THE STRUCTURE OF A CONTRACT
AND THE THEORY OF A
NON-EXCLUSIVE RESOURCE*

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THE process of arriving at a useful concept of analysis is not only slow and painful, but also may go astray and attain nothing useful. Someone begins with one example or observation, followed by a theory which is intuitively plausible. A theoretical term associated with a vague concept is coined. Examples of a seemingly different type emerge, which call for another theory. The process goes on. As examples and theories continue to accumulate, the different categories under the same heading of analysis serve only to confuse, and each associated theory becomes *ad hoc*. Such has been the fate of the concept of "externality."[1]

A more useful approach, I think, is via contractual conditions. The example chosen for illustration is marine fisheries, where the fishing right is taken

as non-exclusive, and where most economists agree that "externalities" exist in several directions.[2] In the absence of exclusive rights to the use of the fishing ground,[3] the right to contract so as to stipulate its use does not exist. This implies the absence of contractual stipulations governing resource use which would exist if the fishing ground were private property, thereby altering the constraint of competition and affecting resource allocation in a number of ways. The alleged "externalities" in fisheries are thus attributable to the absence of the right to contract.

I. PROPERTY RIGHTS AND CONTRACTING

Combining resources of several owners for production involves partial or outright transfers of property rights through a contract.[4] A contract for the partial transfer of rights, such as leasing or hiring—embodies a *structure*. The stipulations, or terms, which constitute the structure of the contract are, as a rule, designed to specify (a) the distribution of income among the participants, and (b) the conditions of resource use. Under transferable rights, these stipulations are consistent with, or determined by, competition in the marketplace. As shown elsewhere,[5] the choice of contracts is determined by transaction costs, natural (economic) risks, and legal (political) arrangements. However, the familiar market prices are but one among many of the contractual terms (indeed, in share contracts, prices are not explicitly specified).

With private property rights governing the use of *all* resources, the postulate of wealth maximization implies that the contractual stipulations are designed to maximize the return to all resources subject to the constraint of competition. Assume away the costs of transactions, the contractual stipulations for every resource use will be so designed that they are consistent with the equimarginal principle. In general, the structure of the contract will be such that the marginal gain and cost are equal. In specific details, however,

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[2] See, for example, Ralph Turvey, Optimization and Suboptimization in Fishery Regulation, 54 Amer. Econ. Rev. No. 2., Pt. 1, at 64 (1964); and Vernon L. Smith, On Models of Commercial Fishing, 77 J. Pol. Econ. 181 (1969).

[3] What resource in marine fisheries is non-exclusive—the ocean bed, the water, or the fish? The answer is that any productive resource is multi-dimensional, and the term "fishing ground" is chosen to include all of them. This term is used synonymously with "fishery resource" or "fishing rights" in this paper.

[4] If only outright transfers exist for all resources, then only owner production will exist, and contractual stipulations on resource use will be absent. Partial transfers, such as leasing and hiring, are emphasized here because (1) they lead more directly to the problems involved and (2) they serve to illustrate more clearly the function of a contract.

[5] Steven N. S. Cheung, Transaction Costs, Risk Aversion, and the Choice of Contractual Arrangements, 12 J. Law & Econ. 23 (1969).

the elements constituting gains and costs are multiple and the marginal equalities of a constrained maximization are several. Since to satisfy one particular marginal equality, one or more contractual stipulations, implicitly or explicitly, are required, pages of stipulations in one contract can be found.

Two questions immediately arise. First, given the contractual stipulations, do we know that the required marginal equalities are satisfied? And second, what bearing do these stipulations have on the actual outcome of income distribution and resource allocation?

The answer to the first is that we know at least whether the stipulations are *consistent* with the requisite marginal equalities. The stipulations of a contract may be inconsistent with marginal equality of resource use (for example, a contract stipulating only a lump-sum charge without quantity stipulation); or the contract may not exist, implicitly or explicitly, as in the case of the use of a non-exclusive right. A defective contract, or the absence of a contract, does not necessarily imply economic inefficiency, and can be traced either to the presence of transaction costs, the existing legal arrangements, or the lack of foresight and the costs of information.[6] The second question—the relation between a set of stipulations and the actual outcome—is one of contractual enforcement. While one may argue that non-enforceable stipulations will not be present in a contract, for our present purpose it suffices to point out that the absence of a contract will lead to different resource use than when an enforceable contract exists.

But the main point here is that a contract may encompass a large set of stipulations, governing a set of marginal equalities associated with various aspects of resource use. If outright transfers exist for all resources engaged in production, the owner alone is responsible for the decision aspects. If partial transfers exist, then the contracting parties mutually negotiate the terms. For any production process, multiple contracts may exist. Given the form of contract, the stipulations would be more complex the more complex the physical attributes of inputs and outputs.

It has become increasingly clear to me that the mushrooming of alleged "externalities" is attributable to either (1) the absence of the right to contract, (2) the presence of a contract but with incomplete stipulations, or (3) the presence of stipulations that are somehow inconsistent with some marginal equalities. Among these cases, however, differences are only a matter of degree. Since the conceivable number of different contractual stip-

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[6] See R. H. Coase, The Problem of Social Cost, 3 J. Law & Econ. 1 (1960); George J. Stigler, The Economics of Information, 69 J. Pol. Econ. 213 (1961); and Harold Demsetz, The Exchange and Enforcement of Property Rights, 7 J. Law & Econ. 11 (1964).

ulations is very large, the rapid growth rate in the literature in recognizing "new" externalities is natural.

As an example, let us examine marine fisheries, wherein the right to use the fishing ground is said to be non-exclusive and hence the right to contract is absent. The assumed condition of a lack of exclusive right to use the resource, free of institutional regulations, does not, of course, correspond to the real world where rules and regulations established by governments and unions are numerous.[7] The issue of regulation versus voluntary contractual arrangements in the marketplace will be discussed briefly in section IV.

Fish, like rice or any other growing (biological) asset, require "planting" as well as "harvesting." Different physical attributes of such resources, however, will lead to different degrees of emphasis on the alternative options of choice. In general, decisions will be made on the product to be produced, the method of production, the amount and type of investment over time, the financial maturity of the catch, and the intensity and method of harvesting. With private property rights, these decisions will result in stipulations mutually negotiated by the contracting parties (for example, the fishing-ground owner, the boat owner and the fisherman). Although the stipulations differ when the forms of contract differ, the implied resource use may not.

In the absence of exclusive rights governing the use of the fishing ground, not only will the intensity of its use be affected, but also the costs of policing (enforcing) the income generated by other private investment inputs will be higher. Higher policing costs will affect decisions pertaining to planting and financial maturity. For example: if the right to the use of land is non-exclusive, the cost of policing *private* fertilizers applied to land for the production of corn will be higher than if the land use is exclusive and is subject to contractual stipulation and enforcement. That is, if private landowner-ship obtained, the owner could enter a contract with labor and fertilizer owners, and restrict non-participants from interfering in any undesirable way. The right to contract is also the *right to exclude*. The same applies to the non-exclusive fishing ground, despite the different physical attributes of fish and corn. Some implications are:

(1)   The choice of product will be constrained by the higher costs of guard-

[7] The literature is immense. See, Francis T. Christy, Jr. & Anthony Scott, The Common Wealth in Ocean Fisheries (1965); James Crutchfield & Arnold Zellner, Economic Aspects of the Pacific Halibut Fishery, Fishery Industrial Research, no. 1 (April, 1962); Expert Meeting on the Economic Effects of Fishery Regulations, Ottawa, 1961, Economic Effects of Fishery Regulation (R. Hamliseh ed., 1962); Myres S. McDougal & William T. Burke, The Public Order of the Oceans (1962); Sol Sinclair, License Limitation-British Columbia: A Method of Economic Fisheries Management (Can. Dep't of Fisheries, 1960); and Int'l Technical Conf. on the Conservation of the Living Resources of the Sea, The Economics of Fisheries (Ralph Turvey & Jack Wiseman eds., 1956). Rules imposed by boat and fisherman unions can best be obtained from the unions themselves.

ing private investment inputs, generated by the non-exclusive use of the resource. This implies that a product, the physical attributes of which entail relatively low costs of policing private investment inputs, will be preferred by the users of the non-exclusive resource. In Tripolitania, for example, potentially lucrative almond trees are reported to have been forsaken for cattle raising owing to the "common ownership" of land.[8] This can be explained by the fact that the cost of policing investment in a tree, perenially "attached" to the common land, is high, whereas cattle are driven home at night. The change in product as described results in a different composition of investment inputs; but the total value of investment may rise or fall. Furthermore, the collectable rent—a residual under non-exclusive land-ownership—will decline even before its dissipation under competition, owing to the choice of a product differing from that chosen to maximize rent under private property.

Does the lack of exclusivity in the fishing ground significantly affect the choice of product in marine fisheries? One impression is that it does not, since the fishing ground appears to be amenable to concurrent uses, or the existing types of marine product might be the most valuable choices. Still, there may be too many of some fish and too few of another, or the product choice in aquaculture may be affected.[9] The issue is an empirical one.

(2) Given the product, some types of investment input will predictably decline when a private fishing ground becomes non-exclusive. For example, privately owned paddy-field fisheries will receive more intensive feeding than if the same fish were placed in a common lake.[10] The phenomenon is again due to the higher cost of policing private feeding inputs, on account of the non-exclusive use of the common lake. In marine fisheries, the rate of return to this type of investment appears negligible, hence unimportant. But the same may not be true for all marine products.

(3) The physical attributes of marine fisheries, together with policing costs, also affect the value at maturity (size of catch) of the growing asset. Should the fishing ground be exclusively owned and its products costlessly

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[8] See Anthony Bottomley, The Effect of Common Ownership of Land upon Resource Allocation in Tripolitania, 39 Land Econ. 91 (1963).

[9] See Anthony Scott, Economic Obstacles to Marine Development, (manuscript prepared for Conf. on Marine Aquaculture, Ore. St. Univ., May 1968).

[10] But investment of this type may not be reduced to zero. While no definitive solution for this is offered here, let me suggest an approach to the problem. Assume that the cost of policing private investment is so high as to be prohibitive. Let p be the marginal rate of return on investment and r be the rate of interest. If the return to investment is non-exclusive, then given n identical people, an individual will invest if $p/n \geqslant r$. It is, of course, possible that investment of this type be reduced to zero even if n is quite small. However, the number of individuals should be treated as a variable partly dependent on p.

enforced as private, the financial maturity of fisheries and the implied rate of rotation (that is, the mesh size) would be so chosen as to maximize wealth.[11] Similarly, the time shape of the income stream of harvesting will differ from that of maximizing wealth under non-exclusive rights.[12] These factors, while significant in marine fisheries, do not appear so for cattle raising in common pastures, since the cost of policing cattle is lower. That is, the cost of policing privately raised fish in a "common" ocean is higher than that of raising cattle in common pastures.

The several changes in decisions pertaining to planting and financial maturity discussed above are only some of the more prominent effects of the absence of exclusive rights in one of the factors of production. While an exhaustive list is not attempted here, our discussion shows that since a contract embodies a structure, the absence of the right to contract, as with a non-exclusive resource, will affect resource allocation in a variety of ways. And since production decisions are usually several, so are the marginal equalities affected: the marginal mesh size, marginal feeding inputs, marginal product choice, and so forth. According to the current practice, these decision aspects affected by the absence of a contract are treated as different types of externalities.

While, in section III, I shall support the existing conclusion of the dissipation of rent under the non-exclusive use of a resource, I shall not endorse the traditionally accepted analysis through which this dissipation takes place. This section has shown that the effects pertaining to planting and financial maturity, if they occur, will in themselves reduce the collectable rent. And it is not difficult to conceive of a situation in which, by harvest time, there is nothing worthwhile to harvest. But marine fisheries have better luck.

II. HARVESTING: PRIVATE PROPERTY RIGHTS AND THE
MARGIN OF DAMAGE

We now turn to analyze the intensity of fishery "harvesting" in two hypothetical worlds, one with private property in all resources and one with a non-exclusive fishing ground. The harvesting issue is singled out here because the existing theoretical solution has been fundamental in recent economic analysis of marine fisheries and of the "common pool." Furthermore, externality is said to exist in its purest form: the catch of one fisher-

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[11] Although the "tree-cutting" problem is well known, I refer here to an early solution by Martin Faustmann (1849), which is resurrected in M. Mason Gaffney, Concepts of Financial Maturity of Timber and Other Assets (A. E. Information Series No. 62, mimeographed at N. Carolina St. Coll., 1960).

[12] The best exposition of "time shape" and wealth maximization is still found in Irving Fisher, The Theory of Interest, ch. 5 & 6 (1961).

man depends not only on his own input, but also on the inputs of other competing fishermen. In this section we discuss the private-property world, and the common pool in the next. The simple manipulation of the law of diminishing returns serves to demonstrate further the function of contracting and the ambiguity of the concept of externality.

Consider two private factor inputs in fishery production: the fishing ground and fisherman labor (assume that fish grow by themselves and ignore biomass value, hence harvesting is the only consideration). The rent derivable from the fishing ground is thus the integral of the difference between the marginal product of labor and the wage rate. To maximize rent (income) under private ownership,[13] the rate of change of rent with respect to labor is required to be set at zero, implying that the marginal product of labor equals the wage rate.

The above equilibrium condition can be viewed in terms of the gain from adding labor to fishery harvesting and the damage the incremental labor inflicts on the productivity of the existing (intramarginal) labor input. Viewing the marginal gain per infinitesimal unit of labor added as its average product (its contribution) minus the wage rate (its alternative earning), we write

$$\Omega(L) = \frac{Q}{L} - W$$

On the other hand, "external" to the labor being added, the productivity of all existing (intramarginal) labor declines. Algebraically, we write

$$\Phi(L, L') = L \left[\frac{Q(L)}{L} - \frac{Q(L + L')}{L + L'} \right],$$

where the function Φ gives the value of damage caused by the increase in L', with L being the intramarginal labor. Taking the derivative of Φ with respect to L', we obtain

$$\frac{\partial \Phi}{\partial L'} = - \frac{\partial Q(L + L')}{\partial L'} \frac{L}{L + L'} + \frac{Q(L + L')L}{(L + L')^2}$$

The marginal damage, $\Lambda(L)$, caused by an infinitesimal increase in labor is thus

$$\frac{\partial \Phi(L, O)}{\partial L'} = - \frac{\partial Q}{\partial L} + \frac{Q}{L} = \Lambda(L)$$

To maximize rent of the fishing ground, the marginal gain of adding labor must equal the associated marginal damage, that is, $\Omega(L) = \Lambda(L)$.

[13] Throughout this paper, the word "rent" is used synonymously with "income", the flow of returns to any private resource right. For constrained maximization, it is viewed as an annuity.

In the above simple model we see that the effects of an action are independent of the system of property rights. To prohibit damage entirely is, insofar as diminishing returns holds (as in our model), to prohibit output entirely. What counts is whether the incremental gain can more than offset the associated damage. And it is one main function of contracting to stipulate the margin of damage that is to be allowed. Private property in the fishing ground grants its owner the right to contract and stipulate. The absence of such a right, as in marine fisheries, will affect the margin of damage.

What, then, is an externality? Does it exist always? If so, why is it treated as a special problem? Does it exist only when the marginal gain from an action is not equal to the marginal damage it causes? If so, should we view an "externality" as becoming less "external" when the inequality diminishes? Does it exist only when the damage is so great that rental income (in our example) is reduced to zero? If so, what is the conceptual difference between a zero rent and a negligibly small rent? In the simple case presented, indeed it is impossible to draw a dividing line such that "externality" can be meaningfully identified. *Every economic action has effects.* Nor is it illuminating to view the damage as external or internal to a firm, for the firm is but a holder of contracts.[14] The same applies to all decisions on resource use. It follows that the classification of various kinds of "externalities," if at all useful, is *ad hoc* theorizing, a cumbersome way to treat a general problem. The problem is general because for every gain there is a cost.

Because the above conclusion appears abrupt, let me retreat for a moment to discuss, by way of illustration, several types of economic effects caused by actions of individual decision units. The first type includes actions which produce trivial effects *and* which are transacted (with contracts) "smoothly" in the market. The traditional term for this appears to be "perfect competition"—with perhaps "constant cost for the industry." Note, however, that the same trivial action may no longer be trivial without contracting (for example, to acquire an apple without payment).

The second type includes effects which are trivial and are not transacted with contracts. Examples for this are to say "sorry" for minor damages done among individuals, or be gentle to the neighbor's dog. Let me refer to this type of behavior as "customs." According to J. S. Mill, when an activity is a customary practice and "not of a varying convention, political economy has no laws of distribution to investigate."[15] While the persuasiveness of Mill

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[14] I believe this accords with R. H. Coase, The Nature of the Firm, 4 Economica 386 (n.s. 1937), reprinted in Readings in Price Theory (George J. Stigler & Kenneth Boulding, eds., 1952). Not every holder of contracts is a firm. The associated complexity is not yet relevant here.

[15] John Stuart Mill, Principles of Political Economy 364 (4th ed., 1857). Mill was commenting on the terms of a share contract.

may yield peace of mind, subsequent economists have frequently employed "custom" as an excuse to avoid analysis.[16] Even a practice that is truly customary may reflect the existence of costs in contracting. Furthermore, the effect of an action which resolves into a custom under one property right arrangement may be taken as a crime under another.

Third, there are actions which produce significant effects and which are transacted in the market place. Examples given have been cases of rising supply,[17] or of interactions among large and perhaps oligopolistic producers. Such actions have been termed "pecuniary external economies or diseconomies,"[18] and do not necessarily entail specifiable economic waste.[19]

Fourth, there are actions which produce significant effects but contractual arrangements are absent—so significant, indeed, that "customs" simply will not bail them out. The classic example is a factory polluting the environment. This type of effect is traditionally termed "technological external economies or diseconomies."[20] Since these effects occur to consumption as well as production activities, in many cases it is difficult to see their "technological" attributes.[21]

Consider finally a fifth type of action, the effects of which may be trivial or significant, and which are governed by contracts. However, for some reasons certain marginal conditions required for the standard constrained maximization are not satisfied. Referring to our earlier exposition of fishery harvesting, such a case would arise if the marginal gain, $\Omega(L)$, from an increment of labor is either greater or smaller than the associated marginal damage, $\Lambda(L)$. The traditional term for this, I think, is "market imperfection."

In the above five paragraphs I have, as perceived in the light of contracting, sketched my impression of the literature relating to externalities. The arbitrariness of the division should be self-evident. What is trivial is at best

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[16] Some asserted "customs" are, in fact, market practices in which the contractual terms are not obvious. See, Steven N. S. Cheung, The Theory of Share Tenancy, ch. 3 & 4 (1969).

[17] See Jacob Viner, Cost Curves and Supply Curves, in Zeitschrift fur Nationalokonomie (1931), reprinted in Readings in Price Theory, supra note 14; Joan Robinson, Rising Supply Price, 8 Economica 1 (1941), reprinted in id.; and Howard S. Ellis & William Fellner, External Economies and Diseconomies, 33 Amer. Econ. Rev. 493 (1943), reprinted in id.

[18] See Jacob Viner, supra note 17; and Tibor Scitovsky, Two Concepts of External Economies, 62 J. Pol. Econ. 143 (1954).

[19] The best exposition on this point appears to be Roland N. McKean, Efficiency in Government Through Systems Analysis 134-150 (1958).

[20] See Jacob Viner, supra note 17; and Tibor Scitovsky, supra note 17.

[21] Francis M. Bator has a somewhat different classification. See his The Anatomy of Market Failure, 72 Q. J. Econ. 351 (1958). Bator's classification would be incomplete if compared with the present count of externalities.

a matter of degree, and the economic significance of the same actions varies under different circumstances. Similarly, "perfection" or "imperfection" is difficult if not impossible to define. And to call some effects of actions "externalities" and some—"internalities" (?)—is to me incomprehensible.

It would be ambiguous enough if "externalities" were confined to effects that are economically significant but with respect to which the rights of actions are not clearly delineated and thus not transacted in the market place. However, such a classification would have the merit of not doing much harm. But—perhaps prompted by the obvious non-existence of "internalities" —the concept of externality has been extended to virtually all economic activities,[22] with endless divisions of types.[23] And the many associated theories serve only to confuse.

The issue at stake is not merely a semantic one. And I do not propose to refine the concept of "externality." I propose to discard the concept entirely. The change in view through the analysis of contracting is not a redundant way of treating the same class of problems, for this change in view leads to different—and I believe more fruitful—questions. Why do market contracts not exist for certain effects of actions? Because of the absence of exclusive rights, or because transaction costs are prohibitive? Why do exclusive rights not exist for certain actions? Because of the legal institutions, or because policing costs are prohibitive? Why do some conceivably more efficient stipulations not exist in the structure of a contract? And what implications for resource allocation and income distribution can we deduce from all this?

III. HARVESTING: THE DISSIPATION OF RENT

As we turn now to analyze the intensity of fishery harvesting—with the fishing ground as a non-exclusive resource—we should keep in mind that we refer to only one of several decision aspects affected by the absence of a contract. The puzzle at stake is, I believe, one of the sources of the stream of "externalities." My main concern in this section, however, is to correct an error in the existing solution. Thus the "externality" issue will be put aside until the next section.

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[22] See, for example, James M. Buchanan & W. Craig Stubblebine, Externality, 29 Economica 371 (n.s. 1962). See also E. J. Mishan, *supra* note 1.

[23] Vernon L. Smith, *supra* note 2, for example, has classified mesh externalities, stock externalities, and crowding externalities for fisheries alone. Classification according to physical attributes can be traced back to J. E. Meade's "creation of atmosphere." See J. E. Meade, External Economies and Diseconomies in a Competitive Situation, 62 Econ. J. 54 (1952). The frequency of new classifications in recent doctoral dissertations is striking. See, for example, Lawrence Schall, Technological Externalities and Resource Allocation, (unpublished doctoral thesis, University of Chicago, 1969).

Ever since F. H. Knight's exposition[24] of A. C. Pigou's example[25] of good and bad roads, which in a tilted mirror image is seen in H. Scott Gordon's analysis[26] of the common fishing ground, models of fishery harvesting have followed the conclusion that, in equilibrium, the *average* product of fishing effort (or labor) equals the wage rate (or the marginal factor cost).[27] Hence economic waste results, since the marginal product of labor in fishing is lower than of that employed elsewhere. The equalization of the average product of labor to the wage rate leads to the dissipation of rent for the fishing ground tautologically.

Obvious as it appears at first sight, two puzzles remain in the dissipation of rent. First, individual decisions are, by definition, made at the margin: how is it possible that the marginal product of fisherman labor be lower than the wage rate (in the social sense) if *no* fisherman (that is, a decision unit) will apply labor to fishing when its marginal product to *any fisherman* is less than the wage rate? Second, just what does a fisherman maximize if exclusive right to the fishing ground is absent? Failure to answer these questions satisfactorily renders the average-product argument, hence the dissipation of rent, an asserted and not a derived result.[28] In what follows I offer an analysis which answers these questions, and the associated solution yields some implications different from those of the existing analysis.

Before proceeding to the formal analysis, an introductory summary will help. Under private ownership of the fishing ground, the right to the rent (income) is exclusive, and a contractual arrangement will make rent a private cost of fishery production. With non-exclusive fishing rights and without collusion among fishermen, rent becomes a residual, with every decision-making unit—a fisherman or a fishing firm—maximizing the portion left behind by others. Behavior is thus consistent with wealth maximization subject to the wage constraint *and* the absence of contractual constraint on other people's use of the fishing ground. With independent maximization, the marginal product of each fisherman is equal to his wage rate. In the absence of both legal and contractual restrictions on the use of the fishing ground, a

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[24] Frank H. Knight, Some Fallacies in the Interpretation of Social Cost, Q. J. Econ. (1924), reprinted in Readings on Price Theory, *supra* note 14.

[25] A. C. Pigou, The Economics of Welfare 194 (1920).

[26] H. Scott Gordon, The Economic Theory of a Common Property Resource: The Fishery, 62 J. Pol. Econ. 124 (1954).

[27] See, for example, Anthony Scott, The Fishery: The Objectives of Sole Ownership, 63 J. Pol. Econ. 116 (1955); Anthony Scott, Optimal Utilization and the Control of Fisheries, in The Economics of Fisheries, *supra* note 7; and James A. Crutchfield, Common Property Resources and Factor Allocation, 22 Can. J. Econ. & Pol. Sci. 292 (1956).

[28] In Gordon's exposition, *supra* note 27, fishing grounds with different fertility are explicit. I find his analysis of the dissipation of rent unclear, particularly if only one homogeneous fishing ground exists.

fisherman will enter the industry so long as the residual (that is, earnings in excess of his alternative wage) for him is positive. With each new entrant, however, the marginal product for all fishermen will fall, and, following the equimarginal rule, each of them will *curtail* their fishing effort (or labor input). The process is thus analogous to Cournot's duopoly solution *with free entry*, with ocean rent replacing monopoly rent, average product of labor in place of demand for product, and a positive wage rate in place of the assumed zero cost of production.[29] Assume that fisherman labor is homogeneous and supply to the industry perfectly elastic, the complete dissipation of rent in equilibrium implies that the *number* of individual fishermen (or firms) approaches infinity, with each committing a trifling amount of fishing effort.

To illustrate geometrically, let us turn to Figure I. In this figure, output per unit of labor is measured along the vertical axis, and labor (or fishing effort) along the horizontal axis. The amount of fishing ground (or fishery resource) is held constant. For simplicity, the linear Q/L and $(\partial Q/\partial L)_a$ are the average and marginal product curves respectively, with W representing the wage rate, or marginal factor cost of labor, $\partial(WL)/\partial L$. If there is only one individual decision unit, say Alpha, to decide the harvesting labor input, the result will be the same as with private property rights governing the use of the fishing ground, with one or many private owners. The owner(s) may employ his (their) own labor, or hire any amount of laborers. In any case, equilibrium is at B, where $(\partial Q/\partial L)_a = \partial(WL)/\partial L$, a condition implied by the maximization of rent subject to the constraints of private property rights. The maximum rent is represented by the area ABCD, with OL_1 of labor employed, or one-half of OL_4—the amount of labor input with which rent will be dissipated.

Under non-exclusive rights to the fishing ground, there exists no contract stipulating the input L_1, and other individuals will freely compete to obtain the rent (now a residual). For a second individual, say Beta, the marginal product of his first unit of labor, with Alpha already supplying OL_1, will be CL_1. Beta's marginal product curve will be $(\partial Q/\partial L)_\beta$, and for constrained maximization he will supply labor from L_1 to L_3, such that $(\partial Q/\partial L)_\beta = \partial(WL)/\partial L$. With Beta's entry, the marginal product of labor for Alpha falls, and he will curtail his fishing effort. The curtailment by Alpha leads to a higher marginal product of labor for Beta, and the latter will accordingly increase his fishing effort. The rule has it that, with two individuals, the equilibrium labor input will be OL_2, or two-thirds of OL_4, with Alpha sup-

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[29] Criticisms of Cournot's duopoly solution, however, are not applicable here because we are concerned with a large number of entrants, and, by the nature of a non-exclusive resource, collusion of any kind among firms does not exist. For two criticisms of Cournot's duopoly solution, see George J. Stigler, The Organization of Industry 36-37 (1968).
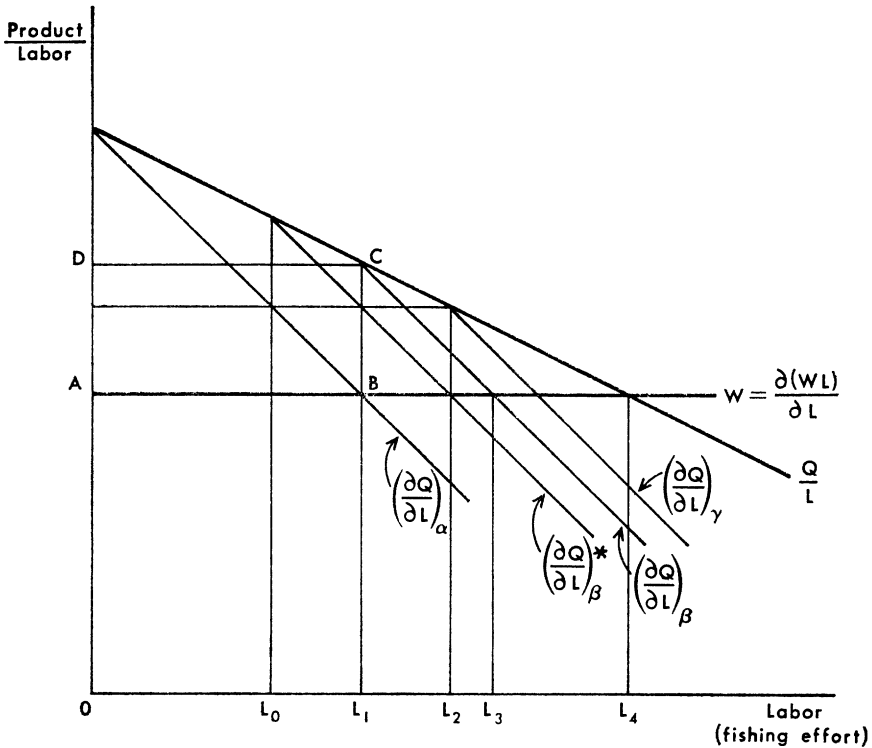
FIGURE I
THE DISSIPATION OF RENT

plying OL_0 and Beta supplying L_0L_2. With the adjustment, Beta's marginal product curve will be $(\partial Q/\partial L)_\beta$. The total rent will be less and will be split equally between the two. However, with labor input OL_2, the marginal product curve for Gamma, a third individual, is $(\partial Q/\partial L)_\gamma$, and he will enter to share in the residual.[30] The process goes on. Equilibrium is reached when the residual is exhausted, which implies that the number of fishermen approaches infinity, with each supplying a trifling amount of fishing effort. The model is instantaneous and timeless.

Algebraically, let the production function be $Q = Q(L,Z)$, where L is labor and Z is a *fixed* amount of fishing ground. For any individual fisherman i, the residual to maximize will be $R_i = q_i - WL_i$, where q_i is the out-

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[30] If the reader finds it difficult to accept that the marginal product curve for a single decision unit is negatively sloping and not horizontal, he may think of a situation where a single unit can hire in fishing labor and be a large firm, or where the fishing ground is small.

put of this fisherman, L_i is his labor input and W is the wage rate. Letting the total amount of *other* fishermen's labor be L*, we write

$$q_i(L_i) = \frac{L_i}{L^* + L_i} Q(L^* + L_i),$$

assuming that each individual decision unit operates identically. From these we obtain $\partial q_i / \partial L_i = W$, and

$$\frac{\partial q_i}{\partial L_i} = \frac{L^* Q(L^* + L_i)}{(L^* + L_i)^2} + \frac{L_i}{L^* + L_i} \frac{\partial Q(L^* + L_i)}{\partial L_i}.$$

Assume that there are N identical individuals, such that the total labor is L_N, then in equilibrium $L_i = L_N/N$, and $L^* = [(N-1)/N]L_N$. Therefore,

$$\frac{\partial q_i}{\partial L_i} = \frac{N-1}{N} \frac{Q(L_N)}{L_N} + \frac{1}{N} \frac{\partial Q(L_N)}{\partial L_N} = W.$$

When the number of fishermen (or fishing firms) approaches infinity, we have

$$\lim_{N \to \infty} \left[\frac{N-1}{N} \frac{Q(L_N)}{L_N} + \frac{1}{N} \frac{\partial Q(L_N)}{\partial L_N} \right] = \frac{Q(L_\infty)}{L_\infty} = W$$

where $L_\infty = \lim_{N \to \infty} L_N$, and where $Q(L_\infty)$ is the total social product of fish.

From the social point of view, the equality of the would-be average product of labor under private exploitation of the fishing ground and the wage rate implies that rent is entirely dissipated, and the corresponding (would-be) marginal product of labor being lower than the wage rate (marginal social opportunity cost) implies economic waste—if all costs associated with defining and policing private property in the fishing ground are ignored. Note that similar results can be obtained for share contracting between boat owner and fisherman,[31] which is of some interest since we are informed that

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[31] Let the production function be $Q = Q(L,H,Z)$ where Z is fixed. Let the shares received by owners of Labor (L_i) and boat (H_i) be

$$q_{L_i} = \frac{L_i W_L Q(L^* + L_i, H^* + H_i)}{(L^* + L_i)W_L + (H^* + H_i)W_H}$$

and

$$q_{H_i} = \frac{H_i W_H Q(L^* + L_i, H^* + H_i)}{(L^* + L_i)W_L + (H^* + H_i)W_H}$$

where W is the respective factor price. Form the Lagrangian for each individual, then the marginal product of his input equals the factor price. When the number of sharing pairs approaches infinity, we obtain $Q = L_\infty W_L + H_\infty W_H$, and rent is dissipated.

share contracts between boat owners and fishermen predominate in marine fisheries.[32]

Strange as the above results may seem to be, the analysis is consistent with maximization by the equimarginal rule, at the same time producing a condition that the social average product is equal to the wage rate. The main feature in which this analysis differs from the traditional average-product argument is in the curtailment of fishing input by one decision unit when the number of competitors increases. The implication is important: if the number of competing fishermen is reduced or restricted, each fisherman will capture part of the ocean rent even though none has an exclusive right to the fishing ground.

But in the real world the observed number of fishermen is finite. To explain this we relax some of the hypothetical specifications which I have implicitly or explicitly employed in the analysis. First, the fishermen are not identical and their supply to the industry is not infinitely elastic. Leaving aside the various meanings of a homogeneous factor, one may point out that not all fishermen are equally productive, and that their alternative earnings are not the same. In other words, their comparative advantages in fishing are not equal. Thus, not all decision units will commit the same trifling amounts of inputs. Second, the cost structure of fishery harvesting has been neglected. The costs of entry will reduce the number of fishermen. And the production function is not necessarily linear homogeneous. There is the possibility of economies of scale, in the minimum boat size, gear size, and distance of travel for operation. And third, institutional arrangements designed to restrict entry, such as fisherman and boat unions and legal regulations, will impose constraints on competition.

So finite they are. Still, the implications of the model remain. The following are worth noting. First, other things being equal, the total outlay per decision unit will be lower with non-exclusive rights over the fishing ground than if it were private property. This may be observed in boat sizes being voluntarily kept small, and the number of days per year engaged in fishing few. Conversely, an effective restriction on entry will result in an increase in outlay per decision unit.

Second, there exist incentives to fishermen to restrict the *number* of decision units who have access to the fishing right. That is, even if each decision unit is free to commit the amount of fishing effort, the "rent" captured by each will be larger the smaller the number of decision units. Could that explain the prevalence of boat and fisherman unions in marine fisheries? An interesting case for further study is the recent issuance of licenses to fishing

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[32] See H. Zoeteweij, Fisherman's Remuneration, in The Economics of Fisheries, *supra* note 7.

boats in British Columbia. Implied by our model is that such a license, if transferable, will yield a market price representing the present value of the ocean rent to be captured.

A third implication is more complex. Consider three alternative arrangements. The first arrangement is a group of individuals forming a tribe, a clan or a union so as to exclude "outsiders" from competing for the use of a non-exclusive resource. In this arrangement each "insider" is free to use the resource as he pleases and derive income therefrom. According to our analysis, the fewer the insiders, the greater will be the "rent" captured by each. On the other hand, the cost of exclusion (for example, bloodshed) for each insider is a rising function of the number of outsiders excluded. In equilibrium, the number of insiders is determined when the gains and costs of excluding outsiders are equal at the margin.

The second arrangement involves not only the exclusion of outsiders, but, as in some cooperatives, there is central regulation of the amounts of work and income for the insiders. The third arrangement is private property rights governing all resources, where the property rights are exclusively delineated and enforced, and where resource use is guided by contracting in the marketplace.

All three arrangements are costly. While it appears that these costs are lowest for the first type and highest for the third, the gains from each arrangement are in a reverse order. Weighing these gains and costs, the choice of property right arrangements becomes predictable. Thus the analysis points to the possibility of a theory of property right formation. Such a theory, however, is not intended here.

IV. THE NATURE OF THE PROBLEM

In this concluding section, I discuss generally the nature of the problem in light of the suggested contractual approach. The economic problem of marine fisheries is not unique, although the physical attributes of the fish and the legal arrangements for that industry yield certain characteristic features.

If an idea must have an origin, then the growth of the concept of "externality" can be traced back to Pigou's analysis of the divergences between social and private net product,[33] although Pigou did not use either the term "externality" or a similar term. At a time when "economic efficiency" began to be understood in terms of the fulfillment of some marginal equalities, it was natural as well as important to think of situations under which certain

[33] A. C. Pigou, The Economics of Welfare Pt. 2, ch. 9 (4th ed., 1932).

marginal equalities may not hold. In imagination Pigou excelled. However, he had weaknesses.

One of Pigou's weaknesses, shown in his discussion of social and private net product, is that he took assertions of fact for granted, accepting claims of deficient contractual arrangements without demanding evidence.[34] The manifestation of this is that, years later, when someone came up with the example of an apple orchard and honey production, it was universally accepted as a clear case of resource misallocation requiring government intervention. No one, however, has ever investigated the actual contractual arrangements between the apple grower and the beekeeper, or even suggested that a contract might exist.[35]

Another weakness in Pigou's analysis is the lack of any thorough attempt to generalize the various kinds of possible "divergence." Pigou seems to say that each kind differs from the others, but with no convincing reason as to why they differ.[36] The ambiguity has since remained a tradition in the "externality" literature, and the nature of the problem remained obscure. Indeed, one wonders what the state of the art would be had Pigou taken advantage of Knight's exposition on "Some Fallacies in the Interpretation of Social Cost."[37] published in 1924, in the subsequent revisions of his book. Commenting on Pigou's example of good and bad roads, where "excessive" use of the good road is said to result in a lower marginal value for the users, Knight wrote:

The [conclusion] does in fact indicate what would happen *if no one owned the superior* [road]. But under private appropriation and self-seeking exploitation of the [roads] the course of events is very different. It is in fact the social function of ownership to prevent this excessive [use of the superior road]. Professor Pigou's logic in regard to the roads is, as logic, quite unexceptionable. Its weakness is one

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[34] This charge is based on my checking of all the references cited in A. C. Pigou, *supra* note 33, at 174, 175, 178, 181 and 182, where deficient lease contracts in agriculture are said to be evident.

[35] However, Harold Demsetz, *supra* note 6, at 15, wrote: "Coase would probably point out, it is possible for beekeepers and apple growers to strike a bargain over how many trees are to be planted." Another alternative, of course, is that the apple growers keep the bees themselves, or purchase the beekeepers' resource ownerships outright. A similar neglect of contractual arrangements is found in the literature of economic development, where technological externalities are frequently said to exist for the training of workers in poor countries. "Undertraining" is alleged on ground that future returns are not capturable by the trainers. However, even casual conversation with teenage apprentices in Southeast Asia reveals the existence of complex training contracts.

[36] Although Pigou frequently referred to "kinds" or "classes" or divergences of social and private products, I have been unable to count them separately, or even to determine where one discussion begins and where it ends.

[37] Frank H. Knight, *supra* note 25.

frequently met with in economic theorizing, namely, that the assumptions diverge in essential respects from the facts of real economic situations. . . . If the roads are assumed to be subject to private appropriation and exploitation, precisely the ideal situation which would be established by the imaginary tax will be brought about through the operation of ordinary economic motives.[38]

The associated analysis is not flawless,[39] but the argument is sound. There was an interval of several years in which Pigou could have revised his analysis on social and private product,[40] by incorporating Knight's "social function of ownership" to his various cases of "divergences." However, Pigou did not do so.

Some thirty years later,[41] R. H. Coase published "The Problem of Social Cost."[42] Although the contribution of this paper is justly well known, the reader may find the following statement of Coase's thesis unfamiliar. Commenting on Pigou, Coase wrote:

Pigou seems to make a distinction between the case in which no contract is possible (the second class) and that in which the contract is unsatisfactory (the first class). . . . But the reason why some activities are not the subject of contracts is exactly the same as the reason why some contracts are commonly unsatisfactory—it would cost too much to put the matter right. Indeed, the two cases are really the same since the contracts are unsatisfactory because they do not cover certain activities.[43]

The *problem* of social cost, therefore, arises either in the absence of exclusive rights (hence the absence of the right to contract), or where the right to contract exists "but where contracts are peculiarly difficult to draw up and an attempt to describe what the parties have agreed to do or not to do . . . would necessitate a lengthy and highly involved document. . . ."[44] It is,

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[38] Frank H. Knight, *supra* note 25, at 163-64.

[39] See *supra*, sect. III. Also, Knight should be more specific on the kind of investment he has in mind when he speaks of "excessive investment in superior situations", *supra* note 25, at 163. A comment on the "imaginary tax" will come later.

[40] After 1924, The Economics of Welfare was revised in 1928 and in 1931. It is, of course, possible that Pigou never knew of Knight's article.

[41] The term "external economies or diseconomies" began, perhaps, with Marshall, and it was used frequently in the 1930's and early 1940's for the derivation of cost and supply curves. The works of both Marshall and Pigou were influential. (See Readings in Price Theory, *supra* note 14, at Pt. 2.) In the 1950's, however, "external" effects became popular in the literature of economic development. In fact, it was the main issue of the debate of balanced versus unbalanced growth and of investment criteria. The general theme is that, in order to achieve rapid economic growth, certain external effects should be maximized. The associated literature is immense. "Externalities" constitute a new trend in the 1960's.

[42] See *supra* note 6. Also important is Coase's earlier work, The Federal Communications Commission, 2 J. Law & Econ. 1 (1959).

[43] R. H. Coase, *supra* note 6, at 38-39.

[44] *Id.* at 16.

therefore, strange that recent discussions of externality are almost invariably associated with Coase's work.[45]

Let us discuss the problem further. The transfer of property rights among individual owners through contracting in the marketplace requires that the rights be exclusive. An exclusive property right grants its owner a *limited* authority to make decision on resource use so as to derive income therefrom. To define this limit requires measurement and enforcement. Any property is multi-dimensional, and exclusivity is frequently a matter of degree. But without some enforced or policed exclusivity to a right of action, the right to contract so as to exchange is absent.

The absence of exclusivity in property may be due to the absence of recognition by legal institutions of that exclusivity, or to the costs of delineating and policing the limit of the right being prohibitively high. The general issue is thus whether contractual arrangements and exclusive rights exist so that gains and costs of actions are weighed in the market; if not, whether alternative legal arrangements or government regulations are economically desirable.

The costs associated with the formation of property and of the subsequent contracts may be viewed in two stages. At one stage, without exchange, there are costs of defining and policing exclusivity. These costs vary, among other things, according to the physical attributes of the resource in question. In our example of marine fisheries, the difficulty of assessing, quantifying, identifying and policing private fishing rights is evident. Even the branding of cattle is costly. At this stage also, these costs also depend on the size of holding: it may cost less per unit of holding if the entire fishing ground is owned by one individual, or a group of individuals through the issuance of stock;[46] it may cost more per unit of holding if all the land in the world is owned by one man. If the individual is left to make the decision, then the degree of exclusivity and the size of holding chosen, among other things, will be such that the marginal cost of enforcing exclusivity equals the associated marginal gain.

At a second stage, there are costs associated with negotiating and enforcing contracts for the exchange or transfer of property rights. At least two reasons may be offered for the difficulty of separating the costs of this second stage from the first. One reason is that the income derivable from an exclusive

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[45] See, for a few examples, James M. Buchanan, Politics, Policy and the Pigovian Margins, 29 Economica 17 (n.s. 1962); J. M. Buchanan & W. Craig Stubblebine, *supra* note 22; Stanislaw Wellisz, On External Diseconomies and the Government Assisted Invisible Hand, 31 Economica 345 (n.s. 1964); E. J. Mishan, *supra* note 1; Charles R. Plott, Externalities and Corrective Taxes, 33 Economica 84 (n.s. 1966).

[46] Note that monopoly in the fishery market is not necessarily implied. There may still exist a large number of fishing firms, potentially or actually, renting the fishing rights.

right, or the *gain* of enforcing it, depends on the existence of transferability in the marketplace, for without transfer the highest-valued option may not be realized. This implies that the lower the costs of contracting for transfer, the higher will be the gain of enforcing exclusivity. A second reason is that the *cost* of enforcing exclusivity also depends on the existence of transfer and its associated costs. The preferred size of resource holding so as to lower policing cost, for example, can be chosen insofar as the market exchange permits. For these reasons it is convenient, although somewhat arbitrary, to lump the costs at the two stages into one broad term, namely, transaction costs. As in the case of joint products, only *marginal* costs are relevant.

In modern societies, private property rights require the recognition and enforcement of law. There are reasons to believe that the existence of government lowers transaction costs. But history has repeatedly demonstrated that market response is much quicker than legal response to changing economic conditions.[47] What was not worthwhile to enforce as private yesterday may be so today: changes in supply and demand conditions, technological innovations and improved methods of organization may lower the transaction costs.[48]

In the case of marine fisheries, it is an empirical question whether the enforcement of private property is economically worthwhile. International conflicts of interest make the problem almost unmanageable. Still, economic theory predicts that since non-migratory marine products cost less to police, private property will be instituted earlier in these than in migratory products. Such has been the case with oyster beds, which in some states in America are recognized and enforced as private by law. Could the lag in government response alone account for the absence of property rights over the oyster beds in the remaining states, and similarly in other non-migratory and aquacultural products?

Finally, let us consider the issue of resource allocation channeled through the market versus government regulations. For any imaginary divergence between private and social costs, there exists an imaginary market contract through which the divergence will be eliminated. As emphasized in Section I, a contract entails a structure of stipulations. It follows that in many cases a single regulation, such as an imaginary tax, will not serve the same function

[47] The Japanese experience is notable. See Yasoburo Takekoshi, The Economic Aspects of the History of the Civilization of Japan (3 vol., 1967). Note, in particular, the duration of various land systems before and after the Taika reforms (chs. 4, 5 and 10), and that decades had passed before Meiji (1868) legally recognized some "grey" market activities existing in Tokugawa agriculture (chs. 81, 82 and 83).

[48] See, as a case in point, Douglass North, Sources of Productivity Change in Ocean Shipping 1600-1850, 76 J. Pol. Econ. 953 (1968).

as a contract.[49] To replace an imaginary contract, an imaginary *set* of regulations is required. Of course, some imaginary contracts—imaginable while ignoring transaction costs and information problems—are farflung and may have no resemblance in the real world.[50] But so are many "ideal" government regulations.

To evaluate economic efficiency by comparing imaginary contracts and regulations is futile, for in so doing any divergence between private and social costs is simply imagined away. Nor is it fruitful to compare the "imaginary" and the "actual," for Demsetz would rightly charge the "grass is greener" fallacy.[51] It is the "actual" compared with the "actual" that is relevant. The question is whether, given the same effects of an action, actual market contracts or realizable government regulations involve lower transaction costs so that a higher net gain or a lower net loss will result. And while facts and measurements are hard to come by, they still require theoretical interpretation.

The effectiveness of the market in weighing the gains and costs of some action is evident. The existence of a great variety of contracts in free markets suggests what an unmanageable situation it would be if all contractual stipulations were replaced by government regulations.[52] Elsewhere I wrote:

For any resource, a number of individuals compete for ownership. Each potential buyer or user possesses some knowledge not only of alternative uses of the resource, but also of different transaction costs associated with different [contractual] arrangements by which the resource may enter into production. Assume away information problems that may exist in competitive trading in the market-

[49] That an imaginary tax may not fully correct an imaginary divergence between private and social costs is seen in Charles R. Plott, *supra* note 45; and Otto A. Davis & Andrew Whinston, Externalities, Welfare, and the Theory of Games, 70 J. Pol. Econ. 241 (1962).

[50] An imaginary contract for the "ideal" pricing of a "public" good—or a good amenable to concurrent consumption—would fall into this category. Needless to say, public goods have given rise to still another type of externality. See, for example, James M. Buchanan, Joint Supply, Externality and Optimality, 33 Economica 404 (1966).

[51] See Harold Demsetz, Information and Efficiency: Another Viewpoint, 12 J. Law & Econ. 1 (1969).

[52] A striking case is the experience of the People's Republic of China. On the one hand, the important role of contracts similar to those developed in the market was recognized; on the other hand, the property right constraints and regulations were at odds with market contracts. The result was the existence of a variety of contracts supervised by the government, involving great complexities and inconsistencies. See the informative Chung Hwa Jen Min Kung Ho Kuo Min Fa Chi Pen Wen Ti (A Textbook of Civil Law of the People's Republic of China, in Chinese, 1958). See also Richard M. Pfeffer, The Institution of Contracts in the Chinese People's Republic, 14, 15 China Q. 153,115 (April-June, 1963; July-September, 1963); Contracts in China Revisited, With a Focus on Agriculture, 1949-63, 28 China Q. 106 (Oct.-Dec., 1966); and Gene T. Hsiao, The Role of Economic Contracts in Communist China, 56 Calif. L. Rev. (1965).

place; the resource will find that owner whose use of the resource yields the highest value. *Competition* for and *transferability* of the ownership right in the market-place thus perform two main functions for contracting. First, competition con-glomerates knowledge from all potential owners—the knowledge of alternative contractual arrangements and uses of the resource; and transferability of property rights ensures that the most valuable knowledge will be utilized. Second, competi-tion among potential contract participants and a resource owner's ability to trans-fer the right to use his resource reduce the cost of enforcing the stipulated terms in a contract. This is because competing parties will stand by to offer or accept similar terms. In sum, competition *in the marketplace* reduces the costs of finding and pursuing the most valuable option in which a resource may be contracted for production. While transaction cost determines, it is also determined.[53]

But the above quotation ignores the possibility that transaction costs may be so high as to result in the absence of exclusive rights and of con-tracting among individuals. Gains and costs of an action are thus not weighed in the market. Is it likely, then, that government action or regulation will actually be more efficient? The question is difficult, and no answer to it will be attempted here.[54]

Let me conclude. In light of the analysis of contracting, this section has discussed the problem of the divergence of private and social costs. External-ity, on the other hand, seems to center on different cases of "divergence" and to ignore the economic problem involved. The concept of "externality" is vague because every economic action has effects; it is confusing because classifications and theories are varied, arbitrary, and *ad hoc*. For these reasons, theories generated by the concept of "externality" are not likely to be useful.

[53] Steven N. S. Cheung, *supra* note 16, at 64.
[54] But see R. H. Coase, *supra* note 6, at 19-28.