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MINIMUM BILL CONTRACTS: THEORY AND POLICY

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I. Introduction

Minimum bill clauses, or take-or-pay provisions, as they are alternately called, have recently attracted considerable attention in both public policy and academic forums. These provisions, which require purchasers to pay for a prespecified minimum quantity of output whether or not that output is actually taken, are common in the sale of resources such as natural gas and coal,[1] and have also been a feature of such controversial projects as the Western European-Soviet gas pipeline and the Washington Public Power Supply System (WPPSS) nuclear power project. In addition, some consumer goods such as telephone service for which per unit charges are assessed only above a specified level have been sold under terms characteristic of minimum bill contracts.[2]

Yet despite the variety of products covered and unresolved contentions over their use in natural gas contracts, the role and implications of these contractual provisions remain widely misunderstood. A common error, for example, has been to regard minimum bill and take-or-pay requirements as the "demand charge" or lump-sum portion of a two-part pricing scheme (see, e.g., Hubbard and Weiner, 1986; and Note, 1986, pp. 131-2). The danger is that, given the current controversy, such misperceptions may lead to inappropriate public policy toward minimum bill contracts.

This paper seeks to eliminate some of the confusion about minimum bills by examining more closely the incentives these contractual arrangements create. In the next section, I examine the nature of the payment schedule implied by minimum bill clauses and show that the latter is distinct from that associated with two-part pricing formulae. Section III considers in more detail the conditions under which minimum bill contracts are likely to be adopted and the factors that affect the magnitude of the minimum payment. The analysis suggests that minimum bill provisions may be beneficial in contracts where the opportunity cost of supplying the product is rising and the demand for the commodity is uncertain at the time the contract is written. Evidence in support of this interpretation is also cited. The final section discusses the policy implications of these findings.

II. The Nature of Minimum Bill Contracts

The tendency to regard minimum bills as lump-sum payments probably derives from the fact that, like lump-sum transfers, these clauses establish a minimum financial obligation of a purchasing firm to its supplier. Closer inspection of actual minimum bills and comparison of the payment schedules they imply with two-part pricing formulae, however, quickly reveal that the two are distinct contractual forms. In particular, two-part pricing schemes have the following general structure:

$$T(q) = \bar{B} + B(q),$$

where T(q) is the total payment schedule as a function of quantity, q, and $\bar{B}$ and B(q) are the fixed and variable portions of the payment schedule.

Glenn Hubbard and Robert Weiner explicitly define the lump-sum portion of this formula, $\bar{B}$, as the take-or-pay obligation (1986, p. 72). Under true minimum bill contracts, however, purchasers become liable for a fixed payment <u>only if</u> the variable portion of the payment schedule, B(q), falls below a stipulated amount, say, B_m. Thus, the payment schedule under a minimum bill contract would take the form

$$T(q) = \begin{cases} B(q), & \text{if } B(q) \geq B_m \\ B_m, & \text{if } B(q) < B_m \end{cases}$$

or

$$T(q) = \min\{B_m, B(q)\} = B_m + \max\{0, B(q) - B_m\}.$$

Note that, whereas the marginal cost of q to the purchaser under the two-part pricing formula is simply dT/dq = B'(q), the marginal payment under the terms of a minimum bill contract is

$$\frac{dT}{dq} = \begin{cases} B'(q), & \text{if } B(q) \geq B_m \\ 0, & \text{if } B(q) < B_m. \end{cases}$$

Because the minimum bill only comes into play if purchases fall below an implicit minimum level, q_m (where $B(q_m) = B_m$), the incremental cost of the product to the buyer is effectively 0 below this level. In other words, since the buyer must pay B_m whether he purchases q_m or some lesser quantity, he incurs no additional cost for taking supplies up to q_m. Thus, rather than being merely a form of "inframarginal (nonprice) compensation" (Hubbard and Weiner, p. 78), minimum bills expressly alter the buyer's incentives to accept or reject deliveries of output. In effect, higher minimums penalize a purchaser for failing to take deliveries, thereby raising the incentive to acquire supplies.[3]

III. The Role of Minimum Bill Contracts

Theory. Although it is evident from the preceding discussion that minimum bills are not equivalent to the lump-sum portion of a two-part price, the role such arrangements play in contractual relationships and their policy implications need to be explored further. One aspect of minimum bills that would seem to merit closer scrutiny is their incentive implications. In general, parties to a long-term contract will wish to provide for adaptation to changing circumstances over the life of the agreement. Because the costs of writing and administering complete contingent claims contracts are typically prohibitive, the parties must often resort to incomplete agreements. The problem is to design that agreement in a way that promotes efficient adaptation without the need for costly court intervention.

To illustrate these concerns, consider a contract between a downstream purchaser (the buyer) and an upstream producer (the seller), both of whom are assumed to be risk neutral. Assume also that most of the uncertainty associated with transaction is on the demand side. Using notation similar to

Hubbard and Weiner's, the buyer's net revenue function (gross of payments to the seller) is assumed to be $R(q,\alpha)$, where $R_q \geq 0$ (strictly positive for some q), $R_{qq} < 0$, and α is a random variable distributed according to $F(\alpha)$. The seller's costs, in turn, are assumed to be $C(q)$, where $C' > 0$ and $C'' \geq 0$.

If the parties can contract over q but not α, then the problem they face ex ante is to determine a payment schedule, $T(q)$, to maximize expected joint profits, where

$$\pi_B = R(q,\alpha) - T(q) \text{ and}$$

$$\pi_S = T(q) - C(q)$$

are the buyer's and seller's ex post net receipts.

As Hubbard and Weiner observe, an efficient contract between the buyer and seller, assuming that courts cannot observe α, would let the buyer choose q and set the variable portion of the payment schedule equal to the seller's costs. The buyer would then be induced to choose output efficiently, that is to say, so that $R_q(q,\alpha) = C'(q)$.

This specification is satisfactory as long as the cost schedule facing the seller is of a form simple enough to be easily represented in the contract. If $C(q)$ is linear, for example, then $B(q)$ can be set equal to $p \cdot q$, where $p = C'$ is a constant. If $C(q)$ is nonlinear, however, so that the opportunity cost of using output in its intended use depends on the level of output, then a linear pricing schedule may no longer be adequate. The objective of the remainder of this section is to show that minimum bill provisions provide a simple mechanism by which a buyer's payment schedule can be made to approximate the opportunity cost of the seller and thereby promote appropriate adjustments to change within the context of a long-term contract.

In practice, minimum bill provisions take a variety of forms. Natural gas contracts, for instance, typically stipulate a price, p, and a minimum take obligation expressed as a percentage, γ, of a contractually stipulated capacity or maximum quantity, $\bar{q}$. (Consequently, $q_m = \gamma\bar{q}$.) Adopting this form defines a set of contracts characterized by $(p,\gamma,\bar{q})$. Letting $\hat{q}(\alpha)$ be the quantity of output that satisfies the buyer's ex post decision rule, $R_q(q,\alpha) = T'$, such a contract divides the buyer's payment schedule into the following regions as a function of α:

	$T(q)$
$\Phi_1 = \{\alpha: \hat{q} < \gamma\bar{q}\}$	$p\gamma\bar{q}$ (for Φ_1 and Φ_2)
$\Phi_2 = \{\alpha: \hat{q} = \gamma\bar{q}\}$	
$\Phi_3 = \{\alpha: \gamma\bar{q} < \hat{q} < \bar{q}\}$	$p\hat{q}$
$\Phi_4 = \{\alpha: \hat{q} = \bar{q}\}$	$p\bar{q}$

The marginal payment schedule associated with this contract is depicted in figure 1. Note that the marginal cost of gas to the buyer is 0 for quantities up to $\gamma\bar{q}$, and p between that point and $\bar{q}$. An efficient contract in this set maximizes the sum of the buyer's and seller's expected profits, $E(\pi_B) + E(\pi_S)$, where

$$E(\pi_B) = \int_{\Phi_1}[R(\hat{q},\alpha)-p\gamma\bar{q}]dF(\alpha) + \int_{\Phi_2}[R(\gamma\bar{q},\alpha)-p\gamma\bar{q}]dF(\alpha) + \int_{\Phi_3}[R(\hat{q},\alpha)-p\hat{q}]dF(\alpha) + \int_{\Phi_4}[R(\bar{q},\alpha)-p\bar{q}]dF(\alpha) \quad ;$$

and

$$E(\pi_S) = \int_{\phi_1} [p\gamma\bar{q} - C(\hat{q})]dF(\alpha) + \int_{\phi_2} [p\gamma\bar{q} - C(\gamma\bar{q})dF(\alpha) + \int_{\phi_3} [p\hat{q} - C(\hat{q})]dF(\alpha) + \int_{\phi_4} [p\bar{q} - C(\bar{q})]dF(\alpha)$$

Assuming that R_q is linear so that $d\hat{q}/dp$ is a constant, the first order conditions for an interior solution to this maximization problem reduce to:

(1) $$p = \int_{\phi_3} C'(q)dF(\alpha) \;;$$

(2) $$\int_{\phi_2} R_q(q,\alpha)dF(\alpha) = C'(\gamma\bar{q}) \;;$$

(3) $$\int_{\phi_4} R_q(q,\alpha)dF(\alpha) = C'(\bar{q}) \quad .$$

These results indicate that the parameters, γ, p and $\bar{q}$ are chosen so that, under the contract, the buyer is induced to take the quantity that equates expected marginal revenue and marginal cost in each region. According to equation (1), the contract price should be set equal to the expected cost of supplying each unit of output in region ϕ_3. The range of ϕ_3, meanwhile, depends on γ and $\bar{q}$ as well as p. Specifically, for a given price, raising γ or $\bar{q}$ raises the limiting values of α in the respective regions, ϕ_2 and ϕ_4, with corresponding changes in ϕ_3. In figure 2, raising γ and $\bar{q}$ would shift to the right the vertical lines at $\gamma\bar{q}$ and $\bar{q}$, moving each further up the marginal cost schedule. By varying the parameters of the contract, the parties can design the buyer's payment schedule to approximate the seller's marginal costs, reducing relative to a single or two-part price the expected losses from inefficient performance occurring during execution of the contract.

An implication of this analysis is that the size of minimum bill obligations is related to the nature of the seller's costs. In particular, the more rapidly opportunity costs decline as output falls from capacity, the higher will be the optimal take-or-pay percentage. In terms of equation (2), the lower C' in the vicinity of q_m the higher γ must be to maintain the equality between marginal costs and expected marginal revenue. Conversely, the flatter the marginal cost curve the lower the optimal take percentage.

Thus, overall, conditions compatible with the use of minimum bill provisions are (i) demand side uncertainty, (ii) rising marginal costs, and (iii) the use of long-term contracts to govern exchange. The latter, in turn, is associated with production requiring large, durable, transaction-specific investments. The potential for contention over the resulting quasi-rents once such assets are in place favors securing the terms of trade beforehand in a formal agreement. In addition, the specialized nature of investments implies, by definition, that the alternative value of the seller's assets will be below the cost of adding new or additional capacity. Under these conditions, minimum bills serve as a means to encourage adaptation that is simple both to specify and enforce.

Evidence. A central contention of the preceding analysis is that minimum bill provisions do not simply distribute gains from trade but influence the size of those gains through their effect on contract incentives. A recent study of natural gas contracting (Crocker and Masten, 1986) provides direct evidence on this issue. As both Masten and Crocker (1985) and Hubbard and Weiner (1986) note, nonprice competition in contract terms raised take-or-pay percentages in natural gas contracts during the period of wellhead price regulation. If the principal role of take-or-pay provisions were to distribute rents, as Hubbard and Weiner maintain, then higher take percentages associated with price regulation would favor longer term contracts. Excessive take obligations, however, would discourage commitments to long-term contracts if such provisions served primarily an efficiency role: the resulting distortion in contract incentives would raise the implicit costs of being bound to a long-term agreement. In fact, the duration of natural gas contracts is negatively related to distortions in take-or-pay provisions caused by well-head price regulation in this industry (Crocker and Masten, 1986), supporting the efficiency as opposed to distributive function of these arrangements.

More generally, considerable evidence also supports the hypothesized relationship between the incidence of minimum bills and the three conditions identified at the end of the preceding section. Independent studies by Masten and Crocker (1985) and Mulherin (1986), for instance, have shown that the size of take-or-pay percentages in natural gas contracts is related to the alternative value of gas reserves. In particular, take obligations tend to be higher (i) the larger the number of producers operating in a particular field, reflecting a low opportunity cost of gas that may be drained away by other wells; and (ii) the fewer the pipelines serving the area, representing alternative outlets for gas sales. The availability of alternative customers appears to influence similarly the size of take-or-pay provisions in long-term coal contracts (Carney, 1978).

Case studies on contracting practices in specific industries also corroborate this view. Victor Goldberg and John Erickson, for example, explicitly discuss the incentive role of contract minimums in their extensive study of petroleum coke contracts. A by-product of the refinement of residual fuel oil into higher value fuels, petroleum coke is, among other things, an input in the production of carbon anodes used in aluminum production. Goldberg and Erickson report that the contracts between aluminum producers and oil refiners they examined universally left quantity decisions to the buyers and employed contract minimums to assure deliveries (p.16-17). The use of contract minimums they attribute to the nature of the refiner's costs (p.10):

> Coke's bulk ... makes it expensive to store. Coke is a fire hazard and a source of pollution unless it is put in covered storage. The cost of storing coke not only includes the direct costs of preparing land, providing railroad spurs, water sprays, bulldozers and loading equipment but it also includes the opportunity cost of the land employed for storage. ... Economizing on inventory costs entails both rapid processing to keep the total inventory low and rapid removal of inventory to lower value storage areas.

While storage costs make timely removal important, transportation costs encourage petroleum coke users to locate near coke suppliers and limit the possibilities for sale to alternative customers (p. 9). The buyer's failure to take deliveries, therefore, imposes costs on the producer (p.11):

> The coker's costs depend upon the rate at which coke is removed from the refinery. If coke is removed too slowly, the coker is faced with a number of costly options. It could accelerate the search for new customers, reduce the selling price, add to inventory if storage space is available, reduce the production rate, or, in the limit shut down its coking operation. The opportunity cost of refinery products not produced is a significant cost of untimely removal.

The high cost of untimely removal translates into a low--possibly even negative--marginal cost of supply at purchases substantially below capacity. Contract minimums effectively shift these costs to the buyer who is thereby given the inventive to maintain removal rates at efficient levels.

John Stuckey's discussion of contract minimums governing the sale of bauxite is also relevant (1983, p. 120):

> Some stability from year to year is normally achieved by stipulating a minimum quantity per annum, but sufficient flexibility in the actual quantity exchanged is left to allow the buyer to adjust to the cyclical ups and downs in the industry and to pass the "market message" through to the supplier. That contracts allow for quantity variation at the outset is a reflection of the mutual recognition that joint profit-maximization in a bilateral monopoly facing uncertain demand often requires quantity adjustment.

In addition, Stuckey's description of "the irregular behavior of average and, particularly, marginal cost curves at about capacity" is consistent with the cost structures previously associated with minimum bills: "At normal and subnormal operating rates, marginal costs are an unusually low proportion of average costs. . . but at about capacity, marginal costs accelerate quickly" (pp. 68-9). The heterogeneity of bauxite ores and consequent need for specialized refineries, moreover, inhibits the sale of bauxite from one mine to other refiners, severely constraining the alternate value of mining capacity. Thus, the circumstances in this industry conform in both demand and cost respects with the conditions previously associated with the use of contract minimums.

IV. Policy Implications

The current controversy over minimum bill clauses centers on their use in contracts governing transactions at both ends of natural gas pipelines. Critics argue that minimum bills provisions inhibit competition in natural gas markets by preventing customers served by long-term contracts from switching to lower cost suppliers. In addition, the failure of gas transportation and distribution companies beginning in 1983 to meet minimum bill commitments has generated considerable litigation and demands for some form of regulatory or legislative solution to the problems of the industry, further fueling the public policy debate. This section considers the merit of legislative or regulatory intervention to reduce minimum bill obligations and the appropriate legal status of minimum bill provisions in light of the analysis of the preceding section.

Legislative and regulatory solutions. Arguments for regulatory or legislative relief from minimum bill obligations emphasize the inefficiency of using high price gas when less expensive supplies become available. Minimum bills, it is argued, obstruct the functioning of the price system by limiting the ability of purchasers to respond to changes in relative prices. Eliminating minimum bills from existing contracts would permit buyers to reallocate purchases away from expensive contract gas to the supplier offering the lowest price, with consequent efficiency gains.

The problem with this reasoning is its use of price to evaluate the allocation of gas supplies. Efficient allocations turn not on the price but on the cost of incremental units from alternative sources. Inasmuch as minimum bills serve better to approximate marginal costs than could linear pricing schedules, elimination of minimum bill obligations ex post could actually lead to too little of the "high priced" gas being taken.

To illustrate, consider a purchaser who had previously entered a contract to purchase gas under terms described in the previous section. Suppose that circumstances in the industry now make available a supply of "spot" gas from a "competitive" producer at a price, p_s, that is less than the contract price, p. The buyer would obviously like to discontinue purchases of the contract gas and switch to the spot gas, but under terms of his take-or-pay agreement, must pay for γ percent of the contract gas whether or not he actually takes it and is, in this sense, "forced" to buy the high price product.

Despite the buyer's interest in purchasing the less expensive spot gas, efficiency may require upholding and possibly even exceeding the quantity minimums implied by the agreement. Figure 3 depicts such a scenario. Even though the price of gas from the new spot producer is lower than the original contract price, the opportunity cost of the contract gas at the contract minimum, $C'(\gamma\bar{q})$, is below the spot gas price (assumed to equal the marginal cost of these supplies). Hence, it is efficient to take not only the full $\gamma\bar{q}$ units of gas contracted for but also additional units up to q'.

Of course, were spot gas prices to fall below $C(\gamma\bar{q})$, a prima facie case could be made for some form of intervention to permit reductions in gas purchases under the contract. The problem is that the extent to which spot prices must fall to justify adjustments to contract minimums, and the size of any adjustment, depends on the opportunity costs of individual suppliers and is therefore specific to each well. Given the contracting parties interest in aligning incentives of the contract in a joint-profit maximizing manner, the efficient ex post adjustment is as likely to require an increase as a decrease in the quantity of gas taken under the agreement. Hence, effective intervention would require that any adjustments to minimum bills be made on a case-by-case basis after evaluation of the costs of each supplier. As a rule, neither regulation nor legislation is capable of making such fine determinations.

Legal solutions. The volume of litigation over minimum bills associated with recent changes in the natural gas market has raised the prospect of some form of legal resolution of minimum bill conflicts. An advantage of judicial over legislative or regulatory remedies is the potential for the courts to intervene in a more discriminating manner, evaluating each case on its merits. The legal debate over minimum bills, however, is uninformed as to the positive role that minimum bill clauses play in long-term contracts and focuses on possible legal justifications for excuse of minimum bill obligations.[4] Consequently, the question of whether a legal mechanism exists or could be devised capable of distinguishing among the conflicting ex post interests of the contracting parties and encouraging efficient responses to new market conditions has not been addressed.

One remedy that would seem to promote efficiency is the application of standard damage penalties for breach of contract requiring the breaching party to compensate the other for lost profits.[5] In the context of a minimum bill contract, this penalty would equal the seller's net profits were the minimum bill satisfied less his net receipts for the quantity actually taken, or $\delta = [p\gamma\bar{q} - C(\gamma\bar{q})] - [p\hat{q} - C(\hat{q})]$. Thus, a buyer taking no deliveries would be required to pay only $p\gamma\bar{q} - C(\gamma\bar{q})$ instead of the contractually stipulated minimum, $p\gamma\bar{q}$, reducing his obligation to the seller by $C(\gamma\bar{q})$. Under this remedy, the total cost to the buyer of acquiring any given total quantity, $q_T = \hat{q} + q_s$, would become

$$p\hat{q} + p_s q_s + \max\{\delta,0\} .$$

Setting the first derivative of this expression equal to 0, the buyer's cost minimizing allocation of total purchases between the two suppliers for $\hat{q} < \gamma\bar{q}$ solves

$$p_s = C' ;$$

that is, the buyer would minimize his costs given this court imposed penalty if he allocated his purchases between contract and spot suppliers to equate the contractual supplier's marginal cost with the alternative supply price. The use of this legal penalty for breaching minimum bill agreements would therefore provide buyers with efficient incentives to allocate purchases between contract and alternative supplies for quantities below the minimum bill level.[6]

Unfortunately, the application of this remedy overlooks the reason minimum bills are adopted in the first place, namely, the inability of the legal system to administer contractual agreements accurately and costlessly. The legal system is a notoriously cumbersome, expensive and imprecise mechanism for governing exchange. For instance, to determine the level of lost profits in natural gas contracts in practice, courts would, at a minimum, have to

(i) predict the quantity of gas the buyer would have been likely to procure during the remainder of the contract, (ii) forecast the amount of gas and price that the seller could receive for supplies from alternative customers, and (iii) assess the amount of gas that would be lost to natural seepage or drainage by other producers.[7] But for such difficulties, parties could stipulate fixed quantity contracts and rely on courts to administer all modifications: Given the knowledge that the legal system would effect perfectly efficient adjustments to such contracts, there would be no need to resort to imperfect nonlinear pricing mechanisms to construct contractual incentives. Hence, it is the inability to rely confidently on the legal system to effect adaptations that motivates parties to seek flexible, low-cost contract designs. Court interference in such "private orderings" (see Williamson, 1983) undermines the purpose and benefits accruing to such arrangements.[8] Given the evidence that minimum bills provide such benefits, court excuse of minimum bill obligations is likely to be detrimental to efficiency in long-term contractual exchange.

V. Conclusions.

Rather than being a form of inframarginal compensation, minimum bill provisions are adopted precisely because of the incentives they create to acquire supplies in response to changing circumstances. Specifically, minimum bills provide a simple mechanism by which parties faced with uncertain demand and rising marginal costs can approximate joint-profit maximizing payment schedules in transaction-specific relationships. Minimum bills are likely to be higher, moreover, the more rapidly the opportunity cost of serving the intended customer declines as output falls from the capacity level. While critics of take-or-pay clauses in natural gas contracts have argued that minimum bill restrictions obstruct the workings of the price system by compelling buyers to purchase higher priced supplies when less expensive alternatives are available, the analysis of this paper indicates that minimum bill provisions promote rather than inhibit efficient responses to changing market conditions.

Nevertheless, the capacity of minimum bill provisions only to approximate cost schedules of suppliers raises the potential for efficiency-enhancing ex post adjustments in resource allocations. The question then becomes how such adjustments could be best accomplished. Proposals for regulatory or legislative reductions neglect the well-specific nature of contract terms. Although purchasers would like to see minimum bills reduced whenever spot prices fall below contract prices, whether or not a reduction is warranted on efficiency grounds and the size of any such reduction depends not on the contract price but the opportunity costs of the supplier. Given the transactors ex ante interests in designing minimum bills to balance incentives to over- and underpurchase supplies, efficiency is as likely to dictate <u>increases</u> as reductions in purchases of contract quantities despite an excess of contract over spot prices. The inability to dictate well-by-well modifications suggests that legislation and regulation are too coarse a tool for effective intervention.

While courts do have the potential to intervene more selectively, the difficulties of assessing opportunity costs and determining optimal penalties in practice undermine the efficacy of legal solutions as well. Indeed, it is the limitations of the legal system that inspire the use of "private orderings" such as minimum bills in the first place. Judicial second-guessing of the parties' interests poorly serves those interests in such cases.

Given the nature of gas production and transmission, it is unlikely that gas will ever be sold under universal spot market conditions. Except for a few regions of concentrated gas production served by a large number of gas pipelines, the large, durable relationship-specific nature of gas transmission will require that large quantities of gas continue to be sold under long-term contracts. As long as this remains true, parties need the latitude to design those contracts to accommodate the need for efficient adaptation in the face of change. Minimum bill contracts appear to be one mechanism that facilitates that objective.

Footnotes

1.See Masten and Crocker (1985) and Mulherin (1986); and Carney (1978) and Joskow (1985). Another essential commodity with which take-or-pay provisions have been associated is ice cream (see Allover Distributors, Inc. v. Kroger Co., 1975).

2.For example, in 1985 GTE Sprint, an early competitor in the long distance telephone market, advertised as an "advantage" of Sprint service "No monthly service charge (only a $5 monthly minimum usage requirement)" (emphasis added).

3.Cf. Masten and Crocker (1985). Unlike this earlier paper, the present paper allows quantity to vary continuously with changes in demand. Whereas the former lends itself more readily to empirical applications, the present treatment is a more accurate characterization of minimum bill contracts and is more conducive to policy analysis.

4.See for instance Roland (1986) and Pierce (1984).

5.Note that according to Pierce (1983) expectations damages normally apply to gas contracts. Precedence for the use of this remedy can be found in Allover Distributors, Inc. v. Kroger Co. (1975).

6.The incentives created by breach penalties in contracts for the sale of discrete items have been investigated by a number of authors; see, for example, Barton (1972), Shavell (1980, 1984), and Rogerson (1984), and more recently Konakayama, Mitsui and Watanabe (1986). To the best of my knowledge, breach incentives in a model using continuous quantities has not been investigated elsewhere.

7.See Allover Distributors, Inc. v. Kroger, Co. (1975) and Red Jacket Oil and Gas Co. v. United Fuel Gas Co. (1944). I am grateful to Harold Mulherin for bringing my attention to the latter. Note that breach of contract remedies require proof with reasonable certainty, a requirement that may be particularly hard to meet in gas contracts where drainage is an issue. Again see Red Jacket Oil (1944) and Farnsworth (1982).

8.There is some evidence that the courts recognize, at least implicitly, these limitations. Breach of contract remedies have traditionally been applied to the failure to perform physical as opposed to financial requirements of a contract. Courts, for example, generally permit privately stipulated penalties for nonperformance to supercede court determined awards. Similarly, in ruling on the availability of "force majeure" protection from minimum bill obligations, an appeals court noted that in take-or-pay contracts "the buyer can perform the contract in either of two ways. It can either (1) take the minimum purchase obligation of natural gas (and pay) or (2) pay the minimum bill. It is a settled law that when a promisor can perform a contract in either of two alternative ways, the impracticality of one alternative does not excuse the promisor if performance by means of the other alternative is still practicable" (International Minerals & Chemical Corp. v. Llano, Inc., 1985). The inability to sell contracted gas supplies thus does not in and of itself excuse the party from the financial obligation of the contract.

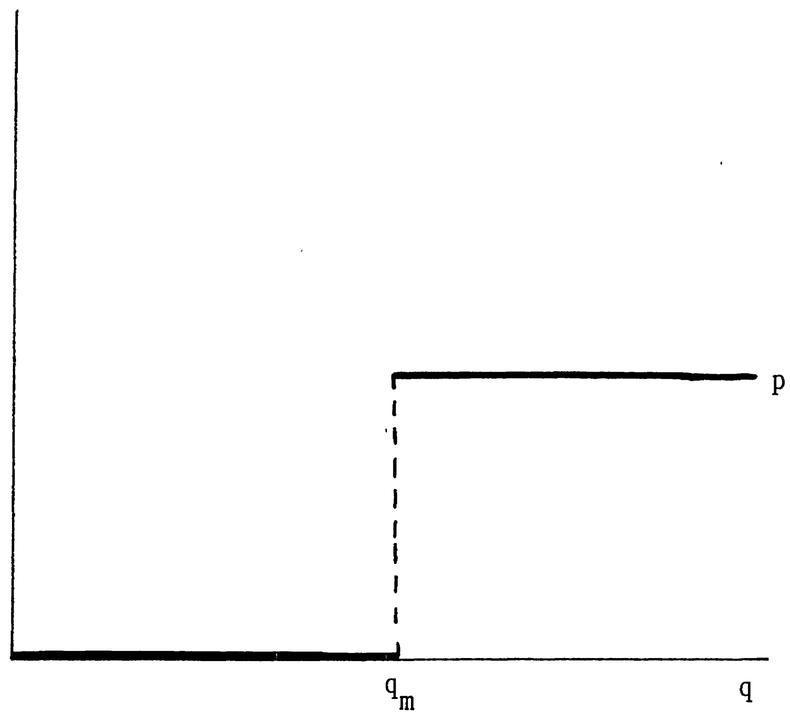

Figure 1

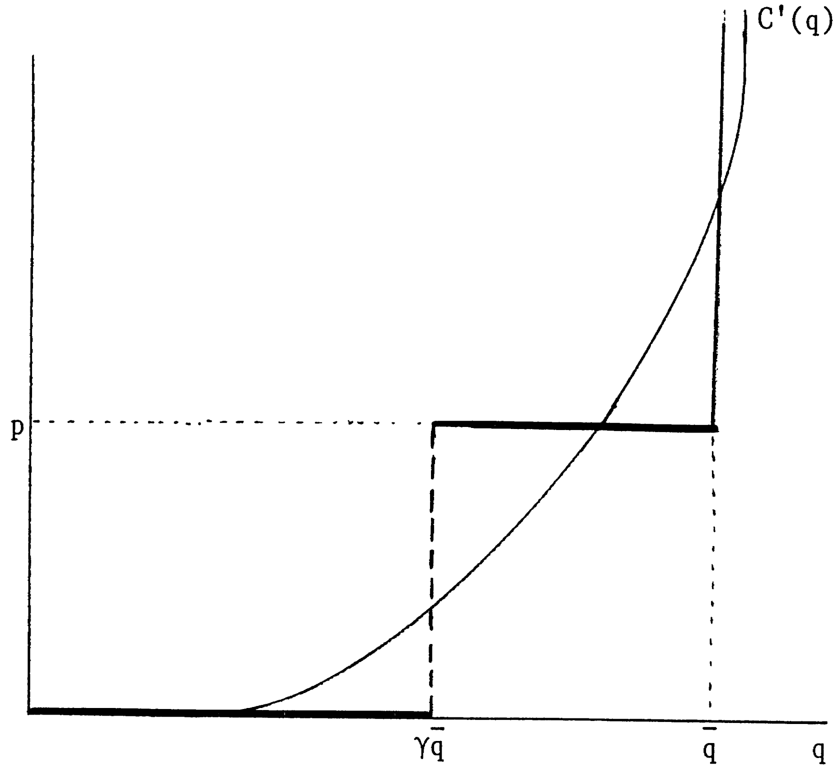

Figure 2

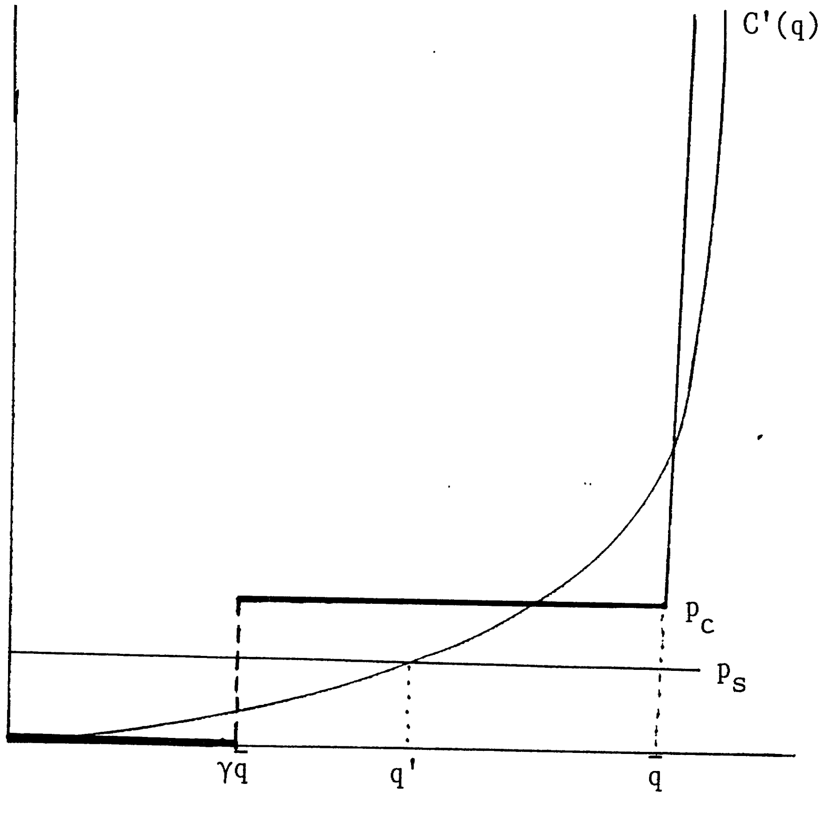

Figure 3

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