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WORKING PAPER
NUMBER UT-ECIPA-ECPAP-96-03

Exclusivity Restrictions in Markets with Adverse Selection: The Case of Extended Warranties

by

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January 12, 1996
Latest Version: January 12, 1996

ISSN 0829-4909

On-line Version: http://www.epas.utoronto.ca:8080/wpa/wpa.html
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Abstract

This paper investigates whether the contractual exclusion of third-party extended warranties should be legally permissible, using a model incorporating consumer heterogeneity. The welfare effects of competition in the market for extended warranties are shown to depend on the degree of competition in the *product* market. In contrast to the approach typically adopted by the courts, the paper argues that manufacturers should not generally be permitted to practice requirements contracting in extended warranties, even when the product market is competitive.

1. Introduction[1]

This paper investigates the problem of whether the contractual exclusion of third-party extended warranties should be legally permissible. Consumer heterogeneity sometimes leads manufacturers to offer a menu of warranty contracts, typically implemented as a base warranty and an optional extended warranty. For most products on which a manufacturer offers an extended warranty, it faces competition from third-party service contracts. Some manufacturers, however, make it a condition of supplying a retailer that she carry only the manufacturer's extended warranty. A recent case is typical of the legal dilemma. Ford of Canada announced that as a condition for the use of its financing plan, dealers had to commit to exclusive sales of Ford's extended warranty program. When the Federal Automobile Dealers Association threatened to take it before the Bureau of Competition Policy, Ford withdrew the condition, leaving dealers free to continue selling third-party extended service contracts. Should manufacturers generally have the right to impose such exclusivity conditions on retailers? A related question being debated vigorously in the courts is whether a manufacturer should be permitted to require that retailers use only the manufacturer's replacement parts when doing repairs. This paper offers a new perspective on this debate, suggesting that competition in the extended warranty or post-warranty repair business has an important effect on the base warranty, and therefore on welfare.

In both the United States and Canada, the legality of such requirements contracting is still uncertain, despite the magnitude of the extended warranty and service contract markets. Extended warranties are increasingly marketed along with most large and many small appliances. Sears alone is reported to have sold over $1 billion worth of extended warranties in 1991 in the United States. Ford recorded profits in excess of $100 million from sales of extended warranties in 1988, despite fierce competition from independent insurers.[2] Around 40% of all automobiles and major appliances are sold with some form of extended warranty, typically with a large profit margin.[3] For retailers of products carrying extended warranties, the profits can be significant: some analysts estimate that around half

[1] I am indebted to Nancy Gallini, Frank Mathewson, Mike Peters, Ralph Winter, and seminar participants at the 1994 meetings of the Canadian Economic Association and at the University of Toronto. This research was financially supported by the Social Sciences and Humanities Research Council of Canada.

[2] Cited in Lutz and Padmanabhan (1995).

[3] Plotkin (1985) and Therrien (1991).

of operating profits for big consumer electronics chains come from sales of extended warranties.[4]

In Section 2, the relationship of this paper to the previous literature on warranties and extended warranties is explained. Section 3 develops a model of warranties in which firms choose warranty duration and price. If firms cannot distinguish between heavy and light users, it is shown that they may offer separating or pooling warranties, where the separating warranty is simply characterized by the offer of an optional extended warranty. Sections 4 (for the monopolistic product market) and 5 (for the competitive product market) examine the effects of competition in extended warranties. If the product market is monopolistic, then the presence of third-party insurers will destroy the price discrimination scheme of the manufacturer. This will be welfare enhancing only if "light" users continue to buy the product. Similarly, if the product market is characterized by competition, attempts to impose exclusivity restrictions on extended warranties may often be welfare-decreasing. This result contrasts with current jurisprudence which is lenient to exclusivity restrictions if the product market is competitive. The paper concludes with a brief discussion of policy implications, and with suggestions for further research.

2. Related Literature

Economic analysis of warranties is divided by the principal function attributed to warranties: some studies are premised on the notion that the function of warranties is to shift risk-bearing from risk-averse consumers to risk-neutral warrantors; while in others, warranties serve to provide a signal of product quality.[5] Analysis of warranties as a form of insurance was begun by Heal (1977) and it is this function of warranties which is of interest in the present paper. Warranties typically seem to provide at best partial insurance,[6] which as we will see may be the result of consumer heterogeneity, as observed by Emons (1989) and Padmanabhan (1995), or of consumer moral hazard. Spence (1977) was the first to show that warranties could be an informative signal for consumers if it is more costly for low quality manufacturers to provide long warranties than for manufacturers of high-quality products in a competitive market. Grossman (1981) extended the analysis to monopolistic markets and found that monopolists would always offer full warranties because not to do so would be a bad signal to consumers. Gal-Or (1989), Welling (1989) and Lutz (1989) derived conditions limiting the effectiveness of such signals in various environments. A series of related papers on two-sided moral hazard

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[4]Therrien (1991).

[5]Two other explanations of the function of warranties are provided by Salop (1977), who observed that with imperfect consumer information on product quality, the warranty may be used as a tool of price discrimination; and by Braverman, Guasch and Salop (1983) who noted that a warranty may be used as part of a two-part tariff to extract consumer surplus.

[6]See e.g. Bryant and Gerner (1982), Gerner and Bryant (1981), and Priest (1981).

considered the problems of using warranties to minimize producer moral hazard in the presence of consumer moral hazard.[7]

The focus of this paper is the market for *extended* warranties, which, despite its importance, has attracted very little economic study. One exception is Lutz and Padmanabhan (1995), which considers a puzzle in the market for contact lenses. Although warranties may be purchased as an option, the standard base warranty on contact lenses is zero. They attribute this to the presence of third-party insurers, whose extended warranties cause a negative externality on base warranties, since consumers with more coverage will be less careful in handling their lenses. They conclude that where consumer moral hazard is a problem and average product durability can be predicted with reasonable accuracy by an independent insurer, this externality will push base warranties to zero. This result is of course exceptional, since on the vast majority of products for which third-party extended warranties are available, base warranties are far from zero. Evidently some other paradigm is required to explain the variety of warranties and extended warranties available on different types of products. The present paper is based on the idea that warranties are heterogeneous because consumers are heterogeneous in their intensity of use and presents a model which helps to explain the variety of warranties which we observe. In contrast to Lutz and Padmanabhan, it relies on adverse selection rather than on moral hazard.

3. The Model

3.1 Consumers

The model specification is designed to allow consumer heterogeneity in the aspect which matters most for warranty length: the intensity of use, or the probability of breaking a product within a given period. In order to focus on this, consumers are assumed to be homogeneous in other ways, including their *ex ante* valuation of the product. In addition, consumers are risk averse, which is what makes the warranty valuable to them. They derive additive utility from money and the services of at most one unit of a durable product. By not buying the product, consumers obtain a reservation expected utility equal to their income, *y*.

Consumers of type *i* who buy the product obtain services of k_i units per unit of time until the product breaks, so that if it breaks at time *t*, $k_i t$ is the cumulative amount of services obtained. The parameter *k* is introduced to reflect the fact that almost all products have some aspects in which intensity of use or roughness affects product durability. The good breaks with probability density $f\left(k_i t\right)$ over the course of being used and all goods are broken by the time they have yielded $\overline{K}$ units of services ($\int_0^{\frac{1}{k}\overline{K}} f(k_i t)dt = 1\ \forall i$). A product which breaks after yielding services of $k_i t$ units yields utility of $u\left(k_i t\right)$, where u is continuous and $u' > 0$ and $u'' < 0$. Thus expected product lifetime is inversely related to intensity of use *k*, but expected total product services is invariant to *k*. A broken product cannot be repaired and yields zero utility. Thus if a consumer of any type *i* were to buy the good (without a warranty) at price *s*, she would obtain von Neumann-Morgenstern expected utility $y - s + \int_0^{\frac{1}{k_i}\overline{K}} u(k_i t) f(k_i t)dt$, independent

[7]Cooper and Ross (1985), Emons (1988), Dybvig and Lutz (1993), and Soberman (1995).

of i. Note that this expression integrates not over services through time but over cumulative services times the probability of breakdown at any time t. Buying the product without a warranty is essentially a lottery, with a range of possible outcomes, depending on t, the actual functioning life of the product. In order to keep the exposition simple, there is no discounting.

A warranty contract Γ_i consists of the pair $\{T_i, p_i\}$. Purchasing a warranty at price p ensures that the consumer obtains an extra x units of services if the product breaks while the warranty is still in effect, that is, for $t \le T$, where T is the terminal date of the warranty. Ideally, a warranty should guarantee some amount of usage, but a limitation that firms face in setting warranties is that they generally cannot make them conditional on usage, which is unobservable; so they use simple time restrictions instead.[8] Thus warranties typically expire after a set period of months or years. Following Dybvig and Lutz (1993), the warranty is restricted to a "block" form, so that there is for some period a constant level of benefits in case of breakdown, at the end of which period coverage drops discontinuously to zero.[9] A consumer of type i who buys the product with a warranty thus obtains expected utility $y - s - p + \int_0^T u(k_i t + x)\, f(k_i t)dt + \int_T^{\frac{1}{k_i}\overline{K}} u(k_i t)\, f(k_i t)dt$.

Consumers value warranty length because it increases the *expected* number of units obtained from the durable good, but their marginal valuation of the warranty is declining with T, since $u'' < 0$. This method of representing the benefit obtained from a warranty is applicable to repair or replacement warranties.[10] The expected surplus a consumer of type i obtains from contract Γ_j is $U_i(\Gamma_j) = -p_j + \int_0^{T_j} \left[u(k_i t + x) - u(k_i t)\right] f(k_i t)dt$.

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[8]Automobiles are a partial exception to this rule, since it is possible to limit warranties by the distance driven. Even in this case, however, the odometer does not specify the type of terrain or the style of driving, which influences the expected rate of car breakdown. So in the case of automobiles, the analysis should not refer to time of driving but to intensity of use.

[9]Note that this analysis ignores the possibility of any kind of deductible. Many types of warranties do not have explicit deductibles, although some of them do: for example, car warranties often have a deductible, and some warranties cover only labor and not parts. Including deductibles in the analysis would not change its flavor or conclusions but would make it considerably more complicated.

[10]Repair or replacement warranties actually have the form $x(T-t)$ where $x(z) > 0$ and $x' > 0\ \forall\, z \ge 0$ and $x(z) = 0\ \forall\ z < 0$. In this formulation, the value to the consumer of the warranty is declining with t because after repair or replacement, the product is returned with only the balance of the warranty. As it turns out, only the marginal condition of warranty value at $t = T$ is of interest, so that we may simplify the model by using a constant without loss of generality

3.2 Firms

For the present the manufacturer is assumed to be a monopolist, although as shown in Section 5 with suitable adjustments the model also applies to the case of competitive manufacturers. The manufacturer has marginal manufacturing cost *c*, and for each buyer of type *i*, warranty servicing cost w for breakdown in any state $t \leq T_i$, and expected warranty servicing cost given T_i of $w\int_0^{T_i} f(k_i t)dt$.[11] Its expected profits per unit sold to a buyer of type i is $s + p_i - c - w\int_0^{T_i} f(k_i t)dt$. Because consumers are assumed to have homogeneous valuations of the product itself, the manufacturer's maximization problem may be simplified by splitting it into two components. First the manufacturer sets *s* equal to the value to the consumer of the product without a warranty. Second, the optimal warranty contract for buyers of type *i* is chosen to maximize expected profits from the sale of the warranty contract only, $\Pi_i(\Gamma_i) = p_i - w\int_0^{T_i} f(k_i t)dt$. We will focus on the second problem.

3.3 The Full-Information Benchmark

If the firm could identify the consumer type, p_i would be set equal to the consumer's valuation of a warranty of duration T_i:

(1) $$p_i = \int_0^{T_i} \left[u(k_i t + x) - u(k_i t)\right] f(k_i t)dt.$$

The maximization problem for the firm is then simply

(2) $$\max_{T_i} \int_0^{T_i} \left[u(k_i t + x) - u(k_i t) - w\right] f(k_i t)dt$$

for each type. The first order condition for this problem requires that

(3) $$u(k_i T_i + x) - u(k_i T_i) = w.$$ [12]

This equality yields an interior solution, called T_i*, given two reasonable conditions: $u(x) - u(0) > w$ and $u(\overline{K} + x) - u(\overline{K}) < w$. Essentially these conditions require that the marginal utility of the warranty be greater than the cost of warranty servicing for low outcomes of *t* and less for high outcomes of *t*. The natural outcome of (3) is that the optimal full-information warranty length T_i* is inversely proportional to k_i, so that $T_i* = \frac{k_j}{k_i} T_j*$.

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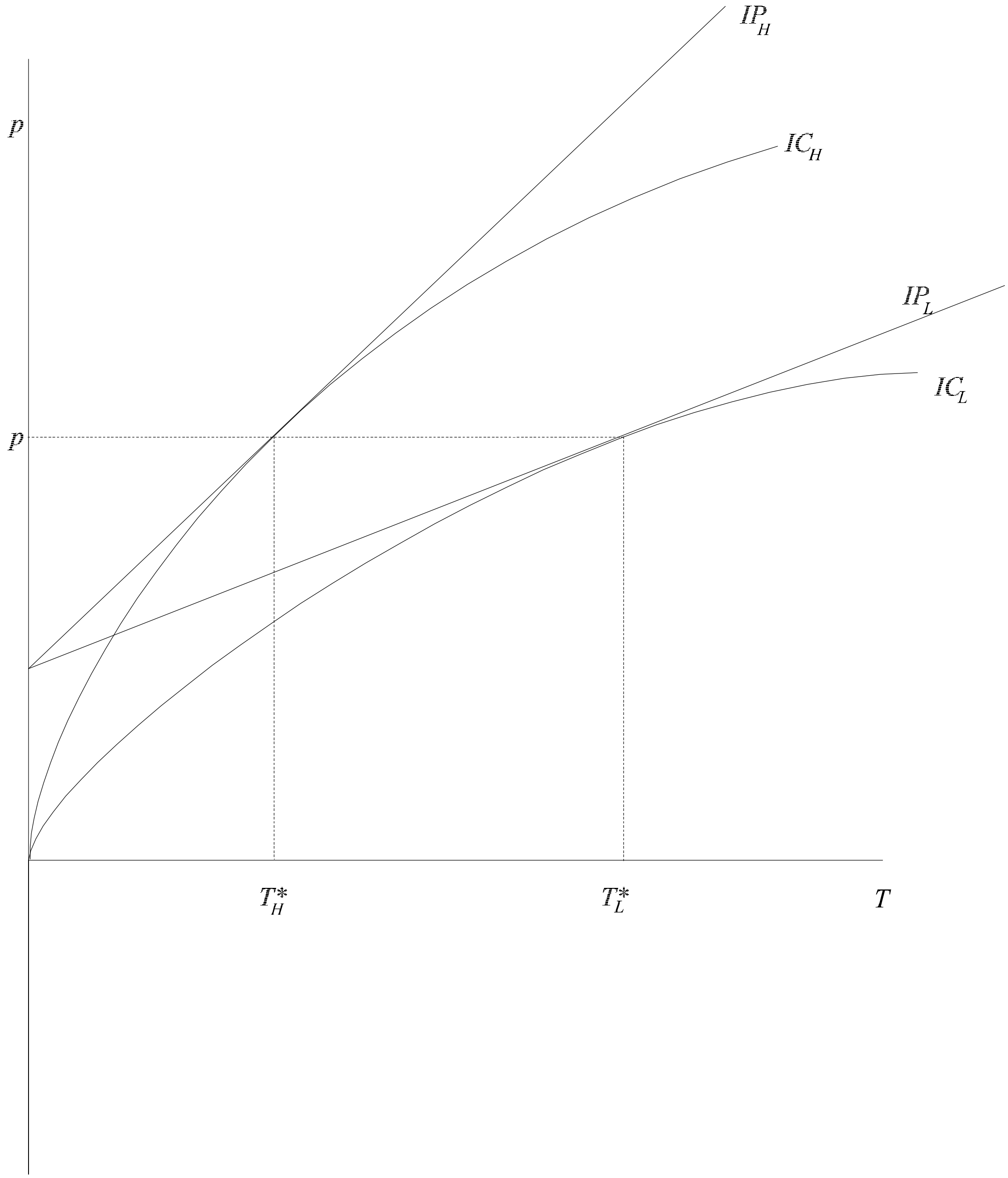
[11]More generally, the warranty servicing cost could be written as $w(kt)$, with the restriction that it be continuous and non-decreasing.

[12]The second order condition is $\frac{d^2\Pi}{dT^2} = \left[u(kT + x) - u(kT) - w\right] f'(kT) + \left[u'(kT + x) - u'(kT)\right] f(kT)$. The second term is negative, and the first term is equal to zero when the first order condition is satisfied so that this is a local maximum.

A convenient graphical interpretation of this is given by Figure 1, which shows iso-profit and indifference curves for two types of consumers buying from the monopolist. Different levels of profits and consumer utility are given by vertical displacements of these curves. Utility is higher for lower indifference curves, while profit is higher for higher iso-profit curves. The slope of the indifference curve at any given t is just $\left[u\left(k_i t + x\right) - u\left(k_i t\right)\right] f\left(k_i t\right)$, the marginal value to the consumer of extending the warranty; while the slope of the iso-profit curves is $wf\left(k_i t\right)$, the marginal cost of extending the warranty. As a result of the linear additivity of utility of money in the model, the negative of consumer surplus from the warranty is given by the intercept of the consumer's indifference curve on the coordinate axis extending below the zero, while the firm's profit per consumer is just the intercept of the iso-profit curve above the zero. When the monopolist has full information about consumer types, consumer surplus will be reduced to zero, as in Figure 1. Note that for both types the optimal price is the same, and only the duration varies, with the light user obtaining a longer warranty. In comparison, in the Stiglitz (1977) and Stiglitz and Weiss (1976) analyses of the insurance market, both types of user optimally obtain the same amount of insurance, but at different prices. The intuition behind this difference is simple: for insurance, in a given period of time, different types of users present different levels of risk. In contrast, with warranties different types of users present the same level of risk over different periods. This seemingly trivial transformation means that one cannot simply transfer the results of analysis of insurance to the warranty market.

Figure 1



4. Asymmetric Information with a Monopolistic Product Market

When firms cannot identify user types *ex ante*, it becomes optimal in some circumstances to separate the types by offering a base warranty and an optional extended warranty. In this section, I compare the outcomes of permitting and excluding independent insurers from the extended warranty market when the product market is monopolistic. I assume that there are two consumer types, $i = H, L$, with $0 < k_L < k_H \leq 1$, and a unit mass of consumers with λ representing the proportion of high-intensity users. The parameters k_H, k_L and λ are assumed to be common knowledge. We require one further assumption on k_H and k_L. The indifference curves of the two types of user are assumed to have a single-crossing property within the region of interest:

(A1) $$\left[u\left(k_H t+x\right)-u\left(k_H t\right)\right] f\left(k_H t\right) > \left[u\left(k_L t+x\right)-u\left(k_L t\right)\right] f\left(k_L t\right) \quad \forall\, t < T_L^*.$$

This assumption states that the indifference curves for a heavy user are steeper than those for a lighter user at any time before the end of the light user's full-information warranty, so that heavy users will always value any warranty extension more than light users.

I first examine the case in which the product manufacturer has exclusivity in its extended warranties; then the case without exclusivity; and finally I compare welfare outcomes in the two cases. As before, T_i^* denotes the optimal full-information warranty duration for consumers of type *i*.

4.1 Product monopoly with exclusivity in extended warranties

When the monopolist is unable to identify the consumer type, the problem of profit-maximizing becomes:

(4) $\max \lambda\Pi_H\left(\Gamma_H\right)+\left(1-\lambda\right)\Pi_L\left(\Gamma_L\right)$ subject to four incentive compatibility and participation constraints:

(4') $$\begin{aligned} &\text{PL:} && U_L\left(\Gamma_L\right)\geq 0 \\ &\text{PH:} && U_H\left(\Gamma_H\right)\geq 0 \\ &\text{IL:} && U_L\left(\Gamma_L\right)\geq U_L\left(\Gamma_H\right) \\ &\text{IH:} && U_H\left(\Gamma_H\right)\geq U_H\left(\Gamma_L\right) \end{aligned}$$

> LEMMA 1: *At the solution to this problem, the constraints PL and IH will be binding.*
>
> *Proof: See Appendix.*

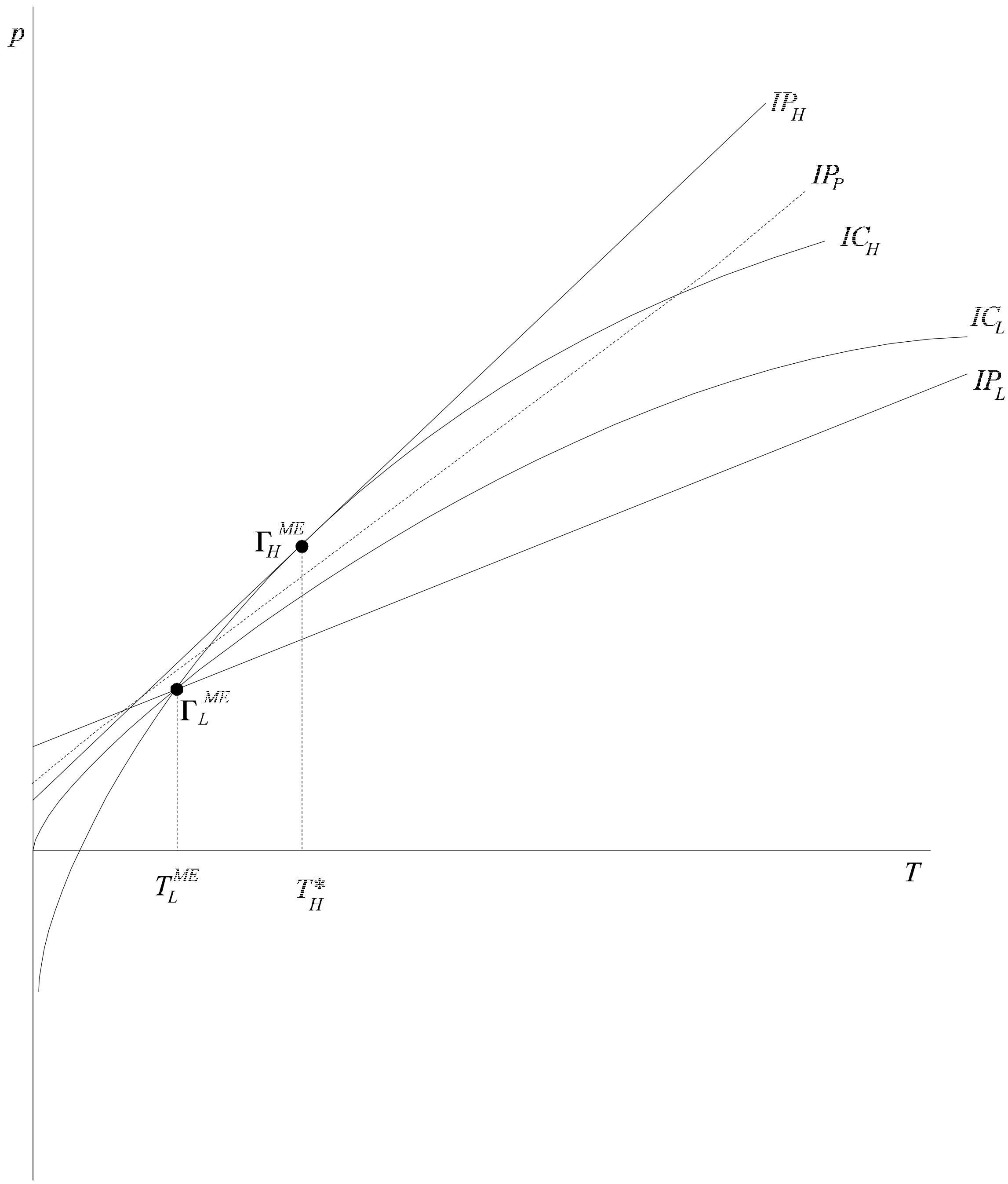
This problem is similar to the familiar insurance problem with adverse selection described by Stiglitz (1977). However, it differs in that there is a range of separating solutions *and* a range of pooling solutions, as described in Propositions 1 and 2 below, depending on λ, the proportion of heavy users. I call the separating warranty contracts offered in response to this adverse selection problem Γ_H^{ME}, and Γ_L^{ME} ; and the pooling warranty contracts Γ_P^{ME}. The first superscript indicates a monopoly in the product market, while the second superscript indicates that the firm has exclusivity in the extended warranties for its own product.

For the following propositions, I define a critical value $\lambda_1 \in \left[0,1\right]$ as the solution to

(5) $$\left[u\left(k_L T_H^*+x\right)-u\left(k_L T_H^*\right)\right] f\left(k_L T_H^*\right)=\lambda w f\left(k_H T_H^*\right)+\left(1-\lambda\right) w f\left(k_L T_H^*\right)$$

This defines the λ such that the tangency of the pooling iso-profit curve with the indifference curve of the light user is at $t=T_H^*$. For an intuitive sense of the significance of this critical value, consider Figure 2. The indifference ("IC") and iso-profit ("IP") curves of each type of user are stacked vertically. The slope of the pooling iso-profit curve ("IP_P")

Figure 2



is given by the weighted average of the iso-profit curves for heavy and light users, and is therefore increasing with the proportion of heavy users. When the proportion of heavy users is high, the tangency between the pooling iso-profit curve and the light user's indifference curve will be to the left of T_H *, and when λ is lower, the tangency must be between T_H * and T_L *.

PROPOSITION 1: *For* $\lambda_1 < \lambda \leq 1$, *the manufacturer's optimal warranty strategy will be a menu of separating contracts* Γ_H^{ME} *and* Γ_L^{ME} *such that the heavy user obtains the full-information warranty duration* $T_H^{ME} = T_H*$ *and the light user obtains a shorter warranty of duration* $T_L^{ME} < T_H * < T_L *$.

Proof: See Appendix.

The separating warranty contracts are typically implemented as a base warranty which is bundled with the product and an optional extended warranty. These are depicted in Figure 2. The light users' warranty contract Γ_L^{ME} is just the base warranty, usually included automatically with the product; while Γ_H^{ME} is the total warranty contract purchased by heavy users. The difference between Γ_H^{ME} and Γ_L^{ME} can thus be seen as an extended warranty. The first order condition of the monopolist's maximization, derived from equation (4), requires T_L^{ME} to satisfy

(6) $$\left[u(k_L T + x) - u(k_L T)\right] f(k_L T) = \lambda\left[u(k_H T + x) - u(k_H T)\right] f(k_H T) + (1-\lambda) wf(k_L T) .$$

Thus the length of the base warranty is determined by the tangency of the light user's indifference curve with the weighted average of the indifference curve for the heavy user and the iso-profit curve for the light user. Note that while the heavy user's warranty duration with the separating contracts is equal to the optimal full information duration T_H*, the light user's warranty is even shorter than that of the heavy user, the reverse of the full-information case.

PROPOSITION 2: *For* $0 \leq \lambda \leq \lambda_1$, *the manufacturer's optimal warranty strategy will be a pooling contract* Γ_P^{ME} *with warranty duration such that* $T_H * \leq T_P^{ME} \leq T_L *$.

Proof: See Appendix.

When $\lambda \leq \lambda_1$, the T_L^{ME} given by (6) is greater than T_H*, and the separating warranty characterized by Proposition 1 is no longer profit-maximizing, since it does not meet IL, the light user's incentive compatibility condition. Thus for $\lambda \leq \lambda_1$, IL is also binding; but since both IL and IH are binding, the only possible solution is a single pooling warranty. This single warranty will have duration T_P^{ME} defined by (7):

(7) $$\left\{u(k_L T + x) - u(k_L T)\right\} f(k_L T) = \lambda wf(k_H T) + (1-\lambda) wf(k_L T).$$

This equation requires that the light user's indifference curve be tangent to the weighted average of the iso-profit curves for both types. To see that only pooling warranties are feasible in this range, note that for $\lambda \leq \lambda_1$, the iso-profit curve is steeper than the indifference curve for heavy users, rendering an extended warranty designed only for heavy users unprofitable. Both types of users would purchase any extension intended for light users, but this would also be unprofitable beyond the pooling optimum.

There is thus a range of pooling warranties Γ_P^{ME} which are profit-maximizing for a sufficiently low proportion of heavy users. Stiglitz never obtains a pooling equilibrium in his well-known 1977 paper on insurance, since the desired amount of insurance is the same across types: the high-risk type is differentiated only by risk. With warranties, however, the "high risk" type actually has a shorter optimal full-information warranty, and it is this difference between warranties and insurance which leads to these different results. The possibility of pooling warranties obtained here can explain why extended warranties are not available on many products, despite user heterogeneity.

4.2 Product monopoly without exclusivity in extended warranties

In this section, I consider a different regime in which independent insurers, having the same insurance costs *w* as the manufacturer, compete in the extended warranty market. The independent insurers can offer one or more contracts for each type *i* $\gamma_i = \{\tau_i, \pi_i\}$ where τ_i is the period of extension of the warranty and π_i is the price paid by the consumer for the extension. Expected surplus for a consumer buying the extended warranty would be $U_i(\Gamma,\gamma) = -p - \pi + \int_0^{(T+\tau)} u(kt+x)\,f(kt)dt + \int_{(T+\tau)}^{\frac{1}{k}\overline{K}} u(kt)\,f(kt)dt$. The independent contracts are thus supplementary to the contract offered by the manufacturer and increase the total period covered by a warranty. The industry may now be described as a sequential game: the monopolist offers one or more contracts; then independent insurers offer contracts of additional warranty protection; and finally consumers select contracts. The extended warranties must be continuous but not overlapping with a previous warranty, and a consumer might purchase a series of warranties. All firms are assumed to form rational expectations about the extended warranties that independent insurers will offer. The independent insurers are perfectly competitive, so that in equilibrium their prices will exactly reflect the costs of the contracts they offer. Following Rothschild and Stiglitz (1976), equilibrium in the competitive extended warranty market is defined as a set of extended warranty contracts such that, when consumers choose contracts to maximize expected utility, (i) no contract in the equilibrium set makes negative expected profits; and (ii) there is no contract outside the equilibrium set that, if offered, will make a non-negative profit.

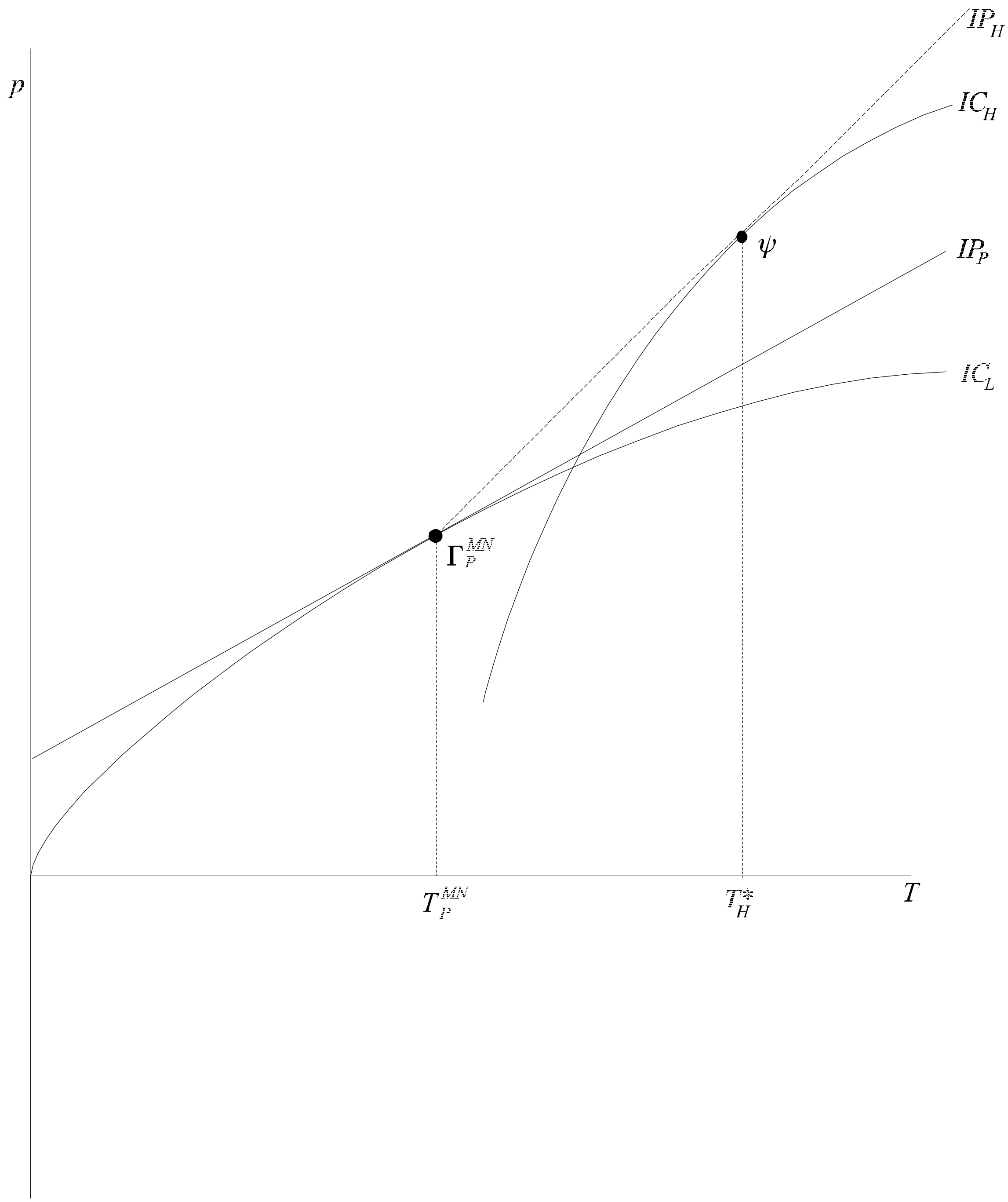
We wish to know how the manufacturer's warranty will differ in the presence of independent insurers. If the manufacturer has optimally offered a pooling warranty even without the threat of entry by independent insurers, then this warranty is unaffected by the possibility of entry, since any extension beyond the pooling warranty would be strictly unprofitable:

PROPOSITION 3: *If* $0 \le \lambda \le \lambda_1$, *then independent insurers cannot profitably enter.*

Proof: Any extension designed only for heavy users will be unprofitable; any extension designed only for light users will attract both types; and any pooling extension will be unprofitable.■

In contrast, if the manufacturer's optimal pre-entry contract separates the two types by the offer of two incentive-compatible contracts, the optimal strategy will be changed by the possibility of entry. The manufacturer cannot make any economic profits in the market for extended warranties because of competition. The monopolist will therefore choose between not serving the light users at all, and offering the most profitable single base warranty $\Gamma_P^{MN} = \{T_P^{MN}, p_P^{MN}\}$, where the second superscript indicates that the

Figure 3



manufacturer does *not* have exclusivity in the extended warranty market. This warranty, depicted in Figure 3, will have duration defined by the tangency of the indifference curve of light users and the iso-profit curve of pooled users. Thus the condition determining the duration of this base warranty will be just the same as (7). This leads to:

PROPOSITION 4: *If* $\lambda_1 < \lambda \leq 1$, *competition from independent insurers will lead to an* <u>*increase*</u> *in the base warranty duration (a) from* T_L^{ME} *to* T_P^{MN} *if both types continue to be served or (b) from* T_L^{ME} *to* T_H* *if the manufacturer does not serve the light users.*

Proof: See Appendix.

In addition to the pooling warranty offered by the manufacturer, for any $T_P^{MN} < T_H*$, the competitive insurers (and perhaps the manufacturer) will offer an extended warranty to provide optimal coverage for heavy users, so that *ex post* there is separation of user types. The heavy users' contract will extend the total period of coverage to T_H* at the fair-odds price $w\int_{T_P^{MN}}^{T_H*} f(k_H t)dt$. The extended warranty purchased by the heavy user can be seen in Figure 3 as the difference between ψ and Γ_P^{MN}.

<u>4.3 Welfare effects of exclusivity in extended warranties</u>

Provided that both types continue to be served, permitting competition in the extended warranty market has a non-negative welfare effect when the product market is monopolistic. Transfers of money in this model have no welfare effect; the only variable of interest is how long warranties are. The closer they are to the full information lengths T_H* and T_L*, the larger is welfare. Thus because competition in extended warranties lengthens the warranty obtained by the light user (while that of the heavy user remains the same), welfare increases.

If, however, light users form a sufficiently small part of the market, then the light user may not be served at all. In this case, the base warranty is equal to the full-information warranty for the heavy user and the light user will not buy the product. The welfare result here is the familiar one of price discrimination. If the profits from light users are not large enough, then without the possibility of price discrimination, they may not be served and welfare decreases. But if light users continue to be served, the elimination by independent insurers of price discrimination increases welfare.

<u>5. Asymmetric Information with a Competitive Product Market</u>

In this section, I undertake the same exercise as in Section 4, but with the assumption that the product manufacturers are in a perfectly competitive industry. In this case, the consumer gains a surplus while firms make zero profits. With full information, the consumer surplus in the competitive case is exactly equal to the firm's profit in the monopoly case. As before, consumers are assumed to be of two *a priori* unidentifiable types.

<u>5.1 Exclusivity in extended warranties</u>

Each firm is initially assumed to have exclusivity in the sale of extended warranties for its own product. This analysis is similar to that of Rothschild and Stiglitz (1976). As in their models, if the proportion of heavy users is sufficiently high, then a separating equilibrium will be obtained, and if the proportion of heavy users is below a critical value, then no equilibrium may exist at all. Equilibrium in this competitive base warranty market is defined as a set of contracts such that, when consumers choose contracts to maximize expected utility, (i) no contract in the equilibrium set makes negative expected profits; and (ii) there is no contract outside the equilibrium set that, if offered, will make a non-negative profit. Each contract consists of the sale of the product plus a warranty for the price $p+s$. The base warranty is restricted to start at the time the consumer purchases the product; and the profitability of any base warranty will also depend on the set of extended warranties which are offered subsequently.

With heterogeneous consumers, there are two possible types of solutions again depending on λ. To write Proposition 5, I define, in the appendix, a new critical value $\lambda_2 \in [0,1]$. λ_2 is the critical value of λ at which light users are indifferent between pooling and separating contracts.

PROPOSITION 5: *(a) For $\lambda > \lambda_2$, separating warranties will be offered in equilibrium such that the heavy user obtains a warranty of duration T_H*, while the light user obtains a shorter warranty of duration T_L^{CE}, and firms make zero profits on each type of warranty; and*

(b) for $\lambda \leq \lambda_2$, no equilibrium will exist.

Proof: See Rothschild and Stiglitz (1976) or Wilson (1977).

The separating warranty contracts will be such that the heavy user's duration is again the full-information one, while the light user obtains a short warranty, constrained by the heavy user's incentive compatibility. Both warranties will be priced at cost. This equilibrium is pictured in Figure 4, in which as we see, Γ_L^{CE} is constrained to be priced at fair cost and to be the best possible contract for the light user subject to the incentive compatibility constraint of the heavy user, who obtains the warranty contract Γ_H^{CE}.

If $\lambda \leq \lambda_2$, the well-known arguments of Rothschild and Stiglitz will show that there is no equilibrium, since both pooling and separating candidate equilibria can be broken profitably. I restate their argument briefly, with reference to Figure 5. Both heavy and light users will prefer the zero-profit pooling warranty Γ_P^{CN} to the separating warranties Γ_H^{CE} and Γ_L^{CE}. However, this pooling warranty is vulnerable to the defection of one firm to the contract ξ, which will attract only light users. But then only heavy users will buy Γ_P^{CN}, which will be withdrawn. Thus neither a pooling nor a separating equilibrium is possible.

5.2 The Effect of Independent Insurers on a Competitive Product Market

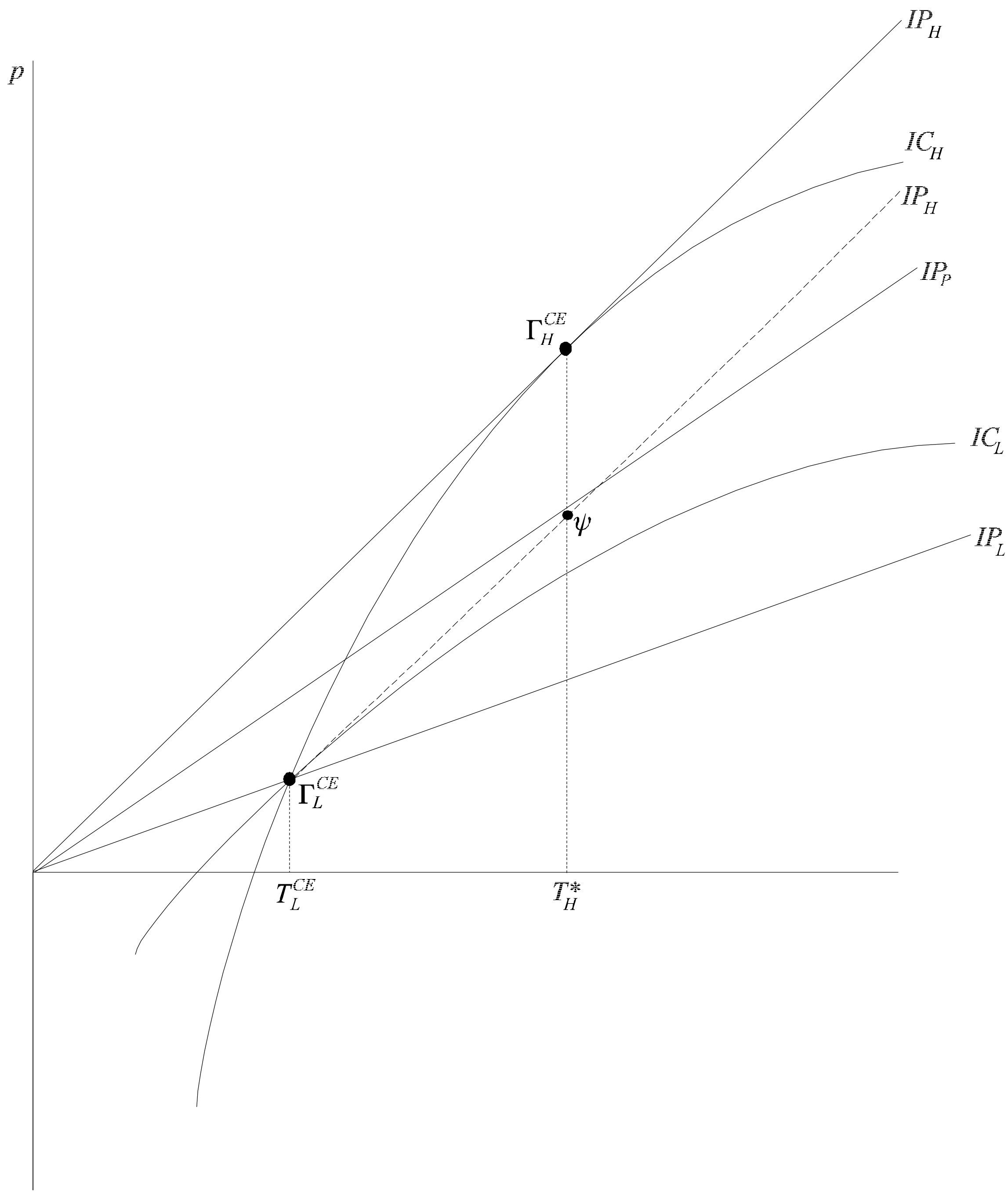
This section examines how competition in the extended warranty market will affect manufacturer warranties. The result here does not depend on the proportion of heavy and light users:

PROPOSITION 6: *In the presence of competitive independent insurers, competitive manufacturers will offer a single base warranty Γ_P^{CN}.*

Proof: See text.

First, consider the effect of non-exclusivity in the range of $\lambda > \lambda_2$. It is clear that the presence of competitive extended warranties renders the manufacturers' separating warranties loss-making, since heavy users will purchase the warranties designed for light

Figure 4



users plus an extension from the independent insurers.[13] (In Figure 4, all users would buy

[13]The potential free-riding by independent insurers, which is what drives Proposition 6, is analogous to the "externality" which Lutz and Padmanabhan (1995) find with consumer moral hazard. They find that competitive provision of extended warranties leads to zero base warranties because consumers will take

the base warranty Γ_L^{CE} and heavy users would also buy the extension ψ.) Therefore, the manufacturers can only offer pooling warranties, as in Section 4.2. The only feasible competitive pooling warranties fall on the zero profit pooling curve, designated IP_P in Figure 4. Independent insurers can offer supplementary extended warranties only to heavy users, since any extended warranty designed for light users only will attract all users.

Now we examine the effect of independent insurers when $\lambda \leq \lambda_2$. Consider the base warranty Γ_P^{CN} shown in Figure 5. With exclusivity in extended warranties, this base warranty can be undermined by the offer of a contract such as ξ, which will attract only light users; thus only the heavy users buy Γ_P^{CN}, leading to equilibrium breakdown. However, the presence of independent insurers has the effect of generating a stable equilibrium. Given the base warranty Γ_P^{CN} independent insurers can offer the extended warranty $\gamma_H = \psi - \Gamma_P^{CN}$. Contract ξ, were it offered, would allow independent insurers to offer the two contracts $\gamma'_H = \psi' - \xi$ and $\gamma'_L = \phi' - \xi$. This would be possible since these two contracts together would make zero profits. (Note that γ'_L is the best extended warranty contract that can be offered to light users since anything below the pooling line would attract other companies to offer yet further extended warranties.) Since light users would prefer the total contracts ϕ' to ϕ, and heavy users would prefer ψ' to ψ, all consumers would buy the contract ξ plus the extensions. But then ξ would become a loss-making pooling contract. Thus no base warranties could be offered which would break the pooling equilibrium. The pooling warranty Γ_P^{CN} also cannot be broken by any extended warranty since it makes zero profits regardless of the extended warranties.

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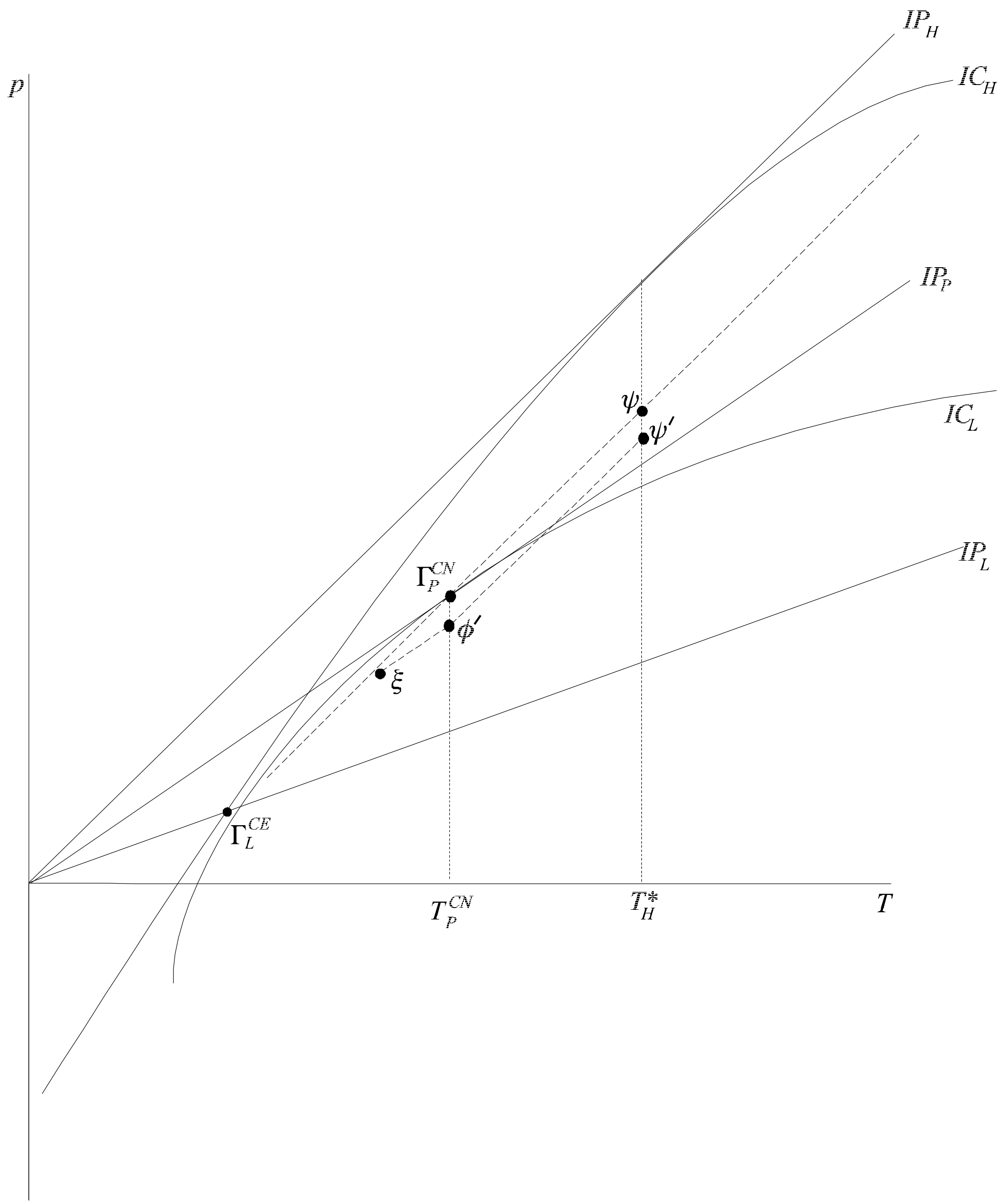
less care of the product than is consistent with a competitively priced warranty. Analogously, in the adverse selection story here, it is not possible for the manufacturer to offer separating warranties. However, the outcome with adverse selection is that the manufacturer will offer a single base warranty which in general will be of strictly positive length.

Figure 5



5.3 Welfare effects of exclusivity in extended warranties

If $\lambda > \lambda_2$, so that separating warranties are offered when manufacturers have exclusivity in their warranties, the loss of exclusivity may have positive or negative welfare effects. If the proportion of heavy users is very high, then the new base pooling warranty Γ_P^{CN} may be even shorter than the separating base warranty Γ_L^{CE}. In this case, welfare will fall with the introduction of competition in extended warranties. However, if the proportion of heavy users is not so high, then the new base pooling warranty will be longer than the base warranty with exclusivity, in which case welfare would increase. Thus even in the perfectly competitive market, there may be a welfare gain from forbidding exclusivity conditions on extended warranties. If $\lambda \leq \lambda_2$, then it is only the presence of independent insurers which permits equilibrium in the market, and it is thus difficult to make any determination of how welfare would be changed.

6. Conclusions

This paper offers clear policy implications for the regulation of the extended warranty market. Manufacturers may very well wish to make supplies to a dealer or retailer conditional on that dealer's carrying only the manufacturer's extended warranty. Should this be permitted? There are two common approaches to this problem. First, the "Chicago" approach would permit tying regardless of market structure. A second approach is the one generally adopted by the U.S. courts: if the manufacturer has market power in the "tying" (product) market, then it should not be permitted to practice tying (or as in this case requirements contracting) into the "tied" (extended warranty) market; and if the manufacturer has no market power in the first market, then tying should be permitted. Neither of these approaches is optimal. If the product market is characterized by monopoly or oligopoly, then competition on extended warranties is beneficial, provided that light users are not excluded from the market, and the monopolist should then be prevented from excluding the independent insurers from the extended warranty market (i.e., tying). On the other hand, *even* if the product market is itself characterized by vigorous competition, then tying in the secondary market for extended warranties may lead to a decrease in welfare! Thus, courts should be sympathetic to retailers who object to supplier requirements that exclude third-party warranties. The conclusion which emerges is in line with other economics analysis of aftermarkets, which suggests that case by case judgements are required rather than any *per se* rule.[14]

The practice of requiring dealers to carry only the manufacturer's replacement parts may be interpreted analogously to a restriction on extended warranties, since the manufacturer is thus restricting competition in service after the base warranty. This type of requirements contracting has been a contentious issue in the courts at least since 1936, when the U.S. Supreme Court upheld a lower court decision approving General Motors' requirement that GM dealers install only GM replacement parts.[15] There has been a variety of cases on similar grounds since then, most of which have revolved around two issues: whether third-party replacement parts might be inferior and result in damage to the

[14]Eg. see Borenstein, MacKie-Mason and Netz, 1994.

[15]*Pick Manufacturing Co.* v. *General Motors Corp. et al.,* 80 F. 2d 641 (1935), affirmed *per curiam*, 299 U.S. 3 (1936).

manufacturer's reputation; and whether the requirement would harm competition.[16] The analysis in this paper helps to clarify another potentially important issue: third-party replacement parts may affect welfare by preventing schemes of price discrimination by manufacturers. It was exactly this reasoning that the successful plaintiffs used in the 1992 (and on-going) U.S. Supreme Court case on *Kodak*.[17]

There are some opportunities for extending this research. In particular, it would be interesting to try to test empirically whether the legal status of manufacturer restrictions on independent extended service contracts in different jurisdictions varied sufficiently to cause different outcomes in manufacturer base warranties. While this paper discusses extended warranties, its analysis applies rather more widely. For example, a simple variation on the model presented here would have manufacturers choosing different qualities, instead of different warranties, in order to separate heavy and light users. In general, the model may be applied to any case in which ancillary services provided by a third-party can effectively bridge the gap between contracts that were intended to separate types of users who impose different costs on the firm, and suggests that it may often be welfare-reducing to allow the first firm to exclude the third party. What is most surprising is that this result will sometimes hold even when the first firm is in a competitive industry.

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[16] *In re General Motors Corp. and General Motors Sales Corp*., 34 FTC 58, 86 (1941); *Dicto Graph Products, Inc.*, v. *Federal Trade Commission*, 217 F. 2d 821, 828 (1954): *Englander Motors, Inc.* v. *Ford Motor Co.*, 267 F. 2d 11 (1959); *Alles Corp.* v. *Senco Products, Inc*., 329 F.2d. 567 (1964).

[17] *Eastman Kodak v. Image Technical Services, Inc*. 112 S.Ct. 2072 (1992).

Appendix

LEMMA 1: *Step 1*. Consider two contract combinations $\{\Gamma_H, \Gamma_L\}$ and $\{\Gamma_H, \overline{\Gamma}_L\}$, where $\overline{T}_L = T_L$ and $\overline{p}_L < p_L$, satisfying the four incentive compatibility and participation constraints. Define Γ_L to be such that $U_L(\Gamma_L) = 0$. Compared to $\overline{\Gamma}_L$, profits may always be increased by choosing Γ_L. Therefore PL is always binding.

Step 2. Consider two contract combinations $\{\Gamma_H, \Gamma_L\}$ and $\{\overline{\Gamma}_H, \Gamma_L\}$, where $\overline{T}_H = T_H$ and $\overline{p}_H < p_H$ satisfying the four incentive compatibility and participation constraints. By IH, $U_H(\Gamma_H) \geq U_H(\Gamma_L)$. For any Γ_H such that $U_H(\Gamma_H) > U_H(\Gamma_L)$, profits may be increased by increasing p_H until IH is binding. ■

PROPOSITIONS 1 AND 2: Proof: First to show that λ_1 is well-defined, we require that $0 \leq \lambda_1 \leq 1$. We require that $wf(k_L T_H *) \leq [u(k_L T_H * + x) - u(k_L T_H *)] f(k_L T_H *) \leq wf(k_H T_H *)$. The first inequality is obviously true. By equation (4), the second inequality is equivalent to $[u(k_L T_H * + x) - u(k_L T_H *)] f(k_L T_H *) \leq [u(k_H T_H * + x) - u(k_H T_H *)] f(k_H T_H *)$. This is true by assumption A1. Thus $0 \leq \lambda_1 \leq 1$.

For $\lambda > \lambda_1$,the problem for the monopolist is to maximize

$$\max_{T_H, p_H, T_L, p_L} \lambda \left[p_H - w\int_0^{T_H} f(k_H t) \right] + (1-\lambda)\left[p_L - w\int_0^{T_L} f(k_L t) \right]$$

subject to the two binding constraints

$$\int_0^{T_H} [u(k_H t + x) - u(k_H t)] f(k_H t) dt - p_H = \int_0^{T_L} [u(k_H t + x) - u(k_H t)] f(k_H t) dt - p_L$$

and $\int_0^{T_L} [u(k_L t + x) - u(k_L t)] f(k_L t) dt - p_L = 0$.

The six first order conditions for the six unknowns are

(a) $$\frac{\partial \pi}{\partial T_L} = -(1-\lambda) wf(k_L T_L) - \beta_1 [u(k_H T_L + x) - u(k_H T_L)] f(k_H T_L)$$
$$+\beta_2 [u(k_L T_L + x) - u(k_L T_L)] f(k_L T_L) = 0$$

(b) $$\frac{\partial \pi}{\partial T_H} = -\lambda wf(k_H T_H) + \beta_1 [u(k_H T_H + x) - u(k_H T_H)] f(k_H T_H) = 0$$

(c) $$\frac{\partial \pi}{\partial p_L} = 1 - \lambda + \beta_1 - \beta_2 = 0$$

(d) $$\frac{\partial \pi}{\partial p_H} = \lambda - \beta_1 = 0$$

plus the two binding constraints. By (c) and (d), we obtain $\beta_1 = \lambda$ and $\beta_2 = 1$. It is obvious from (b) that $T_H^{ME} = T_H *$. The application of IH and PL binding then immediately identifies T_L^{ME}.

For $\lambda < \lambda_1$, the constraints change: in particular, the incentive compatibility constraint for the light user becomes binding, since the separating solution has

$T_L^{ME} > T_H^{ME}$, so that IL is no longer met. Thus IL becomes binding for such values of λ, so that $\int_0^{T_L}\left[u(k_L t + x) - u(k_L t)\right] f(k_L t)dt - p_L = \int_0^{T_H}\left[u(k_L t + x) - u(k_L t)\right] f(k_L t)dt - p_H$.

Now the problem can be simplified to the pooling problem, since the two binding incentive compatibility constraints require that $\Gamma_L = \Gamma_H$:

(9) $$\max_{T_P, p_P} p_P - w\int_0^{T_P}\left[\lambda f(k_H t) + (1-\lambda) f(k_L t)\right]dt$$

subject to the binding constraint

$p_P = \int_0^{T_P}\left[u(k_L t + x) - u(k_L t)\right] f(k_L t)dt$. Substituting this constraint into the objective function and taking the FOC yields the result $\lambda wf(k_H T) + (1-\lambda)wf(k_L T) = \left\{u(k_L T + x) - u(k_L T)\right\} f(k_L T)$, which defines the optimal T_P^{ME}. PL defines the optimal p_P^{ME}, thus identifying the optimal pooling solution. λ_1 is the largest λ for which this optimal $T_P^{ME} \geq T_H*$.

For completeness, I show that this pooling warranty is more profitable than any separating warranty if $\lambda < \lambda_1$. A separating warranty would require an optional extended warranty to be offered to either the heavy or the light user. No profitable extended warranty can be sold to the heavy user, since the slope of the isoprofit curve is steeper for the heavy user than the indifference curve for $t \geq T_H*$. No profitable extended warranty can be offered to the light user only, since by assumption A1, the slope of the indifference curve for the heavy user is steeper than the slope of the light user's indifference curve and any extended warranty beyond T_P satisfying PL will be purchased by both types, making it a pooling warranty. But we have already found the optimal pooling warranty.■

PROPOSITION 4: Proof: Following the entry of any independent insurers, the manufacturer makes zero profits on any optional extended warranty. The manufacturer will therefore choose between the profit-maximizing pooling contract, in which case both types buy the product, or the profit-maximizing contract for heavy users only.

(a) We first consider the case where both types are served. The objective function is the same as (9). The first order condition is given by (7) which solves for the solution T_P^{MN}. Compared with the first order condition for the separating solution (6), only the first term on the RHS is different. Since $\left[u(k_H T + x) - u(k_H T)\right] f(k_H T) > wf(k_H T)\ \forall\ T < T_H*$, the RHS of (7) is less than the RHS of (6) $\forall\ t < T_H*$. But $\left[u(k_L t + x) - u(k_L t)\right] f(k_L t) < \left[u(k_L T_P^{MN} + x) - u(k_L T_P^{MN})\right] f(k_L T_P^{MN})\ \forall\ t > T_P^{MN}$. Therefore $T_P^{MN} \geq T_L^{ME}$.

(b) We now consider the case in which only the heavy user is served. In this case, the monopolist sets the full-information warranty contract Γ_H* and makes profits of $\lambda\Pi_H(\Gamma_H*)$ but loses all profits on the light user. Thus the monopolist will choose to serve only the heavy user if $\lambda\left\{\Pi_H(\Gamma_H*) - \Pi_H(\Gamma_P^{MN})\right\} > (1-\lambda)\left\{\Pi_L(\Gamma_P^{MN}) + (s-c)\right\}$.■

<u>Definition:</u> λ_2 is defined as the λ which satisfies

$$w\int_0^{T_H*}\left[\lambda f(k_H t) + (1-\lambda) f(k_L t)\right]dt = w\int_0^{T_L^{CE}} f(k_L t)dt + \int_{T_L^{CE}}^{T_H*}\left[u(k_L t + x) - u(k_L t)\right] f(k_L t)dt$$

where T_L^{CE} is defined by

$$w\int_0^{T_H^*} f\left(k_H t\right)dt - \int_{T_L^{CE}}^{T_H^*}\left[u\left(k_L t + x\right) - u\left(k_L t\right)\right] f\left(k_L t\right)dt = w\int_0^{T_L^{CE}} f\left(k_L t\right)dt$$

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