Anti-insurance: Analysing the Health Insurance System in Australia*

by

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First Draft: 31st October, 2002
This Version: 30th June, 2003

This paper develops a model to analyse the Australian health insurance system when individuals differ in their health risk and this risk is private information. In Australia private insurance both duplicates and supplements public insurance. We show that, absent any other interventions, this results in implicit transfers of wealth from those most at risk of adverse health to those least at risk. At the social level, these transfers represent a mean preserving spread of income, creating social risk and lowering welfare – what we call *anti-insurance*. The recently introduced rebate on private health insurance can improve welfare by alleviating anti-insurance.

Journal of Economic Literature Classification Numbers: H42, I18.

Keywords. health insurance, mixed system, rebate, anti-insurance.

Suggested running head: Anti-insurance

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* We would like to thank Ian Harper, Rhema Vaithianathan, participants at the 2003 Australian Theory Workshop and two anonymous referees for valuable input into this research. We also thank Medibank Private Ltd for financial assistance. Responsibility for all views and omissions lies with the authors and not with any of the above individuals or organisations. Corresponding author: Stephen King, spking@unimelb.edu.au.

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I. Introduction

Australia has a mixed system of public and private health insurance. Public health insurance coverage is not means tested and private health insurance 'overlaps' with public insurance. A household with private health insurance may use that insurance both to pay for medical expenditures that would otherwise be covered by public health insurance and to pay for services only available in the private system (e.g., choice of doctor, reduced waiting times, private rooms, etc). Thus, private health insurance both supplements and partially duplicates public insurance.

The Australian health insurance system has evolved over the past thirty years as a result of changing government policy over the need for government intervention, the appropriate balance of public and private health insurance and the extent of regulation (Industry Commission, 1997). The viability and desirability of the Australian system has been questioned (Richardson 1994, Industry Commission 1997, Hurley, et. al. 2002) with a variety of reforms suggested, such as a move to managed competition (Scotton 1999).

In this paper, we formally analyse the effectiveness and welfare consequences of this type of health insurance system, and consider the effect of the recently introduced thirty percent rebate for private insurance.[1] We also consider how the existing system could be modified to provide improved welfare outcomes.

A key novelty of our approach is to focus on the insurance properties of the Australian health system. The Australian health debate has been driven by concern about government cost containment and the linking of public insurance with the public provision of medical services and private insurance with the private provision of medical care (e.g. Hurley

[1] This is one of three recent reforms with the stated aim of increasing the take-up of private health insurance; the other two being the introduction of a form of life-time private insurance coverage and an additional tax penalty on high-income earners who do not have private insurance coverage.

et.al., 2002; Duckett and Jackson, 2000).[2] This linking is a feature of the Australian system but has little if anything to do with insurance; the focus of our paper.[3,4] In contrast, we focus on the ability of the Australian health insurance system to protect individuals from the risk of adverse health events.[5]

Our conclusions regarding health insurance are simple. When we consider the welfare of individuals who only differ by their health risk (or equivalently the life-cycle of an average individual) the Australian health insurance system creates poor incentives and has undesirable insurance features. While protecting against some health risk, the insurance system also *increases the underlying risk* associated with adverse health events. This arises because the most-at-risk individuals provide an implicit subsidy through the tax system to individuals who have lower risk of an adverse health event. Unlike pure public insurance systems, where high risk individuals gain by being pooled with those with low health risk (Dahlby 1981, World Health Organization 2000 p.99), in the Australian system, those most at risk of adverse health will tend to opt out of the public insurance scheme. High risk individuals buy private health insurance, while those with low health risk use the public insurance system. But the high risk individuals continue to fund the public insurance system through their taxes, leading to an implicit subsidy from the most-at-risk to the least-at-risk

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[2] It should be noted that this focus is also adopted by the federal government. In this sense, commentators analysing the insurance system purely from a government-cost perspective can legitimately argue that they are merely adopting the government's stated objective. For example, Vaithianathan (2002) formally models the introduction of the private insurance rebate and shows that its effect on government cost, at best, is ambiguous.

[3] For example, there is no reason why a system of pure public insurance could not involve service provision through both public and private providers. The ownership of the institutions providing medical services and the nature of health insurance are analytically separate features of a system of health provision.

[4] The Australian debate about health insurance has also focused on income distribution. Some analysts appear to view the health insurance system as a scheme for redistributing income through the tax system (e.g., Smith, 2001). While income redistribution is a laudable objective, it is far from clear that this redistribution should occur through the health insurance system. Standard economics suggests that income redistribution should occur through well-defined taxation and redistribution systems. Hiding income redistribution through a public health insurance system is likely to be inefficient. For our analysis we separate out the aim of socially desirable income redistribution through the taxation and social security systems and the design of a socially desirable health insurance system (see also Jack, 1998, for a similar approach). To do otherwise is to confuse two separate welfare issues.

individuals. From the perspective of society as a whole, these transfers increase risk. Thus, the underlying health insurance system that currently exists in Australia involves a form of anti-insurance that lowers overall welfare.

The undesirable properties of the Australian health insurance system are partially offset by the recently introduced rebate on private health insurance premiums. At the same time, however, the rebate distorts the price of private health insurance and may lead to the over-consumption of health services by high-health-risk groups. A preferred approach would be a lump-sum rebate on private health insurance premiums. This would provide the insurance benefits of the existing rebate without distorting the marginal price of private health insurance.

This paper proceeds as follows. Section II presents the formal model of the Australian health insurance system and the potential equilibrium outcomes. The welfare properties of these outcomes are analysed in Section III. In particular, we explain why the Australian-style system creates unnecessary risk or anti-insurance. Section IV addresses the rebate policy while Section V concludes.

II. A Model of Health Insurance

The model presented here is based on the classic insurance model pioneered by Rothschild and Stiglitz (1976) and Wilson (1977). We extend this model to consider the specific features of the Australian health insurance system.[6]

There is a population of individuals each of whose utility depends on health status and disposable income. First, consider health status. There are two relevant dates in time. In the first period, denoted t=1, (the *ex ante* period), individuals are uncertain about their future

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[5] Our working paper (Gans and King, 2003) provides additional background material on the Australian health insurance system. Useful background material is contained in Jost (2001) and a recent analysis of supplemental insurance is provided by Finkelstein (2002).

health status. Each individual faces two alternative states of nature and these states of nature are realised in the second period (t=2, the *ex post* period). The alternative states of nature are referred to as 'well' or 'ill.' If an individual is 'ill' in the second period then he requires health expenditure H. This expenditure is not required if the individual is 'well' at $t=2$. Hence, if the individual is ill then this is equivalent to a reduction in *ex post* disposable income by H.[7]

In the second period, individuals will differ by their realised health status. But *ex ante*, before health status is realised, individuals only differ by their probability of being either ill or well in the second period. There are two types of individuals, 'high risk' types (denoted by h) who *ex ante* have a relatively high probability of being ill in the future and 'low risk' types (denoted by l) who *ex ante* are less likely to require future health expenditure. We denote the *ex ante* probability that an individual of type $i \in \{l, h\}$ will be ill in the future by q_i where $q_h > q_l$. The proportion of high-risk types in the population is given by p. Thus, for a randomly chosen member of the population, the probability that the individual is an h-type is given by p while the probability that they are an l-type is given by (1-p). Each individual knows their type at t=1, but this is private information to the individual.

Turning to income, all individuals have an identical base income in period 2 of y. But if a person is ill in period 2, their disposable income in that period is y-H. In the absence of any public or private insurance, an individual's realised period 2 utility is given by $u(y)$ when healthy and by $u(y-H)$ when ill. *Ex ante* expected income for a type i consumer is thus $U_i = (1-q_i)u(y) + q_i u(y-H)$. We make the usual assumptions on u so that $u' > 0$ and $u'' < 0$. In other words, we assume that individuals are risk averse and, as such, will value actuarially fair insurance.

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[6] Finkelstein (2002) uses this framework to consider insurance with multiple contracts (either public or private). For a recent example of this approach applied to the Australian health care system, see Jack (1998).

In general either private and/or public health insurance might be available at $t=1$. Insurance transfers income from the 'well' state to the 'ill' state. Private insurance has a premium, P, and an indemnity, D. Both the premium and the indemnity are set by the insurance company in period 1. An individual can then purchase the insurance in period 1, before they learn their health status. An individual who purchases private insurance will have an income of $y - P$ in period 2 when they are healthy and an income of $y - P - H + D$ when they are ill.

The private insurance market is competitive in the sense that there are an arbitrarily large number of potential providers of private health insurance. Each private insurance provider seeks to maximise expected profits but equilibrium profits are constrained by competition. Thus, in equilibrium, if a fraction π_i of all type-i individuals buy a particular private insurance product then the insurer's average economic profits per member of the population are given by $\left(\pi_h p + \pi_l\left(1-p\right)\right)P - \left(\pi_h p q_h + \pi_l\left(1-p\right)q_l\right)D$. By competition, these profits equal zero.

It is well known that a pure strategy Nash equilibrium may not exist in the one-shot simultaneous move game between insurance companies (Rothschild and Stiglitz, 1976). As our focus here is on the welfare consequences of public insurance rather than on the explicit operations of the private insurance market, we assume that, in the absence of public insurance, there is a well defined Nash equilibrium in the private insurance market. As Rothschild and Stiglitz note, this will be a separating equilibrium, where the high-risk types are fully insured but the low risk types only receive partial insurance.

[7] There is no moral hazard in our model in the sense that individuals cannot take actions that influence their health risk or their health expenditure when ill.

Formally, we assume that for all y, H such that $H \leq y$, p is sufficiently large so that there is a well defined separating Nash equilibrium in the private insurance market. Essentially, this assumption requires that there are not 'too few' *h*-types in the economy.

The separating private insurance equilibrium is shown on Figure One. The *h*-types receive full insurance that is actuarially fair given their probability of illness. The *l*-types also receive actuarially fair insurance given their risk characteristics, but they are not fully insured, reflecting the adverse selection problem for insurers. The contract accepted in equilibrium by the low-risk individuals is the best actuarially fair contract that can be offered without being preferred by the high-risk types to full insurance. The premium paid by the high risk individuals (P_h) is higher than the premium paid by the low risk individuals, but their indemnity (D_h) is also higher.[8]

Public health insurance can also be provided. We consider a fully-funded public system so that total tax revenues equal expected payouts. The tax revenue paid by each member of the population and the members of society who receive a payout will depend on the exact policy adopted by the government. The government sets both taxes and the future payouts in period 1. As an individual's type is private information, the government cannot make tax payments contingent on the likelihood of future illness.

Finally, we require a welfare standard for comparing alternative health insurance systems. There is clearly no unique welfare measure. However, given the structure of our model, a sensible approach is to consider the expected welfare of a representative individual, $W = pU_h + (1-p)U_l$. In other words, for any individual in society, we consider their expected period 2 utility *before they learn their type*. Thus, we could consider an initial period 0, where individuals have not yet learnt their type. In this initial period, every

[8] This represents the simplest model of private health insurance. In practice, partial subsidies exist for doctors' services for privately insured patients in private hospitals but the patient and private insurer pay for all accommodation costs.

individual is identical and has an identical expected utility. This expected utility provides a reasonable measure of social welfare.[9]

(i) The outcome with only comprehensive public insurance

Under comprehensive public insurance, all individuals pay the same tax, *T*, and if sick all individuals receive the same benefit, *b*. The health system must be fully funded so that $T-\left(pq_h+(1-p)q_l\right)b=0$. There are a large number of potential public insurance schemes, and these are illustrated in Figure Two by the 'balanced-budget' line under complete pooling.

The public insurance scheme that maximises the expected welfare of a representative agent, *W*, sets *T* and *b* to maximise:

$$p\left[(1-q_h)u(y-T)+q_hu(y-T-H+b)\right]+(1-p)\left[(1-q_l)u(y-T)+q_lu(y-T-H+b)\right] \quad (1)$$

subject to $T-\left(pq_h+(1-p)q_l\right)b=0$. From the first order conditions of this problem, the optimal *T* and *b* involve setting the marginal utility of income the same whether well or ill. In other words, optimal public insurance involves full insurance.[10]

Public insurance that maximises social welfare *W* involves community rated full insurance. But this situation does not exist in Australia. While public health insurance has community rating, it does not provide full insurance in the sense that it does not cover all medical conditions and it limits the quality of service that is covered for so called elective health procedures.

[9] In our model, this is equivalent to a utilitarian welfare function for a large population.

[10] This result is equivalent to saying that community rated full insurance is optimal when an individual does not know their own type. This result is well known in the health insurance literature (Cutler and Zeckhauser, 2000). Full insurance is optimal because of the absence of moral hazard in our model. It could be argued that some elements of the existing Australian public health insurance system (e.g. non-price rationing) are responses to such moral hazard.

(ii) Outcomes in a mixed public-private system

We now consider the possible outcomes of a mixed public/private insurance system where an individual can take out private insurance in period 1 but only by forgoing the benefits of public insurance and without receiving a tax rebate.[11] Then, in the next section, we consider the welfare consequences of these outcomes.

Individuals take the level of benefits under the public system, b, as given when they choose whether or not to purchase private health insurance. In line with the Australian system, public insurance will only offer partial coverage so $b < H$. The first possible outcome is equilibrium with **pure private insurance**. This occurs if b is very low. In this situation, the public system is meaningless in equilibrium: no-one makes a claim against the public insurance and no taxes are collected to fund this system in equilibrium. The outcome will be identical to the separating private equilibrium in Figure One. This case is illustrated in Figure Three.

At higher levels of b, there may be **separation** between different types of individuals. The h-types take out full private insurance but the l-types rely on only public insurance. The h-types pay both the tax contribution to the public insurance and the private insurance premium.

Formally, a separating public-private equilibrium involves a per person tax T, a public insurance benefit b, a private premium P and a private indemnity D such that:

$$P - q_h D = 0 \quad (2)$$

$$y - T - H - P + D = y - T - P \quad (3)$$

$$u(y - T - P) \geq q_h u(y - T - H + b) + (1 - q_h) u(y - T) \quad (4)$$

$$u(y - T - P) \leq q_l u(y - T - H + b) + (1 - q_l) u(y - T) \quad (5)$$

[11] It is possible for an individual with private health insurance to fail to declare this insurance and to be treated under public insurance. The incentives to 'non-declare' relate to specific details of the Australian system and are

$$T-(1-p)q_l b=0 \tag{6}$$

(2) requires that the *h*-type individuals face actuarially fair insurance while equation (3) involves the *h*-type purchasing full insurance and implies that $D = H$. (4) and (5) are the incentive compatibility constraints for the *h*-type and *l*-type respectively. The former says that an *h*-type prefers full private insurance to the public insurance. The latter requires that an *l*-type prefers the public insurance rather than the private insurance offered to the *h*-type individuals. We also require that the public insurance system is fully funded and this is captured by (6).

Private and public contracts that satisfy (2) to (6) will only constitute a separating equilibrium if there is no unilateral deviation by a private company that would lead to positive profits. Two forms of deviation are possible – where only low-risk individuals are attracted to the 'deviant' contract and where all individuals prefer the deviant contract. Consider the first type of deviation and let $(\tilde{P},\tilde{D})$ be the insurance contract such that (4) binds and $\tilde{P}-q_l\tilde{D}=0$. This is the best contract for low-risk types, given tax payments, that just makes high-risk types indifferent to purchase. Thus, $(\tilde{P},\tilde{D})$ represents the 'best' non-loss-making deviation from the perspective of the low-risk types. If this deviation cannot attract the low-risk types, then no profitable deviation is possible. Thus, we require that

$$q_l u(y-T-H+b)+(1-q_l)u(y-T) \geq q_l u(y-T-\tilde{P}-H+\tilde{D})+(1-q_l)u(y-T-\tilde{P}) \tag{7}$$

Now, consider a pooling deviation. There will be no deviation contract that will attract *both l*-types and *h*-types if there does not exist a $(\tilde{P},\tilde{D})$ such that $\tilde{P}-\left(pq_h+(1-p)q_l\right)\tilde{D}=0$ and (7) is violated.

Proposition 1 shows the existence of a separating public-private equilibrium.

beyond the scope of the analysis here. Rather, we assume that if an individual buys private health insurance that is more comprehensive than public health insurance then they will use that private insurance if necessary.

Proposition 1: *Let* $\hat{y} = y - (1-p)q_l b$ *. For any level of illness* $H < \hat{y}$ *, there exists a public insurance scheme b such that in equilibrium only the low-risk types use public insurance while the high-risk types purchase complete private insurance.*

All proofs are in the appendix. Figure Four illustrates a separating public-private equilibrium.[12]

In addition to fully separating equilibria, there are also equilibria where some high-risk individuals rely on public insurance while others purchase private insurance; i.e., **partial pooling**. Suppose that a fraction ϕ of high-risk individuals opt out of public insurance and purchase private insurance. These individuals will be indifferent between paying for full insurance privately and receiving lower benefits under the public insurance scheme.[13] Equilibrium is characterised by the following conditions:

$$P - q_h D = 0 \tag{8}$$

$$y - T - H - P + D = y - T - P \tag{9}$$

$$u\left(y - T - P\right) = q_h u\left(y - T - H + b\right) + \left(1 - q_h\right) u\left(y - T\right) \tag{10}$$

$$u\left(y - T - P\right) \leq q_l u\left(y - T - H + b\right) + \left(1 - q_l\right) u\left(y - T\right) \tag{11}$$

$$T - \left(1 - p\right) q_l b - \left(1 - \phi\right) p q_h b = 0 \tag{12}$$

Equations (8), (9) and (11) are the same as (2), (3) and (5). Equation (10) requires that high-risk individuals are indifferent between public and private insurance, while (12) means that the public insurance scheme is fully funded from tax revenues given the risk profile of public insurance claimants. Note that the tax burden associated with the public insurance system increases as ϕ falls, reflecting that more high-risk individuals use the public insurance

[12] Note that unlike supplemental private insurance, the public insurance contract is not the 'endowment point' for *h*-types. This is because these types opt out of the public insurance benefits when purchasing private health insurance.

[13] For a brief discussion of a partial pooling (or semi-separating) equilibrium see Dixit and Skeath (1999 p.421). In such an equilibrium, the 'type' associated with two equilibrium actions must be indifferent between those actions in equilibrium, otherwise they will simply choose the preferred action.

system rather than purchasing private insurance. Finally there is a deviation requirement given the level of taxes analogous to the requirement for separating equilibria.

Proposition 2: *Let* $\hat{y} = y - (1-p)q_l b - (1-\phi) p q_h b$. *For any level of illness* $H < \hat{y}$ *and any fraction* $\phi \in (0,1)$, *there exists a public insurance scheme b such that in equilibrium all the low-risk individuals and a fraction* $(1-\phi)$ *of high-risk individual use public insurance while the remaining high-risk types purchase private insurance.*

Finally, if the tax-funded public insurance is sufficiently generous then it can eliminate private insurance; i.e., there is **pure public** insurance. Despite public insurance offering less than complete cover, the high-risk individuals prefer to forgo private insurance and rely on the public scheme. They do this because, at the margin, the public insurance scheme is free. All individuals pay for this scheme through their taxes and do not receive a rebate if they opt out of the public scheme. In contrast, private insurance has a direct avoidable cost for individuals.

A public pooling equilibrium with no private insurance will exist if (8), (9), (11) and (12) hold for $\phi = 0$ with equation (10) replaced by:

$$u(y-T-P) < q_h u(y-T-H+b) + (1-q_h)u(y-T) \tag{13}$$

Under (13), high-risk individuals all prefer to rely on public insurance rather than to purchase actuarially fair private insurance. No high-risk individuals opt out of public insurance and the cost of this insurance is borne by all individuals through their taxes.

(iii) An example with constant risk aversion

The separating and partial-pooling outcomes can be illustrated by a simple example. Suppose that individuals have a utility function $u(Y) = -e^{-aY}$ which has a constant Arrow-Pratt index of risk aversion given by a.[14] (10) becomes $-e^{-a(\hat{y}-q_h H)} + \left[q_h e^{-a(\hat{y}-H+b)} + (1-q_h)e^{-a(\hat{y})}\right] = 0$ where $\hat{y} = y - (1-p)q_l b - (1-\phi)pq_h b$ (see

[14] See Hirshleifer and Riley (1992) for a discussion on measures of risk aversion.

appendix). Proposition 3 shows that if individuals have constant risk aversion then the value of *b* associated with a partial pooling equilibrium is unique.

Proposition 3: *Suppose individuals have constant risk aversion utility. Then for any level of illness* $H < \hat{y}$ *and any fraction* $\phi \in (0,1)$*, there exists a unique public insurance scheme* b^* *such that in equilibrium all the low-risk individuals and a fraction* $(1-\phi)$ *of high-risk individual rely on public insurance while the remaining high-risk types purchase private insurance. Further* b^* *is invariant in* ϕ.

While this proposition only applies to constant risk aversion utility functions, it is a strong result. It says that, given the values of the exogenous parameters y, H, p, q_l, and q_h, there is a unique level of public health insurance that will lead to a partial-pooling outcome. Further, there is a continuum of equilibria at this level of public health insurance. At one extreme of these equilibria there exists a separating mixed public-private outcome. At the other extreme there is only public insurance.

For example, suppose income (y) is $40,000; the cost of medical services (H) is $10,000; the probability that any individual is high-risk (p) is one-quarter; the probability of a high risk individual being ill is one-tenth while the probability of a low risk individual becoming ill is (1/100). Then if the level of risk aversion (a) is 0.25, the critical level of public insurance (b^*) equals $4,618. If public health benefits exceed b^* then there is only public insurance with no private insurance. If public health benefits fall below b^* then there is either separating public-private insurance or just private insurance is the outcome. As expected, b^* rises with risk aversion. For example, if $a = 0.5$, $b^* =$ $5,974. If $a = 1$, $b^* =$ $7,010.

III. Outcomes of the Australian Health Insurance System

The previous section identified four possible outcomes of the Australian mixed public-private insurance system (pure private, separating public-private, partial pooling and pure public equilibria). The outcomes with only private insurance or only public insurance are well understood. However, both the separating public-private outcome and the partial pooling outcome raise important welfare issues. Further, these outcomes most accord with the 'separating' behaviour of the Australian population.[15] This section considers the welfare consequences of these outcomes and shows that both separating and partial pooling outcomes have undesirable welfare consequences.

(i) Anti-insurance with separating public-private insurance

In a separating equilibrium the high-risk individuals are worse off than if there were no public health insurance. In other words, they are worse off than the separating private insurance equilibrium. The reason for this is simple. Public insurance provides inadequate coverage for high-risk individuals. From their perspective the fixed level of benefit b under public insurance is worse than the full insurance coverage offered by private insurers. But, even if they opt out of the public scheme, the high-risk individuals are still required to pay their tax contribution to that scheme. As such, the high-risk individuals are cross subsidising the low-risk individuals.

Observation 1: *Under a separating public-private equilibrium, those in society who are most likely to be ill will 'opt out' of public insurance and purchase private insurance. The public health insurance will only be used by those in society who are healthiest (i.e. least likely to become ill). The high-risk individuals are made worse off by the public insurance because they are required to cross-subsidise the public insurance of the low-risk individuals through the tax system.*

We can characterise the degree of cross-subsidy in a separating public-private equilibrium. To see this, from (2) to (6), the equilibrium utility of a h-type individual is given by $u\left(y-(1-p)q_l b-q_h H\right)$. Note that this is the same utility that a h-type would receive under

[15] Barrett and Conlon (2002) present empirical estimates relating to factors associated with the purchase of private health insurance and how these factors have changed over time. For example, they show for 1995 that age is a significant factor in determining the purchase of private health insurance. Age is also positively correlated with health risk. Thus the use of hospitals (both public and private) tends to be skewed towards the older members of the population. Australians over 65 years of age made up only approximately 12.3% of the population in 2000-01 but accounted for 33.1% of total hospital separations and 48.0% of patient days (Australian Institute of Health and Welfare, 2002).

actuarially fair insurance if they started with a base income of $y-(1-p)q_l b$ rather than a base income of y.

Similarly, in a separating equilibrium, the expected utility of an l-type is $(1-q_l)u(y+pq_l b-q_l b)+q_l u(y+pq_l b-H-q_l b+b)$. This is the same utility that a low-risk type would receive if they had a base income of $y+pq_l b$ and then purchased actuarially fair insurance with indemnity b. Thus a separating public-private equilibrium involves a situation where high-risk types are treated as if they lose $(1-p)q_l b$ dollars in income and then are able to buy full insurance at a fair price while the low-risk types receive an income benefit of $pq_l b$ and then purchase insurance b at an actuarially fair price. These transfers are balanced in that the expected per person transfer to a low-risk type, $(1-p)pq_l b$, exactly equals the expected per person transfer from a high-risk type.[16]

Observation 2: *A separating public-private equilibrium is equivalent to a transfer of $(1-p)q_l b$ dollars from individuals with a high health risk and a transfer of $pq_l b$ to individuals with a low health risk together with the purchase of actuarially fair insurance.*

To understand the nature of this transfer, note that $(1-p)q_l b$ is the per-person cost of the tax required to fund the public health insurance system. The high-risk individuals gain no benefit from this tax. So their contribution is simply given by the tax funding. But the low-risk individuals use the public insurance. This provides them with a benefit equivalent to $q_l b$, the actuarially fair premium associated with the public insurance system. Thus, the net benefit to the low-risk individuals is this insurance benefit less the tax cost, which equals $pq_l b$.

These transfers from high-risk to low-risk individuals create clear equity concerns. They involve transfers from those who are *ex ante* least well off in terms of expected utility and transfers to those who are *ex ante* better off.

[16] We assume away any excess burden from tax financing here. If raising taxes to fund the public health insurance system led to a distortion in other markets (e.g. the labour market) then this would result in a deadweight loss even though the transfers are balanced.

The transfers, however, are not just inequitable. Given the level of insurance coverage, they also lower the level of social welfare W. To see this, consider an individual before they know their type. The individual faces four states of nature depending on their risk category and health status. If the individual knows that they will be able to buy complete and actuarially fair insurance when high-risk and partial but actuarially fair insurance with an indemnity $b < H$ when low risk, then their income in each state is given by:

Income = $y - q_h H$ with probability pq_h (high-risk and ill)

Income = $y - q_h H$ with probability $p(1 - q_h)$ (high-risk and well)

Income = $y + (1 - q_l)b - H$ with probability $(1 - p)q_l$ (low-risk and ill)

Income = $y - q_l b$ with probability $(1 - p)(1 - q_l)$ (low-risk and well)

Consistent with the incentive compatibility constraints for a separating equilibrium, suppose that $y + (1 - q_l)b - H < y - q_h H < y - q_l b$. Holding b fixed, apply the transfers associated with a separating public private equilibrium. This alters the state contingent income for the individual to:

Income = $y - (1 - p)q_l b - q_h H$ with probability pq_h (high-risk and ill)

Income = $y - (1 - p)q_l b - q_h H$ with probability $p(1 - q_h)$ (high-risk and well)

Income = $y + pq_l b + (1 - q_l)b - H$ with probability $(1 - p)q_l$ (low-risk and ill)

Income = $y + pq_l b - q_l b$ with probability $(1 - p)(1 - q_l)$ (low-risk and well)

But these transfers are a mean preserving spread of income. The transfers do not alter the individual's expected income but involve moving income from states with 'moderate' income to those with 'extreme' income in a way that holds the mean income level fixed. If individuals are risk averse, then such a mean-preserving spread of income will lead to a lower level of expected utility. The transfers add risk and are literally 'anti-insurance'.

Observation 3: *The income transfers associated with a separating public-private equilibrium are strictly welfare reducing in the sense that given the level of public insurance benefit b, welfare, W, would be strictly greater if the income transfers were eliminated with high-risk* *individuals still able to purchase full insurance and low-risk individuals able to insure at level b at actuarially fair prices.*

(ii) Anti-insurance and partial-pooling public-private insurance

As with the separating public-private equilibrium, we can consider the income transfers implicit in a partial-pooling outcome. For the high-risk individuals, both those who rely on public insurance and those who opt-out and purchase private insurance have identical utility. This is given by $u\left(y-(1-p)q_l b-(1-\phi)pq_h b-q_h H\right)$. For the low-risk individuals, utility is given by

$$q_l u\left(y-(1-p)q_l b-(1-\phi)pq_h b-H+b\right)+(1-q_l)u\left(y-(1-p)q_l b-(1-\phi)pq_h b\right) \quad (14).$$

This is equal to

$$q_l u\left(y+pq_l b-(1-\phi)pq_h b-H+b-q_l b\right)+(1-q_l)u\left(y+pq_l b-(1-\phi)pq_h b-q_l b\right) \quad (15).$$

Hence the equilibrium welfare for the high-risk individuals is the same as if they were taxed a lump sum equal to $(1-p)q_l b+(1-\phi)pq_h b$ and then were able to fully insure at an actuarially fair price. The utility of low risk individuals is the same as if they received a lump sum transfer of $pq_l b-(1-\phi)pq_h b$ followed by actuarially fair insurance of level *b*. This transfer is positive for high values of ϕ but is negative as fewer high risk individuals opt out.

Summing the implicit equilibrium transfers, the per-person "revenues collected" are $(\phi p)\left[(1-p)q_l b+(1-\phi)pq_h b\right]$. This equals the revenue transfer from a high-risk individual who chooses private insurance times the probability that any individual is both high-risk and opts out of public insurance. The implicit per-person "revenues paid" are $(1-\phi p)\left[pq_l b-(1-\phi)pq_h b\right]$. This is the implicit transfer times the probability that an individual will choose public insurance. Notice that public insurance is now used by all low-risk individuals and a proportion of the high risk individuals. The difference between implicit transfers is given by $(1-\phi)pb[q_h - q_l]$ which is strictly positive. In other words, the total implicit revenue collected *exceeds* the total implicit revenue paid.

This difference is due to the effect of pooling. In equilibrium, the high-risk types who choose public insurance are no better off than the high-risk types who buy private insurance. The saving to a high-risk individual due to lower premiums and the avoidance of the implicit transfer from individuals who privately insure is exactly offset by the reduction in insurance under the public scheme relative to the full insurance under the private scheme. But the low-risk individuals lose in a partial pooling equilibrium because the public system now involves actuarially unfair insurance from their perspective. The public system provides insurance for both low-risk and some high-risk individuals and, as a result, the tax revenue required is not 'actuarially fair' from the perspective of a low risk individuals. In this situation, the "lost transfer", $(1-\phi)pb[q_h - q_l]$, is a measure of the social deadweight loss in equilibrium relative to system where all parties faced fairly priced insurance.

Observation 4. *In welfare terms, the outcome in a partial pooling equilibrium is equivalent to a transfer of* $(1-p)q_l b + (1-\phi)pq_h b$ *dollars from individuals with a high health risk and a transfer of* $pq_l b - (1-\phi)pq_h b$ *to individuals with a low health risk together with the purchase of actuarially fair insurance. However, there is a deadweight loss in a partial pooling equilibrium relative to a system of transfers and actuarially fair insurance, given by* $(1-\phi)pb[q_h - q_l]$. *This deadweight loss arises because the social insurance scheme is not actuarially fair due to the mixing of low-risk and high-risk individuals.*

We can investigate this welfare loss of partial pooling further using the constant risk aversion example presented in Section II(iii).

Proposition 4: *Suppose individuals have constant risk aversion utility and consider* b^* *such that there are partial-pooling public-private equilibria. Then the welfare of all individuals is increasing in the value of* ϕ.

Proposition 4 shows how increased participation in public health insurance can lower the utility of all individuals in society. If we move from an equilibrium where high-risk individuals mainly opt-out of public insurance, to an equilibrium where more high-risk individuals take advantage of public insurance, the utility of all individuals falls. Clearly, this lowers the level of expected social welfare, *W*. This occurs because increased utilisation of the public insurance system by high-risk individuals distorts the 'price' of public insurance and creates a deadweight loss that is shared by all members of society.

The possibility that increased participation in the public health insurance system may be welfare reducing has previously not been raised in the Australian debate. Normally, it is argued that increased use of the public insurance system increases its 'viability' by having greater risk pooling. And, of course, complete pooled public health insurance maximises expected social welfare as noted in Section II. But in the absence of complete public insurance, increased use of the public insurance system may undermine the welfare of existing users by adding relatively high-risk individuals back into the public pool. Further, these high-risk individuals do not themselves gain by the expansion of the public insurance system. These individuals, who are most likely to be ill, give up insurance coverage when they move into the public pool.

Observation 5. *If individuals have constant risk aversion and we compare two partial pooling equilibria, then the equilibrium with a higher participation in the public system (i.e. a lower rate of 'opt out' by high risk individuals) involves a lower level of welfare for all members of society than the alternative equilibrium.*

(iii) Robustness of assumptions

Our conclusions regarding the existence of welfare-reducing anti-insurance are robust to a significant relaxation of some key assumptions. First, if the provision of health insurance is not competitive, our key anti-insurance results remain valid. For example, suppose there was a monopoly private insurer and consider a separating outcome. Given the public health scheme, the insurer would offer high risk individuals a complete insurance contract that would just make them prefer private to public insurance. The high-risk individuals would be worse off than with a competitive private insurance market but the transfer from high-risk to low-risk individuals would remain. The high risk individuals would however also be making a profit transfer to the monopoly insurer. In other words, the inequities of the Australian system are worsened under imperfect private insurance and a lack of competition simply makes the system worse, not better.[17]

Second, our model assumed that all individuals had identical levels of risk aversion. However, similar results would hold, for example, if individuals differed in risk aversion but not health risk. Rather than the Australian system leading to transfers from high-illness-risk to low-illness-risk individuals it would lead to transfers from highly-risk-averse to less-risk-averse individuals. There would seem to be little merit in such a transfer which again moves income from those who are *ex ante* less well off (due to their high disutility of risk) to those who are *ex ante* better off. The system is still characterised by anti-insurance.

Finally, we make a potentially controversial assumption that individuals have identical income levels. This assumption rules out any potential redistributive benefit that might arise from public insurance. While we have shown that the Australian health insurance system transfers income from those most likely to require health treatment to those less likely to require health treatment what will happen if income levels differ? If low income households that cannot afford private cover rely on the public system then they receive a transfer from high income individuals who take out private health insurance. This, however, provides little justification for the current system. Rather, it highlights the inadequate level of insurance support for low-income individuals and the complexity of the existing transfers embedded in the Australian health insurance system. Low income households forced to rely on the public system that only provides partial insurance still receive inadequate coverage

[17] It is useful to note that in the case of a separating outcome and a monopoly insurer, increasing the benefits of the public insurance system can improve the welfare of both high-risk and low-risk individuals. The low-risk individuals gain a larger transfer from the high-risk individuals through the taxation system. But the high-risk individuals also gain utility because the public system is a more effective competitive threat to the private monopoly insurer. The private insurer has to offer the high-risk individuals a better insurance contract and the resultant welfare gain to high-risk individuals more than offsets the loss due to increased tax transfers.

regardless of implicit transfers from high income households. The solution to this is to assist the public system; not to distort insurance mechanisms.

The inadequate nature of the existing insurance system becomes even more obvious when we consider all the transfers. While the poor may receive an implicit subsidy from those richer individuals who have private health insurance, so too do the most healthy rich. Thus, the system provides the same subsidy to those most well off in society as it provides to the poorest in society. At best, the equity of taxing the sick rich to pay both the well rich and the poor is debatable.

IV. The Private Insurance Rebate

In 1997, the Australian Federal government began introducing rebates for private health insurance. While initially a lump-sum based on income level, today this rebate reduces the effective price of private health insurance by 30 percent for all individuals. In this section, we consider the implications of such an *ad valorem* subsidy. We also compare this with a lump sum subsidy.

(i) An ad valorem private insurance rebate

The 30 percent private insurance rebate has two effects. First, it partially reverses the transfers imposed on high-risk individuals under the Australian health insurance system. Second, it distorts the price of private insurance. Denote the fractional rebate on private insurance by s. For ease of analysis we will focus on a separating public-private equilibrium. This involves a per person tax T, a public insurance benefit b, a private premium P, a subsidy s and a private indemnity D such that:

$$P - q_h D = 0 \tag{16}$$

$$D = \arg\max\left(q_h u\left(y - T - (1-s)P + D - H\right) + (1-q_h)u\left(y - T - (1-s)P\right)\right) \tag{17}$$

$$
\begin{aligned}
& q_h u\left(y-T-(1-s)P+D-H\right)+\left(1-q_h\right)u\left(y-T-(1-s)P\right) \\
& \geq q_h u\left(y-T-H+b\right)+\left(1-q_h\right)u\left(y-T\right)
\end{aligned} \tag{18}
$$

$$
\begin{aligned}
& q_l u\left(y-T-(1-s)P+D-H\right)+\left(1-q_l\right)u\left(y-T-(1-s)P\right) \\
& \leq q_l u\left(y-T-H+b\right)+\left(1-q_l\right)u\left(y-T\right)
\end{aligned} \tag{19}
$$

$$
T-(1-p)q_l b-psP=0 \tag{20}
$$

(16) is the same as (2) and simply reflects actuarially fair private insurance. (17) replaces the ‘full insurance’ condition that applies in the absence of the subsidy and generalises (3). (18) and (19) are the incentive compatibility conditions for the separating equilibrium, while (20) requires that total tax revenues pay for both the public insurance scheme and the subsidy to private insurance.

To see how the subsidy distorts the price of private insurance, note from (16) that $P = q_h D$. Substituting this into (17) and solving for the optimal amount of private insurance gives

$$
\frac{u'\left(y-T-(1-s)P+D-H\right)}{u'\left(y-T-(1-s)P\right)}=\frac{1-q_h+sq_h-s}{1-q_h+sq_h} \tag{21}
$$

The left-hand-side of this equation is the ratio of the marginal utility of income when ill to the marginal utility of income when well. If $s = 0$ then the right-hand-side of this equation equals 1, so that the high-risk individual has equal marginal utility (and hence equal income) whether ill or well. In other words, when $s = 0$, the high-risk individual buys complete private insurance. If $s > 0$ however then the right-hand-side of (21) is less than unity. The individual has higher income when ill than when well and the insurance subsidy leads to over insurance by high-risk individuals. This results in a deadweight loss. In practice, we would expect to see individuals who purchase private insurance buying policies that are ‘too comprehensive’ and that provide benefits that are valued by the purchaser at less than their true economic cost. It should be noted that this over insurance is not due to any moral hazard in our model.

Rather it reflects the standard result that a subsidy which reduces the marginal price of any product tends to encourage (potentially excessive) consumption of that product.

Let the degree of over insurance be represented by Δ. The high-risk individuals purchase insurance $D = H + \Delta$ and the per person tax required to fund both the public insurance and the private subsidy is given by $T = (1-p)q_l b + psq_h(H+\Delta)$. The equilibrium expected utility of a high-risk individual is given by

$$\begin{aligned} U_h &= q_h u\left(y-(1-p)q_l b + sq_h(1-p)(H+\Delta)+(1-q_h)\Delta - q_h H\right) \\ &\quad +(1-q_h)u\left(y-(1-p)q_l b + sq_h(1-p)(H+\Delta)-q_h\Delta - q_h H\right) \end{aligned} \tag{22}$$

while the expected utility of a low-risk individual is

$$\begin{aligned} U_l &= q_l u\left(y+pq_l b - psq_h(H+\Delta)-H+b-q_l b\right) \\ &\quad +(1-q_l)u\left(y+pq_l b - psq_h(H+\Delta)-q_l b\right) \end{aligned} \tag{23}$$

The subsidy partly reverses the implicit transfer from high-risk to low-risk individuals under the mixed public-private insurance system. Low-risk individuals' utility is the same as if they received an income transfer of $pq_l b - psq_h(H+\Delta)$ then purchased insurance b at actuarially fair prices. The implicit transfer received by low-risk types is reduced by the size of the subsidy (s) times the probability that an individual is both high-risk and ill (pq_h), times the amount of insurance purchased by high-risk individuals ($H + \Delta$). Further, as the subsidy s increases (which increases Δ), the size of the implicit transfer to low-risk individuals falls.

A high-risk individual's utility is the same as if his income falls by $(1-p)q_l b - sq_h(1-p)(H+\Delta)$, then he purchases complete actuarially fair insurance for $q_l H$, and then he also takes an extra gamble with expected payoff of zero. With probability q_h the high-risk individual is ill and this gamble pays $(1-q_h)\Delta$. But they pay $q_h\Delta$ for this in the state where they are well (i.e. with probability $(1 - q_h)$).

The subsidy not only reverses the transfer between the high-risk and low-risk individuals, it also creates a deadweight loss due to over insurance, and this is reflected in the additional welfare-reducing risk incurred by the high risk individuals.

Observation 6. *In a separating equilibrium the government rebate on private health insurance reduces the transfer from the high-risk individuals to the low-risk individuals. At the same time, the rebate creates a deadweight loss through over insurance that creates a welfare loss for the high-risk individuals.*

Reducing the transfers from high-risk to low-risk individuals raises social welfare W. This follows directly from our discussion of separating equilibria. This improvement in welfare is not related to the level of cover provided by public insurance. The public insurance coverage is constant in our model, although the burden of funding that insurance shifts from high-risk to low-risk individuals when the subsidy is introduced. Similarly, the welfare improvement does not involve a change in the absolute numbers using public or private insurance. In fact, in a separating equilibrium, the number of individuals using public and private insurance is unchanged after the introduction of the subsidy. Rather, the welfare improvement is due to a reduction in social risk. This said, as Observation 6 notes, the private insurance subsidy itself introduces a new distortion leading to excessive private insurance. In the next subsection, we consider how the benefits associated with a subsidy can be achieved without incurring this additional deadweight loss.

(ii) A lump sum private insurance rebate

Suppose that rather than subsidizing the price of private health insurance, the government provides a fixed lump sum rebate, L, to individuals who purchase private health insurance. The public-private separating equilibrium is given by:

$$P - q_h D = 0 \tag{24}$$

$$y - T + L - H - P + D = y - T + L - P \tag{25}$$

$$u\left(y - T + L - P\right) \geq q_h u\left(y - T - H + b\right) + \left(1 - q_h\right) u\left(y - T\right) \tag{26}$$

$$u\left(y-T+L-P\right)\leq q_l u\left(y-T-H+b\right)+\left(1-q_l\right)u\left(y-T\right) \tag{27}$$

$$T-\left(1-p\right)q_l b-pL=0 \tag{28}$$

The lump sum rebate does not distort the marginal price of private health insurance. As such, the high-risk individuals who purchase private health insurance will choose full insurance at actuarially fair prices. The rebate must be funded out of tax collections.

Under a lump sum rebate, the utility of the high-risk individuals is given by $U_h=u\left(y-\left(1-p\right)\left(q_l b-L\right)-q_h H\right)$. The utility of the low-risk types is given by $U_l=q_l u\left(y+p\left(q_l b-L\right)-H+b-q_l b\right)+\left(1-q_l\right)u\left(y+p\left(q_l b-L\right)-q_l b\right)$. With a lump sum rebate the separating public-private equilibrium involves a net transfer of $\left(1-p\right)\left(q_l b-L\right)$ from each high-risk individual with a net transfer of $p\left(q_l b-L\right)$ to each low-risk individual. If these transfers are positive then they increase social risk. As the transfers are decreasing in *L*, social welfare *W* is increasing in *L* for any given level of public insurance *b*. The transfers are completely eliminated if $L = q_l b$.

Observation 7. *Social welfare is increasing as the rebate L increases. If* $L = q_l b$ *then the lump-sum rebate completely reverses the income transfers implicit in the current Australian health insurance system.*

The lump-sum private insurance rebate has all the desirable properties of the *ad valorem* subsidy but avoids the undesirable price distortion created by that subsidy.

V. Conclusion: Reforming the Australian Health Insurance System

Our analysis in this paper highlights significant limitations and inadequacies in the existing Australian health insurance system. Using a simple standard model of insurance, we show that the Australian system creates a form of anti-insurance. The mixed public-private insurance system results in income transfers that raise the risk facing an average individual. Further, these transfers have undesirable equity implications. The health insurance system implicitly transfers funds from those least well off (in terms of health risk) to those most well off in society.

If the current system is inadequate, how should it be reformed? Our analysis considered the existing 30 percent health insurance rebate, and showed that this rebate could help reduce the anti-insurance characteristics of the Australian system. However, the current *ad valorem* rebate also distorts the price of private health insurance. Thus, it reduces one distortion but at the cost of creating another distortion. We show that a lump sum rebate might be preferred to an *ad valorem* rebate.

While the private health insurance rebate provides some welfare benefits, in our opinion, the results in this paper suggest that more fundamental reform of health insurance in Australia is justified. The problem of anti-insurance is systemic in the joint duplication and supplemental nature of private insurance. This could be avoided, for example, if the Australian health insurance system had private insurance as a purely supplemental product. In such a system the benefits of public insurance would be fully available to all individuals. Insurance for health services not covered by public insurance would be available from private firms. If an individual wanted extra insurance cover on top of the public insurance system, they could buy this cover. This type of reform would remove anti-insurance and also avoid the existing linkage of insurance and service provision in Australia; allowing more consumer choice between public and private provision. This said both the benefits (Dahlby, 1981) and potential problems with supplemental insurance schemes, particularly in the presence of moral hazard (Pauly, 1974), have long been debated in the economics literature.

In this paper, we have identified important systemic problems with health insurance in Australia. Research to guide future reform of the Australian system still needs to be carried out.

Appendix

Proof of Proposition 1

Note that $\hat{y}$ is equal to endowment income less the equilibrium per person tax from (6). By substitution, equation (4) becomes $u(\hat{y}-q_h H) \geq q_h u(\hat{y}-H+b)+(1-q_h)u(\hat{y})$. Note that for any H > 0, if b is sufficiently low (but positive) then $u(\hat{y}-q_h H)-[q_h u(\hat{y}-H+b)+(1-q_h)u(\hat{y})]$ is arbitrarily close to $u(y-q_h H)-[q_h u(y-H)+(1-q_h)u(y)]$ and this is strictly positive by risk aversion. Also, for any *H*, if $H = b$ then $u(\hat{y}-q_h H)-[q_h u(\hat{y}-H+b)+(1-q_h)u(\hat{y})]<0$ by first order stochastic dominance. Further, both $u(\hat{y}-q_h H)$ and $q_h u(\hat{y}-H+b)+(1-q_h)u(\hat{y})$ are continuous in both *H* and *b*. Thus by the intermediate value theorem, for any *H* there exists at least one value of *b* such that $u(\hat{y}-q_h H)-[q_h u(\hat{y}-H+b)+(1-q_h)u(\hat{y})]=0$.

Consider such a value of *b* and the pair (H,b). By construction, this pair with the associated tax and private insurance satisfies equations(2), (3), (4) and (6). As $q_l < q_h$ it immediately follows that equation (5) is satisfied.

It remains to show that no profitable deviation exists for (H,b). Note that the relevant contract to check a 'separating' deviation is the same as the separating equilibrium contract for an *l*-type when endowment income is $\hat{y}$. By assumption, such a private separating equilibrium exists for $H > \underline{H}$ so that this contract must be preferred by the *l*-type individuals to any profitable pooling deviation contract. Thus, if a profitable 'separating' deviation does not exist, a profitable 'pooling' deviation cannot exist. That no profitable separating deviation exists, however, follows trivially. By construction full private insurance, the public insurance and the deviation contract $\left(\tilde{P},\tilde{D}\right)$ all make a h-type indifferent. But as $q_l < q_h$ and the deviation contract involves less 'income when well' than public insurance due to the payment of a private premium as well as the tax, the l-type individuals strictly prefer public insurance to the 'separating' deviation contract. Thus there is no profitable deviation and for any $H \in \left(\underline{H},\hat{y}\right)$ we have found a b that satisfies all relevant conditions for a separating public-private equilibrium.

Proof of Proposition 2

The proof is similar to the proof of Proposition 1. $\hat{y}$ is the endowment income less equilibrium per person tax. By substitution, (10) becomes

$$u\left(\hat{y}-q_h H\right)-\left[q_h u\left(\hat{y}-H+b\right)+\left(1-q_h\right)u\left(\hat{y}\right)\right]=0 \tag{29}$$

Note that for any $H \in (\underline{H},\hat{y})$ and $\phi \in (0,1)$, if b is sufficiently low (but positive) then the left hand side of (29) is positive by risk aversion and if $b = H$ then the left-hand-side of (29) is negative by first order stochastic dominance. Thus by continuity for any H and ϕ there exists a value of b such that equations (8), (9), (10), and (12) are simultaneously satisfied. Equation (11) holds as $q_l < q_h$. Deviations are not profitable by the same argument presented in the proof of proposition 1. Thus for any $H \in (\underline{H},\hat{y})$ and $\phi \in (0,1)$, there exists a b such that $\left(H,\phi,b\right)$ form a partial pooling equilibrium.

Proof of Proposition 3

By Proposition 2, we know that for any $H \in \left(\underline{H},\hat{y}\right)$ and ϕ, there exists a value b that leads to a partial pooling equilibrium. To show that this is unique for constant risk aversion utility, note than in this situation, the derivative of the left-hand-side of (29) with respect to b is given by $-a\frac{\partial\hat{y}}{\partial b}\left[-e^{-a\left(\hat{y}-q_h H\right)}+\left[q_h e^{-a\left(\hat{y}-H+b\right)}+\left(1-q_h\right)e^{-a\left(\hat{y}\right)}\right]\right]-aq_h e^{-a\left(\hat{y}-H+b\right)}$. But by (29) the first term equals zero so that the derivative of the left-hand-side of (29) with respect to *b* is $-aq_h e^{-a(\hat{y}-H+b)} < 0$. Thus, as the left-hand-side of (29) is monotonic in *b*, for any *H* and ϕ there is a unique *b* such that equation (29) is satisfied. Denote this value by b^*

To show that b^* is invariant in ϕ, consider any $H \in (\underline{H}, \hat{y})$ and $\phi \in (0,1)$ and the associated b^* that solves equation (29). The derivative of the left-hand-side of (29) with respect to ϕ is given by $-a\frac{\partial \hat{y}}{\partial \phi}\left[-e^{-a(\hat{y}-q_h H)} + \left[q_h e^{-a(\hat{y}-H+b)} + (1-q_h)e^{-a(\hat{y})}\right]\right]$. But by (29), this equals zero. Thus, if b^* solves (29) for any particular *H* and ϕ, then it solves (29) for that value of *H* and any value of ϕ. Thus, b^* is invariant in ϕ.

Proof of Proposition 4

First, consider the expected utility of the high-risk individuals. This is given by $U_h = -e^{-a(\hat{y}-q_h H)}$. Thus, $\frac{\partial U_h}{\partial \phi} = apq_h b^* e^{-a(\hat{y}-q_h H)} > 0$. Noting that $\frac{\partial \hat{y}}{\partial \phi} = pq_h b^*$, the welfare of the high-risk individuals is increasing in ϕ. Now consider the utility of the low-risk individuals. This is given by $U_l = -q_l e^{-a(\hat{y}-H+b)} - (1-q_l)e^{-a(\hat{y})}$. Thus, $\frac{\partial U_l}{\partial \phi} = apq_h b^*\left[q_l e^{-a(\hat{y}-H+b)} + (1-q_l)e^{-a(\hat{y})}\right] > 0$. Hence, both the low-risk and the high-risk individuals are better off if ϕ is larger.

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Figure One: Separating Equilibrium With Private Insurance

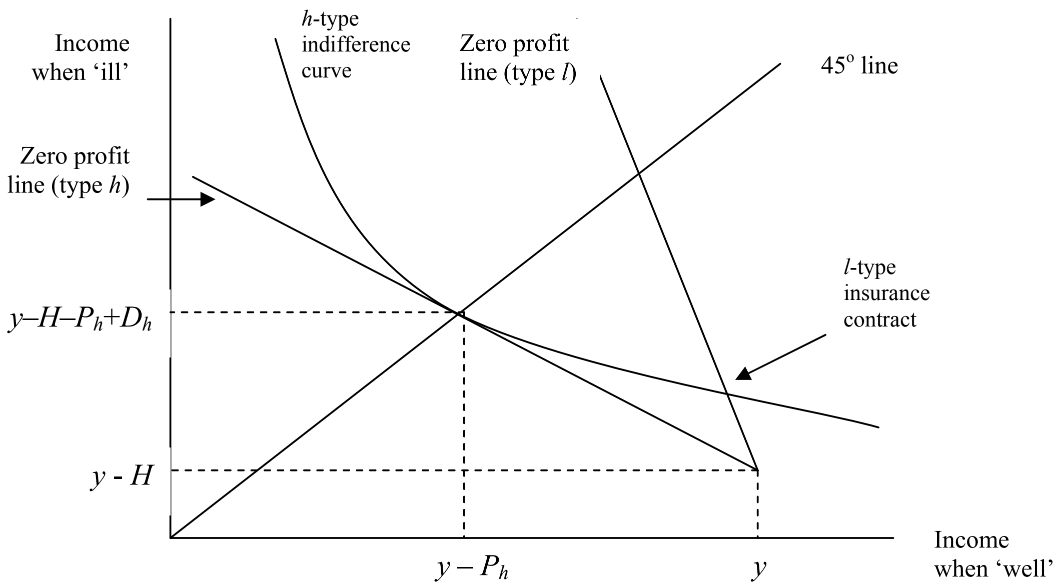

Figure Two: Pure Public Insurance

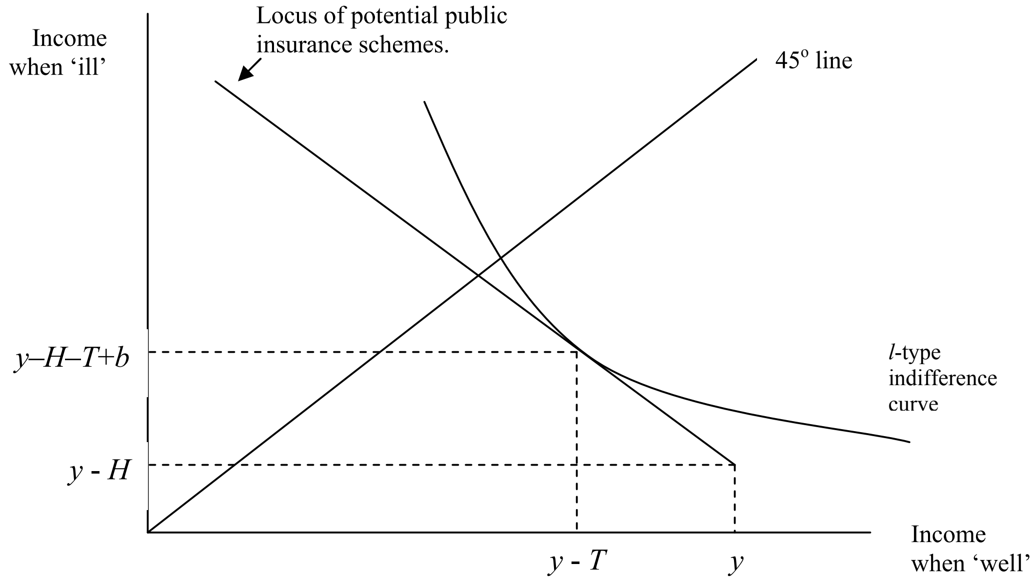

Figure Three: No Take-Up of Public Insurance

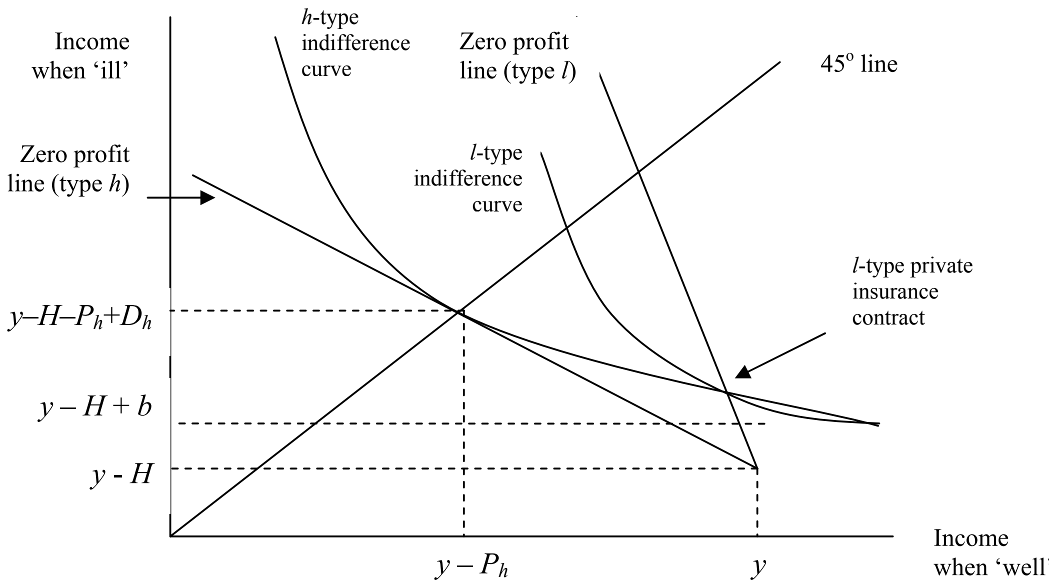

Figure Four: Separating Public-Private Equilibrium