The World(s) in the Model(s):
The Coase Theorem in the Long Run

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I. Introduction

There are several indicators that Ronald Coase did not see himself as laying out an important new proposition in economic theory—to say nothing of a 'theorem'—when penning his negotiation analysis and the result that flowed from it in "The Problem of Social Cost" (1960). One of these was a failure (if it can be called that) to state clearly and precisely the details of the assumptions upon which his analysis rested. This charge was leveled against Coase by several commentators during the 1970s as they attempted to grapple with his result and its implications, and it is reflected in the wide variety of models and theoretical frameworks employed by subsequent commentators to discuss, evaluate, or otherwise analyze Coase's result in the decades following its publication. Another telling indicator was Coase's failure to probe the negotiation result in any significant theoretical depth. This task fell to others, just as had the working out of the unstated assumptions of Marshall's *Principles* (1890), which occupied a generation of economists during the first third of the twentieth century. Coase was eager to move on to the analysis of the real world of positive transaction costs, and the basic negotiation result had, in his mind, served its purpose in showing that the Pigovian claims regarding the *necessity* of tax, subsidy, or regulatory remedies to eliminate divergences between private and social costs were not valid and that, in theory at least, private agreements, too, could efficiently resolve externality problems.

Among of the issues that Coase had failed to pursue in any depth were the implications for his result of the passage of time—that is, the question of whether his assertions regarding the efficiency and invariance of negotiated outcomes would hold up in the long run. Coase (1960, p. 8) had *claimed* that "the long-run equilibrium position … is the same" regardless of how liability is assigned, but he had made no analysis of long-run dynamics to demonstrate this—perhaps because, as we shall argue later, his model (if it can be considered such) presented him with no particular need to do so. As it happened, however, this perceived lacuna in Coase's treatment of the negotiated settlements process turned out to be of no small amount of import for the trajectory of Coase theorem discussion and debate.

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Most of what little early criticism there was of Coase's result focused on long-run issues, and there was a veritable explosion of such analysis in the 1970s. The starting point for the debate was Stanislaw Wellisz's (1964, p. 353) suggestion that the property rights + negotiation approach to externalities opened the door to the possibility of extortion by agents threatening to create harm-causing activities or businesses in order to secure bribes. This was followed shortly by claims, made by David Bramhall and Edwin Mills (1966) and Allen Kneese and Blair Bower (1968, p. 87) in the economics literature, and by Guido Calabresi (1965, p. 730n.28) in the legal literature, that alternative assignments of rights give rise to differential relative profit levels and thus would trigger market entry in the long run, resulting in price and output levels that vary with alternative assignments of rights/liability as well as inefficiencies in the allocation of resources.[1]

Both the extortion and entry charges laid down against the theorem spawned extensive literatures during the 1970s, and the debates they engendered reflected a change in the nature of Coase theorem discussion as compared with what we observed during the 1960s. This earlier period witnessed relatively little in the way of controversy over the validity of Coase's result.[2] It was generally accepted as correct in theory, and the questions went instead to the extent to which the result's insights were applicable in reality, whether to the situations of externality that concerned economists or to legal issues in realms such as accident law and products liability.[3]

The 1970s, though, brought a significant backlash against the Coase theorem. Some of this took the form of waiving the theorem aside as hopelessly unrealistic because of the prevalence of transaction costs—a more full-throated version of the qualms about the extent of the theorem's applicability that we find in the literature of the 1960s. At least as prominent, though, were the numerous attempts to show that the theorem was invalid, or logically incorrect, by taking Coase's assumptions (as these critics understood them, at least) as given and probing more deeply, and rigorously, the implications that followed from them. The result was a slew of articles claiming to prove that the Coase theorem does not hold water, that the equilibrium resulting from the

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[1] Kneese and Bower (1968, p. 87n.17) note that their attention was drawn to this issue by the discussion in J. Hayden Boyd's (1967) doctoral dissertation, about which more below.

[2] The only other objection raised during this time went to the impact of income effects on the invariance claim in externality situations to which consumers are party. This critique led a number of later commentators to add an "income effects aside" qualification to statements of the theorem.

[3] See Medema (2013b20142013d) for a discussion of the treatments of Coase's result in economics and in law during this period.

negotiation process is inefficient or, at least, varies depending upon to which party rights/liability are initially assigned. These challenges did not go unanswered, however, as defenders of the theorem mounted their own counter-arguments in the theorem's defense.

This evolution in the nature of the discussion of the Coase theorem reflects a transition from the contemplation of and focus on what Mary Morgan has referred to as "the model in the world" to that of "the world in the model"—from the study of the world that the model represents to the study of the world of the model itself.[4] The 1970s was very much the heyday of the latter in the Coase theorem literature, as the credence being given to, and even relevance ascribed to, the theorem in certain quarters led some economists to delve more deeply into the question of its theoretical validity. This move to a focus on the world in the model was facilitated, and to some extent driven, by the looseness and vagueness of Coase's own analysis, the simple intuitive analytics of which stand in stark contrast to the tight, rigorous modeling processes that had come to dominate economic analysis.

There are any number of episodes from the 1970s that could be used to illustrate the turn to the world in the model within the Coase theorem literature,[5] but the focus here will be on the controversy over the effects of entry on the theorem's long-run validity. This debate represents an important moment in Coase theorem history for reasons that go well beyond the basic question of the theorem's correctness. First, this debate was tightly linked to the defense of the Pigovian tradition, as the models employed could easily be used to contrast the negotiated solutions of the Coase theorem variety with the results reached via a Pigovian tax. Second, the entry debate nicely illustrates how the Coase theorem discussion moved from the simple, intuitive analytics utilized by Coase to one couched in highly sophisticated (for the day) mathematical formalism. Third, the debate shows how the larger tendency in this formalistic turn to loose economic analysis from the institutional context—here, the law—and economists' ignorance of relevant institutional features influenced the conclusions reached. Finally, and perhaps most importantly in a historical sense, this case study reveals how the context within which the Coase theorem was embedded and,

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[4] On this distinction as a historical and methodological lens for looking at the practice of economics, see Morgan (2012).
[5] This include, for example, the discussion of non-convexities in production sets, separable versus non-separable cost functions, and game-theoretic formulations. Medema and Zerbe (2000) provide an overview of these issues.

indeed, the nature of the theorem itself, was transformed through the focus on the world in the model.

II. The Several Faces of the Entry Problem

Origins

The origins of the economics side of the entry-based critique of the Coase theorem are to be found not in the Coase theorem *per se*, but in the discussion of Pigovian remedies and, specifically, the question of whether Pigovian subsidies and Pigovian taxes—or 'bribes and charges,' was they were often referred to in the literature—had allocatively equivalent effects. The Coase theorem was brought into this stream of analysis relatively early on, owing to its perceived congruence with the bribes and charges issue—damage payments made by, e.g., polluters functioning as the equivalent of Pigovian taxes and bribes offered by victims to polluters to induce abatement playing the part of Pigovian subsidies. The earliest analyses of the potential allocative equivalence of bribes and charges—by Allen Kneese (1964) and by Morton Kamien, Nancy Schwartz, and F.T. Dolbear (1966)—suggested that these remedies did indeed generate identical allocative results in theory, with the only asymmetry in the outcomes occurring in the final distribution of incomes/wealth. The choice between remedies, then, would come down to non-efficiency considerations, such as equity (Kneese 1964, p. 83).[6]

This result was challenged by David Bramhall and Edwin Mills (1966), who argued that these authors had erred in restricting their analysis to short-run effects. While the differences in the distribution of profits under bribes and charges have no allocative implications in the short run, the same, they argued, does not hold in the *long run*:

> The point that is important for long run analysis is that the resulting [short-run] profit levels do differ by a constant. Under the payments scheme [bribes], profits will be larger than they would have been in the absence of intervention, and under the fee [charges] scheme profits will be smaller than in the absence of intervention. On the usual

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[6] As Kneese put it, "the result will be the same whether the cost is an actual outlay or the foregone opportunity to receive a payment" (1964, p. 98). Kamien, Schwartz, and Dolbear also argued that information problems plaguing the governmental agency overseeing the Pigovian tax/subsidy system would lead to asymmetric outcomes in reality, but that is not our concern here.

assumptions about entry and exit, entry will take place in the former case and exit in the latter case. Entry will lower the price of this product relative to prices of other products, and exit will raise it. Thus, relative prices will, in the long run, be different under the payments scheme than under the charge scheme. (1966, pp. 615-16)

As such, concluded Bramhall and Mills, "the choice between the two schemes is partly a matter of efficiency and not, as Kneese concludes, entirely a a matter of equity" (1966, p. 616).

Given that the wording employed by Bramhall and Mills lends itself most directly to Pigovian tax and subsidy instruments, it may be useful to clarify the relevance of their conclusions to the Coase theorem. If the firms in a polluting industry[7] are made liable for damages, they will see their profits decrease owing to the mandated compensation payments—the charges. The result, in the long run, is exit from the industry, higher prices, and lower equilibrium output levels than in the original (efficient) negotiated equilibrium. If victims are liable for pollution damage, in contrast (and assuming there are gains from pollution reduction),[8] they will offer bribes to the firms in the polluting industry, which will then see their profits increase. This higher level of profit will trigger entry into that industry in the long run and thus lead to greater output of and lower prices for this industry's product (as well as more pollution) than we observed in the initial negotiated equilibrium situation. The fact that we observe different long-run equilibrium patterns of prices and output when polluters are liable than when the firms in the victim industry are liable negates Coase's invariance proposition. And because the long-run equilibrium output levels differ from those at the original, efficient equilibrium, these long-run movements must result in inefficient levels of output. Or so the story went.

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[7] Because virtually all of the literature dealt with in the present paper speaks of pollution externalities, we will do likewise here, for the most part, speaking of 'polluters' and 'victims' rather than using more cumbersome terminology such as 'externality emitters' and 'externality receptors.' That is, the terminology employed here should not be construed as having any pejorative implications, and, in particular, should not be taken to deny or ignore the reciprocal nature of externalities—though there is no shortage of such within the literature critical of the Coase theorem.

[8] It should be noted that all of the literature dealt with in this paper speaks in terms of inefficient, or what Buchanan and Stubblebine (1962) called "Pareto-relevant," externalities and thus of situations where Pigovian instruments or Coase-theorem-type mechanisms have the potential to be efficiency-enhancing.

Bramhall and Mills, though, were not the first to raise the issue of entry-driven inefficiencies and asymmetries. This point had originally been brought up, somewhat tentatively,[9] in the legal literature by Guido Calabresi of Yale Law School some eighteen months earlier. Calabresi suggested that Coase's assumption of perfect competition in his now well-known illustration of the farmer and cattle rancher opened the door to entry: "The short of the matter is, liability rules do affect the amount of money people make—in the short run; in the long run people will enter those activities where they make more money" (1965, p. 730n.28).[10] And, following the logic laid out above, Calabresi argued that this spoke against the efficiency and invariance claims of Coase's negotiation result.

It was not long, however, before these critiques were met with rebuttals. Calabresi himself had a change of heart on the matter in 1968, recanting his earlier charge in a brief article published in the *Journal of Law and Economics*. His revised view of the situation was that the same negotiation processes that cured the short-run inefficiencies would also take place to resolve any potential inefficiencies that might arise in the long run and that the outcome would be identical under alternative rights/liability structures (1968, pp. 67-68). His argument, in essence, was that the Coase theorem showed that Coase theorem is also valid in the long run!

Warren Nutter, Coase's former colleague at the University of Virginia, offered a rather different defense of the theorem's long-run validity later in 1968, also published in the *Journal of Law and Economics*. Referencing Coase's farmer-rancher illustration, Nutter employed a simple numerical example to show that a single owner of the two operations in question would efficiently coordinate the production of crops and meat in light of the nuisance caused by the roaming cattle. Nutter noted that this result depended on the prior existence of rents to each of the activities in question, and in an amount sufficient to support the nuisance-related costs. But, he

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[9] "It is not clear to me, however, despite the examples in the article by Professor Coase, … that no difference will exist in the really long run" (Calabresi 1965, p. 730n.28). Calabresi had studied economics as an undergraduate at Yale and as a graduate student at Oxford. Medema (2013c) contains a more extensive discussion of Calabresi's engagements with Coase's negotiation result over the course of his career.
[10] It should be pointed out that Bramhall and Mills were unaware of Calabresi's argument.

noted, this combination of activities would not exist in the first place in a competitive system absent such rents (1968, p. 507).[11]

While his illustration assumed a single owner of the activities in question, Nutter's position was that this simplification was unimportant apart from its utility in illustrating the long-run efficiency of the outcome:

> It is clear that the same reasoning applies to separate enterprises growing wheat and meat on these adjoining plots. If the sum of managerial and transaction costs are lower for two enterprises than managerial costs are alone for a joint enterprise, the former will prevail over the latter under competitive conditions. The legal rule defining which firm is to be responsible for the (joint) nuisance will affect nothing but the distribution of economic rent between the two plots of land. (1968, p. 507)

And so, between Calabresi's negotiation defense and Nutter's merger defense, it would seem that the Coase theorem had survived this challenge to its long-run validity unscathed.[12] Of course, to the extent that Nutter was arguing that the Coase theorem allowed for the possibility of mergers—and it is not obvious that this is exactly what Nutter was on about, subsequent commentaries on his discussion notwithstanding—his argument also represented an evolution in the content of the Coase theorem, since Coase had not raised this possibility in his own negotiation analysis and Stigler had not mentioned the possibility in his elaboration of a 'Coase theorem.'[13]

The Problem Revisited

Neither of these rebuttals to the alleged entry problem put an end to the matter, however, as the whole issue was revisited at great length during the 1970s—on some occasions by scholars seemingly unaware of the previous literature on the topic and at other times by authors hoping to

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[11] "Put another way, the nuisance will come into existence only if output rises by at least enough to compensate for it. In order for this to be the case, each of the activities in the combination must impart an economic rent to some resource employed by the combination of activities" (1968, p. 507).

[12] What makes the Calabresi and Nutter rebuttals to the entry critique all the more interesting is that they were published in the *Journal of Law and Economics*, which was by this time being edited by Coase himself. While Coase remained silent about his negotiation result for some twenty years and even then emphasized that it was pointless to devote attention to the world of zero transaction costs, it is clear that he was something more than a disinterested observer when it came to questions related to the legitimacy of his result.

[13] Coase, of course, had discussed the possibility of a single firm efficiently coordinating externality-relevant activities, but this was separate from his negotiation result and not tied to the merger issue. In fact, firm organization was, for Coase, a response to the existence of transaction costs associated with the bargaining processes present in the negotiation context. See Coase (1960, p. 16). See also Stigler (1966, p. 113).

settle the debate once and for all, often (particularly in the case of the critics) via appeals to one or another type of mathematical formalism.[14] Though it may be tempting to dismiss this literature as simply an instance of economists playing theoretical modeling games with no bearing on reality, there was far more to it than this. Stuart Mestelman (1972, p. 476), one of the players in the entry debate, asserted in 1972 that Coase's invariance result was "quite important considering our current concern about environmental pollution," and this sense is reflected, for example, in the treatment of the Coase theorem within the emerging environmental economics literature of the period. There was a perception that something was at stake here, going both to the realm of policy-related options for dealing with environmental issues and to the question of the relative impacts of holding one party or another (e.g., polluters or their victims, as it was often put) liable for externality-related harms.[15] Rather than providing an exhaustive survey of the 1970s entry literature, we shall content ourselves largely with a discussion of two representative critiques and the responses to them.

The first article to weigh in on the entry topic during the 1970s, by Herbert Mohring and J. Hayden Boyd,[16] appeared in *Economica* in 1971 and was derived from Boyd's 1967 PhD thesis at the University of Minnesota.[17] Mohring and Boyd argued that those disposed toward the Coase theorem had neglected a crucial feature associated with legal rights granted by the courts in externality situations—that they are not lump-sum grants, but instead make the rewards associated with the rights contingent on the performance of particular activities. Consider Coase's invocation of *Sturges v. Bridgman*,[18] a case also taken up by Mohring and Boyd. A physician filed suit against a neighboring confectioner, the noise and vibration from whose equipment interfered

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[14] The present discussion will largely eschew direct reference to the mathematical formalisms involved in these debates, as doing so would add unnecessary length to the discussion. The reader is encouraged to consult the articles touched on here to examine the relevant mathematical models.

[15] See Medema (2013a).

[16] University of Minnesota/York University and Ohio State University/Institute for Defense Analysis, respectively.

[17] Correspondence with the author, August 5, 2013. Mohring was Boyd's thesis advisor. While Mohring and Boyd's discussion of the Coase theorem is largely intuitive, Boyd's (1967) thesis includes a mathematical analysis. The entry critique intuition, though, is better developed in the Mohring and Boyd article. The research behind the article was supported by Resources for the Future, a reflection of the potential relevance that it saw in the Coase theorem for dealing with environmental issues. The fact that Mohring and Boyd explicitly pointed to the "close formal similarity" between Coase's example of cattle and crops and the problem of air pollution speaks to this link (1971, p. 358n.1). The connection to Resources for the Future may also explain how Kneese and Bower came to be aware of Boyd's dissertation work, given that Kneese and Bower were affiliated with this organization at that time. See note 1, above.

[18] See *Sturges v. Bridgman*, 11 Ch. D. 852 (1879).

with the physician's ability to practice medicine, and the court ruled in his favor. Coase argued that, in a world of zero transaction costs, the court's decision would have no impact on the final result—that regardless of who prevailed at law, the allocation of resources that maximized the value of output would obtain, whether achieved via one party paying the other to move locations, the installation by one party or the other of noise abatement devices, or the payment of compensation for damage caused. What was key for Mohring and Boyd here, however, were the implications of the legal situation for the physician and others like him—that the physician must be practicing medicine adjacent to the confectioner (or some other suitably noisy neighbor) in order to receive the benefits conferred by his right to practice with suitable quiet (1971, pp. 258-59); he would not be entitled to compensation from the confectioner were he located, say, six blocks away, or if he were not practicing medicine at all. The analysis of externality situations dealt with via grants of such rights, they claimed, must take into account the incentives engendered by those rights and the attendant rewards—something that they felt Coase theorem supporters had failed to do.

The problem posed for the Coase theorem, said Mohring and Boyd, comes in when one recognizes that these rights "increase in the income stream accruing to an activity," the effect of which will generally be to increase the amount of that activity undertaken. Thus, if physicians are given the right to demand an amount of quiet appropriate to their practice, the number of locations at which they can profitably practice will increase and, as a result, the supply of physician services will be greater than in the absence of such a right or than it would be if physicians were forced to purchase that right.[19] In short, entry will result, with the predictable effects. This increase in supply would only fail to materialize, said Mohring and Boyd, if the supply of physician services was "completely inelastic" (p. 359). But if, as we would realistically expect, the supply of physician services is somewhat elastic, then a physician's right to quiet "would lead to an increase in the quantity of physicians' services supplied along with the number of sites they occupy" as physicians attempted "to capture the fruits of the bounty" (pp. 359-60).[20]

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[19] That is, absent the court-granted right to practice in quiet surroundings, physicians still have the ability to secure quiet through purchase—e.g., by paying a noisy neighbor to undertake noise abatement or to relocate.
[20] Mohring and Boyd attributed the failure to account for the impact of entry on the property rights + negotiation outcome to the "use by Coase and others of two-party models," arguing that this simple modeling approach "obscures" the entry question by effectively assuming that the supply of output by polluters is "completely

The entry issue, for Mohring and Boyd, was an inevitable byproduct of bestowing on firms involved in certain types of activities a property right that has "no opportunity cost" (p. 360). This right is treated as a free good and does not enter into marginal cost. As a consequence, the marginal equivalences for profit maximization will cause agents to expand their activities in the long run to an inefficiently high level, and the result will be too much, e.g., pollution when polluters have rights and too little pollution when victims have rights, relative to what is optimal—whether the increased output levels comes via entry of new firms or the expansion of output by existing firms. The Coase theorem, they concluded, thus fails on both the efficiency and invariance fronts, whereas an appropriately structured Pigovian tax scheme, in contrast, had no such incentive effects and so would lead to an efficient allocation of resources.[21]

This descent into "the world in the model" took a significant formalistic, mathematical turn with the publication of Richard Tybout's[22] "Pricing Pollution and Other Negative Externalities" in 1972 and William Schulze and Ralph d'Arge's,[23] "The Coase Proposition, Information Contstrains, and Long-Run Equilibrium" in 1974. Tybout's article was the first to model the Coase theorem in a general equilibrium framework and, though he seems not to have been acquainted with the Mohring and Boyd paper, his own article employed a similar line of attack with a view to reinforcing, by means of a formal demonstration of what had previously been asserted intuitively, and even extending the conclusions reached by the earlier critics.[24]

The model that Tybout employed assumed two industries, the firms in which have linear homogeneous production functions. The production of good *A* generates pollution that reduces the profitability of firms in industry *B*. We will forego the derivations here in the interests of space, contenting ourselves with final results. If *polluters* are liable for damages, Tybout found, the marginal conditions for profit maximization inform us that an equilibrium price for pollution

inelastic" (1971, p. 360). This was just one piece of a larger reaction against the use of two party models where environmental externalities were concerned. See Medema (2013c).

[21] Marchand and Russell (1973, p. 617), in passing, leveled the same entry-based argument against the theorem two years later. Their focus, though, was not on long-run entry issues but instead on the nature of the cost functions of the firms party to the externality, and their conclusion was that the theorem holds only if cost functions are separable. See Marchand and Russell (1973) and the discussion in Medema and Zerbe {%Medema 2000}.

[22] Professor of Economics, Ohio State University.

[23] Assistant professor of economics, University of New Mexico, and professor of economics, University of California, Riverside, respectively.

[24] Tybout's discussion of the long-run entry issue was just one part of a broader critique of the Coase theorem, but his other lines of criticism will not concern us here.

will emerge that is equal to both the marginal benefit to the polluter from an additional unit of pollution and the marginal damage to the victim from an additional unit of pollution. Specifically,

$$P_P = P_A \frac{\partial X_A}{\partial X_P}\bigg|_{X_P=S} = -P_B \frac{\partial X_B}{\partial X_P}\bigg|_{X_P=S} = K,$$

where $P_P = K$ is the price of a unit of pollution, X_A, X_B, and X_P are the outputs of good A, good B, and pollution, respectively; and P_A and P_B are the prices of goods A and B.[25] Given linear homogeneous production and complete exhaustion of product, equilibrium profits in the two industries are defined by the following expressions:

$$\pi_A = P_A X_A - KS - wL_A - rC_A = 0$$
$$\pi_B = P_B X_B + KS - wL_B - rC_B = 0,$$

where w and r are input prices, L and C are labor and capital inputs, and S is the equilibrium level of pollution.[26] The equilibrium level of pollution, S, is determined by the balancing of A's marginal profits from pollution and B's marginal losses from pollution at its market price, K, and KS represents the compensation paid by the firms in industry A and received by the firms in industry B.

When victims are liable for damages—what Tybout called a "bribery" system—the marginal conditions that emerge are identical (though of opposite sign, as one would expect) to those in the polluter liability case,[27] meaning that the equilibrium output levels, including pollution (S), are unaffected. But the equilibrium expressions for profits *are* altered, since firms in industry B now pay those in industry A for each unit of pollution abated—or for, as Tybout called it, "withholding." The equilibrium conditions here, per Tybout's model, are given by:

$$\pi_A = P_A X_A + K(Z - S) - wL_A - rC_A = KZ$$
$$\pi_B = P_B X_B - K(Z - S) - wL_B - rC_B = -KZ,$$

[25] See equations (10) and (11) on p. 255 of Tybout's article.
[26] See equations (1a) and (3a) on p. 258 of Tybout's article.
[27] See equation (16) on p. 259 of Tybout's article.

where Z is the pre-abatement level of pollution.[28] Thus, profits in the two industries are different under polluter liability than under victim liability. As Tybout noted, the equivalence of the marginal conditions in these two cases informs us that the Coase theorem's invariance claim holds in the short run; the only asymmetry is the lump-sum difference in profits (the transfer, KZ) that exist between the two sets of equilibrium profit conditions. The question, he said, is whether the profit differential is, in fact, purely distributional in its effects, as the Coase theorem's supporters had claimed.

Referencing Bramhall and Mills' statement of what he called "the total-profits anomaly,"[29] Tybout set out to probe the implications of his results for long-run equilibrium in the compensation and bribery cases.[30] What he found was that, while dynamic competitive adjustment processes would generate an stable equilibrium outcome under polluter liability (akin to that associated with a Pigovian tax), as the Coase theorem predicts, things get more murky the bribery case, where victims are liable for pollution damage. The ambiguity of the latter situation was an artifact of Tybout's move to embed the Coase theorem within a more sophisticated model environment, beyond the simple entry and exit stories of elementary competitive analysis. While Bramhall and Mills and Mohring and Boyd had posited a smoothly functioning entry process that results in divergent long-run equilibrium outcomes, Tybout found nothing so simple and obvious. His characterization of the long-run results under bribery is illustrative of how the formalistic turn impacted the analysis:

Consider the situation with bribery. Industry A may expand, but it is not clear what will

be produced. With Z held constant, $\frac{\partial X_A}{\partial X_W} < 0$ is a property of all expansion curves for

industry A. See Figure 2(a) [reprinted below], which is consistent with $\frac{\partial X_A}{\partial X_P} > 0$ and

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[28] See equations (1b) and (3b) on p. 259 of Tybout's article.

[29] See p. **X**, above.

[30] Tybout actually misinterprets the directions of payment flows in the Bramhall and Mills statement regarding entry effects, but it does not alter the essential character of his analysis. See Tybout (1972, p. 259) and the relevant passage from Bramhall and Mills, quoted and explained above.

equation (14). One solution is to drop equation (14) and assume that witholding is sold from some level of $X_P > Z$. Whether this is a possible result depends on *B*'s willingness to believe that *A* would, in fact, produce pollution at a level greater than *Z*. Point *Z* represents *A*'s noninternalization optimum. Expansion in industry *A* might take place by balancing losses from *A* and *W* at the margin until the total profits in industry *A* are zero, but economic theory gives us no guidance as to whether or by what expansion path this will be done. In Figure 2(a), marginal profits are zero at point *U*, though total profits are *KZ*. See equations (15) and (lb). (1972, p. 261)

FIGURE 2

PRODUCTION–EXPANSION
CURVES

(a) INDUSTRY A

(b) INDUSTRY B
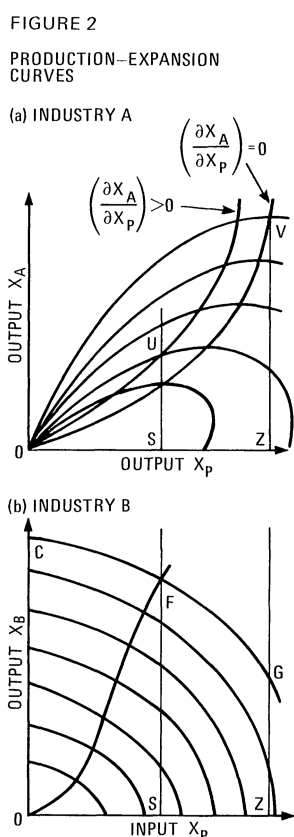
Source: Tybout (1972, p. 259)[31]

The ambiguity here, said Tybout, is the result of the conflicting implications of marginal and total profits in the bribery case. As he pointed out, Coase had emphasized marginal profits, while Bramhall and Mills had emphasized total profits. "Total profits," he said, "cannot help influencing the adjustments, but when there is a conflict between total and marginal profits, the

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[31] The increase in sophistication over Turvey's (1963) original diagrammatic exposition of the Coase theorem and even that of Dolbear (1967) is significant.

outcome is a behavioral question." Because of this, he argued, "Stability is not assured, even if we assume that B has infinite resources with which to pay bribes" (1972, p. 261). Thus, Tybout concluded, while it is "possible" that a stable total profits equilibrium will emerge in the long run, the requirements necessary for this to obtain make it "implausible" (p. 262).[32] The fact that it there *are* conditions under which long-run outcomes that vary with the assignment of liability, though, was sufficient to negate the Coase theorem's validity.

Even more pessimistic conclusions were reached by William Schulze and Ralph d'Arge in their 1974 article published in the *American Economic Review*.[33] They, too, found that that the short-run equilibrium profit differentials give rise to asymmetric long-run effects, including the absence of a stable equilibrium solution exists when victims are liable.[34] In light of this, Schulze and d'Arge concluded that "The Coase proposition … reduces to an intuitive result" rather than an idea that can be supported within a sophisticated modeling framework. While they allowed that it may be reasonable to adopt a property rights + negotiation approach to settle "two-party disputes between private individuals over nuisances such as motorcycle noise by the allocation of rights," they were convinced that a Pigovian tax scheme offered the only hope for an efficient resolution of an inter-industry externality in a competitive situation where entry is possible (1974, p. 769).[35]

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[32] Thus, where Coase had assumed only zero transaction costs and clear definitions of property rights, the requirements derived by Tybout included: "agreement between *A* and *B* on the value of *Z* from which withholding is to take place; demand and supply curves for withholding that have the right relative bow to permit a tangency solution …?; and some part of *B*'s bribery contraction curve with positive total profits, and these profits high enough to pay the bribe. This last condition depends on the relative sizes of industries *A* and *B*. Size affects the relative prices for conventional commodities *A* and *B* and also the internalization price P_w. Finally, there is the conflict of marginal and total profit conditions in *A*. *B* may find it possible, through contraction and increases in marginal profits in other lines, to pay the bribe. But *A* will be receiving a lump sum transfer beyond returns at zero marginal profits, which can only be offset by expanding to negative marginal profits levels elsewhere as long as the bribe is received and total profits are above normal" (1972, pp. 262-63).

[33] Assistant professor of economics, University of New Mexico, and professor of economics, University of California, Riverside, respectively.

[34] Schulze and d'Arge utilized a partial equilibrium model—though, as they pointed out, they also considered, but did not employ in the paper, a two-sector general equilibrium model which generated "essentially identical results" (1974, p. 764n.5).

[35] It should be pointed out that Schulze and d'Arge actually found that a negotiated solution *could* produce an efficient allocation in the long run in theory if the negotiation process was supplemented with an appropriate Pigovian tax scheme. Specifically, their analysis showed that the profits that exist in the negotiated (and socially optimal) short-run equilibrium will be "precisely equal to" the revenue that would result from an optimally specified Pigovian tax and, if taxed away, would remove the incentive for entry. However, they dismissed this option due to the associated "information and enforcement costs" (1974, p. 768). Curiously, they exhibited no such qualms about a traditional Pigovian tax.

The Best of All Possible Worlds?

The critics of the long-run validity of the Coase theorem had adopted a variety of means for illustrating the inefficiencies and asymmetries that would result—intuitive and mathematical, general equilibrium and partial equilibrium—but the conclusions reached were uniform and, seemingly, devastating to the theorem. While the short-run market outcomes reinforced Coase's conclusion, the consideration of long-run effects appeared to leave little room for concluding other than that the Coase theorem did not hold water. Perhaps equally important, it was likely that a system of victim liability would result in long-run levels of the externality-generating activity— and thus of the externality—that were greater, and perhaps substantially so, than those dictated by efficiency. Further compounding the problems for the theorem was the fact that, in each instance, the critics showed that a Pigovian tax *would* generate an efficient allocation.

There can be no question that the challenge which the Coase theorem had posed to the entrenched Pigovian view of externalities gave it a "too good to be true" quality. At the same time, however, its "all is for the best in the best of all possible worlds" character made the theorem easy to buy into for those disposed to believe in the efficiency of markets and market-like outcomes. It would seem, then, that the analysis of a zero transaction costs world and a perfectly competitive system would be tailor-made for showing the validity of the theorem, rather than a potential source of its demise. So why did the theorem seem to break down?

Schulze and d'Arge provided what they believed was the key insight for understanding this seeming incongruity, locating the source of the entry problem in the information environment within which Coase's result was embedded. The issue, they said, was a potential conflict between Coase's simultaneous assumptions of zero transaction costs and firms operating in perfectly competitive markets. The former, they asserted, includes full information within the negotiation process. Now this was certainly a legitimate reading of the zero transaction costs assumption[36] and one that is prominently reflected in the writings of, for example, Harold Demsetz and George Stigler during the 1960s and 1970s. But readings this broad were by no means universal in the

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[36] Coase's (1960, p. 15) description of the costs of transaction in his 1960 article consisted largely of activities related to the acquisition of information.

Coase theorem literature at this time—and in fact, still are not to this day.[37] The inconsistency, argued Schulze and d'Arge, comes in when one realizes that the "commonly accepted" assumptions attending perfect competition include *imperfect* information regarding future profits; that is, the competitive model posits *positive* transaction costs (1974, p. 763).

The information costs associated with perfect competition, which Schulze and d'Arge accused both Coase and the 1968 Calabresi of ignoring, are, they said, at the heart of the entry-based critique. *Expectations* regarding profitability determine entry-related behavior, and entry occurs in response to positive profits because expected future profits are assumed by firms to be identical to current profit levels. Were firms aware that the entry process will instantaneously drive profits to zero—that is, were we actually dealing with a *world* of zero transaction costs—there would be no entry and the long-run equilibrium would be equivalent to the (efficient) short run one. Schulze and d'Arge decided to resolve the tension between these disparate transaction-cost-related assumptions by working with the assumptions of each of the relevant literatures, assuming zero transaction costs in the externality negotiation process but positive transaction costs around the competitive behavior of firms. They did so explicitly, but the other critics did the same implicitly—and the results followed logically. The Coase theorem, it appeared, could not support the twin assumptions of zero transaction costs and perfect competition. But given the grip that the theorem by this time had on the minds of many in the profession, it should come as no surprise to find that these pessimistic conclusions did not go unchallenged.

III. Responses to the Entry Critique

The several entry-based challenges to the validity of the Coase theorem were met with a slew of responses in the months and years that followed—responses that, in various ways, attempted to defend the theorem from the charges that had been leveled against it. The defenses, like the critiques, ranged from mathematical to intuitive and from general equilibrium to partial equilibrium. In the process, they illustrated the vagueness of the Coase theorem world and the trickiness of navigating life within it.

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[37] Carl Dahlman (1979, p. 148) was the first to emphasize the idea that transaction costs ultimately come down to "resources losses incurred due to imperfect information."

Reactions to the 1960s

The earliest post-Calabresi and Nutter defenses of the Coase theorem against the entry critique were targeted at the arguments laid down by Bramhall and Mills and the earlier Calabresi, as well as at shoring up the original defenses offered by Calabresi and Nutter in 1968. They were also published almost simultaneously with the critiques put forward in the early 1970s and apparently in ignorance of them, as these defenses did not tend to specifically take up the more recent attacks.

The first salvo in this second round of theorem defenses was offered by Stuart Mestelman, then an assistant professor at McMaster University (Canada), in an article published in the *International Economic Review* in 1972. We have already noted that Mestelman considered the theorem of no small import for pollution analysis, and its importance, he said, was reflected in the fact that, in the decade since Coase's article was published, "the 'Coase Theorem' has been mathematized, demathematized, supported and debated" (1972, p. 476). But Mestelman was not satisfied with the character of the debate to that point, including the defenses laid out by Calabresi and Nutter, because these results had been derived within a *partial equilibrium* framework. He thus took as his task the examination of the competing claims regarding the theorem's long-run validity within "a more rigorous, general equilibrium context" (p. 476).[38]

Mestelman utilized a two-good, three input general-equilibrium model, focusing on the effects of Pigovian taxes and subsidies and generalizing from those results to the Coase theorem context. His analysis showed that while efficiency and invariance are assured if the firms behave as maximizers of *industry* profits, this result breaks down under a system of atomistic competition, in which each producer attempts to maximize its own profits. The former behavioral rule effectively precludes entry, Mestelman pointed out, while the latter facilitates it. However, he continued, if the government is able to redistribute income "in such a way so that whatever the economic adjustment process may be, it will always lead to the same production of output," the results will indeed be symmetric across alternative assignments of liability. Lacking the ability to makes such transfers, however, there is no guarantee that identical output levels will obtain under

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[38] Tybout, as we have seen, utilized a general equilibrium model in his critique published several months earlier, but Mestelman seems to have been unaware of Tybout's article.

alternative liability rules (p. 487). In light of this, Mestelman concluded that alternative specifications of liability "*may* lead to the same point on an economy's production possibilities frontier," and thus that his analysis "tends to give qualified support" to the theorem's invariance proposition (pp. 486-87, emphasis added).[39] Of course, Coase and the supporters of his negotiation result had suggested nothing in the way of necessary government transfer payments to ensure allocative invariance; the argument, instead, was that this result would occur naturally via the negotiation process. Mestelman's result, then, was something less than a fully helpful defense of the theorem.

A second argument against the entry-related criticisms of the 1960s, this one more forceful, came from Harold Demsetz (1972), who at that time was a colleague of Coase's on the Law School faculty at Chicago, with a joint appointment in the Graduate School of Business. In a wide-ranging essay entitled, "When Does the Rule of Liability Matter?" Demsetz took up a variety of objections that had been made against Coase's result, including that concerning long-run entry effects. The thrust of his argument was that the entry critics had failed to grasp the fact that the opportunity costs associated with foregone bribe payments are "just as much a cost" as are the direct costs associated with liability for damages, meaning that cost functions should be unaffected by the rule of liability. Given that this is just as true in the long run as in the short run, Demsetz said, "short-run versus long-run considerations should have no bearing on the Coase theorem" (1972, p. 19). Nutter's merger example, he noted, had provided one demonstration of this, but Demsetz felt compelled to offer a defense for the non-merger case.

To demonstrate his point, Demsetz utilized a numerical example, based on Coase's illustration of the farmer and the cattle rancher, to show that the uses of land that maximize profits under one system of liability will also maximize profits if the rule of liability is changed, meaning that there is no incentive for entry—that is, to convert, e.g., what was sub-marginal farmland to working farmland following a move from farmer liability to rancher liability. Demsetz put the point this way:

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[39] Mestelman's suggestion that government could engage in redistribution activities that would generate allocative equivalence is not unlike the possibility, pointed to by Schulze and d'Arge (1974), that the government could tax away the entry-inducing profits in the subsidy case. See note **X**, above. Schulze and d'Arge, though, seem to have been far more pessimistic about this option, even in theory, than was Mestelman.

To understand the effect of altering the rule of liability it is important to recognize that the owner of a resource who finds it in his interest to employ that resource in a particular way when he bears the cost of an interaction will be paid to employ that resource in the same way when the rule of liability is reversed. What can happen, and in this case does happen, when the rule of liability is changed is that present owners of land having a comparative advantage in ranching suffer a windfall loss in the value of their land while owners of farmland enjoy a windfall gain. But this redistribution of wealth cannot alter the uses of these lands. (1972, pp. 21-22)

As such, he concluded, the output mix is unaffected by the rule of liability. Note, however, that Demsetz was speaking here of a *change* in the existing rule of liability—transferring liability (which had already internalized the externality) from one party to another. Coase's analysis, though, as well as that of the entry critics against whom Demsetz was reacting, were probing the effects of assigning liability to one party or the other where *no* rule of liability had previously been in place. This, one could argue, is an entirely different matter, making Demsetz's response, too, less than a resounding defense of the theorem's long-run validity.

Parrying the New Generation of Critiques

Though these earliest defense of the theorem were targeted at the 1960s critiques, it was not long before the more recent critiques, too, began to attract responses. The first of these came from UCLA's H.E. Frech (1973), who took issue with Tybout's critique in a response published in the *Bell Journal* in 1973. Frech pointed out that Tybout's critique of the theorem was, in fact, refuted by Nutter's merger analysis (which Tybout had not referenced), but he found Nutter's defense, as well as the one laid down by Demsetz (1972)—which, too, relied on the presence of non-transferable rent-earning resources—less than fully satisfying. So, rather than appealing to Nutter's results as a final word against Tybout, Frech fashioned a different line of attack—one based on the flaw that he claimed to have identified in Tybout's analysis (1973, pp. 316-17).

Tybout, Frech argued, had failed to include in his analysis "the asset value (and rent thereof) of the right to control pollution of the environment" (p. 317)—that is, of the right to use the resource in question. This right, as Coase (1960) had emphasized, is both valuable and central to the externality problem. When the right lies with the victims, the value of this right to each

victim firm is given by the receipts from compensation, KS (to use Tybout's terminology), plus the bribe payments avoided, $K(Z - S)$; if the right is assigned to the polluter, its value to the polluter is given by the sum of bribes received, $K(Z - S)$ and compensation payments avoided, KS. The value of the right, or imputed rent to ownership of the resource in question, then, is given by

the present value of KZ, $r\dfrac{KZ}{r}$.

Building the value of the right into the model, said Frech, results in the following reformulation of the problem. If rights are assigned to the victim industry, B, then profits for firms in these two industries are given by:

$$\pi_A = P_A X_A - KS - wL_A - rC_A = 0$$
$$\pi_B = P_B X_B + KS - wL_B - rC_B - r\frac{KZ}{r} = 0.$$

Simplifying the expression for π_B gives,

$$\pi_B = P_B X_B + K(Z - S) - wL_B - rC_B = 0.$$

That is, short-run equilibrium profits are equal to zero in both industries. If the right is assigned to the polluting industry, A, then profits for each firm in the polluting industry are given by:

$$\pi_A = P_A X_A + K(Z - S) - wL_A - rC_A - r\frac{KZ}{r} = 0$$
$$\pi_B = P_B X_B - K(Z - S) - wL_B - rC_B = 0.$$

Simplifying the expression for π_A gives,

$$\pi_A = P_A X_A - KS - wL_A - rC_A = 0.$$

Once again, short run profits are equal to zero in both industries.

These results tells us that, when the value of the relevant property right is included in Tybout's model, profits are identical (at zero) regardless of the liability rule in force. Thus, there are no asymmetries across liability rules that give rise to differential long-run entry effects. This line of argument was not unlike the opportunity cost defense offered by Demsetz, but Frech had

demonstrated the equivalence mathematically and without relying on the prior existence of rents. His summary conclusion was unambiguous: "The Coase Theorem holds." Specifically, "abstracting from distributional effects on demand and transaction costs, as do all participants in the debate, resource allocation is unaffected whether the property rights to the polluted basin are assigned to the recipients (compensation), to the polluters (bribery), or to a third party who rents the asset." The only asymmetry that results is in the distribution of wealth, but this is "a purely windfall gain or loss" (p. 318). It was model misspecification, then, that would seem to have been driving Tybout's conclusions regarding long-run asymmetries.[40]

A different line of attack on Tybout's conclusions (as well as those of Bramhall and Mills), but with a similar underlying flavor, can be found in Adam Gifford and Courtenay Stone's[41] "Externalities, Liability and the Coase Theorem: A Mathematical Analysis," published in *Economic Inquiry*, also in 1973. Gifford and Stone set out to "resolve much of the controversy" over the long-run validity of the theorem not by confronting the critics and supporters on the 'turf' of their own models, but instead by developing a mathematical model that they believed was "consistent with *Coase's* framework of analysis"—the implication being that previous discussions of the subject were not. Such a model, they argued, would demonstrate that invariance obtains in both the short run and the long run, and thus that "the counter-arguments to the validity of the Coase Theorem [are] either false or irrelevant" (1973, p. 260, emphasis added).

Where previous contributors to the entry debate had employed competitive partial and general equilibrium models, Gifford and Stone took a different approach, utilizing a two-firm bargaining model. The bargaining process was assumed to take the form of a non-constant sum cooperative game that is played until all gains from exchange have been exhausted, an outcome reached via "some iterative or tatonnement [sic] process." They assumed zero costs of transacting but, unlike Schulze and d'Arge, did not define this state of the world to include full information; instead, they assumed that the necessary information regarding profits, costs, and the like would

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[40] Tybout (1973) responded by claiming that it was inappropriate to specify rights in the environmental resource—that the rights should be specified in, e.g., pollution and that such a specification validated his results.
[41] Assistant Professor and Associate Professor, respectively, Department of Economics, Cal State Northridge.

be revealed within the context of the negotiation process (1973, p. 262n.5).[42] Given their conscious attempt to construct a mathematical model that mimicked Coase's intuition and numerical analysis, it is perhaps not surprising that Gifford and Stone, like virtually all other commentators to this point, were able to demonstrate that the Coase theorem's efficiency and invariance claims hold in the short run, with the conventional distributional asymmetries on the profits front.

When it came to analyzing the long-run implications of this wealth asymmetry, though, Gifford and Stone switched course from mathematical argumentation to an intuitive approach. The specific error identified by Gifford and Stone lay in the critics' failure to recognize that the wealth asymmetry is caused by the assignment of liability, not by the internalization of the externality. While profit and output levels *prior to negotiations* will vary with the assignment of liability, they said, the negotiation/internalization process will bring the relevant opportunity costs to bear on each party and thus generate prices and output levels that are identical across alternative liability rules (income effects aside). As such, there are no differential incentives for entry or expansion one way or the other (1973, p. 266), meaning that the results derived for the short-run situation also apply in the long run. This, of course, was akin to the opportunity cost argument that had been offered by Demsetz, and not far removed from the defense put forward by Frech.[43] Thus, they concluded, "Mathematical analysis of alternative liability assignments for the case of a technical supply externality reaffirms Coase's conclusions with respect to the efficiency of resource use and the invariance of such use irrespective of the initial liability assignment for the externality when transactions costs are zero" (p. 267).

While Frech and Gifford and Stone had been quick to jump on Tybout's critique of the theorem, it was not until four years after its publication that someone took issue with Mohring and Boyd's critique in *Economica*, and it was Coase's University of Chicago colleague J.R. Gould (1975) who rose to the theorem's defense.[44] As was the case for several of the Coase

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[42] Gifford and Stone (1973, p. 262n.5) claimed to be following Davis and Whinston (1965) in this formulation. However, Davis and Whinston explicitly rejected game-theoretic approaches to the problem, though they did allow that all necessary information will be revealed through the negotiation process. See Davis and Whinston (1965, pp. 114-115).
[43] Gifford and Stone did cite Demsetz's article, but his long-run defense of the theorem is not mentioned by them. They made no mention of Frech's piece.
[44] Gould was a faculty member in the Graduate School of Business.

theorem's defenders, Gould's interest in the theorem was not some passing fancy. He referred to it repeatedly during the 1970s in articles dealing with externalities and legal issues, and he was one of the first to introduce it into an intermediate microeconomics textbook—doing so when he was brought on to prepare the fourth edition of C.E. Ferguson's *Microeconomic Theory* (1975) following Ferguson's death.

As Gould pointed out, Mohring and Boyd's main objection to the theorem went to the precedent-setting effect of a particular rule of liability and the consequent implications for entry in the long run in order to receive the windfall associated with the exercise of a legal right to compensation. The fundamental flaw that Gould identified in the Mohring and Boyd analysis here was, in the essentials, identical to the objection that Demsetz had raised against the 1960s critics.[45] While the legal rule in force will impact the maximum rent or profit that can be earned by each party, production functions and prices of goods and factors remain the same, he said. As such, *aggregate* rents and the production decisions that determine them, too, will remain unchanged.

This logic, for Gould, effectively negated each of Mohring and Boyd's objections to the theorem. First, Gould pointed out, it tells us that there will be no expansion of output or failure to mitigate damages in order to secure larger bribes/compensation payments. As for the entry question, he said, the same basic logic applies:

> that a physician was previously extra-marginal implies that he could not find a site next to a confectioner such that the maximization of the aggregate economic rents would require the production of a positive quantity of the physician's services. This condition obviously continues to hold at the pre-decision equilibrium set of prices after the law is changed. (p. 204)

Gould did not dispute the claim that some previously extra-marginal physicians may find it profitable to establish operations next to confectioners. Instead, he argued that if they did so their profit-maximizing levels of output would be zero. These physicians were not offering services at *any* location, noisy or quiet, prior to the establishment of the right to quiet, meaning that it was

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[45] Gould referenced Demsetz's (1972) argument in a footnote, saying that he had discovered it only after he had written his own paper (Gould 1975, p. 204n.2).

not profitable for them to do so. Being compensated for noise-related losses after entry would not affect the essential nature of this result. And even if there did exist some small net gain from entry, Gould argued, both the physician and the confectioner would be better off negotiating a payment the would cause the physician to stay out of the market. Thus, the legal precedent impacts the distribution of economic rents but leaves the allocation of resources unaffected (p. 204). These findings, said Gould, reflect "The essence of Coase's theorem,"[46] which, as he viewed the matter, is that "technologically interdependent producers have a mutual interest in coordinating their production decisions to maximize their aggregate economic rents," as a result of which "the gains from coordination will be fully exploited" in equilibrium if there are no costs or other impediments associated with transacting (1975, p. 203).

<p align="center">* * *</p>

Each of the blows landed against the long-run validity of the Coase theorem, it would seem, was met with a counter-punch. It is notable, however, that the counter-punches were something less than knock-out blows, as one gets the impression that the defenders of the theorem seldom met the critics on their own playing field. Mathematical refutations were met with intuitive counters or with counters grounded in differently specified models. For the casual observer in particular, there was little basis for choosing one result over another, and any decision to support or oppose the theorem's long-run validity based on the arguments put forward in this debate would have been based on little more than which of the various arguments pro and con resonated with the reader.

IV. Resolving the Controversy?

A potential path out of this ambiguity and confusion was discovered in the late 1970s by one of the aforementioned players in this debate, H.E. Frech. What is perhaps most remarkable here, given the array of economic modeling techniques and arguments that had been brought to bear on

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[46] We should point out Gould's interesting phraseology here in referring to the negotiation result as "Coase's" theorem, given that Coase himself put forward no theorem. It is not uncommon to see this terminology used outside the walls of Chicago, but very rare within them.

the entry issue, was that the solution to the entry puzzle appeared to be found not in economics, but in *law*.

In 1972, Guido Calabresi and A. Douglas Melamed had published an article, "Property Rules, Liability Rules, and Inalienability: One View of the Cathedral" (1972), in the *Yale Law Journal* that examined the efficiency-related implications of these alternative means of delineating legal rights. Though Calabresi and Melamed made no mention of the implications of these legal alternatives for the long-run validity of the Coase theorem,[47] Frech realized that the distinction between property rules and liability rules—or, as he put it, economists' "confusion" over this distinction—provided an explanation for the divergent results reached by those on the two sides of the entry debate (1979, p. 255). Drawing on Calabresi and Melamed, Frech characterized the distinction between liability rules and property rules as follows:

> Liability rules, as I use the term, refer to legal rules or regulations which assign liability for all damage created by pollution to either polluting firms or to victims. They are general, impersonal rules of law which apply to any polluter or any recipients. Property rights confer exclusive rights to control the use of a resource—here, exclusive rights to control pollution in a particular basin. (1979, p. 255)

Frech then set out to contrast the implications of alternative liability rules and alternative property rights systems for the Coase theorem, doing so in the context of a simple general equilibrium model.

After deriving the conditions necessary for efficiency, Frech first took up the question of whether these conditions would be satisfied under alternative *liability rules*. A rule of *polluter* liability for damages, he showed, would generate an efficient short-run equilibrium outcome, but one which, owing to the damage payments flowing from polluters to victims, resulted in positive profits for the victim firms. This result, of course, was completely consistent with the literature on both sides of the debate. Because liability rules "apply to any polluter or any recipients," including new entrants into the market, however, the positive profit opportunities resulting from

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[47] They did, however, talk about the implications of each for negotiation and for the efficiency of the allocations that would result from these legal rules in different situations.

damage payments will trigger entry into the victim industry in the long run and, following the standard logic, lead to over-production in that industry. Moreover, the increased damage payments for firms in the polluting industry that result from this expanded victim class reduce profits in the polluting industry and thus induce exit, meaning that the production of the pollution-generating product will be sub-optimal. The Coase theorem's efficiency claim is thereby refuted, said Frech, for those situations in which polluters are liable for damage.

A rule of *victim* liability, he found, generated exactly the opposite outcome. The positive profits resulting from the bribes paid by victims to polluters induce entry into the polluting industry and thus an overproduction of the pollution-generating good. Meanwhile, the increased bribe payments associated with polluter entry lead to negative profits in the victim industry, which results in exit and thus the underproduction of the good produced in that industry. Thus, Frech concluded, both liability rules give rise to inefficiency, and the divergent outcomes that attend the alternative rules of liability also negate the Coase theorem's invariance claim.

Frech then turned his attention to the effects of using *property rules* to deal with pollution problem. What distinguishes a property right from a liability rule, he pointed out, is its exclusivity—the ability to "exclude others from control, use, and reception of income streams" (p. 262). This exclusivity confers value on these rights, the holding of which thus has an associated opportunity cost equal to sum of payments received from other parties and payments avoided by being a rights holder—as in his 1973 analysis.[48] With this opportunity cost associated with property rights taken into account, Frech was able to demonstrate that the effect of a property rule is to fully internalize the externality, and that this result obtains whether rights are assigned to polluters or to victims. Formally speaking, the equilibrium conditions derived from each of the two property rules were identical the conditions for an efficient resolution of the externality. As such, he concluded, the Coase theorem holds under a system of property rules.

What Frech had demonstrated, then, was that the Coase theorem is valid under property rules but not under liability rules. The explanation for these divergent outcomes lies in the

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[48] See the discussion on pp. **XX-YY**, above. Frech's 1979 analysis of property rules, then, was in the essentials identical to the analysis contained in his 1973 rebuttal to the entry critics.

implications of the alternative legal rules for agent behavior. Property rights are exclusive to the firms upon which they are originally conferred, meaning that no other firms can access the value of these right simply by entering the market. Entrants would have to pay for a share of these rights, but since the price would be equivalent to their value—that is, to the gains that would result from entry—there would be no incentive to purchase them. Liability rules, in contrast, have no such exclusivity attached to them; they are, in effect, incomplete property rights. Entrants can capture a share of their value simply by entering the market. Differently put, under property rules, the private cost of entry is identical to the social cost, whereas it is less than the social cost under liability rules. The differential implications for entry, then, are obvious (pp. 265-66).

One might reasonably ask how Frech's analysis resolved or clarified the controversy rather than simply adding another layer to it. The answer, as Frech himself pointed out, was that the entry critics, by making entrants eligible for compensation for damages, had all assumed that the legal rule in force was a liability rule.[49] Defenders of the theorem, meanwhile, had all pointed to the opportunity costs associated with rights to things like quiet or clean air and water, and so were implicitly or explicitly grounding their analysis in property rules.[50] Thus, it was the *legal* analysis rather than issues of 'proper' economic analysis upon which the divergent conclusions regarding the theorem's long-run validity turned. That the economists had failed to recognize this over more than a decade of debating the entry issue was no doubt an artifact of their lack of familiarity with the nuances of legal analysis and, by extension, how legal rules interact with and condition the nature of economic relationships.

The conclusion that emerged from this lengthy debate, then, was that a Coase theorem written in terms of of property rights is correct, while one written in terms of liability rules is not. A Coase theorem thus survived, but one that was, perhaps, more narrowly drawn.

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[49] Schulze and d'Arge (1974) were the only critics to state this universal eligibility assumption explicitly, while the others, by allowing for all entrants to receive compensation in their analysis, were implicitly making this same assumption.

[50] Gifford and Stone, for example, spoke in terms of a firm having "the property right to generate the externality" versus the other firm having "the (property) right to the profit" coming out of the internalization process when the polluting firm is liable (1973, pp. 261, 263), while Gould (1975, p. 204) spoke in terms of the the victim firm having the "power to restrain noise"—both clear statements of property rights.

V. The World(s) in the Models(s)

At this point, the reader would understandably like to see a summary judgment as to which side triumphed in this debate over the Coase theorem's long-run validity. The answer, though, is far from clear or simple, as the parties involved in the debate were often talking past each other, debating very different environments and models, and on different terms.

Worlds Large and Small

The entry critics, as well as certain defenders of the theorem, framed their analysis around industry-wide externalities—an approach that was by no means unusual in the externalities literature. James Meade's (1952) pathbreaking analysis of "unpaid factor" and "atmosphere" externalities had modeled these relationships at the industry level, and the bribes vs. charges debate, which was couched from the start in the context of large-scale pollution problems and within which the Coase theorem quickly became bound up, carried forward this modeling framework. These models assumed large numbers of homogeneous externality emitters and receptors operating within competitive industries characterized by free entry, and the working out of exchange/market resolutions among (or applying to) all members of these industries. The intersection of this competitive environment and the distributional asymmetries that resulted from bribes and charges, whether Pigovian or Coasean, raised the specter of the allocation-impacting entry and exit activity that so concerned the critics.

Now let us juxtapose this with Coase's own analysis. Coase, you will recall, assumed two agents whose interests are in conflict—a farmer and a rancher, a physician and a confectioner, and so on. Each of these agents was assumed to to operate *within* a competitive industry, but there is no suggestion that ranchers as a group have cattle that trample the crops of farmers as a group or that all physicians are practicing adjacent to noisy neighbors.[51] That is, the externalities contemplated by Coase were isolated, not industry-wide, and the rights in question and the incentives that they created were relevant only to the two parties to the dispute. If, for example, the farmer is liable for damage caused by the rancher's cattle and gains from exchange are

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[51] In fact, Coase made mention of competitive industries only in the farmer-rancher illustration. He made no mention of industry structure in his subsequent analysis of how his negotiation result might bear on several legal cases.

available, the farmer will bribe the rancher to fence or reduce herd size. But the only rancher to receive bribes and so have his profits increased is *that particular rancher*. As such, there is no industry-wide profit-enhancing effect associated with farmer liability and thus no trigger for entry into the ranching industry.[52] Gifford and Stone, Demsetz, and Gould had achieved their theorem-affirming results by modeling the externality relationship along the same lines as had Coase.

What we see in the entry debate, then, are two very different conceptions of the world in the model—of the contexts for modeling the Coase theorem and the externality problems to which it might potentially apply. The decision to model the Coase theorem at the industry level, a context completely different from that envisioned by Coase, would seem to factor into the very different conclusions regarding efficiency and invariance that were reached by the entry critics. In fact, *the very possibility of entry and the genesis of the long-run entry debate were driven by the translation of Coase's result to a market context*. Curiously, though, nearly all of the participants in the debate seem to have been unaware of, or at least left unremarked, this contextual dichotomy—the exceptions being Tybout (1972) and Marchand and Russell (1973), who nonetheless continued on without regard to the fact that this might have some bearing on the conclusions derived from the analysis.[53]

It goes almost without saying that this move to apply Coase's result to a market-wide context requires some sort of explanation. One possible answer is that all of this turns on George Stigler's original elaboration of a "Coase theorem" which, in his formulation, proclaimed that "under perfect competition private and social costs will be equal" (1966, p. 113). While Stigler's formulation of the theorem appears to resonate with the competitive markets models employed by the entry critics, there are at least two reasons to doubt this explanation. First, Stigler's statement and discussion of the theorem was not referenced in this literature. One might respond by saying that the authors of scholarly articles would be unlikely to cite a textbook as their authority, which

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[52] And, it might be noted, potential entrants who might see a precedent for profits in locating their ranching operations adjacent to farmers (who would then have to pay bribes) would find this profitability capitalized into land prices in a zero transaction costs world, meaning that the net gains from entry are zero. Stigler to Frech, March 15, 1977.

[53] Tybout, for his part, noted that while Coase had discussed the problem in terms of bilateral monopoly, his model invoked "universal pure competition" and the associated parametric prices (1972, p. 257), while Marchand and Russell (1973, p. 617) justified their industry-wide framing of the problem by arguing that this is the only "theoretically correct" way to model it—that the homogeneity postulate of perfect competition requires that all firms in a competitive industry face identical cost functions.

is reasonable enough. But a second factor, too, speaks against the Stigler explanation: Stigler's textbook discussion utilized the same two-party analysis that was employed by Coase. As such, it is sensible to conclude that he, like Coase, was assuming a competitive *environment* within which the two parties to the externality operated—an environment that allows one to make efficiency claims absent concerns about the effects of factors such as monopoly power.[54]

A more reasonable explanation for the transformation in Coase theorem modeling is that it was driven by the nature of externality analysis and its intersection with the problem to which this analysis was increasingly being applied—that of large-scale industrial pollution. Following Meade, much of the externality modeling was being done at an industry-wide level, and those analyzing environmental issues were leaning heavily on the received theory of externalities—into which Coase's analysis was quickly incorporated.[55] Meanwhile, the heightened concern about large-scale environmental problems was reflected in a growing propensity to couch externality analysis in environmental contexts and in the use of environmental illustrations in these works. In short, while Coase's analysis did pull externality modeling in a two-agent direction,[56] the opposite was also true: Coase's result was, in the hands of no small number of commentators, being expanded to the industry-wide level, as part of a larger concern to address the environmental issues of the day.

This expansion of the (potential) domain ascribed to the Coase theorem is, in and of itself, of great significance. But did it bear on the conclusions reached by the participants in the debate over the theorem's long-run validity? Frech's (1979) discussion would suggest not, for his conclusions implied that it was not the economic modeling framework per se that was driving the the divergent conclusions regarding the theorem's long-run validity, but rather the legal context through which externality disputes and any subsequent negotiations are worked out. If his analysis was correct, the debate had indeed been resolved: The Coase theorem holds for property

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[54] One might also hypothesize that Kenneth Arrow's (19691970) discussion of externalities and of Coasean solutions in a competitive equilibrium context had some influence on the 1970s debate but, as was the case with Stigler, Arrow's work is not referenced in these discussions.

[55] See, e.g., Wellisz (1964), who lamented immense influence that he believed Coase's analysis had exerted on externality theory.

[56] This move was criticized within the field of environmental economics (e.g., (Kneese 1971), on the grounds that that the two-agent models abstracted from perhaps the defining feature of large-scale externality problems: their large-scale. See Medema (2013c).

rules but not for liability rules, irrespective of the number of agents involved or the economic modeling framework employed.[57]

In reality, however, Frech's distinction between effects of property rules and liability rules did *not* go to Coase's two-party case at all: Coase's analysis holds under either type of rule because of the isolated nature of the externality situation that he assumed. So, it would appear that the modeling context *did* matter in the end, and that Frech's conclusion must be modified along the following lines: The Coase theorem holds under both property rules and liability rules in an isolated externalities environment; in a competitive externality environment, however, the theorem holds under property rules but not under liability rules. But there is one additional issue that remains to be addressed, one that goes to the character of the competitive modeling framework and casts doubt even on our revised version of Frech's judgment.

When Worlds Collide

As the title of Frech's 1979 article, and no less the analysis contained within it, makes clear, Frech was evaluating what he labeled the "*extended* Coase theorem," where the extension was to "a world with some *positive* transactions costs" (1979, p. 256, emphasis added). In fact, Frech noted, there are *two* forms of transaction costs that are present in each of the entry-based critiques of the theorem. First, as Schulze and d'Arge (1974) had pointed out, entry in a competitive environment is an artifact of the existence of information-related transaction costs, meaning that any modeling process that brings entry into the picture is necessarily introducing transaction costs into the analysis. Second, the critics had either explicitly ruled out (by assuming prohibitive associated transaction costs), or had ignored, the merger possibility raised by Nutter in 1968. The incentive for such coordinated action is always present where independent action leads to sub-optimal outcomes and, as Frech noted, such coordination would arise to resolve inefficiencies if transaction costs did not get in the way.[58]

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[57] Frech's conclusion would seem to be reinforced by his finding that Coase himself had been operating in a property rules environment when he laid out his negotiation analysis in "The Problem of Social Cost." See Frech (1979, pp. 266-67).

[58] This extends even to the instability under victim liability that had been identified by Tybout and by Schulze and d'Arge.

We are left to conclude, then, that the economic modeling environment influenced the results of the entry debate in yet another way—that the critics had reached their conclusions not simply by working with liability rules rather than property rules, but by introducing transaction costs into the analysis, in violation of one of Coase's foundational assumptions. Given this, one could reasonably argue that *the entry critics had not refuted the Coase theorem at all*,[59] but instead had merely illustrated what Coase had argued from the outset: that in a regime of positive transaction costs, resource allocation will be a function of the initial specification of legal rights.

VI. Conclusion

It should be clear by this point that, once the dust had settled, that the entry critics had done nothing to negate Coase's negotiation result. What is less clear, however, is whether something called the 'Coase theorem' had emerged unscathed. The answer to this question hinges crucially on what one means by the 'Coase theorem,' and if the entry debate indicates anything, it is that the theorem's meaning, domain, and content had yet to stabilize by the end of the 1970s. Charles Plott and Stuart Mestelman (1968, p. 197) noted early on in the bribes vs. charges debate that "There are many types of institutional and/or behavioral assumptions that will yield any type of results desired" on this front, and the controversy over the Coase theorem's long-run validity did nothing to contradict this. The looseness of Coase's reasoning certainly played a role here, making it possible, for those so inclined, to model the theorem in a variety of ways, and with a variety of results. The entry critics demonstrated time and again that it was possible to construct models which showed that the Coase theorem's efficiency and invariance claims do not hold up once the effects of long-run dynamics are taken into account. But as the theorem's defenders illustrated, it was equally possible to construct rebuttals showing, or at least arguing, that these critiques did not really go to the Coase theorem at all. What was ultimately at issue, then, was not the validity of the Coase theorem, but its content and meaning, and any judgments as to the

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[59] Frech would appear to provide support for this interpretation, having noted that, "Obviously, in a world with literally zero transactions costs, the Pareto efficient or optimum point must be achieved" (1979, p. 256).

theorem's validity hinged crucially upon what was meant by the 'Coase theorem'—something that was still very much being worked out.[60]

Once again, however, we cannot ignore the fact that this debate—and the increasing focus on the world in the model that it exemplifies—did not arise or take place within a vacuum. The challenges posed by large-scale industrial pollution and what was to be done about it were were on the front burner, and the Coase theorem's validity, rightly or wrongly, was perceived as having important implications for pollution policy (Medema 2013c). While the theorem's validity in the world of the model did not ensure its relevance beyond it, the case for the Pigovian tax solution was based upon its performance in the world of the model. If the Coase theorem, too, was valid in such a world, the case for the Pigovian tax as *the* efficient prescription for pollution externalities was correspondingly diminished and the door was cracked to the use of exchange/market-based remedies. The conclusions generated through the examination of the world in the model, then, would determine whether the model could be brought to bear on the world. The stakes here were anything but unimportant and go a long way toward explaining the observed turn in Coase theorem discourse.

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[60] Interestingly, Schulze and d'Arge (1974) did not even deign to call it such, choosing instead the label, "Coase proposition."

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