

Regulation by Entry*

Francesca Cornelli

(London Business School and CEPR)

Oved Yosha

(Brown University and Tel-Aviv University)

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Abstract

In markets suffering from adverse selection low valuation individuals purchase too little of the good in question. We study the effectiveness of a particular form of government intervention in such markets, centered on making sure that a certain contract be available on the market. Once this contract is available, private sellers respond optimally by offering contracts of their own, and buyers are free to buy from whoever they wish. The intervention scheme increases the quantity purchased by low valuation individuals, in the competitive and the monopolistic cases. In both cases the intervention scheme generates a Hicks-Kaldor welfare improvement. The central feature of the post-intervention equilibrium is that high valuation individuals purchase the contract introduced by the government, whereas low valuation individuals purchase contracts sold by private firms. By targeting the “lemons” with an appropriately designed contract, the government makes it worthwhile for private firms to increase the quantity sold to low valuation individuals.

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1 Introduction

Many real world markets are “thin” as a result of adverse selection. In such markets—whether competitive or monopolistic—firms find it optimal to offer contracts that attract only high valuation buyers, while low valuation buyers are typically offered contracts which involve “underproduction,” namely these buyers purchase a smaller quantity than that which would have been purchased had information been symmetric. In extreme cases these buyers are completely cut out of the market. A classic example are insurance markets with adverse selection where low risk individuals obtain little or no coverage (Rothschild and Stiglitz (1976) for the competitive case and Stiglitz (1977) for the monopolistic case). Other examples are markets for initial public offerings (Myers and Majluf (1984)), markets for educational loans (Mankiw (1986)), annuities markets (Bodie (1989)), health insurance markets, and markets for residential mortgages.

In some cases this market failure has serious consequences. The lack of fairly priced financing for educational loans may prevent talented young people from investing in human capital; shortage of financing for risky enterprises prevents young innovative firms from pursuing their ideas; the presence of segments of the population who are uninsured (in particular medically uninsured) and without an adequate old age income source or adequate housing involves negative externalities for the rest of the population. The issue has in fact attracted attention by researchers who often advocate intervention in such markets. In the context of the competitive insurance market, for example, compulsory partial coverage which permits private companies to sell supplementary insurance, and various tax-subsidy schemes have been proposed to deal with the problem.¹

A basic difficulty associated with intervention in markets with adverse selection is that, despite their obvious malfunction, economic theory tells us that a planner without superior information to that of market participants cannot, in most cases, generate a Pareto improvement. That is, using the terminology of Holmström and Myerson (1983), the market

¹Dahlby (1981) and Crocker and Snow (1985) respectively. See also Summers (1989) who advocates mandating health coverage on the grounds that there may be positive externalities associated with health insurance. For example, society may care “about preventing the spread of contagious diseases more than any individual does or would take account of.” (p.178)

equilibrium in the presence of adverse selection is typically *interim incentive efficient*; see also Prescott and Townsend (1984) and Gale (1991). Therefore, a planner is unable to induce an allocation where all buyers *and* sellers are better off.² Any intervention scheme designed to increase market participation must take this constraint into consideration.

Indeed, the intervention scheme we propose takes as given that the government does not possess superior information to that of market participants, and hence cannot always increase market participation *and* generate a Pareto improvement. However, a major strength of the intervention scheme is that despite this fact, it always generates a welfare improvement in the Hicks-Kaldor sense, also when generating a Pareto improvement is not possible. By a Hicks-Kaldor welfare improvement we mean that when there are losers as a consequence of the intervention, the gains (in monetary terms) exceed the losses, although the gainers do not actually compensate the losers.

The proposed intervention scheme is centered on the following idea. The government must make sure that a certain contract, which we characterize in our analysis, be available on the market. Private sellers respond optimally by offering any number of contracts, and buyers select a contract from the enhanced menu of contracts offered. In this respect the intervention scheme is market oriented, as it merely requires competition on the part of the government with private firms by means of a government designed contract.

Furthermore, the scheme does not involve any direct regulation of the activities of private firms, nor the computation of (and the bargaining over) rates, terms, and conditions set by them. As contracts can be relatively complex, monitoring them is resource consuming. The need for a government regulator to read a contract written by a private firm, and decide whether this contract qualifies for a subsidy or whether it deserves to be taxed never occurs in the scheme we propose. We therefore believe that regulation by entry is relatively easy to implement. The public firm enters the market, offering a single standard contract, competing with private firms, and buyers choose freely which contract to buy.

The specific institutional arrangement through which the government implements the policy is not very important for our analysis. Our model assumes that the government

²An exception is the competitive case when the proportion of high valuation individuals is small; see Rothschild and Stiglitz (1976, pp.643–5).

designed contract is marketed via a public (state owned or state chartered) firm who enters the market, competing with privately owned firms. However, it should be kept in mind that the essential ingredient of our suggested method is the introduction of a government designed contract to the market, not the existence of a state owned firm.³

A central feature of the intervention scheme is that in equilibrium high valuation individuals—those who were fully served by private firms prior to government intervention—purchase the contract introduced by the government, whereas low valuation individuals—those who were partially served (or not served) by private firms—purchase from private firms.

At first glance it may seem counter-intuitive that the government should target the high valuation individuals who are already being fully served by the private sector. The point is that directly targeting low valuation individuals—who do not purchase the good or purchase less than when information is symmetric—will not always work: any contract accepted by low valuation individuals will also be purchased by the high valuation individuals. By contrast, when the government offers a contract that attracts the high valuation individuals, private firms respond by offering contracts which are purchased by the rest of the buyers, the low valuation individuals. By targeting the “lemons” with an appropriately designed contract, the government reduces the externality which arises from the presence of high risk buyers in the market, making it worthwhile for private firms to increase the quantity sold to low valuation buyers. This holds both in the competitive and the monopolistic cases.

Our paper is related to the analyses of Dahlby (1981) and of Crocker and Snow (1985). Dahlby studies a policy of compulsory partial coverage which permits private companies to sell supplementary insurance. Crocker and Snow demonstrate how a Pareto improvement can be generated by a tax-subsidy scheme in those cases when the market outcome with no government intervention is not *interim incentive efficient*. We argue in this paper that even when the market outcome with no government intervention is *interim incentive efficient*,

³Instead of competing via a public firm the government may contract with one or several private firms for the provision of pre-specified contracts to the public. In Germany, for example, the government nominates certain private insurance companies as “official” suppliers of medical insurance on condition that these companies offer for sale particular health insurance packages.

and hence generating a Pareto improvement is not possible, regulation by entry—which involves no taxes or subsidies—increases market participation and achieves a Hicks-Kaldor welfare improvement.

The paper is also related to the literature on mixed markets, where public firms coexist with private firms. See, for example, Beato and Mas-Colell (1984), Cremer, Marchand, and Thisse (1989), De Fraja and Delbono (1989), and Fershtman (1989). A common feature of this literature is that public firms enter the market with the aim of reducing the market power of concentrated private industries. Our paper focuses on the role that the entry of a public firm may have in alleviating the special problems which arise in markets which are “thin” as a result of adverse selection. In fact, the proposed intervention scheme achieves a “thicker” market and a Hicks-Kaldor welfare improvement even when the market is competitive with firms making zero profits.

We illustrate the intervention scheme in a classic setting, that of Rothschild and Stiglitz (1976) for the competitive case and Stiglitz (1977) for the monopolistic case (Section 2). Towards the end of Section 2 we show, for the monopolistic case, how the analysis can be extended to a situation where there are more than two valuation levels for the good (risk categories), and how the analysis for the insurance market carries over to other kinds of markets with adverse selection. Section 3 concludes.

2 The model

Consider an insurance market where there are two types of individuals differing only in the probability of having an accident. They have an initial endowment of w . The damage if an accident occurs is d , with $w - d > 0$, and the probabilities of accident are p_h and p_l , with $p_h > p_l$. All individuals are expected utility maximizers, with the same strictly concave von Neumann-Morgenstern utility function $u(\cdot)$. The reservation utility level, \bar{u}_i , for an individual of type $i = l, h$ is $\bar{u}_i = (1 - p_i)u(w) + p_i u(w - d)$. Let μ_i denote the proportion of type $i = l, h$ individuals in the population.

An insurance contract is a pair of numbers: The first is $w - c^{na}$, the payment to the insurance company in the event of no accident; the second is $c^a - (w - d)$, the payment by

the insurance company if an accident occurs. As such a contract is fully characterized by (c^{na}, c^a) , we abbreviate notation by calling points in state contingent consumption space “contracts.” The superscripts na and a denote “no accident” and “accident” respectively. Expected profits from a contract (c_i^{na}, c_i^a) with an individual of type $i = l, h$ are $E\tilde{\pi}_i = (1 - p_i)(w - c_i^{na}) - p_i[c_i^a - (w - d)]$. We denote the zero expected profits lines by $(\pi = 0)_l$ and $(\pi = 0)_h$. The zero expected profits line for pooling contracts is denoted $(\pi = 0)_o$.

Consider the following scenario. First, a public firm offers an insurance contract for sale. Private firms observe the contract offered by the public firm, and then offer new contracts of their own. The public firm is committed to its original contract.⁴ Finally, each buyer of insurance chooses his preferred contract from the entire menu of contracts offered.

The above scenario is in fact a simple two stage game where the public firm is the first mover. Private insurance firms maximize expected profits by offering insurance contracts. We turn to the objective of the public firm. The public firm cares in a lexicographically decreasing order about (1) the expected utility levels of individuals (as in the competitive case); and (2) the profits of the private insurance firms.⁵ The need for a preference by the public firm for the welfare of one type of agent over another is an inevitable consequence of the *interim incentive efficiency* of the equilibrium without government intervention.

We must impose a bound on the amount of money that the public firm is allowed to lose. Without such a restriction any allocation can be achieved by the government via a generous, money losing contract offered by the public firm. Let $s \geq 0$ be the maximal amount of money the public firm is allowed to lose. The actual profit or loss from a contract offered by the public firm depends on the contracts offered in response by the private sellers of insurance.

The public firm is allowed to offer any contract which would be considered efficient had information been symmetric. In the case of the insurance market this is a full insurance

⁴We assume that the government’s ability to commit to its policy is greater than that of private firms, possibly because a change in government policy requires legislation. Therefore we assign the public firm the role of the Stackelberg leader.

⁵Alternatively, we could postulate a social welfare function which is a weighted average of the sum of the expected utility levels of buyers of insurance and of firms’ profits, the latter receiving a sufficiently low weight. We refrain from doing this as it would not affect the solution of the model.

contract anywhere on the 45° line.⁶ Prior to offering the contract the public firm decides whether to enter the market or not. A decision not to enter is equivalent to the public firm offering a contract which no buyer of insurance would accept. Therefore we omit without loss of generality the explicit mentioning of the entry decision in the analysis.

We have to make certain conventions regarding the choices of the buyers of insurance whenever an individual rationality or an incentive compatibility constraint is binding. This is common practice in the incentive literature. We shall assume that whenever the public firm and a private firm offer the same contract, low risk individuals prefer the contract offered by the private firm, whereas high risk individuals prefer the contract offered by the public firm. Also, whenever high risk buyers are indifferent between a full coverage and a partial coverage contract, they purchase the full coverage contract.

We turn to an analysis of the intervention scheme in a market with one private insurance firm and in a market with more than one insurance firm, comparing the resulting outcomes with the equilibrium prior to government intervention (Stiglitz (1977) and Rothschild and Stiglitz (1976) respectively).

2.1 A monopolistic insurance market

In the equilibrium without government intervention the private firm offers two distinct contracts: a full insurance contract, purchased by the high risk individuals, and a less than full insurance contract purchased by the low risk individuals. Let these contracts be points X and Y in Figure 1 and Figure 2. The analysis also holds for the particular case when point X coincides with point F , and point Y coincides with point E , namely when low risk

⁶Constraining the public firm to a full insurance contract renders the intervention scheme simple, which in our view is of great importance. A further rationale for this requirement is that the primary motivation for government intervention is the fact that some individuals are purchasing little or no insurance. Since there is no moral hazard, full insurance is a natural choice for a government concerned with increasing coverage. If moral hazard were present, the government would be facing a trade-off between the desire to provide full coverage and the desire to create incentives. Then we could think of the government solving this trade-off by offering contracts on a line lying below the 45° line and parallel to it, or on a ray from the origin lying below the 45° line. The analysis would be similar. For a related model dealing with the role of the public sector in the provision of unemployment insurance when there is adverse selection and moral hazard, see Chiu and Karni (1994).

individuals purchase no insurance at all.⁷

Let $s = 0$, namely we require the public firm to break even.⁸ An equilibrium consists of a full insurance contract offered by the public firm, and contracts offered by the private firm such that (a) given the contract offered by the public firm, the private firm maximizes profits; and (b) the public firm optimizes, namely it cannot offer another full insurance contract that does not lose money yielding a preferred outcome, given the best response of the private firm and the decisions regarding purchase of insurance by individuals.

We now characterize the equilibrium, distinguishing between two cases, described in Figures 1 and 2 respectively.

Case 1: Suppose both zero profits lines lie to the right of both indifference curves through the endowment point, as shown in Figure 1. This case occurs when the two types of buyers do not differ by much, i.e. $p_h - p_l$ is small, or when $u(\cdot)$ exhibits high risk aversion, i.e. the slope of both indifference curves at the endowment point is close to zero. The equilibrium for case 1 is characterized in

Proposition 1 (a) *The public firm serves the high risk individuals at point H in Figure 2, breaking even; (b) the private firm serves the low risk individuals at (the same) point H , making strictly positive profits.*

Proof. The proof can be done graphically. Suppose the public firm offers point H in Figure 1. There is no contract preferred by high risk individuals to H which does not lose money. Thus, the best response of the private firm is to attract all the low risk individuals at H , where profits are maximal. Intuitively, this can be described as follows. In order to ensure that no low risk individual buys insurance from the public firm, the private firm must offer a contract which is infinitesimally more attractive to them than point H , without

⁷This occurs when the proportion of low risk individuals in the population is sufficiently low. The analysis does not apply to the case where the number of high risk individuals is very small and the monopolist finds it optimal to cross subsidize high risk individuals (on which it loses money) with profits from contracts with low risk individuals (points X_ϵ and X'_ϵ in Figure 2). However, in that event it is hard to make the case for government intervention in the first place.

⁸Of course, as we shall show at the end of this subsection, the analysis extends to situations when the public firm is allowed to lose no more than $s > 0$. We focus on the case $s = 0$ in order to stress that a subsidy is not necessary for the intervention scheme to work.

attracting the high risk individuals. This is a point arbitrarily close to point H in the region between the indifference curves through H below the 45° line in Figure 1. Formally, the private firm simply offers point H itself rendering low risk individuals indifferent. By our convention, they will purchase the contract offered by the private firm. Thus, the private firm attracts the low risk buyers and makes strictly positive profits, while the public firm is left with the high risk buyers at point H , breaking even.

We shall now show that offering any point other than H will either yield an outcome which is less preferred by the public firm, or will result in the public firm losing money. Suppose the public firm offers a point such as X_2 . Without studying in detail the best response of the private firm, it is clear that it will not offer contracts which lie above both indifference curves through H . Therefore offering X_2 cannot result in an outcome which is preferred by the public firm to the equilibrium outcome. Suppose the public firm offers a point such as X_1 . The best response of the private firm is to attract all the buyers of insurance at point X_1 . The public firm prefers the equilibrium outcome to this outcome. Suppose the public firm offers a point such as X_3 . The private firm will respond by attracting the low risk individuals at point X_3 . The public firm will be left with the high risk individuals at point X_3 , losing money. Suppose the public firm offers a point such as X_4 . The private firm will choose not to serve anyone, and the public firm will lose money, which completes the proof. ||

Case 2: Suppose the line $(\pi = 0)_h$ crosses the 45° line to the left of \bar{u}_l , as in Figure 2, where point H lies to the left of point J . This case occurs when types are very different, i.e. $p_h - p_l$ is big, or when $u(\cdot)$ exhibits low risk aversion. In this case the intervention scheme improves the degree of coverage of low risk individuals, but not all the way to full coverage. In this respect the intervention scheme is less effective than in case 1, as the difference between types is big. The equilibrium is characterized in

Proposition 2 (a) *The public firm serves the high risk individuals at point H in Figure 3, breaking even; (b) the private firm serves the low risk individuals at point K , on \bar{u}_l , which provides higher coverage than point Y , but not full coverage. The private firm's profits are strictly positive.*

Proof. For any contract offered by the public firm, the solution to the private firm's maximization problem must satisfy the following properties: (a) $c_h^{na} = c_h^a = c_h$, i.e. full insurance for high risk individuals; (b) the individual rationality constraint for low risk individuals binds; (c) the incentive compatibility constraint for high risk individuals binds; and (d) the incentive compatibility constraint for low risk individuals is redundant. From (a) and (c) we have

$$u(c_h) = (1 - p_h)u(c_l^{na}) + p_h u(c_l^a), \quad (1)$$

and from (b) we have

$$(1 - p_l)u(c_l^{na}) + p_l u(c_l^a) = \bar{u}_l. \quad (2)$$

Per capita profits are then given by

$$\begin{aligned} E\tilde{\pi} &= \mu_l E\tilde{\pi}_l + \mu_h E\tilde{\pi}_h = \\ &= \mu_h(w - p_h d - c_h) + \mu_l\{(1 - p_l)(w - c_l^{na}) - p_l[c_l^a - (w - d)]\}. \end{aligned} \quad (3)$$

Differentiating (1) and (2) with respect to c_h yields $\frac{dc_l^{na}}{dc_h} = -\frac{p_l u'(c_h)}{(p_h - p_l)u'(c_l^{na})} < 0$ and $\frac{dc_l^a}{dc_h} = \frac{u'(c_h)(1 - p_l)}{u'(c_l^a)(p_h - p_l)} > 0$. Differentiating (3) with respect to c_h and substituting for $\frac{dc_l^{na}}{dc_h}$ and $\frac{dc_l^a}{dc_h}$ yields

$$\frac{dE\tilde{\pi}}{dc_h}(c_h, c_l^{na}, c_l^a) = \mu_l \frac{(1 - p_l)p_l u'(c_h)}{p_h - p_l} \left(\frac{1}{u'(c_l^{na})} - \frac{1}{u'(c_l^a)} \right) - \mu_h. \quad (4)$$

As long as the derivative in (4) is negative, the monopolist will decrease c_h , decreasing the coverage of low risk individuals. By differentiating (4) we obtain $\frac{d^2 E\tilde{\pi}}{dc_h^2} < 0$, which implies that if $\frac{dE\tilde{\pi}}{dc_h}(\bar{c}_h, c_l^{na}, c_l^a) < 0$ for some \bar{c}_h , then $\frac{dE\tilde{\pi}}{dc_h}(c_h, c_l^{na}, c_l^a) < 0$ for any $c_h > \bar{c}_h$. This means that for any contract offered by the public firm to the right of point X , the private firm will want to push the contract offered to the high risk individuals as far as it can along the 45° line towards the origin (but not beyond point X). For example, the best response to X_5 is X'_5 . As the public firm is offering point H the private firm will offer point K , serving the low risk individuals. The public firm will serve the high risk individuals at point H , breaking even.

As contracts with high risk buyers at H break even, we assume that the private firm

does not offer point H in addition to point K , and therefore does not serve any high risk individuals. It would make no difference for the analysis if we allowed the private firm to split the high risk market segment with the public firm.

We now show that offering any point other than H is not optimal for the public firm. Suppose the public firm offers a point such as X_6 . The private firm will attract the low risk individuals at X'_6 . If the public firm offers X_7 the private firm will attract the low risk individuals at X_7 . In both cases the public firm will be left with the high risk individuals, losing money. If the public firm offers X_5 the private firm will attract the low risk individuals at X_5 . The public firm prefers the equilibrium outcome to this outcome. Suppose the public firm offers a point such as X_8 . The private firm will choose not to serve anyone, and the public firm will lose money, which completes the proof of Proposition 2. ||

In both cases, an interesting feature of the equilibrium is that the public firm serves the high risk buyers. Notice that adverse selection hurts low risk individuals who prior to government intervention receive little or no coverage. However, the intervention scheme results in high risk individuals being covered by the government designed insurance contract. Upon reflection, this has a simple explanation: *By targeting the "lemons" the public firm makes it worthwhile for private firms to increase the coverage offered to low risk individuals.*

Another attractive property of the intervention scheme is that it involves no direct regulation of private firms on the part of the government. The contracts offered by private firms are never inspected or pre-approved by a regulator. The only thing the government does is enter the market and sell insurance. The rest happens endogenously, as an equilibrium response. We therefore regard the regulatory scheme as a *market oriented* form of regulation.

Next, we compare the above equilibrium with the equilibrium in the same market with no government intervention (Stiglitz (1977)), studying the welfare consequences of the intervention scheme.

Welfare analysis of the intervention scheme. We compare the equilibrium without government intervention (points X and Y in Figure 1) to the equilibrium resulting from the intervention scheme. Although intervention cannot result in a Pareto improvement

with respect to the equilibrium without government intervention, it generates a welfare improvement in the Hicks-Kaldor sense. We turn to a systematic analysis of these issues.

We employ the following notion of efficiency. An allocation A_1 is said to interim Pareto dominate an allocation A_2 if all agents achieve a higher expected utility under A_1 , and at least one strictly so, given that each agent privately knows his type. Consider a game with asymmetric information, and let M be an equilibrium allocation of this game. Being an equilibrium allocation, M must satisfy the individual rationality and incentive compatibility constraints. The allocation M is said to be *interim incentive efficient* if there is no other game—for the same set of players—with an equilibrium allocation M' which interim Pareto dominates the allocation M .⁹

In particular, this means that a planner without better information than that available to private sellers of insurance, is unable to reallocate consumption so as to make all agents (buyers and sellers) better off. That is, the planner is unable to formulate another game which has an equilibrium allocation M' which interim Pareto dominates the allocation M .

First, we shall show that the equilibrium without government intervention described above is *interim incentive efficient*. Consider the following problem: Choose contracts (c_l^{na}, c_l^a) and (c_h^{na}, c_h^a) to maximize $\alpha_l \mu_l u_l + \alpha_h \mu_h u_h + \alpha E\tilde{\pi}$, subject to incentive compatibility constraints for the buyers, and individual rationality constraints for the buyers and the monopolist, where u_l , u_h , and $E\tilde{\pi}$ are the expected utility levels and the expected profits of the monopolist given the chosen contracts, and the α 's are arbitrary constants. Any solution to this problem, for some non-negative weights α_l , α_h , and α is *interim incentive efficient* (see, for example, Prescott and Townsend (1984)). Set $\alpha_l = \alpha_h = 0$, and let α be any strictly positive constant. The resulting problem is precisely the monopolist's problem in the equilibrium prior to government intervention. Note that the individual rationality constraint for the monopolist is redundant and can be dropped. Thus, the equilibrium is *interim incentive efficient*.

As the equilibrium prior to government intervention is *interim incentive efficient*, we cannot hope to achieve—with any form of intervention—an interim Pareto dominating

⁹See, for example, Holmström and Myerson (1983), Prescott and Townsend (1984), and Gale (1991).

allocation. However, the intervention scheme succeeds in increasing the degree of coverage of low risk buyers and is socially desirable in the following sense:

Proposition 3 *For all parameter configurations the post-intervention equilibrium dominates the equilibrium without government intervention in the Hicks-Kaldor sense.*

We shall first provide an intuitive argument for a particular case, and then proceed with a formal proof. Consider case 2 (Figure 2), and suppose that in the equilibrium prior to government intervention the private firm offers points F and E . For the low risk buyers of insurance, the transition from the equilibrium prior to government intervention to the post-intervention equilibrium involves no gain or loss in expected utility (from point E to point K). The profits of the private firm from contracts with low risk individuals increase from zero to a positive level. So far, we have identified a gain, and no losses. For the high risk buyers of insurance, the transition from the equilibrium prior to government intervention to the post-intervention equilibrium involves a gain in expected utility (from point F to point H), whereas the profits of the private firm from contracts with high risk individuals decrease from a positive level to zero. The important fact to note is that when translated to certainty equivalent terms (i.e. monetary terms) the gain of the high risk buyers is exactly the loss to the monopolist. Hence total gains exceed total losses. The argument for the other cases is similar, although less transparent, and is carried out in the following proof.

Proof of Proposition 3.

Notation: (a) For any contract Z on the 45° line denote by $c_i^{(Z)}$ (a scalar) the consumption of an individual of type $i = l, h$ at Z ; (b) for any contract Q (not necessarily on the 45° line) sold by the private firm, denote by $E\tilde{\pi}_i^{(Q)}$ the per capita (expected) profits from selling Q to an individual of type $i = l, h$; (c) recalling that profits from a contract (c_i^{na}, c_i^a) with an individual of type $i = l, h$ are $E\tilde{\pi}_i = (1 - p_i)(w - c_i^{na}) - p_i[c_i^a - (w - d)]$, a contract Z on the 45° line yields expected profits $E\tilde{\pi}_i^{(Z)} = w - p_i d - c_i^{(Z)}$.

Case 1: The aggregate change in expected utility for high risk buyers, in certainty equivalent terms, is $\mu_h[c_h^{(H)} - c_h^{(X)}] > 0$, and for low risk buyers it is $\mu_l[c_l^{(H)} - c_l^{(J)}] > 0$ (see Figure 2). The change in the private firm's profits is $[\mu_h E\tilde{\pi}_h^{(h)} + \mu_l E\tilde{\pi}_l^{(h)}] - [\mu_h E\tilde{\pi}_h^{(X)} + \mu_l E\tilde{\pi}_l^{(Y)}] <$

0. Adding up these changes, using property (c) in the proof of Proposition 2, yields $\mu_l[E\tilde{\pi}_l^{(J)} - E\tilde{\pi}_l^{(Y)}] > 0$.

Case 2: The aggregate change in certainty equivalent terms for high risk buyers is $\mu_h[c_h^{(H)} - c_h^{(X)}] > 0$, and for low risk buyers it is zero (see Figure 3). The change in the monopolist's profits is $[\mu_h E\tilde{\pi}_h^{(H)} + \mu_l E\tilde{\pi}_l^{(K)}] - [\mu_h E\tilde{\pi}_h^{(X)} + \mu_l E\tilde{\pi}_l^{(Y)}] < 0$. Adding up these changes, using property (c) in the proof of Proposition 2, yields $\mu_l[E\tilde{\pi}_l^{(K)} - E\tilde{\pi}_l^{(Y)}] > 0$. ||

Remark 1. In the post-intervention equilibrium (in both cases 1 and 2), the monopolist chooses to remain in the market, and is making strictly positive profits. This outcome is consistent with the concept of *ex-post participation* (Green (1985)). Thus, the coexistence of a privately owned firm, alongside a public firm, is obtained endogenously in the post-intervention equilibrium.

Remark 2. An analogous analysis can be carried out when the public firm is allowed to lose money. Suppose we allow the public firm to lose no more than s . Then, in case 2 (Figure 2), for example, the public firm offers a point like X_6 . The private firm's best response is point X'_6 . At X_6 the public firm loses s , i.e. a loss of $\frac{s}{\mu_h}$ per high risk buyer. The result of Proposition 3 goes through—the loss s and the reduction in monopoly profits are fully compensated by the gain of high risk buyers, while the gain of low risk buyers is a net social gain. Note that the expected utility levels of both types of buyers, and the profits of the private firm are strictly increasing in s .

2.2 A competitive insurance market

In the absence of government intervention the equilibrium in this market is characterized by high risk individuals obtaining full coverage, low risk individuals obtaining partial coverage, and insurance firms breaking even. The contracts offered to high and low valuation buyers are points H and A in Figure 3. We turn to the intervention scheme.

Suppose that there are several private insurance firms, and let $s > 0$ be the maximal amount of money that the public firm is allowed to lose. An equilibrium of the model is a contract offered by the public firm and a set of contracts offered by private firms such that:

(I) Given the contract offered by the public firm, (a) no contract offered by private firms loses money; and (b) there is no other contract or set of contracts which would (strictly) make money if offered, assuming that all other contracts continue to be offered; and (II) the public firm optimizes subject to its maximal loss constraint, s ; that is, there is no other full insurance contract that does not lose more than s yielding a preferred outcome, given the best response of the private firms and the decisions regarding purchase of insurance by individuals.

Following Rothschild and Stiglitz (1976) we assume that the proportion of high risk individuals is sufficiently large. More specifically, we assume that the line $(\pi = 0)_o$ lies entirely to the left of the low risk indifference curve through A , and hence also entirely to the left of the low risk indifference curve through A' . The equilibrium, presented in Figure 3, is similar to that of Figure 2 (one private seller): The public firm attracts the high risk buyers inducing private firms to improve the insurance terms for low risk buyers. The equilibrium is characterized in

Proposition 4 *There is a unique equilibrium where (a) the public firm provides full coverage to the high risk individuals at point H' (Figure 3), losing $\frac{s}{\mu_h}$ per buyer; and (b) private sellers of insurance serve the low risk individuals at point A' , breaking even.*

Proof. The proof can be done graphically. Let H' be such that the loss from a high risk individual is s . Given that the public firm offers H' and private firms offer A' , there is no other contract which makes strictly positive profits. Any such contract would have to attract at least some buyers of insurance. If the contract lies above both indifference curves through A' , it is purchased by both types of buyers and loses money. If it lies between the indifference curves through A' , it is purchased only by high risk buyers and loses money. Furthermore, the private firms are breaking even when serving the low risk buyers at A' .

Offering point H' is optimal for the public firm since there is no other contract on the 45° line which, when offered by the public firm, loses not more than s making buyers better off (given the private firms' best response); and since offering a point to the left of H' (losing less than s) would generate an outcome where both types of buyers are worse off than they are in equilibrium. Thus, the configuration described in the Proposition is the

unique equilibrium, which completes the proof. ||

Welfare analysis of the intervention scheme. The equilibrium without government intervention consists of points H and A in Figure 3. When μ_h is lower than a cut-off value the equilibrium is not *interim incentive efficient*.¹⁰ When μ_h is above this cut-off value the equilibrium is *interim incentive efficient*, implying that a planner that does not possess more information than private sellers of insurance cannot achieve an allocation which interim Pareto dominates the equilibrium prior to government intervention. However, as in the previous subsection, we have

Proposition 5 *The post-intervention equilibrium in Proposition 4 welfare dominates the equilibrium without government intervention in the Hicks-Kaldor sense.*

Proof. By construction, the total gain of high risk individuals in monetary (certainty equivalent) terms is exactly s , which is the amount the public firm loses in equilibrium. Therefore, the expected utility gain of low risk individuals is a net social gain. The gainers, though, do not compensate the losers—those who paid taxes in order to finance the public firm’s losses. ||

2.3 Robustness

More than two types. We now extend the analysis, for the one private insurer case, to situations where there are more than two risk categories in the population. Suppose the public firm is required to break even. Let there be three types—low, medium, and high risk individuals. There are three cases. First, suppose that all zero profits lines lie to the right of all indifference curves through the endowment point, as shown in Figure 4 (This situation is similar to case 1 above). Without government intervention, a typical profit maximizing set of contracts for the private firm are points X , Y , and Z , as shown in the figure.¹¹

¹⁰This is shown in Rothschild and Stiglitz (1976, pp.643-645). They, of course, do not use the term *interim incentive efficient* which was introduced later by Holmström and Myerson (1983). For this particular case Crocker and Snow (1985) show how an interim Pareto improvement can be achieved by an appropriately chosen tax-subsidy scheme. In order to generate further increases in coverage for the partially insured the intervention scheme we propose can be applied after the possibilities for Pareto improvement using such tax-subsidy schemes have been exhausted.

¹¹A special case of this case are points X , Y' , and E , where low risk individuals buy no insurance.

When the public firm enters, the resulting equilibrium is identical to the equilibrium in case 1 above: The public firm offers point H , serving the highest risk population, breaking even. The private firm serves the medium and low risk buyers at point H , making strictly positive profits on both. This is true for any number of types. Therefore, the result of case 1 extends to any number of risk categories in the population.

Next, consider the case described in Figure 5. Points X , Y , and Z are the contracts offered by the monopolist prior to the entry of the public firm. When it enters, the public firm offers, in equilibrium, point H serving the highest risk population, breaking even on average. The private firm offers a menu of two contracts, serving the medium risk population at point H and the low risk population at point K , making strictly positive profits on both types of buyers. This equilibrium combines the features of the equilibria described in Propositions 1 and 2.

The case described in Figure 6 is more complex. It is possible to show that the intervention scheme generates an increase in coverage (with no loss in expected utility) for all types of buyers if the utility function is homothetic. For reasons of space the analysis is omitted. However, if we allow the public firm to lose no more than some pre-determined amount of money, the following policy can be applied without having to impose any restrictions on the utility function. Suppose that the public firm offers point M in Figure 6. The private firm will respond by serving the low risk individuals at point P . The public firm ends up serving the medium risk population on which it breaks even on average, and the high risk population on which it loses $\mu_h[w - p_m d - (w - p_h d)] = \mu_h d(p_h - p_m)$. The coverage of both medium and low risk individuals increases with respect to the equilibrium without government intervention.

In general, if there are many very different types in the population, with reservation utilities and zero profits lines as in Figure 6, then the government must decide how much to allow the public firm to lose. This will determine the impact of the entry of the public firm on the coverage of the lower risks in the population. It should be noted, though, that for *any* number of risk categories in the population, it is sufficient that *two* reservation utilities lie to the left of $(\pi = 0)_h$, the zero profits line of the highest risk individuals, for the coverage

of *all* types to increase when the public firm offers point H (breaking even). Therefore, in most cases, even when there are many risk categories in the population, regulation by entry with the public firm breaking even achieves very satisfactory results.

2.4 Applying the results to other markets with adverse selection.

In the introduction we claimed that the intervention scheme applies to markets with adverse selection in general, whereas the analysis focused on the particular case of insurance markets. In this section we illustrate how the intervention scheme works in another type of market.

Consider, for example, a market for a single good with two types of consumers—low and high valuation buyers. Let $\theta_i u(q) - T$ denote the utility of a buyer of type $i = \ell, h$ who purchases q units of the good for a total payment of T , where $u(\cdot)$ is a strictly concave function satisfying $u(0) = 0$, and $\theta_h > \theta_\ell$. There is one seller with constant marginal cost equal to $c > 0$, who cannot distinguish between the two types of buyers. The seller can offer any menu of contracts (q_i, T_i) , $i = \ell, h$, and each buyer chooses the contract he prefers. Since the cost of production is the same whether the good is purchased by a type ℓ or a type h buyer, there is a single zero profits line with slope c . Therefore, this example corresponds to case 1 in the monopolistic insurance market.

The equilibrium prior to government intervention is represented by points X and Y in Figure 7. Point X is tailored for the high valuation buyers. As a consequence, low valuation buyers are offered contracts which involve “underproduction” (point Y), namely these buyers purchase a smaller quantity than that which would have been purchased had information been symmetric (point B). If this constitutes a social problem which justifies intervention, e.g. the good in question contributes to reduce probabilities of accidents or to reduce pollution, then the government may want to intervene. Let us emphasize once more that we are not advocating intervention in general whenever there is such price discrimination between buyers of different valuations, only illustrating how it can be done with the aid of an appropriately designed contract offered for sale by the government.

According to our proposed intervention scheme a public firm that enters will offer point

H (which is an efficient contract when information is symmetric since at point H marginal utility equals marginal cost), serving the high valuation buyers and breaking even. The private seller's best response is to serve the low valuation buyers at L . In the transition from point X to point H high valuation buyers gain surplus at the expense of the private seller. The gain in utility for low valuation buyers (from point Y to point L) is a net social gain. Hence, the entry of the public firm constitutes a Hicks-Kaldor welfare improvement and increases the participation of low valuation buyers. A similar analysis can be carried out for other kinds of markets with adverse selection, both monopolistic and competitive.

3 Concluding Remarks

An interesting feature of the intervention scheme is the specialization of private firms in low valuation buyers, and the shift of the high valuation buyers from private firms to the public firm. In the context of the insurance market this outcome conforms with a possible view regarding the “division of labor” between the public and the private sectors: the public sector should support the high risk population. Although in the equilibrium with no government intervention the *low* risk individuals were without insurance, the public firm ends up serving the *high* risk individuals. In fact, the public firm intentionally steals the high risk clients from private firms. By doing so it is indirectly helping the low risk individuals whom the private firms now serve. As pointed out in the introduction, this approach is appropriate whenever the government decides to intervene in a market which is thin as a result of an adverse selection problem—the government should attract the “lemons,” leaving the rest of the clients for the private sector.

It is important to bear in mind that regulation by entry does not require that the government possess information which is superior to the information of private firms. Also, it does not involve any direct regulation of the activities of these firms, nor the computation of (and the bargaining over) rates, terms, and conditions set by them. As contracts can be relatively complex, monitoring them is resource consuming. The need for a government regulator to read a contract written by a private firm, and to choose an action as a consequence—for example, decide whether this contract qualifies for a subsidy or whether

it deserves to be taxed—never occurs in the scheme we propose. We therefore believe that it is relatively easy to implement. The public firm enters the market and offers a single standard contract, and private firms respond optimally. Another point to notice is that the coexistence of a public firm and private firms in the same market imposes discipline not only on the private firms, but also on the public firm. The public firm cannot afford to become inefficient, as it would lose all its clients or make large losses.

References

- Beato, P. and A. Mas-Colell**, 1984, The Marginal Cost Pricing Rule as a Regulation Mechanism in Mixed Markets, in M. Marchand, P. Pestieau, and H. Tulkens eds., *The Performance of Public Enterprises*, North-Holland, Amsterdam, pp.81-101.
- Bodie, Z.**, 1989, Pensions as Retirement Income Insurance, NBER working paper, #2917.
- Chiu, H. and E. Karni**, 1994, Unemployment Insurance: Endogenous Adverse Selection, Delayed-Start Policies, and the Role of the Public Sector, mimeo.
- Cremer, H., Marchand, M. and J.F. Thisse**, 1989, The Public Firm as an Instrument for Regulating an Oligopolistic Market, *Oxford Economic Papers*, 41, pp.283-301.
- Crocker, K. and A. Snow**, 1985, A Simple Tax Structure for Competitive Equilibrium and Redistribution in Insurance Markets with Asymmetric Information, *Southern Economic Journal*, 50, pp.1142-1150.
- Dahlby, B.**, 1981, Adverse Selection and Pareto Improvements through Compulsory Insurance, *Public Choice*, 37, pp.547-558.
- De Fraja G. and F. Delbono**, 1989, Alternative Strategies of a Public Enterprise in Oligopoly, *Oxford Economic Papers*, 41, pp.302-11.
- Fershtman, C.**, 1989, The Interdependence between Ownership Status and Market Structure: The Case of Privatization, *Economica*, 57, pp.319-28.
- Gale, D.**, 1991, Incomplete Mechanisms and Efficient Allocation in Labor Markets, *Review of Economic Studies*, 58, pp.823-851.
- Green, J.**, 1985, Differential Information, the Market and Incentive Compatibility, in K. Arrow and S. Honkapohja eds., *Frontiers of Economics*, Basil Blackwell, Oxford, pp.178-199.
- Holmström, B. and R. Myerson**, 1983, Efficient and Durable Decision Rules with Incomplete Information, *Econometrica*, 50, pp.863-894.
- Mankiw, N.G.**, 1986, The Allocation of Credit and Financial Collapse, *Quarterly Journal of Economics*, 110, pp.455-470.
- Myers, S. and N. Majluf**, 1984, Corporate Financing and Investment Decisions when Firms Have Information that Investors Do Not Have, *Journal of Financial Economics*, 13, pp.187-221.
- Prescott, E. and R. Townsend**, 1984, Pareto Optima and Competitive Equilibria with Adverse Selection and Moral Hazard, *Econometrica*, 52, pp.21-45.

Rothschild, M. and J. Stiglitz, 1976, Equilibrium in Competitive Markets: The Economics of Markets with Imperfect Information, *Quarterly Journal of Economics*, 90, pp.629–650.

Stiglitz, J., 1977, Monopoly, Non-linear Pricing and Imperfect Information: The Insurance Market, *Review of Economic Studies*, 44, pp.407–430.

Summers, L., 1989, Some Simple Economics of Mandated Benefits, *American Economic Review*, 79, pp.177–183.