# Unisex-Calculation and Secondary Premium Differentiation in Private Health Insurance

**Oliver Riedel**

**University of Giessen**

**Risk Management & Insurance**

**Licher Strasse 74, D - 35394 Giessen, Germany**

**Email: oliver.t.riedel@wirtschaft.uni-giessen.de**

# Unisex-Calculation and Secondary Premium Differentiation in Private Health Insurance

The de facto paid premium in the (German) private health insurance depends on the insurance payments in the past (claim's experience). In case the insured does not make use of the insurance contract and accepts his health costs, he receives a defined premium refund – based on the monthly premium – the following year. The insured should therefore trade off between the premium refund and the health costs he pays by her own, which can be calculated with the stochastic dynamic optimization, to minimize the total financial burden of the health costs (sum of insurance contract and out-of-pocket payment).

Primary and secondary premium differentiation have to be analyzed simultaneously. If there is a tendency in German or European legislation to prohibit gender based (primary) premium differentiation (like in Germany for "Riester"-contracts (as from 2006) or private compulsory nursing care insurance), the insurance industry has still the opportunity to adjust the secondary premium differentiation – especially in health insurance with high claim probability.

In this paper various premium refund systems – which differ e.g. in the amount of the repaid monthly premiums – and their results on the total financial burden of the insured are discussed under realistic assumptions (regarding interest rate, inflation of health costs, gender based probability of medical treatment). It is shown that under these assumptions strongly differentiating premium refund systems result in total financial burdens of the insured that are close to the values achieved by gender based premiums. Simulation studies lead to the conclusion that the strongly differentiating premium refund systems can be accepted even if they have a wider range of the stochastic financial burden. The reason is that women will pay less than in actual premium refund systems with differentiated premiums and men will be better off than in actual premium refund systems with unisex-calculation.

Classification: unisex-tariffs, out-of-pocket-payment, experience rating, simulation study, stochastic dynamic optimization

# Unisex-Calculation and Secondary Premium Differentiation in Private Health Insurance



## 1 Introduction

On December 13th 2004 the Council of the European Union has adopted a directive to implement the principle of equal treatment between men and women in the access to and supply of goods and services. This directive represents a further stage of the proposal for a directive made by Anna Diamantopoulou in 2003. For the insurance business the main focus is on unisex-tariffs which must be the basis of calculation if there is no relevant and accurate actuarial and statistic data. The German government has also established unisex-tariffs in different class of insurance (for example in compulsory nursing care insurance). Therefore it does seem impossible that there may be an obligation to calculate unisex-tariffs in German insurance markets even if the insurers do have relevant and accurate actuarial and statistic data.

In contrast to life insurance, private health insurers cannot only use primary (ex ante) premium differentiation but also secondary (experience-based) premium differentiation. In this paper the possibility to compensate the loss of primary premium differentiation for unisex-tariffs through an extended premium refund system is discussed.

## 2 Primary and secondary premium differentiation in health insurance

### 2.1 Primary premium differentiation

Private insurance companies calculate their premiums according to the actuarial equivalent principle. The net risk premium (P) equals the expected payments by the insurer E(S), where S represents the random variable of the insurer's benefit:

$$P = E(S).$$

If this equation is applied to a group of individual contracts we use the term *collective* equivalent principle. The term *individual* equivalent principle is used, if the equation holds for each risk and policy holder. Individual equivalent premiums are also called (risk-) differentiated, risk-adequate or fair premiums. Fair premiums only refer to actuarial fairness but can be socially undesirable. In these cases the government is in a position to prohibit such tariffs. For example in Germany §81e VAG (Insurance Supervisory Law) prohibits to use the ethnic group or the nationality of the applicant to calculate different premiums for these groups.

Premium differentiation can be divided into *primary* and *secondary* forms. Primary premium differentiation is based on risk factors which can be easily observed ex ante like gender and age in life insurance or type of vehicle and miles travelled in car insurance. All these risk factors are some kind of *objective* in terms of verifiable.

In German private health insurance these fundamental principles have to be adapted for long-term insurance contracts. The employer does only have to pay his 50%-share of the premium if the substitutional health insurance[1] is calculated along the lines of life insurance. In the end almost every German private health insurance contract is calculated this way. So the private health insurance company has to calculate premiums which – on some assumptions – do not

[1] §12 (1) VAG states that a substitutive health insurance is a private which can replace the public health insurance.

rise during the duration of the contract – especially when the insured ages even if the expected medical costs rise with age.

The adapted expected individual equivalent principle for long-term insurance contracts can be formulated as follows: expected discounted paid premiums by the insured must equal expected discounted payments by the insurer. German private health insurers use –apart from the extend of the insurance coverage – three tariff factors to differentiate premiums ex ante: *state of health* and *age* at the begin of the contract as well as *gender* of the insured.

Let x be the age of the insured at the commencement of the contract, $C_i$ the estimated medical costs (differentiated by gender) resulting from the contract and paid by the insurer, i the interest rate (set to 0.035 by the calculation regulation) and $P_x$ the (constant) premium paid by the insured, using the expected individual equivalent principle the premium can be calculated as follows:

$$P_x = \frac{\sum_{j=x}^{\omega} C_j \cdot l_j \cdot \left(\frac{1}{1+i}\right)^{j-x}}{\sum_{j=x}^{\omega} l_j \cdot \left(\frac{1}{1+i}\right)^{j-x}}$$

where $l_j$ represents the remaining portfolio of policyholders of age j ($l_{20}$ is set to 100,000). This parameter is calculated using mortality rate ($q_j$) and probability of cancellation at age j ($w_j$) which are published by the insurance supervisors (VerBaFin) according to the formula:

$$l_{j+1}=l_j\cdot(1-w_j-q_j)$$

In conclusion, as in live insurance the health insurance premium will be too high compared to the expected medical costs at the beginning of the contract and the systematic surplus will be transferred to a special reserve (called ageing reserve). After some years the premium will be too low to cover the expected medical costs and the missing amount will be taken from the ageing reserve.

## 2.2 Secondary premium differentiation

Even in a primary differentiated collective of policyholders there are often still different types of risks which should pay different premiums but are calculated identically. The resulting claim histories depend – in ex ante equal groups of insured risks – on risk factors which can not be used as tariff-parameters although they have a significant influence. Such risk factors are usually called *subjective* and cannot be observed ex ante because they depend strongly on the acts of the insured and her attitude towards damages.

To include subjective risk factors – at least ex post – in calculation, the insurer can use secondary premium differentiation as a part of experience-based rating where the premium depends on the insurance payments in the past (claim's experience). But experienced-based rating has more effects because it can also be used in homogeneous groups where secondary premium differentiation (aspect of rating) does not make any sense. The aim in such groups is not an ex post premium differentiation but creating incentives for the insured to pay for small damages on her own (aspect of co-payment / own contribution).[2] The last aim seems surprising because the contract could have implemented deductibles with same incentives for the insured to pay for small amounts of medical costs by her own. However in Germany the employer usually pays 50% of the premium but often only 0% of the deductible (although a payment by the employer for the deductible is possible), so the insured gets 50% of premium reduction but pays 100% deductible. Therefore significant deductibles are rare in the German health insurance market but can be indirectly achieved through refund systems where the insured gets a 100% reduction of the de facto paid premium for 100% of out-of-pocket payment.

A high probability of loss is necessary to be able to apply experience rating to aspects of secondary premium differentiation.[3] Health insurance contracts meet the requirements because of the high probability of medical treatment. Though, existing premium refund systems in health insurance are far less pronounced than in automobile insurance where the proportion between the highest and the lowest premium is about ten.[4] Usually the insurer refunds a number of monthly premiums (depending on the insurance company these may be up to six resulting in a spread no higher than two) if the insured does not get payments from the contract in the previous year with significant influence to current years de facto paid premium. The number may be constant (considering only the previous year) or may depend on the number of years passed since the last insurance compensation. During the last years some insurance companies have changed from a constant to a variable refund system. At first sight, we should assume that this implies a shift of systems with focus on co-payments to those with focus on secondary premium differentiation. We will discuss this intuitive conclusion in chapter 4.2.

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[2] See Farny (2000), p. 74-77.

[3] See Karten (1993), p. 60 ff.

[4] See Morlock/Zimplemann (1999), p. 7

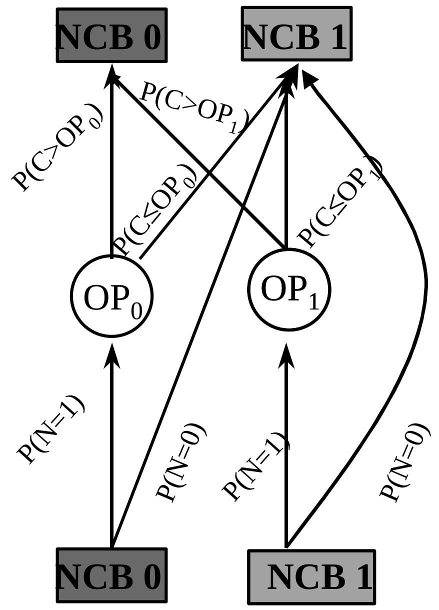
## 3 Optimal out-of-pocket payment in different refund systems

### 3.1 Constant premium refund systems

The premium refund in these systems only depends on the previous year's claims: If the insurer has not paid for the insured's medical treatment and the insurance contract continues to exist until the end of June, the insured receives a fixed number of monthly premiums, for example three.

Let N be the number of annual payments for medical costs, NCB i the no claims bonus class i, $OP_i$ the out-of-pocket payment of the insured and C the medical cost in NCB i. The insured should make her own decision using the following figure.

Figure 1: Out-of-pocket payment in constant premium refund systems




If there has not been any medical treatment in the previous year (N=0), the insured is located in NBC 1 with the probability P(N=0) and may for example receive a premium refund of three monthly premiums. If there was at least one medical treatment (N=1) the insured has to decide whether she pays on her own to reach NBC 1 and get the premium refund or to shift the medical costs to the insurer an get no premium refund in NCB 0.

Since only the previous year is considered in the constant premium refund system, there are no effects of the total medical financial burden in following years. Therefore the insured only compares medical costs and premium refund. The optimal out-of-pocket payment equals the premium refund – neglecting interest rates[5] – and is identical in NCB 0 and NBC 1 because each no claim bonus class can be reached every year. Therefore the insured should pay any medical costs below three monthly premiums on her own.[6] The insured should act as if they had an insurance contract with a deductible of three monthly premiums (aspect of co-payment).

On the other hand, this implicit deductible is the lowest amount paid out to the insured. Therefore the probability of claims in the interval [0, OP) equals zero and the insurance company has to anticipate this insured's reaction and increases the premium.[7]

### 3.2 Variable premium refund systems

To determine the extend of premium refund when using variable premium refund systems, the insurer does not only consider the previous year but all of them since the last insurance compensation. Usually the insured receives one monthly premium for every continuous year without indemnification and the maximum number of premium refunds being limited to three or four. If the insurer pays for medical costs, the insured does not receive a premium refund independent from her current no claim bonus class.

The insured's decision for a refund system with no claim bonus classes 0 to 3 (representing a premium refund of 0 to 3 monthly premiums) can be explained using Figure 2:

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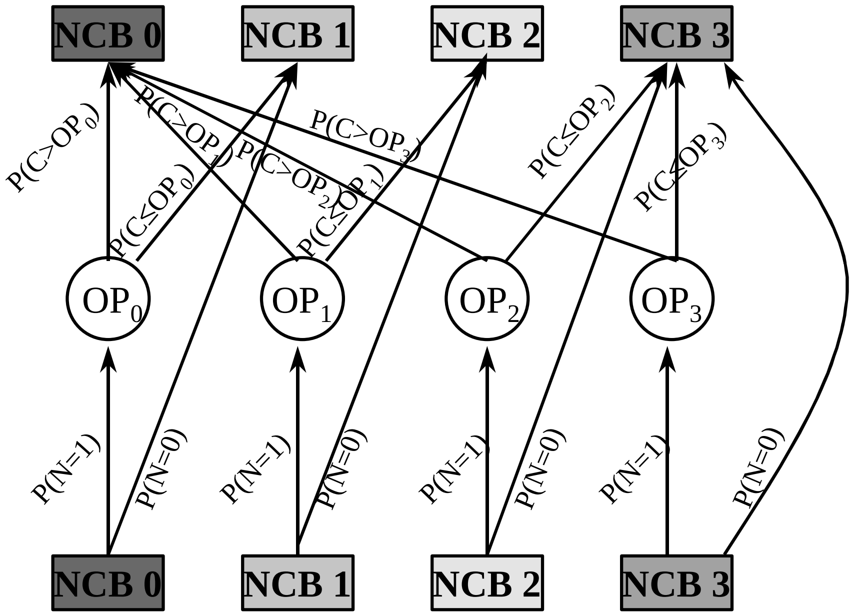
[5] If interest rates are taken into account, optimal out-of-pocket payment equals the discounted premium refund.

[6] We should assume optimal out-of-pocket payment to be slightly higher than the premium refund due to transaction costs (like postage for letters) – but empirical studies about claims show claims of 0,56 EUR in health insurance. Therefore transaction costs can be neglected.

[7] The refund system should not depend on the annual balance, because only these refund systems can be applied without alterations for the whole duration of the contract and for this reason trusted for optimization by the insureds.

Figure 2: Out-of-pocket payment in variable premium refund systems




For variable refund systems the optimal out-of-pocket payment can not be calculated as easily as in systems with constant refunds because only comparing the costs of one year neglects the fact that – with exception of NBC 0 – each no claim bonus class i can only be reached if the insured was located in class i-1 during the previous year.

Therefore a payment by the insurer does not only effect the premium refund of the current year but also reduces the premium refund for the following year. Assuming there will not be any medical treatment in the following years, an insured in NBC 3 has got to take into account that a payment by the insurance in 2004 will decrease the premium refund by six monthly premiums in the following years:

Figure 3: Basis model to calculate optimal out-of-pocket payment

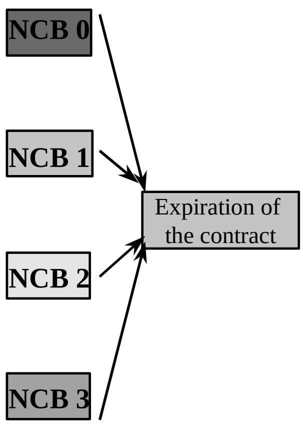
| Year | NCB (payment by the insurer) | NCB (payment by the insured) | Difference |
|---|---|---|---|
| 2005 | 3 | 0 | 3 |
| 2006 | 3 | 1 | 2 |
| 2007 | 3 | 2 | 1 |
| 2008 | 3 | 3 | 0 |

This basic example with strict assumptions shows that the optimal out-of-pocket payment exceeds the current premium refund. In conclusion, the out-of-pocket payment is not only the self payment of one year's medical costs but also an investment in future premium refunds. It is monotonically increasing in relation to the actual NBC[8] not only because of the following year's higher premium refund but also because of the extended period to reach (highest refund) NBC 3.

Under more realistic assumptions further medical treatments during the following years have to be considered. If risk neutral behaviour is assumed the optimal out-of-pocket payment is one which minimizes the expected discounted health costs for the entire life as a sum of insurance premiums, out-of-pocket payments and premium refunds. For each treatment, the insured has to decide whether she pays on her own or whether she lets the insurer pay.

To determine the optimal out-of-pocket payment for the entire contract duration, the stochastic dynamic optimisation[9] is used.[10] This procedure uses a backward calculation with the expiration of the contract as starting point.

Figure 4: Decision at age 100




During the final year of life the insured should not pay medical costs of her own because she will not receive any premium refund which depends on an existing contract until June the following year. If we assume that no insurance holder will live after her 100$^{th}$ birthday, the

[8] Optimal out-of-pocket payment in NBC 2 equals 6 monthly premiums, 5 monthly premiums in NBC 1 and 3 monthly premiums in NBC 0.

[9] The procedure of stochastic dynamic optimisation is extensively presented in Neumann/Morlock (2002), p. 593-621.

[10] Obviously this technique can also be used for constant premium refund systems, but the previous approach is less complex.

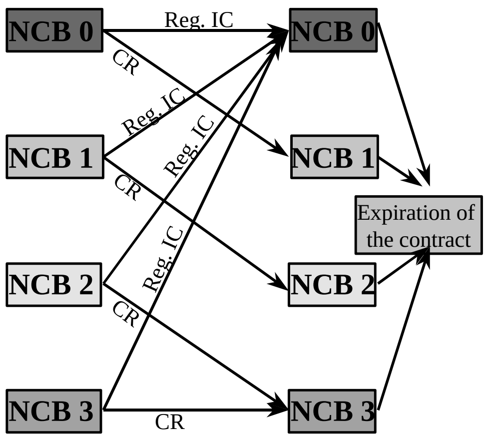
optimal out-of-pocket payment at age 100 does not depend on the no claim bonus class and equals zero.

We can conclude that the total financial burden at age 100 depends only on the NBC and equals for NBC i:

Premium (age 100) – i monthly premiums (age 99).

At age 99 the optimisation can be described as in Figure 5:

Figure 5: Decision at age 99




Now the insured has to take into account that her out-of-pocket payment influences the financial burden at age 100. If the insured is located in NBC i her expected financial burden only depends on her decision about her out-of-pocket payment ($OP_i^m$), which – as stated before – depends on her current age (m) and current NBC i. This sum includes the expected financial burden of all ages till death and is composed of annual premium (age 99), premium refund (age 98), expected out-of-pocket payment (age 99) and expected financial burden at age 100 (as calculated before). Similar calculations can be made for ages 98, 97, 96,…

Therefore, the expected financial burden till death at each age only depends on the out-of-pocket payment at this age, assuming optimal insured's decisions during the following years till death and can be calculated for each age m, and NBC i<3 according to:

$$E\left(C_i^m\left(OP_i^m\right)\right) = yearly\ premium - premium\ refund + (1-q_m)\cdot\left[\underbrace{P(N=0)\cdot E\left(C_{i+1}^{m+1}\right)}_{\substack{following\ costs\ without\\ medicial\ treatment}}\right.$$

$$\left.+P(N=1)\cdot\left[\underbrace{\int_0^{OP_i^m} xf^m(x)dx}_{\substack{expected\ out-of-\\ pocket\ payment}} + \underbrace{P\left(C^m \le OP_i^m\right)\cdot E\left(C_{i+1}^{m+1}\right)}_{\substack{expected\ cost\ reduction\ by\\ out-of-pocket\ payment\ (NBC\ i+1)}} + \underbrace{P\left(C^m > OP_i^m\right)\cdot E\left(C_0^{m+1}\right)}_{\substack{no\ effect\ by\ out-of-pocket\\ payment\ (NBC\ 0)}}\right]\right]$$

and for each age m and NBC i = 3 – due to restraining no claim bonus classes to three – according to:

$$E\left(C_3^m\left(OP_3^m\right)\right) = yearly\ premium - premium\ refund + (1-q_m)\cdot\left[\underbrace{P(N=0)\cdot E\left(C_3^{m+1}\right)}_{\substack{following\ costs\ without\\ medicial\ treatment}}\right.$$

$$\left.+P(N=1)\cdot\left[\underbrace{\int_0^{OP_3^m} xf^m(x)dx}_{\substack{expected\ out-of\\ pocket\ payment}} + \underbrace{P\left(C^m \le OP_3^m\right)\cdot E\left(C_3^{m+1}\right)}_{\substack{expected\ cost\ reduction\ by\\ out-of-pocket\ payment\ (NBC\ i+1)}} + \underbrace{P\left(C^m > OP_3^m\right)\cdot E\left(C_0^{m+1}\right)}_{\substack{no\ effect\ by\ out-of-pocket\\ payment\ (NBC\ 0)}}\right]\right]$$

where

| | |
|---|---|
| $OP_i^m$ | out-of-pocket payment, NBC i and age m |
| $C^m$ | random variable of health costs at age m |
| $f^m$ | density function of health costs at age m |
| $E\left(C_i^m\left(OP_i^m\right)\right)$ | expected financial burden till death as a function of $OP_i^m$, NBC i and age m |
| $E\left(C_{i+1}^{m+1}\right)$ | expected financial burden from age m+1 till death – assuming optimal out-of-pocket payment from age m+1 till death[11] |
| $q_m$ | probability of death at age m. |

This equation is minimized for i<3 by

$$OP_i^m = E\left(C_0^{m+1}\right) - E\left(C_{i+1}^{m+1}\right)$$

and for i=3 by

$$OP_3^m = E\left(C_0^{m+1}\right) - E\left(C_3^{m+1}\right).$$

# 4 Different refund systems

## 4.1 Expected Financial burden

First of all considering the effects of changes in refund systems on the financial burden, these effects are calculated using following statistics:

- mortality rate (published in VerBaFin 6/2003)
- probability of cancellation (published in VerBAV 12/2002)
- estimated expected medical costs (published in VerBaFin 11/2003).

To obtain more detailed information about the distribution of medical costs – and not only using an estimator for expected medical costs – a health insurance collective of a German insurance company has been analysed. The relevant interval [0, $OP^{max}$) can be analysed for age m using an exponential distribution with the parameter $1/C^m$ and the probability of medical treatment being 80% per year throughout the collective.

Furthermore, for simplification – but not risking oversimplification – it must be assumed that

- the annual premium is paid on January 1st,
- medical treatment takes place on January 1st and
- people die on December 31st.

Explicitly, only the net risk premium is considered. In Germany there is a 10% loading to prevent the insureds from very high premiums at retirement age which is no part of the premium refund. Therefore, this loading is only implicitly regarded: if there is a rise in health costs, it only affects the premiums for people under 65.

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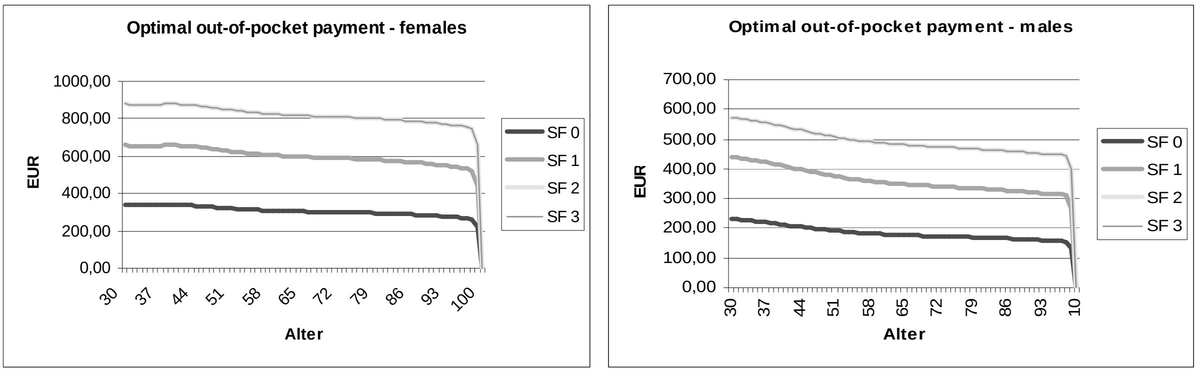
11 $E(C_i^{101}) = 0$ will be used as optimization's starting point.

Using these parameters, we obtain an annual premium of € 2,648.82 at the age of 30 for a female and of € 1,591.13 for a male, assuming that the insured minimizes the financial burden and the insurer anticipates the premium refund of a variable refund system in the calculation.[12] The resulting optimal out-of-pocket payments are as follows:

Figure 6: Optimal out-of-pocket payments




The figure shows a similar scheme for both sexes. At the beginning of the contract, the optimal out-of-pocket payment is higher than during the duration or at the end of the contract.[13] The optimal out-of-pocket payment is monotonically increasing with NBC i but differs between the sexes. The difference depends mainly on the higher absolute premium refund for females due to their higher premiums (compared to males' premiums). The resulting expected financial burden (premium, premium refund and out-of-pocket payment) is 148,120.98 EUR for females and 83,381.98 EUR for males.

Considering a constant premium refund system with a no claims bonus of three monthly premiums, the insurer calculates a premium of € 2,767.86 for females and € 1,667.51 for males. The optimal out-of-pocket payment is a constant € 691.97 during the duration of the contract for females and € 416,88 for males. Resulting expected financial burden is € 148,155.99 for females and € 83,649.13 for males, so a refund system with anticipated refunds does not influence the expected financial burden.[14]

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[12] The analysed system refunds up to three monthly premiums.

[13] There are some exceptions for women up to the age of 42 due to medical treatment during pregnancy and costs of giving birth

[14] The difference of 0,03% for females and 0,5% for males results from the use of the exponential distribution for calculating the expected out-of-pocket payment.

## 4.2 Secondary premium differentiation

Since the expected financial burden does not differ between the analysed refund systems, it should be examined which system has advantages with respect to secondary premium differentiation.

We consider a portfolio of policyholders with 50% high and 50% low risks. Three scenarios have been analysed, assuming differences between these two types of risks as follows:

- expected medical costs equal 4/3 (high risk) and 2/3 (low risk) of expected costs of all policyholders [scenario 1],
- probability of medical treatment for one year equals 0,9 (high risk) or 0,7 (low risk) with respect to 0,8 for an average risk [scenario 2] and
- both effects considered simultaneously [scenario 3].

Figure 7: Proportion of the expected financial burden between high risk and low risk, constant and variable (0-1-2-3) premium refund system

| Variant | Proportion of the expected financial burden between high risk and low risk | |
|---|---|---|
| | female | |
| | constant system | variable system |
| Scenario 1 | 1,50% | 0,79% |
| Scenario 2 | 4,85% | 3,06% |
| Scenario 3 | 6,37% | 3,93% |
| | | |
| Variant | male | |
| | constant system | variable system |
| Scenario 1 | 1,55% | 0,98% |
| Scenario 2 | 4,81% | 3,09% |
| Scenario 3 | 6,38% | 4,14% |

Surprisingly, the more differentiated variable refund system is less differentiating for both sexes than the constant refund system, if the insured's total financial burden of health costs is taken into consideration. Therefore an increase in the maximum number of refunded monthly premiums has been analysed. It can be shown that, given the assumptions mentioned above, the variable refund system is more differentiating if the number of refunded premiums exceeds eight.

Figure 8: Proportion of the expected financial burden between high risk and low risk, constant and variable (0-1-2-3-4-5-6-7-8) premium refund system

| Variant | Proportion of the expected financial burden between high risk and low risk | |
|---|---|---|
| | female | |
| | constant system | variable system |
| Scenario 1 | 1,50% | 11,13% |
| Scenario 2 | 4,85% | 5,75% |
| Scenario 3 | 6,37% | 15,93% |
| | | |
| Variant | male | |
| | constant system | variable system |
| Scenario 1 | 1,55% | 8,09% |
| Scenario 2 | 4,81% | 6,87% |
| Scenario 3 | 6,38% | 18,66% |

Scenario 2 with only differences in the probability of medical treatment is the least differentiating. Scenario 1 with differences in the expected medical costs is far more differentiating is. The highest differentiation can be observed in scenario 3 with differences in the probability of medical treatment and differences in expected medical costs.

# 5 Unisex-Tariffs in Health-Insurance

## 5.1 European and German law

On December 13th 2004 the Council of the European Union has adopted a directive (Council Directive 2004/113/EC) to implement the principle of equal treatment between men and women in the access to and supply of goods and services. For the insurance industry article 5 [actuarial factors] is important. All new contracts concluded after December 21st 2007 should be calculated without taken the insured’s sex into consideration. In contrast to Anna Diamantopoulou’s proposal of a directive the new directive grants the member states the right to allow using the insured’s sex as a risk parameter if the assessment of risk is based on relevant and accurate actuarial and statistic data with exception of costs related to pregnancy and maternity.

The German private insurance industry has to use unisex-tariffs in the compulsory nursing care insurance and from 2006 on in state-aided annuity insurance (so-called “Riester-Rente”). Other restrictions of premium calculation can be found in the German law against discrimination which has yet to be implemented by the government and will not be implemented before the election in September 2005. Nevertheless, it must be taken into account that the German government has not only adopted the European directive into the German law but went further by implementing more restraining laws than the European directive demands.

### 5.2 Economic Effects of Unisex-Tariffs

Unisex-Tariffs would result in equal premiums for different types of risks. This may be socially desirable but implies economic reactions of the insureds with have to be taken into account.

First of all, the effect of adverse selection should be considered. If high risks (females, regarding unisex-tariffs) pay the same premium as low risks (males, regarding unisex-tariffs) there should be an increase in females' insurance demand and a decrease in males' insurance demand.[15] German private health insurers therefore stated that unisex-tariffs will equal females' tariffs.

Learning from Rothschild/Stiglitz (1976), such effects can be neglected if different insurance policies with different extents of coverage are offered. Under these conditions, high risks should buy full coverage and low risks only partial coverage. Therefore, there is a self-signalling and both types of risks can be calculated according to the actuarial equivalent principle. As discussed in 2.2, deductibles are not very popular in Germany due to employer's 50% share of the premium. Therefore, deductibles can not solve the problem and different premium refund systems should be analysed.

### 5.3 Unisex-Tariffs and Experience Rating

Technically unisex-tariffs are only a variation of primary premium differentiation. As discussed in 4.1, the total financial burden of the insured does not only depend on primary premium differentiation but also on secondary premium differentiation. Morlock/Zimpelmann (1999) analysed analogue effects on the Germans car insurance market after deregulation. After 1994 many insurance companies extended their primary premium differentiation and

[15] The adverse selection should occur especially in complementary insurance. The effects for substitutive insurance may be less strong due to the actual premium system of public health insurance with high premiums for people who may buy substitutive private health insurance instead of public health insurance. Unisex-Tariffs in private health insurance for these males may still be lower than public premiums. But regarding the discussion about a fixed premium for everyone in Germany a changeover to this calculation principle would increase the effects of unisex-tariffs in private health insurance.

Morlock/Zimpelmann showed in their paper that those insurers should have adapted their premium refund systems to calculate risk adequate premiums and to avoid over-differentiation with high risks' premiums being to high and low risks' premiums being too low.

The same technique can be used for unisex-tariffs. In contrast to car insurance industry with its extended primary differentiation and the resulting need for less secondary premium differentiation, unisex-tariffs stand for less primary premium differentiation and should therefore result in extended secondary differentiation.

Using the results of 4.2, secondary premium differentiation can be used to obtain a risk adequate financial burden of the insureds:

- Statistics, published by German insurance supervisors, present significant differences in expected health costs between both genders with higher expected costs for females.
- It can be derived from gender studies that females and males have different probabilities of medical treatment with a higher probability for females.[16]

Therefore, unisex-tariffs are a type 3 scenario and an extensive secondary premium differentiation can be expected. To quantify the impact of secondary premium differentiation various premium refund systems have been analysed. To model the differences between females and males the following results are based on the assumption that the probability of medical treatments is not 0.8 for both sexes but 0.9 for females and 0.7 for males.[17] Furthermore it can be assumed that the insureds anticipate an increase of health costs by 1% per year and use an interest rate of 3% per year. The results are as follows:

[16] See Klotz (1998), p. 37 f. and p. 94.

[17] These probabilities correspond to empirical data for screening with the observation, that 35% of the females but only 17-18% of the males participate in these screenings.

Figure 9: Proportion of the expected financial burden between females and males, different premium refund systems

| NBC | system A | system B | system C | system D | system E | system F | system G | system H |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 2 | 1 | 1 | 3 | 3 | 3 | 4 | 4 |
| 2 | 4 | 2 | 2 | 3 | 6 | 6 | 6 | 8 |
| 3 | 6 | 3 | 3 | 3 | 6 | 9 | 6 | 8 |
| 4 | 8 | 4 | 3 | 3 | 6 | 9 | 6 | 8 |
| 5 | 10 | 5 | 3 | 3 | 6 | 9 | 6 | 8 |
| 6 | 10 | 6 | 3 | 3 | 6 | 9 | 6 | 8 |
| 7 | 10 | 7 | 3 | 3 | 6 | 9 | 6 | 8 |
| 8 | 10 | 8 | 3 | 3 | 6 | 9 | 6 | 8 |
| 9 | 10 | 9 | 3 | 3 | 6 | 9 | 6 | 8 |
| 10 | 10 | 10 | 3 | 3 | 6 | 9 | 6 | 8 |
| 11 | 10 | 11 | 3 | 3 | 6 | 9 | 6 | 8 |
| Proportion | 45,64% | 44,49% | 7,66% | 9,85% | 19,51% | 38,45% | 19,65 | 31,01% |

Females’ expected financial burden of current primary premium differentiation is in system C (reference refund system) 63,80% higher than males’ expected financial burden. The results lead to the conclusion, that an almost risk adequate expected financial burden can be achieved even in unisex-tariffs as long as secondary premium differentiation is considered. Except for different expected premium refunds due to different probabilities of medical treatments the main influence is based on the higher out-of-pocket payment of males and the lower out-of-pocket payment of females due to higher premiums for males and lower for females in unisex-tariffs compared to actual differentiated premiums. The extent of the differentiation of the expected financial burden between females and males depends on the premium refund system and is greater for refund systems with

- more no claims bonus classes and
- higher premium refunds in each no claims bonus class.

Apart from differentiation between females and males an extended experience rating also differentiates between high and low risks of each gender. Therefore the expected financial burden is risk adequate, not only gender adequate.

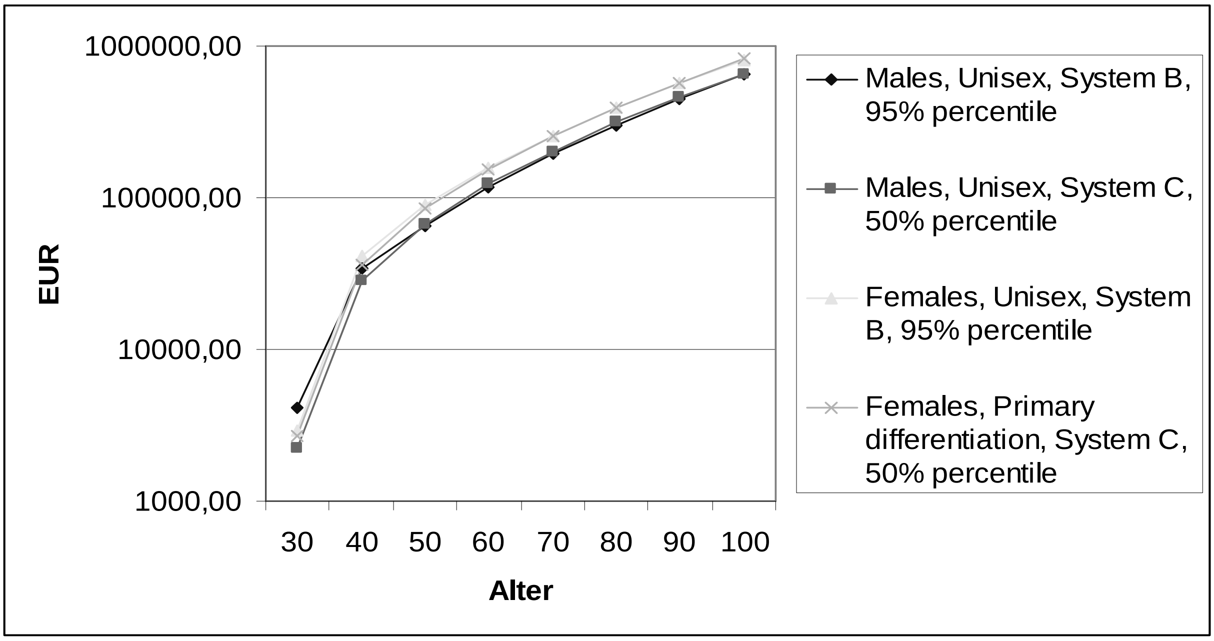
Associated with an increase in secondary premium differentiation is the risk transfer back to the insured. Especially in long term insurance the contract implies a coverage of changes in the health status of the insured during the duration of the contract. To value this effect a Monte-Carlo-Simulation has been executed. The results for refund system B (measured with the relation of 95% percentile to 5% percentile) are as follows:

Figure 10: Proportion of 95% percentile to 5% percentile (system B)

| age | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|
| males | 1,60 | 1,46 | 1,51 | 1,53 | 1,49 | 1,43 | 1,37 | 1,34 |
| females | 1,15 | 1,25 | 1,28 | 1,23 | 1,20 | 1,17 | 1,16 | 1,15 |

The differences of the expected financial burden between the 95% and 5% percentile are greater than in the actual system with differentiated premiums for females and males. This leads to the conclusion that the coverage for changes in the health status has decreased. But we should also consider that the males' 95% percentile of financial burden in more differentiated refund systems is after some years lower than the 50% percentile in less differentiated ones considering unisex-tariffs. Therefore, the additional uncertainty seems for males acceptable. The same argument holds for females. First of all, the differences between the 95% and 5% percentile are much smaller than the difference for males but greater than in current systems. But if we consider that females' 95% percentile of financial burden in more differentiated refund systems and unisex-tariffs is after some years lower than the 50% percentile in less differentiated refund systems and current primary premium differentiation, it can be concluded that the additional risk can and should be accepted by the insureds. This argumentation uses the following figure.

Figure 11: Percentiles of the insured's financial burden




## 6 Conclusion

The implementation of unisex-tariffs in health insurance is technically "only" a variation of primary premium differentiation. Because the expected financial burden of the insured is determined by primary and secondary premium differentiation, the private health insurance has (in contrast to life insurance) the opportunity to compensate less primary differentiation by more secondary differentiation. More differentiated premium refund systems lead, even in unisex-tariffs, to widely differentiated expected financial burdens of different types of risks.

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