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Abstract

Premium subsidies have been advocated as an alternative to social health insurance. These subsidies are paid if expenditure on health insurance exceeds a given share of income. In this paper, we examine whether this approach is superior to social insurance from a welfare perspective. We show that the results crucially depend on the correlation of health and productivity. For a positive correlation, we find that combining premium subsidies with social insurance is the optimal policy.

JEL classification: H21, H51, I18

Keywords: social insurance, health insurance, redistributive taxation, equity.

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1 Introduction

Private health insurance markets discriminate according to risk of illness. Those with a higher risk of illness usually have to pay higher premiums than those with a lower risk. In many countries, this price discrimination is regarded as unjust, violating equity principles such as 'equal access' or 'solidarity'. A common solution are social health insurance schemes which establish transfers from low risks to high risks by forcing all citizens into one health insurance contract with a uniform premium.

In a recent paper, Zweifel and Breuer (2006a) fundamentally question this equity argument in favor of social insurance. They maintain that being a high risk does not necessarily imply that a person should receive transfers:

> "[Uniform premiums] result in a cross-subsidization of high-risk by low-risk, low-income individuals. This can result in counter-productive effects. For example, a healthy young worker subsidizes a wealthy older manager who is a heavy user of medical services. Equity considerations seem to call for redistribution from everyone else to the double disadvantaged, viz. the high-risk, low-income individuals." [Zweifel and Breuer (2006a), p. 172]

Based on the above argument Zweifel and Breuer propose to substitute social insurance by "premiums subsidies". These subsidies are targeted to individuals whose expenditure on health insurance exceeds a given share of income. By this policy, they want to focus transfers on high-risk, low-income individuals.

Zweifel and Breuer also advance efficiency arguments for risk-based premiums, stating that these allow cost sharing to be tailored to the individual risk type, thereby dealing better with moral hazard. In addition, they point out that risk-based premiums avoid possible costs due to risk selection induced by uniform premiums. This applies if social insurance is provided by competing insurers.

The case for social insurance also depends on the severity of risk discrimination in private health insurance markets. For the individual health insurance market in the US, Pauly and Herring (1999, 2007) find that premiums are not proportional to risk, pointing to a substantial amount of risk pooling. However, risk pooling is only partial because higher health risk is significantly related to higher premiums overall and to lower coverage rates in unregulated states [Pauly and Herring (2007), p. 775–776].

Social insurance is also defended by its effect on the income distribution. Empirical studies show that poverty and ill-health are positively correlated.[1] For this reason, McGuire (2006) argues that social insurance may well be optimal from a second-best perspective. It not only redistributes to those with higher health risks but also tends to make the poor better off. Formally, this line of reasoning has been analyzed by Cremer and Pestieau (1996) who show that a positive correlation of health and income provides a strong argument for social insurance.

Van de Ven (2006) criticizes the concept of premium subsidies advocated by Zweifel and Breuer. He points out that high-risk, low-income consumers have little incentive to shop around for a well-priced health plan if their premiums are subsidized. Furthermore, the fact that they receive a subsidy at the margin creates a moral hazard problem. These individuals will tend to over-insure.[2] Zweifel and Breuer (2006b) also mention a negative incentive effect of their proposal. Low-income individuals who receive a premium subsidy effectively face a higher marginal tax rate as the subsidy is decreasing in income.

Whether premium subsidies in combination with risk-based premiums are an alternative to social insurance is therefore an open issue. The fact that in Switzerland premium subsidies go along with social insurance also raises the question whether premium subsidies are substitutes or complements to social insurance.

In the following, we analyze these questions in a theoretical framework. We allow for heterogeneity in productivity and risk types. The government maximizes a social welfare function and uses a linear income tax to redistribute between high and low-productivity individuals. To support

high-risk individuals, it can pay premium subsidies if expenditure for health in-

[1]See, e.g., van Doorslaer et al. (1997), Gerdtham and Johannesson (2000) and Breyer et al. (2003).

[2]Van de Ven (2006) also advocates an alternative consisting of risk-based and non-means-tested subsidies which is explained in detail in van de Ven et al. (2000). A similar proposal has been made by Pauly et al. (1992) who want to introduce refundable tax credits which reflect a household's risk category and are inversely related to household income.

surance exceeds a given share of pre-tax income or introduce social insurance. Since Zweifel and Breuer want to target transfers to the worst-off in society, we pay particular attention to the solutions for a maximin social welfare function. In addition, we present results for the utilitarian welfare function.

We examine three schemes in detail. The benchmark is social insurance combined with optimal linear taxation, a scheme which has been analyzed in detail by Cremer and Pestieau (1996).[3] The second is the proposal by Zweifel and Breuer with risk-based premiums and premium subsidies. The third scheme combines premium subsidies with social insurance, an approach which is taken in Switzerland. Building on these results, we extend the analysis and examine whether different combinations of social insurance and premium subsidies can increase welfare.

Our model takes explicitly into consideration the incentive effects on labor supply, in particular, those due to changes in the marginal tax rate induced by premium subsidies. Furthermore, we allow for different degrees of correlation of health and productivity. To keep the analysis tractable, we abstract from further moral hazard problems. For private health insurance markets, we assume that premiums are actuarially fair given an individual's risk type. Therefore, we do not consider partial risk-pooling in the private health insurance market.

The paper is structured as follows. In Section 2 we present the model. Section 3 introduces premium subsidies and examines when these will be claimed by individuals. In Section 4 we present the general problem of choosing premium subsidies and social insurance and analyze different solutions. Section 5 concludes.

[3] A similar analysis can be found in Blomqvist and Horn (1984). Boadway et al. (2003, 2006) extend the analysis by Cremer and Pestieau (1996) to include moral hazard and adverse selection. They show that with moral hazard, the case for public intervention in insurance markets remains. The introduction of adverse selection has the effect of fostering social insurance. Netzer and Scheuer (2007) find that more social insurance can be counterproductive in the presence of adverse selection if individuals have a precautionary labor motive.

2 The model

We consider an economy in which individuals supply labor and consume one numeraire good. Labor supply is denoted by l and consumption of the numeraire by c. The earning ability of an individual is w, implying labor income wl. Individuals become ill with probability π. If ill, they require treatment leading to medical expenditure L. We assume that medical treatment fully restores health in a short period of time and therefore has no effect on labor supply. The utility function $u(c,l)$ is increasing in consumption, decreasing in labor supply, and strictly quasi-concave. Furthermore, $\partial^2 u/\partial c^2 < 0$, which implies that individuals are risk averse in consumption. Individuals maximize expected utility.

Individuals differ in their earnings ability w_i $(w_1 < w_2)$ and in their probability of falling ill π_j $(\pi_l < \pi_h)$. This gives rise to 2×2-types, where θ_{ij} is the fraction of ij-types. The share of productivity type i is given by θ_i and the share of high risks among each productivity type is denoted by κ_i. Hence, the proportions of the four types in the population can be written as

$$\theta_{1h} = \theta_1\kappa_1,\ \theta_{1l} = \theta_1(1-\kappa_1),\ \theta_{2h} = \theta_2\kappa_2,\ \theta_{2l} = \theta_2(1-\kappa_2). \tag{1}$$

If $\kappa_1 > \kappa_2$, i.e., if there are relatively more high risks among low-productivity individuals, then productivity and health are positively correlated.

The government maximizes a social welfare function. As Cremer and Pestieau (1996) and Zweifel and Breuer (2006a), we suppose that the government cannot make transfers contingent on π. We also make the standard assumption in problems of income taxation that the government can observe labor income $y = wl$ but neither productivity w nor hours worked l. However, the government knows the joint distribution of both characteristics, π and w. An income tax is available for redistributive purposes. The tax schedule $T(y)$ is assumed to be linear, consisting of a marginal tax rate t and a uniform lump-sum transfer τ:

$$T(wl) = twl - \tau.$$

In addition, the government can introduce social insurance which covers a share s of the possible health expenditures at a uniform premium. A uniform contribution $s\bar{\pi}L$ by each individual guarantees that social insurance has a balanced budget in expectation. Here $\bar{\pi}$ is the average probability of illness,

$$\bar{\pi} \equiv (\theta_{1h} + \theta_{2h})\pi_h + (\theta_{1l} + \theta_{2l})\pi_l. \tag{2}$$

On the private health insurance market individuals can buy insurance coverage I at an actuarially fair premium $\pi_j I$. Without premium subsidies, we can apply Mossin's theorem [Mossin (1968)], which states that individuals will fully insure: individuals solve the problem

$$\begin{aligned}\max_{I,l} E[u] &= (1-\pi)u\big((1-t)wl + \tau - s\bar{\pi}L - \pi I, l\big) + \\ &\quad \pi\, u\big((1-t)wl + \tau - s\bar{\pi}L - \pi I - L + sL + I, l\big).\end{aligned}$$

The first-order condition for I calls for equality of the marginal utilities of income in both states implying $I^* = (1-s)L$. Utility of individual-ij is therefore given by

$$u_{ij} = u\big((1-t)w_i l_{ij} + \tau - ((1-s)\pi_j + s\bar{\pi})L, l_{ij}\big).$$

With premium subsidies, individuals may have the incentive to buy even more insurance. We rule out this possibility by restricting coverage to medical expenditure not paid for by social insurance. Individuals will therefore always purchase coverage $I^* = (1-s)L$.

In the following, we consider two social welfare functions. Zweifel and Breuer (2006a) want to target transfers to the worst-off in society, i.e., low-income, high-risk individuals. This objective can be captured by a maximin welfare function. In a second-best environment, welfare W will then always be given by the utility of the low-productivity, high-risk individuals, i.e.,

$$W = \min\{u_{1h}, u_{1l}, u_{2h}, u_{2l}\} = u_{1h}. \tag{3}$$

Furthermore, we consider the utilitarian welfare function

$$W = \sum_{ij} \theta_{ij} u_{ij}. \tag{4}$$

To illustrate our results, we frequently use GHH-preferences, a generalized version of quasi-linear utility introduced by Greenwood, Hercowitz, and Huffman

(1988).[4] In particular, we work with the following variant of GHH-preferences

$$u = \begin{cases} \frac{1}{1-\nu}\left(c - \frac{1}{1+1/\varepsilon} l^{1+1/\varepsilon}\right)^{1-\nu} & \text{for} \quad \nu > 0 \\ \ln\left(c - \frac{1}{1+1/\varepsilon} l^{1+1/\varepsilon}\right) & \text{for} \quad \nu = 1 \end{cases} \tag{5}$$

where ν is the coefficient of relative risk aversion and $\varepsilon > 0$ the elasticity of labor supply. Since there is no income effect on labor supply, the compensated and uncompensated elasticity of labor supply coincide.

3 Premium subsidies

The key element of the proposal by Zweifel and Breuer (2006a) are premium subsidies. In this section, we analyze the effect of these subsidies on the behavior of individuals given that a tax and transfer system is in place. This analysis prepares for the study of the optimal tax and transfer policy in Section 4.

Following Zweifel and Breuer (2006a), the objective of premium subsidies is to avoid that expenditures for health insurance exceed a given share of pre-tax income $y_{ij} = w_i l_{ij}$. We denote this "health insurance limit" by γ. For example, if $\gamma = 0.1$, then net health insurance expenditures cannot be more than 10 percent of labor income. Therefore, the premium subsidy needs to cover any positive difference between the maximum amount which has to be paid for health insurance, $\gamma w_i l_{ij}$, and the total health insurance premium for an individual with health risk j given by

$$p_j = \left(s\bar{\pi} + (1-s)\pi_j\right) L. \tag{6}$$

Thus, the premium subsidy, denoted by σ_{ij}, amounts to

$$\sigma_{ij} = \max\left\{p_j - \gamma w_i l_{ij}; 0\right\}. \tag{7}$$

This shows that a smaller health insurance limit γ implies a more generous subsidy scheme. Furthermore, expenditures on overall health insurance depend on the extent of social insurance s through p_j. Zweifel and Breuer consider only the case

[4] The general form is

$$U(c,l) = u(c - G(l))$$

with $u' > 0, u'' < 0, G' > 0, G'' > 0$.

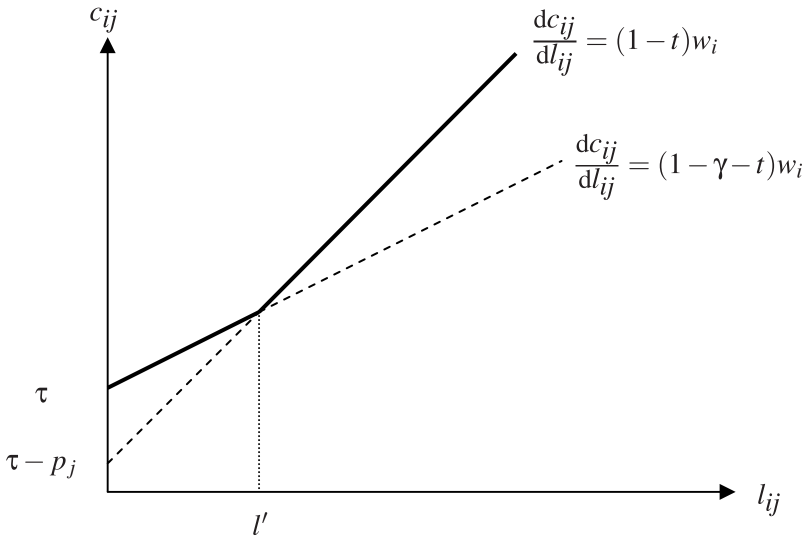

Figure 1: Budget constraint

with no social insurance, i.e., $s = 0$. Our analysis is more general because we also allow for a combination of premium subsidies and social insurance.

If an individual receives a positive premium subsidy, consumption is

$$c_{ij} = (1-t)w_i l_{ij} + \tau - p_j + \sigma_{ij} = (1-\gamma-t)w_i l_{ij} + \tau.$$

Without premium subsidies, it is $c_{ij} = (1-t)w_i l_{ij} + \tau - p_j$. This leads to the kinked budget constraint

$$c_{ij} = \max\left\{(1-\gamma-t)w_i l_{ij} + \tau; (1-t)w_i l_{ij} + \tau - p_j\right\} \tag{8}$$

which is shown in Figure 1. Whether or not an individual obtains a premium subsidy depends on whether the optimal solution is to the left or right of the kink. If the highest attainable indifference curve is tangent to the budget constraint to the left of l' at the optimum, individuals will claim the premium subsidy. If it is tangent to the right of l', they pay their premiums themselves.

To determine the factors inducing an individual to claim a premium subsidy, we compare the individual optimum for both parts of the budget constraint. Given that the individual receives a premium subsidy, the problem is

$$\begin{aligned} \max_{c,l} \quad & u(c,l) \\ \text{s.t} \quad & c = (1-\gamma-t)wl + \tau \end{aligned} \tag{9}$$

yielding the indirect utility function $\hat{V}(\tau, t+\gamma, w)$. Comparative-static analysis leads to the intuitive results

$$\frac{\partial \hat{V}}{\partial \tau} > 0, \quad \frac{\partial \hat{V}}{\partial t} < 0, \quad \frac{\partial \hat{V}}{\partial \gamma} < 0, \quad \frac{\partial \hat{V}}{\partial w} > 0.$$

Without a premium subsidy, by contrast, the individual's maximization problem is

$$\begin{aligned} \max_{c,l} \quad & u(c,l) \\ \text{s.t} \quad & c = (1-t)wl + \tau - p. \end{aligned} \tag{10}$$

The indirect utility function $V(\tau, t, w, p)$ has the following properties

$$\frac{\partial V}{\partial \tau} > 0, \quad \frac{\partial V}{\partial t} < 0, \quad \frac{\partial V}{\partial w} > 0, \quad \frac{\partial V}{\partial p} < 0.$$

Setting $\hat{V} = V$ defines $\hat{\gamma}$, the critical value of the health insurance limit where individuals are indifferent between claiming and non-claiming. Due to $\partial \hat{V}/\partial \gamma < 0$, an individual will claim if and only if $\gamma < \hat{\gamma}$.[5]

The critical value $\hat{\gamma}$ generally depends on τ, t, w and p. Turning first to the effect of an increase in combined health insurance premiums p, we find

$$\frac{\partial \hat{\gamma}}{\partial p} = \frac{\partial V/\partial p}{\partial \hat{V}/\partial \gamma} > 0. \tag{11}$$

For a given value of γ, this shows that it is more likely that individuals with higher health insurance premiums will claim because they have a higher critical value $\hat{\gamma}$.

[5]This presupposes that $\hat{V}(\tau, 1, w) \leq V(\tau, t, w, p)$, i.e., individuals do not claim if $\gamma + t = 1$. If this condition is violated, individuals would prefer consumption $c = \tau$ to working and paying health insurance. Our analysis can be extended to cover this case as well.

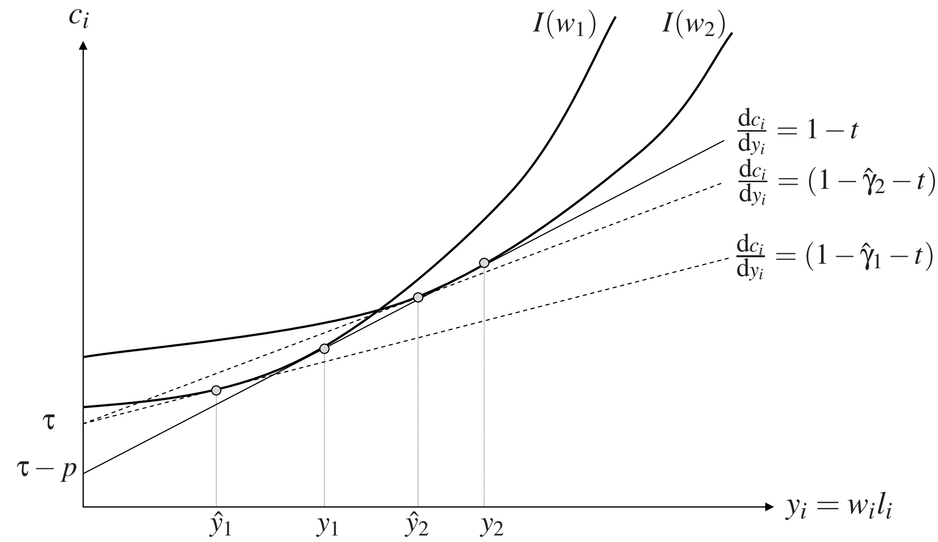

Figure 2: Agent monotonicity

With respect to the other variables determining $\hat{\gamma}$, the sign is not determinate unless one further specifies preferences. As in most studies on optimal income taxation, we assume that Seade's (1982) condition of agent monotonicity is fulfilled. This condition requires that the marginal rate of substitution between consumption and pre-tax income is smaller for high-productivity individuals' preferences at any point in the (y, c)-space, i.e.,

$$MRS^1 = -\frac{U_y^1(c,y)}{U_c^1(c,y)} > MRS^2 = -\frac{U_y^2(c,y)}{U_c^2(c,y)}. \tag{12}$$

Agent monotonicity implies $\partial\hat{\gamma}/\partial w < 0$. This is shown in Figure 2 where low-productivity individuals are indifferent between claiming and non-claiming if $\gamma = \hat{\gamma}_1$ $\left[\text{indifference curve } I(w_1)\right]$. By agent monotonicity, the indifference curves of high-productivity individuals are less steep. Thus, they prefer not to claim if $\gamma = \hat{\gamma}_1$, implying that their critical value $\hat{\gamma}_2$ is smaller than $\hat{\gamma}_1$ $\left[\text{indifference curve } I(w_2)\right]$.

Assuming agent monotonicity and denoting by $\hat{\gamma}_{ij} \equiv \hat{\gamma}(\tau, t, w_i, p_j)$ the critical value of individuals with productivity i and risk type j, the derivatives $\partial\hat{\gamma}/\partial p > 0$ and

$\partial\hat{\gamma}/\partial w < 0$ lead to the following ranking, provided that there is no or incomplete social insurance ($s < 1$ implying $p_l < p_h$):

(i) $\hat{\gamma}_{1h}$

(ii)/(iii) $\hat{\gamma}_{1l}$ or $\hat{\gamma}_{2h}$. If a large share of health insurance is covered by social insurance, $\hat{\gamma}_{1l} > \hat{\gamma}_{2h}$ since (6) and (11) imply

$$\frac{\partial\hat{\gamma}_{1l}}{\partial s} > 0, \quad \frac{\partial\hat{\gamma}_{2h}}{\partial s} < 0 \quad \text{and} \quad \hat{\gamma}_{1l} > \hat{\gamma}_{2h} \quad \text{for} \quad s = 1. \tag{13}$$

(iv) $\hat{\gamma}_{2l}$

With full social insurance, health insurance premiums are uniform. In this case, the budget constraints are independent of the risk type and the critical values depend only on productivity with $\hat{\gamma}_{1h} = \hat{\gamma}_{1l} > \hat{\gamma}_{2h} = \hat{\gamma}_{2l}$.

For the GHH-utility function (5), the critical values can be derived explicitly (see Appendix A.1). Setting $\hat{V}$ equal to V yields

$$\hat{\gamma} = (1-t) - w^{-1}\left[((1-t)w)^{1+\varepsilon} - (1+\varepsilon)p\right]^{\frac{1}{1+\varepsilon}}. \tag{14}$$

This term is increasing in w as the utility function (5) satisfies the agent monotonicity condition.[6]

Figure 3 illustrates for GHH-preferences the effect of a premium subsidy targeted to low-productivity high-risk individuals in the absence of social insurance. We focus on low-productivity individuals. Initially, there is no premium subsidy. The budget constraints run parallel, with the $1h$-types' being below the $1l$-types' because of the higher insurance premium. Since there is no income effect on labor supply with GHH-preferences, both individuals would supply the same amount of labor $l^*_{1l} = l^*_{1h}$ (points A and B), implying utility U_{1h} for $1h$-types. Now consider a premium subsidy scheme with γ set equal to $\hat{\gamma}_{1l}$. Assuming that $1l$-types do not

[6] With $l = y/w$, we have

$$u(c,y,w) = \frac{1}{1-\nu}\left(c - \frac{1}{1+1/\varepsilon}\left(\frac{y}{w}\right)^{1+\frac{1}{\varepsilon}}\right)^{1-\nu} \quad \Rightarrow \quad \left.\frac{\partial c}{\partial y}\right|_{\mathrm{d}u=0} = y^{\frac{1}{\varepsilon}} w^{-\frac{1+\varepsilon}{\varepsilon}}$$

which is decreasing in w for $\varepsilon > 0$, implying $MRS^1 > MRS^2$.

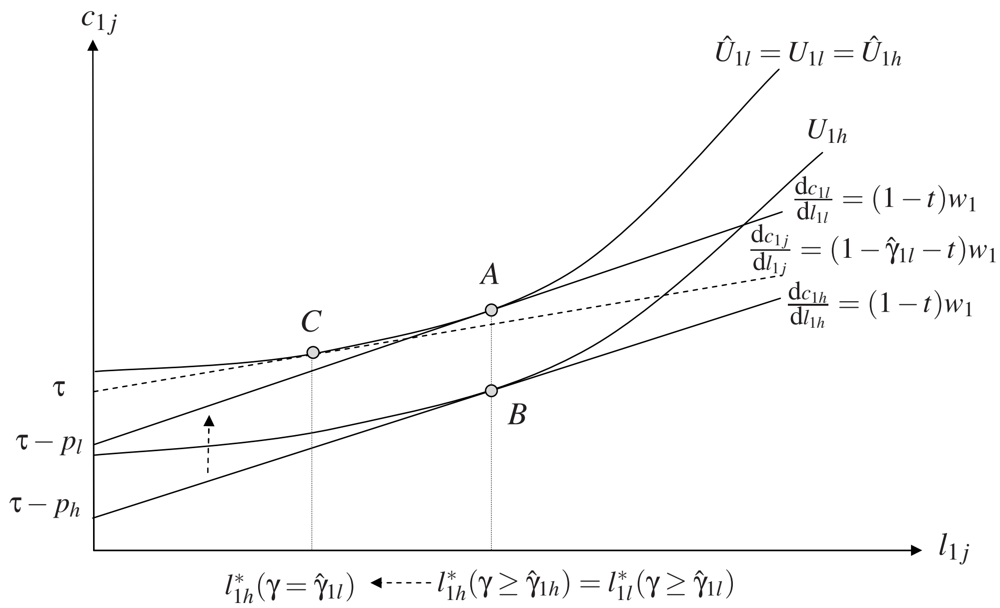

Figure 3: Budget and incentive constraints for low-productivity types

claim when indifferent, their optimum is described by point A with utility $\hat{U}_{1l}$. By contrast, $1h$-types will claim. They reach the same utility in point C as $1l$-types in point A.

The negative effect of premium subsidies noted by Zweifel and Breuer (2006b) becomes evident in Figure 3. In order to obtain premium subsidies, claiming individuals of type $1h$ reduce their labor supply to $l^*_{1h}(\gamma = \hat{\gamma}_{1l})$. This also shows that the labor supply function is not continuous. There is downward jump in labor supply when γ falls below the critical value $\hat{\gamma}_{ij}$.

Figure 3 assumes that the tax rate and the lump-sum transfer stay constant. Therefore, it does not compare two equilibria. If individuals claim premium subsidies, then the income tax system must be adjusted to finance the additional expenditure. This is taken into account in the following section where we analyze the government's problem of simultaneously choosing premium subsidies, social health insurance coverage and an optimal linear income tax.

4 Optimal social insurance and transfers

4.1 The general problem

In this section, we analyze how a government can optimally design a tax and transfer system by choosing the parameters t, τ, s and γ. So far, the literature has only examined the choice of the first three variables.[7]

We formulate the government's budget constraint in per capita terms. Denoting optimal labor supply by $l_{ij}^* = l_{ij}(t,\tau,s,\gamma)$, per capita tax revenue is given by $t\sum_{ij}\theta_{ij}w_i l_{ij}(t,\tau,s,\gamma)$. Per capita expenditure consists of the lump-sum transfer τ and premiums subsidies. Using (7), per capita government spending on premium subsidies corresponds to

$$\sum_{ij}\theta_{ij}\sigma_{ij} = \sum_{ij}\theta_{ij}\max\left\{p_j - \gamma w_i l_{ij}(t,\tau,s,\gamma); 0\right\}.$$

Social insurance coverage, s, is assumed to be in the interval $[0,1]$. It is restricted to full coverage as otherwise individuals may pretend to be ill. The government's problem therefore amounts to

$$\max_{t,\tau,s,\gamma} \quad W \tag{15}$$

$$\text{s.t.} \qquad \tau + \sum_{ij}\theta_{ij}\max\left\{p_j - \gamma w_i l_{ij}(t,\tau,s,\gamma); 0\right\} = t\sum_{ij}\theta_{ij}w_i l_{ij}(t,\tau,s,\gamma)$$

$$s \in [0,1].$$

Although problem (15) only contains one constraint apart from the limitation on s, it is not easy to solve analytically. As shown in Figure 3, there are "jumps" in labor supply if a group switches from non-claiming to claiming.[8] Therefore, our approach is first to focus on a number of interesting cases:

(a) No premium subsidies: $\gamma \geq \hat{\gamma}_{1h}$.

This is the problem examined by Cremer and Pestieau (1996). We analyze this case in Section 4.2. It serves as the benchmark case.

[7] See Blomqvist and Horn (1984) and Cremer and Pestieau (1996). Ideally, the optimal solution would allow for a non-linear income tax. However, this is a complex problem. It has only been analyzed for the special case of a perfect correlation of productivity and health [see Cremer and Pestieau (1996), Section 4].

[8] For $\gamma \geq \hat{\gamma}_{ij}$ optimal labor supply is given by the solution to problem (10) while for $\gamma < \hat{\gamma}_{ij}$ optimal labor supply follows from problem (9).

(b) The Zweifel-Breuer proposal: $s = 0$, $\hat{\gamma}_{1h} > \gamma \geq \max\{\hat{\gamma}_{1l}, \hat{\gamma}_{2h}\}$.

Zweifel and Breuer propose to abandon social insurance. Premium subsidies for risk-based premiums are to be targeted to low-productivity high-risk types which requires $\hat{\gamma}_{1h} > \gamma \geq \max\{\hat{\gamma}_{1l}, \hat{\gamma}_{2h}\}$. This case is studied in Section 4.3.

(c) The Swiss approach: $s = 1$, $\hat{\gamma}_1 > \gamma \geq \hat{\gamma}_2$.

Switzerland combines social health insurance with premium subsidies to all low-productivity individuals, calling for $\hat{\gamma}_1 > \gamma \geq \hat{\gamma}_2$. We discuss this regime in Section 4.4.

In Sections 4.2 to 4.4, we assume that the government maximizes a maximin social welfare function. This is motivated by Zweifel and Breuer's emphasis of the worst-off in society. In Section 4.5, we extend the analysis. First, we examine how a utilitarian welfare function changes the results. Second, we consider interior solutions for social insurance as well as more generous premium subsidies schemes.

4.2 No premium subsidies

In this section, we briefly replicate the analysis by Cremer and Pestieau (1996) who derive conditions for optimal income taxation and social insurance in the absence of premium subsidies. This applies if $\gamma \geq \hat{\gamma}_{1h}$. This case will serve as a benchmark in the following. Since the parameter γ is irrelevant by assumption, we drop it in this section.

Without premium subsidies, the individual budget constraint (8) simplifies to

$$c_{ij} = (1-t)w_i l_{ij} + \tau - \left[s\bar{\pi} + (1-s)\pi_j\right] L. \tag{16}$$

Maximizing expected utility subject to (16) yields the optimal values $c_{ij}(t, \tau, s)$, $l_{ij}(t, \tau, s)$ and the indirect utility function $V_{ij}(t, \tau, s)$.

In absence of premium subsidies, the government's budget constraint is given by $\tau = t\sum_{ij}\theta_{ij}w_i l_{ij}(t, \tau, s)$. The policy instruments are t, τ and s. Thus, the government's problem is given by

$$\max_{t,\tau,s} \quad W \quad \text{s.t.} \quad \tau = t\sum_{ij}\theta_{ij}w_i l_{ij}(t,\tau,s), \quad s \in [0,1]. \tag{17}$$

To characterize the optimum, we use the definition of the net social marginal valuation of income [Diamond (1975)] in terms of government revenue which here is given by[9]

$$b_{ij} \equiv \frac{1}{\theta_{ij}\lambda^*}\frac{\partial W}{\partial u_{ij}}\frac{\partial u_{ij}}{\partial \tau} + tw_i\frac{\partial l^*_{ij}}{\partial \tau}. \tag{18}$$

It captures the effect of an increased transfer τ on the objective function via the individual's utility and via the effect on the budget constraint through labor supply changes, both measured in terms of government revenues. With the Slutsky decomposition, the optimal tax rate t^* can be shown to meet the standard condition [see Atkinson and Stiglitz (1980, p. 407)]:

$$\frac{t^*}{1-t^*} = -\frac{\text{Cov}(w_i l^*_{ij}, b_{ij})}{\sum_{ij}\theta_{ij}w_i l^*_{ij}\varepsilon_{ij}}. \tag{19}$$

It reflects the trade-off between efficiency and equity that is fundamental to the theory of optimal taxation. The covariance $\text{Cov}(w_i l^*_{ij}, b_{ij})$ can be interpreted as a welfare-based measure of inequality and reflects the goal of redistribution. A large negative correlation makes a higher tax rate more desirable. The distorting effect of taxation is captured by the denominator, which is increasing in ε, the compensated elasticity of labor supply, calling for lower tax rates.

With respect to social insurance, one obtains

$$\text{Cov}(\pi_j, b_{ij}) \begin{cases} \leq 0 & \qquad s^* = 0 \\ = 0 & \text{if} \quad 0 < s^* < 1 \\ \geq 0 & \qquad s^* = 1. \end{cases} \tag{20}$$

If $\text{Cov}(\pi_j, b_{ij})$ is always positive, we must have $s^* = 1$. A positive correlation of health and productivity provides a strong argument for this case. The intuition is that not only high-risk types benefit from social insurance. In addition, many low-income types are made better off. Social insurance redistributes to these individuals without distortions and is important even though an income tax exists.

[9] In the definition of b_{ij}, the Lagrange multiplier λ^* needs to be multiplied with the share of ij-types, θ_{ij}, to take into account that there are more individuals of one type.

The model by Cremer and Pestieau (1996) therefore provides a justification for the argument by McGuire (2006) that social insurance can be optimal from a second-best perspective if poverty and ill health are positively correlated. However, it remains to be seen whether this argument still holds if one also considers premium subsidies.

For GHH preferences (5) and maximin welfare, $\mathrm{Cov}(\pi_j, b_{ij}) > 0$ as long as $t < 1$. This is due to the fact that there is no income effect on labor supply which implies $b_{1h} > 0, b_{1l} = b_{2l} = b_{2h} = 0$. Hence, $s^* = 1$ is the solution irrespective of the correlation between health and productivity [see Appendix A.2 for an explicit solution].

4.3 The Zweifel-Breuer proposal

In this section, we examine the proposal by Zweifel and Breuer (ZB). They want to abandon social insurance, i.e., set $s = 0$ and to introduce premium subsidies targeted to the worst-off. These are $1h$-types in the present context. The health insurance limit must thus be smaller than $\hat{\gamma}_{1h}$ because otherwise $1h$-types would not receive a premium subsidy. To rule out that other individuals claim, γ cannot be lower than the second-ranking critical value $\hat{\gamma}_{ij}$ which is either $\hat{\gamma}_{1l}$ or $\hat{\gamma}_{2h}$. This gives rise to the following incentive constraint

$$\hat{\gamma}_{1h} > \gamma \geq \max\left\{\hat{\gamma}_{1l}, \hat{\gamma}_{2h}\right\}. \tag{21}$$

The government budget constraint for the ZB proposal is given by

$$\tau + \theta_{1h}\sigma_{1h} = t\sum_{ij}\theta_{ij}w_i l_{ij}(t, \tau, 0, \gamma), \tag{22}$$

where the premium subsidy for $1h$-types is given by $\sigma_{1h} = p_h L - \gamma w_1 l_{1h}(t, \tau, 0, \gamma)$. To find the optimal solution for the ZB proposal, the parameters t, τ and γ must be chosen as to maximize social welfare subject to the incentive constraint (21) and the budget constraint (22). This yields the following problem

$$\max_{t,\tau,\gamma} \quad W \tag{23}$$

$$\text{s.t.} \qquad \tau + \theta_{1h}\left(p_h L - \gamma w_1 l_{1h}(t,\tau,0,\gamma)\right) = t \sum_{ij} \theta_{ij} w_i l_{ij}(t,\tau,0,\gamma).$$

$$\hat{\gamma}_{1h} > \gamma \geq \max\left\{\hat{\gamma}_{1l}, \hat{\gamma}_{2h}\right\}.$$

ZB want to target transfers to the worst-off in society. Therefore, we pay particular attention to the solutions for the maximin social welfare function with $W = \hat{V}_{1h}(t,\tau,0,\gamma)$. In combination with GHH preferences, this allows us to derive some analytical results (see Appendix A.3). Results for the utilitarian welfare function are presented in Section 4.5.1.

Comparing the optimal solutions for the ZB proposal and the model by Cremer and Pestieau (CP) which implies full social insurance, we can derive the following result:

Proposition 1: *With GHH preferences (5), the ZB proposal makes the worst-off* $(1h$*-types*$)$ *better off compared to full social insurance without premium subsidies if* $\gamma^* = \hat{\gamma}_{1l}$ *and the share of* $1h$*-types is small. Only if there are no high risks among high-productivity types, do the two solutions lead to the same welfare.*

Proof: See Appendix A.3.

The intuition behind this result is that the efficiency losses due to premium subsidies are small if these are claimed by few individuals. The gains, by contrast, are large as transfers are now targeted. The regimes are only equivalent when all high risks are low-productivity types. In this case, the ZB regime has no targeting advantage.

To further examine the factors which regime is superior, we examine the difference in the welfare of both regimes,

$$\Delta W \equiv W^{ZB} - W^{CP}.$$

We start from a situation in which both regimes lead to the same welfare, $W = W^{ZB} = W^{CP}$.[10] Applying the Envelope Theorem, we obtain the following results

[10] Assuming $W^{ZB} = W^{CP}$ allows to focus on the pros and cons of each regime. The analysis can also be performed for $W^{ZB} \neq W^{CP}$. In this case, there are additional level effects (different values of α in equations (24) and (25) for each regime) which yield no additional insights.

with respect to κ_i, the share of productivity type i who are high risks:

$$\left.\frac{\partial \Delta W}{\partial \kappa_1}\right|_{W^{ZB}=W^{CP}} = \alpha\left[\theta_1(\pi_h - \pi_l)L - \theta_1\delta\right] \gtrless 0 \tag{24}$$

$$\left.\frac{\partial \Delta W}{\partial \kappa_2}\right|_{W^{ZB}=W^{CP}} = \alpha\theta_2(\pi_h - \pi_l)L > 0, \tag{25}$$

where $\alpha = (1-\nu)W^{-\frac{\nu}{1-\nu}}$ and

$$\delta \equiv \left(t^* - (1-\gamma^* - t^*)^{\varepsilon}(t^* + \gamma^*)\right) w_1^{1+\varepsilon} + \pi_h L > 0.$$

The term δ measures the transfers to $1h$-types in the ZB proposal and the tax losses due to reduced labor supply.

Equation (24) shows that an increase in the share of high risks among low-productivity individuals, κ_1, has a negative effect in the CP model as measured by $\theta_1(\pi_h - \pi_l)L$ since social insurance premiums must increase. This makes everyone worse off, including the worst-off. No such effect is present in the ZB proposal. However, more high risks claim premium subsidies. These require additional transfers and supply less labor, implying a lower tax base. This negative effect of the ZB proposal is captured by $\theta_1\delta$. If the difference in illness probabilities is sufficiently small, the effects for the ZB proposal are stronger, making the CP model superior.

Equation (25) reveals that an increase in the share of high-productivity individuals who are high risks, κ_2, has a negative effect in the CP model captured by $\theta_2(\pi_h - \pi_l)L$. Again, this is the increase in social insurance premiums. In the ZB proposal there is no effect, as θ_{2h}-types do not receive a transfer and labor supply is not affected. An increase in κ_2 therefore makes the ZB proposal superior.

Furthermore, we obtain

$$\left.\frac{\partial \Delta W}{\partial \pi_h}\right|_{W^{ZB}=W^{CP}, \hat{\gamma}_{1l} > \hat{\gamma}_{2h}} = \alpha\theta_{2h}L > 0, \tag{26}$$

which can be explained as follows: an increase in π_h has a negative effect on the social insurance premium in the CP model measured by $(\theta_{1h} + \theta_{2h})L$. In the ZB proposal, by contrast, only the transfers to $1h$-types increase. This effect is less severe and captured by $\theta_{1h}L$, resulting in a net advantage of $(\theta_{1h} + \theta_{2h})L - \theta_{1h}L = \theta_{2h}L$.[11]

[11] If $\hat{\gamma}_{1l} \leq \hat{\gamma}_{2h}$, there can also be an effect on the incentive constraint since $\hat{\gamma}_{2h}$ depends on π_h.

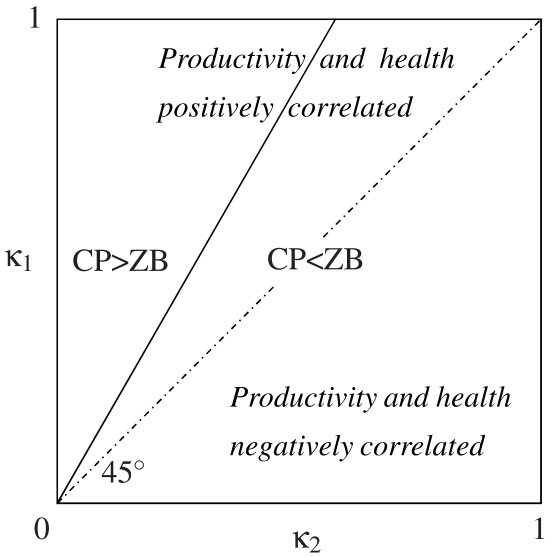

Figure 4: Comparison between ZB and CP
GHH utility, $w_1 = 5$, $w_2 = 10$, $\pi_l = 0.2$, $\pi_h = 0.5$, $\theta_1 = 0.5$, $L = 15$, $\varepsilon = 1$.

With respect to the other parameters of the model, it is not possible to derive obvious results. We therefore perform numerical simulations and compare the results of the maximization problem (23) with welfare in the Cremer and Pestieau model [see Appendix A.2] which calls for full social insurance. The simulation is done for all possible combinations of κ_1 and κ_2. The parameters ensure $\hat{\gamma}_{1l} > \hat{\gamma}_{2h}$ for all t. At the optimum, we find $\gamma^* = \hat{\gamma}_{1l}$. The optimal policy parameters for the ZB regime are in the intervals $t^* \in [0.31; 0.37]$, $\tau^* \in [10.2; 14.7]$ and $\gamma^* \in [0.20; 0.23]$. For the CP regime, we obtain $t^* = 0.375$ and $\tau^* = 14.6$.

In Figure 4, the simulation results are presented. In the upper left corner $\kappa_1 = 1$ and $\kappa_2 = 0$, i.e., health and productivity are perfectly positively correlated. In the lower right corner, health and productivity are perfectly negatively correlated. On the diagonal, the two are uncorrelated. From Figure 4, we observe the implications of Proposition 1: the ZB proposal is superior if $\kappa_1 = 0$ and $\kappa_2 > 0$ and the two schemes perform equally well for $\kappa_1 = \kappa_2 = 0$.

Figure 4 gives a clear picture. The ZB proposal is more likely to perform better, the less positive the correlation of health and productivity. In this example, the ZB proposal even yields higher welfare if health and productivity are positively correlated. Large values of κ_1 and low values of κ_2, which make health and productivity more positively correlated, make the CP model with full social insurance more attractive. Overall, this comparison supports the argument by Zweifel and Breuer. Premium subsidies and risk-based premium may perform better than social insurance since they target transfers better to the worst-off.[12]

Changes in the parameters π_h, θ_1, L and ε rotate the line separating the regimes around the origin. Equation (26) shows that an increase in π_h leads to a counter-clockwise rotation, making it more likely that regime ZB is superior. With respect to the other parameters, it is not possible to determine the effects analytically. Numerical simulations yield the following results:

- Increasing the share of low-productivity individuals θ_1 makes it less likely that the ZB proposal is superior. This can be explained by an increase in transfers in the ZB proposal, causing more efficiency losses due to distorted labor supply.
- Increasing medical expenditure L favors the social insurance solution. This can be explained by $\partial\hat{\gamma}_{1l}/\partial L > 0$ since $\hat{\gamma}_{1l}$ depends positively on the health insurance premium [equation (11)] which is increasing in L. As a consequence, the incentive constraint for the ZB proposal becomes more stringent and the transfer system can be less generous to $1h$-individuals.
- Increasing the elasticity of labor supply ε also puts the CP solution at an advantage. This effect can be explained by the additional labor supply distortions induced by the ZB proposal.

4.4 The Swiss approach

In this section, we examine a regime (CH) with full social insurance, $s = 1$, and premium subsidies to all low-productivity individuals. Such a system is akin to the current Swiss scheme which relies on social insurance. Depending on the canton of residence, a subsidy is granted as soon as health insurance costs more than a percentage of taxable income, e.g. 8 percent in Zug and 12 percent in Schaffhausen.[13]

[12] We also ran numerical simulations for $\hat{\gamma}_{2h} > \hat{\gamma}_{1l}$. Again, the ZB proposal is likely to perform better the more negative the correlation between health and productivity and can be superior if this correlation is positive. A difference is that the CP model yields higher welfare for $\kappa_1 = \kappa_2 = 0$.

[13] In contrast to the regime we examine, the Swiss system has mandatory copayments.

Comparing this regime with the ZB-proposal, it can be examined whether premium subsidies are complements rather than substitutes for social insurance. Indeed, premium subsidies introduce non-linear income taxation. In the ZB model, the effective marginal income tax is $t+\gamma$ for $1h$-types and t for all other individuals. From the theory of optimal non-linear income taxation, it is well known that a higher marginal tax rate for low-productivity individuals can be optimal.[14] The intuition is that the efficiency losses of high marginal tax rates are lower for these individuals than for high-productivity types. This reasoning should apply with and without social insurance.

Since social insurance makes high and low-risk types equally well-off given productivity, the introduction of premium subsidies effectively leads to a two-bracket linear income tax with a marginal income tax $t+\gamma$ for low incomes and t for high incomes. Such a scheme has been analyzed by Slemrod et al. (1994). Using a utility function with no income effects on labor supply, they find that a optimal tax system features decreasing marginal tax rates if the task is to redistribute to low-productive individuals.[15] In our model, premium subsidies impose decreasing marginal tax rates since additional transfers are paid if income is low in relationship to expenditure on health insurance.

To examine the optimal solution for regime CH, we first note that the critical values of γ must be uniform for each productivity type since types differ only in productivity with full social insurance:

$$\hat{\gamma}_{1l} = \hat{\gamma}_{1h} = \hat{\gamma}_1 > \hat{\gamma}_{2l} = \hat{\gamma}_{2h} = \hat{\gamma}_2.$$

We set $\gamma \in [\hat{\gamma}_2, \hat{\gamma}_1)$ which implies that all low-productivity individuals will use the transfer. This leads to the following government budget constraint

$$\tau + \theta_1\sigma_1 = t\sum_i \theta_i w_i l_i(t,\tau,1,\gamma), \tag{27}$$

where $\sigma_1 = \bar{\pi}L - \gamma w_1 l_1(t,\tau,1,\gamma)$.

[14] See Stiglitz (1982) for an analysis with two productivity types.

[15] Slemrod et al. (1994) point out a mistake in Sheshinski (1989) who stated the opposite result.

The problem for regime CH can thus be written as

$$\max_{t,\tau,\gamma} \quad W \tag{28}$$

$$\text{s.t.} \qquad \tau + \theta_1(\bar{\pi}L - \gamma w_1 l_1(t,\tau,1,\gamma)) = t\sum_i \theta_i w_i l_i(t,\tau,1,\gamma)$$
$$\hat{\gamma}_1 > \gamma \geq \hat{\gamma}_2.$$

Again, we assume GHH-preferences and maximin welfare (see Appendix A.4). Comparing regime CH with the ZB proposal, we can prove the following result.

Proposition 2: *With GHH preferences (5), social insurance combined with premium subsidies makes the worst-off better off if all low-productivity individuals are high-risk types* ($\kappa_1 = 1$).

Proof: See Appendix A.4.

Proposition 2 shows that social insurance can be an important instrument even if premium subsidies are in place. If all low-productivity individuals are high risks, there are no $1l$-types who receive premium subsidies. The transfers in both regimes therefore target equally well low-productivity, high-risk individuals. Regime CH, however, leads to an additional welfare gain. Through social insurance it provides additional transfers to $1h$-types without any efficiency loss. It can therefore be expected that regime CH performs particularly well if the share of high-risks among low-productivity individuals is high.

With $\Delta W \equiv W^{ZB} - W^{CH}$ and $\alpha = (1-\nu)W^{-\frac{\nu}{1-\nu}}$, we obtain the following results with respect to changes in κ_1 and κ_2:

$$\left.\frac{\partial \Delta W}{\partial \kappa_1}\right|_{W^{ZB}=W^{CH}} = \alpha\left[\theta_1^2(\pi_h - \pi_l)L - \theta_1\delta\right] + \mu^*\frac{\partial \hat{\gamma}_2}{\partial \kappa_1} \lesseqgtr 0 \tag{29}$$

$$\left.\frac{\partial \Delta W}{\partial \kappa_2}\right|_{W^{ZB}=W^{CH}} = \alpha\theta_1\theta_2(\pi_h - \pi_l)L + \mu^*\frac{\partial \hat{\gamma}_2}{\partial \kappa_2} > 0, \tag{30}$$

where $\mu^* \geq 0$ is the Lagrange-multiplier associated with the incentive constraint.

Equation (29) shows that an increase in κ_1 has a negative effect in both regimes. In regime CH, premium subsidies for all low-productivity types increase as social health insurance becomes more expensive. Additionally, the incentive constraint becomes more binding since $\partial\hat{\gamma}_2/\partial\kappa_1 > 0$. These two effects are given by $\theta_1^2(\pi_h -$

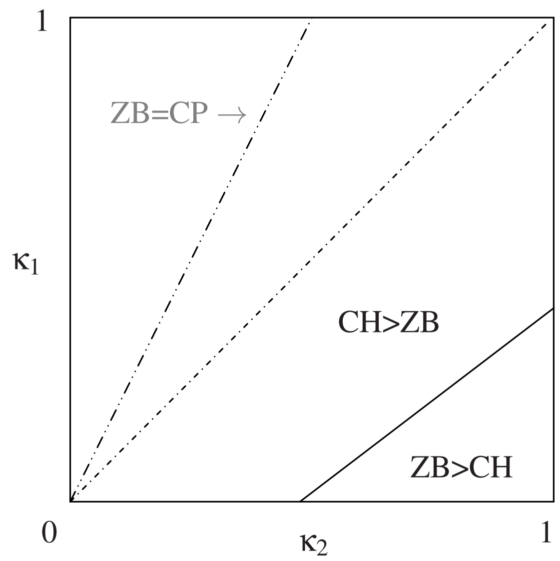

Figure 5: Comparison between ZB and CH
GHH utility, $w_1 = 5$, $w_2 = 10$, $\pi_l = 0.2$, $\pi_h = 0.5$, $\theta_1 = 0.5$, $L = 15$, $\varepsilon = 1$.

$\pi_l)L$ and $\mu^* \partial\hat{\gamma}_2/\partial\kappa_1$. In the ZB solution, more transfers have to be given to $1h$-types leading to higher losses due to reduced labor supply. This is measured by $\theta_1\delta$. The overall effect on ΔW is ambiguous.[16]

From equation (30), it can be seen that an increase in κ_2 only affects regime CH. First, it increases the government's expenditures for all low-productivity types and, second, the incentive constraint becomes more binding, $\partial\hat{\gamma}_2/\partial\kappa_2 > 0$. Therefore, an increase in κ_2 makes the ZB proposal superior.

It is not possible to derive obvious results with respect to the other parameters of the model. Therefore, we again perform numerical simulations and compare the results of the maximization problem (28) with welfare in the ZB model as given by (23). At the optimum, we always find that $\gamma^* = \hat{\gamma}_2$. The optimal policy parameters for the CH regime are in the intervals $t^* \in [0.34; 0.36]$, $\tau^* \in [10.6; 13.1]$ and $\gamma^* \in [0.05; 0.13]$.

Figure 5 shows the simulation results for our benchmark case. As predicted,

[16] Note that the negative effect of increased social insurance premiums in regime CH is only a fraction θ_1 of the negative effect in regime CP [see equation (24)]. In contrast to regime CP, higher social insurance premiums affect welfare only by increased premium subsidies to low-productivity individuals.

regime CH is superior for $\kappa_1 = 1$ and raising κ_2 puts the ZB proposal at an advantage. Increasing κ_1 is in favor of regime CH as the additional distortions in labor supply are smaller. Again the ZB solution is more likely to be superior, the more negative the correlation between health and productivity. Compared to the CP model, however, the range of parameters is much smaller. This shows that a considerable part of advantage of the ZB proposal can be explained by the introduction of non-linear taxation. The increase in the marginal tax rate for low-productivity individuals does not decrease welfare as argued by Zweifel and Breuer (2006b) but rather serves to increase welfare in a second-best setting. Our main insight is therefore that premium subsidies are complements rather than substitutes to social insurance for a large range of parameters.

Changes in the parameters π_h, θ_1, L and ε shift the line separating the regimes, making it more likely that one regime is superior. Numerical simulations indicate the following effects:

- As above, an increase in the high-risk types probability of illness π_h is in favor of the ZB solution. In contrast to regime CH, $2h$-types do not receive more transfers.
- A higher share of low-productivity individuals θ_1 turns regime CH inferior. This regime is more affected since transfers are also given to $1l$-types which results in more efficiency losses due to distorted labor supply.
- An increase in medical expenditure L makes it more likely that the ZB proposal is superior since transfers are only given to $1h$-types.
- Increasing the elasticity of labor supply ε puts the CH solution at an advantage. An explanation for this result is a higher welfare gain by non-linear taxation if the elasticity of labor supply is larger. Regime CH fares better because it sets the same marginal tax rate for all low-productivity individuals.

We also find that the CH solution always dominates the CP solution for GHH preferences and maximin welfare. Since both regimes have full social insurance, this shows that the introduction of premium subsidies generates a welfare gain on its own. The intuition is that non-linear taxation with decreasing marginal tax rates in the CH solution is superior to the linear tax scheme in the CP model.

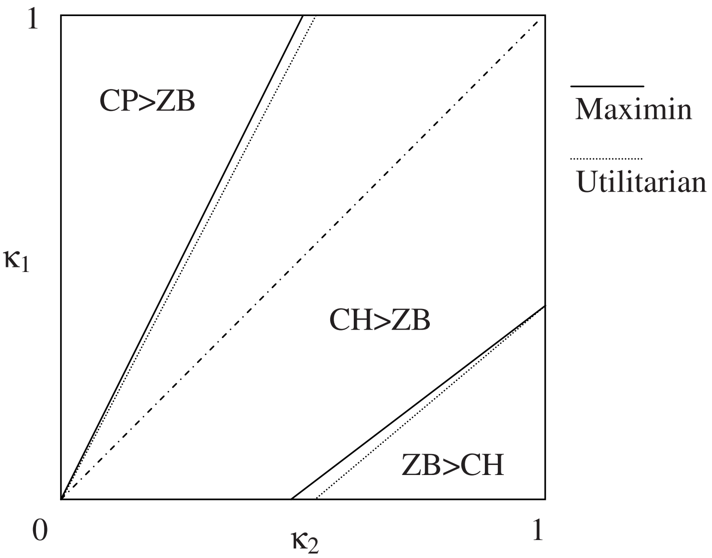

Figure 6: Results for maximin and utilitarian welfare
GHH utility, $w_1 = 5$, $w_2 = 10$, $\pi_l = 0.2$, $\pi_h = 0.5$, $\theta_1 = 0.5$, $L = 15$, $\varepsilon = 1$.

4.5 Extensions

So far, we assumed that the government maximizes a maximin social welfare function and analyzed regimes in which some parameters of the general problem presented in Section 4.1 were restricted. In this Section, we extend the analysis. First, we examine how a utilitarian welfare function changes the results. Second, we consider interior solutions for social insurance as well as more generous premium subsidies schemes.

4.5.1 Utilitarian welfare

Figure 6 compares results for maximin and utilitarian welfare assuming logarithmic utility, i.e., $u = \ln(\cdot)$. The differences are small. In general, the ZB solution performs somewhat worse for utilitarian welfare.

Comparing the ZB solution to regime CP, i.e., full insurance without premium subsidies, the two regimes fare equally well under an utilitarian objective if there are no high-risk individuals in society, i.e., $\kappa_1 = \kappa_2 = 0$. There is no advantage of having social insurance as all individuals are of the same risk type. Additionally, no benefit of targeting towards $1h$-types prevails as there are only low-risk types in the society. For given κ_1, however, an increase in κ_2, puts the CP solution with utilitarian welfare slightly at an advantage. The intuition is that social insurance also redistributes from $2l$- to $2h$-types. Benefits of the latter do not count with maximin welfare but are considered with utilitarian welfare.

Contrasting the ZB solution with the Swiss scheme CH shows that the ZB solution performs slightly worse for utilitarian welfare. At first sight, this may be surprising since $1l$- types are now considered in the welfare function. They must pay higher health insurance premiums in the CH solution. However, they also receive a premium subsidy. Overall, the Swiss scheme makes $1l$-types better off, which implies that the case for this scheme is stronger with utilitarian welfare.

4.5.2 The general solution

The three regimes CP, ZB and CH do not include all possible scenarios. All restrict the recipients of premium subsidies (CP none, ZB only $1h$-types, CH only low-productivity types) and the extent of social insurance (either none or full).[17] Thus, they do not allow

- interior solutions for social insurance, i.e., $0 < s < 1$, and
- premium subsidies for groups beyond the worst-off.

We therefore perform numerical simulations for the general problem presented in Section 4.1 in which all parameters t, τ, s and γ are optimally chosen. Our results are shown in Figure 7.

A common feature of all solutions are premium subsidies. The benchmark model without premium subsidies is never optimal. For a positive correlation between productivity and health, the Swiss regime, i.e., having full social insurance and subsidizing all low-productivity individuals, is always the best regime. The ZB proposal is only superior if health and productivity are highly negatively correlated and the welfare function is utilitarian. However, an extended version of ZB,

[17] For regime CP, however, we showed in Appendix A.2 that $s^* = 1$ is the solution irrespective of the correlation between health and productivity.

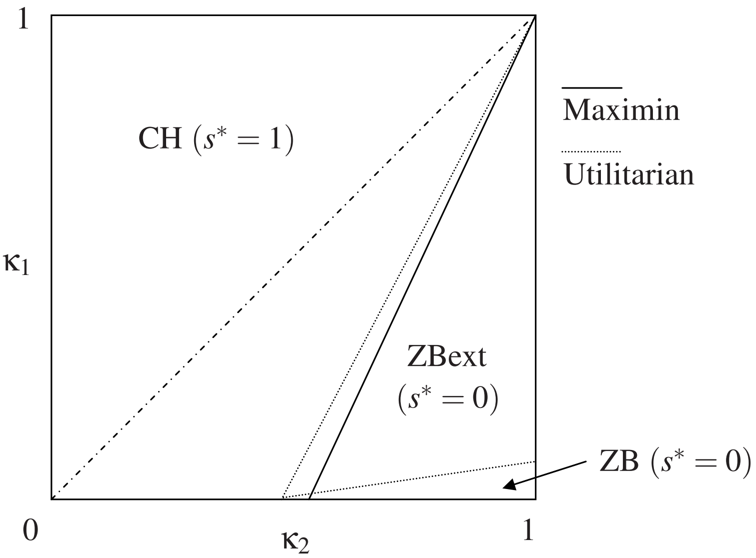

Figure 7: General case
GHH utility, $w_1 = 5$, $w_2 = 10$, $\pi_l = 0.2$, $\pi_h = 0.5$, $\theta_1 = 0.5$, $L = 15$, $\varepsilon = 1$.

"ZBext", which gives premium subsidies to all low-productivity individuals, i.e., $1h$- and $1l$-types, can be optimal.

For maximin and utilitarian welfare, Figure 7 shows that premium subsidies complement social insurance if health and productivity are positively correlated. By contrast, the argument by Zweifel and Breuer requires a strong negative correlation of health and productivity. Only then it is advantageous to abandon social insurance and to solely rely on premium subsidies. Figure 7 also shows that interior solutions for social insurance are generally not optimal. Only along the border between regime CH and ZBext are they possible.

Again, the results for maximin and utilitarian welfare do not differ much. The CH regime performs slightly worse than the ZBext solution for utilitarian welfare. In both cases, all low-productivity individuals receive premium subsidies. However, the cross-subsidization from $1l$ to $2h$-types via the social health insurance scheme in regime CH is not present in the ZBext solution. As utility of $1l$-agents is counted with utilitarian welfare, the ZBext solution is more likely to dominate regime CH from a utilitarian perspective.

5 Conclusion

To best redistribute to the double disadvantaged, i.e., the high-risk, low-income individuals, Zweifel and Breuer (2006a) propose to abandon social insurance and to introduce premium subsidies combined with risk-based premiums instead. In Switzerland, by contrast, premium subsidies are used in combination with social insurance. This raises the question whether premium subsidies are substitutes or complements to social insurance.

In this paper, we assessed the merits of premium subsidies in a theoretical framework. First, we characterized the optimal solution for the ZB proposal as well as for social insurance. We found that the correlation of health and productivity is crucial. The ZB proposal is more likely to be superior, the less positive this correlation.

Second, we compared the ZB proposal with a social insurance scheme that also contains a premium subsidy. This changed the results strongly in favor of social insurance and shows that a considerable part of the welfare advantage is due to the fact that premium subsidies introduce an element of non-linear taxation. In particular, we found that premium subsidies complement social insurance if health and productivity are positively correlated. Our results apply for both maximin and utilitarian welfare. Numerical simulations which allow for general combinations of social insurance and premium subsidies confirm our findings.

Our main insight is that premium subsidies are complements to social insurance if health and productivity are positively correlated. Only if there is a considerable negative correlation between productivity and health, premium subsidies substitute for social health insurance. The findings by Cremer and Pestieau (1996) that a positive correlation of health and income provides a strong argument for social insurance can therefore be extended to include premium subsidies. This supports the argument by McGuire (2006) that social insurance can be optimal from a second-best perspective if poverty and ill health are positively correlated.

A limitation of our analysis is that we abstracted from moral hazard effects. This would shift the argument in favor of the ZB proposal if there are considerable benefits of making optimal cost sharing dependent on risk types. On the other hand, the premium subsidy reduces the incentives to search for a well-priced health plan.

Furthermore, individuals who receive a subsidy will tend to over-insure.

Our analysis did not include the retired who cause a large part of health care expenditure. Typically, social insurance is organized on a pay-as-you-go basis and therefore redistributes between age groups. The impact of premium subsidies then depends on how premiums vary with age. Future work could consider these effects in a model with overlapping generations.

Finally, we assumed that risk-based premiums are actuarially fair given an individual's risk type. Although a common assumption in the literature, studies by Pauly and Herring (1999, 2007) indicate a substantial amount of risk pooling even if risk-based premiums are allowed. An encompassing evaluation of the merits of premium subsidies in combination with risk-based premiums would have to take into account this aspect as well.

A Appendix

A.1 GHH-preferences and the critical value $\hat{\gamma}$

We first determine the indirect utility functions. Solving problem (9) yields

$$c^* = \tau + [(1-\gamma-t)w]^{1+\varepsilon}, \quad l^* = [(1-t-\gamma)w]^{\varepsilon}. \tag{A.1}$$

This leads to the indirect utility function

$$\hat{V}(\tau, t+\gamma, w) = \frac{1}{1-\nu}\left(\tau + \frac{1}{1+\varepsilon}[(1-\gamma-t)w]^{1+\varepsilon}\right)^{1-\nu} \tag{A.2}$$

The solution to problem (10) is

$$c^* = \tau - p + [(1-t)w]^{1+\varepsilon}, \quad l^* = [(1-t)w]^{\varepsilon}. \tag{A.3}$$

Hence, the indirect utility function is given by

$$V(\tau, t, w, p) = \frac{1}{1-\nu}\left(\tau - p + \frac{1}{1+\varepsilon}[(1-t)w]^{1+\varepsilon}\right)^{1-\nu} \tag{A.4}$$

From setting $\hat{V}$ equal to V, we obtain the critical value

$$\hat{\gamma} = (1-t) - w^{-1}\left[((1-t)w)^{1+\varepsilon} - (1+\varepsilon)p\right]^{\frac{1}{1+\varepsilon}}. \tag{14}$$

A.2 GHH-preferences and the Cremer-Pestieau model

With maximin welfare (3), the government maximizes $V_{1h}(t,\tau,s)$ which using (A.4) and (6) is given by

$$V_{1h}(t,\tau,s) = \frac{1}{1-\nu}\left(\tau + \frac{1}{1+\varepsilon}[(1-t)w_1]^{1+\varepsilon} - [s\bar{\pi} + (1-s)\pi_h]L\right)^{1-\nu}$$

subject to the budget constraint

$$\begin{aligned} \tau &= t(\theta_{1h}w_1 l_{1h}^* + \theta_{1l}w_1 l_{1l}^* + \theta_{2h}w_2 l_{2h}^* + \theta_{2l}w_2 l_{2l}^*) \\ &= t(1-t)^\varepsilon \left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right). \end{aligned} \tag{A.5}$$

(see (A.3) for the labor supply functions). Substitution of (A.5) into the maximin welfare function (3) yields the following maximization problem

$$\max_{t,s} W(t,s) = \frac{1}{1-\nu}\left(t(1-t)^\varepsilon \left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right) + \frac{[(1-t)w_1]^{1+\varepsilon}}{1+\varepsilon} - [s\bar{\pi} + (1-s)\pi_h]L\right)^{1-\nu}$$

As can easily be seen, $s^* = 1$ is the solution irrespective of the correlation between health and productivity. For the optimal tax rate, we obtain the following condition

$$\frac{t^*}{1-t^*} = \frac{1 - w_1^{1+\varepsilon}\left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right)^{-1}}{\varepsilon}.$$

Therefore, the optimal solution is given by

$$W^* = \frac{1}{1-\nu}\left(t^*(1-t^*)^\varepsilon \left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right) + \frac{[(1-t^*)w_1]^{1+\varepsilon}}{1+\varepsilon} - \bar{\pi}L\right)^{1-\nu} \tag{A.6}$$

A.3 Proof of Proposition 1

With preferences given by the utility function (5), labor supply is

$$\hat{l}_{1h}^* = [(1-\gamma-t)w_1]^{\varepsilon} \quad \text{and} \quad l_{ij}^* = [(1-t)w_i]^{\varepsilon} \quad \text{for} \quad ij \neq 1h. \tag{A.7}$$

Inserting into (23) yields the following maximization problem for maximin welfare:

$$\begin{array}{rcl} \max_{t,\tau,\gamma} \quad \hat{V}_{1h}(t,\tau,\gamma) & = & \frac{1}{1-\nu}\left(\tau + \frac{1}{1+\varepsilon}[(1-\gamma-t)w_1]^{1+\varepsilon}\right)^{1-\nu} \\ \text{s.t.} \quad \tau + \theta_{1h}\sigma_{1h} & = & t\theta_{1h}(1-\gamma-t)^{\varepsilon}w_1^{1+\varepsilon} + t\sum_{ij\neq 1h}\theta_{ij}(1-t)^{\varepsilon}w_i^{1+\varepsilon} \\ \sigma_{1h} & = & \pi_h L - \gamma(1-\gamma-t)^{\varepsilon}w_1^{1+\varepsilon} \\ \hat{\gamma}_{1h} & > & \gamma \geq \max\{\hat{\gamma}_{1l}, \hat{\gamma}_{2h}\} \end{array} \tag{A.8}$$

where $\hat{\gamma}_{ij}$ is given by (14). Substituting in the constraints into the objective function, we have for $\gamma = \hat{\gamma}_{1l}$ and $\kappa_1 \to 0$

$$W^{ZB} \approx \frac{1}{1-\nu}\left(t(1-t)^{\varepsilon}\left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right) + \frac{(1-\hat{\gamma}_{1l}-t)^{1+\varepsilon}w_1^{1+\varepsilon}}{1+\varepsilon}\right)^{1-\nu}$$

Equation (14) implies $[(1-\hat{\gamma}_{1l}-t)w_1]^{1+\varepsilon} = ((1-t)w_1)^{1+\varepsilon} - (1+\varepsilon)\pi_l L$. Thus,

$$W^{ZB} \approx \frac{1}{1-\nu}\left(t(1-t)^{\varepsilon}\left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right) + \frac{(1-t)^{1+\varepsilon}w_1^{1+\varepsilon}}{1+\varepsilon} - \pi_l L\right)^{1-\nu}$$

From (A.6), we have for $\kappa_1 \to 0$

$$W^{CP} \approx \frac{1}{1-\nu}\left(t(1-t)^{\varepsilon}\left(\theta_1 w_1^{1+\varepsilon} + \theta_2 w_2^{1+\varepsilon}\right) + \frac{(1-t)^{1+\varepsilon}w_1^{1+\varepsilon}}{1+\varepsilon} - [(\theta_1+\theta_{2l})\pi_l + \theta_{2h}\pi_h]L\right)^{1-\nu}$$

Thus, the ZB proposal is superior unless $\kappa_2 = 0$ and therefore $\theta_{2h} = 0$. In this case, the two solutions lead to the same welfare.□

A.4 Proof of Proposition 2

With GHH-preferences and maximin welfare, problem (28) corresponds to

$$\begin{array}{rcl} \max_{t,\tau,\gamma} \;\; \hat{V}_{1h}(t,\tau,\gamma) & = & \frac{1}{1-\nu}\left(\tau+\frac{1}{1+\varepsilon}\left[(1-\gamma-t)w_1\right]^{1+\varepsilon}\right)^{1-\nu} \\ \text{s.t.} \quad \tau+\theta_1\sigma_1 & = & t\theta_1 w_1^{1+\varepsilon}(1-\gamma-t)^{\varepsilon}+t(1-t)^{\varepsilon}\theta_2 w_2^{1+\varepsilon} \\ \sigma_1 & = & \bar{\pi}L-\gamma(1-\gamma-t)^{\varepsilon}w_1^{1+\varepsilon} \\ \hat{\gamma}_1 & > & \gamma \geq \hat{\gamma}_2 \end{array} \tag{A.9}$$

where

$$\hat{\gamma}_i = (1-t)-w_i^{-1}\left[((1-t)w_i)^{1+\varepsilon}-(1+\varepsilon)\bar{\pi}L\right]^{\frac{1}{1+\varepsilon}}.$$

If all low-productivity individuals are high-risk types, the constraint $\gamma \geq \hat{\gamma}_{1l}$ does not apply in the ZB solution as there are no $1l$-types. Comparing problems (A.8) and (A.9), we find that they differ only in health insurance premiums. To see which solution is better, we analyze the general problem

$$\begin{array}{rcl} \max_{t,\tau,\gamma} \;\; V_{1h}(t,\tau,\gamma) & = & \frac{1}{1-\nu}\left(\tau+\frac{1}{1+\varepsilon}\left[(1-\gamma-t)w_1\right]^{1+\varepsilon}\right)^{1-\nu} \\ \text{s.t.} \quad \tau+\theta_1\sigma_1 & = & t\theta_1 w_1^{1+\varepsilon}(1-\gamma-t)^{\varepsilon}+t(1-t)^{\varepsilon}\theta_2 w_2^{1+\varepsilon} \\ \sigma_1 & = & \left[s\bar{\pi}+(1-s)\pi_h\right]L-\gamma(1-\gamma-t)^{\varepsilon}w_1^{1+\varepsilon} \\ \hat{\gamma}_{1h} & > & \gamma \geq \hat{\gamma}_{2h} \end{array} \tag{A.10}$$

with $\hat{\gamma}_{ij} = (1-t)-w_i^{-1}\left[((1-t)w_i)^{1+\varepsilon}-(1+\varepsilon)\left[s\bar{\pi}+(1-s)\pi_j\right]L\right]^{\frac{1}{1+\varepsilon}}$.

This yields maximum utility $V^*_{1h}(s)$ as a function of the share of health care expenditure covered by social insurance. Applying the Envelope Theorem we find

$$\operatorname{sgn}\left(\frac{\partial V^*_{1h}}{\partial s}\right) = \operatorname{sgn}\left(\theta_1(\pi_h-\bar{\pi})-\mu^*\frac{\partial\hat{\gamma}_{2h}}{\partial s}\right),$$

where $\mu^* \geq 0$ is the Lagrange-multiplier associated with the incentive constraint. The term $\theta_1(\pi_h-\bar{\pi})$ is clearly positive. $\partial\hat{\gamma}_{2h}/\partial s < 0$ since $\hat{\gamma}_{2h}$ is increasing in the health insurance premium [equation (11)] which is decreasing in s for high-risk types. This shows that increasing social insurance always increases welfare. Regime CH must therefore be superior if all low-productivity individuals are high-risk types.□

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