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FALSE DIAGNOSES: PITFALLS OF TESTING FOR ASYMMETRIC INFORMATION IN INSURANCE MARKETS*

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Abstract

Established tests for asymmetric information in insurance markets are examined. The most commonly used, that information is symmetric if high and low cover contracts have the same loss rate, is inconsistent with standard assumptions that imply that under symmetric information, all contracts offer full-cover. Incomplete cover and symmetric information can be reconciled if there are claim-processing costs, but now existing tests fare badly, partly due to the divergence between marginal and average selection effects. Ignoring the nature of loading factors may cause recent studies to mismeasure the welfare costs of asymmetric information but these problems are remedial.

Economists' fascination with insurance markets is mostly due to the theoretical possibility that their functioning is impaired by asymmetric information. A substantial empirical literature, surveyed by Cohen and Seigelman (2010), seeks to determine whether this is a problem in practice. In the view of many, adverse selection justifies major market interventions;

> *"That problem [adverse selection] is not an abstraction invented by economists to justify trampling individual liberties. As experience in most countries around the world has confirmed, it is a profound source of market failure that renders unregulated insurance markets a catastrophically ineffective way of providing access to health care."*
> Robert H Frank, New York Times, Aug 3 2010

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As the quote indicates, the policy concern is not so much determining whether selection effects are present, but knowing whether they lead to substantial inefficiency. This does not diminish the importance of establishing whether premiums incorporate selection effects. As Einav, Finkelstein and Cullen (2010) note, "....detecting the existence of selection is a necessary precursor to analysis of its welfare effects." (p895).

Our concern is whether the evidence for asymmetric information has been correctly interpreted. The most influential methodology is that of Chiappori and Salanie (2000), henceforth CS, which has inspired an upsurge in empirical work on contracts more generally. The procedure is to examine whether, amongst observationally identical individuals, losses are increasing in insurance cover. The rationale of this Positive-Correlation-Property (PCP) test is that if information is asymmetric, greater cover induces more reckless behavior and attracts those with private knowledge that they are more than averagely prone to loss. If "large" differences in loss rates between contracts can be rejected, it is concluded that information is close to symmetric.[1] For young French drivers, CS find that buyers of comprehensive insurance do not experience significantly higher accident rates than those with only third-party cover. According to the PCP-test, information symmetry cannot be rejected.

An augmented test is developed by Chiappori, Julien, Salanie and Salanie (2006). This $CJSS$-test takes into account the often considerable administrative cost of insurance. When applied to data on young French motorists, conclusions are reversed from those in the earlier paper. The modified test "corroborates" the presence of asymmetric information in the market for young French drivers.

Given that the two tests deliver conflicting conclusions, it is natural to enquire, which, if either, is correct. It is easily seen that under standard assumptions the $PCP-$test involves a contradiction. The reason is that if neither type nor action is hidden, under standard assumptions, all contracts offer full cover.[2] If a choice of cover is available, as the PCP-test requires, information is not symmetric. One way to reconcile contractual choice with symmetric information is to introduce administrative costs, often a major part of insurers' costs. Increased cover may then lower expected income even when type is known. The $CJSS$-test explicitly takes these costs into account, though as a concession to realism rather than to eliminate the contradiction. An inequality is derived which holds under asymmetric information, but as it also holds under symmetric information, the $CJSS$-test cannot diagnose whether asymmetric information is present.

This leaves open whether the PCP-test works when there are administrative costs. de Meza and Webb (2001) show that claim processing costs may result in a negative correlation (which they term advantageous selection) when type

[1] Puelz and Snow (1994) also use the PCP approach, though the statistical implementatiion differs from CS. Some studies incorrectly conclude that inability to reject a zero correlation is evidence of symmetric information.

[2] That is, expected utility theory, competition and no administrative cost.

is hidden.[3] Hence, asymmetric information can never be rejected statistically. Einav, Finkelstein and Schrimpf (2007) show that with fixed administrative costs and exogenously given contracts, the equilibrium may be efficient whether or not the insured have higher or lower loss rates than the uninsured. The Appendix to our paper extends these results to endogenous contracts and claim processing costs, allowing comparison between insurance contracts. It is also shown that a zero correlation between distinct contracts does not imply efficiency and that a negative correlation is consistent with too much insurance.

Chade and Schlee (2014) also analyse administrative costs. Their paper mostly concerns monopoly, but similar to our Observation 2A, they note that under competition, a negative correlation is consistent with efficiency. In their case, preferences are homogeneous and administrative costs proportional to the value of claims, whereas we have heterogeneous preferences but claim processing costs.[4]

In the body of the paper we assume two risk classes but a continuum of risk preferences and a fixed contract. It is then easily seen that a welfare improving tax (subsidy) is consistent with a positive or zero (negative or zero) correlation, the opposite of the usual presumption.

An alternative to the correlation test is to find or create experimentally an exogenous premium change. The effect on the loss rate of the policy is then measured. Though this procedure is harder to implement than the correlation test, we note that it is analytically related. In drawing welfare conclusions, it remains necessary to take administrative costs into account.

The remainder of the paper is as follows. Section 2 explains why administrative costs are more than an optional extra when testing for asymmetric information. Then in Sections 3 and 4 we show that both the $CJSS$ and PCP tests for asymmetric information may be passed when information is symmetric and claim-processing costs are present. Section 5 shows that the PCP-test may misidentify the nature of selection effects. In fact, how to define adverse and advantageous selection effects becomes an issue. Section 6 discusses the adequacy of premium change tests and their relation to the correlation test. The implications of our analysis for estimating the welfare cost of asymmetric information are examined in Section 7. Finally, brief conclusions are offered.

1 The PCP-test is invalid under Rothschild-Stiglitz assumptions

The seminal paper of Rothschild and Stiglitz (1976), henceforth RS, is invoked by Chiappori and Salanie (2000, p.58) as a foundation for the PCP-test. RS as-

[3] Hemenway (1990) suggests that risk averse people may avoid risk and seek insurance and offers interesting evidence but does not analyse the role of administrative cost in establishing a negative correlation in equilibrium.

[4] Chade and Schlee (2012) show that under monopoly, a convex relationship between premium and cover is consistent with adverse selection. So quantity discounts do not rule out adverse selection.

sume two types of risk-averse agent differing only in loss probability. There are two or more risk-neutral competitive insurance companies whose only costs are indemnity payments. Assuming type is private information, any pure-strategy Nash equilibrium must be separating. High-loss types are fully insured and low-loss types are incompletely covered. Consistently with the PCP-test, asymmetric information implies a positive correlation between cover and loss propensity. The issue is what happens under symmetric information. Given actuarially fair offers, risk-averse agents prefer full cover. It is trivial that the Nash equilibrium is that everyone is fully insured. This though implies the PCP-test is inapplicable as there is no variation in cover. The empirical findings of CS are inconsistent with the RS model when information is symmetric.

Observation 1. *Under symmetric information, the RS assumptions imply all contracts provide full cover.*

The result is not restricted to the RS model. Nash competition, zero administrative costs, insurer risk neutrality and rationality imply that the loading factor is zero. Risk averse individuals prefer to equalise income across states as long as this can be achieved without sacrificing expected income. Observation 1 also applies under monopoly as each consumer type would be offered the efficient contract with the seller extracting the full surplus.

2 Claim-Processing Costs

Observation 1 is trivial but potentially destructive. To preserve the correlation based methodology, the RS assumptions must be tweaked so as to generate multiple cover levels under symmetric information. The potential modifications are to drop at least one of the assumptions: rational expectations; perfect competition; costless administration; or insurance company risk-neutrality. Introducing administrative costs is the least fundamental change.[5] If, though, such costs are equal for all contracts, this does not resolve the problem. As competition results in premiums equalling administrative cost plus expected indemnity payments, the expected income of the insured is the same whichever contract is chosen. Customer risk aversion implies that greater cover will be preferred to less. There is still no variation in cover under symmetric information, other than between those not insuring at all and the fully insured.[6] It is though almost inevitable that administrative costs will vary between contracts. Assuming a non-degenerate loss distribution, the lower the deductible the more claims there are and the greater are expected processing costs. Under competition, administrative costs will be fully priced into contracts, so expected income is lower on contracts offering greater cover. Even under full information, contractual choice depends on loss probabilities and risk preferences. So a variety of contractual choices does not of itself imply asymmetric information.

[5] Administrative costs play a key role in generating a negative correlation in de Meza and Webb (2001) whilst Chade and Schlee (2014) use them to explain why bad risks may be denied insurance and to show the possibility of pooling under monopoly.

[6] Being uninsured may be chosen as this does raise expected income.

Not only do claim-processing costs potentially explain the existence of contractual variety under symmetric information, they are empirically relevant. We are not aware of a detailed empirical analysis of claim processing costs, but have examined individual insurance returns lodged with the then UK regulator, the FSA. Claims management costs for non-life lines of insurance are reported at between 8 per cent and 12 percent of claims paid across the different lines of insurance. See also KPMG (2011), which puts the average loss ratio (net claims and claims expenses as a percentage of net earned premiums) for UK general insurance at 63%. So the payout ratio (claims as a percentage of premiums) is very substantially below the 100% implied by RS assumptions. Total expenses (not just claim processing costs) are some 32% of income.[7]

Introducing claim-processing costs is the minimal change to the RS assumptions that a test must cope with. The $CJSS$-test does explicitly allow for such costs (though the motivation for their introduction is not obviously to reconcile a multiplicity of contracts with symmetric information). The first issue is whether the $CJSS$ test can detect the presence of information asymmetry.

3 Administrative Costs and the Failure of the $CJSS$ test

The starting point of the $CJSS$ analysis is a "Revealed Preference Test" that is necessary for rationality. In principle, this can be applied whatever the structure of administrative costs, the extent of competition in the insurance market, or its information structure.

Revealed Preference Test (RPT): *"....., if an agent chooses one contract, C_1 over another with better coverage, C_2, the decrease in premium must be sufficient for the expected income of the agent to increase at unchanged behaviour"* ($CJSS$ p.787)

If RPT does not hold, there must be some buyers of the low-cover contract who would be better-off if they switched to the high-cover policy. So either the buyers are not observationally equivalent (so do not have the option to switch) or at least some buyers are optimistic, i.e. understate their own accident probability.[8]

$CJSS$ next substitute out for the premiums in the RPT test. Assuming competition and corporate risk neutrality, the premium on a policy equals the expected cost of providing it, which is the expected payout under the policy plus

[7] Some estimates of payout ratios are here;
http://www.lovemoney.com/news/4378/insurance-policies-that-pay-out–and-ones-that-dont
For example, motoring 84%, property insurance 55%, travel insurance bought stand alone 67%, or bought through travel operators 40%, mobile phone insurance, 47%.

[8] There is a further implicit assumption. Insurees do not face any claim processing costs. For some potential applicants, the psychic costs of claiming is substantial. If a low-deductible policy involves more claims then even for a risk averse individual it may not be preferable even if expected monetary income is no lower.

the expected cost of administering it.[9] Using the actual loss rates associated with each policy and making an assumption about the nature of administrative costs enables the premiums to be estimated. Replacing in the RPT the actual premiums with the derived premiums yields the $CJSS$-test inequality- their inequality 7 or its unnumbered successor.[10] If the inequality is violated and the assumptions on loading factors are correct, some buyers' would obtain an increase in expected income from switching to a higher cover policy which is inconsistent with risk aversion and rationality. Notice that in deriving the inequality, no assumption has been made concerning whether information is symmetric or asymmetric. Hence, satisfaction of the inequality cannot speak to the information structure. In fact, failure to satisfy inequality 7 does not even imply irrationality, as the constructed premiums may not equal the premiums actually charged to clients.

To emphasise, the test inequalities are correctly derived from the assumptions. Realism of the assumptions is not the issue. The problem is that the inequalities also hold if information is symmetric. Hence, satisfaction of the inequalities cannot test for asymmetric information.

$CJSS$ examine whether their inequality is satisfied in the data. Assuming a proportional loading factor (κ in their paper) set at a reasonable level, they find that for young French motorists the inequality holds. According to $CJSS$:

"*Our conclusion is that this test gives evidence for the positive correlation property: the null of zero correlation is rejected. By taking into account both the dispersion of claims and the cost structure of the insurer, we are able to corroborate the presence of asymmetric information."(p.795).*

The objection to drawing this conclusion is not that theories can never be proved empirically as opposed to not falsified but that satisfaction of the inequality provides no evidence either way concerning information structure. For the inequality to hold, the average low-cover individual would experience a fall in expected income from switching to a high-cover contract. Finding that expected income would decline is consistent with rationality, as long as the assumption concerning the loading factor is realistic, whether or not asymmetric information is present. Not switching when higher cover raises expected income is irrational even if information is symmetric. Therefore the inequality is uninformative as to the presence of asymmetric information. It is not even a sufficient condition for asymmetric information.

Observation 2 *The $CJSS$ test cannot detect the presence of asymmetric information.*

[9] As $CJSS$ point out, the zero-profit condition of competition is more restrictive than necessary. Their inequality holds as long as the higher coverage policy is no less profitable than the low coverage policy.

[10] In the notation of CJSS, $R_h(L)$, $h = 1, 2$, are payouts as a function of the loss, L, for contract C_h ; $F_h(L)$ are the distribution of loss functions associated with the contracts. κ represents a loading factor proportional to claim size, presumably reflecting transaction costs and $E_h(L) = \int L dF_h(L)$ are expected claims from contract C_h. CJSS derive and apply their Inequality (7), $\int R_2(L)dF_2(L) - \int R_2(L)dF_1(L) \geq \kappa[E_1(L) - E_2(L)]$, to test for asymmetric information.

4 Administrative Costs and the Failure of the PCP-Test

The failure of the $CJSS$ test does not directly imply that the PCP-test breaks down in the presence of administrative costs. To examine, as simply as possible, whether this is the case, we follow the theoretical papers of Einav, Finkelstein and Cullen (2010) and Mahoney and Weyl (2014) in taking contracts as fixed. The Appendix endogenises contracts in a two-type or three-type setting, finding similar results.[11]

When contracts are prescribed by regulation, the assumption of exogenous contracts is often appropriate. It is true, for example, of Medigap insurance, studied by Fang, Keane and Silverman (2008). They find the healthy buy more insurance, attributable to selection effects arising from heterogeneous income and cognitive ability. This could be regarded as advantageous selection, but we show that it does not follow that the market is inefficiently large.

In general, standard theoretical models struggle to endogenise contracts so as to encompass two stylised facts; a) most contracts involve some degree of pooling b) there are normally relatively few contracts in the market. The first property is famously ruled out in the RS model, but an important recent paper by Azevedo and Gottlieb (2014), AG, makes considerable progress. They assume a continuum of consumers differing with respect to loss probabilities and risk preferences. A Nash equilibrium involving a continuum of pooling contracts is shown to exist in most cases. So the puzzle of why there are so few contracts remains.

As a compromise between tractability, conformity with the characteristics of typical insurance markets, and desirability of explaining all the features, suppose only a single contract is allowed.[12] The cost of processing a claim is c.[13] There are two unobservable risks types who differ in their exogenous probability of suffering a fixed financial loss of Z.[14] For high-risk types, the chance of loss is $h > l$ where the latter is the loss probability of low risks. Moral hazard is initially absent. There is a non-degenerate distribution of an unobservable risk-aversion parameter for each risk-type.[15] Conditional on risk-

[11] This is a mild extension of the Appendix to Einav, Finkelstein and Schrimpf (2007) who assume fixed contracts and no pooling.

[12] If exclusionary contracts are impossible, there is just one contract in equiklibrium. For example, sellers do not monitor an individual's total holding of annuities (Abel (1986)). Contracts must, therefore, be linear. The mix of buyers fixes the purchase price of a given income stream. Each type buys a different quantity of annuities and the main features of our model apply.

[13] Were there no administrative costs all bad risks participate in a pooling equilibrium since doing so must raise their expected income as well as lowering their risk, Hence, if there are any uninsured, they must have a lower accident rate than the insured.

[14] Moral hazard lowers the loss rate of the uninsured. A zero correlation can therefore result from advantageous selection offsetting moral hazard. There is nevertheless market failure due to selection effects as those insuring following a premium fall would lower precautions and so have higher losses than the incumbents.

[15] Multidimensional heterogeneity is not necessary for the results. Similar effects are possible if types only differ in risk preference but there is hidden action as well as hidden types, as In

type, demand for the insurance contract is therefore smoothly decreasing in premium. For high risks, demand is $H(p)$ and for low risks it is $L(p)$ where the premium is p. For example, under CARA, utility is $-e^{-rY}$. A high risk individual charged a premium at which they are just willing to buy a full-cover policy satisfies $p = \frac{\log(1-h+he^{rZ})}{r}$, which is increasing in the CARA parameter, r, and in h. Writing the cut off risk preference as $r^* = r(p,h)$, and CDF^i as the group i distribution function of r, the demand curve of the high-risk types is $H(p) = \{1 - CDF^H[r(p,h)]\}n^h$ where n^h is group h size. Similarly, the demand by the low risks is $L(p) = \{1 - CDF^L[r(p,l)]\}n^l$. Although $r(p,h) < r(p,l)$, demand by the high risks is not necessarily higher at given p, it all depends on the cdfs of the two groups. The *per capita* demand curves could cross, indeed they must do so if one cdf is sufficiently compressed relative to the other. In general, the positions of the demand curves of the two groups relative to each other depends on the cdfs, on which no plausible restrictions can be imposed. The demand curves can in effect be regarded as the primitives.

There are constant returns to individual firms in offering contracts, so in a competitive equilibrium, companies expect to breakeven, inclusive of claim processing costs, with the premium satisfying[16]

$$\frac{[hH(p^e) + lL(p^e)](Z + c)}{H(p^e) + L(p^e)} = p^e$$

To determine whether this outcome is efficient, note that at premium p^*, aggregate benefit, the sum of consumer surplus and the financial surplus, is

$$W(p^*) = \int_{p^*}^{\infty} [H(p) + L(p)]dp + [p^* - (Z + c)h][H(p^*) + L(p^*)] \tag{1}$$

Assuming the policy maker does not observe type and sets the premium to maximise aggregate surplus (ignoring any deadweight costs from raising revenue), the F.O.C. is

$$\begin{aligned} \frac{dW(p^*)}{dp^*} &= \frac{H'(p^*)p^*}{H}H[1 - \frac{(Z+c)h}{p^*}] + \frac{L'(p^*)p^*}{L}L[1 - \frac{(Z+c)l}{p^*}] \\ &= -\eta_H H(1 - \frac{h(Z+c)}{p^*}) - \eta_L L(1 - \frac{l(Z+c)}{p^*}) = 0 \end{aligned} \tag{2}$$

where $\eta_i = -\frac{i'(p)p}{i} > 0$ $i = H, L$. As $h > l$, to satisfy the equation, the second bracket of (2) must be positive. If p^* is an optimum, the financial surplus is therefore

$$\begin{aligned} \pi(p^*) &= p^* H(1 - \frac{h(Z+c)}{p^*}) + p^* L(1 - \frac{l(Z+c)}{p^*}) \\ &= p^* L(1 - \frac{l(Z+c)}{p^*})(1 - \frac{\eta_L}{\eta_H}) \end{aligned} \tag{3}$$

de Meza and Webb (2001).

[16] For an individual seller, marginal and average revenue is the ruling premium. Marginal and average cost is the expected claim per policy inclusive of claim processing cost.

where the second equality follows from (2). Thus, at an optimum, $\pi \lesseqgtr 0$ as $\eta_H \lesseqgtr \eta_L$.[17] Relative elasticities determine whether a tax or subsidy is necessary for optimality, but play no role in the $PCP-$test.[18] Specifically, if the total number of individuals of each type is n^i, the positive correlation property holds $iff\ \frac{hH+lL}{H+L} < \frac{h(n^H-H)+l(n^L-H)}{n^H+n^L-H-L}$.So the $PCP-$test does not identify whether a subsidy or tax is required or whether the market should be contracted or expanded. Relative elasticities depend in the relative density of the risk aversion parameters of the marginal types of each risk class, about which no obvious restrictions apply.

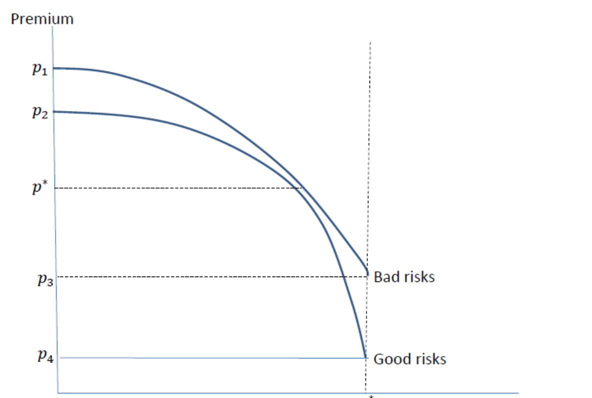

Figure 1

The analysis is illustrated in Figure (1) which shows demand by the two risk-types, equally numerous in the population, and from which the cost curves of Figure (2) are derived. The demand curves are chosen to generate non monotone average cost. To follow the mechanics, note that at all premiums between p_1 and p_4, $H(p) > L(p)$, so the insured have a lower loss rate than the uninsured. According to the PCP-test, if the premium settles in this range there is adverse selection. At premiums between p_1 and p_2 the only buyers are bad risks so the marginal cost of expansion resulting from premium cuts is constant and equal to average cost. Below p_2 good risks enter and therefore average cost of provision starts to fall. The ratio of good to bad risks reaches a maximum at p^* so average cost has a turning point here. Below p_3 all n^* bad risks are insured and further premium falls only attract good risks. Hence, average cost falls reaching a global minimum when all good risks are insured. The equilibrium premium is p^e, but the global maximum involves market contraction and the higher premium of p^o.

It is easily seen that if, say, administrative costs were higher there could be an interior equilibrium, where the loss rate of the insured equals that of the

[17] Relative elasticities depend on the distribution of risk preferences. Where the pdf is dense elasticity will be high. if one type has a much more concentrated distribution than the other demand curves will typically cross.

[18] The optimal premium does not replicate the full information outcome. It is the best pooling outcome. Under full information, there would be fewer bad risks and more good.

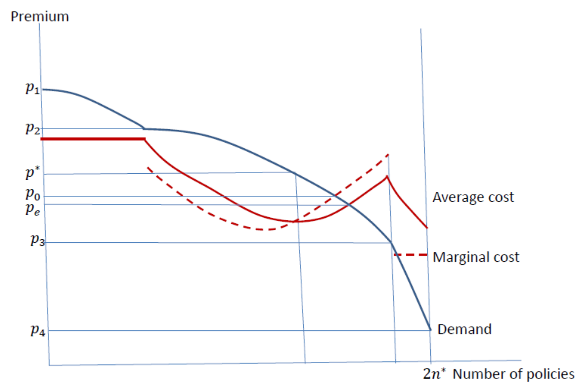

Figure 2

uninsured but a tax is welfare improving.[19] Reversing the labels on the demand curves of Figure 1, a parallel analysis allows a negative or zero correlation but a premium subsidy is welfare improving. The key to local efficiency is whether a premium cut will change the proportion of low risks in the pool and therefore affect the average cost of supplying policies.

Observation 3 *In a pooling equilibrium, local expansion (contraction) of the market is efficiency enhancing if the demand elasticity of the low risks is greater (lesser) than the high risks and does not depend on the loss rate of the insured relative to the uninsured. For global efficiency, not even the relative magnitude of the elasticities determines whether expansion or contraction is appropriate.*

That the sign of selection effects depends on the magnitude of the premium change has implications for what is really meant by adverse selection. Consider two recent, contradictory, definitions. According to Einav, Finkelstein and Levin (2010, p316), EFL, adverse (advantageous) selection is present if it would be less (more) costly per capita to insure the whole population. That is, the sign of the difference between the loss rates of the insured and the uninsured (the correlation test) defines the nature of selection. In the context of a single exogenous contract model, Einav, Finkelstein and Cullen (2010), EFC, state *"....the sign of the slope of the marginal cost curve tells us whether the resultant selection is adverse (if marginal cost is increasing in price) or advantageous (if marginal cost is decreasing in price)."* (p.879). As just illustrated, it is perfectly possible one definition would classify a market as subject to adverse selection and the other as advantageous.

Of course, definitions cannot be right or wrong, just more or less useful. The

[19] To illustrate, suppose $h = 0.079, l = 0.083, Z = 10, c = 0.19$.and and all utility functions are $CARA$. If $p = 1$,the marginal H has $r = 0.04$ and the marginal L has $r = 0.05$.If the rs are uniformly distributed with support $[0.02, 0.08]$ for the Ls and $[0.03, 0.05]$ for the $H's$,then at $p = 1$ half of each group is insured making average cost 1.A competitive equilibrium is therefore found in which the correlation between the loss rate of the insured and uninsured is zero but as demand by Hs is more elastic, a tax is welfare improving.

purpose of a definition is therefore relevant in judging its value. In many cases, the reason for distinguishing adverse and advantageous selection is to identify the nature of market failure and the appropriate policy response. A definition along EFC lines is then the most appropriate, with two qualifications. Rather than the slope of marginal cost, the slope of average cost is the appropriate measure. This is because the sign of the local externality is given by the sign of the difference between average and marginal cost, which equals the sign of the slope of average cost. If marginal cost is monotone, so is average cost, but the reverse is not the case. Secondly, when average cost is not monotone, EFC gives the correct answer for local changes but a global optimum may require the opposite change in coverage.

The EFL definition does not directly determine the nature of welfare improving interventions, either local or global. It is perhaps best seen as a descriptive measure of overall selection.

These definitions have analogues when there are multiple endogenous contracts, as very neatly shown in the competitive model of Azevedo and Gottlieb (2015). Loosely expressed, their definition of selection effects considers buyers taking a particular contract and computes their loss rate (including moral hazard effects) if all switched to an adjacent, higher cover contract. The loss rate of the switchers is then compared to the existing loss rate on that contract. This comparison is similar in spirit to the EFL definition. As AG note, this is a local result in that the sign of the comparison may depend on which contract it is measured at. A second measure, implicit in AG, looks at the consequences of decreasing the price of all contracts offering cover in excess (or below) some threshold by the same small increment.[20] There will be one-way substitution from slightly lower cover contracts. The loss rate of the switchers is compared to those already choosing the threshold contract. This measure differs from the first because the mix of switchers induced by a price change may not be the same as all those buying the relevant adjacent contract. The measure can be used to determine whether a premium change would raise welfare and is similar to EFC. Again, it is a local measure.

Taking all these issues into account, a possible policy orientated definition of selection effects follows. *Adverse (advantageous) selection is present if under full information everyone has at least as much cover as in the equilibrium.* As noted, the effect of asymmetric information on cover may not have the same sign for everyone, so even this definition is incomplete nor does this definition always lead to the same classification as the $PCP-$test or the EFL and EFC definitions.

5 Premium-change Tests

A correlation test implicitly estimates the effect of a particular premium change. In the case of Figure 2, it is the effect on the loss rate were the premium lowered from the equilibrium of p^e to p^4, at which level everyone is insured. A caveat is

[20] AG use this measure to determine the optimal premium schedule.

that, to the extent moral hazard is present, the loss rate of the uninsured would be higher were they actually insured. This obscures the selection effects on which efficiency depends. It is not the only issue. As shown in the previous section, whatever the nature of selection over the price interval that attracts all buyers, the opposite form of selection may apply locally. The selection designation may therefore be misleading, along with policy based on it. Finally, the correlation test gives no indication how large a premium change is needed to induce all to buy. This prevents the estimation of welfare cost or the determination of the appropriate policy level.

For these reasons, it is useful to examine the effect of exogenous premium changes (preferably many of them) on loss rates. Of course, it is empirically much more demanding to implement a premium change test than to conduct a correlation test. One method is to find a natural experiment, such as a tax change, or the introduction of a mandate, as in Hackmann, Kolstad and Kowalski (2015). Einav, Finkelstein and Cullen (2010) find a company that offers different deals to workers in otherwise similar business units for seemingly arbitrary reasons. Finally, price-change tests can also be implemented through a specially designed field experiment, as exemplified by Karlan and Zinman (2009) for a consumer loan market or for insurance contracts by Gunnsteinsson (2012) and Polimeni and Levine (2012).

If multiple contacts are available in the market, a premium change in a single intermediate contract will typically lead to substitutions affecting both higher and lower cover contracts, making it difficult to draw conclusions. In principle, a full demand system should be estimated. As noted by Azevedo and Gottlieb (2015) and discussed in the previous section, if the premium change is applied to all contracts above or below some cover threshold, clean selection effects can be identified. This is automatic if the experiment is conducted for the highest cover policy available in the market.[21] A special case is when there is only a single market policy or there is virtually no private insurance at all, as is the case in the experiments of Gunnsteinsson (2012) and Polimeni and Levine (2012). In summary, the correlation test amounts to an estimate of the selection effects of a possibly large price change but the critique of its reliability applies to price changes whatever their magnitude.

Observation 4 *The $PCP-$test is equivalent to a specific premium-change test plus any moral-hazard effects.*

6 Welfare Measurement

Estimates of how premium changes affect demand and loss rates have been used to quantify the welfare consequences of asymmetric information and the benefits of counteracting interventions. What has often been neglected is that the nature of Ioading factors potentially has major effects on the welfare measure.

[21] If it is the-low cover policy, a discount will attract the otherwise uninsured and those with high cover so again, there will be ambiguous results even in the presence of asymmetric information.

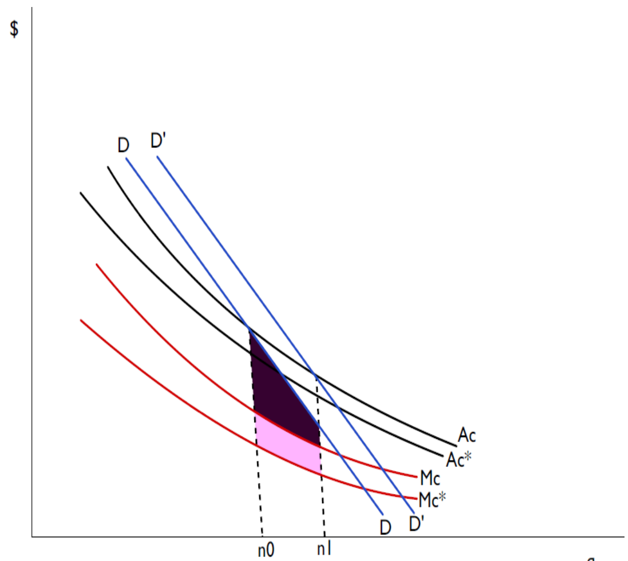

Figure 3

To see the role of claim processing cost, consider the single-contract pooling model of Section 5. The average cost of providing n contracts to the highest willingness to pay types is

$$A = p(n)(Z + c) = p(n)(1 + m)Z \tag{4}$$

where p is the average loss rate, Z is the insured loss, and $m = c/Z$, the loading factor due to claim processing costs. The corresponding social marginal cost is

$$\frac{dnA}{dn} = [p(n) + np'(n)](1 + m)Z = p(n)[1 + \epsilon](1 + m)Z \tag{5}$$

where $\epsilon = p'n/p$ is the elasticity of the aggregate loss rate with respect to n, the sign of which identifies the nature of the local selection effect. The absolute gap between average and marginal cost is $p(n)\epsilon(1+m)Z$. If the surplus created by a marginal change in market size in the beneficial direction is calculated without taking claim processing cost into account, it will, therefore, be overestimated by proportion m. For finite changes, the error will be greater as for all intra-marginal units, price does not equal average cost.

To illustrate, consider, for example, the Hackmann, Kolstad, and Kowalski (2015), HKK, study of the effect of the introduction of a mandate on the individual health insurance market in Massachusetts. The mandate involves fining non-buyers, so has the effect of increasing demand for insurance. HKK estimate that claims per policy fall, indicating adverse selection.[22] In Figure 3, average

[22] In the initial equilibrium the claims of marginal buyers are estimated to be some 60% of the average buyer. So there is considerable adverse selection.

claim costs per policy are AC^* with associated marginal cost MC^*. Adding the loading factor brings average cost to AC. The mandate shifts demand from DD to $D'D'$ with equilibrium sales increasing from no to $n1$. HKK assume the marginal social cost of providing extra policies is just the extra claims. The welfare gain from counteracting adverse selection is, therefore, the sum of the two shaded areas in Figure 3. If, though, the loading factor is due to claim processing cost (or reserve requirements), true marginal cost is higher at MC. Hence, only the upper shaded area should be included in the welfare gain from the mandate. In the HKK case, this lowers the gain from the mandate by about a third.

According to HKK, loading factors are not cost based but are pure profit. This interpretation is also problematic. The double shaded area is designated by HKK as the welfare gain due to offsetting the adverse selection distortion. Accepting their assumption that payment of claims are the only variable cost, makes this designation debatable. Even if average claim cost is constant and equal to marginal cost, so there are no selection effects, there is still an upper shaded area so market expansion, if not too great, yields a gain. The reason is that if loading factors do not reflect variable cost, the loading factor is itself a distortion offset by the mandate. The welfare gain area is the result of two distortions and to attribute it only to selection effects does not seem appropriate, most dramatically illustrated when there is no selection effect.[23]

Under advantageous selection, average cost is rising, and a competitive market over expands. Now, for efficiency, buying insurance that should be taxed rather than not buying it. The analysis goes into reverse and ignoring claim processing costs, which add to marginal cost, leads to an underestimate of the efficiency gain from market contraction.

Observation 5 *In competitive equilibria with given contracts, if the effect of a premium change on costs is limited to the outlay on claims, under adverse (advantageous) selection, the welfare gain from market expansion (contraction) is over (under) estimated.*

Loading factors also drive the results in Einav, Finkelstein and Schrimpf (2010), *EFS*. They provide a sophisticated measurement of the welfare costs of selection effects in the UK annuity market. Three annuity contracts differing in the duration of the guaranteed payment were available in the market. The paper first applies the correlation test to establish whether asymmetric information is present. Mortality is not monotone in guarantee length, suggesting an ambiguous answer.[24]

[23] Following imposition of the mandate, the loading factor actually fell from 11% to 2%. HKK attribute this to increased competition eating into profit and regulation prohibiting differentiation between group and individual rates. The expansion in sales due to the fall in loading factor is given a separate welfare measurement, not due to adverse selection. A 2% loading factor is extremely low. On average, medical loading factors on individual contracts are much higher, in the range 17%-21% (Cox, Gary Claxton, and Larry Levitt (2013)). Perhaps insurers are willing to take a temporary loss to sign up the new buyers in the expectation of making money from them later in the HKK case.

[24] The middle option is by far preferred, possibly because buyers are confused and avoid extremes.

To estimate the magnitude of the efficiency cost of asymmetric information, EFS adopt a structural approach. Specific forms for the utility and hazard function are assumed, allowing mortality and preference parameters to be calibrated from the observed distribution of contractual choices. Were symmetric information to replace asymmetric information, it is assumed that the same three guarantee durations would be offered, with each contract priced according to individual-specific mortality risk. The crucial assumption is that symmetric information equalises loading factors. Specifically, every annuity is priced such that the expected payout ratio is the weighted average of the three loading factors observed in the initial market equilibrium. Under this assumption, EFS show that introduction of symmetric information results in everyone switching to the longest duration contract. Rerunning the model assuming asymmetric information but equal loading factors also results in everyone choosing the longest contract. Asymmetric information, therefore, imposes a welfare cost only if it is the cause of unequal loading factors. EFS(footnote 16, p.1066) note that this is a key but debatable assumption. Unlike HKK, loading factors are taken to be a consequence of asymmetric information. A possible theoretical justification is that in contrast to a Nash equilibrium, in an anticipatory equilibrium (Wilson (1977)), cross subsidies are possible in the setting of exclusive insurance contracts (Miyazaki (1977), Spence (1978). High cover contracts taken by the high risks are sold below cost. Annuities are not exclusive contracts, however. Unequal loading factors under asymmetric information could alternatively be due to administrative costs, differential corporate risk costs, imperfect competition or actuarial mistakes.[25] In all these cases, loading factors will not be equalised by symmetric information.

If the EFS assumption is valid, it provides an easy test for the presence of asymmetric information; whether loading factors differ across contracts. The assumption is, though, hard to believe.

7 Conclusion

According to the correlation test, hidden types and hidden action are absent if distinct insurance policies chosen by observationally identical types have the same loss rate. This claim involves a contradiction. If information is symmetric, the standard model implies that all contracts offer full cover. Claim processing costs and other ingredients of loading factors, often large in practice, allow a variety of contractual forms. These costs are incorporated in the $CJSS$ test, but the inequality proposed as a sufficient condition for asymmetric information also applies when information is symmetric.

With claim processing costs, the standard $PCP-$test cannot be relied on. Even with no moral hazard, a zero correlation does not rule out hidden types, nor does the sign of the correlation necessarily sign local selection effects, which

[25] Cannon and Tonks (2014) provide strong arguments that risk varies over contracts and will be reflected in premiums. It, therefore, has the same effects as administrative cost.

may be the relevant effects to judge market failure. These results have a paradoxical element. If two contracts are offered to observably identical types, but the loss rates of buyers are very different, it seems that selection effects must be present. They are, but the choice of many buyers may be unresponsive to variation in premiums over particular ranges and their loss characteristics may be very different to those of the responders. The correlation test goes wrong, at least for policy purposes, because it implicitly assumes the ranking of contracts by average and marginal loss rate coincide, and the relationship is invariant to where it is measured.[26] There seems no natural way to rule out divergences, nor to conclude that they must be small. Multiple exogenous premium changes, if available, can help and may be used to evaluate the welfare cost of hidden types and the benefits of remedial action. These estimates depend heavily on the nature of loading factors, whether cost based, due to imperfect competition or asymmetric information itself. This does not seem to have been fully appreciated. Administrative costs are not normally negligible or innocuous in understanding insurance markets.

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APPENDIX

ENDOGENOUS CONTRACTS

The results of Einav, Finkelstein and Schrimpf (2007) call the correlation test into question, showing that a non-zero correlation between cover and loss is consistent with efficiency when there are fixed administrative costs. They assume insurance contracts are exogenously given, remarking *"Endogenizing the equilibrium contract set is difficult when unobserved heterogeneity in risk preferences and risk types is allowed..." (p.5)* but consider it likely that the results will hold even if contract form is endogenised. We now show that the main results do carry over, but there are some restrictions on what can be observed and some additional possibilities are noted. In particular, we show that a negative correlation, normally associated with advantageous selection, is consistent with less insurance than under full information, and a zero correlation between distinct policies does not imply the equilibrium is efficient.[27] In our analysis, claim processing costs rather than fixed administrative costs are assumed. Whereas fixed costs independent of contract can explain diverse full-information choices between insurance and no insurance, to do the same between contracts requires claim processing costs or some other reason why administrative costs differ between contracts. For simplicity, in what follows only a single loss is possible. As a result, full information outcomes can only involve differences between the uninsured and the insured. If two or more loss levels are possible, all results apply to comparisons of more and less (but still positive) insurance.

The assumptions we work with are as follows:

a) All individuals have the same income endowment, Y, but may suffer financial loss Z.

b) The probability a high (low) risk type has an accident is h (j).

c) There are at least two risk-neutral insurance companies making simultaneous offers of insurance contracts. A contract is defined by deductible d and the premium charged to risk type j, p^j.

d) Processing an insurance claim costs the company c irrespective of the size of the claim.

e) In addition to being high or low risk, individuals may have high risk aversion denoted by R, or low risk aversion by r. Let V^{ij} denote the expected utility of risk type j with increasing, strictly concave utility function of risk aversion type i, U^i, so

$$V^{ij} = jU^i(Y - Z + (Z-d)^+ - p^j) - (1-j)U^i(Y - p^j) \quad i = r, R. \; j = h, l. \quad (1A)$$

The insurer's break-even premium for an individual of known risk is given by

$$p^j = j((Z-d) + c) \quad (6)$$

The first task is to determine how claim processing costs influence full information choices.

[27] With exogenous contracts, Einav, Finkelstein and Schrimpf (2007) find that a full pooling equilibrium may arise. This though is not a zero correlation which requires distinct contracts have the same loss rates.

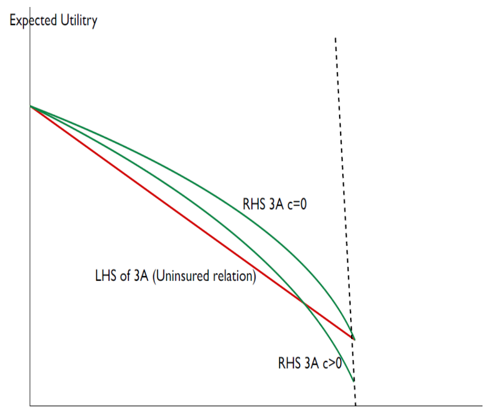

Figure 1A

Observation 1A *If two insurance buyers have the same preferences but differ in their full information choices, the low loss type is fully covered and the high loss type is uninsured.*[28]

Proof If insurance is to be bought, full cover is the best buy as increments in cover are available on actuarially fair terms. So insurance is bought under full information iff

$$U(Y-\pi(Z+c)) > \pi U(Y-Z)+(1-\pi)U(Y) \tag{3A}$$

where π is loss probability treated for analytical reasons as a continuous variable. When $\pi=0$, there is no advantage in insuring and if $\pi=1$ the claim processing cost implies it is best not to insure. The slope of the LHS of (3A) in expected utility-loss probability space is $-(Z+c)U'(Y-\pi(Z+c))$ and so is decreasing in π. The slope of the RHS of (3A) is constant. The two sides of (3A) are plotted in Figure 1A. Observation 1A is immediate.

The reason for introducing claim processing costs is to allow for different choices under full information. Observation 1A implies that if this occurs and preferences are the same for both high and low risks, there cannot be an asymmetric information equilibrium. Such an equilibrium, as in RS, involves separation with full cover by the high risks, but this contradicts the full information preference for no insurance. In what follows, preferences therefore differ between risk types.

The remainder of the Appendix is concerned with equilibria in which the $PCP-$test fails. If the full information and hidden types equilibria coincide, then the latter is efficient, so there are no selection effects. In line with the discussion in the text, if there is unambiguously less (more) insurance than in the first-best full information case then there is adverse (advantageous) selection.

[28] This does not hold for fixed administrative costs as assumed by Einav, Finkelstein and Schrimpf.

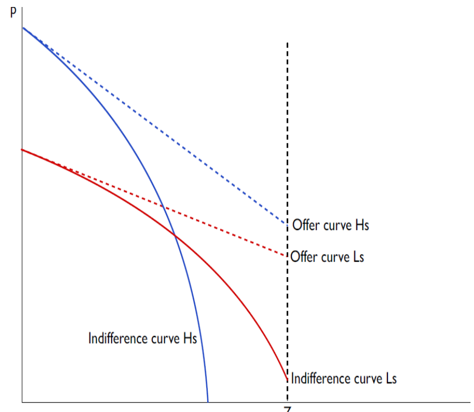

Figure 2A

Observation 2A *A negative correlation between cover and loss probability is consistent with efficiency.*

Figure 2A shows the offer curves of the two risk classes under full information. As *ex ante* moral hazard is absent, offer curves are linear, and lower for the better risks. As the deductible approaches the loss, insurance tends to zero, but claim processing costs are still involved. Lower indifference curves are preferred to higher. The outcome if insurance is not taken is contract Z. In the configuration shown, high risks are insured under full information but the more risk tolerant low risks are not. If information is asymmetric, the equilibrium is unchanged. Full cover is now even less attractive to good risks if offered on the terms appropriate to bad risks. Similarly, the attraction of partial cover is not enhanced for the good risks relative to the full information case.

Observation 3A *A negative correlation between cover and loss probability is consistent with less insurance than under full information.*

Following Smart (2000), Wambach (2000) and de Meza and Webb (2001), Figure 3A shows a partial-pooling equilibrium. Here, good risks are more risk averse than bad risks, who, for simplicity, are assumed to be risk neutral (so offer curves and indifference curves coincide). Under full information, bad risks are uninsured. Good risks are risk averse and choose full cover under full information. When types are hidden, the equilibrium policy is at E with all the good risks buying. Bad risks are equally well-off buying the policy or going uninsured, with the number buying just enough to yield zero expected profit on the contract. Any deviation that leaves the good risks at least as well off brings all the bad risks into the market, rendering the deviation unprofitable.

It is not obvious whether this equilibrium should be characterised as adverse or advantageous selection or neither. The average loss probability of the insured is lower than the uninsured. Some bad risks are insured when for a first best outcome they should not be, whilst all good risks buy less insurance than under full information.

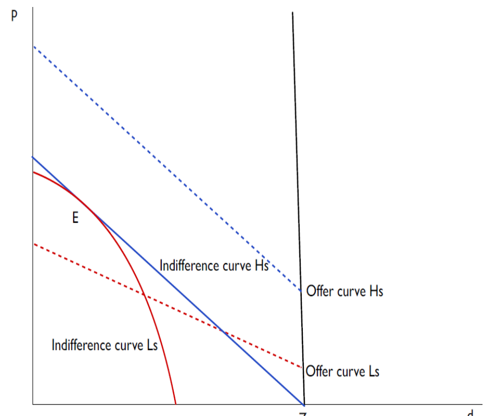

Figure 3A

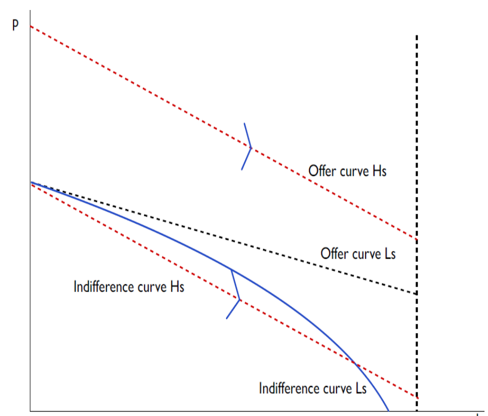

Figure 4A

Observation 4A *·A positive correlation does not imply inefficiency*

This case, illustrated in Figure 4A, again involves all good risks being risk averse whilst, for simplicity, the bad risks are risk neutral. Under full information, the good risks are fully covered but the bad risks are better off uninsured, avoiding the burden of the claim processing costs. Note that even if the bad risks could take full cover on the same terms as the good risks, thereby benefiting from a cross subsidy, this is insufficient to fully offset their claim processing costs so their expected income would fall. Hence, the full information equilibrium is also the asymmetric information equilibrium.

Observation 5A *A zero correlation between distinct policies does not imply efficiency.*

This time three types are necessary to make the point. Low risks are divided into high and low risk aversion types, the latter risk neutral. As shown in Figure 5A, under full information, the former take full cover and the latter do not insure.

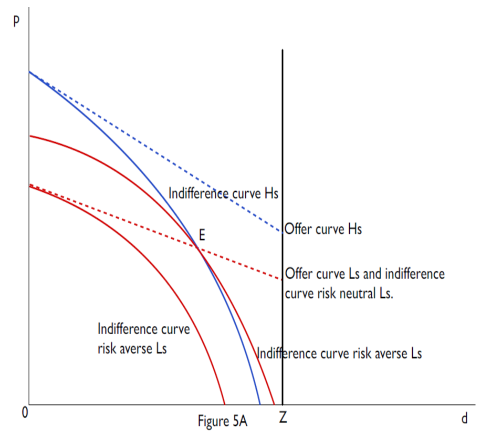

Figure 5A

Bad risks are all high risk aversion and choose full cover under full information. When risk type is private information, there is an equilibrium in which bad risks are fully covered, the more risk averse of the good risks are partially covered at E and the risk neutral good risks are uninsured. The key property is the relative slope of the indifference curves through E. The bad risks must have a bigger premium cut to compensate for a given increase in deductible than the good risks. At E, deviation to lower cover (increased d) on terms that retain good risks,continues to separate but is unprofitable. Increasing cover fails to separate if the terms are set to retain good risks and is therefore also unprofitable. The hidden types equilibrium has the property that there is zero correlation between the loss rates of those with partial and no cover, though the fully insured have higher loss rate. Asymmetric information has resulted in underinsurance by high risk aversion, low risk types, but a comparison between the uninsured and the partially insured finds no difference in loss rates.