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Socially Optimal Liability Rules for Firms with Natural Monopoly

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1. INTRODUCTION

It has been shown by Polinsky (1980) and Shavell (1980, 1987) that the strict liability rule is socially superior to the negligence liability rule when firms are injurers, strangers are victims, and accidents have a unilateral nature. The analysis presupposes perfectly competitive behavior of firms.

We consider in this article the problem of socially efficient liability rules in a market where natural monopoly prevails due to decreasing average cost. Intuitively, it can be concluded that strict liability rules are more appropriate for firms with natural monopoly, for they are either allowed to enjoy the protection of the government or exercise their market power. The present article shows that this intuition may not necessarily be true from the view point of economic efficiency.

We consider a case where average cost pricing is achieved in a naturally monopolized market either through well-organized government regulation or the weak invisible hands of contestability. After the presentation of the model and its basic assumptions in the next section, we discuss the effects of different liability regimes on resource allocation in sections 3 and 4. Section 5 concludes our study with a summary of the implications of this article, in comparison with those of previous contributions on the subject.

2. THE MODEL

Suppose that a monopolistic firm is selling its products to its customers. For the production of the good, the firm must bear a constant marginal cost $c > 0$. In addition, the firm must bear a (probably very large) fixed cost $F > 0$ when it starts the business. The production process involves some risk of accident, and there is a certain probability per sale that an accident occurs and causes harm to strangers. The firm can partially control the probability and extent of harm that may occur in the event of accident by paying attention to safety. We denote the cost of care x, expected amount of loss by the accident $\delta > 0$ and suppose that $\delta = \delta(x)$, with $\delta'(x) < 0$ and $\delta''(x) > 0$.

The monopolistic firm discussed here minimizes its total cost either by proper adaptation to government regulations or under the competitive pressure of the contestable market. Therefore, analogous to the case of competitive firms shown by Shavell (1980, 1987), this monopolistic firm chooses a socially optimal amount of care

$x = x*$, either under a strict liability rule or a negligence rule with proper due care standard. Hereafter, we denote $\delta(x^*)$ simply as δ.

Regarding the consumption side, we assume a partial equilibrium setting where marginal utility of income is constant for consumers. The market demand function $q = D(p)$, where $D'(p) < 0, D''(p) \geq 0$, exists where q is the aggregate amount of consumption of the product of the monopolistic firm and p is a consumption price of the good.

Again, analogous to the case discussed by Shavell, the monopolistic firm must bear the burden of liability when the legal rule is one of strict liability; the firm can escape the burden of liability payment by appropriately choosing the due care level when the negligence rule is adopted. This means that the average cost price adopted by the monopolistic firm will vary depending on kind of liability rules instated. Let us denote the set of market price and quantity at the average cost pricing equilibrium (ACPE hereafter) as (p^s, q^s) under the strict liability regime, and (p^n, q^n) under the negligence regime respectively. Then we have the average cost pricing formulae in both regimes as follows:

(1) $p^s = c + \delta + \frac{F}{q^s}$,

(2) $p^n = c + \frac{F}{q^n}$.

Suppose that all parties are risk neutral. Social welfare of the market is therefore measured by the sum of the utilities of the customers minus the cost of production of the good and the expected cost of accident. The maximum social surplus is obtained at the marginal cost pricing equilibrium where $p^* = c + \delta$, $q^* = D(c + \delta)$, and the fixed cost F is covered by the lump-sum tax.

Before starting on a detailed welfare analysis, let us summarize some additional assumptions and preliminary results. We first assume that $q^* > 0$, which means that this monopolistic firm provides positive welfare to the economy, at least when it is optimally operated. We also assume that $q^s > 0, q^n > 0$.[1] We further assume that

(3) $-\frac{1}{D'(p)} > \frac{F}{q^2}$

is satisfied for the range of q between q^n and q^s.[2] Then, the proposition below follows.

[1] In general, it is not possible to rule out the case $q^s = 0$, or even $q^n = 0$, even if we assume that $q^* > 0$. However, these cases are not particularly interesting and especially irrelevant to the issue we discuss in this article.

[2] Assumption (3) means that the slope of the market demand curve is steeper than that of the average cost curve at the ACPE.

Proposition 1(i) $q^* > q^s$, $q^n > q^s$.
(ii) the ACPE in the strict liability regime cannot be Pareto efficient.
The ACPE in the negligence regime cannot be Pareto efficient except for a coincidental case that satisfies $D(c + \delta) = \frac{F}{\delta}$.

Proof (i): As $p^* = c + \delta$ is smaller than p^s in (1), the first result follows. We next consider (1) as a function of δ, satisfying the demand condition as $p(\delta) = c + \delta + \frac{F}{D(p(\delta))}$. Differentiating the equation with respect to δ,

(4) $p'(\delta)\left(1 + \frac{F}{q^2}D'(p)\right) = 1$

follows. However, from assumption (3), $-1 < \frac{FD'(p)}{q^2} < 0$ is satisfied so that the second bracket on the left-hand side of equation (4) is positive. Therefore, $p'(\delta) > 0$ is implied for δ that corresponds to a value of q between q^n and q^s. This means that, starting from $\delta = 0$, as we increase the value of δ while satisfying the average cost pricing condition (1) and the market demand function, the market price increases constantly and the level of consumption falls. Therefore, $q^n > q^s$ follows.
(ii): For the resource allocation to be Pareto efficient, the output level must be q^*. From (i), q^s is smaller than q^* and hence the ACPE in a strict liability regime cannot meet this condition. To have $q^n = q^* = D(c + \delta)$, so that the ACPE in a negligence regime is Pareto efficient, $p^n = c + \frac{F}{q^n} = c + \delta$ must be satisfied. From these two equations, $D(c + \delta) = \frac{F}{\delta}$ follows. With this relationship, it is easy to verify that $q^n = q^*$ follows. //

From the above proposition, we know that the ACPE can be at most second best, barring the almost impossible exceptional cases. The rest of this article is devoted to the analysis and comparison of the social welfare obtainable at the ACPE in the two alternative liability regimes, in order to see which liability system should be second best preferred at the ACPE. We distinguish the two cases $q^* \geq q^n$ and $q^n > q^*$. The former case is discussed in the next section, and the latter case is discussed in section 4.

3. THE CASE WHEN $q^* \geq q^n$ IS SATISFIED

The case discussed in this section offers us a clear-cut result, which is as follows.

Proposition 2: When $q^* \geq q^n$ is satisfied, the ACPE in the negligence regime is superior to the ACPE in the strict liability regime in terms of social surplus.

Proof: Considering the above condition and Proposition 1(i), $D(c + \delta) = q^* \geq q^n > q^s$ is satisfied. Under this condition, the marginal benefit of consumption always exceeds $c + \delta$ so that the increase of consumption always improves welfare even if we consider the expansion of harm that accompanies the increase of output by switching to the negligence regime; the conclusion follows. //

Diagrammatic illustration should help clarify the above result. The situation that is discussed in this section can be illustrated as shown in Figure 1.

[Figure 1 about here]

The social surplus obtained at the Pareto efficient resource allocation $W(PE)$ is characterized by the consumers' surplus at the marginal cost price $p^* = c + \delta$, minus fixed cost F, i.e., $\int_{c+\delta}^{\infty} D(p)dp - F$. By the same token, the social surplus at the ACPE in the strict liability regime $W(S)$ and that in the negligence regime $W(N)$ can be characterized. $W(S)$ is identified with the consumers' surplus at p^s, and $W(N)$ is the consumers' surplus at p^n minus the amount of the expected harm δq^n, i.e., $W(S) = \int_{p^s}^{\infty} D(p)dp$, and $W(N) = \int_{p^n}^{\infty} D(p)dp - \delta q^n$. From these representations, we can summarize the welfare cost formulae in the two liability regimes $L(S)$ and $L(N)$ as follows:

(5) $L(S) = W(PE) - W(S) = \int_{c+\delta}^{p^s} D(p)dp - F,$

(6) $L(N) = W(PE) - W(N) = \int_{c+\delta}^{p^n} D(p)dp - F + \delta q^n.$

In Figure 1, the first integrated part of the right-hand side of (5) is depicted as IAEK, while $F = p^s q^s - (c + \delta)q^s$ from (1) is depicted as IAHK. Therefore, L(S) coincides with the triangle AEH. On the other hand, the integrated part of the right-hand side of (6) is JBEK. As $F = (p^n - c)q^n$ from (2), $F - \delta q^n = (p^n - (c + \delta))q^n$ is depicted as JBGK. Therefore, L(N) can be depicted as the triangle, BEG. Comparing the two triangles AEH and BEG, L(N) is definitely smaller than L(S) for the amount ABGH, which corresponds to the net social value of additional consumption made possible by switching from the strict liability regime to the negligence regime.

4. THE CASE WHERE $q^n > q^*$ IS SATISFIED

Let us consider the alternative case $q^n > q^*$ in this section. This case is illustrated in Figure 2.

[Figure 2 about here]

The welfare cost formulae (5) and (6) are still applicable to this case as well. The integrated part of the right-hand side of (5) is depicted as IAEJ in Figure 2, while F coincides with IACJ. Therefore, $L(S)$ is identified as the triangle AEC. The integrated part in the right-hand side of (6) coincides with (minus)JEBK; F coincides with KBGL and δq^n equals JHGL. Therefore, $L(N)$ equals the triangle EHB.

This diagrammatic illustration clarifies why the clear-cut result in the previous section cannot be carried over to the present case. The welfare cost of the two liability regimes $L(S)$ and $L(N)$ now depends on the relative distance of q^s and q^n from the optimum consumption level q^*, and it is not *a priori* determinable. However, we have some interesting comparative static results.

Proposition 3: As the level of the fixed cost F rises,

(i)the welfare loss in the strict liability regime $L(S)$ definitely increases,

(ii)the welfare loss in the negligence regime $L(N)$ decreases iff $q^n > q^*$.

Proof: (i) Differentiating $L(S)$ in (5) with respect to F while considering p=p(F), we have

(7) $$\frac{dL(S)}{dF} = D(p^s)\frac{dp^s}{dF} - 1,$$

where $\frac{dp^s}{dF}$ is $p'(F)$ evaluated at $p = p^s$. By rewriting relation (1) as $p(F) = c + \delta + \frac{F}{D(p(F))}$ and differentiating it with respect to F, again evaluating it at $p = p^s$, we have $\left[1 + \frac{FD'(p^s)}{(q^s)^2}\right] D(p^s)\frac{dp^s}{dF} = 1$. However, from supposition (3), we have $0 < \left[1 + \frac{FD'(p^s)}{(q^s)^2}\right] < 1$, so that $D(p^s)\frac{dp^s}{dF} > 1$ follows, and from (7), we have $\frac{dL(S)}{dF} > 0$.

(ii) Differentiating $L(N)$ in (6) with respect to F while considering $p = p(F)$, we have

(8) $$\frac{dL(N)}{dF} = \left[1 + \delta\frac{D'(p^n)}{D(p^n)}\right] D(p^n)\frac{dp^n}{dF} - 1,$$

where $\frac{dp^n}{dF}$ is $p'(F)$ evaluated at $p = p^n$. By rewriting relation (2) as $p(F) = c + \frac{F}{D(p(F))}$ and differentiating it with respect to F, again evaluating it at $p = p^n$, we have $\left[1 + \frac{FD'(p^n)}{(q^n)^2}\right] D(p^n)\frac{dp^n}{dF} = 1$. Substituting the relation into (8), we have $\frac{dL(N)}{dF} = \Big[1 +$

$\delta \frac{D'(p^n)}{D(p^n)}\Big] \left[1 + \frac{FD'(p^n)}{(q^n)^2}\right]^{-1} - 1$. Since $0 < \left[1 + \frac{FD'(p^n)}{(q^n)^2}\right] < 1$, we have $\frac{dL(N)}{dF} < 0$ iff $\delta \frac{D'(p^n)}{D(p^n)} < \frac{FD'(p^n)}{(q^n)^2}$, which is in turn identical to $q^n > \frac{F}{\delta}$. This inequality is equivalent to $c + \delta > c + \frac{F}{q^n} = p^n$, which is equivalent to $q^n > q^* = D(c + \delta)$ because of the consistency with the demand condition. //

The implication of the above proposition is clear enough. As for the case under discussion in this section, as F becomes larger, the negligence regime, socially, becomes increasingly preferable to the strict liability regime.

In contrast, the next proposition makes a case for the adoption of the strict liability regime.

Proposition 4: As the level of the unit expected harm δ increases,

(i)the welfare loss at the negligence regime $L(N)$ increases iff $q^n > q^*$.

(ii)the welfare loss at the strict liability regime $L(S)$ decreases iff $\theta\varepsilon < \frac{q^* - q^s}{q^*}$,

where $\theta \equiv \frac{F}{(c+\delta)q^s + F}$ and $\varepsilon \equiv -\frac{p^s}{q^s} D'(p^s)$.

Proof: (i) Considering pricing condition (2), p^n and hence q^n cannot be affected by the change of δ. Therefore, from (6), $\frac{dL(N)}{d\delta} = -D(c + \delta) + q^n = q^n - q^*$, and the result follows.

(ii) Differentiating $L(S)$ in (5) with respect to δ while considering $p = p(\delta)$, we have $\frac{dL(S)}{d\delta} = D(p^s)\frac{dp^s}{d\delta} - D(c + \delta) = q^s \frac{dp^s}{d\delta} - q^*$, where $\frac{dp^s}{d\delta}$ is $p'(\delta)$ evaluated at $p = p^s$. Therefore, $\frac{dL(S)}{d\delta} < 0$ iff $\frac{q^*}{q^s} > \frac{dp^s}{d\delta}$. Substituting (4), evaluated at $p = p^s$, this is equivalent to $\frac{q^*}{q^s}\left[1 + \frac{FD'(p^s)}{(q^s)^2}\right] > 1$. Rearranging terms, and substituting the definitions of θ and ε and (1), result (ii) follows. //

This shows that an increase in the expected external harm makes the choice of the negligence scheme socially less preferable. In contrast, the effect on the desirability of the strict liability regime is ambiguous; however, it is suspected that in many cases, the strict liability regime becomes more desirable socially as expected harm increases.

5. CONCLUSION

The conclusion of this article seems clear enough. The rigorous proofs of Shavell (1980) and Polinsky (1980) indicate that, the strict liability regime is socially more preferable to the negligence regime for controlling the external harm caused by firms, if the market is perfectly competitive. Once imperfect competition is introduced, however, the result can be easily overturned.

In this article, we introduced imperfect competition by considering the case of a natural monopoly; however, the environment remained quasi-competitive, either as a result of the second-best regulation of the government or the competitive pressure of potential entry created by the contestability of the market. Even in this quasi-competitive case, it is expected that in most cases, the negligence regime is socially more desirable than the strict liability regime. This is due to the fact that under conditions of natural monopoly, the strict liability scheme requires firms to set very high prices in order to cover both their fixed costs and high damage payments. On the other hand, the effect of excessive provision under the negligence scheme that is responsible for economic inefficiency in perfectly competitive market conditions is weakened when there is a natural monopoly. This is because in a natural monopoly firms can charge higher prices than in perfect competition in order to cover their fixed costs.

If we were to consider further cases of a monopolistic economy, it may be expected that the negligence scheme would have emerged as the more preferable liability rule for society than the case discussed in this article. This is because, as the monopoly power of a firm becomes stronger, its supply of products becomes smaller than the economy analyzed in this article, so that the case of the firm discussed in section 3 is more likely to apply, and the negligence regime becomes definitely more efficient.[3] We hope that the present article has shed some light on the relationship between the market structure and the socially desirable liability system to firms.

[3] The desirability of the negligence regime with monopoly is analyzed by Polinsky and Rogerson (1983) for the case of product liability.

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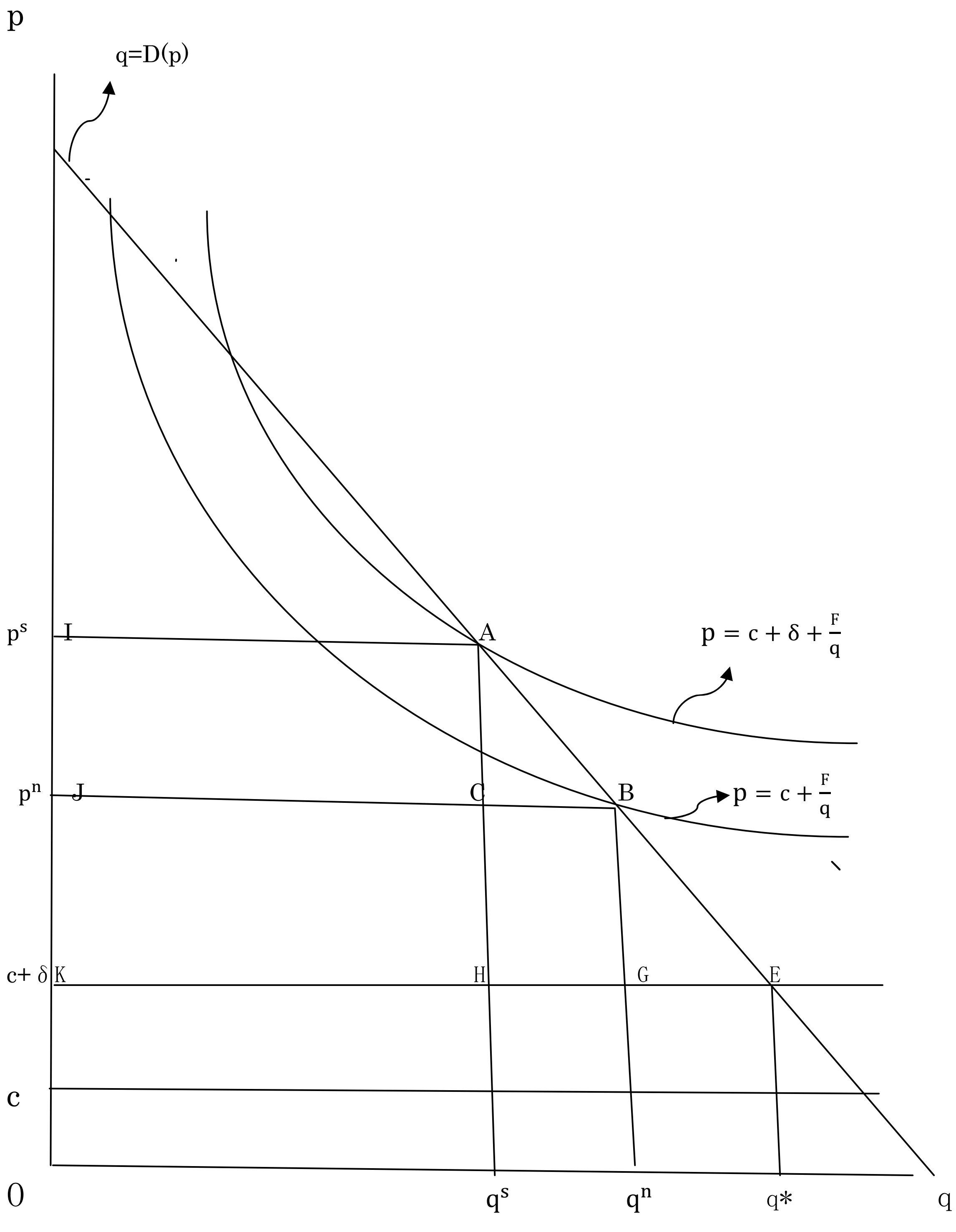

Figure 1

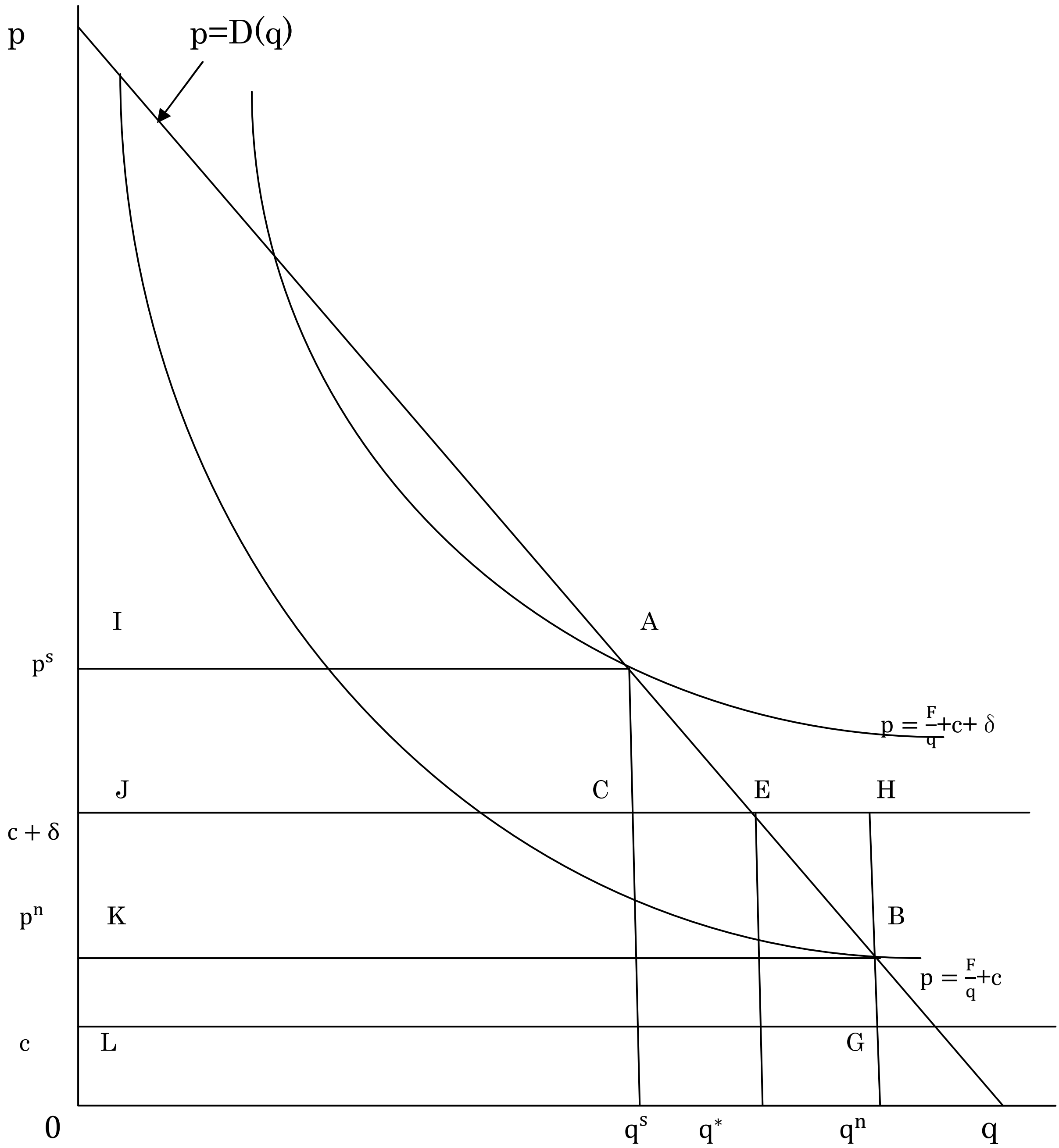

Figure 2