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Abstract

We develop a test for adverse selection and use it to examine private health insurance markets. In contrast to earlier papers that consider a purely private system or a system in which private insurance supplements a public system, we focus our attention on a system where privately funded health care is substitutive of the publicly funded one. Using a model of competition among insurers, we generate predictions about the correlation between risk and the probability of taking private insurance under both symmetric information and adverse selection. These predictions constitute the basis for our adverse selection test. The theoretical model is also useful to conclude that the setting that we focus on is especially attractive to test for adverse selection. Using the British Household Panel Survey, we find evidence that adverse selection is present in this market.

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1 Introduction

Although adverse selection is one of the main assumptions of contract theory, empirical papers find mixed evidence of its existence. Yet the existence of adverse selection is important because it is one of the main justifications for public intervention in areas such as insurance markets (Dalbhy, 1981).

In this paper we test for the existence of adverse selection in health insurance markets in a framework where a public health administration finances health care in full through income taxes and where individuals with private insurance may resort to an alternative source of care. In other words, privately funded and publicly funded care are, *de facto*, mutually exclusive; we refer to this setting as the “substitutes framework,” and test propositions from a theoretical model that incorporates the features of this framework. This distinction is important because the competitive equilibrium that arises within this framework has, to our knowledge, never been studied under either symmetric information or adverse selection. Previous literature has focused either on a “supplements framework,” where the private insurance is supplemental to the public one, or on one where the public insurance is absent, which we call a “purely private framework.”

As our theoretical model shows, the consequences of adverse selection are more dramatic in our framework than in the other two. Consequently, our institutional setting is better suited to test for the existence of adverse selection. Our theoretical model also shows that, as far as the test of adverse selection is concerned, the supplements framework and the purely private framework yield similar predictions.

To apply these frameworks to a few real world examples, in the US, a large

segment of the population is not eligible for either Medicaid or Medicare and must resort to private insurance. Hence, this is an example of a purely private framework. In France and Belgium, as well as for the part of the population covered by Medicare in the US, an individual obtains a basic insurance contract from the insurer of his choice and receives funding from the government to cover this basic coverage. In addition, the individual can buy a supplementary contract to cover whatever copayments and services are not covered by the basic contract. Hence these are examples of the supplements framework. Finally, in the UK, Spain, Italy, and many other European countries, the public insurance system provides treatment instead of just financing some basic coverage. Moreover, except for prescriptions and dental care, copayments in the public system are nil so there is no room to supplement the public coverage. Instead, an individual can only substitute the public coverage by receiving care funded through private insurance.

Consistent with the above discussion, we perform a test of adverse selection in the UK, a substitutes framework (Besley and Coate 1991). Everyone is publicly insured through the British National Health Service (NHS). The NHS is, in turn, financed through taxation. Hence individuals contribute to the financing of public care whether they use it or not. It may seem a puzzle why, in such a system, anyone would purchase private insurance in the first place. The reason is that enrollees are able to obtain treatment from the private sector without having to put up with long waiting lists (Besley and Coate, 1991; Propper and Maynard, 1989). Health care obtained through private insurance also offers better ancillary services.

The contributions of this paper are two-fold. First, we solve a theoretical model of competition among insurers under the substitutes framework. We compare the equilibrium set of contracts and choices under symmetric information with those under adverse selection. In order to draw comparisons, we also briefly recall the equilibrium contracts under the supplements

and purely private framework. For each setting, we adapt and extend the perfectly competitive paradigm developed by Rothschild and Stiglitz (1976). As a second contribution, we test for adverse selection in the UK. To our knowledge, this is the first time such a test has been carried out under a substitutes framework. In this sense, our theoretical contribution is key for our empirical test, as we need to know the equilibrium features under the substitutes framework to be able to test for adverse selection there.

According to our theoretical results, under the substitutes framework and under adverse selection, high-risk individuals are the ones who purchase private insurance. In contrast, under this framework and in the absence of adverse selection, low-risk individuals are the ones who purchase private insurance. In other words, under the substitutes framework the sign of the correlation between the probability of purchasing private insurance and risk is positive in the presence of adverse selection and negative in its absence.

This stands in clear contrast to what occurs under the supplements framework, where all individuals have a strong incentive to purchase private insurance regardless of their risk and regardless of the presence or absence of adverse selection. In other words, under the supplements framework there is absolutely no correlation between enjoying private insurance and risk. This does not mean, of course, that no test can be performed under this framework. Our theoretical model shows (and this is not new) that, under adverse selection, high-risk individuals tend to purchase more coverage. That is, under adverse selection a positive correlation between risk and coverage should be observed. In the absence of adverse selection, all individuals purchase high coverage contracts in equilibrium, hence there is no correlation between risk and coverage.

Notice that there are two differences between the substitutes and the supplements frameworks. First, the test under the latter must be based on observations on each individual's coverage, whereas in the former, it suffices

to observe whether private insurance is purchased or not. Second, in a supplements framework, we need to distinguish a positive correlation from zero correlation, while in a substitutes framework we need to distinguish a positive correlation from a negative one. This gives more power to our test.

We test for adverse selection using the British Household Panel Survey. Our test compares the probabilities of hospitalization of employees who receive private medical insurance as a fringe benefit, and those who buy it directly. Since the benefits offered by corporate policies are very similar to those offered by individually purchased policies (Propper and Maynard, 1989) both groups will have the same access conditions to hospitalization. Consequently, any positive difference in the probabilities of hospitalization between the two groups is due to differences in risk.

We find that individuals who purchase medical insurance have a higher probability of hospitalization than individuals who receive private medical insurance as a fringe benefit. This constitutes evidence in favour of the presence of adverse selection in the English private medical insurance market. Our test could be biased if individuals in worse health status tend to be employed in jobs with employer-provided medical insurance. However, if this bias were present, it could only reinforce the empirical results found. One could also argue that our findings could be due to heterogeneity in the benefits provided by employer-provided and individually purchased medical insurance. We use the same dataset to rule out this possibility.

Let us briefly review the theoretical literature on adverse selection where private health insurance coexists with the public system. In the supplements framework, the Medigap system in the US (supplemental to Medicare) has received the most attention. Gouveia (1997) studies the political outcome on a model of supplementary private health insurance in the absence of adverse selection. Feldman *et al.* (1998) study the equilibrium under adverse selection. Delipalla and O'Donnell (1999) combine the two previous papers in a

supplementary private health insurance market.

As for the substitutes framework, the general approach in the literature on the substitutive public provision of private goods (such as health care or education) has focused on its role as a redistributive device. A seminal paper here is the one by Besley and Coate (1991), who propose the NHS in the UK as an example of a substitutes framework. Blomquist and Christiansen (1998) study when governments should implement supplementary rather than substitutive systems.¹ In contrast to them, we do not aim to analyze the redistributive role of the substitutive system, rather we focus on how informational assumptions of health risk heterogeneity influence the equilibrium.

The literature on empirical testing of adverse selection has recently gained attention. On the one hand, some works cast doubts on the presence of adverse selection. For example, in his review, Chiappori (2000) concludes that the importance of adverse selection is limited. Cardon and Hendel (2001) do not find evidence of adverse selection in the US employer-provided health insurance market either. Chiappori and Salanie (2000) find no evidence of adverse selection in the automobile insurance market. In the life insurance market, neither Cawley and Philipson (1999) nor Hendel and Lizzeri (2003) find evidence of adverse selection.

On the other hand, Ettner (1997) finds evidence of adverse selection in the Medicare market in the US and Gardiol *et al.* (2005) provides evidence of adverse selection in a strongly regulated private insurance market in Switzerland. Abbring *et al.* (2003) discuss econometric approaches to distinguish between adverse selection and moral hazard. Cohen and Einav (2005) develop a structural econometric model that allows for unobserved heterogeneity in both the probability of accident and risk aversion. Although some of their results could be indicative of adverse selection, the authors recognize that

¹See also this paper for a literature review on publicly provided private goods.

they cannot separately identify moral hazard from adverse selection. Finkelstein and Poterba (2004) find evidence of adverse selection in the UK annuity market. It is clear that more research is needed to obtain a better assessment of the presence of adverse selection in insurance markets.²

As for the UK, our testing arena, several papers have investigated the determinants of private medical insurance (King and Mossialos 2002, Propper *et al.* 2001, Besley *et al.* 1999, Besley *et al.* 1998, Propper 1993, Propper 1989). These papers highlight the role of political ideology, quality, resources available to the private sector, insurance premiums and income. However, to our knowledge, adverse selection has not been investigated in this particular market.

Our paper is organized as follows. In Section 2 we introduce the model of the substitutes framework. In Section 3 we study the equilibrium under this framework. We do this under symmetric information in subsection 3.1 and under adverse selection in subsection 3.2. In Section 4 we study the equilibrium under the supplements framework and discuss what a test of adverse selection should be in this setting, and we compare it with the substitutes framework. In Section 5 we perform the empirical analysis. In subsection 5.1 we describe the data. In subsection 5.2 we explain the test in detail, and in subsection 5.3 we report our main results and show a sensitivity analysis. In Section 6 we conclude the paper. The proofs of all lemmata and propositions are in Appendix A. The definition of the variables and descriptive statistics are in Appendix B.

²Cameron *et al.* (1988), Coulson *et al.* (1995), Vera-Hernández (1999) and Schellhorn (2001) focus on estimating how coverage influences health care use while controlling for the endogeneity of insurance coverage, i.e., for adverse selection. As a subproduct, it is tempting to interpret the results of the endogeneity test as evidence of asymmetric information. However, as Chiappori (2000) emphasizes this approach is likely to overestimate adverse selection substantially, as most specification errors will give evidence of endogeneity even in the absence of adverse selection.

2 The model

We start by describing our main framework, the substitutes framework. Two features distinguish this framework: (i) If an individual with private insurance falls ill, he must choose between the private treatment covered by his insurance and the public treatment. He cannot have an operation in the public sector and then receive its postoperative treatment in a private hospital. Private and public services cannot be combined. (ii) When a privately insured individual chooses the private treatment, the private insurer must bear the full cost of treatment. These two features rule out supplementary private health coverage, i.e., insurance to cover the copayments borne by the individual when treated in the public sector.³

All individuals in the economy are obliged to pay income taxes, which are dedicated to finance public sector expenditures, including public health care. This care is provided by a set of providers that are either public or have been subcontracted by the NHS.⁴ We refer to this set as PUB henceforth.

We study the game that starts once (i) the health authority (HA henceforth) has chosen and committed to a specific package of services that is provided free of charge, and (ii) the individual has already paid his personal income taxes, which contribute to the financing of the PUB. An important but realistic assumption is that all individuals in a given observable class (say women of a certain age) receive the same treatment, rather than being

³In the UK, a substitutes framework, the public insurance only charges copayments for outpatient drugs, vision tests, and dental treatment. These copayments are quite low. For instance, individuals only pay out-of-pocket £6.5 (US\$ 11.50) for each out-of-pocket drug prescribed. Charges for dental treatment and vision tests are also small (see <http://www.dh.gov.uk/assetRoot/04/10/69/10/04106910.pdf>). In fact, as far as we are aware, all the countries under the substitutes framework have very low copayments for a limited set of services. Most services covered by the public insurer are free of charge. Consequently, there is no room for private insurers to supplement the copayments that the public insurer charges.

⁴The subcontracted providers may be private, public-private consortia, or not-for-profit foundations. However, since they have signed contracts with the NHS to treat NHS patients, we still refer to them as public providers.

offered a menu of options.

In this game there are two sets of players, a large set of private insurance companies (insurers henceforth) that compete for individuals, and a large number of individuals, where each can be one of two types (described below).

The first movers are the insurers, who take into account the option that individuals can resort to the PUB set of providers for free. The insurers simultaneously choose the package of services that will be delivered in case of illness and also the premium that consumers must pay before knowing whether or not they will become ill. We assume that insurers as well as the HA condition their offers to each observable class of individuals. We therefore perform all of our analysis for a single and prespecified class.

The second and last movers are the individuals. Once they have learned their probability of becoming ill (i.e., their type) but before they know whether or not they will actually become ill, they simultaneously decide whether to purchase private insurance and, if so, from which insurer. Conceptually, each individual first looks at the best contract for him and then compares it with the public package.

The assumption that insurers take the public package of services as given can be justified as follows. The quality, waiting time, copayment regime, and so on at the PUB is determined by the HA's budget, which is the result of a lengthy political process. In contrast, insurers make these decisions more flexibly. The assumption is also convenient because it allows us to leave aside the way in which the HA's budget is decided, as well as the objective function of whomever decides this budget (e.g., the government or the parliament).

If an individual has chosen to purchase private insurance from a specific insurer, he enjoys double coverage. If this individual falls ill, he chooses between two options associated with two distinct sets of providers, the set PUB and the set of providers that are offered by his insurer, which we call PRI. The sets PUB and PRI may imply different copayments, waiting times,

qualities, ancillary services, or protocols. We will measure all of these characteristics, as well as the initial health status, in monetary units, as is standard in models of insurance under adverse selection.⁵

We denote by ℓ_0 the loss suffered by an individual who is not treated at all and has fallen ill. We can describe an insurer's offer, henceforth "contract," by a two-dimensional vector (ℓ_{PRI}, q) , where ℓ_{PRI} denotes the insurer's commitment to reduce the insuree's final losses from ℓ_0 to ℓ_{PRI} if he seeks treatment through the set PRI, and q denotes the insurance premium.

If an individual obtains treatment from the set PUB (either because he has not purchased private insurance or because he prefers the public treatment), his loss is reduced to ℓ_{PUB} . Notice that the public package constitutes an outside option for an individual who has not yet decided whether to purchase private insurance. This outside option can also be described as a two-dimensional vector $(\ell_{PUB}, 0)$, where the second component is zero because taxes paid are independent of whether private insurance is purchased or not.⁶ We refer to this option as "the public package," henceforth. It is important to note that private contracts where $\ell_{PRI} > \ell_{PUB}$ are irrelevant as they are dominated by the public package.

Finally, notice that an ill consumer could also choose to go untreated even

⁵In some models of health insurance in the absence of adverse selection, individuals have preferences (often additively separable) over disposable income and health. See, for instance, Gouveia (1997). Our analysis is simpler in this dimension.

⁶An implicit assumption is that an agent does not receive a tax rebate if he chooses to purchase private insurance. In the presence of a tax rebate, if an agent decides to purchase private insurance, the government returns part of the taxes paid by this consumer. Since we will be drawing the analysis in the final wealth space, the position of the zero isoprofit constraint associated with attracting a given type depends on this tax rebate. We can, however, prove that our results do not change if the tax rebate is *proportional* to the premium paid. More specifically, one can show that this is equivalent to a simultaneous change in the exogenous probability of illness for each type. If, on the other hand, the tax rebate were a fixed constant, then our theoretical results would have to be revised. Nevertheless, such fixed rebates are not usually observed. As for our testing arena, a rebate was in place for individuals over age 60 in the UK prior to the July 1997 budget, but this rebate was proportional to the premium.

though public treatment is free. We rule out this possibility by assuming that $\ell_0 \geq \ell_{PUB}$, that is, public treatment does reduce the losses suffered by an ill individual. We solve the game by backward induction.

We are now ready to describe the players' payoffs. At the point in time (τ , for expositional simplicity) when the individual must decide whether or not to purchase private insurance he does not know if, at time $\tau' > \tau$, he will become ill. At point in time τ the individual initial position is measured by a single parameter w , which includes his health status as well as his disposable wealth, i.e., net of taxes. We refer to this parameter as initial wealth.

Suppose that the individual has purchased some private insurance contract (ℓ_{PRI}, q) . As noted before, this means that $\ell_{PRI} < \ell_{PUB}$. If the individual does not become ill, he enjoys final wealth $w - q$. If he does become ill, he enjoys final wealth $w - q - \ell_{PRI}$. In contrast, suppose that the individual has not taken private insurance. If he does not fall ill he enjoys final wealth equal to w . Otherwise, since we have assumed that $\ell_0 > \ell_{PUB}$, he obtains public treatment from PUB and hence enjoys final wealth equal to $w - \ell_{PUB}$.

There are two types of individuals, low risks and high risks. Low-risk individuals may suffer an illness with probability p_L . High-risk individuals may suffer the same illness with probability p_H . Of course, $0 < p_L < p_H < 1$. The individual's probability of illness is publicly observable under symmetric information, and is only observed by him under asymmetric information. We analyze both the symmetric and the asymmetric information cases. It is common knowledge that the proportion of low risks in the economy is $0 < \gamma < 1$. We denote by $\bar{p} = \gamma p_L + (1 - \gamma)p_H$ the average probability of illness in the population. This parameter will play an important role below. All individuals have the same utility function u over final wealth, with $u' > 0$ and $u'' < 0$.

An individual who may suffer an illness with probability p and who decides not to purchase private insurance enjoys expected utility $pu(w - \ell_{PUB}) +$

$(1-p)u(w)$. If he does purchase some private contract (ℓ_{PRI}, q) , his expected utility is $pu(w - \ell_{PRI} - q) + (1-p)u(w - q)$.

Insurers are risk neutral. Suppose that an insurer S has attracted an individual i of type $J \in \{L, H\}$ with a contract (ℓ, q) . Suppose that i falls ill. Then S must bear the costs of ensuring that i does not suffer a loss larger than ℓ , as promised in the contract. Since we are under the substitutes framework, these costs must be borne in full by the insurer. Since losses in the lack of treatment are ℓ_0 , the insurer in fact bears the cost of reducing losses from ℓ_0 to ℓ . We simplify the analysis by assuming that each dollar of loss reduction costs the insurer exactly one dollar. This yields linear isoprofit lines, as it is standard in insurance models. The expected profits of offering (ℓ, q) are therefore given by $q - p_J(\ell_0 - \ell)$.

It is perhaps clarifying to discuss here the main difference between the substitutes and the supplements frameworks. Under the supplements framework, the only costs that the insurer would bear when committing to a loss of ℓ are the costs of reducing losses from ℓ_{PUB} to ℓ so that expected profits would be given by $q - p_J(\ell_{PUB} - \ell)$.

We now perform a change of variable to conduct the standard graphical analysis in the space of final wealths. Suppose an individual has purchased a private insurance contract (ℓ, q) . His final wealth in case of illness is given by $a = w - \ell - q$ (a for "accident"). In case of no illness, it is given by $n = w - q$ (n for "no accident"). It is easy to check that $q = w - n$ and $\ell = n - a$. Hence, an insurer attracting a J -risk with a final-wealth contract (n, a) expects to obtain

$$\Pi_J(n, a) = q - p_J(\ell_0 - \ell) = w - n - p_J(\ell_0 - n + a). \quad (1)$$

Isoprofits have slope $da/dn = -(1 - p_J)/p_J$. It is easy to check that the zero isoprofit goes through the point of neither private nor public insurance, given by $(n, a) = (w, w - \ell_0)$ and denoted by A . The zero isoprofits are

depicted in Figure 1 and labeled $\Pi_J(\cdot) = 0$ for $J = L, H$.

Notice that in the presence of the public package, the status-quo point of an individual is not A but $(w, w - \ell_{PUB})$. This is the final wealth vector associated with the public package and we denote this point as P . In Figure 1, each point in the vertical line through $n = w$ is a possible position of P . As ℓ_{PUB} decreases (or as public coverage increases), P lies at a higher point in this vertical line. If $\ell_{PUB} = \ell_0$, we are back to the no-insurance point A .

By virtue of the change of variable performed above, an individual's expected utility is given by $U_J(n, a) = p_J u(a) + (1 - p_J)u(n)$. His marginal rate of substitution between states is given by

$$\frac{da}{dn} = \frac{\frac{\partial U_J(n,a)}{\partial n}}{\frac{\partial U_J(n,a)}{\partial a}} = -\frac{1 - p_J}{p_J} \frac{u(n)}{u(a)}.$$

In Figure 1 we depict one indifference curve for each type. The slope of an indifference curve at the 45-degree line is $-\frac{1-p_J}{p_J}$, and coincides with the slope of the corresponding isoprofit. Therefore efficiency is attained for any contract in the 45 degree line. This corresponds to contracts with full coverage, where $n = a$, or $\ell = 0$.

The presence of the public package P at the outset (i.e., constituting a committed offer) may imply that some contracts that were attracting individuals in the equilibrium in the absence of P may now become inviable, and vice versa. Hence the following terminology.

Definition 1 *If a contract α attracts some individuals we say that the contract is active. Analogously, if the public package P attracts some individuals we say that the public sector is active.*

A sufficient condition for a contract to be active in equilibrium is that it offers strictly more utility to some risk type than both the rest of the contracts offered and the public package. The same goes for the public package.

However, this condition is not necessary. If some type is indifferent between two offers, both offers may attract individuals of this type. Anyhow, the only tie-breaking rule that we need to solve the model is the following.

Assumption 1 *If all individuals of type J are indifferent between the public package P and the best private contract for them, all individuals of type J choose the public package.*⁷

Our equilibrium notion is the following.

Definition 2 *An equilibrium set of active contracts S (ESAC henceforth) is a set of contracts (that may or may not include the public package P) such that*

(i) Each and every contract in S is offered either by some insurer(s) or by the public sector and is active.

(ii) If a single insurer deviates by offering a contract outside this set, either this contract will be inactive or this insurer will not make additional profits.

3 The substitutes framework

We solve first the game under the hypothesis of symmetric information. We then proceed to the case where health risks are an individual's private information. Finally, we compare the equilibria in the two settings.

3.1 The game under symmetric information

The low-risk and the high-risk markets are segmented. Consider first the situation where there is no public system. We know from Rothschild-Stiglitz (1976) that the competitive equilibrium entails efficient contracts (full insurance) and zero profit per individual no matter his type. Therefore, for

⁷Assuming that some agents do choose the private sector out of indifference would not greatly change our results.

all $J = L, H$; we have $n_J = a_J$ and $\Pi_J(n, a) = 0$, which implies, using (1), that $w - a_J - p_J \ell_0 = 0$, or $a_J = n_J = w - p_J \ell_0$. This yields contracts $\{\alpha_H^*, \alpha_L^*\} = \{(w - p_H \ell_0, w - p_H \ell_0), (w - p_L \ell_0, w - p_L \ell_0)\}$, which are depicted in Figure 1.

We now find the ESAC for each possible P . We illustrate our arguments by means of Figure 1. Point H_0 is the public package $(n, a) = (w, w - \ell_{PUB})$ such that a high risk is indifferent between α_H^* and H_0 . Point L_0 is the public package such that a low risk is indifferent between α_L^* and L_0 . The following lemma cannot be proven graphically and is a consequence of Jensen's inequality.⁸

Lemma 1 $H_0 < L_0$.

Once the positions of H_0 and L_0 are known, we can analyze the situation case by case, i.e., for each possible position of P . In Case 1, P lies below point H_0 ; in Case 2, P coincides with H_0 ; in Case 3, P lies strictly between point L_0 and point H_0 ; in Case 4, P coincides with L_0 ; in Case 5, P lies above L_0 . For each case, we find the ESAC. This yields the following proposition.

Proposition 1 *Suppose that adverse selection is absent. Then, under assumption 1, a unique ESAC exists for each and every position of the public package P , and is characterized as follows.*

- a) *In Case 1, the ESAC is $\{\alpha_L^*, \alpha_H^*\}$, high risks pick α_H^* , and low risks pick α_L^* ; the public sector is inactive.*
- b) *In Cases 2 and 3, the ESAC is $\{\alpha_L^*, P\}$, low risks pick α_L^* , and high risks pick P .*
- c) *In Cases 4 and 5, the ESAC is $\{P\}$ and only the public sector is active.*

⁸We are indebted to Juan Enrique Martínez-Legaz for providing the elegant proof that can be found in the Appendix.

Notice that the only cases where both sectors are active are 2 and 3, where only the low risks resort to the private sector. This yields the following corollary.

Corollary 1 *Suppose that the two sectors are active and adverse selection is absent. Under assumption 1, the probability of illness among the privately insured is p_L , which is smaller than \bar{p} , the average in the general population.*

The reason we compare the probability of illness of those who purchase insurance with the average probability in the general population will be explained in Section 5, since it is relevant for our empirical test.

3.2 The game under adverse selection

As in the previous section, consider first the situation where there is no public health system. We know from Rothschild-Stiglitz (1976) that the competitive equilibrium, if it exists, entails an efficient contract (full insurance) for the high risks and zero profits for an insurer attracting a high risk. Therefore, the high risk contract under asymmetric information is the same as under symmetric information, α_H^* . The low-risk contract must satisfy the high-risk incentive compatibility constraint with equality and also yield zero profits. These two equations yield the contract depicted by $\hat{\alpha}_L$ in Figure 2.

As it is well known, this set of contracts $\{\hat{\alpha}_L, \alpha_H^*\}$ constitutes only a candidate, albeit unique, for a competitive equilibrium. Recall that in the purely private competitive model there exists a critical γ (γ^* henceforth), such that an equilibrium exists *if and only if* $\gamma \leq \gamma^*$. This γ^* is the proportion of low risks such that the zero-isoprofit line associated to pooling contracts (not depicted) is tangent to the indifference curve \hat{U}^L in Figure 2. If $\gamma > \gamma^*$ then a lens appears between this isoprofit line and curve \hat{U}^L . Any contract in the interior of the lens pools both risks, but makes positive profits on average,

thus constituting a profitable deviation from the candidate. We will prove later that the condition for existence in the purely private market also ensures existence of an equilibrium once we introduce the public sector. Hence we introduce it here.

Assumption 2 *The proportion γ of low risks in the population is less than or equal to the critical proportion γ^* for existence in the purely private framework.*

Using the set of contracts $\{\hat{\alpha}_L, \alpha_H^*\}$ that is active in the equilibrium in the absence of a public package, we can divide the possible positions of the public contract P into five cases, as in the previous section. In Figure 2, point H_0 is again the public contract such that a high risk is indifferent between α_H^* and H_0 . Notice that point H_0 is the same whether adverse selection is present or not, since the equilibrium contract for the high risk is the same. Point L_1 is the public contract such that a low risk is indifferent between $\hat{\alpha}_L$ and L_1 . The relative position of H_0 and L_1 is given in the next lemma.

Lemma 2 $H_0 > L_1$.

We are now ready to establish the five possible cases that one has to deal with when characterizing the competitive equilibrium. In Case 1, P lies below point L_1 ; in Case 2, P coincides with L_1 ; in Case 3, P lies strictly between point L_1 and point H_0 ; in Case 4, P coincides with H_0 ; in Case 5, P lies above H_0 . For each case, we find the ESAC. This yields the following proposition:

Proposition 2 *Suppose that adverse selection is present. Then, under assumptions 1 and 2, a unique ESAC exists for each and every position of the*

public package P , and is characterized as follows.

a) In Case 1, the ESAC is $\{\hat{\alpha}_L, \alpha_H^*\}$, high risks pick α_H^* , and low risks pick $\hat{\alpha}_L$; the public sector is inactive.

b) In Cases 2 and 3, the ESAC is $\{\alpha_H^*, P\}$, low risks pick P , and high risks pick α_H^* .

c) In Case 3, assumption 2 is no longer necessary for existence of a competitive equilibrium.

d) In Cases 4 and 5, the ESAC is $\{P\}$ and only the public sector is active.

The proof follows the usual arguments used in the purely private model. However, they have to be modified because the committed presence of the public package offer must be taken into account. Perhaps the only instance where this presents some difficulty is the following. Some deviations that are not profitable in the purely private model because they violate incentive compatibility may become profitable in the presence of P . The idea is that the public package may absorb the high-risk individuals who otherwise would have flocked to the deviation. We prove that this cannot be true in Cases 1, 2, and 3 because P is not attractive enough, while in Cases 4 and 5 the private sector is not active in the first place.

Notice that both sectors are active in cases 2 and 3 only. We have the following and most important corollary.

Corollary 2 *Suppose that the two sectors are active and adverse selection is present. Then, under assumptions 1 and 2, the probability of illness for those who decide to purchase private insurance is p_H , which is larger than \bar{p} , the average in the general population.*

Again, the reason we compare the probability of illness of those who purchase private insurance with the average probability in the population

will be explained in Section 5. In any case, notice that corollaries 1 and 2 tell us that the sign of the difference between \bar{p} and the probability of illness of the privately insured crucially depends on the presence of adverse selection. This stands in clear contrast with the results that we obtain in the next section, where we explore the supplements framework.

4 Comparisons with the Supplements framework

The underlying model of supplementary private insurance is quite different from the one with substitutive insurance. The HA commits beforehand to a specific level of loss reduction, say $\ell_0 - \ell_{PUB}$. If the individual has purchased private insurance, he enjoys a further reduction in loss, say $\ell_{PUB} - \ell'$. Most importantly, the private insurer bears the cost of only this last loss reduction. This is the key distinction with the substitutes framework, where the insurer bears the full cost of reducing the loss from ℓ_0 to ℓ' . To sum up, under the supplements framework, the expected profit of an insurer committing to a final loss equal to $\ell' < \hat{\ell}$ is given by $(1 - p_J)q + p_J(q - (\ell_{PUB} - \ell')) = q - p_J(\ell_{PUB} - \ell')$.

We conduct the same change of variable as in the previous section. For an individual who has purchased private insurance, we have $a = w - q - \ell'$ and $n = w - q$. Then $q = w - n$ and $\ell' = n - a$. Therefore, expected profit is given by $w - (1 - p_J)n - p_J(a + \ell_{PUB})$. We next find the location of the zero-isoprofit line in the space (n, a) . Notice that if $\ell' = \ell_{PUB}$ (zero private coverage) then $q = 0$ as well. Then $a = w - \ell_{PUB}$ and $n = w$, i.e., the status quo of the individual without private insurance who resorts to public treatment. The slope of any isoprofit is given by

$$\frac{da}{dn} = -\frac{\frac{\partial \Pi_J(n,a)}{\partial n}}{\frac{\partial \Pi_J(n,a)}{\partial a}} = -\frac{1 - p_J}{p_J},$$

as before. Hence, this model is equivalent to the classic Rothschild-Stiglitz model except that the status quo point is $(n, a) = (w, w - \ell_{PUB})$ instead of $(n, a) = (w, w - \ell_0)$. Hence, Figure 2 can be used to depict the competitive equilibrium under both symmetric information and adverse selection by replacing the vertical intercept for point A shown there (i.e., $w - \ell_0$) with $w - \ell_{PUB}$.⁹ The competitive equilibrium without adverse selection is given by (α_L^*, α_H^*) , whereas the equilibrium under adverse selection is given by $(\hat{\alpha}_L, \alpha_H^*)$. Note that if an individual does not purchase private insurance, then his final wealth pair is at point A, which is clearly inferior for both types of individuals under both symmetric and asymmetric information. This yields the most important result here. That is, regardless of the presence or absence of adverse selection, all types would, in principle, take private insurance. Hence the average probability of illness in the private sector would always be equal to \bar{p} . Having purchased private insurance or not cannot be an explanatory variable for differences in risk.

In order to obtain a test for adverse selection in the supplements framework, one needs to observe the particular private contract that each individual enjoys in the sample chosen. The model then predicts that in the absence of adverse selection all individuals take full coverage. Among those with full coverage, the average probability of falling ill is \bar{p} , the same as in the general population. If, on the other hand, adverse selection is present, then the model predicts that low risks will enjoy lower coverage than high risks. Hence, those who choose to purchase full coverage have a higher probability of requiring treatment than the average probability in the population.

⁹This does not mean that the position of the isoprofit lines remains intact after the introduction of public insurance. Only the construction of the competitive equilibrium remains the same. In particular, by introducing public insurance in such a way that private insurance becomes supplemental (a supplements framework), the status quo point A not only changes its vertical position but also its horizontal one. This is because initial income w includes taxes, and these will surely change if the public coverage is to be financed through income taxation.

The methodological difference between this test and the one we propose is discussed at the end of subsection 5.2.

5 Empirical test for adverse selection

In the UK, everyone is entitled to free treatment under the public sector. However, the losses borne in case of illness are quite large because waiting times are long for hospital stays, for elective surgery, and for consultation with a specialist.¹⁰ Private insurance, in contrast, allows individuals to obtain hospitalization services with negligible waiting time. These institutional features are shared with other countries with a substitute system, for instance Spain. In relation to our theoretical model, individuals with private insurance suffer from a smaller loss than individuals with only public insurance. This indicates that our testing ground satisfies a feature of our model, namely, active insurers must be offering larger loss reductions than the public option.

5.1 The data

In this paper we use the British Household Panel Survey (BHPS). The BHPS is an annual survey designed as a nationally representative sample of households. All individuals in respondent households become part of the longitudinal sample. The same individuals are interviewed again in successive years; the survey retains those individuals who split from existing households in the sample by including the new households that they form.

We will restrict our sample to waves 6 to 12 of the BHPS. These waves correspond to data collected between August 1996 and April 2003. The previous waves do not have information on employer-provided health insurance.

¹⁰Other causes of high loss in the public system are a restricted choice of specialists and poor ancillary services.

We will consider only the case of employees who have private medical insurance in their own names because it is the only instance in which we know who pays for the private medical insurance. We will focus on England, which accounts for 62% of the BHPS sample for the waves that we use. The samples of Scotland, Wales, and Northern Ireland are quite small for the 6th, 7th, and 8th waves of the panel. Moreover, the percentage of individuals with private medical insurance varies substantially across these four nations. The percentage of individuals with private medical insurance is 18% in England, while it varies between 10% and 12% in the others. In addition, the organization of the NHS can vary substantially across these four nations. Thus, we focus our estimation on England. The definition of the variables and their descriptive statistics for the sample used in the estimation can be found in Table B1 in Appendix B.

5.2 The test

In the UK, public and private insurance coexist. In the terminology of our theoretical section, both sectors are active. According to our theoretical model (corollary 2), if adverse selection is present then the probability of privately insured individuals requiring medical care is higher than the average in the population. Conversely, in the absence of adverse selection, the probability of requiring medical care of the privately insured is lower than the average in the population, see corollary 1. In sum, our theoretical model predicts that in a substitutes framework, such as the UK, adverse selection has a drastic effect on the sign of the difference between the average probability of requiring medical care and this probability for those who decide to buy private health insurance. The sign of this difference will depend on whether or not adverse selection is present. Moreover the difference will never be zero in equilibrium. This makes our institutional framework attractive for testing for adverse selection.

Therefore, one could build a test for adverse selection by comparing the risk of requiring medical care of those who decided to buy private medical insurance with the risk of those who decided not to buy it. However, one does not observe whether an individual *truly requires* medical care but whether an individual *actually uses* health care services. Hence, we use actual utilization as a proxy for requiring medical care. Unfortunately, this proxy may suffer from an upward bias. Individuals with private health insurance might be hospitalized more often than individuals without private health insurance because they enjoy better access conditions (e.g., less waiting time) and not because they have a higher probability of requiring medical care. We correct this bias by comparing two groups of individuals with the same access conditions to hospitalization. To this end, we will test for adverse selection using only people who are privately insured.

In the UK, there are three ways to acquire private insurance. First, private medical insurance can be bought directly in the market by the individual. Second, some employers offer their employees the option to buy private medical insurance. If the employee decides to buy the insurance offered by his employer, he will have the premium deducted explicitly from his wage. Consequently, he might decide not to buy it. However, most employees will decide to buy it because the premium will tend to be lower than if he buys the insurance directly. Third, and very importantly for us, some employers directly provide their employees with private medical insurance as a fringe benefit.¹¹ The BHPS asks about the source of private health insurance only for individuals who have health insurance in their own name. According to the BHPS, privately insured employees obtain their private insurance as follows: 43.7% pay directly for it, 12% have the insurance deducted from their

¹¹We cannot rule out the possibility that an employee could approach his employer asking for an increase in wages in exchange of not enjoying the fringe benefit. However, this would only attenuate the results that we find.

wages, and 44.3% get it from the employer as a fringe benefit.

Our test for adverse selection will compare the probability of hospitalization of those who purchase private medical insurance directly with those who receive it as a fringe benefit from their employer.¹² Individuals that have the insurance deducted from their wages pay the private medical insurance in total. However, as the purchase is arranged through the company, the insurance premium might be particularly low. Consequently, they do not face the same prices as the group of individuals who buy private medical insurance directly. That is why we exclude them from our analysis.¹³

According to Propper and Maynard (1989, p.11), the benefits offered by corporate policies are very similar to those offered by individually purchased policies. This is very important for our test, as this means that both groups will face the same access conditions to hospitalization. We will discuss this further at the end of this section. Notice that our results on the presence of adverse selection will only be valid for the employee population. In order to extend the homogeneity of the comparison groups even further, we will restrict the sample to individuals who are employed on a permanent basis.

Our identification assumption is that, conditional on covariates and being permanently employed, having employer-provided health insurance is independent of health status. As a consequence, the group with employer-provided health insurance has a probability of hospitalization equal to the average probability of hospitalization in the population of employed individuals with permanent jobs. This assumption is, of course, conditional on covariates that we will include in the model as education, age, gender, and income.

Two types of selection issues could potentially invalidate our identifica-

¹²We choose hospitalizations because in the UK private medical insurance is mainly used for hospital treatment.

¹³The results are very similar when we include them and we use a dummy variable for their category.

tion assumption, and therefore bias our results. One type of selection is “employer driven” and the other one is “employee driven.” The first one is related to the fact that some jobs are more likely to offer employer-provided health insurance than others. According to Tables 1 and 2, the percentage of employees with employer-provided health insurance differ considerably by industry and type of occupation.¹⁴ For instance, managers and administrators are more likely to enjoy employer-provided health insurance than clericals workers. Financial services are also more likely to enjoy employer-provided health insurance than the agriculture sector. An employer-driven bias could potentially emerge if the health characteristics of employees of certain industries or occupations tend to be different from the average, conditional on covariates. However, in order to be sure that this will not bias our results, we include industry and occupation among our set of covariates.

[TABLES 1 AND 2 AROUND HERE]

Another possible source of bias in our comparison could be an “employee driven” bias. This would be the case if employees in worse health status look for jobs that offer employer-provided health insurance. Our source of data offers some evidence against such behavior. The BHPS asks individuals who changed jobs what was the main reason why they did so. The survey specifies sixteen possible reasons, as well as the option “other”. Most individuals answered “more money,” or “better promotion prospects.” However, the option of health insurance was not given in the list of 16 possible reasons. Nonetheless, only 7.6% of the individuals chose “other.” In any case, as we will discuss later, even if this source of bias were present, it would only attenuate the effect that we find.¹⁵

¹⁴The percentages in the table are for employees who have health insurance in their own name because it is for this group that we know who pays their health insurance.

¹⁵Ettner (1997) already gave this argument in the US context.

We believe that our identification assumption is credible for the reasons mentioned above. A similar identification assumption has been maintained for the US by Ettner (1997) and Cardon and Hendel (2001).¹⁶ We believe that this assumption is more likely to hold in the UK than in the US. The provision of health insurance by the employer should be less important in the UK than in the US because the NHS is available free to anyone in the UK, and individuals cannot opt out of it.

The logic of the test we perform is that the population of employed individuals with permanent jobs is split into two groups: those who must decide whether to buy private insurance or not (or group D, for “deciders”) and those who receive private medical insurance from their employer as a fringe benefit (or group N, for “non deciders”). As we previously justified it, our assumption is that, conditional on covariates, this division can be considered independent with respect to the risk of requiring hospitalization. Consequently, both groups have a probability of hospitalization that is equal to the population average conditioned on covariates. Now, group D can again be divided into two subgroups: those who purchase private insurance, or group D1, and those who do not, or group D2. Since individuals in group D decide whether or not to buy private medical insurance, their behavior will follow our model of a substitutes framework (Section 3). Consequently, if adverse selection is present, the probability of hospitalization in group D1 should be higher than the population average, i.e., that in group N. Conversely, in the absence of adverse selection, the probability of hospitalization in group D1 should be lower than in group N.

Notice that if the difference in the probability of hospitalization were not significantly different from zero then the only possible conclusion would

¹⁶Chiappori and Salanie (2003) state in page 129 that “the main identifying assumption used by Cardon and Hendel is that agents do not choose their employer on the basis of the health insurance coverage.”

be that the data are not informative enough to reject the null hypothesis that information is symmetric. It could not mean that adverse selection is absent, since if this were the case then the difference in the probability of hospitalization would not be zero but negative. This is strikingly different from the tests performed under the supplement or fully private framework where a non significant correlation between health care use and insurance coverage is taken as evidence against the presence of adverse selection.

5.3 Results

We will use a probit model to estimate the difference in the probability of hospitalization between groups N and D1. We prefer to use a standard probit model rather than a random effect probit model to avoid making distributional assumptions on the individual random effect. The estimates of the standard error are adjusted to take into account that the same individual is observed in different waves. The variable IND takes value 1 when the individual pays directly for the private medical insurance and takes value 0 otherwise.¹⁷ The omitted category is formed by individuals that receive private medical insurance as a fringe benefit. The key coefficient for our test is the one corresponding to IND that will drive the difference in the probability of hospitalization between groups N and D1.

The results are reported in Table 3. We first focus on the second and third columns where dummies for occupation and industry are not included as covariates. The table shows that the estimates of income and education are not significantly different from zero. According to these results, it is not easy to find variables that predict the probability of hospitalization. This suggests that adverse selection could be important since insurers will also find

¹⁷As we mentioned before, we exclude from the analysis those individuals whose insurance premium is explicitly deducted from their wage. The results do not change if we include them and we use a different binary variable for them.

it difficult to predict this probability. Regarding our formal test for adverse selection, we find that individuals who buy private medical insurance directly have a higher probability of hospitalization than individuals whose provides private medical insurance as a fringe benefit. The difference in probability of hospitalization when covariates are fixed at their average value is 0.021. This is a large difference given that the average probability of hospitalization in the sample is 0.064. This constitutes clear evidence of adverse selection in the English private medical insurance market.

As a robustness test of our results, we estimate the same model for hospitalizations as before but include the dummies for occupations and industry that are given in Tables 1 and 2. As mentioned before, we do this because the probabilities of having employer-provided health insurance differ significantly by industry and occupation, so that an “employer driven” bias could be present in the absence of these dummies. The results in the fourth and fifth columns show that the dummies for industry and occupation are not jointly significant. Consequently, the rest of the results hardly change. We still find a statistically significant difference in the probability of hospitalization between those who purchased health insurance and those with employer-provided health insurance. The difference in probability of hospitalization when covariates are fixed at their average value is 0.020 for this specification.

[TABLE 3 AROUND HERE]

Above we have found that the probability of hospitalization is larger for group D1 individuals than for group N individuals. We interpret this as evidence of adverse selection, as we have assumed that individually purchased policies are as generous as corporate policies. Our assumption is in line with existing information about the private insurance market in England (Propper and Maynard, 1989, p.11). However, an alternative explanation

of our empirical findings is that individually purchased policies are more generous than corporate policies. In what follows, we will argue that this alternative explanation is not supported by data. Recall first that individuals with private medical insurance are still eligible to be covered by the NHS. Whether they will choose to be treated by the NHS or by private insurance will depend on the waiting time in the NHS and the generosity of their private coverage policy (deductibles, maximum amount covered, illnesses excluded, covered treatments, and so on). If individually purchased policies were more generous than corporate policies, then we should observe that, conditional on having a hospitalization, the probability of choosing NHS-funded treatment is smaller for individuals in the D1 group than for individuals in the N group. We test this hypothesis using data from the BHPS.¹⁸ In Table 4, the estimate of the coefficient of IND is not statistically different from zero at 95% of confidence. This shows that there is no statistically significant difference in the probability of choosing NHS coverage between group D1 and group N. Consequently, the hypothesis that individually purchased policies are more generous than corporate policies lacks empirical support. Though the sample size is relatively small, the sign of the coefficient is positive rather than negative. If anything, this could indicate that corporate policies are more generous than individually purchased ones. If that were true, we would be underestimating the presence of adverse selection. Our results in Table 4 are in line with Propper and Maynard (1989), who claim that the benefits provided by corporate and individually purchased insurance policies are very similar.

[TABLE 4 AROUND HERE]

Finally, we address another robustness feature of our analysis. Before we

¹⁸There are 15 individuals that declare that their treatment was only partially funded by the NHS. We included them as if they did not choose NHS funded treatment.

assumed that individuals would not consider whether the employer-provided private medical insurance when deciding whether to accept their current job. It is important to mention that if this assumption were false in reality then the most likely bias would lead us to underestimate adverse selection. If anything, those in worse health status would be more likely to join group N (i.e., wait until they are offered jobs that include private medical insurance as a fringe benefit). This would mean that group N is less healthy than the average employee. Our data indicate that individuals who have bought medical insurance directly (group D1) are in a worse health status than individuals in group N. Therefore, if the bias were present then the difference in health status between group D1 and the average employee which indicates adverse selection would in fact be larger than the difference that we have estimated.

6 Conclusions

Recent empirical literature has found mixed support for the presence of adverse selection. In this paper, we focus on an institutional framework that has not been exploited before to test for adverse selection. In particular, we focus on a NHS framework where privately and publicly funded care are substitutive. Using a theoretical model, we have derived the properties of the equilibria in the presence and in the absence of adverse selection. The nature of the equilibria depends on the generosity of the public coverage. In the interesting case in which public and private markets coexist, we show that the probability of requiring medical care for individuals with private health insurance is higher than the average in the population in the presence of adverse selection. Conversely, in its absence, the probability of requiring medical care for those with private health insurance is smaller than the average in the population. Hence, our model predicts that in a substitutes

framework like the NHS, adverse selection has a dramatic effect on the sign of the difference between the average probability of requiring medical care and the average probability for those who decide to buy private health insurance. The sign of this difference will depend on whether or not adverse selection is present. Moreover the difference will never be zero in equilibrium. This makes our institutional framework an attractive one for an adverse selection test.

In England, private medical insurance is mostly used for hospitalizations. We test for adverse selection by comparing the probabilities of hospitalization of permanent employees that receive private medical insurance as a fringe benefit, and those who buy it directly. We find strong evidence of adverse selection in the English private medical insurance market. Our test could be biased if individuals in worse health status tend to be employed in jobs with employer-provided medical insurance. However, if this bias were present, it could only attenuate the evidence of adverse selection.

7 Appendix A

Proof of Lemma 1

Let $H_0 = (w, a_H)$ and $L_0 = (w, a_L)$. We need to prove that $a_H < a_L$, or equivalently that $u(a_H) < u(a_L)$. Now H_0 satisfies $U_H(w, a_H) = U_H(\alpha_H^*)$. This implies $p_H u(a_H) + (1 - p_H)u(w) = u(w - p_H \ell_0)$. Similarly, L_0 satisfies $U_L(w, a_L) = U_L(\alpha_L^*)$. This implies $p_L u(a_L) + (1 - p_L)u(w) = u(w - p_L \ell_0)$. Solving for $u(a_H)$ and $u(a_L)$, we need to prove that

$$u(a_H) = \frac{u(w - p_H \ell_0) - (1 - p_H)u(w)}{p_H} < \frac{u(w - p_L \ell_0) - (1 - p_L)u(w)}{p_L} = u(a_L).$$

After some manipulation, this can be rewritten as

$$u(w - p_L \ell_0) > \frac{p_L}{p_H} u(w - p_H \ell_0) + u(w) \frac{p_H - p_L}{p_H}. \quad (2)$$

Let $x_1 = w - p_H \ell_0$, $x_2 = w$, $p_1 = \frac{p_L}{p_H}$, and $p_2 = \frac{p_H - p_L}{p_H}$. Notice that $0 < p_1 < 1$, $0 < p_2 < 1$, $p_1 + p_2 = 1$; so that (p_1, p_2) is a system of probabilities. Let $E_p(\cdot)$ be the expectation operator associated to these probabilities. Notice that $E_p(x) \equiv p_1 x_1 + p_2 x_2 = w - p_L \ell$. Therefore, expression (2) can be rewritten as

$$u(E_p(x)) > E_p(u(x)).$$

This is true by Jensen's inequality and the fact that $u(\cdot)$ is strictly concave.

Proof of Proposition 1

Step 1. We prove first that no contract outside the set $\{P, \alpha_L^*, \alpha_H^*\}$ can belong to an ESAC. In other words, any ESAC must be a subset of $\{P, \alpha_L^*, \alpha_H^*\}$. Under symmetric information, the private market is segmented. Fix a type $J = L, H$. Suppose, by contradiction, that in equilibrium the private sector attracts some individuals of type J with contract $\alpha_0 \neq \alpha_J^*$. Then $U_J(\alpha_0) > U_J(P)$ and moreover either α_0 does not yield zero profits or is not efficient, since if both were false then efficiency and zero profit would imply that $\alpha_0 = \alpha_J^*$. Take the first case, where profits are positive. Then there exists $\varepsilon > 0$ such that $\alpha' = \alpha_0 + \varepsilon \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $U_J(\alpha') > U_J(\alpha_0) \geq U_J(P)$, so α' monopolizes all individuals of type J and still makes positive profits per consumer if ε is small enough, contradiction. Suppose now that α_0 is not efficient, then there exists another contract α' such that $U_J(\alpha') > U_J(\alpha_0) \geq U_J(P)$ and $\Pi_J(\alpha') > \Pi_J(\alpha_0)$ (and α' monopolizes all individuals of type J), contradiction.

Step 2. We now prove the proposition on a case-by-case basis.

Proof of part (a). Suppose that P is below H_0 in Figure 1. We prove first that $\{\alpha_L^*, \alpha_H^*\}$ is indeed an ESAC. Suppose that α_J^* is offered in exclusivity

to type J individuals, which is possible since types are publicly observable here. Since $U^J(\alpha_J^*) > U^J(P)$ for all J , we have that both α_L^* and α_H^* are active. If any other contract is offered by an insurer with exclusivity to some type J , this contract will either attract no one or will result in losses, by construction of α_J^* . We prove now that no other ESAC exists. By step 1 any ESAC must be a subset of $\{P, \alpha_L^*, \alpha_H^*\}$. Consider $\{P, \alpha_L^*, \alpha_H^*\}$. Notice that P is inactive, which violates condition (i) of the definition of an ESAC. Consider $\{P, \alpha_J^*\}$ for some J . Again P is inactive. Consider $\{P\}$. Since P lies below the indifference curve going through α_J^* , $\forall J$, we have that, for ε small enough, an insurer offering $\alpha' = \alpha_J^* - \varepsilon \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ with exclusivity for type J makes positive profits.

Proof of part (b). Suppose that P is on or above point H_0 but below point L_0 in Figure 1. We start by proving that $\{P, \alpha_L^*\}$ is an ESAC. Suppose an insurer offers a contract with exclusivity for high risks. By assumption 1, to attract high risks it must lie strictly above the high-risk indifference curve U^{H^*} . By construction such a contract will result in losses. Suppose an insurer deviates by offering a contract with exclusivity for low risks. To attract low risks it must lie on or above curve U^{L^*} . No such contract will make positive profits. We now prove that $\{P, \alpha_L^*\}$ is the only ESAC. No ESAC may contain α_H^* , because all low risks prefer P to α_H^* and high risks choose P out of indifference by assumption 1. Then by Step 1 an ESAC must be a subset of $\{P, \alpha_L^*\}$. Consider $\{P\}$. Since P lies below L_0 , we have that, for ε small enough, an insurer offering $\alpha' = \alpha_L^* - \varepsilon \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ makes positive profits. Consider $\{\alpha_L^*\}$. If insurers offer α_L^* with exclusivity to low risks, high risks will be attracted by P , so it should belong to the ESAC, contradiction. If insurers offer α_L^* to the whole population, then also high risks will pick this contract, and hence insurers will suffer losses. The only other possible subset is the same $\{P, \alpha_L^*\}$, and we are done.

Proof of part (c). Suppose that P is on or above L_0 . To see that $\{P\}$ is

an ESAC, notice that any private offer that attracts individuals of any type will suffer losses. To see that $\{P\}$ is the only ESAC, pick any other set of contracts. Since P is an outstanding offer, neither α_L^* nor α_H^* can be active. By Step 1 we are done.

Proof of Lemma 2

This lemma is a straightforward consequence of the single-crossing condition. The proof is therefore omitted.

Proof of Proposition 2

A few statements are proved as preliminary steps.

Step 1. *If the private sector attracts any individual at all in equilibrium, it must do so at zero average profit per individual.*

Suppose by contradiction that the ESAC S includes a contract α offered by the private sector that makes profits $\Pi_\alpha > 0$ per individual. Since the premise is that it is active, it must attract individuals with types in some set T and be rejected by the rest of types, i.e., in the complement of T (T^C henceforth) which could be empty, as in the case where α is pooling. In other words,

(i) For all $J \in T$, we have $U^J(\alpha) \geq U^J(\alpha')$ for all $\alpha' \in S \cup \{P\}$.

(ii) For all $J \in T^C$, we have $U^J(\alpha) \leq U^J(\alpha')$ for some $\alpha' \in S \cup \{P\}$.

Due to the single-crossing condition, there is always a deviating contract β arbitrarily close to α that

(iii) will be preferred to α by all types in T , i.e., $U^J(\beta) > U^J(\alpha)$ for all $J \in T$;

(iv) will be dispreferred to α by all types in T^C , i.e., $U^J(\beta) < U^J(\alpha)$ for all $J \in T^C$;

so we can write

(i') for all $J \in T$, we have $U^J(\beta) > U^J(\alpha')$ for all $\alpha' \in S \cup \{P\}$;

(ii') for all $J \in T^C$, we have $U^J(\beta) < U^J(\alpha')$ for some $\alpha' \in S \cup \{P\}$.

To sum up, β will attract and repel the same types of individuals as contract α , but will monopolize all the individuals of any type in T . Since β can be made arbitrarily close to α , we find that profits per individual Π_β are arbitrarily close to Π_α (by continuity), whereas the number of individuals attracted is multiplied due to monopolization. Thus β constitutes a profitable deviation from S .

Step 2. *If the private sector attracts some high risks and no low risks in equilibrium through some contract α , this contract must be efficient.*

We already proved that it should yield zero profits. Suppose by contradiction that contract α is not efficient but attracts high risks in equilibrium. Then $U^J(\alpha) \geq U^J(\alpha')$ for all $\alpha' \in S \cup \{P\}$. Since α is not efficient, there exists another contract β that yields higher profits and attracts all high risks and may or may not attract low risks. In both cases (since low risks have a lower probability of illness), β constitutes a profitable deviation.

Step 3. *There does not exist an equilibrium where the private sector attracts both individuals through a single contract α .*

Recall first that such a contract would have to make zero profits on average per individual. Moreover, by assumption 1 it must be true that $U^J(\alpha) > U^J(P)$ for all J . Due to the single-crossing condition, a contract β always exists that is preferred to α by low risks and at the same time it is dispreferred to α by high risks. Therefore β will also be preferred to P by low risks, while high risks stick to α . Hence β constitutes a profitable deviation.

Step 4. *In equilibrium, if a contract attracts type J only, it must yield zero profits per client.*

By Step 1 we know that if α is active, on average it must make zero profits. Now suppose that it makes positive profits per low risk and negative profits per high risk. Then this contract must be a pooling one. By step 3 this can never be part of an equilibrium.

Step 5. *If the private sector attracts high risks, it must be through contract α_H^* .*

This follows directly from steps (4) and (2).

We turn now to characterizing the competitive equilibrium, case by case. The proof is based on Figure 2.

Case 1. P lies below point L_1

We prove first that $\{\hat{\alpha}_L, \alpha_H^*\}$ is indeed an ESAC in the presence of such package P . We must prove that it cannot be the case that a deviation from $\{\hat{\alpha}_L, \alpha_H^*\}$ that was unprofitable in the absence of P ("before") becomes profitable once P is present ("now"). This could only happen in the following ways.

1.1 The deviation did not attract any consumers before and now it not only attracts consumers but also does so in a profitable way.

1.2 The deviation did attract some high risks, but in an unprofitable way, whereas now it still attracts them but now become profitable.

1.3. The deviation did attract some low risks, but in an unprofitable way, whereas now it still attracts them but now become profitable.

1.4. The deviation did attract both risks, but in an unprofitable way, whereas now it only attracts low risks, thus making the deviation profitable.

We now prove that none of these statements is possible. Statement 1.1 is impossible because if a contract β did not attract anyone in the absence of P , the presence of this alternative cannot make consumers more willing to accept α' contract β . Statements 1.2 and 1.3 are impossible because the per-client profits of attracting a given risk are independent of the existence of an alternative contract P . Statement 1.4 requires that

(i) package P attracts the high risks that otherwise would have picked β , i.e., $U^H(P) \geq U^H(\beta)$;

(ii) contract β attracts some or all low risks, i.e., $U^L(\beta) \geq \text{Max}\{U^L(\hat{\alpha}_L), U^L(P)\}$;

(iii) contract β is profitable when it attracts a low risk, i.e., $\Pi_L(\beta) > 0$.

Now (i) and (ii) imply $U^H(P) \geq U^H(\beta) \geq U^L(P)$. The single-crossing condition implies that β is on or to the right of the vertical line going through A (autarky) and P . Also, (ii) and (iii) imply that $U^L(\beta) \geq U^L(\hat{\alpha}_L)$ and $\Pi_L(\beta) > 0$. By inspection of Figure 2, this implies that β lies in the lens formed by isoprofit $\Pi_L(\cdot) = 0$ and indifference curve \hat{U}^L . This lens is strictly to the left of the vertical line going through A , which leads to a contradiction.

Let us now prove that $\{\hat{\alpha}_L, \alpha_H^*\}$ is the unique ESAC in the presence of P . We begin by showing that P cannot belong to an ESAC. Suppose it does. If it attracts high risks, all other contracts in the ESAC must lie below the high-risk indifference curve going through P , U_P^H henceforth. Since P lies below L_1 , curve U_P^H and isoprofit $\Pi_H(\cdot) = 0$ form a lens. Any deviation in the interior of the lens will attract high risks and bring positive profits, contradiction. As a corollary, the private sector must be attracting the high risks. By step 5 this implies that the private sector is offering α_H^* . Suppose now that P attracts low risks. Then, again since P is on the vertical line through w and below L_1 , we find that an area appears between the low-risk indifference curve going through P , the indifference curve U^{H*} , and isoprofit $\Pi^L(\cdot) = 0$. Any contract in this area is preferred to P by low risks, it is dispreferred to α_H^* by high risks, and it makes positive profits per low risk, so it constitutes a profitable deviation.

Finally, since only the private sector is active and we have already shown that the high risks must be attracted by α_H^* , then the only other incentive compatible contract α_L that attracts low risks and yields zero profits must lie on the segment $\overline{\hat{\alpha}_L A}$. If it coincides with $\hat{\alpha}_L$, we are done. If it is strictly below, an area appears between the low-risk indifference curve going through α_L , the indifference curve U^{H*} , and isoprofit $\Pi^L(\cdot) = 0$. Any contract in this area constitutes a profitable deviation, and we are done. This proves part (a) of the proposition.

Cases 2 and 3. P coincides with or is above point L_1 but below H_0 .

We prove first that $\{P, \alpha_H^*\}$ is indeed an ESAC. If a deviation is to attract low risks (and perhaps other risks as well) it must lie strictly above the indifference curve \widehat{U}^L , by assumption 1. Contracts in region IV (including those in the cord joining H_0 and $\hat{\alpha}_L$) will bring losses even from low risks. Contracts in Region V (except those in the cord joining H_0 and $\hat{\alpha}_L$) will attract all risks and yield non-positive profits even from low risks. Finally, consider a deviation to a contract in region VI. This will attract all risks. Suppose by contradiction that it makes positive profits on average. Then this would have been a profitable deviation from the $\{\hat{\alpha}_L, \alpha_H^*\}$ equilibrium in the absence of P , which contradicts assumption 2.

We now prove that no other ESAC exists. By contradiction suppose that S' is another ESAC. Suppose that in S' the private sector does not attract high risks. Then all other elements in S' must be on or below U_P^H . Since P is below H_0 , a lens is formed between $\Pi_H(\cdot) = 0$ and U_P^H . A deviation inside this lens will make positive profits per high risk and attract all high risks, contradiction. Hence the private sector attracts high risks, and by step 5 this means that α_H^* must be in S' . By assumption 1 and by step 4, the presence of P implies that if the private sector is to attract low risks in equilibrium, it must be through a contract in $\Pi^L(\cdot) = 0$, strictly to the left of $\hat{\alpha}_L$, and in region V. Such a contract will also attract high risks, so by step 3 this can never constitute an equilibrium. Hence all low risks choose P . To conclude, $S' = \{P, \alpha_H^*\}$. This concludes the proof of part (b) of the proposition.

To prove part (c), fix P above L_1 and consider the low-risk indifference curve going through P and call it U_P^L . Then U_P^L lies strictly above \widehat{U}^L . Suppose that $\gamma = \gamma'$ is such that the zero isoprofit line associated to pooling contracts is tangent to U_P^L . This γ' is strictly above γ^* since γ^* makes the pooling zero isoprofit tangent to \widehat{U}^L . By construction, for any $\gamma^* \leq \gamma \leq \gamma'$, no profitable deviation exists from the candidate $\{P, \alpha_H^*\}$. Hence, the condition

$\gamma \leq \gamma^*$ is not necessary for existence.

Cases 4 and 5. P coincides with H_0 or is above it

We prove first that $\{P\}$ is indeed an ESAC. Consider any deviation. If it is to attract high risks it must lie strictly above the high-risk indifference curve U^{H*} . Any such contract will result in losses on high risks. To compensate for these losses, the deviation must also attract low risks at positive profits. Since P is well above L_1 , this implies that the deviation must lie in the interior of VI. That such a deviation makes positive profits on average violates assumption 2.

Let us show now that no other ESAC exists. Suppose that the private sector attracts high risks. Then this contract must be α_H^* , by step 5. However, by assumption 1, contract α_H^* cannot be active because P is above H_0 . The proof that the private sector cannot attract low risks in equilibrium is the same as for cases 2 and 3.

8 Appendix B

In this appendix we show the descriptive statistics for the estimating sample.

[TABLE B1 AROUND HERE]

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Tables

Table 1. Percentage of individuals with employer-provided health insurance by industry among employees who have health insurance in their own name

Industry (Indust)	Percent
Agriculture, forestry and fishing	15%
Energy and water supplies	59%
Extraction minerals, manufacture of metals, mineral products, and chemicals	59%
Metal goods, engineering, and vehicles industries	65%
Other manufacturing industries	59%
Construction	40%
Distribution, hotels and catering	41%
Transport and communication	45%
Banking, finance, insurance, business services & leasing	66%
Other services	20%

Table 2. Percentage of individuals with employer-provided health insurance by occupation among employees who have health insurance in their own name

Occupation (Occ)	Percent
Managers and administrators	63%
Professional	48%
Associate professionals and technical	53%
Clerical and secretarial	45%
Craft and related occupations	40%
Personal and protective service	20%
Sales	55%
Plant and machine operatives	38%
Other	15%

Table 3. Probit model for hospitalizations

Variable	Coef.	Std. Error	Coef.	Std. Error
IND	0.169*	0.076	0.166*	0.081
Inc	-0.835	2.579	0.411	2.519
Age	-0.019	0.023	-0.020	0.024
Age2	0.024	0.027	0.023	0.029
Female	0.886*	0.260	0.880*	0.262
Age*Female	-0.016*	0.007	-0.017*	0.007
Edu2	0.098	0.081	0.047	0.082
Edu3	-0.003	0.107	-0.054	0.113
Industry dummies in Table 1	Not included		P-Value	0.221
Occupation dummies in Table 2	Not included		P-Value	0.136
Constant	-1.559*	0.496	-1.350*	0.636
Observations	4348		4291	

Employees with permanent jobs and private medical insurance in their own name. Regional and time dummies included.

(*) Indicates that the estimate is significantly different from zero at 95% of confidence

Table 4. Probit model for choosing NHS-funded treatment among those who have been hospitalized

Variable	Coef.	Std. Error	Coef.	Std. Error
IND	0.312	0.195	0.216	0.239
Inc	-8.542	8.546	-13.64	9.747
Age	0.023	0.050	-0.006	0.054
Age2	-0.028	0.057	-0.003	0.061
Female	1.062	0.720	0.726	0.780
Age*Female	-0.015	0.018	-0.003	0.020
Edu2	0.100	0.215	0.218	0.259
Edu3	-0.282	0.247	-0.297	0.300
Industry dummies in Table 1	Not included		P-Value	0.272
Occupation dummies in Table 2	Not included		P-Value	0.051
Constant	-0.312	1.280	0.903	1.410
Observations	278		270	

Employees with permanent jobs and private medical insurance in their own name. Regional and time dummies included.

Table B1. Descriptive statistics for the estimating sample

Name	Definition	Mean	Std.Dev.
Hosp	1 if the individual has been in hospital or clinic as an in-patient overnight or longer since September, 0 otherwise	0.064	0.245
IND	1 if the individual pays directly by the private medical insurance, 0 otherwise	0.325	0.468
Inc	real household income divided by 1,000,000	0.024	0.014
Edu2	1 if individual's highest academic qualification is A-levels or a teaching qualification, 0 otherwise	0.340	0.473
Edu3	1 if individual is a university graduate, 0 otherwise	0.238	0.426
Age	age in years	39.11	10.52
Age2	(Age*Age)/100	16.40	8.62
Female	1 if individual is female, 0 if individual is male	0.330	0.470
Occ1	1 if individual is manager or administrator, 0 otherwise	0.329	0.470
Occ2	1 if individual is a professional, 0 otherwise	0.116	0.320
Occ3	1 if individual is an associate professional or technician, 0 otherwise	0.139	0.345
Occ4	1 if individual works as a secretary, 0 otherwise	0.145	0.352
Occ5	1 if individual's occupation is craft, 0 otherwise	0.084	0.277
Occ6	1 if individual works in personal and protective services, 0 otherwise	0.037	0.193
Occ7	1 if individual works in sales-related occupations, 0 otherwise	0.060	0.236
Occ8	1 if individual works as a machine operator, 0 otherwise	0.067	0.250
Occ9	1 if individual does not have any of the occupations related above, 0 otherwise	0.021	0.145

Continuation Table B1: Descriptive statistics for the estimating sample

Name	Definition	Mean	Std.Dev.
Indust1	1 if individual works in agriculture, forestry, or fishing industries, 0 otherwise	0.005	0.071
Indust2	1 if individual works in energy or water supplies industries, 0 otherwise	0.021	0.145
Indust3	1 if individual works in extraction minerals, or manufacture of metals and chemicals industries, 0 otherwise	0.047	0.212
Indust4	1 if individual works in the metal goods or engineering or vehicles industries, 0 otherwise	0.125	0.331
Indust5	1 if individual works in other manufacturing industries, 0 otherwise	0.111	0.315
Indust6	1 if individual works in Construction, 0 otherwise	0.047	0.211
Indust7	1 if individual works in distribution, hotel or catering industries, 0 otherwise	0.117	0.322
Indust8	1 if individual works in the transport and communication industries, 0 otherwise	0.070	0.255
Indust9	1 if individual works in the banking, finance, insurance or business services, 0 otherwise	0.286	0.452
Indust10	1 if individual works in other services, 0 otherwise	0.168	0.373

FIGURES

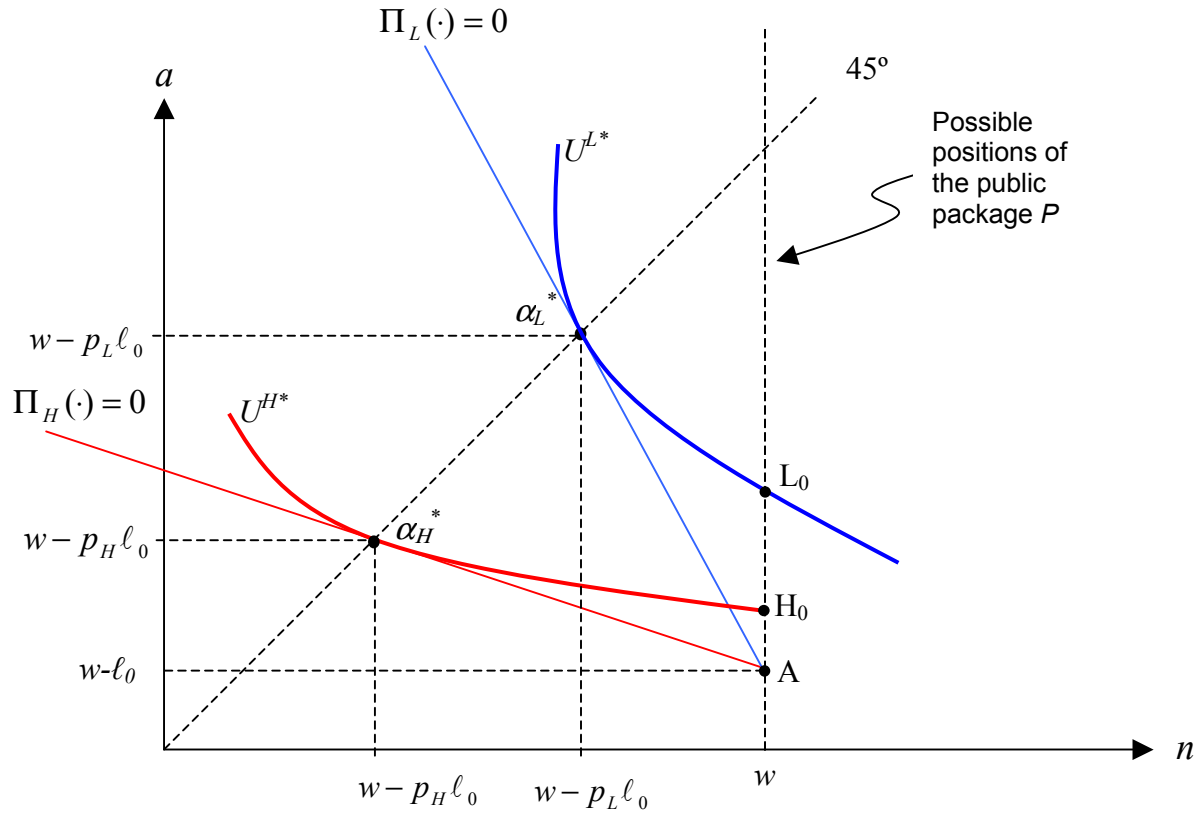


Figure 1. The competitive equilibrium in the absence of a public health system under symmetric information is (α_L^*, α_H^*) .

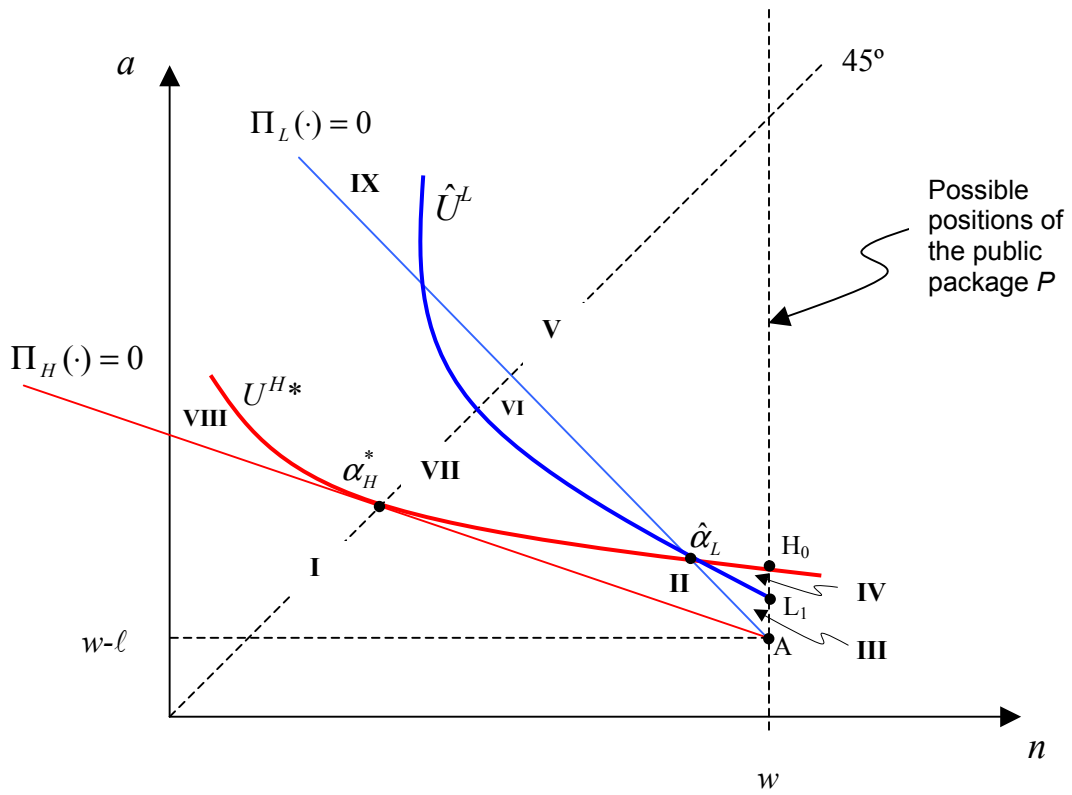


Figure 2. The competitive equilibrium in the absence of a public health system under adverse selection is $(\hat{\alpha}_L, \alpha_H^*)$. The roman numbers label regions used in the proofs.