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Product Safety, Liability Rules and Retailer Bankruptcy

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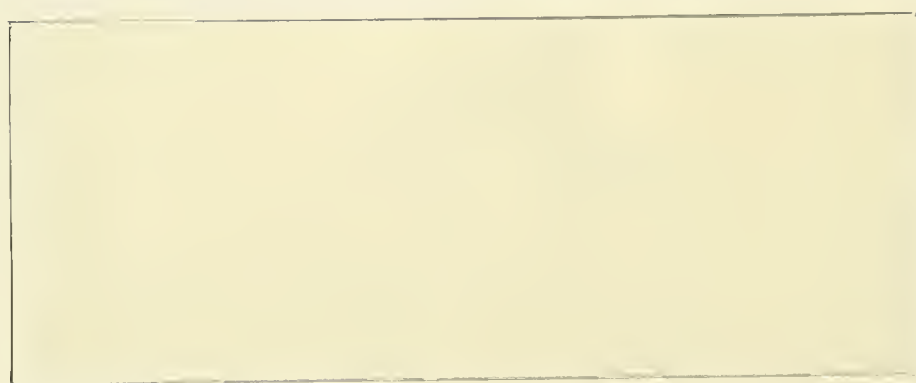
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Number 304

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Product Safety, Liability Rules and Retailer Bankruptcy

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Abstract

In this paper, we examine the levels of care which would be chosen by a monopolistic manufacturer and competitive retailer, when both the manufacturer and retailer can affect the probability of an accident and when the manufacturer cannot observe ex ante the care chosen by the retailer. We show that if retailer bankruptcy is not possible, retailer liability is superior to manufacturer liability. If retailer bankruptcy is possible, the equilibrium contract between the manufacturer and retailer will include positive profits for the retailer and inefficient levels of care. Society can improve on the equilibrium contract by either increasing the retailer's share of liability or by increasing the retailer's "due care standard". If bankruptcy costs are sufficiently high, the positive profits and inefficiencies are eliminated.

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I. Introduction

Whenever the manufacturer of a potentially hazardous product does not also directly distribute it to the consumer, there exists a problem of inducing proper precautionary behavior from the retailer. Ethical drugs are dangerous unless the prescriptions are filled and the consumer informed about their use, in an appropriate manner. Automobiles, power tools, and other equipment require a kind and degree of dealer service sufficient to insure they are delivered without serious defect. Electrical appliances can be deadly if the sale is not accompanied by inspections, proper installation, and education as to use. Indeed, any product which when accompanied by inadequate advice, installation, or inspection imposes undue risk on the final consumer falls into this category if manufacture and sale are undertaken by separate firms.

From either the perspective of social efficiency (i.e., the minimization of the expected value of all accident related costs) or the maximization of manufacturer's profits, this problem can be solved by any of the negligence-based, common-law product liability rules or their contractual equivalents. For example, consider the case in which there were no cost effective safety precautions which can be undertaken by the consumer and the rule that the manufacturer would be strictly liable for accident costs unless the retailer used less than the efficient due care level in which case the retailer would be liable. Under these circumstances it is well known that the two parties in equilibrium would choose the economically efficient levels of safety inputs. This is true of any of the negligence based common law rules discussed in Brown [1973]. In addition without imposition by the courts of any of these rules, the manufacturer and retailer would agree to a contingent contract which would be one of these rules equivalent. For any contract

which did not minimize social costs there would exist one which did while producing higher profits for both parties.

The proper functioning of these rules, however, requires two key assumptions. First, care is assumed observable by the parties, at least ex post. And second, all agents are presumed to honor their legal or contractual obligations. In this paper, we examine the impact both on market equilibria and optimal legal rules (a) whether or not information is ever available about retailer care and, more centrally (b) when the retailer can escape large liabilities through bankruptcy.

The market outcomes involve various contracts which create value in the retail franchise so that the retailer exhibits some amount of care and does not go bankrupt if a defect causes loss to the consumer. These equilibria, in general, are inefficient. It may, then, be advisable for the courts to adopt rules other than those to which the parties would have agreed.

This work is a special case of a more general principal-agent problem. The same sort of incentive management situations occur whenever a retailer's quality or quantity inputs are costly to observe and when the costs of his mis-, mal-, or nonfeasance are borne by others. Creating a value to the franchise which could be potentially forfeited can generate retailer behavior desirable from the perspective of manufacturer profits if not of economic efficiency. Our model involves a retailer whose care is not observable ex ante and who has no exogenously given reason for staying in business. On the other hand, our manufacturer's safety inputs are known by all, perhaps because they are observable, perhaps because of reputation. Further, it is known that he will not declare bankruptcy to avoid liability. This latter condition could be handled by a competitive firm with sufficiently large equity financing. It may be easiest, though, for the purpose of both

assumptions if we visualize the manufacturer as a monopolist. As the single firm in the market, his product reputation would be known, and given positive profits, he would not opt for bankruptcy.

The results of section II are derived without considering retailer bankruptcy. The results when care is observable ex post replicate the received literature in our specific context. The results when care is not observable are a useful contrast with full retailer liability being both the efficient legal rule and the equilibrium contract when retailer bankruptcy is not possible. In sections III and IV bankruptcy is possible. In section III, positive retailer profits are created so that solvent retailer strategies will be chosen, both when care is observed ex post and when it is not. In section IV, the equilibrium contracts are compared with the efficient contract. In each case, it is found that efficiency could be improved on by either modifying the contractual due care standards or the extent of retailer liability. In Section V, consumer liability and bankruptcy costs are discussed. The results are summarized in Section VI.

II. The Structure of the Problem: Liability Rules When Bankruptcy is not Possible

The Model:

In this section, we will present several liability-sharing rules when it is impossible or extremely costly for the retailer to declare bankruptcy to escape liability. We show that retailer liability is Pareto superior to manufacturer liability. Under retailer liability, the manufacturer and the retailer will both exercise the optimal levels of care.¹ The monopoly quantity of output, given expected unit costs, will be sold. Under manufacturer liability, expected unit costs are no longer minimized. Consequently, monopoly profits and consumers' surplus are higher in the first case. Competitive retailers earn zero profits in either case.

Definitions and Assumptions

Three possible assignments of liability are discussed: retailer liability, manufacturer liability and consumer liability.² In each case, it is assumed that the manufacturer is a monopolist, who sells his output to many perfectly competitive retailers. The retailer will purchase one unit of output from the manufacturer each period at the wholesale price, q . He will use some care, y , in his handling of the product and sell the output to the consumer at the retail price, p . Let m be the markup, $p-q$.

The probability of an accident, $\pi(x,y)$, depends on the care used by the manufacturer, x , and the care used by the retailer, y . We assume that both x and y are measured in dollars, x is observable by all agents and the observability of y is a distinguishing characteristic of the models that follow. The probability function is decreasing in its arguments and strictly convex.³ The cost of an accident is A . The cost-minimizing level of care for the manufacturer, given the care used by the retailer, is $x^*(y)$. Similarly, the retailers' cost minimizing care is a function of the

manufacturer's care: $y^*(x)$.⁴ The efficient care levels will be denoted x^* and y^* .⁵

The consumers' demand is given as a function of the expected full price: the retail price plus the expected uncompensated accident costs [Oi, 1973]. For retailer liability and manufacturer liability, this is simply the retail price, since the consumer is fully compensated in the event of an accident. The demand function is $Q(p)$, where p is the expected full price and Q is the total quantity of output sold per period.

Case 1: Retailer Liability.

Under retailer liability, the manufacturer will maximize expected profits subject to two constraints: First, the retailers are selecting a level of care to maximize expected profits, and second, the competitive retailers earn zero expected profits. Since the retailers are paying the entire cost of the accidents, they will minimize expected accident costs given the care chosen by the manufacturer, i.e., the first constraint becomes: $y = y^*(x)$. The second constraint gives the markup as a function of the level of care used by the manufacturer and the retail price. This is the markup for which the optimizing retailer's profit per unit is zero.

With retailer liability, the manufacturer's problem is then:

$$[1.1] \quad \max Q(p)(p - m - x),$$

subject to:

$$[1.1a] \quad m = y^*(x) + \pi(x, y^*(x))A.$$

By substituting [1.1a] into the maximand, we see that the manufacturer's problem can be simplified:

$$[1.2] \quad \max Q(p)(p - x - y^*(x) - \pi(x, y^*(x))A),$$

where $y^*(x)$ is chosen to minimize expected unit costs, $x + y + \pi(x, y)A$.

When we solve this problem, we see that the manufacturer selects the optimal level of care, given y , and that he selects the monopoly quantity of output, given that expected unit costs are minimized. Expected unit costs are $x^0 + y^0 + \pi(x^0, y^0)A$, where x^0 and y^0 are the optimal levels of care.

It is not surprising that both the manufacturer and the retailer select the optimal care levels. The expected accident costs are being paid by the retailer, providing him with the incentive to exercise care. He will set the marginal cost of care equal to the marginal reduction in his expected liability. In addition, the manufacturer sees a reduction in expected accident costs as an increase in the wholesale price he can charge at any level of output. Therefore, he, too, has the incentive to minimize expected accident-related costs.

Case 2: Manufacturer Liability:

Given that we have assumed that it is impossible for the manufacturer to monitor the retailer's care, the retailer will use the minimum possible level of care when the manufacturer is liable for all accident costs. This level of care has been normalized to zero. Since the retailer's cost is zero, the wholesale price at which the retailer is earning zero profits is p , the retail price, i.e., the markup is zero.

The manufacturer's problem is then:

$$[2.1] \quad \max Q(p)(p - x - \pi(x, 0)A).$$

His first order conditions are:

$$[2.2a] \quad 1 + \pi_x(x, 0)A = 0, \text{ and}$$

$$[2.2b] \quad Q(p) = (p - x - \pi(x, 0)A)Q'(p).$$

The manufacturer sees the full expected accident costs; and, therefore, he will minimize expected accident-related costs given that the retailer

exercises no care. The equilibrium levels of care are: $y=0$, and $x=x^*(0)$. Expected unit costs are higher under manufacturer liability than under retailer liability.

Again, the manufacturer will sell the monopoly level of output, given expected unit costs. Since expected unit costs are higher than in case 1, the manufacturer will sell less output than in case 1, at a higher price. Consumers' surplus is lower than under retailer liability and the monopolist's profits are lower than under retailer liability. The competitive retailers earn zero profits under either system.

In Figure 1, we have graphed the manufacturer's problem under retailer liability and under manufacturer liability. Under retailer liability, the retailer will use the optimal level of care, given the behavior of the manufacturer. Also, the manufacturer uses the cost minimizing level of care. Total expected unit costs are minimized. Expected unit costs under retailer liability are OA . The manufacturer, in setting quantity, will consider total expected unit costs. He pays x^0 himself, and sees $y^0 + \pi(x^0, y^0)A$ as a reduction in the wholesale price. With retailer liability, he will sell Q_R at a price P_R . The manufacturer's profits plus consumer's surplus is $ABCD$.

Under manufacturer liability, the retailer will use the minimum level of care, 0, and the manufacturer will use the optimal level of care, given the retailer's behavior. Expected unit costs for the manufacturer are OA' . This is higher than total expected unit costs under retailer liability. The manufacturer sells Q_M units at a price P_M . Consumer's surplus plus manufacturer's profits are $A'B'C'D$. This is contained in $ABCD$, profits plus consumer's surplus under retailer liability. Both consumer's surplus and manufacturer's profits have fallen. Therefore, retailer liability is Pareto superior to manufacturer's liability whenever it is not feasible for the

Price
Expected Unit Cost

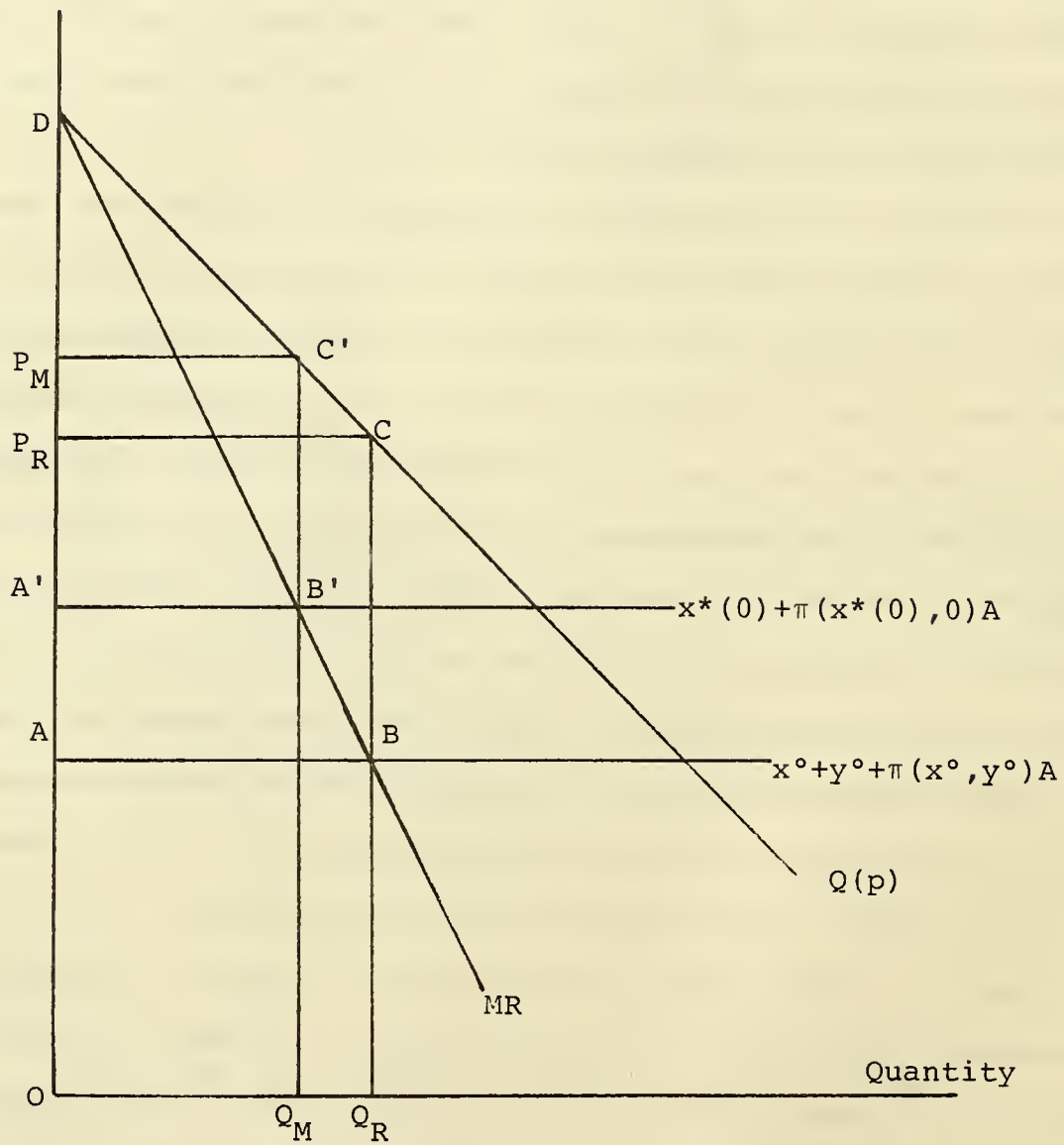


Figure 1: Retailer Liability and Manufacturer Liability, when Retailer Bankruptcy is not feasible.

retailers to go bankrupt to escape liability.

The explanation is straightforward. With retailer liability, the retailer has the incentive to minimize his expected unit costs, $y + \pi(x,y)A$. He will choose the optimal level of care, given the behavior of the manufacturer. Accident related costs are also considered by the manufacturer, since they are seen as an increase in the markup.

With manufacturer liability, when the manufacturer cannot monitor the care of the retailer, expected accident costs do not enter into the retailer's decision and total expected unit cost must exceed expected unit cost under retailer liability. Since the total costs are higher, the manufacturer will sell a lower quantity of output at a higher retail price.

Case 3: Care-based Contracts for Indemnification.

When the manufacturer can observe ex post the care used by the retailer, a more complex incentive system can be used. The liability of the retailer can be based on his care level. If the retailer cannot go bankrupt to escape liability, the retailer can always be induced to use the optimal level of care.

When the retailer's share of liability can depend on his level of care, the manufacturer can set up an incentive structure which resembles the negligence system. The retailer is liable for all accident costs if he chooses a level of care, y , less than the optimal level of care, y° . Otherwise, the manufacturer is liable for all accident costs. It is straightforward to show that the retailer will select the optimal level of care.⁶ If the retailer uses y° , the manufacturer pays all accident costs. The retailer's costs are simply y° . If he chooses any care level below y° , his expected unit costs are $y + \pi(x^\circ, y)A$. Since y° minimizes $x^\circ + y + \pi(x^\circ, y)A$, $y^\circ < y^\circ + \pi(x^\circ, y^\circ)A < y + \pi(x^\circ, y)A$, for all y . The retailer will always choose y° .

the manufacturer minimizes expected unit costs and will therefore choose x° .

Similarly, if the court can observe ex post the care used by the retailer, a liability system can be devised in which the retailer and the manufacturer select y° and x° , respectively. The manufacturer is liable if the retailer chooses at least y° . Otherwise the retailer is liable.

The results of cases 1 through 3 are summarized in Proposition 1:

Proposition 1: When retailer bankruptcy is not possible retailer liability is Pareto superior to manufacturer liability. Under retailer liability, the quality and quantity of output is higher, but the retail price is lower.

If the manufacturer can observe the retailer's level of care, the manufacturer can provide the retailer with the incentive to use the cost minimizing level of care. The quality and quantity of output will be the same as under retailer liability.⁷

III. Liability-Sharing Arrangements with Bankruptcy Possible.

Case 4: Care-based Indemnification when Bankruptcy is Possible

The Model

If bankruptcy is possible and if the consumer cannot observe retailer care or if the manufacturer is liable when the retailer goes bankrupt, the equilibria described in cases 1 and 3 are no longer feasible. The competitive retailer, expecting zero profits in the future, will prefer bankruptcy to paying the accident costs when incurred. Given that he will declare bankruptcy in the event of an accident, the incentive effects of the liability rule are diluted. In our model, the retailer would exercise reduced care and never pay damages if an accident occurs.

The monopolist can remedy this situation with a care-based liability contract and by guaranteeing the retailer positive expected profits in the future. If the present discounted value of his expected future profits when he fulfills the contractual requirements are greater than or equal to his most profitable bankruptcy strategy, the retailer will exhibit contractual "due care" and not go bankrupt when an accident occurs. To guarantee the retailer positive expected profits, the manufacturer must control the retail price of output and limit quantity. Each retailer will sell one unit of output each period. The time period is then defined by how much output the retailer sells. The interest rate per period is r , decisions are made at the beginning of each period, while payments are made at the the end. The probability and cost of an accident are described in section II, above. It is assumed that litigation is costless and that all accidents will result in the manufacturer and retailers paying total damages of A .

The Manufacturer's Problem

If the manufacturer can observe ex post the care used by the retailer, the manufacturer can set up an incentive system which is similar to the negligence system. The manufacturer chooses a "due care standard", y_d , and the retailer is liable for some proportion of accident costs, θA , only if he used a level of care less than y_d .

The manufacturer must select the "due care standard", the retailer's conditional liability, θ , and the manufacturer's level of care, x^* . The retailer's liability must be sufficiently high that the retailer will choose to use the care level, y_d , rather than use some lower level of care and pay the expected accident costs. In addition, the retailer's expected future profits must be sufficiently high that the retailer will not pursue a "fly-by-night" strategy in which he would choose bankruptcy after an accident occurs.⁸

The manufacturer's problem is then:

$$[4.1] \quad \max \quad Q(p)[p-m-x^*-\pi(x^*,y_d)A],$$

subject to:

$$[4.2] \quad y_d \leq y + \theta\pi(x^*,y)A, \text{ for all } y \leq y_d,$$

and:

$$[4.3] \quad \frac{m - y_d}{r} \geq \max_y [m-y] \sum_{i=1}^{\infty} \left(\frac{1-\pi(x^*,y)}{1+r} \right)^i = k(x^*,m,r),$$

where $k(x^*,m,r)$ is the present discounted value of the retailer's most profitable bankruptcy strategy. In calculating k , profits in each period, $m-y$, are discounted by both the interest rate and the probability of no accident occurring by the period (i.e., $(1-\pi)^\lambda$ is the probability of no accident occurring through period λ .) Solving the expression on the right hand

side of [4.3], we see that:

$$[4.3a] \quad k(x^*, m, r) = \max_y [m - y] \frac{1 - \pi(x^*, y)}{r + \pi(x^*, y)}.$$

Since the retailer's share of liability, θ , does not appear in the objective function or in constraint (4.3), constraint (4.2) is never binding. The retailer's conditional liability can be set equal to 1, with a "due care standard" as high as $y^*(x^*)$. Since the manufacturer's profits are a decreasing function of the markup, constraint (4.3) will always hold as an equality:

$$[4.3b] \quad y_d = m - rk(x^*, m, r).$$

This can be rewritten as: $m = M(x^*, y_d, r)$.⁹

The manufacturer will maximize:

$$[4.4] \quad Q(p) [p - M(x^*, y_d, r) - x^* - \pi(x^*, y_d)A].$$

Differentiating with respect to price, we see that:

$$[4.5] \quad Q'(p) [p - M(x^*, y_d, r) - x^* - \pi(x^*, y_d)A] + Q(p) = 0.$$

The manufacturer will then choose x^* and y_d to minimize his expected unit costs:

$$[4.6] \quad \min_{x^*, y_d} C(x^*, y_d) = x^* + \pi(x^*, y_d)A + M(x^*, y_d, r).$$

He chooses the monopoly price and quantity of output, given his expected unit costs, $C(x^*, y_d)$.

Minimizing these costs implies:

$$[4.7] \quad 1 + \pi_x(x^*, y_d)A = - \frac{\partial M}{\partial x}.$$

and:

$$[4.8] \quad 1 + \pi_y(x^*, y_d)A = 1 - \frac{\partial M}{\partial y_d}.$$

The right hand side of condition [4.7] is negative¹⁰, i.e., increasing the manufacturer's care level will increase the value of the optimal bankruptcy strategy. The level of care chosen by the manufacturer is then less than $x^*(y_d)$.

From equation [4.8], we see that the manufacturer will choose the retailer's "due care standard" to be less than the cost minimizing level of retailer care, given his care level, i.e., $y_d < y^*(x^*)$, since $\frac{\partial M}{\partial y_d}$ is greater than one and the right hand side of [4.8] is negative.

The explanation is straightforward. When the manufacturer increases his level of care, he reduces the probability of an accident for every y . This will increase the expected present discounted value for the retailer's bankruptcy policy for every y , and therefore will increase the value of the optimal bankruptcy policy. When the manufacturer increases his care level, he increases the profits he must share with the retailer to prevent the retailer from selecting the bankruptcy strategy. When he considers this additional cost of care, he will select a sub-optimal care level.

Similarly, since if the due care standard is increased the markup must increase by more than the increase in y_d , the cost to the manufacturer of increase y_d is greater than the resource cost. Therefore he will choose a suboptimal "due care standard" given x .

In this case, retailer size will influence the degree of inefficiency. As noted above, the retailer's volume is implicitly given by r , since this is the interest per period between sales. As the retailer gets large, r approaches 0. From [4.7] and [4.8] we note that if $\frac{\partial M}{\partial x}$ were to approach zero and $\frac{\partial M}{\partial y_d}$ were to approach 1, the equilibrium contract will approach the efficient allocations of x and y_d . These derivatives converge with certain restrictions on $\pi(x, y)$.¹¹ Inspection of [4.3] gives the intuition of these

results. As r becomes small, the present value of any positive level of any "non-negligent" profits dominates the present value of the best bankruptcy strategy as long as the accident technology is sufficiently regular (i.e., $\pi(x, y_d)$ is not zero and $\pi_x(x, y)$ is bounded from below.) If so, the distortion introduced by preventing retailer bankruptcy vanishes.

These results are summarized in Proposition 2:

Proposition 2: When it is possible for the retailer to go out of business and when the manufacturer can select a liability sharing arrangement which depends on the ex post observation of retailer care:

1. The manufacturer will choose a level of retailer liability and the "due care standard", y_d , for the retailer, such that the retailer will always choose to use y_d , and avoid liability in the event of an accident.
2. The manufacturer will choose a level of retailer care which is less than optimal, given the care used by the manufacturer.
3. The manufacturer will choose a level of manufacturer care which is less than that which is optimal, given that the retailer uses y_d .
4. The manufacturer will sell the monopoly quantity of output, given his expected unit costs. These costs include the expenditures of both the manufacturer and the retailer of accident avoidance, the total expected cost of accidents and the profits per unit of output he must share with the retailer.
5. Generally, as the quantity of output handled by each retailer increases, the care used by the manufacturer and the retailer will approach the cost-minimizing levels of care.

Case 5: Indemnification when bankruptcy is possible and retailer care is unobservable.

The manufacturer will maximize expected profits over p , x and θ , subject to two constraints: The retailer will choose a level of care, y , to minimize expected unit costs, and the retailer's expected future profits must be sufficiently high that he would not prefer bankruptcy to paying his share of damages in the event of an accident. Since care cannot be observed ex post, θ cannot be care-based and will enter as a non-trivial variable.

The manufacturer's problem is:

$$[5.1] \quad \max [p - m - [x + (1 - \theta)\pi(x, y)A]]Q(p)$$

subject to:

$$[5.1a] \quad m - [y + \theta\pi(x, y)A] > r\theta A, \text{ and}$$

$$[5.1b] \quad y = y(x, \theta),$$

where $y(x, \theta)$ is given by the retailer's first order condition: $1 + \theta\pi_y(x, y)A = 0$. Since θ is restricted to the unit interval, it is clear that the retailer will choose a level of care less than or equal to that which is optimal given the care chosen by the manufacturer. He will choose $y^*(x)$ only if $\theta = 1$.

By substituting constraints [5.1a] and [5.1b] into the objective function [5.1], the problem can be rewritten as:

$$[5.2] \quad \max [p - [x + (1 - \theta)\pi(x, y(x, \theta))A + m]]Q(p).$$

The first term of the maximand is the manufacturer's profits per unit. His costs include his direct and indirect costs. His direct costs are his avoidance costs plus his expected liability. While his indirect cost is the markup: the retailer's costs per unit plus the profits which are necessary to prevent retailer bankruptcy. By substituting in constraint [5.1a], we get:

$$[5.3] \quad \max [p - [x + y(x, \theta) + \pi(x, y(x, \theta))A + r\theta A]]Q(p).$$

By differentiating [5.3] with respect to p , x , and θ , we find the manufacturer's first order conditions:

$$[5.4] \quad Q(p) + [p - [x + y + \pi(x, y)A + r\theta A]]Q'(p) = 0,$$

From condition [5.4] and constraint [5.1b], we see that the manufacturer will sell the monopoly quantity of output, given his expected unit costs. We note that his total expected unit costs are:

$$[5.5] \quad C(x, \theta) = x + y(x, \theta) + \pi(x, y(x, \theta))A + r\theta A.$$

In this case, his expected unit costs are the sum of his accident avoidance measures, x , his share of liability, $(1-\theta)\pi(x, y)A$, and the retailer's mark-up. The retailers mark-up is composed of: the retailer's accident-related costs, $y + \theta\pi(x, y)A$, and the per unit profits he must share with the retailer to prevent bankruptcy, $r\theta A$.

First order conditions with respect to x and θ imply:

$$[5.6] \quad 1 + \pi_x(x, y)A = - \frac{\partial y}{\partial x} [1 + \pi_y(x, y)A], \text{ and}$$

$$[5.7] \quad [1 + \pi_y(x, y)A] \frac{\partial y}{\partial \theta} = - rA.$$

The level of care chosen by the manufacturer is determined by condition [5.6]. Using the retailer's first order condition, this can be rewritten:

$$[5.6'] \quad 1 + \pi_x(x, y)A = (1-\theta)\pi_y(x, y)A \frac{\partial y}{\partial x}.$$

The manufacturer is selecting the optimal level of care, given y , when the left hand side of [5.6'] is zero. The left hand side of [5.6'] is an increasing function of x , so the manufacturer will select a care level higher than $x^*(y)$ if and only if the right hand side of [5.6'] is positive. If the right hand side of [5.6'] is negative, the manufacturer will select a level of care below $x^*(y)$. It is positive (negative), and the manufacturer will select a care level above (below) $x^*(y)$, if the two types of care are

complements (substitutes).¹²

The explanation is straightforward. The manufacturer must take into account the relationship between the care he chooses and the cost minimizing care for the retailer. If the two types of care are substitutes, an increase in the manufacturer's care will reduce the level of care selected by the retailer. The return to the manufacturer is then less than the reduction in expected accident costs, and the manufacturer will select a level of care less than $x^*(y)$. If the two types of care are complements, the manufacturer will see an increase in the retailers' care when he increases his care. The return to care then exceeds the reduction in expected accident costs and the manufacturer will select a care level greater than $x^*(y)$.

The profit-maximizing liability-sharing arrangement is given by the manufacturer's condition [5.7]. The left hand side of [5.7] is the increase in the profits which the manufacturer must share with the retailers in each period, if the proportion of damages paid by the retailers is raised. The right hand side of [5.7] is the reduction in the manufacturer's expected liability each period, resulting from the incentive effects of raising θ . As the interest rate falls, the left hand side of [5.7] decreases and the share of damages paid by the retailer increases. As r approaches zero, θ approaches one, and the levels of care used by the manufacturer and the retailer approach x^0 and y^0 , the cost minimizing levels of care. Since the interest rate is based on the time period between sales, a declining interest rate can be interpreted as an increase in the amount of output handled by each retailer. As the retailer becomes large, the per unit profits which must be earned to prevent bankruptcy fall, and it becomes less expensive to the manufacturer to create the appropriate incentives. The care used by each firm approaches the optimal care. The retailer's care increases because he

is paying a higher fraction of the accident costs, and the manufacturer's care approaches the optimal level as the right hand side of equation [5.6'] approaches zero.

These results are summarized in Proposition 3:

Proposition 3: When it is possible for the retailer to go out of business and when the manufacturer can select a liability-sharing arrangement:

1. The manufacturer will select a liability-sharing arrangement with θ less than one. The retailer will not pay the entire cost of the accident.
2. Since the retailer is paying less than the full accident costs, he will choose a level of care less than that which is optimal given the care selected by the manufacturer, i.e., y is less than $y^*(x)$.
3. The relationship between the level of care chosen by the manufacturer and $x^*(y)$ depends on whether the two types of care are substitutes or complements. If the two types of care are substitutes (complements), the manufacturer will select a level of care less than (greater than) $x^*(y)$.
4. The manufacturer will sell the monopoly quantity of output, given his expected unit costs. These costs include the expenditures of both the manufacturer and retailer on accident avoidance, the expected cost of accidents and the profits per unit of output he must share with the retailer.
5. As the quantity of output handled by each retailer increases, the care used by the manufacturer and the retailer will approach the cost minimizing levels of care.

IV. Social Welfare and the Equilibrium Contract

When the government can determine the liability-sharing arrangement and when retailer care is observable ex post, social welfare can be improved by increasing the retailer's "due care standard".

Let y_d' be the liability-sharing arrangement selected by the monopolist. At y_d' , the monopolist's first order conditions hold. Profit maximization as defined by equations [4.1] through [4.3] implies that the manufacturer minimizes his private expected unit costs over x and y_d . The manufacturer's unit costs, [4.6], can be written as:

$$[6.1] \quad C(x, y_d) = [x + y_d + \pi(x, y_d)A] + [M(x, y_d, r) - y_d].$$

The first term on the right hand side of [6.1] is the expected social cost and the second term is the retailer's profits per period. A small change in y_d will result in no change in the manufacturer's expected unit costs, and therefore there will be no change in the monopoly quantity of output. Since there is no change in the quantity of output sold, there is also no change in the consumer's surplus. Since as shown in footnote 9, $\frac{\partial M}{\partial y_d} > 1$, an increase in the "due care standard" will result in an increase in the retailer's expected profits. Unit production costs plus unit expected accident costs, $x + y + \pi(x, y)A$, have declined.

In Figure 2, we have graphed the manufacturer's problem at the "due care standard" selected by the manufacturer, y_d' , and at $y_d'' = y_d' + \epsilon$. OE is the manufacturer's expected unit costs, $C(x, y_d')$, when he chose y_d' to minimize his these costs, so: $C_y(x, y_d') = 0$. Therefore, OE is also his expected unit costs with y_d'' , $C(x, y_d'')$. When the retailer's standard increases, the manufacturer must guarantee the retailer higher expected future profits to prevent bankruptcy. Since expected unit costs plus the retailer's profits has not changed, expected unit costs must fall when the retailer's profits have

Price
Expected Unit Cost

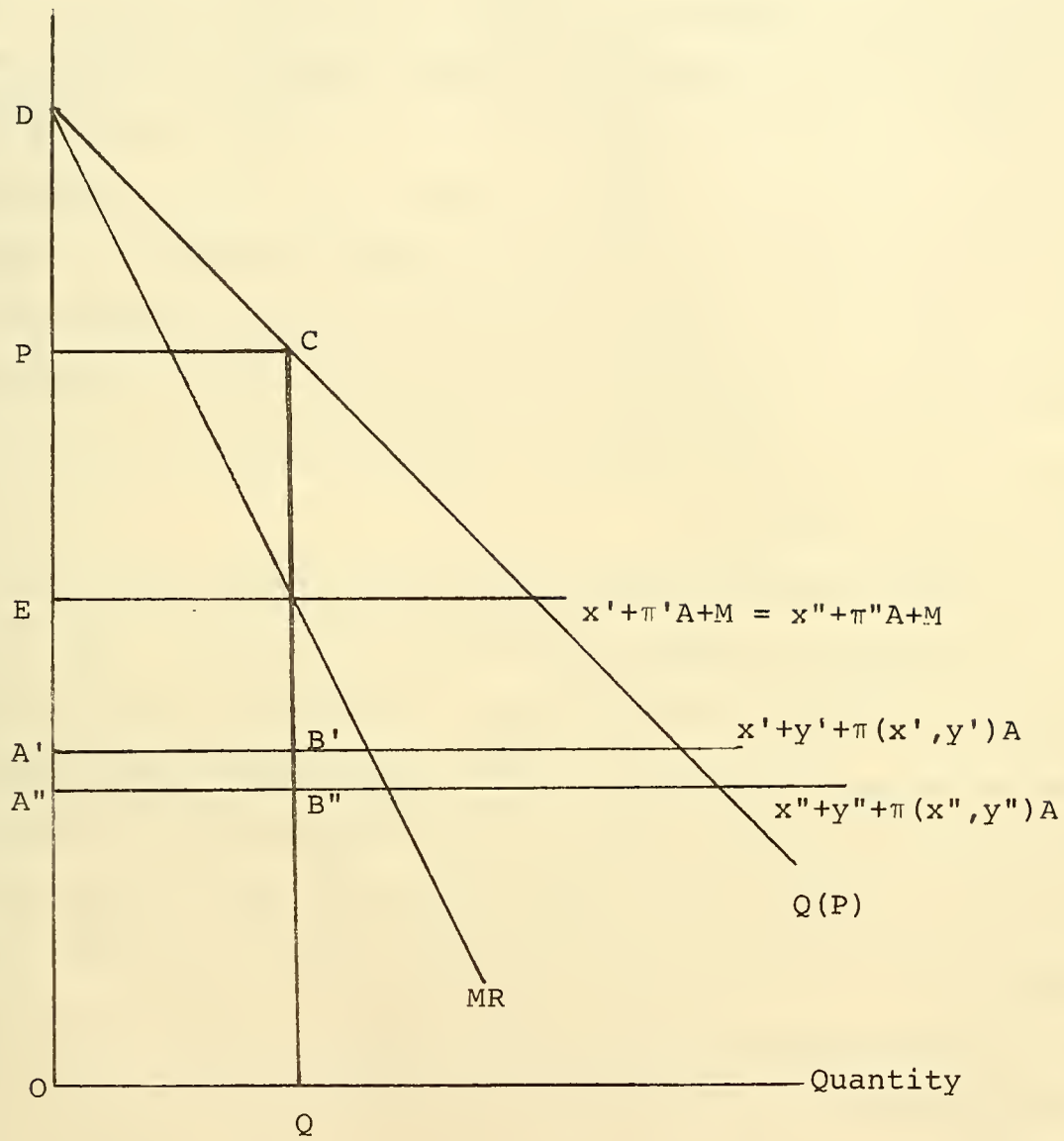


Figure 2: Increasing the Retailer's "due care Standard",

increased. OA' is expected unit costs, $x' + y' + \pi(x', y')A$, with the manufacturer's equilibrium contract. OA'' is expected unit costs when the retailer faces a higher "due care standard". OA' must be greater than OA'' . With either system, the manufacturer will sell OQ units at a retail price, OP . The manufacturer's profits and consumers' surplus are $EFCP$ and PCD , respectively. With θ' , the retailers' profits are $A'B'CP$. With the "due care standard" raised, the retailers' expected profits have increased to $A''B''CP$. The manufacturer's profits and the consumer's surplus are unchanged, but the increase in the retailer's standard has resulted in an increase in retailers' profits. Thus, when the government can alter the equilibrium contract, it should always increase the retailer's standard, over the level selected by the monopolist.

We can make a similar argument in the non-care-based case. Let θ' be the liability-sharing arrangement selected by the monopolist. At θ' , the monopolist's first order conditions hold. From condition [5.4], the manufacturer minimizes his expected unit costs, $C(x, \theta)$. A small change in θ will result in no change in the manufacturer's expected unit costs, and therefore there will be no change in the monopoly quantity of output. Since there is no change in the quantity of output sold, there is also no change in the consumer's surplus. But, an increase in the proportion of damages paid by the retailer will result in an increase in the retailer's expected profits. Unit production costs plus unit expected accident costs, $x + y + \pi(x, y)A$, have declined. Again, when the government can determine the liability-sharing arrangement, it should always increase θ over the level selected by the monopolist.

For any large change in y_d or θ , we see that the monopoly quantity problem is exacerbated. At the efficient contract, there will be a trade-off

between a decrease in the unit social costs and a reduction in the monopoly quantity of output. Proposition 4 follows.

Proposition 4: When the manufacturer can use a care-based contract for indemnification, society can always improve on the liability-sharing scheme selected by the monopolist by increasing the retailer's "due care standard".

Similarly, when the manufacturer cannot use a care-based contract for indemnification, society can always improve on the liability-sharing scheme selected by the monopolist by increasing the proportion of damages that are paid by the retailer.

V. Extensions

A. Consumer Liability

The allocation of resources under consumer liability depends on the amount of information available to the consumer prior to purchase. We will consider the allocations which would result from two extreme assumptions.

First, one can assume that the consumers have no retailer-specific information. They know the average level of care available. Here, when there are many retailers, the individual retailer is not rewarded for any increase in the safety of his output, and therefore has no incentive to exercise care. He will set y equal to zero. The manufacturer's optimization is:

$$[7.1] \quad \max Q(p^{C1})[p-x],$$

where p^{C1} is the "expected full price":

$$[7.1a] \quad p^{C1} = p + \pi(x,0)A.$$

By solving this optimization, we see that, the manufacturer will use the optimal level of care, given $y=0$, since the price depends on expected accident costs. The manufacturer will sell the monopoly quantity of output, given expected unit costs: $x^*(0)+\pi(x^*(0),0)A$. This is the same quantity and quality of output as in manufacturer liability.

Another possible assumption is that the consumer can determine the quality of output prior to purchase. Since the consumer can determine the expected full price of the output of any specific retailer, the consumer will choose the retailer with the lowest expected full price, and each retailer will have the incentive to use the cost-minimizing level of care, given the care used by the manufacturer. The retailer will choose $y^*(x)$. The manufacturer will maximize profits, subject to the constraint that the

retailer earns zero profits. His optimization is:

$$[7.2] \quad \max \quad Q(p^{C2})(q - x),$$

subject to:

$$[7.2a] \quad p = q + y^*(x),$$

and where p^{C2} is the expected full price when the retailer uses the cost minimizing level of care:

$$[7.2b] \quad p^{C2} = p + \pi(x, y^*(x))A.$$

By substituting the constraints into the maximand, we see that the cost-minimizing quality of output is produced and the monopoly quality of output is sold.

Since the consumer can observe retailer care, the retailer chooses the optimal level of care, given the care used by the manufacturer. Similarly, the quality of output sold by the manufacturer will affect the wholesale price. The manufacturer will choose the cost-minimizing level of care. As in the case of retailer liability, the output will be produced at the lowest expected unit cost, but the monopoly quantity of output will be sold. The equilibrium quality and quantity of output is the same as in retailer liability.

These allocations differ from cases one and two, respectively, only in the distribution of income among the consumers. Under retailer or manufacturer liability, the consumers involved in an accident will be compensated, whereas under consumer liability, the individuals involved are not compensated. Under consumer liability, the consumers have the same expected income as the other two systems, but in the absence of insurance,

their ex post incomes differ.¹³ Proposition 5 follows:

Proposition 5:

Consumer liability will result in the same quality and quantity of output as retailer liability if the consumers can judge the quality of output sold by each retailer.

When consumers know only the average quality of output available in the market, consumer liability will result in the same quality and quantity of output as manufacturer liability.

B. Bankruptcy Costs

The retailer's decision can also be examined when there are set-up costs financed out of retailer equity, which would be forfeited if the retailer goes bankrupt. These set-up costs could arise from non-convexities in the production process or may come from institutional arrangements such as a franchising fee imposed by a manufacturer.¹⁴ If these costs are sufficiently high, the manufacturer will either choose retailer liability, when retailer care is unobservable, or a "negligence" rule with the due care standard equal to y^0 , when retailer care is observable ex post.

When a care-based indemnity arrangement is possible, the manufacturer will choose to use a "due care standard", to maximize [4.1] subject to the following modification of constraint [4.3]:

$$[7.3] \quad \frac{m-y_d}{r} > \max_y (m-y-\pi(x,y)B) \sum_{i=1}^{\infty} \left(\frac{1-\pi}{1+r}\right)^i = k(x,m,B,r).$$

Inequality [7.3] includes the probability of incurring B in any period in which the firm continues to operate with a "fly-by-night" strategy. If B is at least \bar{B} , where $k(x,m,\bar{B},r)=0$, then m is equal to y_d and the manufacturer will minimize social costs, setting $y_d=y^0$.

When retailer care is unobservable, retailer liability will be chosen if the cost of bankruptcy to the retailer is at least A. The manufacturer's

second constraint becomes:

$$[7.4] \quad \frac{p - [q+y+\theta\pi(x,y)A]}{r} > \theta A - B.$$

If B is greater than or equal to A , the retailer will not choose a bankruptcy strategy for any θ on the unit interval. The manufacturer will then choose $\theta=1$, minimizing both private and social costs.

These results can be stated as:

Proposition 6: When care-based contracts are feasible and private bankruptcy costs, B , are such that $k(x,m,B,r) \leq 0$, the equilibrium "due care standard" is y° . Likewise, when care is not observable ex post and $B > A$, the manufacturer will set $\theta=1$ and the retailer will choose y° . With either assumption, when the cost of bankruptcy is sufficiently high, the retailer will be induced to choose the optimal level of care and the profit-maximizing manufacturer will then also select the optimal level of care.

If the manufacturer can observe ex post the retailer's care and the retailer's cost of bankruptcy is less than \bar{B} , $k(x,m,B,r)$ is greater than zero and consequently, $\frac{dM}{dy_d}$ is greater than one. From [4.8], we see that the manufacturer will choose a "due care standard" less than y° .

If the manufacturer cannot observe ex post retailer care, and if the cost of bankruptcy is less than A , the right hand side of equations [7.4] must be positive for any θ on the unit interval. Therefore, the manufacturer will choose a liability-sharing arrangement with θ less than one, and the retailer will choose a care level less than $y^*(x)$.

Proposition 4 can then be extended to include low bankruptcy costs. From [7.3] and [7.4] we can calculate the manufacturer's private expected unit costs in these cases, just as for equation [4.6] and [5.5]. Then using the same analysis as for Proposition 4, we see that we reach a similar

conclusion. These results are summarized as:

Proposition 7:

When the manufacturer can use a care-based contract for indemnification and when the retailer's cost of bankruptcy is less than \bar{B} , society can always improve on the liability-sharing scheme selected by the monopolist by increasing the retailer's "due care standard."

Similarly, when the manufacturer cannot use a care-based contract for indemnification and when the retailer's cost of bankruptcy is less than A , society can always improve on the liability-sharing scheme selected by the monopolist by increasing the proportion of damages that are paid by the retailer.

VI. Conclusion

In the preceding four sections, we examined the equilibrium contracts for a manufacturer and retailer when both the retailer and manufacturer can affect the probability of an accident and when the care used by the retailer is not observable *ex ante*.

In Section II, the equilibrium care levels are derived for the manufacturer and the retailer under retailer liability and manufacturer liability if retailer bankruptcy is not possible. We have shown that under retailer liability, the optimal quality of output will be produced. Under both manufacturer liability and retailer liability, the monopoly quantity of output, given expected unit costs, is produced. It is then straightforward to show that consumers' surplus and manufacturer's profits are both higher under retailer liability. The competitive retailers' expected profits are zero under both systems. Retailer liability dominates manufacturer liability in the absence of retailer bankruptcy.

In Sections III and IV, we examined the equilibrium contract if retailer bankruptcy is possible. If the manufacturer can observe retailer care *ex post*, the equilibrium contract will involve suboptimal inputs to safety and positive retailer profits. Society can always improve on the manufacturer's care-based indemnification contract by increasing the retailer's "due care standard". If the manufacturer cannot use a care-based indemnity contract, the level of safety inputs relative to the optimum will turn on whether they are "substitutes" or "complements". Again, the retailer earns positive profits in equilibrium and society can always improve on the liability-sharing scheme selected by the manufacturer by increasing the retailer's share of damages.

In Section V, consumer liability and positive bankruptcy costs are discussed. It is shown that if bankruptcy costs are small, social welfare can be increased by either increasing the retailer's share of liability or his "due care standard".

FOOTNOTES

1. Similar results have been reached in the principal-agent literature.

See, for example, Harris and Raviv (1978 and 1979) and Shavell (1979).

2. Here, "consumer liability" is used to mean that neither firm is liable.

Consumer liability will be discussed in Section V.

3. It is assumed that additional care by the manufacturer or retailer will reduce the probability of an accident at a decreasing rate, i.e., π_x and π_y are both negative, and that π_{xx} and π_{yy} are both positive. No assumption is made about the sign of π_{xy} .

4. These optimal levels of care are given by the following first order conditions. $x^*(y)$ is given by: $1 + \pi_x(x^*(y), y)A = 0$. $y^*(x)$ is given by: $1 + \pi_y(x, y^*(x))A = 0$.

5. These optimal care levels are given by: $x^\circ = x^*(y^\circ)$ and $y^\circ = y^*(x^\circ)$.

6. See also Brown [1973].

7. The results in cases 1 and 2 may not be robust to alternative retailer technologies. The retailer's ability to substitute away from the manufacturer's product will change the outcomes in these cases. In addition, Shavell [1980, 1982] discusses some circumstances in which these outcomes may differ.

8. See Shapiro [1980].

9. This function can be inverted since $\frac{\partial y_d}{\partial M} = 1 - rk_m$, which equals $1 - \frac{r(1-\pi)}{r+\pi}$, which is on the unit interval. This implies that $\frac{\partial M}{\partial y_d}$ is greater than one.

When y_d is increased the resulting increase in the markup is the increase in the retailer's costs plus the increase in the profitability of the best bankruptcy strategy, since m increases.

10. From equation (4.3a), we see that $\frac{\partial M}{\partial x} = k_x / 1 - k_m$. From footnote 9, we see that the denominator is positive and the numerator is $-r(m-y)\pi_x / (r+\pi)^2 > 0$. M_x is therefore positive.

11. Neither of these derivatives, however, converge uniformly to the respective values without some restrictions placed on $\pi(x,y)$. If we assume that there exists $\alpha > 0$, such that $\pi(x, y_d) > \alpha$, then $\lim_{r \rightarrow 0} \frac{\partial M}{\partial y_d} = 1$. Similarly, if there exists β such that $\pi_x(x, y) > \beta$, for all $y < y_d$, then $\lim_{r \rightarrow 0} \frac{\partial M}{\partial x} = 0$.

12. From the retailers' first order condition: $\frac{\partial y}{\partial x} = -\pi_{xy} / \pi_{yy}$. We have defined the inputs to be substitutes (complements) if an increase in x will result in a decrease (increase) in y . The two types of care are substitutes (complements) if and only if π_{xy} is positive (negative).

13. Analogous results are obtained in Shavell [1980].

14. With a franchising fee, the retailer will place an amount F in escrow on which he receives the competitive rate of interest, r . F would be transferred with any sale of the retail franchise and would therefore become part of the equity of the firm under such a scheme. The value of the retailer's profit maximizing bankruptcy strategy would be the solution to:

$$k(m, x, F, r) = \max_y \frac{m - y - \pi(x, y)F}{r + \pi(x, y)}.$$

Retailer entry and profit maximization on the part of the manufacturer together imply that F would be set such that $k(m, x, F, r) = 0$, or that, from [4.3], $m = y_d$. The manufacturer's problem is now:

$$\max Q(p) [p - y_d - x - \pi(x, y_d)A].$$

Monopoly price is again chosen, but the equilibrium franchising scheme alters the minimized private costs given by [4.6] to the social costs. The manufacturer thus chooses $y_d = y^\circ$ and $x = x^\circ$. The appropriate franchising fee, F^* , can then be generated from: $k(y^\circ, x^\circ, F^*, r) = 0$.

To be regarded as a true bankruptcy costs, F must represent retailer net wealth. If there are limitations on the availability of such franchisees, the above solutions cannot be reached. Initial research indicates that partial franchising may not improve social welfare.

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