and $x_k = f_k(\ldots)$ = Mr. k's production function for transactions in terms of his work input,

and

$$V_1 = U_1[q_{11}, q_{211}, q_{213}, f_1(q_{211})] + \lambda_1[p_1^s(q_1^0 - q_{11}) - p_2^s q_{211} - (p_2^s + c_2)q_{213}], \qquad (2.21)$$

$$V_2 = U_2[q_{122}, q_{123}, q_{22}, f_2(q_{122})]$$

$$+ \lambda_2[-p_1^s q_{122} - (p_1^s + c_1)q_{123} + p_2^s(q_2^0 - q_{22})], \qquad (2.22)$$

$$V_3 = U_3[q_{133}, q_{233}, f_3(q_{123}, q_{213}, q_{133}, q_{233})]$$

$$+ \lambda_3[c_1 q_{123} + c_2 q_{213} - p_1^s q_{133} - p_2^s q_{233}], \qquad (2.23)$$

let each individual maximize his utility subject to his budget constraint. The 13 equations (first-order conditions for utility maximization) are then solved simultaneously with

$$q_1^0 = q_{11} + q_{122} + q_{123} + q_{133} \qquad (2.24)$$

$$q_2^0 = q_{22} + q_{211} + q_{213} + q_{233} \qquad (2.25)$$

$$x_1 = f_1(q_{211}) \qquad (2.26)$$

$$x_2 = f_2(q_{122}) \qquad (2.27)$$

$$x_3 = f_3(q_{123}, q_{213}, q_{133}, q_{233}). \qquad (2.28)$$

The 18 equations, 17 of which are independent, may be solved to obtain a unique solution for the 17 unknowns $(q_{11}, q_{122}, q_{123}, q_{133}, q_{22}, q_{211}, q_{213}, q_{233}, x_1, x_2, x_3, \lambda_1, \lambda_2, \lambda_3, p_2^s/p_1^s, c_1/p_1^s, c_2/p_1^s)$. As with our previous model, the conditions for efficiency in production are satisfied. The conditions for efficient consumption are

$$\frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial q_{211}} = \frac{\partial U_2/\partial q_{122}}{\partial U_2/\partial q_{22}} = \frac{\partial U_3/\partial q_{133}}{\partial U_3/\partial q_{233}} = \frac{p_1^s}{p_2^s} \tag{2.29}$$

$$\frac{\partial U_1/\partial q_{211}}{\partial U_1/\partial q_{213}} = \frac{p_2^s}{p_2^s+c_2} \tag{2.30}$$

$$\frac{\partial U_2/\partial q_{122}}{\partial U_2/\partial q_{123}} = \frac{p_1^s}{p_1^s+c_1} \tag{2.31}$$

$$\frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial q_{213}} = \frac{p_1^s}{p_2^s+c_2} \neq \frac{\partial U_2/\partial q_{123}}{\partial U_2/\partial q_{22}} = \frac{p_1^s+c_1}{p_2^s} \neq \frac{\partial U_3/\partial q_{133}}{\partial U_3/\partial q_{233}} = \frac{p_1^s}{p_2^s}. \tag{2.32}$$

The condition (2.32) is the same as the condition (2.17). However, condition (2.29) shows that, provided each individual performs the transactions services required to purchase the goods he buys, the rates of commodity substitution between the two goods, 1 and 2, are the same for all individuals. Conditions (2.30) and (2.31) show that each individual chooses efficiently between performing his own transactions services and having them professionally performed. The conditions for efficient consumption are satisfied. As in the previous model, the conditions for efficient production of transactions are satisfied. Thus, complete Pareto-efficiency is attained.

The above analysis demonstrates that where transactions services are useful and desirable, but require a work input, their purchase does not necessarily violate the necessary conditions for

Pareto-optimality. Microeconomic production theory tells us that if any purchased inputs, as well as work, are required in the production of transactions, Pareto-optimality may be achieved provided these inputs are also produced and sold under perfectly competitive conditions.

When transactions require effort, Pareto-optimality is achievable, so long as buyers and sellers are not forced to use the services of a professional transactor. However, the buyers and sellers may often rationally choose to employ a professional transactor; this would violate none of the requirements for Pareto-optimality. When consumers are not constrained to use the services of the professional transactor against their will, Condition (2. 32) does not preclude Pareto-efficiency.

Summary

A simple model for the exchange of two goods between two people is developed for a situation in which transactions costs are zero. Necessary conditions for Pareto-optimality are shown. Then, it is assumed that the performance of transactions requires a work input. Transactions services may be purchased from professional transactors. Where gains from trade between two individuals exist, the existence of transactions costs amounting to less than the total gains from trade will not preclude exchange. Pareto-optimality can be achieved when the transactions cost is greater than zero, provided all the usual conditions for Pareto-optimality are met. Among these conditions, one deserves special mention: perfect competition in the transactions industry. This implies that no professional transactor can perceptibly affect the price of transactions services and that no barriers to entry into the transactions industry exist. This implies that individual buyers and sellers may choose, if they so desire, to themselves perform the transactions services required.

If it is specified that the services of a professional transactor must be used (as is often the case when legal services, for example, are involved), a second-best optimum can be achieved. In cases where the professional transactor has a large comparative advantage in this work and/or the buyers and sellers have a substantial distaste for this type of work, the Pareto-optimal solution may be the same as the second-best solution (i. e., professional services may be used exclusively, even though there is no constraint requiring that they be).

In this chapter, it is established that, for the simple situation examined, the existence of costs of arranging and enforcing agreements to exchange does not necessarily preclude Pareto-optimality. If the transactions industry is perfectly competitive, and so is the rest of the economy, Pareto-optimality will be achieved. This finding is useful in subsequent testing of the Weak and Strong Hypotheses.

III. EXTERNALITY IN CONSUMPTION

Coase, in his seminal paper (1960), concerned himself primarily with externalities in production, either because he felt externalities in consumption to be of considerably less importance, or because he thought his theorem would be relevant, regardless of whether the individuals were both producers, both consumers, or one a consumer and one a producer. However, the massive recent popular and political concern with environmental factors affecting the "quality of life" has given much prominence to externalities where at least one of the parties concerned is a consumer.

Davis and Whinston (1965) examine an externality where both parties are consumers (only because this assumption makes analysis easier, they say). They show that, for an external diseconomy in consumption,

1. in most cases[8], a Pareto efficient solution may be achieved by bargaining, regardless of whether the law (a) prohibits the creation of an externality (unless affected parties agree otherwise), thus placing the costs of the nuisance in the hands of the externality producer, or (b) has nothing at all to say,

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[8] They do establish the existence of one exception. In the case of externalities in consumption, certain configurations of preferences will lead to a "Giffen's Paradox" type result. Then it is possible to obtain an equilibrium solution which is not Pareto-optimal.

thus effectively placing the costs in the hands of the consumer of the externality, or (c) some intermediate case, such as permitting only a specified amount of nuisance to be created (unless the affected parties agree otherwise). In each of these situations, bargaining solutions are the same as the solutions obtained using tax-subsidy schemes (when total tax income is equal to total subsidy payments). These results are obtained under the assumption of zero transactions costs.

2. the law, by defining the _status quo_ point, implicitly affects the distribution of income, although movement towards Pareto efficient solutions, given a specified _status quo_ point, does not involve interpersonal comparisons of utility.
3. the selection of the _status quo_ point is a question of ethics. The economist can leave distributional questions to the legal process and concern himself with problems of efficiency (Davis and Whinston, 1965, p. 125).

The conclusions reached by Davis and Whinston appear to be a statement of that which is referred to here as the Weak Coasian Hypothesis on Optimum Externality. However, the statement that "the law, which determines the _status quo_ point, affects only the final distribution of income" (Davis and Whinston, 1965, p. 123) seems to suggest that they would also support the Strong Hypothesis for the case of externality in consumption. Presumably, if the law "affects _only_ the final distribution of income" (italics added), it does not affect the equilibrium output of externality.

Dolbear (1967), in effect, rejects the Strong Hypothesis but not the Weak Hypothesis for the case of externality in consumption. Dolbear presents a diagrammatic analysis which utilizes a "half-Edgeworth box". He shows that different liability rules can be represented as different *status quo* or starting points along the mutual budget constraint line. Only in special cases will negotiation between the two consumers from different *status quo* points result in the same equilibrium output of externality.[9] Dolbear attributes this result to the existence of an "income effect" associated with the different starting points on the mutual budget constraint, resulting from the different liability rules.

In the remainder of this chapter, the problem of negotiated solutions to externality in consumption is examined with the aid of simple mathematical models. The existence of Dolbear's "income effect", which here is called the "income transfer effect" to distinguish it from the familiar income effect derived from Slutsky equation analysis of consumption where no externality exists, is considered. Supply and demand curves for the abatement of an externality are derived and the

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[9]The present author, in the course of this study, made the same "discovery" independently. Dolbear's contribution was noticed during a later literature search.

results of negotiation from different *status quo* points are established.

This analysis has several advantages relative to the Dolbear treatment.

(i) The existence of an income transfer effect due to different liability rules is shown, and the conditions under which it is non-zero can easily be established.

(ii) The use of supply and demand curves for abatement of the externality seems to be an expositional device which is more widely applicable than the "half-Edgeworth box", since supply and demand curves may be used in open economy models as well as in exchange models and in production situations as well as in consumption situations.

(iii) The analysis lends itself to some useful extensions, two of which are used here. Situations are examined in which (a) both consumers and producers are involved in an externality situation and (b) transactions costs are greater than zero.

An Open Economy Model with an Externality in Consumption

The basic model for analysis of externality in consumption is presented.[10] An exchange model, being a general equilibrium model

[10] The analysis to follow examines the case of external diseconomies. Davis and Whinston (1965) note that the analysis for the case of external economies proceeds analogously, with one initial difference. In the case of external diseconomy, the affected party has

for a closed economic entity, is more general than an open economy model. However, the latter allows the simplifying assumption that the prices of market goods remain constant while only the bribe or compensation price associated with the externality varies. This assumption is reasonable in this analysis, since we are dealing with perfectly competitive production and consumption. Thus, an open economy model is used. The general form of the open economy model used is presented below, with budget constraints relevant to the case where status quo liability is zero (i. e., the law allows an unlimited output of externality).

The following assumptions are made.

(i) Let goods q_i $(i = 1, 2, \ldots, m, n)$ be available in indefinitely large quantities at fixed prices, $\bar{p}_i$ $(i = 1, 2, \ldots, m, n)$. Perfectly elastic supply curves face individual consumers.

(ii) Let individual consumers have fixed incomes $\bar{Y}_j$, $(j = 1, 2, \ldots, k)$. Let us initially concern ourselves with just two consumers, $j = 1, 2$.

(iii) Let q_{n2} be the amount of the good, n, consumed by Mr. 2. Then $f(q_{n2})$ is the amount of externality which affects Mr. 1's level of utility as a result of Mr. 2's

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incentive to induce the acting party to reduce his output of externality; in the case of external economy, the affected party would like an increase in the output of the externality.

consumption of q_{n2}. For consumers 1 and 2, who are rational utility maximizers,

$$U_1 = U_1[q_{11}, \ldots, q_{m1}, f(q_{n2})]$$

$$U_2 = U_2(q_{12}, \ldots, q_{m2}, q_{n2})$$

Let, for example, $\frac{\partial U_1}{\partial f} \cdot \frac{\partial f}{\partial q_{n2}} < 0$. Mr. 1 suffers an external diseconomy from Mr. 2's consumption of q_{n2}.

Where institutional barriers prevent any attempt by Mr. 1 to modify Mr. 2's output of the external diseconomy, equilibrium consumption of each good by each consumer is q_{ij}^0. Now, let these institutional barriers be removed, and assume that the possibility of Mr. 2 consuming q_{n2} only in Mr. 1's absence is excluded. Mr. 1 now has an incentive to attempt to induce Mr. 2 to modify his consumption of the good, n.

Since the law specifies no limit upon Mr. 2's consumption of q_{n2}, and since forms of coercion outside of litigation and bargaining are proscribed, Mr. 1 decides to offer Mr. 2 a financial incentive, a bribe, to reduce his consumption of q_{n2} and hence the output of externality. Let p_n^N be the bribe paid for each unit of $(q_{n2}^0 - q_{n2}) > 0$ (i.e., each unit by which Mr. 2's consumption of the good, n, is reduced from the level q_{n2}^0).

A work input is likely to be necessary in the negotiations which take place before Mr. 1 and Mr. 2 agree on the bribe price p_n^N and number of units of $(q_{n2}^0 - q_{n2})$, abatement of the external diseconomy, purchased by Mr. 1. Similarly, enforcement of the bargain requires effort.[11] Let us assume that Mr. 1 may either provide the required transactions services himself or purchase transactions services from Mr. 3, a professional transactor.

Where

$(q_{n2}^0 - q_{n2})_i$ = the amount of externality abatement arranged with transactions services provided by Mr. i,

$x_i = g_i(q_{n2}^0 - q_{n2})_i$ = the work input required by Mr. i to arrange these transactions,

and c_n^N = the price charged by Mr. 3 for professional transactions services provided to allow purchase of one unit of $(q_{n2}^0 - q_{n2})_3$,

let each individual maximize his utility subject to his budget constraint.

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[11] In a completely general model, purchases of the market goods, 1, . . . , m, n, would also involve transactions costs. These transactions costs can be ignored with a minimal reduction in validity; since $\bar{p}_1, \ldots, \bar{p}_m, \bar{p}_n$ are fixed (i. e., the goods are supplied by perfectly competitive industries), it is not unreasonable to assume $\bar{c}_1, \ldots, \bar{c}_m, \bar{c}_n$ are also fixed. As already shown, the existence of these transactions costs does not necessarily preclude achievement of Pareto-efficiency.

$$V_1 = U_1[q_{11}, \ldots, q_{m1}, f(q_{n2}), g_1(q^0_{n2}-q_{n2})_1]$$
$$+ \lambda_1[\overline{Y}_1-\overline{p}_1 q_{11}-\cdots-\overline{p}_m q_{m1}-p^N_n(q^0_{n2}-q_{n2})_1-(p^N_n+c^N_n)(q^0_{n2}-q_{n2})_3] \quad (3.1)$$

$$V_2 = U_2[q_{12}, \ldots, q_{n2}, q_{n2}]$$
$$+ \lambda_2[\overline{Y}_2-\overline{p}_1 q_{12}-\cdots-\overline{p}_m q_{m2}-\overline{p}_n q_{n2}+p^N_n(q^0_{n2}-q_{n2})] \quad (3.2)$$

$$V_3 = U_3[q_{13}, \ldots, q_{m3}, g_3(q^0_{n2}-q_{n2})_3]$$
$$+ \lambda_3[c^N_n(q^0_{n2}-q_{n2})_3-\overline{p}_1 q_{13}-\cdots-\overline{p}_m q_{m3}] \quad (3.3)$$

Let $m = 2$.

On partial differentiation and setting the partial derivatives equal to zero, Equation (3.1) yields five equations (first-order conditions for utility maximization), Equation (3.2) yields four equations and Equation (3.3) yields four equations. Simultaneous solution of these 13 equations with the three following equations

$$(q^0_{n2}-q_{n2}) = (q^0_{n2}-q_{n2})_1 + (q^0_{n2}-q_{n3})_3$$
$$x_1 = g_1(q^0_{n2}-q_{n2})_1$$
$$x_3 = g_3(q^0_{n2}-q_{n2})_3$$

should yield unique solutions for the 15 unknowns $[q_{11}, q_{12}, q_{13}, q_{m1}, q_{m2}, q_{m3}, (q^0_{n2}-q_{n2})_1, (q^0_{n2}-q_{n2})_3, \lambda_1, \lambda_2, \lambda_3, x_1, x_3, c^N_n, p^N_n]$, since there are 15 independent equations.

At equilibrium,

$$\frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial q_{m1}} = \frac{\partial U_2/\partial q_{12}}{\partial U_2/\partial q_{m2}} = \frac{\partial U_3/\partial q_{13}}{\partial U_3/\partial q_{m3}} = \frac{\bar{p}_1}{\bar{p}_m}, \tag{3.4}$$

$$\frac{1}{\lambda_1}\cdot\frac{\partial U_1}{\partial f}\cdot\frac{\partial f}{\partial(q^0_{n2}-q_{n2})_1} = p^N_n \tag{3.5}$$

and

$$\frac{1}{\lambda_1}\cdot\frac{\partial U_1}{\partial f}\cdot\frac{\partial f}{\partial(q^0_{n2}-q_{n2})_3} = (p^N_n+c^N_n)$$

where

$$\frac{\partial U_1}{\partial f}\cdot\frac{\partial f}{\partial(q^0_{n2}-q_{n2})_i} > 0, \quad \text{for} \quad i = 1, 3,$$

and

$$\frac{\partial U_1}{\partial f}\;\frac{\partial f}{\partial q_{n2}} < 0.$$

Therefore

$$\frac{\partial U_1/\partial(q^0_{n2}-q_{n2})_1}{\partial U_1/\partial(q^0_{n2}-q_{n2})_3} = \frac{p^N_n}{p^N_n+c^N_n} \tag{3.6}$$

and

$$\frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial(q^0_{nq}-q_{n2})_1} = \frac{\bar{p}_1}{p^N_n} \quad\text{and}\quad \frac{\partial U_1/\partial q_{11}}{\partial U_1/\partial(q^0_{n2}-q_{n2})_3} = \frac{\bar{p}_1}{p^N_n+c^N_n}. \tag{3.7}$$

$$\frac{1}{\lambda_2}\cdot\frac{\partial U_2}{\partial q_{n2}} = \bar{p}_n+p^N_n \quad\text{and}\quad \frac{\partial U_2/\partial q_{12}}{\partial U_2/\partial q_{n2}} = \frac{\bar{p}_1}{\bar{p}_n+p^N_n}. \tag{3.8}$$

$$\frac{1}{\lambda_3} \cdot \frac{\partial U_3}{\partial g_3} \cdot \frac{\partial g_3}{\partial (q_{n2}^0 - q_{n2})_3} = -c_n^N \tag{3.9}$$

where

$$\frac{\partial U_3}{\partial g_3} \frac{\partial g_3}{\partial (q_{n2}^0 - q_{n2})_3} < 0 .$$

Equation (3.4) indicates that all consumers consume goods $1, \ldots, m$ efficiently. Equations (3.5), (3.7) and (3.8) indicate efficient internalization of the externality. Mr. 1 chooses efficiently between performing the transactions services required and purchasing them (3.6). Mr. 3 produces transactions efficiently (3.9). In a larger model, Mr. 3 would have the opportunity to perform transactions of other types between other individuals; then he would equate his rate of product transformation between transactions of various types with the ratio of the rewards per unit of each type of transaction. Complete Pareto-optimality is achieved and the externality is internalized, but only as a special case does it completely disappear.

If, instead, the <u>status quo</u> situation is full liability (i.e., the acting party, Mr. 2, may not produce any externality unless the affected party agrees to permit it), Mr. 2 has an incentive to offer Mr. 1 compensation for the inconvenience suffered, in order to induce Mr. 1 to accept some positive output of the externality. Mr. 1 receives p_n^N for each unit of q_{n2} and Mr. 2 pays p_n^N for each unit of q_{n2} for which agreement is obtained through his own efforts (i.e., q_{n22}) and $(p_n^N + c_n)$ for each unit of q_{n2} for which agreement is obtained through the efforts of the professional transactor (i.e., q_{n23}). New budget constraints are:

for Mr. 1, $\bar{Y}_1 - \bar{p}_1 q_{11} - \cdots - \bar{p}_n q_{m1} + p_n^N q_{n2} = 0$

$$\text{i.e.,}\quad \bar{Y}_1 - \bar{p}_1 q_{11} - \cdots - \bar{p}_m q_{m1} + p_n^N q_{n2}^0 - p_n^N (q_{n2}^0 - q_{n2}) = 0; \qquad (3.10)$$

$$\text{for Mr. 2,}\quad \bar{Y}_2 - \bar{p}_1 q_{12} - \cdots - \bar{p}_m q_{m2} - \bar{p}_n q_{n2} - p_n^N q_{n22}$$

$$- (p_n^N + c_n^N) q_{n23} = 0$$

$$\text{i.e.,}\quad \bar{Y}_2 - \bar{p}_1 q_{12} - \cdots - \bar{p}_m q_{m2} - \bar{p}_n q_{n2} - p_n^N q_{n22}^0 + p_n^N (q_{n2}^0 - q_{n2})_2$$

$$- (p_n^N + c_n^N) q_{n23}^0 + (p_n^N + c_n^N)(q_{n2}^0 - q_{n2})_3 = 0. \qquad (3.11)$$

These budget constraints differ from those in (3.1) and (3.2) by the addition of $p_n^N q_{n2}^0$ (where q_{n2}^0 is a constant) and the subtraction of $[p_n^N q_{n22}^0 + (p_n^N + c_n^m) q_{n23}^0]$, respectively. Solution of the three individual constrained utility maximization problems of Mr. 1, Mr. 2 and Mr. 3 by the method of Lagrangian multipliers yields 11 equations exactly the same as those obtained when the status quo is zero liability, and two which are different ($\partial U_1 / \partial \lambda_1 = 0$ and $\partial U_2 / \partial \lambda_2 = 0$); these two are the budget constraints for Mr. 1 and Mr. 2. Complete Pareto-efficiency is achieved, as for the zero liability case. The Weak Coasian Hypothesis on Optimum Externality is not rejected. It would, however, seem that the change in budget constraints with the change in liability rules may result in an "income transfer effect" associated with changes in liability rules. This question is considered below.

In this section, the basic model for analysis of negotiated solutions to externality problems has been established. This model, or abbreviated and simplified versions of it, is used to examine the deductive foundations of the Strong Coasian Hypothesis on Optimum Externality, for the case of externality in consumption.[12]

The Income Transfer Effect of Changes in Liability Rules

The Slutsky equation for Mr. 1 is derived, under both the zero liability rule and the full liability rule. The analysis follows Henderson and Quandt (1958). To simplify exposition, let q_k be a composite good made up of all commodities other than $(q^0_{n2} - q_{n2})$, abatement of an external diseconomy, in Mr. 1's utility function. Let

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[12] Several authors have considered the problem of achievement of unique solutions to bargaining problems of this kind. Davis and Whinston (1965) suggest a process similar to a tatonnement. For bargaining problems in the absence of externalities, Newman (1965) has suggested methods by which unique solutions (in quantitites and price ratios) may be achieved. Such questions are not considered in detail here. We can have confidence that, provided all necessary and sufficient conditions for utility maximization are met, unique solutions can be achieved when Mr. 1, Mr. 2 and Mr. 3 stand for large groups of people each with the same utility function and budget constraint.

Mr. 1's utility function be

$$U_1 = f[q_{k1}, (q^0_{n2} - q_{n2})]. \qquad (3.12)$$

Budget constraints are, for the zero liability case,

$$Y_1 - p_k q_{k1} - p^N_n (q^0_{n2} - q_{n2}) = 0 \qquad (3.13)$$

and, for the full liability case,

$$Y_1 - p_k q_{k1} + p^N_n q_{n2} = 0$$

i.e.,

$$Y_1 - p_k q_{k1} + p^N_n q^0_{n2} - p^N_n (q^0_{n2} - q_{n2}) = 0 . \qquad (3.14)$$

The full liability case is examined first. V_1 is maximized.

$$V_1 = f[q_{k1}, (q^0_{n2} - q_{n2})] + \lambda_1 [Y_1 - p_k q_{k1} + p^N_n q^0_{n2} - p^N_n (q^0_{n2} - q_{n2})] . \qquad (3.15)$$

The first order conditions are

$$\frac{\partial V_1}{\partial q_{k1}} = f_{k1} - \lambda_1 p_k = 0$$

$$\frac{\partial V_1}{\partial (q^0_{n2} - q_{n2})} = f_{n1} - \lambda_1 p^N_n = 0 \qquad (3.16)$$

$$\frac{\partial V_1}{\partial \lambda_1} = \bar{Y}_1 - \bar{p}_k q_{k1} + p^N_n q^0_{n2} - p^N_n (q^0_{n2} - q_{n2}) = 0$$

where

$$\frac{\partial U_1}{\partial q_{k1}} = f_{k1}$$

and

$$\frac{\partial U_1}{\partial (q^0_{n2} - q_{n2})} = f_{n1} .$$

Total differentiation yields

$$f_{k1k1} dq_{k1} + f_{k1n1} d(q^0_{n2} - q_{n2}) - p_k d\lambda_1 = \lambda_1 dp_k \ ,$$

$$f_{n1k1} dq_{k1} + f_{n1n1} d(q^0_{n2} - q_{n2}) - p^N_n d\lambda_1 = \lambda_1 dp^N_n \ , \qquad (3.17)$$

$$-p_k dq_{k1} - p^N_n d(q^0_{n2} - q_{n2}) = -dY_1 - p^N_n dq^0_{n2} - q^0_{n2} dp^N_n + q_{k1} dp_k$$

$$+ (q^0_{n2} - q_{n2}) dp^N_n .$$

Unknowns are dq_{k1}, $d(q^0_{n2} - q_{n2})$ and $d\lambda_1$; and dp_k, dp^N_n, dY_1 and dq^0_{n2} are held constant, The array of coefficients formed by (3.17) contains the same terms as the bordered Hessian determinant, D.

$$D = \begin{vmatrix} f_{k1k1} & f_{k1n1} & -p_k \\ f_{n1k1} & f_{n1n1} & -p^N_n \\ -p_k & -p^N_n & 0 \end{vmatrix}$$

Denoting the cofactor of the element in the ith row and the jth column by D_{ij}, the solution of (3.17) by Cramer's Rule is

$$dk_1 = \frac{\lambda_1 D_{11} dp_1 + \lambda_1 D_{21} dp_n^N + D_{31}[-dY_1 - p_n^N dq_{n2}^0 - q_{n2}^0 dp_n^N + q_{k1} dp_k + (q_{n2}^0 - q_{n2}) dp_n^N]}{D}, \tag{3.18}$$

$$d(q_{n2}^0 - q_{n2}) = \frac{\lambda_1 D_{12} dp_k + \lambda_1 D_{22} dp_n^N + D_{32}[-dY_1 - p_n^N dq_{n2}^0 - q_{n2}^0 dp_n^N + qk_1 dp_k + (q_{n2}^0 - q_{n2}) d_n^N]}{D}. \tag{3.19}$$

Now,

$$\frac{\partial(q_{n2}^0 - q_{n2})}{\partial p_n^N} = \frac{\lambda_1 D_{22}}{D} + (q_{n2}^0 - q_{n2}) \frac{D_{32}}{D} - q_{n2}^0 \frac{D_{32}}{D} \tag{3.20}$$

and

$$\frac{\partial(q_{n2}^0 - q_{n2})}{\partial Y_1} = \frac{-D_{32}}{D}, \quad \text{and} \quad \left(\frac{\partial(q_{n2}^0 - q_{n2})}{\partial p_n^N}\right)_{U=\overline{U}} = \frac{D_{22}\lambda_1}{D}. \tag{3.21}$$

Therefore

$$\frac{\partial(q_{n2}^0 - q_{n2})}{\partial p_n^N} = \left(\frac{\partial(q_{n2}^0 - q_{n2})}{\partial p_n^N}\right)_{U=\overline{U}} - (q_{n2}^0 - q_{n2}) \left(\frac{\partial(q_{n2}^0 - q_{n2})}{\partial Y_1}\right)_{p=\overline{p}} + q_{n2}^0 \left(\frac{\partial(q_{n2}^0 - q_{n2})}{\partial Y_1}\right)_{p=\overline{p}}. \tag{3.22}$$

There are three terms on the right-hand side of Mr. 1's Slutsky equation (3.22) for $(q^0_{n2}-q_{n2})$. The first term is the substitution effect; the second is the usual income effect; and the third is here called the income transfer effect. First, observe that if the budget constraint (3.13) had been used (i.e., if the *status quo* had been zero liability), the term $(-p^N_n dq^0_{n2}-q^0_{n2}dp^N_n)$ would not have appeared on the right-hand side of the third equation in (3.17). In this case, the third term in the Slutsky equation (3.22) would not exist, and only the usual substitution and income effects would be found. The income transfer effect exists in Mr. 1's Slutsky equation for $(q^0_{n2}-q_{n2})$ only when he can expect to receive compensation. Slutsky equation analysis of Mr. 2's demand for q_{n2} (not presented here, since the analysis is similar to that for Mr. 1) shows that the income transfer effect exists for Mr. 2 when the *status quo* is zero liability and Mr. 2 could expect to receive a bribe to induce him to reduce his consumption of q_{n2}, but not when the *status quo* is full liability. The income transfer effect is found when the consumer receives a bribe or compensation in the negotiated solution to an external diseconomy in consumption. When the individual must pay to internalize the externality, only the usual income and substitution effects are found.

Now, let us return to the case of Mr. 1. When the *status quo* rule is full liability, the income transfer effect will be non-zero in all but two possible cases: (i) the trivial case, when $q^0_{n2} = 0$, and

(ii) when $(\partial(q^0_{n2} - q_{n2})/\partial Y_1)_{p=\overline{p}} = 0.$

When the income effect is zero, the income transfer effect is also zero. More specifically, the income transfer effect will be zero only when the income elasticity of demand for abatement of the externality is zero.

Let us examine the Slutsky equation (3.22) to determine the impact of a non-zero income transfer effect on the slope of Mr. 1's demand curve for abatement of the external diseconomy. Where it is reasonable to assume that

$$\left(\frac{\partial(q^0_{n2} - q_{n2})}{\partial p^N_n}\right)_{U_1=\overline{U}_1} < 0 \quad \text{and} \quad \left(\frac{\partial(q^0_{n2} - q_{n2})}{\partial Y_1}\right)_{p=\overline{p}} > 0 ,$$

as it is in the cases of normal goods, it can be seen that the existence of a non-zero income transfer effect will make $\partial(q^0_{n2} - q_{n2})/\partial p^N_n$ closer to zero, if negative, and possibly positive and thus make the slope of the demand curve for $(q^0_{n2} - q_{n2})$ steeper if negative and possibly positive. It follows that, for an external diseconomy in consumption, the demand curve for abatement is likely to be steeper sloped (and possibly forward-bending) when the <u>status quo</u> is full liability than when it is zero liability. If the same assumptions with respect to signs hold for the acting party, his demand curve for q_{n2} and hence his supply curve for $(q^0_{n2} - q_{n2})$ is steeper (and may

Possibly be backward-bending) in the zero liability case than in the full liability case.

Even without assumptions about the signs of

$$\left(\frac{\partial(q^0_{n2} - q_{n2})}{\partial p^N_n}\right)_{U_j=\overline{U}_j} \quad \text{and} \quad \left(\frac{\partial(q^0_{n2} - q_{n2})}{\partial Y_j}\right)_{p=\overline{p}}$$

it is possible to predict that, for externality in consumption, changes in liability rules will affect the equilibrium output of externality unless

$$\left(\frac{\partial(q^0_{n2} - q_{n2})}{\partial Y_j}\right)_{p=\overline{p}} = 0$$

for both the acting and the affected parties.

In Figure 3, the income effect, the substitution effect and the income transfer effect for Mr. 1 are shown in the zero liability case and the full liability case. It seems reasonable that the indifference curves between q_{k1} and $(q^0_{n2}-q_{n2})$ would approach a zero slope as $(q^0_{n2}-q_{n2})$ approaches q^0_{n2} (i.e., as q_{n2} approaches zero), as shown. When $p^N_n = 0$, the budget constraint is AB. Under the zero liability rule, equilibrium is at the point B when the bribe price is zero. The full liability rule also results in equilibrium of B when the compensation price is zero. For $p^N_n = k$, where $k > 0$, the budget constraint is AD under the zero liability rule, since Mr. 1 must pay a bribe in order to induce an increase in $q^0_{n2} - q_{n2})$;

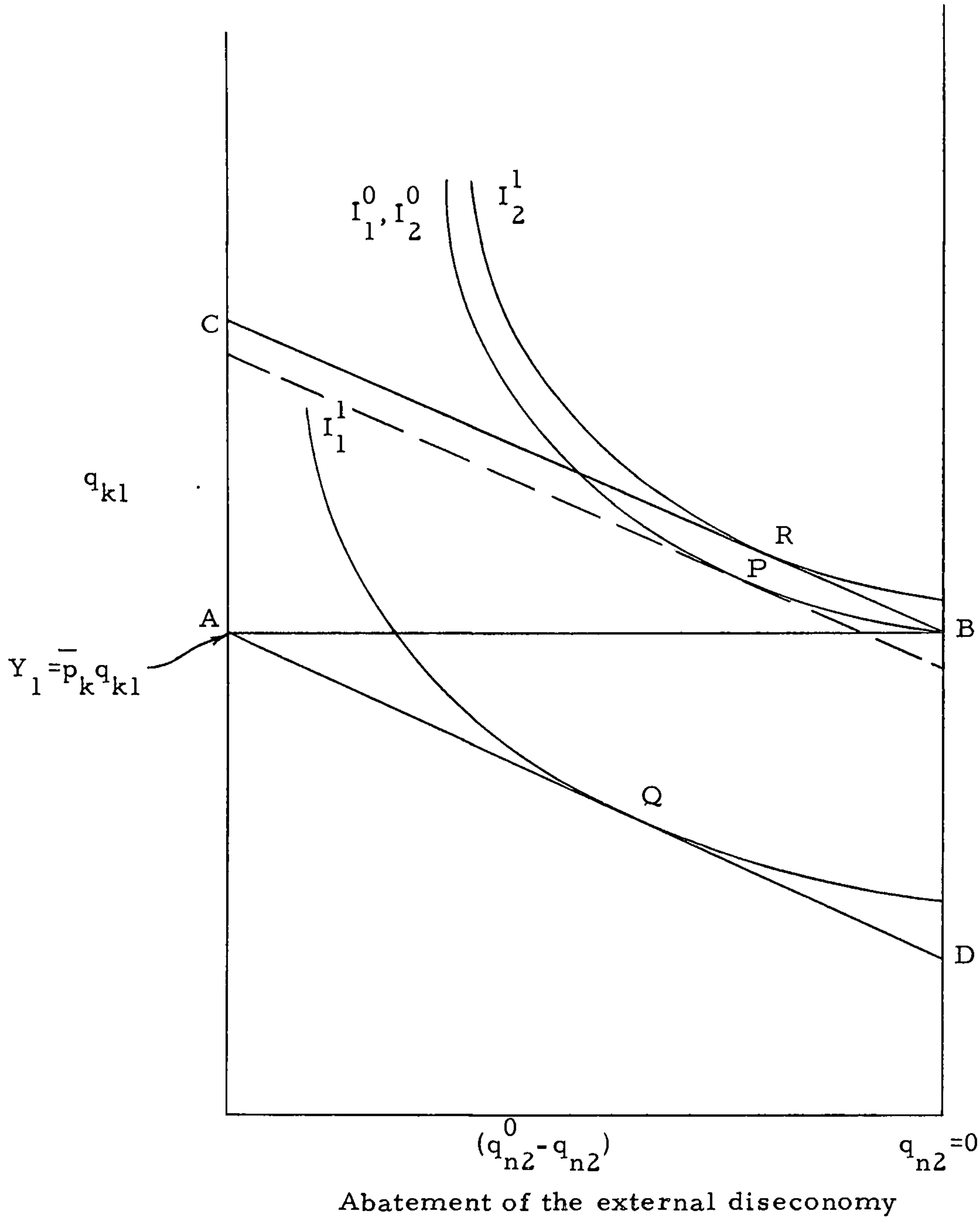

Figure 3. Mr. 1: the effects of a change in the price of $(q_{n2}^0 - q_{n2})$, abatement of an external diseconomy, under two different liability rules: (1) zero liability and (2) full liability.

essentially, he must buy abatement of the external diseconomy. His equilibrium position is Q on the indifference curve I_1^1. The increase in the price of abatement has made him worse off. The substitution effect is the movement from B to P and the income effect is the shift from P to Q. Under the full liability rule and when $p_n^N = k$, where $k > 0$, Mr. 1's budget constraint is BC; each additional unit of q_{n2} consumed by Mr. 2 adds to Mr. 1's income and his power to purchase q_{k1}. The new equilibrium position is R on I_2^1. In this case, the substitution effect of the change in p_n^N from 0 to k is again the movement from B to P and the income effect is again the shift from P to Q. The income transfer effect is the shift from Q to R. The net effect of the income effect and the income transfer effect is a shift from P to R. Under the full liability rule, the rise in p_n^N makes Mr. 1 better off. It can also be seen that the equilibrium positions, Q and R, resulting from the two different liability rules involve different quantities of abatement demanded at the same price, $k > 0$.

An Example: Negotiated Solutions to an External Diseconomy Problem when Transactions Costs are Zero

Let the consumers, 1 and 2, have utility functions,

$$U_1 = 4q_{11}^{1/2}(q_{n2}^0 - q_{n2})^{1/2} + 4q_{m1}^{1/2} \tag{3.23}$$

and

$$U_2 = 6q_{12}^{1/2} q_{n2}^{1/2} + 4q_{m1}^{1/2} \tag{3.24}$$

Mr. 1 suffers an external diseconomy, $f(q_{n2})$, from Mr. 2's cigar smoking, q_{n2}. Let q_{n2}^0 be Mr. 2's equilibrium consumption of cigars when Mr. 1 has no way to influence Mr. 2's consumption. Mr. 1 would gain positive utility from $(q_{n2}^0 - q_{n2}) > 0$, a reduction in Mr. 2's cigar smoking. Mr. 2, of course, enjoys cigar smoking and does not suffer any inconvenience from the smoke and odor generated by this activity. These utility functions are so chosen that the second-order conditions will be satisfied. We may concentrate upon first-order conditions.

Status quo is zero liability. The law specifies no limit to Mr. 2's cigar smoking and makes no provision for Mr. 1 to collect compensation for any inconvenience he may suffer from this activity. The relevant budget constraints are

$$\text{for Mr. 1,} \quad \overline{Y}_1 - \overline{p}_1 q_{11} - \overline{p}_m q_{m1} - p_n^N (q_{n2}^0 - q_{n2}) = 0 \qquad (3.25)$$

$$\text{and for Mr. 2,} \quad \overline{Y}_2 - \overline{p}_1 q_{12} - \overline{p}_m q_{m2} - \overline{p}_n q_{n2} + p_n^N (q_{n2}^0 - q_{n2}) = 0 \qquad (3.26)$$

Mr. 1 has no desire to buy cigars, but he offers to pay Mr. 2 the amount p_n^N for each cigar by which he reduces his previous cigar consumption, q_{n2}^0. Now, Mr. 2 must pay the open market price, $\overline{p}_n$, for each cigar consumed and he must forego the amount p_n^N which would have been paid had he not consumed the cigar. To him, the price of cigars has been effectively raised. Since q_{n2}^0 was Mr. 2's equilibrium cigar consumption, when institutions prevented Mr. 1 from influencing his cigar smoking, he will never increase his cigar consumption above q^0_{n2} in response to Mr. 1's bribe (an incentive to reduce q_{n2}).

Solution of Mr. 1's maximization problem by the method of Lagrangian multipliers yields these four equations representing the first-order conditions for constrained utility maximization:

$$2q_{11}^{-1/2}(q^0_{n2}-q_{n2})^{1/2} - \lambda_1\bar{p}_1 = 0$$

$$2q_{11}^{1/2}(q^0_{n2}-q_{n2})^{-1/2} - \lambda_1 p^N_n = 0$$

$$2q_{m1}^{-1/2} - \lambda_1\bar{p}_m = 0$$

$$\bar{Y}_1 - \bar{p}_1 q_{11} - \bar{p}_m q_{m1} - p^N_n(q^0_{n2}-q_{n2}) = 0$$

Simultaneous solution of the first three equations yields

$$q_{11} = (q^0_{n2}-q_{n2})\frac{p^N_n}{\bar{p}_1} \quad \text{and} \quad q_{m1} = \frac{p^N_n \cdot \bar{p}_1}{(\bar{p}_m)^2} .$$

Substitution into the fourth equation, the budget constraint, yields

$$\bar{Y}_1 - \frac{p^N_n \cdot \bar{p}_1}{\bar{p}_m} = 2p^N_n(q^0_{n2}-q_{n2}) .$$

Mr. 1's demand for reductions in the output of offensive material (and hence for reductions in Mr. 2's cigar smoking) is

$$D^1 = (q^0_{n2} - q_{n2}) = \frac{\overline{Y}_1}{2p^N_n} - \frac{\overline{p}_1}{2\overline{p}_m} . \tag{3.27}$$

By a similar procedure, we can derive Mr. 2's demand for cigars. We get

$$\overline{Y}_2 + p^N_n q^0_{n2} = 2(\overline{p}_n + p^N_n) q_{n2} + \frac{4\overline{p}_1(\overline{p}_n + p^N_n)}{9\overline{p}_m} .$$

So, Mr. 2's demand for cigars is

$$D = q_{n2} = \frac{\overline{Y}_2 + p^N_n q^0_{n2}}{2(\overline{p}_n + p^N_n)} - \frac{2\overline{p}_1}{9\overline{p}_m} . \tag{3.28}$$

Mr. 2's supply of reductions in cigar smoking (a measure of his willingness to reduce cigar smoking, in return for a bribe) is

$$S^1 = (q^0_{n2} - q_{n2}) = q^0_{n2} - \frac{\overline{Y}_2 - p^N_n q^0_{n2}}{2(\overline{p}_n + p^N_n)} + \frac{2\overline{p}_1}{9\overline{p}_m} . \tag{3.29}$$

Let us assume some values for those variables whose value is assumed to be fixed:

Let

$$\overline{Y}_1 = \overline{Y}_2 = 100, \quad \overline{p}_1 = 2, \quad \text{and} \quad \overline{p}_m = \overline{p}_n = 4 .$$

Solution of Mr. 2's maximization problem when $p^N_n = 0$

(i.e., when Mr. 1 is unable to influence Mr. 2's consumption of q_{n2}) yields the value

$$q^0_{n2} = 12.39 . \quad (3.30)$$

Substitution of the known values for $\overline{Y}_1$, $\overline{Y}_2$, $\overline{p}_1$, $\overline{p}_m$, $\overline{p}_n$, and q^0_{n2} into Mr. 1's demand equation for $(q^0_{n2}-q_{n2})$ and Mr. 2's supply equation for $(q^0_{n2}-q_{n2})$ yields from the demand equation,

$$p^N_n = \frac{200}{4(q^0_{n2}-q_{n2})+1}, \quad 0 \leq (q^0_{n2}-q_{n2}) \leq 12.39, \quad p^N_n \geq 0, \quad (3.31)$$

and from the supply equation,

$$p^N_n = \frac{8(q^0_{n2}-q_{n2})}{12.61-2(q^0_{n2}-q_{n2})}, \quad 0 \leq (q^0_{n2}-q_{n2}) \leq 12.39, \quad p^N_n \geq 0. \quad (3.32)$$

Status quo if full liability. Now, let us assume the law is such that $q_{n2} = 0$ unless Mr. 1 can be persuaded to agree otherwise. Mr. 2 then has an incentive to bribe Mr. 1 in order to obtain permission to smoke [i.e., to compensate Mr. 1 for any inconvenience which he may suffer from $f(q_{n2})$].

New budget constraints are in order.

For Mr. 1, $\overline{Y}_1 - \overline{p}_1 q_{11} - \overline{p}_m q_{m1} + p^N_n q_{n2} = 0$

i.e., $\overline{Y}_1 - \overline{p}_1 q_{11} - \overline{p}_m q_{m1} + p_n^N q_{n2}^0 - p_n^N (q_{n2}^0 - q_{n2}) = 0.$ (3.33)

For Mr. 2, $\overline{Y}_2 - \overline{p}_1 q_{12} - \overline{p}_m q_{m2} - (\overline{p}_n + p_n^N) q_{n2} = 0$

i.e., $\overline{Y}_2 - \overline{p}_1 q_{12} - \overline{p}_m q_{m2} - \overline{p}_n q_{n2} - p_n^N q_{n2}^0 + p_n^N (q_{n2}^0 - q_{n2}) = 0$. (3.34)

In this case, Mr. 1's income is increased by p_n^N and Mr. 2's income decreased by $(\overline{p}_n + p_n^N)$ for each cigar Mr. 2 consumes. The budget constraints for Mr. 1 and Mr. 2 are changed by the change in liability rules in such a way that all first-order conditions of the type $\partial U_j / \partial q_{ij} = 0$ are unchanged. Only $\partial U_j / \partial \lambda_j = 0$ (i.e., the budget constraints, themselves) are changed.

Each individual maximizes his utility subject to his budget constraint. Solution of Mr. 1's first order conditions for $(q_{n2}^0 - q_{n2})$ yields the demand curve for abatement of cigar smoke and odor. Solution of Mr. 2's first order conditions for q_{n2} yields the demand curve for cigars, from which the supply curve for abatement can be derived. Under full liability,

$$D^2 = (q_{n2}^0 - q_{n2}) = \frac{\overline{Y}_1 + p_n^N q_{n2}^0}{2p_n^N} - \frac{\overline{p}_1}{2\overline{p}_m} \qquad (3.35)$$

and

$$p_n^N = \frac{100}{2(q_{n2}^0 - q_{n2}) - 11.89}, \quad 0 \leq (q_{n2}^0 - q_{n2}) \leq 12.39, \quad p_n^N \geq 0\,; \qquad (3.36)$$

$$S^2 = (q^0_{n2} - q_{n2}) = q^0_{n2} - \frac{\overline{Y}_2}{2(\overline{p}_n - p^N_n)} + \frac{2\overline{p}_1}{9\overline{p}_m} \qquad (3.37)$$

and

$$p^N_n = \frac{50}{12.5 - (q^0_{n2} - q_{n2})} - 4, \quad 0 \leq (q^0_{n2} - q_{n2}) \leq 12.39, \quad p^N_n \geq 0. \qquad (3.38)$$

The change in liability rules is sufficient to shift both the supply and demand curves for reductions in offensive emissions. Figure 4 shows the demand and supply curves, D^1 and S^1, for the zero liability status quo point (Equations 3.31 and 3.32) and the demand and supply curves D^2 and S^2, for the full liability status quo point (Equations 3.36 and 3.38).

Under status quo point 1 (zero liability), both p^N_n and $(q^0_{n2} - q_{n2})$ are lower than under status quo point 2 (full liability). Under status quo point 1 the supply curve for abatement, $(q^0_{n2} - q_{n2})$, is asymptotic to the line $(q^0_{n2} - q_{n2}) = 6.305$. No matter how high the unit bribe, p^N_n, Mr. 2 would never reduce his cigar smoking by more than 6.305 units. Under status quo point 2, the demand curve for abatement, $(q^0_{n2} - q_{n2})$, is asymptotic to the line $(q^0_{n2} - q_{n2}) = 5.945$. No matter how high the unit compensation, p^N_n, Mr. 1 would never accept a reduction in Mr. 2's cigar smoking of less than 5.945 units.

The existence of these asymptotes coincides with the existence

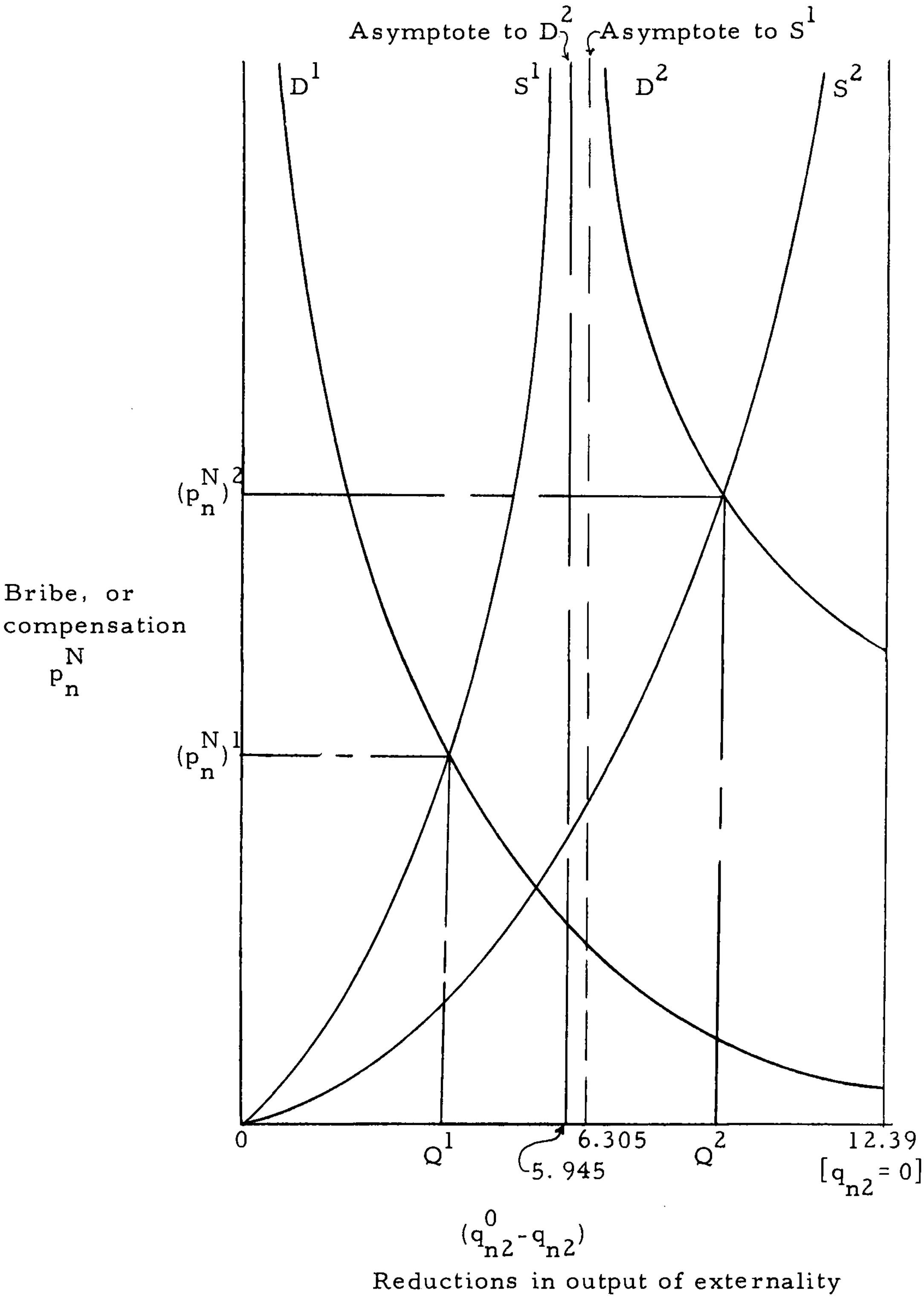

Figure 4. Equilibrium bribe (or compensation) and degree of externality modification, under two sets of liability rules.

of the "income transfer effect" term in the relevant Slutsky equations. Under the zero liability rule, Mr. 1's income transfer effect is zero and Mr. 2's Slutsky equation has a non-zero income transfer effect [unless $(\partial q_{n2}/\partial Y_2)_{p=\bar{p}} = 0$]. In this case, Mr. 2's supply of abatement (derived from his demand for q_{n2}) is asymptotic to a vertical line through a point $(q^0_{n2}-q_{n2})$, $0 < (q^0_{n2}-q_{n2}) < q^0_{n2}$, and always to be left of this point. Under the full liability rule, Mr. 1's Slutsky equation for $(q^0_{n2}-q_{n2})$ has a non-zero income transfer effect, while Mr. 2's Slutsky equation for q_{n2} has no income transfer effect. In this case, Mr. 1's demand curve for $(q^0_{n2}-q_{n2})$ is asymptotic to a vertical line through a point $(q^0_{n2}-q_{n2})$, $0 < (q^0_{n2}-q_{n2}) < q^0_{n2}$, and always to the right of this point.

Figure 5, which is based on Figure 3, shows how the income transfer effect leads to a shift in Mr. 1's offer curve of q_{k1} for $(q^0_{n2}-q_{n2})$ with a change in liability rules. An offer curve is the locus of the points of tangency (i. e., utility maximizing solutions) at different price ratios, given an initial endowment (in this case, of q_{k1}).

Under the zero liability rule, a price ratio exists at which Mr. 1 will accept a zero reduction in the nuisance [i. e., $(q^0_{n2}-q_{n2}) = 0$]. However, under the full liability rule, Mr. 1 will never accept a zero reduction in the nuisance. This corresponds to the situation in the example, where under the full liability rule, no p^N_n exists at which

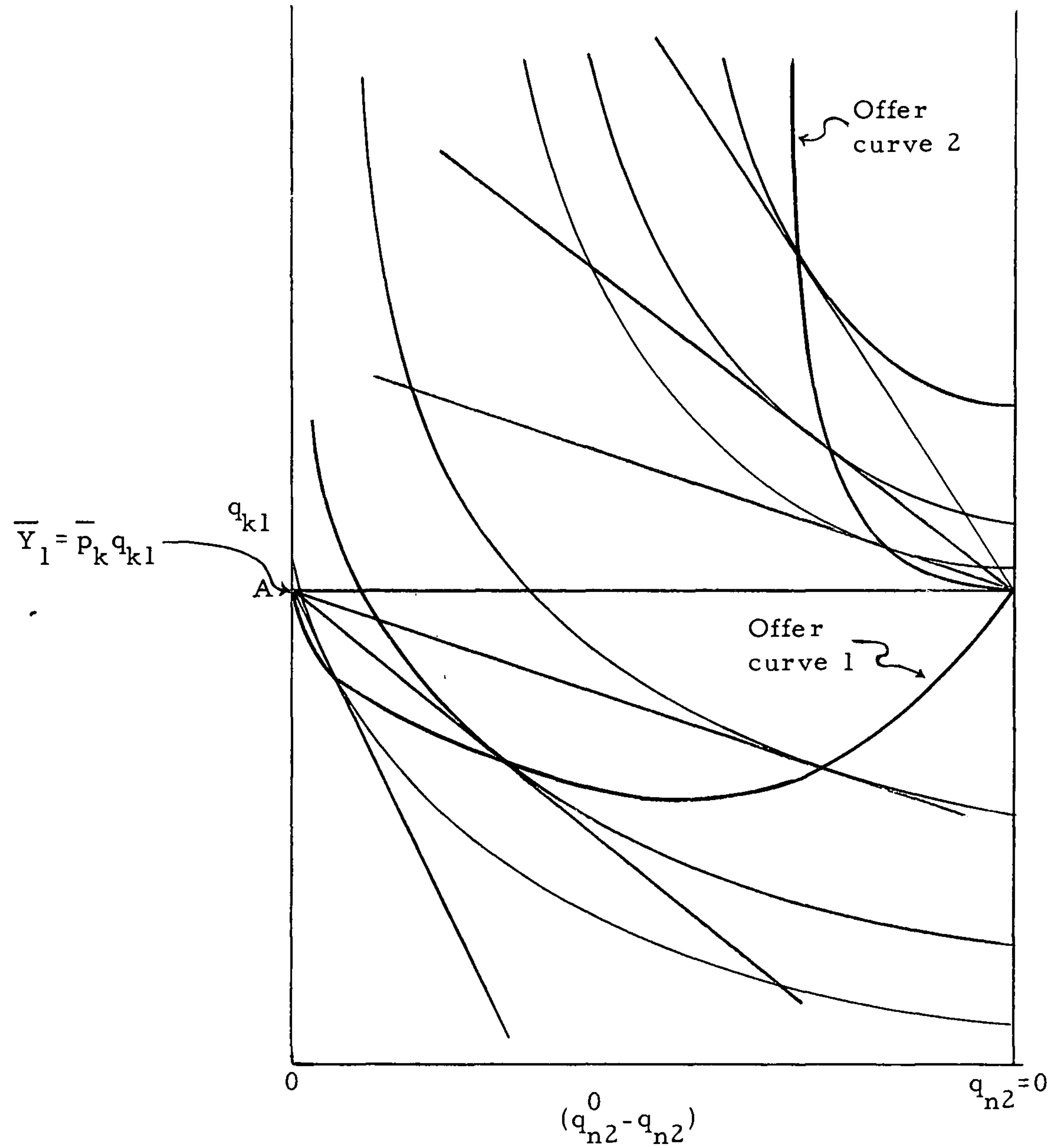

Figure 5. Mr. 1's offer curves for abatement of an external diseconomy under two different liability rules: (1) zero liability and (2) full liability.

Mr. 1 demands no $(q^0_{n2}-q_{n2})$, no abatement of the nuisance. The income transfer effect, which is non-zero (when the individual can expect to receive a bribe or compensation) in all cases except that where $[\partial(q^0_{n2}-q_{n2})/\partial Y_j]_{p=\overline{p}} = 0$, results in a shift in the relevant supply or demand curve for modification of an externality when the liability rule changes. Except for the special case where $[\partial(q^0_{n2}-q_{n2})/\partial Y_j]_{p=\overline{p}} = 0$, the Strong Hypothesis can be rejected for the case of externality in consumption. For externality in consumption, the Weak Hypothesis is not rejected.

An Example: Negotiated Solutions to an External Diseconomy Problem when Transactions Costs are Greater than Zero

Now, the assumption that transactions can take place free of cost is relaxed. In its place a very simple assumption is made: the supply curve relating the number of transactions, measured by the number of units of $(q^0_{n2}-q_{n2})$ obtained as a result of successful negotiations, and the price (cost) of transactions, c^N_n, is perfectly elastic to the individual consumers. An unlimited number of units of $(q^0_{n2}-q_{n2})$ may be "purchased" or "sold," each at the same transactions cost, c^N_n. Using the same example used in the previous section of this chapter, let $c^N_n = 4$ and let this unit transactions cost be the same, regardless of which party has to pay it. These are a particularly simple set of assumptions; in further research, it would be interesting to relax them.

As assumed in the general model presented in section 1 of this chapter, the individual who must pay the bribe or compensation must also pay the transactions costs.[13] For each unit of $(q_{n2}^0 - q_{n2})$ the individual who pays, pays $(p_n^N + c_n^N)$, while the individual who receives, receives p_n^N.

Status quo is zero liability. The relevant budget constraints are:

$$\text{for Mr. 1,} \quad \overline{Y}_1 - \overline{p}_1 q_{11} - \overline{p}_m q_{m1} - (p_n^N + c_n^N)(q_{n2}^0 - q_{n2}) = 0, \tag{3.39}$$

$$\text{and for Mr. 2,} \quad \overline{Y}_2 - \overline{p}_1 q_{12} - \overline{p}_m q_{m2} - \overline{p}_n q_{n2} + p_n^N (q_{n2}^0 - q_{n2}) = 0. \tag{3.40}$$

Demand and supply curves are derived, as before. The subscript, $t=4$, refers to the transactions cost of four per unit of $(q_{n2}^0 - q_{n2})$.

$$D_{t=4}^1 = (q_{n2}^0 - q_{n2}) = \frac{\overline{Y}_1}{2(p_n^N + c_n^N)} - \frac{\overline{p}_1}{2\overline{p}_m} \tag{3.41}$$

and

$$p_n^N = \frac{200}{4(q_{n2}^0 - q_{n2}) + 1} - 4, \quad 0 \leq (q_{nq}^0 - q_{n2}) \leq 12.39, \quad p_n^N \geq 0 \tag{3.42}$$

[13] Where solutions to externality problems are negotiated from a status quo point, the amount of abatement achieved at equilibrium is the same and the net bribe or compensation price at equilibrium is the same (for the same status quo point) regardless of which party actually pays the transactions costs.

$$S^1_{t=4} = (q^0_{n2} - q_{n2}) = q^0_{n2} - \frac{\overline{Y}_2 + p^N_n q^0_{n2}}{2(\overline{p}_n + p^N_n)} + \frac{2\overline{p}_1}{9\overline{p}_m} \qquad (3.43)$$

and

$$p^N_n = \frac{8(q^0_{n2} - q_{n2})}{12.61 - 2(q^0_{n2} - q_{n2})}, \quad 0 \leq (q^0_{n2} - q_{n2}) \leq 12.39, \quad p^N_n \geq 0. \qquad (3.44)$$

Status quo is full liability. The relevant budget constraints are:

for Mr. 1, $\overline{Y}_1 - \overline{p}_1 q_{11} - \overline{p}_m q_{m1} + p^N_n q^0_{n2} - p^N_n (q^0_{n2} - q_{n2}) = 0;$ (3.45)

for Mr. 2, $\overline{Y}_2 - \overline{p}_1 q_{12} - \overline{p}_m q_{m2} - \overline{p}_n q_{n2} - (p^N_n + c^N_n) q^0_{n2}$

$+ (p^N_n - c^N_n)(q^0_{n2} - q_{n2}) = 0.$ (3.46)

Demand and supply curves are derived, as before:

$$D^2_{t=4} = (q^0_{n2} - q_{n2}) = \frac{\overline{Y}_1 + p^N_n q^0_{n2}}{2p^N_n} \qquad (3.47)$$

and

$$p^N_n = \frac{100}{2(q^0_{n2} - q_{n2}) - 11.89}, \quad 0 \leq (q^0_{n2} - q_{n2}) \leq 12.39, \quad p^N_n \geq 0; \qquad (3.48)$$

$$S^2_{t=4} = (q^0_{n2} - q_{n2}) = q^0_{n2} - \frac{\overline{Y}_2}{2(\overline{p}_n + p^N_n + c^N_n)} + \frac{2\overline{p}_1}{9\overline{p}_m} \qquad (3.49)$$

and

$$p^N_n = \frac{16(q^0_{n2} - q_{n2}) - 100}{25 - 2(q^0_{n2} - q_{n2})}, \quad 0 \leq (q^0_{n2} - q_{n2}) \leq 12.39, \quad p^N_n \geq 0. \qquad (3.50)$$

In Figure 6, the supply and demand curves for $(q_{n2}^{0}-q_{n2})$ are presented under two sets of liability rules, for the case where transactions cost is zero and the case where transactions cost is four per unit of $(q_{n2}^{0}-q_{n2})$. It can be seen that with the introduction of transactions costs greater than zero, the difference in equilibrium output of externality due to changes in liability rules is magnified. There is a good reason for this result, a reason which has general application not confined to the special case (i. e., the particular utility functions) of this example. If Mr. 2 is to receive a bribe, he is concerned with the net value of that bribe, $p_n^N(q_{n2}^{0}-q_{n2})$, rather than the gross value, $(p_n^N+c_n^N)(q_{n2}^{0}-q_{n2})$. Similarly, if Mr. 1 is to receive compensation, he evaluates the offer on the basis of its net value. The existence of positive transactions costs will shift the effective demand curve for abatement under zero liability and the effective supply curve of abatement under full liability, both downward, since part of the offered bribe or compensation must go toward payment of the transactions costs. There will be no compensating shifts in the demand curve under full liability or the supply curve under zero liability.

The introduction of positive transactions costs does not change the decision to reject the Strong Hypothesis in the case of externality in consumption. As shown in Chapter 2, the introduction of transactions costs may or may not preclude the achievement of Pareto-optimality. If the transactions industry has no barriers to entry and

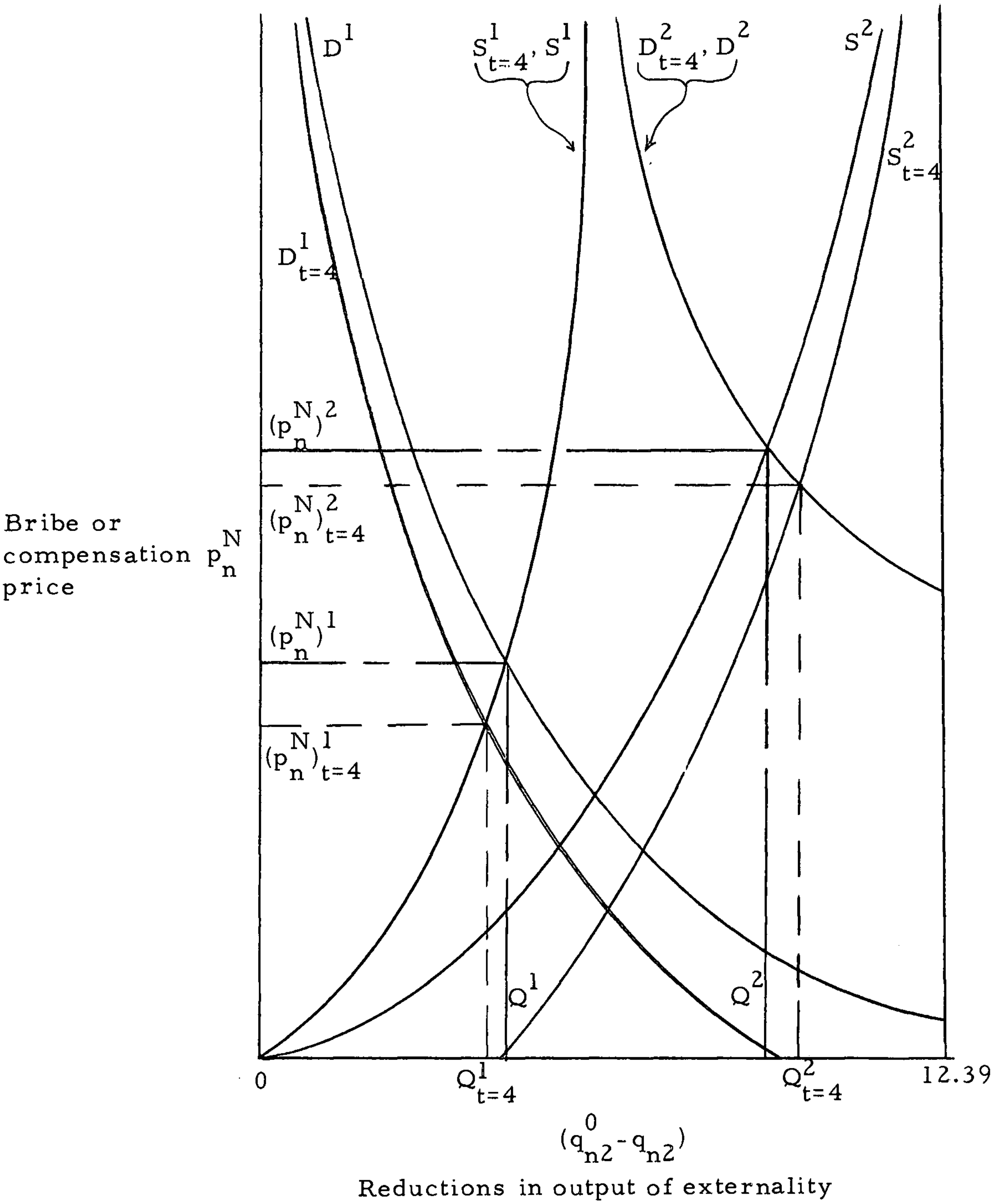

Figure 6. Equilibrium bribe (as compensation) and degree of modification of the externality, under two sets of liability rules and two assumptions about transactions costs.

the individual may perform his own transactions if he chooses, Pareto-efficiency may be achieved. In this case, the Weak Hypothesis would not be rejected.

Summary

After an examination of two relevant recent contributions to the literature, a general model for negotiated solutions to the problem of externality in consumption is presented. This general model includes the assumption that transactions require effort for both negotiation and enforcement of a bargain. It is found that, for externality in consumption, unimpeded negotiations can result in Pareto-efficient internalization of the externality regardless of the *status quo* liability rules. Provided that the transactions industry is perfectly competitive and the individuals have the option of themselves performing the transactions services required, the introduction of positive transactions costs does not preclude achievement of Pareto-efficiency. The Weak Coasian Hypothesis on Optimum Externality is not rejected.

The Strong Hypothesis is rejected however, in the case of externality in consumption. Changes in liability rules change the budget constraints of the individuals concerned. This, in turn changes the Slutsky equation describing the individual's demand for abatement of the externality. When the affected party receives payment (a bribe or compensation) as a result of modification of an externality, an "income transfer effect" appears in his Slutsky equation for abatement. This effect is non-zero, unless his income elasticity of demand for abatement is zero. When the affected party must pay to induce modification of the externality (the zero liability case), the income transfer effect disappears. The Slutsky equation describing the acting party's demand for the externality-producing activity responds to liability rules in the opposite fashion: there is no income transfer effect under the full liability rule, but there is an income transfer effect under the zero liability rule. The income transfer effect induces shifts in the relevant supply or demand curve for abatement of the externality as liability rules change. In all but a special case (when the income elasticity of the affected party's demand for abatement is zero and that of the acting party's demand for the externality-producing activity is zero) changes in liability rules will change the equilibrium output of externality and the equilibrium bribe price or compensation price. When the substitution effect is negative and the income effect is positive, as in the case of normal commodities, the equilibrium output of externality is higher when the *status quo* is zero liability than when the *status quo* is full liability.

The introduction of transactions costs greater than zero magnifies the difference in the equilibrium output of externality under different liability rules.

IV. EXTERNALITY IN PRODUCTION

Coase (1960) was concerned with externalities in production (i.e., externality situations where the affected party and the acting party are both firms engaged in production). For the case of externality in production, Coase (1960, Sections III and IV) clearly believed that what is here called the Strong Coasian Hypothesis on Optimum Externality is correct, given the necessary assumptions.

Given the rather restrictive assumptions used (the firms are perfectly competitive and operating under conditions of static certainty, property rights are secure and well defined for all factors and commodities, and transactions costs are zero), Coase's observation that the parties will make the same calculation of marginal cost regardless of liability rules seems sufficient to ensure that equilibrium resource allocation and output of externality will be the same regardless of liability rules.[14] Within the context of Coase's assumptions, attacks on the Coase theorem as it applies to externalities in production would seem to have had insignificant impact upon it.

Kamien, et al. (1966) demonstrate that, in a dynamic case with

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[14]Where administered solutions to externality problems are sought, this phenomenon is called the symmetry of bribes and charges. Bribes paid to the acting party and charges made against him both achieve the same equilibrium output of externality, if the unit price is equal to the unit charge.

changing cost functions and imperfect information, asymmetry between bribes and charges exists. Freeman (1967) suggests that, where costs and benefits flow over time, symmetry will exist only if the firm and the authority administering charges use the correct (and therefore, the same) social discount rate. These comments fail to demolish the Coase theorem, since they deal with cases in which Coase's assumptions are not met.

Calabresi (1965), and Bramhall and Mills (1966) suggest that, in the long run, bribes and charges have asymmetrical effects, since a bribe will reduce the profit level of the affected firm, while a charge will reduce the profit level of the acting firm. As profit levels in an industry affect the rate of entry and exist in that industry, it was postulated that bribes and changes may have quite different long-run effects. Nutter (1968) demonstrates that, in the long run, bribes and charges have symmetrical effects on resource allocation and output of externality. For a combination of activities "producing" an externality to exist, that combination of activities must produce a greater rent than alternative use of the same resources. Thus, changes in liability rules will not change resource allocation and output of externality, but will change the profit level of the firms, and may change the rates of entry and exit in the two industries of which the firms are members. This author must point out, however, that such changes in entry and exit rates may lead to the creation of "externality-wide firms." Thus, two previously perfectly competitive industries may, by a change in liability rules, experience substantial changes in market structure.[15] It remains an open question whether such possible changes in market structure would be sufficient to lead to asymmetry between bribes and charges.

Leaving aside this latter issue, it would seem that the Coase theorem has remained impervious to attack within the context of externality in production and within Coase's assumptions. In the remainder of this chapter, a simple model of externality in production is presented. It is shown that the Strong Hypothesis holds. While remaining in Coase's context of negotiated solutions to externality in production under conditions of static certainty, two extra assumptions are added: (i) the producers have inflexible constraints on capital available at the start of the production period, and (ii) variable transactions costs are greater than zero. The Strong and Weak Hypotheses are subjected to deductive testing, under these assumptions. Then, the Strong and Weak Hypotheses are examined deductively for the case where one party in an externality situation is a producer and one party is a consumer.

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[15] Buchanan (1969), in an application of the theory of second-best (Lipsey and Lancaster, 1956) suggests that where the acting firm is a monopoly in its particular industry, symmetry between bribes and charges may not exist, and shows that charges may have a perverse effect on the activities of the acting firm, resulting in increased output of the external diseconomy.

Externality in Production, when Transactions Costs are Zero

A simple two firm open economy production model with an externality in production is used to consider the effect of a change in liability rules on the equilibrium output of externality. Firm 1 produces a "market commodity," q_1, using two inputs, a market good, q_3 and a "non-market" input, q_n. Firm 2 produces a "market commodity," q_2, and a "non-market" good, q_n, using two inputs, q_4 and q_5. When the law does not prevent firm 2 producing and releasing q_n and when the price of q_n is zero, firm 2 can be said to be "producing" an externality and firm 1 "consuming" an externality. The externality will be produced in the quantity, q_n^0. The industries producing commodities q_1 and q_2 and inputs q_3, q_4 and q_5 are all perfectly competitive. Firm 1 and firm 2 are operated by rational profit maximizers operating with perfect information under static certainty. Then, the prices of goods q_1, q_2, q_3, q_4 and q_5 are constant. It is assumed that neither firm has an operative capital constraint.

Let, for example, $\partial q_1 / \partial q_n$ be less than zero; firm 1 suffers an external diseconomy. Assuming the externality is Pareto-relevant, a bargain may be struck between firm 1 and firm 2 resulting in a reduction in q_n. Firm 1 has an incentive to attempt to induce firm 2 to reduce q_n. Let there be no impediments to market transactions between firm 1 and firm 2 affecting the output of q_n.

Status quo liability is zero. In this case, firm 1, the affected party, has an incentive to bribe firm 2. Firm 1 offers a positive price, p_n^N, per unit of the commodity $(q_n^0 - q_n)$, reductions in q_n below its equilibrium amount when $p_n^N = 0$ and status quo liability is zero. Firm 1 maximizes profit subject to its production function.

$$J_1 = \bar{p}_1 q_1 - p_n^N(q_n^0 - q_n) - \bar{p}_3 q_3 + \lambda_1 \{f[q_1, (q_n^0 - q_n), q_3]\}. \qquad (4.1)$$

Firm 2 maximizes profit subject to its production function.

$$J_2 = \bar{p}_2 q_2 + p_n^N(q_n^0 - q_n) - p_4 q_4 - p_5 q_5 + \lambda_2 \{g[q_2, (q_n^0 - q_n), q_4, q_5]\}. \qquad (4.2)$$

When each firm separately maximizes its profit, the first-order conditions for profit maximization can be represented by a total of nine equations, four for firm 1 and five for firm 2.. Let us assume that the production functions, $f[q_1, (q_n^0 - q_n), q_3]$ and $g[q_2, (q_n^0 - q_n), q_4, q_5]$, respectively, are such that the second-order conditions are satisfied. Firm 1's four first-order conditions can be solved simultaneously to obtain a demand curve for externality abatement, expressed in terms of $(q_n^0 - q_n)$ and p_n^N. If the marginal cost to firm 1 of increased amounts of the external diseconomy is rising, the marginal revenue from externality abatement is therefore falling, and the demand curve for abatement has a negative slope. Firm 2's five first-order conditions can be solved simultaneously to obtain a supply curve for $(q_n^0 - q_n)$ in terms of p_n^N. If the marginal cost of externality abatement is rising, a not unreasonable assumption, this supply curve has a positive slope. Since q_n^0 is by definition the output of q_n when $p_n^N = 0$, the supply curve for $(q_n^0 - q_n)$ passes through the origin.

Status quo is full liability. Under this liability rule, the acting party must cease production of the external diseconomy or pay compensation, $p_n^N > 0$, to firm 1, so that firm 1 will permit some positive level of q_n. Now, firm 1 maximizes the constrained profit function

$$J_1 = \bar{p}_1 q_1 + p_n^N q_n - \bar{p}_3 q_3 + \lambda_1 \{f[q_1, (q_n^0, q_n), q_3]\}$$

which is equal to

$$J_1 = \bar{p}_1 q_1 + p_n^N q_n^0 - p_n^N (q_n^0 - q_n) - \bar{p}_3 q_3 + \lambda_1 \{f[q_1, (q_n^0 - q_n), q_3]\}. \qquad (4.3)$$

Firm 2 maximizes the constrained profit function

$$J_2 = \bar{p}_2 q_2 - p_n^N q_n - \bar{p}_4 q_4 - \bar{p}_5 q_5 + \lambda_2 \{g[q_2, (q_n^0 - q_n), q_4, q_5]\}$$

which is equal to

$$J_2 = \bar{p}_2 q_2 - p_n^N q_n^0 + p_n^N (q_n^0 - q_n) - \bar{p}_4 q_4 - \bar{p}_5 q_5$$

$$+ \lambda_2 \{ g [q_2, (q_n^0 - q_n), q_4, q_5] \} . \qquad (4.4)$$

Equation (4.3) differs from (4.1) only by the amount, $+p_n^N q_n^0$; Equation (4.4) differs from (4.2) only by the amount, $-p_n^N q_n^0$. Since q_n^0 is a constant, the first order conditions for profit maximization for the individual firms remain unchanged. The supply and demand curves for abatement of the external diseconomy are the same, regardless of the <u>status quo</u> liability rules. Accordingly, the equilibrium output of externality remains the same, regardless of whether the full liability rule or the zero liability rule is in operation.[16]

The situation is shown in Figure 7. The demand curve for abatement, D, is not shifted by the change in liability rules. Nor is the supply curve for abatement, S. Equilibrium bribe or compensation price, p_n^N, and output of the commodity, externality abatement $(q_n^0 - q_n)$, are the same under zero liability and full liability.

It is clear that, while the <u>status quo</u> liability rules do not affect

[16]It can be shown, but is not shown here, that the equilibrium output of q_n will also be the same (i) under some intermediate liability rule (e.g., output of q_n may not exceed a specified amount unless the affected party is adequately compensated), and (ii) if production of both q_1 and q_2 is undertaken by a single firm.

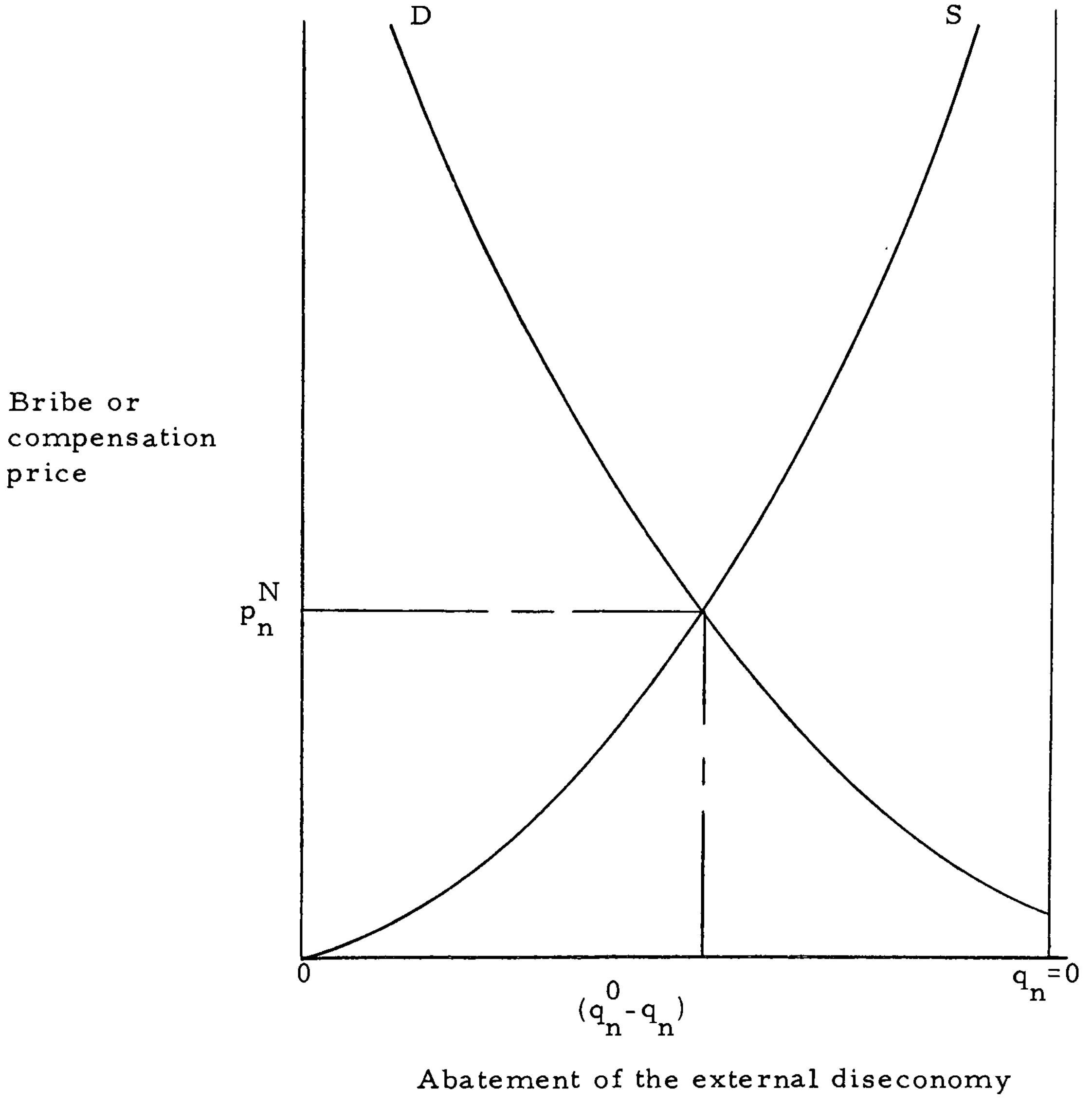


Figure 7. Externality in production: equilibrium solution is the same under two different liability rules, when transactions costs are zero.

the equilibrium output of externality, the change from zero to full liability adds the amount $p_n^N q_n^0$ to the profits of one firm while subtracting that amount from the profits of the other. It is not difficult to imagine cases where a sudden change in liability rules could drive one firm out of business.

Imagine a case where the acting party, firm 2, has been operating under the zero liability rule and making annual net profits of π_2. The firm's income comes from sales of q_2 and bribes, $p_n^N(q_n^0 - q_n)$, received from firm 1. A change to the full liability rule would reduce firm 2's net profit to $(\pi_2 - p_n^N q_n^0)$ which would be a negative amount if $p_n^N q_n^0$ were greater than π_2. Firm 2 would go out of business. No other firm in the industry producing q_2 could buy the business and make a profit (assuming that any other firm operating firm 2's plant would have the same production function). However, firm 1 would find it profitable to operate both its own plant and firm 2's plant. An externality-wide firm would be created and total output of goods q_1, q_2 and $(q_n^0 - q_n)$ would be unchanged (assuming no change in production functions).

On the other hand, a change to the zero liability rule after a period when the full liability rule had been in operation would have the opposite effect. An affected firm, firm 1, which had previously made a net profit of π_1 from an income including sales of products and compensation from firm 2, would go out of business after the change in liability rules, if $p_n^N q_n^0$ was greater than π_1. Firm 2, the acting party, would then purchase and operate firm 1's plant. Again the equilibrium output of goods and of externality would remain unchanged.

These simplified models have assumed that the industries producing goods q_1 and q_2 and inputs q_3, q_4 and q_5 are perfectly competitive. However, only two firms are involved in a particular externality situation. In this case an element of monopsony power exists. A change in liability rules which drove firm i out of business would place firm j in the position of being the only bidder for the plant formerly operated by firm i.

Where there are many acting parties and many affected parties in a single externality situation, this would not be the case. There should be competitive bidding for the plants of the firms going out of business. Many mergers would take place between firms in different industries. However, there would be no tendency for a monopoly to develop to operate all firms in the externality situation.

Given perfect competition, neither the Strong nor the Weak Hypotheses is rejected following deductive testing with simple models. The equilibrium output of externality is the same, regardless of _status quo_ liability rules. It is clear, however, that profit levels of involved firms can be vastly affected by liability rules. In the extreme, a change in liability rules may drive one of the parties in an externality situation out of business. The selection of liability rules has important ethical considerations, which involve hard choices between the claims of individual firms to remain in business and make profits.

A Special Case: Production with Inflexible Capital Constraints

If all inputs in the production process are purchased or paid wages and salaries, it is reasonable to consider capital as the only variable input. Let us consider a special case, where capital can be considered the only scarce variable input for both the acting and the affected party and where there is a strict and inflexible constraint on capital available at the start of the production period. Let us assume that income from sales of products accrues at the end of the production period, while agreements with regard to output of externality must be concluded at the start of the production period. This latter assumption is not unreasonable, since agreements on output of externality affect both the input combination and the quantity of saleable output of the both parties and, accordingly, must be made before other production decisions can be made. So, payments of bribes or compensations add to or subtract from the initial capital supply of the firms.

Firm 1, the affected party suffers an external diseconomy as a result of firm 2's output of q_n. Both firms maximize revenue from the sale of a single commodity (different for each firm) at a known, fixed price subject to a capital constraint. Cost functions are:

for firm 1, $\quad \text{cost} = h[q_1, (q_n^0 - q_n)]$

and for firm 2, $\quad \text{cost} = \ell[q_2, (q_n^0 - q_n)]$.

The initial capital supply of the ith firm is C_i^0.

Status quo Liability is Zero. Let each firm maximize revenue subject to its cost constraint.

$$R_1 = \bar{p}_1 q_1 + \mu_1\{[C_1^0 - p_n^N(q_n^0 - q_n)] - h[q_1, (q_n^0 - q_n)]\}. \tag{4.5}$$

$$R_2 = \bar{p}_2 q_2 + \mu_2\{[C_2^0 + p_n^N(q_n^0 - q_n)] - \ell[q_2, (q_n^0 - q_n)]\}. \tag{4.6}$$

Assuming that second-order conditions are satisfied, the first-order conditions for firm 1 can be solved simultaneously to obtain a demand curve for abatement of the external diseconomy. The first-order conditions for firm 2 can be solved simultaneously to obtain a supply curve for abatement.

Status quo is Full Liability. For the full liability case, the constrained revenue function for firm 1 is

$$R_1 = \bar{p}_1 q_1 + \mu_1\{[C_1^0 + p_n^N q_n] - h[q_1, (q_n^0 - q_n)]\}$$

i.e., $$R_1 = \bar{p}_1 q_1 + \mu_1\{[C_1^0 + p_n^N q_n^0 - p_n^N(q_n^0 - q_n)] - h[q_1, (q_n^0 - q_n)]\}. \tag{4.7}$$

For firm 2

$$R_2 = \bar{p}_2 q_2 + \mu_2\{[C_2^0 - p_n^N q_n] - \ell[q_2, (q_n^0 - q_n)]\}$$

i.e., $$R_2 = \bar{p}_2 q_2 + \mu_2\{[C_2^0 - p_n^N q_n^0 + p_n^N (q_n^0 - q_n)] - \ell[q_2, (q_n^0 - q_n)]\} \quad . \qquad (4.8)$$

As above, supply and demand curves for abatement of the external diseconomy can be obtained.

Examination of the effect of a change in liability rules on the firms' constrained revenue functions suggests that the case of revenue maximization subject to a cost contraint is analogous to the case of utility maximization subject to a budget constraint. The first-order conditions for each firm include its cost constraint, which changes when liability rules change. Thus, a shift in liability rules leads to a shift in the supply and demand curves for abatement of the external diseconomy, and to changes in the equilibrium output of the market goods, q_1 and q_2, and external diseconomy, q_n. In the case of production subject to inflexible capital constraints, the Strong Hypothesis is rejected, while the Weak Hypothesis is not.

This is a rather special case, in that the capital constraint is assumed inflexible. In practice, borrowing money for the length of the production period may often be a solution to this problem. This example does, however, suggest a case which is quite likely to occur in practice: that where capital has a rising supply price to the individual firm. In such a case, it could be expected that the Strong Hypothesis would be rejected.

Externality in Production, when Variable Transactions Costs are Greater than Zero

Let us assume that transactions costs are equal to c_n^N per unit of abatement finally agreed upon, and that c_n^N is greater than zero. The party who receives a bribe or compensation receives p_n^N per unit, while the party who pays, pays $(p_n^N + c_n^N)$ per unit. No capital constraint is assumed.

Let the demand curve for abatement when transactions costs are zero be expressed as follows:

$$p_n^N = [D],$$

where

[D] is the result of simultaneously solving firm 1's first-order conditions for profit maximization in terms of p_n^N and $(q_n^0 - q_n)$.

Similarly, the supply curve for abatement when transactions costs are zero can be expressed as:

$$p_n^N = [S],$$

where

[S] is the result of simultaneously solving firm 2's first-order conditions for profit maximization in terms of p_n^N and $(q_n^0 - q_n)$.

Status *quo* Liability is Zero. Firm 1's constrained profit function is

$$J_1 = \bar{p}_1 q_1 - (p_n^N + c_n^N)(q_n^0 - q_n) - \bar{p}_3 q_3 + \lambda_1 \{f[q_1, (q_n^0 - q_n), q_3]\}. \quad (4.9)$$

Firm 2's constrained profit function is

$$J_2 = \bar{p}_1 q_1 + p_n^N (q_n^0 - q_n) - \bar{p}_4 q_4 - \bar{p}_5 q_5$$
$$+ \lambda_2 \{g[q_2, (q_n^0 - q_n), q_4, q_5\}]. \quad (4.10)$$

When firm 1's first order conditions for profit maximization are simultaneously solved, the demand curve for abatement is

$$p_n^N + c_n^N = [D]$$

or

$$p_n^N = [D] - c_n^N. \quad (4.11)$$

When firm 2's first-order conditions are simultaneously solved, the supply curve for abatement of the externality is

$$p_n^N = [S]. \quad (4.12)$$

Status *quo* is Full Liability. In the full liability case, the constrained profit functions are ,

$$J_1 = \bar{p}_1 q_1 + p_n^N q_n^0 - p_n^N (q_n^0 - q_n) - \bar{p}_3 q_3 + \lambda_1 \{f[q_1, (q_n^0 - q_n), q_3]\} \quad (4.13)$$

and

$$J_2 = \bar{p}_2 q_2 - (p_n^N + c_n^N) q_n^0 + (p_n^N + c_n^N)(q_n^0 - q_n) - \bar{p}_4 q_4 - \bar{p}_5 q_5$$

$$+ \lambda_2 \{g[q_2, (q_n^0 - q_n), q_4, q_5]\}. \quad (4.14)$$

The demand curve for abatement is

$$p_n^N = [D]. \quad (4.15)$$

The supply curve for abatement is

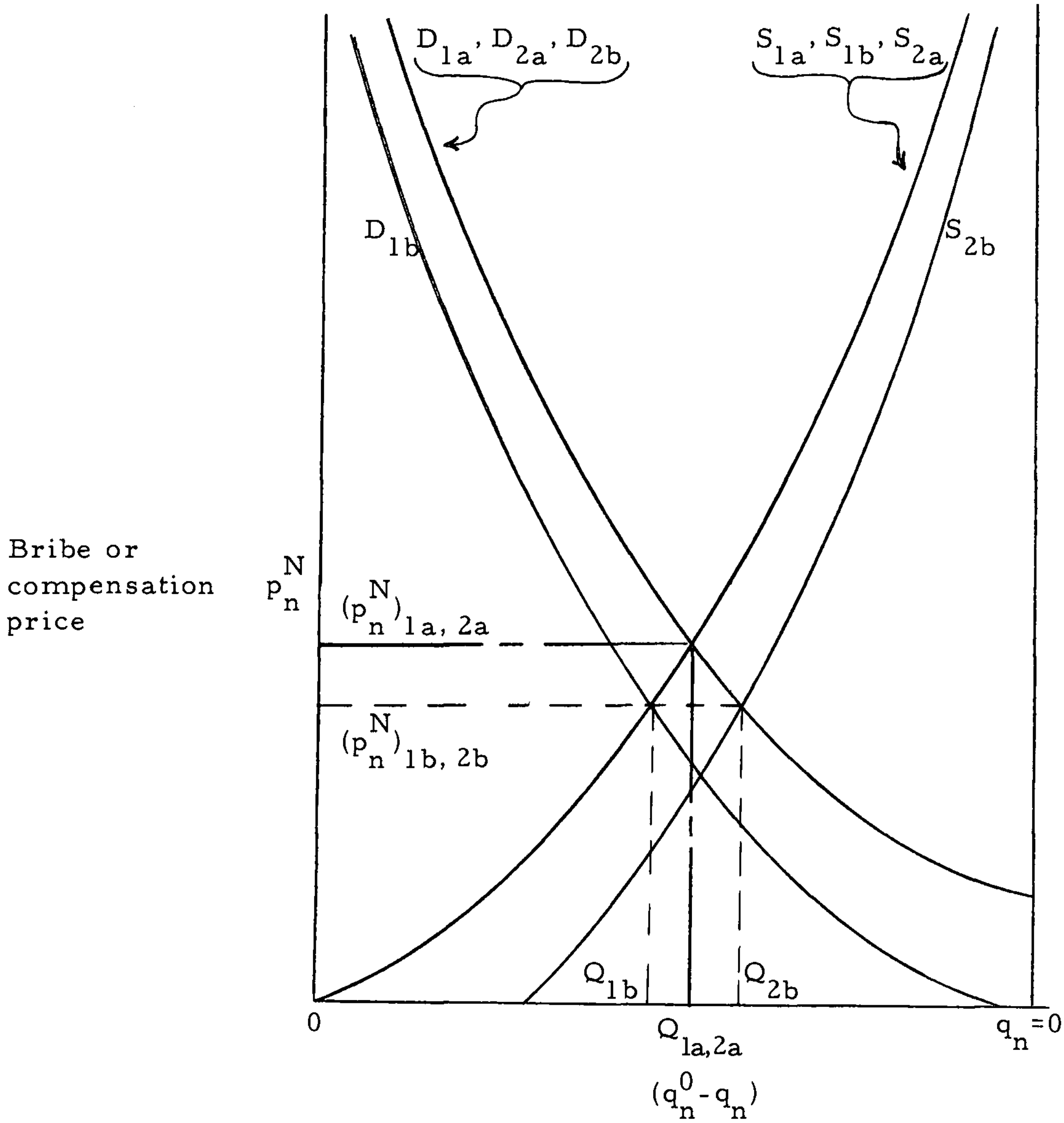
$$p_n^N + c_n^N = [S]$$

or

$$p_n^N = [S] - c_n^N. \quad (4.16)$$

When variable transactions costs are greater than zero, a change in liability rules shifts the supply and demand curves for abatement of an external diseconomy as shown in Figure 8.

When variable transactions costs are greater than zero, the zero liability rule results in less abatement of the external diseconomy at equilibrium than does the full liability rule. When variable transactions costs are a constant amount per unit of $(q_n^0 - q_n)$ and when this amount is the same regardless of which party pays the transactions costs, the bribe or compensation price, p_n^N, is the



Subscripts:
1. zero liability
2. full liability

a. $c_n^N = 0$

b. $c_n^N > 0$, and constant per unit of $(q_n^0 - q_n)$

Figure 8. Externality in production, under two different liability rules and two assumptions about transactions costs.

same at equilibrium regardless of which liability rule is in operation.

The shifts in the supply and demand curves occur because the party who receives a bribe or compensation evaluates the offer on the basis of its net value, while the party who must pay makes decisions on the basis of the total payment. Under the zero liability rule the demander of abatement must pay $(p_n^N + c_n^N)$ per unit of abatement. The demand curve (expressed in terms of net p_n^N) shifts downward when transactions cost per unit of abatement rises; the supply curve does not shift. Under the full liability rule, it is the supplier of abatement who pays compensation of $(p_n^N + c_n^N)$ per unit q_n. The demand curve does not shift, but the supply curve (expressed in terms of net p_n^N) shifts downward as c_n^N rises.

When variable transactions costs are greater than zero, the Strong Hypothesis is rejected for the case of externality in production. The Weak Hypothesis is not rejected, as long as the industries producing all relevant commodities and inputs and the transactions industry are perfectly competitive.

Externality where One Party is a Consumer and One Party is a Producer

Externality situations where both producers and consumers are involved would seem to be an empirically important group of externality problems. In many problems of air pollution, water pollution, noise pollution and visual pollution, the acting party is a producer or group of producers and the affected party is one or more consumers. This particular case is now examined.

Since both the case of externality in production and externality in consumption have been examined with simple mathematical models, there is no need to develop a mathematical model for the case where the acting party is a producer and the affected party is a consumer. Let us assume, once again, that the externality is an external diseconomy and that transactions costs equal zero. It is known from Chapter 3 that, except in the special case where income elasticity of demand for abatement is zero, a change from the zero liability rule to the full liability rule shifts an affected consumer's demand curve for abatement (usually to the right). Earlier in this chapter it was shown that, except in a special case where there is an inflexible constraint on the capital available at the start of the production period, a change in liability rules does not shift an acting producer's supply curve for abatement. Figure 9 shows the effect of a change in liability rules on the equilibrium bribe or compensation price, p_n^N, and equilibrium output of externality abatement. The demand curve shifts while the supply curve does not. When status quo liability is zero, both the bribe or compensation price, p_n^N, and the amount of abatement, $(q_n^0 - q_n)$, at equilibrium are lower than when the status quo is full liability.

Similarly, it can be shown that when the acting party is a

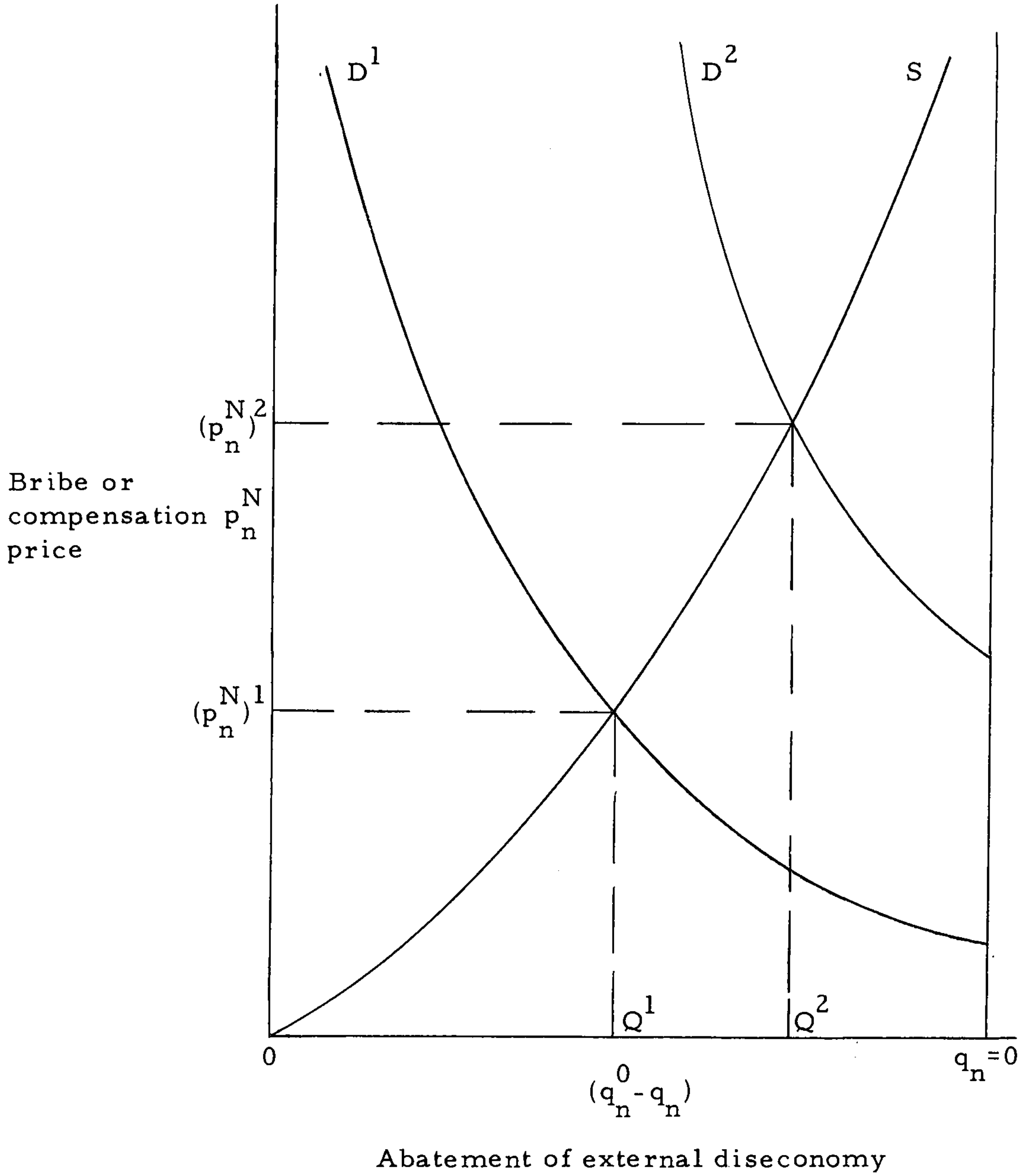


Figure 9. Externality where the acting party is a producer and the affected party is a consumer, under two different liability rules.

consumer and the affected party is a producer, the demand curve for abatement will not shift in response to a change in liability rules while the supply curve will be further to the left when the status quo is zero liability than when it is full liability. This case is shown in Figure 10. Under the zero liability rule, the equilibrium abatement is less and the equilibrium p_n^N is higher than under the full liability rule.

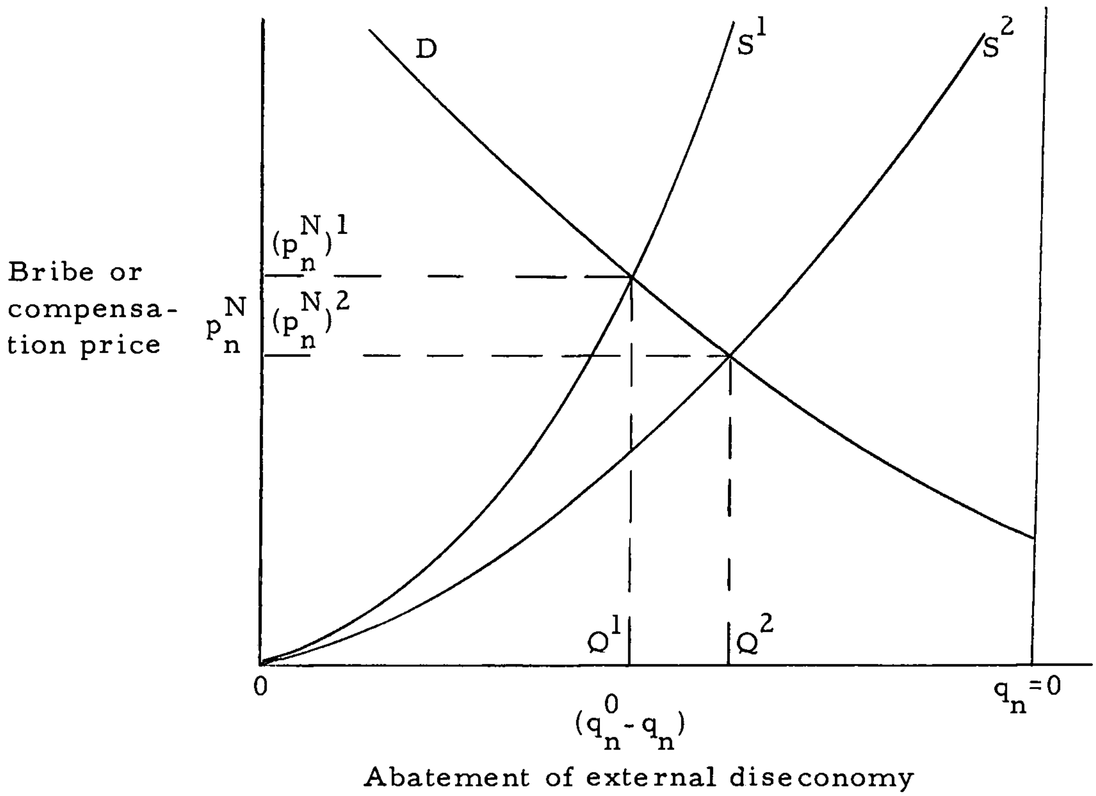


Figure 10. Externality where the acting party is a consumer and the affected party is a producer, under two different liability rules.

As in both the production case and the consumption case previously examined, the introduction of transactions costs greater than zero increases the differences in the equilibrium amount of abatement due to different liability rules.

Even when transactions costs are zero, the Strong Hypothesis must be rejected for externality situations where both producers and consumers are involved (except for the very special case where all consumers involved have a zero income elasticity of demand for abatement or of demand for the externality-producing item, whichever is relevant). Again the Weak Hypothesis is not rejected, (whether or not transactions costs are zero) as long as perfect competition conditions prevail in all relevant industries.

Summary

The case of externality in production is examined under the assumption that all relevant industries are perfectly competitive. It is found that when both parties are producers (who are not bound by inflexible cost constraints) and variable transactions costs are zero, the Strong Hypothesis is not rejected following deductive analysis with simple models. This is the only externality situation of all those examined in this study where the Strong Hypothesis is not rejected. If the producers are bound by inflexible constraints on operating capital available at the start of the production period, the Strong Hypothesis is rejected. However, this is a rather special case which may not be very significant empirically. For externality situations in which some producers and some consumers are involved, the Strong Hypothesis is rejected. Likewise, the Strong Hypothesis is rejected for all externality situations where variable transactions costs are greater than zero.

Provided that all of the usual perfect competition assumptions hold for all relevant industries, the Weak Hypothesis is not rejected in any of the externality situations deductively examined here.

V. SOME ALTERNATIVE ASSUMPTIONS ABOUT TRANSACTIONS COSTS

In the analysis presented in Chapters 3 and 4, only two assumptions about transactions costs have been considered: (i) transactions costs are zero, and (ii) variable transactions costs are a constant amount per unit of externality abatement achieved. It is demonstrated that the introduction of variable transactions greater than zero increases the disparity between the equilibrium outputs of externality under different _status quo_ liability rules. It would seem useful to further consider the effects which changes in the size and shape of the transactions cost curve would have on the equilibrium output of externality. On the next few pages, simple verbal and graphical analyses are used to indicate the effect of some different assumptions about the transactions cost curve. For this analysis, the simplifying assumptions used in Chapters 3 and 4 are retained.

(i) Transactions costs have only a fixed component; variable transactions costs are zero. Where only producers are involved in an externality situation, and transactions costs include only a fixed component, changes in liability rules do not change the equilibrium output of externality. This is because increases or decreases in fixed costs do not shift the _position_ of the supply and demand curves for abatement.[17] However, the fixed transactions costs are subtracted from the profits of the firm which has to pay the bribe or compensations. As the amount of this fixed transactions cost increases, the likelihood increases that one party may be forced out of business as a result of a change in liability rules. The tendency for changes in liability rules to result in mergers between acting and affected parties increases.

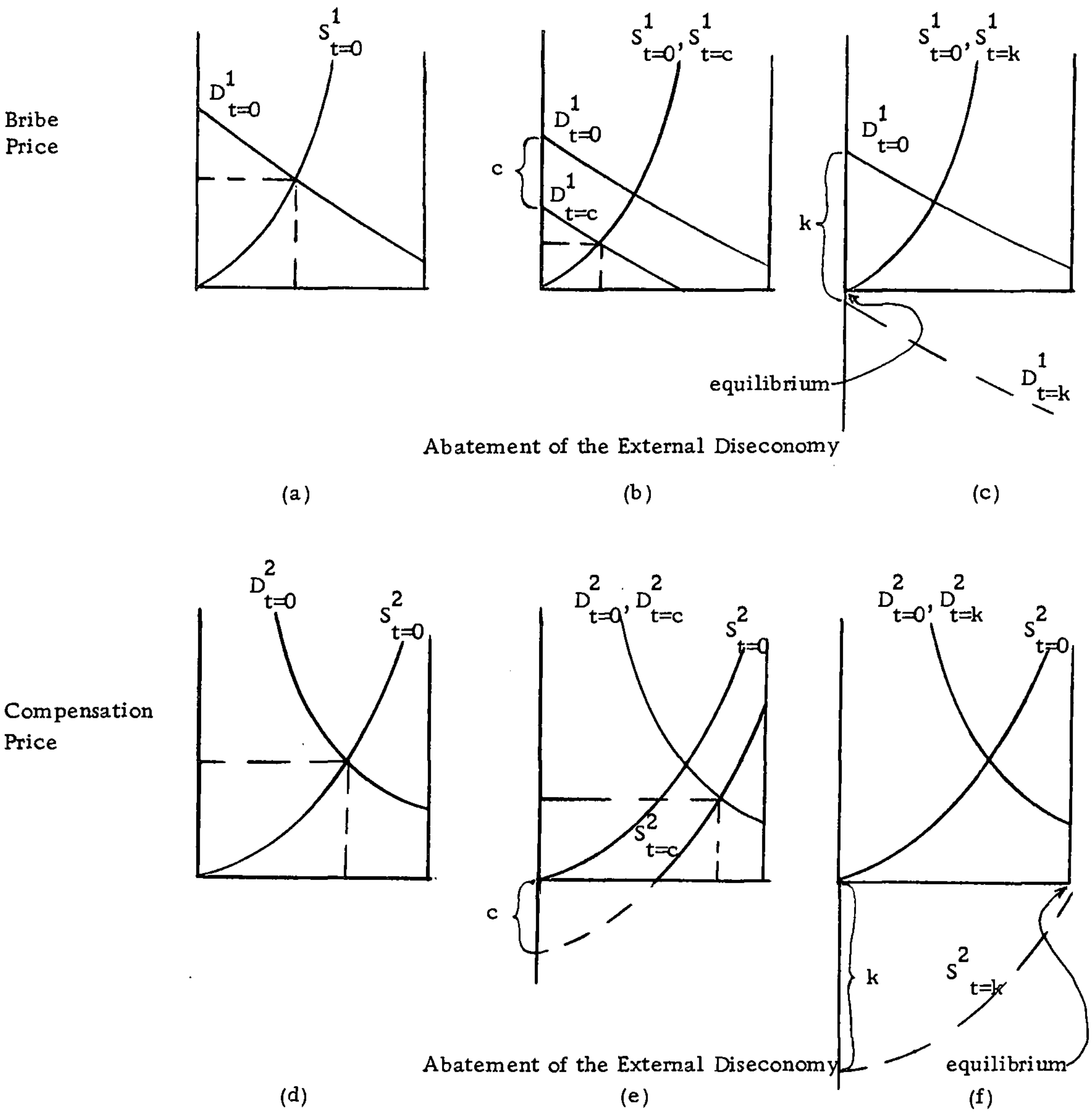
Where consumers are involved and transactions costs are all fixed, changes in liability rules change the individuals' budget constraints. The demand and supply curves for abatement shift unless the income elasticity of demand for, or supply of, abatement is zero. Thus, the equilibrium output of externality changes as liability rules change. As the size of the fixed transactions cost increases, the disparity between equilibrium solutions under different status quo rules increases. It is possible to conceive of a fixed transactions cost which is so large that the effective supply curve or demand curve for abatement, depending on the status quo rule in operation, may not pass through the two dimensional space defined by $0 < (q^0_{nj} - q_{nj}) < q_{nj}$ and $p^N_n \geq 0$. That is, the fixed transactions cost could conceivably be so large that there would be no effective demand for abatement

[17]The supply curve for abatement may be viewed as the supply of an output. The demand curve for abatement may be viewed as the demand curve for an input in a production process.

under the zero liability rule; under the full liability rule, complete abatement would be supplied at even a zero compensation price. In this case, transactions costs would be so large that negotiated movements away from the _status quo_ point would be impossible.

(ii) Changes in the size of the variable element of transactions costs. The possibility that transactions costs may be so great as to preclude any negotiated solution to an externality situation is also conceivable when transactions costs are composed of only variable costs. This could occur in the cases of externality in production and in consumption. Figure 11 shows the equilibrium solution to a Pareto-relevant externality in consumption under zero and full liability _status quo_ rules and under three different levels of variable transactions costs. Each of the six solutions shown is different. Figures 11(c) and 11(f) are of particular interest. In these cases, the variable transactions costs of k per unit are so large that no movement away from the _status quo_ point can be obtained through market transactions.

It is most likely that the transactions costs associated with market transactions to realize gains from trade would have both fixed and variable components. If so, the introduction of transactions costs into the analysis would result in some combination of the effects attributed above to variable transactions costs and to fixed transactions costs.



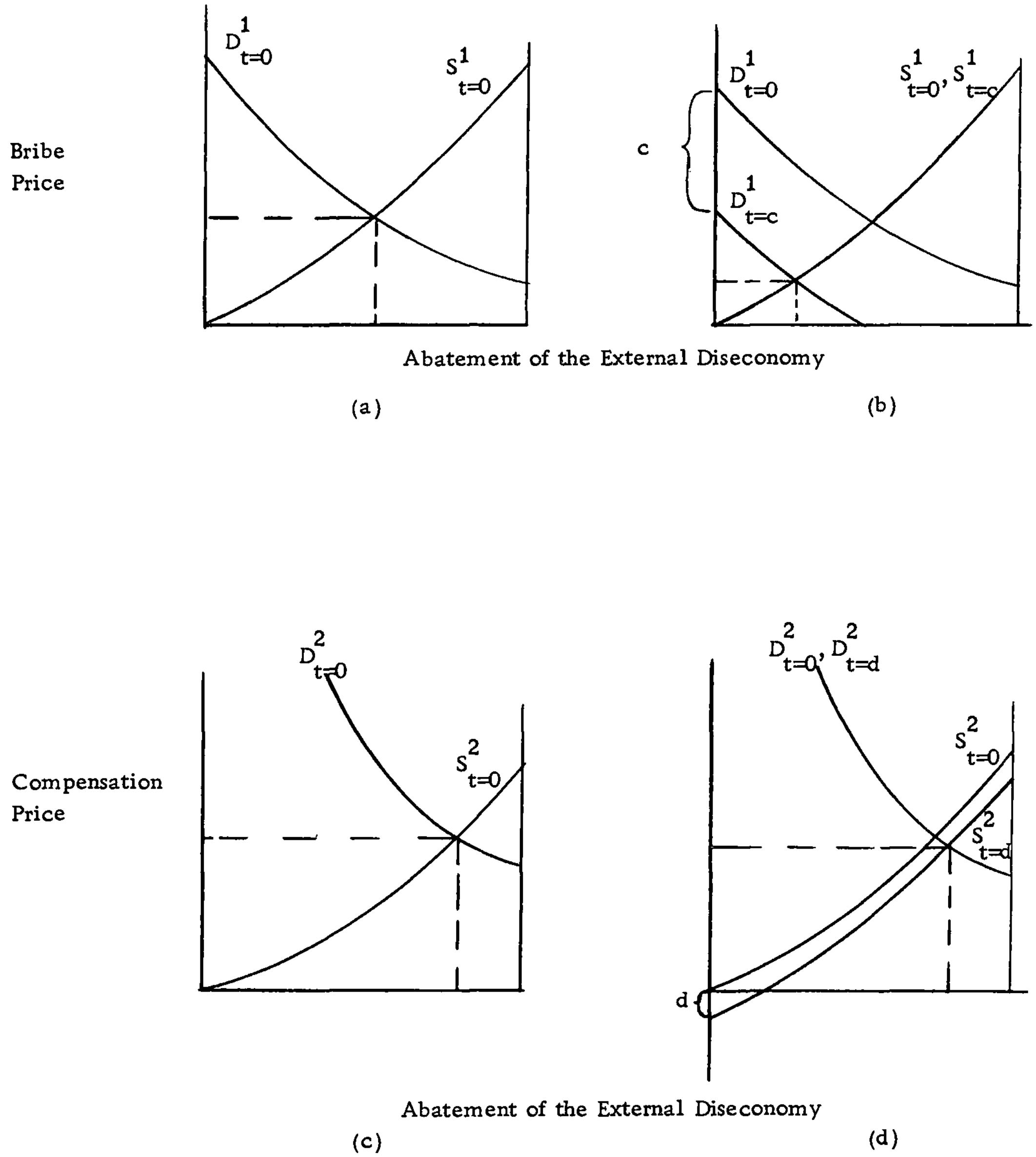
Legend: 1 = zero liability
2 = full liability
t = variable transactions costs per unit abatement

Figure 11. Externality in consumption, under two different liability rules and three different assumptions about the level of transactions costs.

(iii) Transactions costs where more than two firms or individuals are involved in an externality situation. The models used in Chapters 3 and 4 are all concerned with negotiations between two firms or individuals who are involved in an externality situation. However, an externality situation may involve many acting or affected parties. A cursory examination of books by Buchanan and Tulloch (1962) and Olson (1965) suggests that the costs in time, effort and other inputs of achieving concerted action by all parties who are involved may increase as the number of parties increases. It is argued persuasively that the costs of organizing a large group of individuals, each only peripherally concerned with this particular externality problem, into a cohesive bargaining unit would be greater than the costs of organizing a group which has fewer members, each more vitally concerned with this one issue.

Where the acting party is composed of many members and the affected party is composed of considerably fewer members, or vice-versa, it may be expected that transactions costs may be different, depending on which party must take the initiative in bargaining. If this is so, changes in liability rules would change the total amount of transactions costs. This would magnify the disparity between equilibrium outputs of externality under different liability rules.

In Figure 12, an example is considered where the acting party is a producer or a numerically small group of producers while the



Legend: 1 = zero liability
2 = full liability
t = variable transactions costs per unit abatement

Figure 12. External diseconomy where acting party is a producer and affected party is a group of consumers, under two different liability rules.

affected party is a numerically much larger group of consumers. It is assumed that transactions costs are substantially larger when bargaining is initiated by the consumers than when it is initiated by the producers. In this case, different *status quo* rules result in different equilibrium outputs of externality, and substantially different distributions of income among the producers, the consumers and the transactions industry.

In an example such as this, it is conceivable that transactions costs may be so large that no negotiated movements away from the *status quo* point would be possible. When the *status quo* is zero liability and the group of consumers must initiate bargaining, this is more likely to happen than when the *status quo* is full liability and the producers must initiate bargaining. This may explain why negotiated solutions to industrial pollution problems in residential areas are not often observed when the *status quo* is zero liability.

Summary

The deductive testing of the Strong and Weak Hypotheses in Chapters 3 and 4 demonstrates that the introduction of variable transactions costs greater than zero increases the disparity between equilibrium outputs of externality under different *status quo* liability rules. In this chapter, simple verbal and graphical analyses are used to indicate the effects of some different assumptions about the transactions cost curve. It is shown that increases in the fixed component of the transactions cost increase the tendency for a change in liability rules to lead to mergers between acting and affected parties which are both producers. Increases in variable transactions (where all parties are producers) and in both fixed and variable transactions costs (where some consumers are involved) increase the disparity between equilibrium output of externality under different liability rules. It is conceivable that transactions costs could be so large that no movement away from the _status quo_ point would be possible. Where the demand curve for abatement of an external diseconomy has a negative slope and the supply curve has a positive slope, this would result in equilibrium solutions producing no abatement under the zero liability _status quo_ point, and complete abatement under the full liability rule.

Where one party in an externality situation is composed of many more independent members than the other party, a _status quo_ point which requires that the numerically larger party initiate negotiations may result in higher transactions costs than would the opposite _status quo_ rule. This observation may present some insights to help explain why negotiated movements away from a zero _status quo_ point are seldom obtained in practice when the acting party is a producer and the affected party is composed of thousands of nearby residents.

VI. SUMMARY AND POLICY IMPLICATIONS

A Pareto-relevant externality is defined as existing when an activity under the control of an acting party and influencing the level of utility attainable by an affected party may be modified in such a way as to make the affected party better off without making the acting party worse off. A Pareto-relevant externality is characterized by the existence of potential gains from trade between the acting and affected parties. It seems reasonable, then, to hypothesize that negotiations between the involved parties could lead to market transactions which would exhaust these potential gains from trade. At this point an optimal level of externality would, by definition, have been achieved. Necessary pre-conditions for successful negotiations to achieve an optimal level of externality include the existence of secure and well defined property rights for all factors and commodities. A well defined liability rule specifying the rights of involved parties with respect to the externality is needed, to serve as a *status quo* point for these negotiations.

In this study, simple deductive models have been used to examine negotiated solutions to externality problems.[18] These models

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[18] Analysis has been concentrated upon external diseconomies but the case of external economies is equally amenable to analyses such as those performed in this study.

assume perfect competition in the markets for all commodities (other than abatement of the external diseconomy) and all factors; consumers and producers aim to maximize utility and profits, respectively; and all parties have perfect information. The analysis is static.

Two hypotheses are tested under these conditions. The Weak Hypothesis states that "(m)arket transactions between individuals or firms involved in an externality situation will result in achievement of a Pareto-efficient solution, regardless of the status quo liability rules." The Strong Hypothesis includes the Weak Hypothesis and adds that "(e)xactly the same equilibrium output of externality will be produced, regardless of the status quo liability rules."

In Chapters 3 and 4 of this study, it is shown that the Strong Hypothesis is rejected for all cases except that where all of the following conditions are met: all parties involved in the externality situation are firms involved in production; no firm has an operative constraint on capital available at the start of the production period; and the variable transactions costs involved in achieving and enforcing agreement are zero. The Strong Hypothesis is rejected when there are any consumers involved as acting or affected parties (except for the special case where the income elasticities of both supply and demand for abatement are zero). It is also rejected for all cases where variable transactions costs are greater than zero.

Two observations seem to be in order. First, it seems unlikely that the conditions for failure-to-reject the Strong Hypothesis would be met in many instances. Even where no consumers are involved in an externality situation, the variable transactions costs of achieving and enforcing a negotiated solution are likely to be greater than zero. Second, it must be pointed out that this deductive testing of the Strong Hypothesis is performed under conditions especially favorable to that Hypothesis. The perfect competition, full information and static single time period assumptions are most favorable to a hypothesis such as this.

Provided that all of the assumptions are met, the Weak Hypothesis is not rejected in any of the cases considered. The assumption of perfect competition in all relevant industries, including the transactions industry, is crucial to this conclusion.

Policy Implications

The analysis and commentary presented thus far has concentrated on the effects of different *status quo* liability rules upon the equilibrium output of externality and distribution of income. Coase (1960) and Davis and Whinston (1965) apparently accepted the proposition which is here called the Strong Hypothesis. They recognized that different liability rules would lead to different distributions of income but insisted that income distribution is the *only* variable which is responsive to changes in liability rules.[19] If this were true, then the selection of appropriate *status quo* liability rules involves only an ethical decision about distribution of income among the parties involved in the externality situation.

The rejection of the Strong Hypothesis for all situations which are likely to exist in practice rules out such a simple conclusion.

Given our assumption of unchanging production functions and initial incomes of consumers (within the single time period), different equilibrium outputs of externality imply (i) different allocation of resources in production and (ii) different allocation of consumers' budgets. Two solutions which have different equilibrium outputs of externality can be expected to differ in several other respects: resource allocation throughout the whole economy, relative and absolute price levels, aggregate production and consumption and the level of real income.

Selection of a *status quo* liability rule involves some hard choices among the competing claims of the involved parties: both the equilibrium level of externality and the distribution of income among the involved parties are influenced by the selection of the *status quo* point. However, a social decision-maker would have to consider many other variables, as well as these. Aggregate consumption,

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[19] See, for example, Davis and Whinston (1965, p. 123).

production and investment, real income, relative and absolute prices and, in some cases, resource allocation are all legitimate targets for national policy. A social decision-maker would need to consider these issues carefully before making decisions about a general pattern of liability rules to handle the many externality situations which occur in a whole economy.

This conclusion has a substantial bearing upon the policy debate which surrounds the issue of externality. While the Strong Hypothesis appeared acceptable, a prime attraction of the negotiated solution method of solving externality problems was its simplicity: just set any status quo point and the same efficient solution will be achieved "by the invisible hand";[20] if any income distribution problems appear, they may be solved by judicious selection of the status quo point or by any other suitable income redistribution device.

It is no longer possible, however, to regard negotiated solutions from a specified status quo as being such a gloriously simple institutional device for the solution of externality problems. This is not to reject negotiated solutions out of hand. Rather, it merely suggests a

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[20] The analysis presented has concentrated upon two alternative status quo points, zero liability and full liability. These represent the extreme points of a continuum. Intermediate points involve the selection of some particular amount of externality which may only be exceeded if the acting party pays compensation considered adequate by the affected party. If the method of negotiated solutions is to be used, the status quo point may be selected from among all points on this continuum.

lowering of the pedestal upon which Coase (1960), Davis and Whinston (1965) and others had placed this particular method.

If the method of negotiated solutions from a specified status quo point is to be used, the selection of the precise status quo rule is a matter of particular importance. The theorizing presented in Chapter 5 suggests that the choice of a particular status quo rule becomes increasingly crucial when transactions costs are any or all at the following: (i) substantial, (ii) dependent on the number of individuals or firms which would have to act in concert, and (iii) larger for consumers than for producers. In situations where transactions costs have these characteristics, the setting of a zero liability status quo rule may be tantamount to doing nothing at all about the externality problem.

There are other institutional devices which have been proposed to handle externality problems. Intervention by some arm of the government is probably the major alternative to market solutions.[21]

In the case of external diseconomies, common forms of control by government action are (i) the setting and enforcement of standards

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[21] Action through courts of law is not properly regarded as an alternative to market solutions or administered solutions. Rather, it can provide essential aid to either type of solution. Where market solutions are used, the courts can be used to enforce recognition of the status quo rule, while market forces establish the equilibrium solution following negotiation. Where administered solutions are used, the courts can be used to enforce adherence to the rules which are established.

(e. g. , emission standards for pollution) which serve as standards to be achieved rather than _status quo_ points for bargaining among involved parties and (ii) the setting and enforcement of taxes and subsidies in order to change the incentives facing acting parties. It is immediately clear that Pareto-efficient solutions may be approached by these methods only as a result of expert decision-making by the governing body.[22] Both excellent decision models and near perfect information would be needed to facilitate achievement of results approaching Pareto-optimality.

This study has demonstrated that, in the case of market solutions, transactions costs can vastly affect the eventual solution and may even prohibit achievement of solutions other than the original _status quo_ point. Administered solutions also incur transactions costs: the cost to all parties involved (including, of course, any legislative, administrative or judicial bodies) of reaching and enforcing decisions. Cases may exist where administered solutions incur transactions costs which are much lower than the transactions costs incurred in reaching negotiated solutions to the same problem. In such instances the administered solution may be preferred, even

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[22] See some comments on systems of taxes and subsidies in Buchanan and Stubblebine (1962). For one thing, it can be shown that Pareto-efficient fine-subsidy solutions can be achieved only if the amount of fines taken from acting parties is exactly equal to the subsidies paid to affected parties.

though it may appear sub-optimal if transactions costs were ignored. Even if institutional choice is to be made on efficiency grounds alone, the benefit-cost calculus which provides the basis for that choice should include transactions costs on the cost side of the account.

Let us digress for a moment, to consider an example of a particular externality situation and to allow a brief and superficial discussion of the institutional choices open to society. This example will serve to illustrate some of the points which have been made above, and it will indicate a degree of complexity in real world examples which is not found in our simple deductive models.

Consider a paper mill which directly employs 50 people. As well as paper products, this mill produces substantial volumes of a pale brown and strongly odorous smoke which it releases directly into the atmosphere.[23] This air pollution is discernible by residents in an area several miles wide, around the mill. Thirty thousand people live in this area.

The definition of the acting party is clear: it consists of the owners and operators (the decision-makers) of the mill. The affected party consists of those who breathe the polluted air. The affected party consists mainly of people who could be expected to act as

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[23] It may also release pollutants into a nearby stream, but let us simplify matters a little by concentrating upon the single externality involved in the air pollution.

consumers, but also includes some people who may act and think as producers since their income is higher when the mill is producing at full capacity.

The existence of a large number of individuals among the affected party who may be expected to act mainly as consumers would suggest that the Strong Hypothesis would not be accepted in this case. Even if the method of negotiated solutions is used, it is not reasonable to expect that the equilibrium output of externality would be the same regardless of the status quo point. If administered solutions were used, the equilibrium output of externality would depend on the precise characteristics of the particular institution used. As explained above, different outputs of externality imply different allocation of resources and different relative prices, and may even affect aggregate consumption, production, income and investment. Since there are many paper mills in the nation and any institutional solution which applies to this particular mill would probably apply to many or all others, the choice of institutional response to this air pollution problem may significantly affect these other economic variables. The partial equilibrium analysis used in this study serves, then, as a warning that general equilibrium analysis would be required to trace the full affects of this institutional choice, even if the chosen institutional type involves only the setting of a status quo point and letting negotiations "happen".

Now, let us consider some of the institutional choices available to solve this particular externality problem. A status quo point may be set by law, and society may rely upon spontaneous market transactions to achieve an efficient solution. The status quo point may be zero liability. Then the affected parties, the 30,000 residents, could attempt to organize themselves into a cohesive bargaining unit and negotiate with the mill operators. The residents would offer a cash payment in return for a specified reduction in the output of pollutant. Eventually agreement may be achieved. Income would be redistributed from the residents to the mill operators and some reduction in pollution would be obtained. An inspection device would be required to ensure that the agreement was being adhered to, and the judicial system of the nation would stand ready to ensure enforcement.

On the other hand, it is possible that the costs of organizing a rather diverse group of 30,000 residents, of negotiations and of possible court action may be so high that a negotiated solution would be impossible and no movement away from the status quo point could be obtained. The public goods problem (Samuelson, 1954, 1955) is another factor which could limit the effectiveness of group action by the residents. If contributions toward payment of the bribe are voluntary, no self-interested individual would contribute if he thought others may contribute enough in the absence of his donation. If society desired, the latter problem could be solved by some coercive method of collection of contributions from all residents.

A *status quo* point which placed full liability on the mill operators may be chosen. This would forbid emission of any pollutants, unless the residents could be induced to permit it. The mill operators would then offer compensation to the residents; in return, the residents would be asked to accept some specified level of pollution. The residents would need to establish some kind of representative institution to bargain on their behalf and to distribute the compensation gained. The courts would stand ready to enforce (i) recognition of the *status quo* point and (ii) adherence to the negotiated agreement. It could be hypothesized that a negotiated solution (other than the *status quo* point) may be more readily obtained under the full liability rule, since it may be easier and cheaper to organize the residents to receive and distribute compensation than to collect the money to pay a bribe. The analysis presented in Chapter 4 suggests that, even if transactions costs were the same under either *status quo* rule, the full liability rule would result in more abatement.

Liability could be assigned at any point along the continuum between zero and full liability. Each point may result in different total transactions costs, output of externality, distribution of income, allocation of resources, relative and absolute prices and aggregate consumption, production, income and investment.

As an alternative to negotiated solutions, administered solutions could also be used. A system of taxes per unit of "excessive" emissions or subsidies to encourage investment in cost-increasing but pollution-reducing devices may be suggested. Such systems may result in solution more or less closely approaching the optimum level of externality. Alternatively, strict emission standards may be set and penalties may be used to enforce them. These types of institutions would affect all of the same economic variables which are listed above as being affected by negotiated solutions. Administered solutions would also have transactions costs: the time, effort and expense invested by all parties in deciding upon the exact institutional solution and enforcing it.

This example is used to demonstrate the large number of economic variables, other than just output of externality and distribution of income among involved parties, which are responsive to the effects of institution on the incentives facing acting and affected parties in an externality situation. It also draws attention to the role which transactions costs may play in determining the response of externality levels to the choice of institutions. Even if the economist is concerned chiefly with efficiency, transactions costs should be included in the benefit-cost calculus on which institutional choice should be made.

Directions for Empirical Research

The Hypotheses deductively examined in this study are not directly amenable to empirical testing. Both of these Hypotheses include claims that Pareto-efficiency will be achieved. No empirical test for Pareto-efficiency is currently available.

Since the Strong Hypothesis is rejected in deductive testing under conditions favorable to it, it seems unlikely that different *status quo* rules would in practice result in the same equilibrium output of externality. The empirical question concerns the extent of the disparity due to different liability rules. It may be possible to find cases where empirical studies of this question could be performed.

Time series or cross-sectional observations, or both, could be used. A time series approach would seek out firms and consumers in industries or localities where *status quo* liability rules had been markedly changed at some time in the past. Data from the "before" and "after" periods would be used to examine, with projections where necessary, the output of externality and allocation of resources *with* and *without* the change in liability rules. Apart from the statistical problems with this approach, problems may be encountered in finding cases where clear changes in liability rules had taken place over time.

Cross-section data would be obtained from two or more groups of individuals or firms which, while similar in other respects, are operating under different liability rules. Again, as well as the statistical problems inherent in this approach, problems may be encountered in finding similar groups of consumers or firms operating under different liability rules.

The major problems in gathering suitable data may be the problems of finding different status quo rules operating in similar contexts, to facilitate meaningful comparisons, and the problems of finding cases where negotiated solutions have actually been achieved, or at least attempted.

This study has also drawn attention to transactions costs, as one of the variables which should be considered in evaluation of alternative institutions for externality situations. Empirical information on the transactions cost curves associated with feasible market solutions and administered solutions would be useful in the selection of institutions to handle externality situations. The transactions costs associated with each type of solution and information on the economic effects of each type of institution could be used together to provide an economic evaluation of various institutions. Information on transactions costs could be a vital input into design, selection and evaluation of institutions to handle externality problems.

Some Hypotheses about Transactions Costs

The transactions costs associated with market solutions to externality problems are likely to be made up of the costs of obtaining information and making individual decisions, bargaining and making group decisions and enforcing these decisions. These transactions costs could include legal and court costs in several phases. In particular, legal and court expenses may arise in the information gathering phase when *status quo* rules need interpretation, in the group decision-making phase when contracts are drawn up and signed, and in the enforcement phase. In enforcement, it would be essential to enforce the *status quo* rule so that the intended incentive to bargaining would be operative and to enforce the contractual agreement which results from the group decision.

In comparison, the transactions services associated with administrative solutions may have similar types of functions, but the transactions costs may be quite different in amount and may be paid to different people in return for different services. The information gathering phase would most likely consist of taking evidence from involved individuals and firms and from all manner of experts (scientists, economists, laywers, etc.). All of these people would encounter some costs in informing themselves and giving evidence. An administrative or executive agency would then decide what to do and draft suitable proposals. Often, a legislative body would then consider these proposals and pass them, pass them with amendments, or reject them. (In the latter case, the administrative body may start again to develop new proposals.) This period of consideration may include the taking of further evidence from involved parties and experts. When a set of rules is made, it may be subjected to tests in court, possibly with several appeals to higher courts. Eventually a set of rules would be developed which would be accepted (if not liked) by all parties. From that point, enforcement would involve detection of violations and conviction of offenders.

Over the long pull, this process may be repeated at intervals as changes in technology and market conditions render earlier laws, rules, or standards obsolete.

This is not intended as a complete list of the types of transactions costs which may be incurred in attempts to modify externalities. Rather, it is intended to given some idea of the variety of transactions costs which may exist. It would seem that empirical information on the transactions cost curves associated with each suggested type of solution for each type of externality situation should be an essential component of the information available for evaluation of alternative institutions.

As a start in the collection of such empirical information, it is suggested that the following null hypotheses (which do not comprise an exhaustive list) be empirically tested.

1. In market solutions found through negotiations based on a specified <u>status quo</u> point, transactions costs are not larger if paid by the party which is numerically larger and more amorphous than if paid by the party which is numerically smaller and individually more vitally concerned with the

outcome of negotiations.

2. In such situations, laws which facilitate class actions in courts do not reduce the transactions costs faced by the larger and more amorphous group.

Where the compensation paid by an acting party which "produces" an external diseconomy is specified by courts of law rather than by negotiation from a status quo point, the affected party may be faced with quite high transactions costs. In this case, the compensation received is not net compensation (as it was in the cases examined in Chapters 3 and 4). Rather, it is gross compensation, from which transactions costs must be subtracted. In such circumstances, methods of reducing the transactions costs faced by plaintiffs should be sought, so that solutions can be achieved more efficiently and so that plaintiffs are not intimidated by the prospect of high court costs.

3. Laws which specify status quo points, fines and subsidies, or emissions standards, broadly rather than precisely do not result in higher court costs in cases settled in court and fewer cases settled out of court.

Intuitively, one would expect this hypothesis to be rejected. On the other hand, it is possible that precisely and narrowly defined laws or status quo rules may result in inefficient treatment of borderline cases and may become obsolete with changing technology and market conditions.

Many hypotheses could be generated and should be tested. In this manner, empirical knowledge of the transactions cost curves associated with all of the alternative institutions to handle externality situations could be slowly and painstakingly built up.

BIBLIOGRAPHY

Bramhall, D. F. and E. S. Mills. 1966. A note on asymmetry between fees and charges. Water Resources Research 2:615-616.

Buchanan, J. M. 1969. External diseconomies, corrective taxes, and market structure. American Economic Review 59:174-177.

Buchanan, J. M. and W. C. Stubblebine. 1962. Externality. Economica 29:371-384.

Buchanan, J. M. and G. Tulloch. 1962. The calculus of consent. Ann Arbor, University of Michigan Press. 361 p.

Calabresi, G. 1965. The decision for accidents: an approach to non-fault allocation of costs. Harvard Law Review 78:713-730.

Calabresi, G. 1968. Transactions costs, resource allocation and liability rules. Journal of Law and Economics 11:67-73.

Coase, R. H. 1960. The problem of social cost. Journal of Law and Economics 3:1-44.

Davis, O. A. and A. B. Whinston. 1965. Some notes on equating private and social cost. Southern Economic Journal 32:113-125.

Demsetz, H. 1964. The exchange and enforcement of property rights. Journal of Law and Economics 7:11-26.

Dolbear, F. T. 1967. On the theory of optimum externality. American Economic Review 57:90-103.

Freeman, A. M. 1967. Bribes and charges: some comments. Water Resources Research 3:287-298.

Henderson, J. M. and R. E. Quandt. 1958. Microeconomic theory. New York, McGraw-Hill. 291 p.

Kamien, M. C., N. L. Schwartz and F. T. Dolbear. 1966. Asymmetry between bribes and charges. Water Resources Research 2:147-157.

Lipsey, R. G. and K. Lancaster. 1956. The general theory of second best. Review of Economic Studies 24:11-32.

Newman, P. 1965. The theory of exchange. Englewood Cliffs, N. J., Prentice-Hall. 201 p.

Nutter, G. W. 1968. The Coase theorem on social cost: a footnote. Journal of Law and Economics 11:503-507.

Olson, M. 1965. The logic of collective action. Cambridge, Mass., Harvard University Press. 176 p.

Samuelson, P. A. 1954. The pure theory of public expenditures. Review of Economics and Statistics 36:387-89.

Samuelson, P. A. 1955. A diagrammatic exposition of a theory of public expenditure. Review of Economics and Statistics 37:350-56.

Stigler, G. 1966. The theory of price. 3rd Edition. New York, Macmillan. 355 p.