A median voter model of health insurance with ex post moral hazard[*]

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Abstract

One of the main features of health insurance is moral hazard, as defined by Pauly (1968); people face incentives for excess utilization of medical care since they do not pay the full marginal cost for provision. To mitigate the moral hazard problem, a coinsurance can be included in the insurance contract.

First, we analyze under what conditions there is a conflict between individuals on what coinsurance rate should be set with public health insurance. Then we allow the public insurance to be supplemented with private insurance, and we see that people will face lower coinsurance rates with non-exclusive public insurance compared with pure private insurance. This has most likely the implication that aggregate utilization of medical care will be larger with non-exclusive public provision compared with pure private provision.

Keywords: health insurance; moral hazard; public provision; median voter

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1 Introduction

No matter what system for the provision of health care—private or public—a country has opted for, the consumer pays only a small part of the total cost out-of-pocket at the occasion of consumption. While insurance premiums pays for the bulk of the cost in a private system, tax receipts are used if provision is public. But irrespective of how health care is financed, we have to deal with the fact that once people have fallen ill they face incentives to consume more than optimal health care, since they do not have to pay the full marginal cost for the care they utilize. This is in the health economics literature referred to as moral hazard (Pauly, 1968). Or sometimes as ex post moral hazard (Zweifel and Breyer, 1997) to stress the fact that it is something arising after the bad state has occurred—as opposed to ordinary moral hazard which is a change in behavior before the actual accident.

The problem of ex post moral hazard has attracted a lot of attention in conjunction with private health insurance. And in Feldstein (1973) and Feldman and Dowd (1991) it is shown that it is not just a problem of theoretical interest, but also of substantial empirical relevance.

The usual way of mitigating moral hazard is to require patients to pay some part of the costs out-of-pocket, i.e. to include a coinsurance in the insurance contract. The larger the part paid out-of-pocket (the higher the coinsurance rate) the less excess utilization of medical care. On the other hand, the higher the coinsurance rate the less risk reduction. So, there is an inherent conflict between reducing excess utilization and reducing risk when deciding on the coinsurance rate.[1] The optimal coinsurance rate makes an ideal trade-off between minimizing deadweight losses and reducing risk.

[1] It is in the interest of the buyer of insurance to reduce overconsumption since the premium will depend on the expected costs for the buyer's medical care.

Not everybody will want the same coinsurance rate since people differ in how they want to strike the balance. With private health insurance the market can offer buyers different contracts, so that people preferring a lower coinsurance have to pay higher premiums. This is generally not the case when health insurance is fully tax-funded. Then people cannot choose how much to pay and get a coinsurance in accordance with their contribution, but instead one contract applies to everyone.

It is quite different to have a uniform coinsurance rate determined in a political process, than having different rates varying in accordance with one's preferences. It will, for instance, have different consequences for efficiency and distribution. Our first objective is to provide insights on what factors cause individuals to have different preferences over policy alternatives: Under what conditions is there a conflict in society on what coinsurance rate should be set? It turns out that the two crucial parameters are the income elasticity, whether it is larger or smaller than one, and risk aversion, whether people are characterized by constant, increasing or decreasing relative risk aversion.

After that, we allow the public insurance to be supplemented with private insurance. Then we answer two questions: Who will buy the extra coverage? And how does the coinsurance rates people now face compare with the rates chosen with pure private provision? The answer to the first question is: low-income individuals will (under reasonable assumptions) be the ones purchasing supplementary insurance. And the answer to the second question is that people will face a lower coinsurance rate with public than with private insurance.

What coinsurance rate is set will affect how much health care people will consume. And in the end this will determine the aggregate level of health care expenditures in the economy. It is therefore interesting to analyze what system, public or private, render the highest aggregate spending on medical services. We argue that public insurance which allows private supplementary insurance will actually result in larger aggregate expenditure.

An objection to the claim that coinsurance rates determine demand could be that many types of medical services are rationed, so that people cannot choose to consume as much as they want to. We do not deny that rationing is an important aspect of health care provision.[2] But some types of care are easier to ration than others. Care that is labor intensive can be rationed by restricting the supply of doctors and nurses, thus creating waiting lists for surgery for instance (see Besley et al, 1999, for an analysis of the importance of waiting lists as devices for rationing). But waiting lists is a rationing device not available for all types of care. Pharmaceutical drugs only requires a prescription to be filled out by a physician—a not very time consuming procedure—and then the patient can treat himself at home. And an indication of the problem with rationing pharmaceutical drugs is that Medicare in the U.S. does not cover ambulatory drugs for the fear of moral hazard (Schweitzer, 1997).[3]

So, although rationing is an important aspect of health care we do believe that there are enough instances where rationing does not take place—or is

[2] This is probably more common when provision is public rather than private. In fact, the combination of letting richer people pay a larger share of the health care bill by tax funding while at the same time restricting everybody to consume more or less the same amount, is probably an important political rationale to why public provision is so common (see Besley and Gouveia, 1994, for a discussion).

[3] A further indication of the problems with rationing drugs is the dramatic increase in expenditures on drugs that as taken place in most OECD countries during the last decade, eating into health care budgets. That rationing is harder with drugs than other types of care and demand have to be restricted in some other way, is also indicated by the fact that coinsurance rates are usually much higher for drugs than other types of care.

so incomplete—that it merits a separate analysis.

This paper is most closely related to two separate research lines. One concerns positive analysis of public provision of private goods in general (Usher, 1977, Epple and Romano, 1994). In these papers it is assumed that the good is provided uniformly to everybody. Wilson and Katz (1983), however, analyzes what should characterize an non-rationed good that a political majority finds beneficial to subsidize. Further, they analyze what the level of subsidization chosen by the majority depends upon. One conclusion is that goods with large compensated price elasticities are bad targets, because subsidies lead to too much wasteful consumption, i.e. large deadweight losses. The two examples of goods they mention as actually being subsidized are education and health care.

Deciding on a level for subsidization or setting a coinsurance rate could seem like two sides of the same coin. But then we forget that even without public intervention there will be "subsidization" of health care at the time of consumption. So, the situation to compare the outcome under public provision with is not one of zero deadweight losses since there will be deadweight losses even with private provision.

Another way of putting this is that the provision of health care should be analyzed in expected utility terms and what the government provides should be considered as insurance. This is done in the second line of research this paper is closely related to: the literature on public provision of health insurance. Breyer (1991, 2000) does this from a normative perspective, while Gouveia (1997) does it from a positive perspective in a voting model. Gouviea, however, abstract from moral hazard, and everybody consumes the same amount of health care.

The rest of the paper is organized as follows; in Section 2 the theoretical model is introduced and some results for publicly provided health insurance is presented. Further the conditions for a political equilibrium are discussed. In Section 3 we allow the public insurance to be supplemented with private insurance (we call this case non-exclusive public insurance), and in Section 4 we discuss whether aggregate medical care utilization will be larger with non-exclusive public insurance than with pure private insurance. Finally, Section 5 concludes and summarizes.

2 Exclusive public health insurance

2.1 The Model

In this section we analyze publicly provided health care insurance, when supplementary private insurance is not allowed. In the economy there are n individuals who differ only in endowed income, y_i. For the individuals there are two possible states of the world: ill, I, and well, W. They all face probability p of becoming ill, and therefore they are well with probability $(1-p)$. So p is exogenous and constant between individuals. The individuals can consume two types of goods, c, non-health goods, and m, a composite health good. The prices of both goods are normalized to one.

In case of good health utility depends only on general consumption $U^W(c)$. An individual that has fallen ill gets utility both from general consumption and from medical care, and preferences are given by the separable utility function $U^I(c,m)$ such that $U_c^{\prime}, U_m^{\prime} > 0, U_{cc}^{\prime\prime}, U_{mm}^{\prime\prime} < 0$, and $U_{cm}^{\prime\prime} = U_{mc}^{\prime\prime} = 0$. By consuming medical care one's utility thus increases but full health is never recovered.

The government provides health insurance that reimburses the individual for part of his medical expenses. The patient's out-of-pocket payment will equal βm_i, where β is the coinsurance rate. The health insurance is financed from a proportional income tax. The total tax payment for the individual is $T^i = ty_i$, where t is the tax rate and y_i is endowed income for individual i. There are no other public expenditures, so tax receipts are used solely for providing health insurance.

We assume that the government balances the budget in expected terms, so tax revenues should equal the government's expected costs for medical care:

$$\sum_i T^i = t \sum_i y_i = p(1-\beta) \sum_i m_i. \tag{1}$$

The tax rate t needed to raise enough revenue can now be expressed in terms of mean income, $\overline{y}$, and mean medical care expenditures, $\overline{m}$:

$$t = p(1-\beta)\overline{m}\frac{1}{\overline{y}}. \tag{2}$$

And individual i's tax payment will hence be:

$$T^i = p(1-\beta)\overline{m}\frac{y_i}{\overline{y}}. \tag{3}$$

It is instructive to compare the tax payments for different individuals with the premiums they would have to pay if health insurance was instead purchased on the market. The actuarially fair insurance premium, q_i, equals the expected claim:

$$q_i = p(1-\beta)m_i. \tag{4}$$

All individuals with $m_i > \overline{m}y_i/\overline{y}$ will have their health insurance subsidized if it is publicly provided and financed from a proportional tax on income. Who will be subsidized depends on the income elasticity of medical care. If the income elasticity equals one, everybody spends the same share of income on medical care, so that the ratio m_i/y_i is constant. From this follows that $m_i = \overline{m}y_i/\overline{y}$ and, hence, everybody's tax payments equals their actuarial insurance premium. If the income elasticity is less (larger) than one individuals with below (above) mean income are subsidized.

The objective in this subsection is to study how the desired coinsurance rate varies between individuals. Each individual has to make two decisions. In the first stage, they decide which rate of coinsurance they prefer, and in the second stage they decide what amount of medical care to consume in case of illness. When making their decision in stage one, they will consider how much medical care they will utilize in stage two depending on the coinsurance rate. So before we are able to derive an expression defining the optimal coinsurance, we have to derive an expression for optimal expenditure on medical care given β.

The budget constraint facing the ill individual is

$$y_i = c_i + \beta m_i + T_i. \tag{5}$$

Substituting the budget constraint for c_i in the utility function, we can write the maximization problem as

$$\max_{m} U^I(y_i - \beta m_i - T_i, m_i). \tag{6}$$

The first order condition for this problem is

$$\frac{U_m^I}{U_c^I} = \beta, \tag{7}$$

which implicitly defines m as a function of β and y_i (as well as t, but we suppress t in the following). By differentiating (7) with respect to m, β and y it can be shown that $dm/d\beta < 0$ and $dm/dy > 0$.

To determine the optimal coinsurance, we maximize expected utility with respect to β—taking the dependency of m_i and $\overline{m}$ on β into account. The tax payment $T_i = p(1-\beta)\overline{m}\frac{y_i}{\overline{y}}$ is now endogenous, so the budget constraint when ill is

$$y_i = c_i^I + \beta m(\beta, y_i) + p(1-\beta)\overline{m}(\beta, \overline{y})\frac{y_i}{\overline{y}} \tag{8}$$

and when well

$$y_i = c_i^W + p(1-\beta)\overline{m}(\beta, \overline{y})\frac{y_i}{\overline{y}}. \tag{9}$$

Substituting this into the utility functions we get the following maximization problem for each individual to solve:

$$\begin{aligned} \max_{\beta} EV_i &= pV^I\left(y_i - \beta m(\beta, y_i) - p(1-\beta)\overline{m}(\beta, \overline{y})\frac{y_i}{\overline{y}}, m(\beta, y_i)\right) + \\ &(1-p)V^W\left(y_i - p(1-\beta)\overline{m}(\beta, \overline{y})\frac{y_i}{\overline{y}}\right), \end{aligned} \tag{10}$$

where V^I and V^W are the indirect utility functions (utility given that m is chosen optimally) when ill and well, respectively. The first order condition for the problem is

$$\frac{V_c^{iW}}{V_c^{iI}} = \frac{p}{1-p}\left(\frac{m_i}{p\overline{m} - p(1-\beta)\frac{\partial \overline{m}}{\partial \beta}}\frac{\overline{y}}{y_i} - 1\right). \tag{11}$$

Expression (11) defines the optimal β implicitly.

Our main interest in this section is to analyze under what conditions there is a conflict between individuals on the (uniform) coinsurance rate in the publicly provided health insurance. To see how the optimal coinsurance rate varies between individuals we differentiate the first order condition with respect to β and y and obtain (for details see Appendix A.1)

$$\frac{d\beta^*}{dy} = -V_c^{iI}\frac{p\frac{m_i}{y_i}\left\{\frac{\Omega_i}{C_i^I}\left[\rho_i^I\left(\frac{C_i^W}{m_i} - \beta\eta\right) - \rho_i^w\left(\frac{C_i^W}{m_i} - \beta\right)\right] + 1 - \eta\right\}}{S.O.C.} \tag{12}$$

where η is the income elasticity, $\rho_i^j = -\frac{V_{cc}^{ij}}{V_c^{ij}}c_i^j$, $j = I, W$ is the relative risk aversion, and $\Omega_i = m_i - p\overline{m}\frac{y_i}{\overline{y}} + p\ (1-\beta)\frac{\partial \overline{m}}{\partial \beta}\frac{y_i}{\overline{y}} > 0$ (we show that $\Omega_i > 0$ in

Appendix A.1). The second order condition, $S.O.C < 0$, is assumed to be satisfied.

The sign of $d\beta^*/dy$ is ambiguous. It will depend on the size of the income elasticity and how relative risk aversion changes with income. Noteworthy, however, is that it does not depend on the individual's price elasticity. The price elasticity is an important factor in setting the optimal coinsurance, but with tax financed health insurance everybody base their decision on the same price elasticity—how the *average* demand for medical care responds to price changes. So even if the price elasticity differs between individuals, this will not imply a conflict on preferred coinsurance.

Analyzing how income elasticity and risk aversion affect the preferred coinsurance, we have the following result:

Proposition 1 *If people are constantly relatively risk averse (CRRA) and the income elasticity is smaller than one, $\eta < 1$, optimal coinsurance increases with income.*

Proof: If $\rho^I = \rho^W$ (CRRA) expression (12) collapses to

$$\frac{d\beta^*}{dy} = \frac{1}{V_c^{iI}} \frac{-(1-\eta)\left(\frac{\beta\Omega_i m_i \rho}{y_i c_i^I} + 1\right)}{S.O.C.}, \tag{13}$$

where it can be seen that if $\eta < 1$, it follows that $d\beta^*/dy > 0$.

It can also be seen that $d\beta^*/dy = 0$ when $\eta = 1$. When $\eta > 1$ we have that $d\beta^*/dy < 0$ but we see this as a less interesting case. Actually, the assumption of $\eta < 1$ finds strong support in the literature, see for example Getzen (2000).

The intuition is the following: The income elasticity affects β^* in two ways. First, the income elasticity will determine how the tax-price for health insurance varies between individuals, as discussed earlier. If $\eta < 1$, low income earners are subsidized given the proportional income tax. The lower the income, the larger the subsidy. Therefore, poorer people will want more health insurance, i.e. lower coinsurance. When $\eta = 1$ nobody is subsidized and there is no tax-price argument for different persons wanting different coinsurance.

Second, even if there was no subsidization—and everybody paid their actuarial premium regardless of the size of the income elasticity—Proposition 1 still holds. If $\eta < 1$, the higher the income the lower will the share of income spent on medical care be, and the lower relative risk will the individual be exposed to. Hence, richer people will be exposed to lower risk relative to their income. And this will drive up their preferred coinsurance. When $\eta = 1$ everybody regardless of income face the same relative risk, so the risk exposure is no source of conflict regarding what coinsurance should be set.

In short, both effects work in the same direction when $\eta < 1$, and neither effect is present if $\eta = 1$.

To see how the other crucial parameter, the relative risk aversion, affects the preferred coinsurance rate, assume the income elasticity is equal to one. Then we find that equation (12) may be written as

$$\frac{d\beta^*}{dy} = -V_c^{iI} \frac{\frac{\Omega_i}{y_i}\left[\rho_i^I - \rho_i^w\right]}{S.O.C.} \tag{14}$$

We find that

- with increasing relative risk aversion, $\rho_i^W > \rho_i^I$, the optimal coinsurance will be lower the higher the income.
- with decreasing relative risk aversion, $\rho_i^W < \rho_i^I$, the optimal coinsurance will be higher the higher the income.

This result is quite intuitive and should need no discussion.

2.2 Median voter equilibrium

With the assumptions in Proposition 1 optimal coinsurance is monotone in voters' type, which implies that a median voter equilibrium exists (Gans and Smart, 1996). What characterizes the median voter equilibrium? By construction all individuals will have identical insurance contracts with the same coinsurance rate, β. This means that some individuals typically will get more insurance than they desire, while others get less. The only person always getting the exact right amount is the median voter. For the cases we looked at in (13) and (14) the median voter will be the individual with median income.[4] This also follows from the monotonicity in voters' type.

3 Non-exclusive public insurance

The fact that nearly half the population gets less insurance coverage than they desire with exclusive public insurance leaves room for a private supplementary insurance. We will now extend the analysis in Section 2 and allow for a supplementary private insurance which covers some part of the individuals' out-of-pocket costs.[5]

In this section we shall analyze how much extra coverage (if any)—how much lower coinsurance rate—will different individuals demand. In particular, we want to answer the question: Will the coinsurance rate people face with non-exclusive public insurance, be higher or lower than the one people face when insurance is purely privately provided? The answer has important

[4] The income distribution is assumed to be skewed to the right, so that the median voter will have less than mean income.

[5] Examples of such supplementary insurance are the so called "Medigap" plans available in the USA, that cover deductibles and coinsurances required by Medicare (Schweitzer, 1997).

implications for whether aggregate utilization of medical care is larger with non-exclusive public provision or with pure private provision. We shall restrict attention to the case when the income elasticity is less than one, $\eta < 1$, and people are characterized by constant relative risk aversion, CRRA.

Voting over the coinsurance rate in the public insurance is a two-stage problem. In the first stage, agents vote over β^P. In the second stage the individual takes the coverage provided by the government, β^P, as given, and then decides on how much extra insurance she wants to buy—how much she wants to reduce the public coinsurance. As usual in multi-stage problems we start with the last step.

We denote the reduction of the public coinsurance rate α, so the coinsurance rate faced by the individual when having bought supplementary insurance is $\beta^S = \beta^P - \alpha$. Assuming perfect competition on the private insurance market, the actuarially fair premium for the extra coverage is

$$q_i = p\alpha m_i = p(\beta^P - \beta^S)m_i. \tag{15}$$

When deciding on degree of supplementary coverage, β^S, the individual maximizes the following expression:

$$\max_{\beta^S} EV_i = pV^I\left(y_i - \beta^S m(y_i,\beta^S) - p(\beta^P - \beta^S)m(y_i,\beta^S) - T_i, m(y_i,\beta^S)\right) \tag{16}$$

$$+(1-p)V^W\left(y_i - p(\beta^P - \beta^S)m(y_i,\beta^S) - T_i\right). \tag{17}$$

The first order condition is

$$\frac{V_c^{iW}}{V_c^{iI}} \leqslant \frac{p}{1-p}\left(\frac{m_i}{pm_i + p(\beta^P - \beta^S)\frac{\partial m}{\partial \beta}} - 1\right), \tag{18}$$

which will hold with equality for everybody with $\beta^{*S} < \beta^P$ (those purchasing supplementary insurance) and with inequality for everybody with $\beta^{*S} = \beta^P$ (those not purchasing supplementary insurance).

After this follows the first step, deriving optimal β_i^{*P}, while recognizing that $\beta_i^{*S}(\beta_i^P)$. However, it is not important for our purposes to get a formal expression defining β_i^{*P} in the presence of supplementary insurance, so we choose not to perform a formal analysis here. An informal discussion will do.

Will preferred public coinsurance rates, β^{*P}, change when supplementary insurance is available? Yes. Individuals paying taxes higher than the actuarial premium will now vote for $\beta^P = 1$, since they now can buy insurance coverage at a lower cost on the market. This will be everybody with $y_i > \overline{y}$. Individual's with $y_i < \overline{y}$, on the other hand, have no reason to change their voting behavior since public provision still is cheapest. So, there will be three groups of voters:

- Low income earners: $y_i < y_m$, purchasing supplementary insurance, and having $\beta_i^{*P} < \beta_m^{*P}$.
- Middle income earners: $y_m < y_i < \overline{y}$, not purchasing supplementary insurance, and having $\beta_m^{*P} < \beta_i^{*P} < 1$.
- High income earners: $\overline{y} < y_i$, not purchasing supplementary insurance, and having $\beta_i^{*P} = 1$.

The low income earners form a coalition trying to influence politicians to lower the coinsurance rate, and the middle- and high-income earners form another coalition trying to raise the coinsurance rate. Neither coalition is happy with the coinsurance the median voter sets, but unlike the middle and high income earners the low income earners can improve their situation by purchasing supplementary private insurance. Therefore, the low income earners will always be better off with non-exclusive public insurance than with pure private insurance. High income earners, on the other hand, will be better off with pure private insurance than with non-exclusive public insurance. Middle income earners we cannot say under what regime they are better off.

Will the political equilibrium change when supplementary insurance is available? Yes. The reason is that an indirect effect when people buy supplementary insurance is that costs for the public insurance increase. And in order to mitigate that effect to some degree the median voter sets a higher coinsurance when supplementary insurance is allowed compared with when it is not allowed.

The explanation is the following. Choosing a lower β induces increased medical care utilization, and this imposes higher costs on the insurer. With pure private insurance this extra cost will be fully reflected in a higher premium. While with supplementary insurance, some part of the extra costs falls on the government, so the premium for the extra coverage does not fully reflect the increase in costs. So marginal cost for extra coverage is lower when buying supplementary rather than pure private insurance.[6] And as an effect the presence of supplementary insurance will increase the government's costs for providing health insurance.

The fact that the marginal cost for additional coverage is lower with supplementary insurance compared to pure private insurance, has implications for the choice of coinsurances under the respective regimes. We have the following result:

Proposition 2 *All individuals with $y_i < y_m$ will face a lower coinsurance rate with non-exclusive public insurance than with pure private insurance.*

Noting that pure private insurance is a special case of non-exclusive public

[6] It is $pm_i - p(\beta^P - \beta^S)\frac{\partial m}{\partial \beta}$ with supplementary insurance, versus $pm_i - p(1 - \beta^M)\frac{\partial m}{\partial \beta}$ with pure private insurance.

insurance, with $\beta^P = 1$, the Proposition is proved by using expression (18) to show that $d\beta^{*S}/d\beta^P > 0$ (see Appendix). See Figure 1 for an illustration.

Expression (18) cannot be used to analyze the behavior of individuals with $y_i \geqslant y_m$ since (18) does not hold with equality for them and hence cannot be differentiated. So we have no formal result concerning these individuals. It seems very likely though that also these individuals will face a lower coinsurance rate with non-exclusive public insurance than with pure private insurance. In fact, studying Figure 1 it is hard to see how it could be in any other way.

4 Is aggregate expenditure larger with private or non-exclusive public insurance?

The total effect on aggregate spending for medical care when switching from pure private to non-exclusive public provision can be separated in two effects. The first is that tax-funding redistributes net income, since tax payments do equal actuarial premiums. Call this the income effect. The second effect is that the coinsurance rates people face are not the same under the two regimes. Call this the price effect.

Just as in the previous section we will here restrict attention to the case when the income elasticity is less than one, $\eta < 1$, and people are characterized by constant relative risk aversion, CRRA.

The income effect works unambiguously in the direction of increasing aggregate spending on medical services when switching from private to public provision. The reason being that the proportional tax in combination with an income elasticity of less than one, redistributes net income from the rich to the poor. And–also due to the income elasticity being less than one—poor people spend a larger fraction of their income on medical services than richer people do.[7]

To isolate the price effect we want to see what happens with aggregate spending when coinsurance rates change while incomes net of premiums/tax payments remain the same. An individual will then increase his spending on medical care if the coinsurance rate he faces with non-exclusive public provision is lower than the rate he faced with pure private provision.

We know from Proposition 2 that everybody with $y_i < y_m$ faces a lower coinsurance with non-exclusive public insurance than with private insurance. And we also argued that individuals with $y_i \geqslant y_m$ most likely will do the same. Then we know that aggregate expenditure is larger with non-exclusive public provision than with pure private provision: the income and price effects will work in the same direction.

5 Summary and conclusions

To put the results here in perspective a comparisons with the some of the result in Gouviea (1997) can be useful, where the case of public provision when health care can be rationed is analyzed. In that case, the ones supplementing the publicly provided care with private care is high income individuals (with above "median voter" income). This is because high-income earners get too little health care in median voter equilibrium, while low-income earners get "too much": the marginal tax dollar is better spent on something else than health care. And "too much" cannot be adjusted by the individual as "too little" can, at least if health care services cannot be resold on the market. So

[7] The higher spending induced by redistribution of net income when switching from private to public provision, does not mean that deadweight losses increase. Income effects do not create deadweight losses.

for low-income earners public provision has a pro (the tax-price is lower than the market price) as well as a con (too much health care). And we cannot say from theory which effect that dominates.

In our case, when health care cannot be rationed, low-income earners are on the other hand certain to be better off with (non-exclusive) public provision than with pure private provision. Their tax price is lower than the market price and they get their preferred coinsurance rate by supplementing on the market. Instead high-income earners are the ones who will be worse off. And then there is middle group, with incomes between median and average, that on the one hand pays a tax-price lower than the market price but on the other hand faces a too low coinsurance rate, i.e. get too much coverage.

Finally, we want to point out some limitations of our study and indicate what could be done in the future. First, it is probably too strong an assumption that no rationing at all takes place. Even for the type of services where rationing is hard, e.g. pharmaceuticals, the no-rationing assumption is quite strong. Second, in our model everybody faces the same probability of becoming sick. A more realistic model would account for the differences in probability of falling ill we know exist, and for the negative correlation between health and wealth (Smith, 1999).

A Appendix

A.1 Exclusive publicly health insurance

To study how optimal coinsurance, β, varies with income, we differentiate the first order condition for optimal β with respect to β and y, and this yields:

$$
\begin{aligned}
0 &= (1-p)V_{cc}^{iW}\left[1-p(1-\beta)\frac{\overline{m}}{\overline{y}}\right]\left[p\frac{y_i}{\overline{y}}\left(\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right)\right]dy \qquad (19)\\
&+(1-p)V_c^{iW}\left[p\overline{m}\frac{1}{\overline{y}}-p(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\frac{1}{\overline{y}}\right]dy\\
&-pV_{cc}^{iI}\left[1-\beta\frac{\partial m_i}{\partial y}-p(1-\beta)\frac{\overline{m}}{\overline{y}}\right]\left[m_i+p\frac{y_i}{\overline{y}}\left((1-\beta)\frac{\partial\overline{m}}{\partial\beta}-\overline{m}\right)\right]dy\\
&-pV_c^{iI}\left[\frac{\partial m_i}{\partial y}+p\frac{1}{\overline{y}}\left((1-\beta)\frac{\partial\overline{m}}{\partial\beta}-\overline{m}\right)\right]dy+(S.O.C)\,d\beta\\
&= Ady+(S.O.C)\,d\beta,
\end{aligned}
$$

so $\frac{d\beta}{dy}=-\frac{A}{S.O.C}$. We assume the second order condition to be fulfilled, so in the following we concentrate on the sign of A.

Dividing all terms in A by V_c^I and inserting the first order condition for optimal β, we can separate the expression into two parts: one part, G, including all terms containing the indirect utility function, G, and one part, F, that does not.

Simplify F/V_c^{iI}:

$$
\begin{aligned}
\frac{F_i}{V_c^{iI}} &= p\left[p\frac{\overline{m}}{\overline{y}}-p(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\frac{1}{\overline{y}}\right]\underbrace{\frac{p}{1-p}\frac{m_i-p\frac{y_i}{\overline{y}}\left(\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right)}{p\frac{y_i}{\overline{y}}\left(\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right)}}_{V_C^W/V_C^I} \qquad (20)\\
&-p\frac{\partial m_i}{\partial y}+p\left[p\frac{\overline{m}}{\overline{y}}-p(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\frac{1}{\overline{y}}\right]\\
&= p\left[p\frac{\overline{m}}{\overline{y}}-p(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\frac{1}{\overline{y}}\right]\frac{1}{p\frac{\overline{m}}{\overline{y}}-p(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\frac{1}{\overline{y}}}\frac{m_i}{y_i}-p\frac{\partial m_i}{\partial y}\\
&= p\left[\frac{m_i}{y_i}-\frac{\partial m_i}{\partial y_i}\right]\\
&= p\frac{y_i}{m_i}(1-\eta). \qquad (21)
\end{aligned}
$$

where $\eta=(\partial m_i/\partial y_i)(y_i/m_i)$ denotes the income elasticity.

Now, simplify G_i/V_c^{iI}:

$$
\begin{aligned}
\frac{G_i}{V_c^{iI}} &= (1-p)\frac{V_{cc}^{iW}}{V_c^{iW}}\underbrace{\left[1-p(1-\beta)\frac{\overline{m}}{\overline{y}}\right]}_{\Phi} p\frac{y_i}{\overline{y}}\left[\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right]\times \\
&\quad \underbrace{\frac{p}{1-p}\frac{m_i-p\frac{y_i}{\overline{y}}\left(\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right)}{p\frac{y_i}{\overline{y}}\left(\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right)}}_{V_C^W/V_C^I} \\
&\quad -p\frac{V_{cc}^{iI}}{V_c^{iI}}\underbrace{\left[1-\beta\frac{\partial m_i}{\partial\beta}-p(1-\beta)\frac{\overline{m}}{\overline{y}}\right]}_{\Phi_i-\beta\frac{\partial m_i}{\partial\beta}}\underbrace{\left[m_i-p\frac{y_i}{\overline{y}}\left(\overline{m}-(1-\beta)\frac{\partial\overline{m}}{\partial\beta}\right)\right]}_{\Omega_i} \\
&= p\Omega_i\left[\Phi_i\left(\frac{V_{cc}^{iW}}{V_c^{iW}}-\frac{V_{cc}^{iI}}{V_c^{iI}}\right)+\beta\frac{\partial m_i}{\partial y}\frac{V_{cc}^{iI}}{V_c^{iI}}\right]. \qquad (22)
\end{aligned}
$$

Defining relative risk aversion $\rho^j = -\frac{V_{cc}^j}{V_c^j}c_j, j = I, W$, adding F and G together, and doing some other manipulations, among other things multiplying with c_i^I/c_i^I (note that $c_i^I = c_i^W - \beta m_i$), we arrive at:

$$
\frac{A}{V_c^{iI}} = \frac{G_i+F_i}{V_c^{iI}} = p\frac{m_i}{y_i}\left\{\frac{\Omega_i}{C_i^I}\left[\rho_i^I\left(\frac{c_i^W}{m_i}-\beta\eta\right)-\rho_i^w\left(\frac{c_i^W}{m_i}-\beta\right)\right]+1-\eta\right\}. \qquad (23)
$$

And thus we have:

$$
\frac{d\beta^*}{dy} = -V_c^{iI}\frac{p\frac{m_i}{y_i}\left\{\frac{\Omega_i}{C_i^I}\left[\rho_i^I\left(\frac{C_i^W}{m_i}-\beta\eta\right)-\rho_i^w\left(\frac{C_i^W}{m_i}-\beta\right)\right]+1-\eta\right\}}{S.O.C.}, \qquad (24)
$$

which is expression (12) in Section 2.

To sign this expression we need to know the sign of $\Omega_i = m_i + p\frac{y_i}{\overline{y}}\left[(1-\beta)\frac{\partial\overline{m}}{\partial\beta}-\overline{m}\right]$. Using the first order condition for β, we can write

$$0 < \frac{V_c^{iW}}{V_c^{iI}} = \frac{p}{1-p} \frac{m_i - p\frac{y_i}{\overline{y}}\left[\overline{m} - (1-\beta)\frac{\partial \overline{m}}{\partial \beta}\right]}{p\frac{y_i}{\overline{y}}\left[\overline{m} - (1-\beta)\frac{\partial \overline{m}}{\partial \beta}\right]} < 1 \tag{25}$$

(we know that $V_c^W / V_c^I < 1$ since $V_c^W < V_c^I$ with a positive β). So,

$$0 < \frac{p}{1-p}\left[\frac{m_i}{p\frac{y_i}{\overline{y}}\left(\overline{m} - (1-\beta)\frac{\partial \overline{m}}{\partial \beta}\right)} - 1\right] < 1, \tag{26}$$

from which it follows

$$\frac{m_i}{p\frac{y_i}{\overline{y}}\left(\overline{m} - (1-\beta)\frac{\partial \overline{m}}{\partial \beta}\right)} - 1 > 0 \tag{27}$$

$$\frac{m_i}{p\frac{y_i}{\overline{y}}\left(\overline{m} - (1-\beta)\frac{\partial \overline{m}}{\partial \beta}\right)} > 1 \tag{28}$$

$$m_i - p\overline{m}\frac{y_i}{\overline{y}} + p(1-\beta)\frac{\partial \overline{m}}{\partial \beta}\frac{y_i}{\overline{y}} > 0 \tag{29}$$

$$\Rightarrow \Omega_i > 0 \tag{30}$$

In short, $V_c^W < V_c^I$ implies $\Omega_i > 0$.

A.2 Supplementary private insurance

Proof of Proposition (4): We look at the derivative $\frac{d\alpha}{d\beta^P}$, and from the relation $\frac{d\beta^S}{d\beta^P} = -\frac{d\alpha}{d\beta^P}$ we will sign the derivative$\frac{d\beta^S}{d\beta^P}$. The derivative $\frac{d\alpha}{d\beta^P}$ is obtained by differentiating (18) with respect to β^P gives and α (where index i is dropped).

$$\left\{pV_c^{iI}\left[\frac{\partial m_i}{\partial \beta^P} - p\frac{\partial m_i}{\partial \beta^P} - p\alpha\frac{\partial^2 m_i}{\partial \beta^S \partial \beta^P}\right]\right\} d\beta^P +$$
$$\left\{pV_{cc}^{iI}\left[-m_i - \beta^P\frac{\partial m_i}{\partial \beta^P} - p\alpha\frac{\partial m_i}{\partial \beta^P} + p\overline{m}\frac{y_i}{\overline{y}} - p(1-\beta^P)\frac{\partial \overline{m}}{\partial \beta^P}\right] \times\right.$$
$$\left.\left[m_i - pm_i - p\alpha\frac{\partial m_i}{\partial \beta^S}\right]\right\} d\beta^P +$$
$$\left\{(1-p)V_c^{iW}\left[-p\frac{\partial m_i}{\partial \beta^P} - p\alpha\frac{\partial^2 m_i}{\partial \beta^S \partial \beta^P}\right]\right\} d\beta^P +$$

$$
\begin{aligned}
&\left\{pV_{cc}^{iW}\left[-p\alpha\frac{\partial m_i}{\partial\beta^P}+p\overline{m}\frac{y_i}{\overline{y}}-p(1-\beta^P)\frac{\partial\overline{m}}{\partial\beta^P}\right]\times\right.\\
&\left.\left[-pm_i-p\alpha\frac{\partial m_i}{\partial\beta^S}\right]\right\}d\beta^P+\\
&\{S.O.C\}\,d\alpha\\
=\;& 0 \qquad (31)
\end{aligned}
$$

After using the facts that $\frac{\partial m}{\partial\beta^P}=\frac{\partial m}{\partial\beta^S}$, $\frac{\partial^2 m}{\partial\beta^2}=\varepsilon\frac{m(\varepsilon-1)}{\beta^2}$, (where $\varepsilon=\frac{\partial m}{\partial\beta}\frac{\beta}{m}$ is the price elasticity), assuming CRRA, and some further manipulations we arrive at the following expression

$$
\frac{d\alpha}{d\beta^P}=-V_c^I\frac{\overbrace{\frac{p\varepsilon m\alpha}{\beta^P(\beta^P+\varepsilon\alpha)}}^{C}+\overbrace{\frac{p\phi m}{c^I}\frac{V_{cc}^W}{V_c^W}\left[c^I\Omega\beta^P+c^W(1+\epsilon)\right]}^{D}}{S.O.C}<0. \qquad (32)
$$

$C<0$ since i) $\varepsilon<0$, and ii) $\beta^P+\varepsilon\alpha$ (because $\alpha<\beta^P$ and $|\varepsilon|<1$ by assumption).

$D<0$ since i) $\frac{p\phi}{c^I}\frac{V_{cc}^W}{V_c^W}<0$ and ii) $c^I\Omega\beta^P+c^W(1+\epsilon)>0$ (since $\Omega>0$ and $1+\epsilon>0$).

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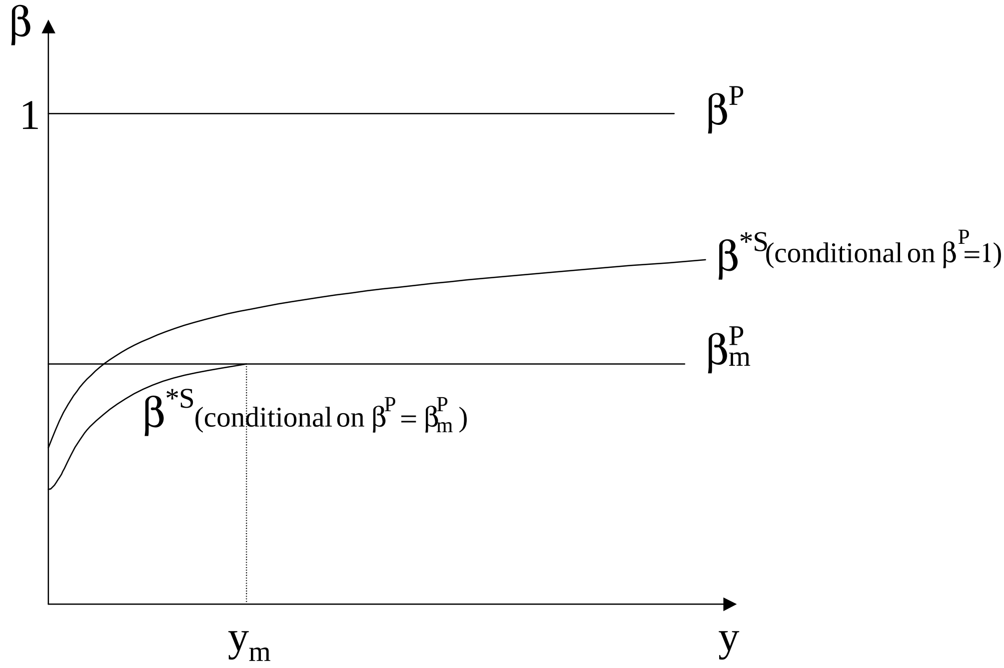

Figure 1: Optimal coinsurance rates. When $\beta^P = 1$, β^{*S} is the coinsurance rates with pure private insurance. When $\beta^P = \beta^P_m$ (public coinsurance rate in median voter equilibrium) β^{*S} shows the coinsurance rate faced by individuals with $y_i < y_m$.