Risk Adjustment in Health Insurance: Effectiveness and Sustainability[1]

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Abstract

Risk adjustment as currently implemented or proposed has two important weaknesses. First, health insurers are unlikely to invest in risk selection unless profits are sufficiently large. Second, to the extent that their planning horizon exceeds one year, they target permanently favorable risks that are permanent members. Neglecting these considerations results either in excessive fine tuning of risk adjustment or in its insufficient neutralization of the insurers' incentive in favor of risk selection. For rendering risk adjustment sustainable, both shortcomings need to be amended.

This paper seeks to contribute to this objective by distinguishing risk types with high and low profit potential and by estimating *long-run* profits of risk selection in four scenarios (no risk adjustment, demographic only, including prior hospitalization, and including prior hospitalization and Pharmaceutical Cost Groups). The data base covers 180,000 Swiss individuals over eight years, three of which are used for model building and five, to estimate insurers' profits due to risk selection in the four scenarios. While these profits prove to be very high without risk adjustment and still substantial with demographic risk adjustment, they become surprisingly low when a crude morbidity indicator is included in the formula. These results clearly indicate the need for health status – related risk adjustment in an insurance market with community rating.

JEL classification: I18; I11; G22; D82

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1 Introduction

Enthoven's proposal for regulated competition between social health insurers (Enthoven 1978) has been introduced in several countries (see van de Ven et al. 2006). One example is Switzerland with its comprehensive mandatory coverage for all citizens, offered by some 90 competing nonprofit health insurers. The new law of 1994 calls for semiannual open enrollment and community rating. However, with everyone paying the same premium but expected health care expenditure (HCE) varying widely, strong incentives for risk selection are created. Although risk selection is illegal, its prevalence in Swiss social health insurance has been reported repeatedly (Beck and Zweifel 1998, Beck et al. 2003). As van de Ven and Ellis (2000, section 2.5) argue, risk selection produces no benefits to society (unless a dynamic view is adopted, where the threat of being classified as an unfavorable risk in the future helps to reduce moral hazard). Therefore, resources devoted to risk selection represent a welfare loss.

The objective of risk adjustment is to mitigate incentives for risk selection. So far, the different schemes have been judged mainly in terms of their ability to predict individual HCE one year ahead (Newhouse et al. 1989, van Barneveld et al. 2000, Holly et al. 2003).

This criterion is subject to at least two criticisms. First, risk selection is not costless to insurers. As pointed out by van Barneveld et al. (2000) as well as Zweifel and Breuer (2006), this means that they will invest in this activity only if expected profits exceed the cost. However, the regression criterion of minimizing squared prediction error with regard to HCE fails to take cost considerations into account. Second, Zweifel and Breuer also point out that insurers who want to stay in business must have an eye on present values rather than one-period profits.

This paper, then, follows the lead of Shen and Ellis (2002) by estimating expected profits attainable by risk selection, given the information available to the insurer. It therefore only models the classification of risk types, neglecting the problem of how to attract or deter types. However, if profits are large enough, strategies to perform risk selection will most certainly be developed by crafty insurers.

However, unlike Shen and Ellis (2002), the present analysis goes beyond one-year profits predicted using information of one previous year. In an attempt to reflect the longer planning horizon of insurers (who have always shown a preference for long-run contracts and guaranteed renewability (Pauly et al. 1998) unless prevented by regulation), the period of observation of expected profits is extended to five years. This permits to take into account the fact that a currently favorable risk may develop into an unfavorable one, change to a competitor, or die. Conversely, an unfavorable risk may recover to become a favorable one in the future. In statistical theory, these effects are well known as “regression towards the mean” (Welch 1985; Beck 2004). However, no insurer pursuing a longer-term strategy would act on an information set comprising just one year, incurring the risk of confounding transitory and permanent effects. This is borne out by the fact that experience rating is gradual, involving an update of information extending over several years. Accordingly, future HCE is predicted using data from three previous years. This is possible thanks to a panel data set covering some 180,000 individuals over eight years.

The reminder of this article is structured as follows. In section 2, a model of risk selection is formulated from which expected profits from selection can be derived. After a brief description of the database in section 3, the details of the empirical estimation are explained in section 4. Results are presented in section 5. They indicate that even crude adjustments in the risk adjustment formula to take future HCE into account serve to neutralize incentives for risk selection to a substantial extent. The final section 6 is devoted to a summary and conclusions.

2 Modeling risk selection

The objective of this section is to model a health insurer's decision to attract or deter certain risk types. This decision is assumed to reflect insurers' expected profits or losses ($E[\pi_{i,j}]$) pertaining to costumer *(i),* taking into account the risk adjustment formula *(j)* applied by the regulator. To estimate this quantity, five elements must be considered; viz. (1) the expected fair community-rated premium ($E[P_{i,t,j}]$), (2) expected health care expenditure ($E[HCE_{i,t}]$), (3) the expected contribution to the risk adjustment scheme ($E[RA_{i,t,j}]$), a positive quantity for favorable risks, a negative one for unfavorable ones, its value depending on the risk adjustment formula *(j)*, and (4) the probability of an individual dying $(p_{i,t}^{death})$ or (5) switching to a competitor $(p_{i,t}^{switch})$. This all boils down to expression (1), with the interest rate r used to discount future payments,

$$(1)\; E[\pi_{i,j}] = \sum_{t=2000}^{2004} \left(E[P_{i,t,j}] - E[HCE_{i,t}] + E[RA_{i,t,j}] \right) \prod_{h=2000}^{t} (1 - p_{i,h}^{death}) \prod_{k=2001}^{t} (1 - p_{i,k}^{switch}) \frac{1}{(1+r)^{t-2000}} \,.$$

Loadings for administrative expenses are neglected, because they are part of $E[P_{i,t,j}]$ and $E[HCE_{i,t}]$ but do not enter $E[RA_{i,t,j}]$. Note that HCE does not depend on the type of risk adjustment imposed, although insurers' incentives to combat moral hazard (by launching product innovations) may well be weakened by risk adjustment (Zweifel 2006). Evidently, the planning horizon comprises the years 2000 (current) to 2004. This should be sufficient to approximate expected long-term profits. Following the approach proposed by van Barneveld et al. (2000) only „sufficiently large“ profits or losses are assumed to cause risk selection activities. Profits in principle are „sufficiently large“ if returns to risk selection exceed its total cost, which not only comprises the expenses for product development, marketing, and actual administration of the risk portfolio but also the loss of reputation if found out by the media or the regulator. Clearly, information to estimate this quantity is not publicly accessible. Therefore, it is simply assumed that expected profits from risk selection must exceed CHF 1000 (= $800 at 2006 exchange rates) p.a. in present value to trigger selection activities. In a sensitivity analysis, results changed surprisingly little when the threshold was lowered to CHF 400 and increased to CHF 1200 p.a. The impact of this ad hoc assumption is therefore limited.

Accordingly, customers are divided into four mutually exclusive subsets. Group A' contains all individuals with expected profits in excess of CHF 1000 p.a., while B' has those with expected profits up to CHF 1000 p.a. Conversely, C’ contains all individuals with expected losses up to CHF 1000 p.a. and D’ those with losses beyond CHF 1000 p.a.

Table 1: Assumed risk selection strategies, 1 CHF ≈ 0.8 $

Risk type	Characterization	Strategy
A’	Expected profit > 1000 CHF p. a.	Attract
B’	Expected profit ≤ 1000 CHF p. a.	Passive
C’	Expected loss ≤ 1000 CHF p. a.	Passive
D’	Expected loss > 1000 CHF p. a.	Deter

Therefore, A’ is the set of risks the insurer seeks to attract, D’ contains the risks it wants to deter, while B’ and C’ are the risks that do not call for any risk selection effort. It is important to note that risk selection does not describe a “young-and-healthy-people-only” strategy under all circumstances. It will be shown in section 5.2 that risk adjustment can turn elderly and even chronically ill individuals into favorable risks.

Ex-post profits generated by individual *i* and associated with risk adjustment scheme *j* are specified as follows,

$$(2) \qquad \pi_{i,j} = \sum_{t=2000}^{2004} \left(P_{i,t,j} - HCE_{i,t} + RA_{i,t,j} \right) \frac{1}{(1+r)^{t-2000}} \frac{1}{\tau_t} \qquad \text{with } \tau_t = \frac{\sum_i HEC_{i,t} \Big/ \sum_i m_{i,t}}{\sum_i HEC_{i,2000} \Big/ \sum_i m_{i,2000}}.$$

Here τ_t is a deflator and $m_{i,t}$ is the number of months individual *i* is enrolled during a given year. Since τ_t reflects the general development of HCE since 2000, real profits are defined in terms of the cost of health care, which makes sense for a health insurer. Considering first the strategy of deterring unfavorable risks, the financial benefit attainable, Π, is defined as profits contributed by the remaining risk types (i.e. A’, B’ and C’) relative to their total (deflated) premium revenue,

$$(3) \qquad \Pi_{[\text{deter D'}]} = \frac{\sum_{i \in \{A',B',C'\}} \pi_{i,j}}{\sum_{i \in \{A',B',C'\}} \sum_{t=2000}^{2004} P_{i,t,j} \frac{1}{\tau_t} \frac{1}{(1+r)^{t-2000}}}$$

The other strategy, attracting good risks, has to be defined differently because it is inconceivable that the population insured consist of the subset of A’ only. Rather, let $x > 1$ be the factor by which the size of A’ is increased. Then, the financial benefit is given by,

(4) $$\Pi_{[\text{attract A'}]} = \frac{(x-1)\sum_{i\in A'}\pi_{i,j}}{(x-1)\sum_{i\in A'}\sum_{t=2000}^{2004}P_{i,t,j}\frac{1}{\tau_t}\frac{1}{(1+r)^{t-2000}}+\sum_{i}\sum_{t=2000}^{2004}P_{i,t,j}\frac{1}{\tau_t}\frac{1}{(1+r)^{t-2000}}}.$$

The better the risk adjustment scheme works, the smaller are these profits. As Beck and Zweifel (1998) point out, however, risk selection is a risky business. Some costumers who are expected to be profitable will in effect turn out to be unfavorable risks, while some who are deemed unfavorable will in fact contribute to profits. As will be seen in section 5.4, this uncertainty increases when the risk adjustment formula is refined.

3 The data

The sample contains individual data from 182,529 adults (aged 26+) enrolled by CSS, the leading sickness fund of Switzerland, during the full year of 1999 and not opting for a Managed Care plan during the period of observation. For data quality reasons, only residents of the French and Italian speaking parts of Switzerland are included.[3] Individuals were observed from 1997 to 2004, with 1997 to 1999 used for prediction. The selection decision is assumed to be taken at the beginning of the year 2000. The data from 2000 to 2004 serve for calculating the present value of profits an insurer would have made by pursuing the respective strategy.

4 Calculating expected profits from risk selection

To calculate expected profits from risk selection according to expression (1), all components such as expected premiums, expected HCE, expected payments into and from the risk adjustment fund as well as probabilities of death and of switching to a competitor need to be determined. This section is devoted to these issues.

4.1 Expected premiums

No profits are allowed in Swiss compulsory health insurance; therefore total premium revenue equals total expected admissible cost, the latter made up of expected HCE plus a loading of about

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[3] Due to different billing modalities, detailed information on drug expenditure is of good quality only in the French and Italian speaking parts. Except for the Pharmaceutical Cost Group variant of risk adjustment**,** the analysis presented in sections 4 and 5 was repeated, using a larger sample containing 250,000 insured from all parts of the country. The result was very similar.

five percent. Since the admissible loading is part of premium revenue as well as of cost, it does not affect profits and is neglected[4]. Premiums must be community-rated for all adults within the same region, but premium reductions for deductibles above the mandatory minimum of CHF 230 annually are possible. The choice of deductible is regulated, ranking from CHF 170 to 1270 in excess of the minimum. Because contracts with high deductibles are especially attractive to good risks, they can serve as an effective means for risk selection. Perfect risk adjustment neutralizes these incentives both on the part of customers and insurers; however, given imperfect formulas – and all formulas analyzed in this study are imperfect – differences in expected profits across deductible options remain. In order to secure the transfers from favorable risks with high deductibles to unfavorable risk with low deductibles, the regulator limits the premium reductions, making high-deductible plans cross-subsidize low-deductible plans.

In order to use the observed values in the benchmark year 2000, the insurer considered is assumed to have predicted total HCE of that year with perfect precision. Moreover, to simplify calculations, inflation during the forecasting period 2001 –2004 is neglected. In fact, as long as inflation affects all components of eq. (1) in the same way (including payments to / from the risk adjustment scheme), real profits do not change. Therefore, calculated premiums $E[P_{i,t,j}]$ are constant over these four years.

4.2 Expected health care expenditure

Predicted individual HCE is derived from prior experience, covering the years 1997 – 1999. The year 1999 was complete, missing entries from 1997 or 1998 were replaced by the average values of their demographic group. It comes close to reality to assume that the insurer knows individual HCE of the past, because for new enrollees, it can be predicted using information from questionnaires that have to be filled by new applicants as soon as they apply for supplementary insurance (which is regulated differently, by the Law on Insurance Contracts). Only switchers having no more than compulsory coverage are not made declare their health status. Still, sales personel obtains an (often visual) impression of the customer’s health. The choice of the deductible for the compulsory part also helps to predict HCE.

Future individual HCE is estimated in three steps. The first step is an OLS regression with HCE in 2000 net of deductible and coinsurance as the dependent variable. In spite of skewness, OLS estimation is the preferred alternative because predicted HCE need to be in CHF for decision making by the insurer. Any transformation of the data would give rise to a retransformation problem (see e.g. Manning and Mullahy 2001). The explanatory variables are age classes interacted with gender,

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[4] A detailed analysis of administrative expenses might show different loadings for different risk groups; however, this goes beyond the scope of this study.

deductibles as of year 2000, HCE in 1997, 1998, and 1999, the latter split up in its components, viz. physician's services, drugs dispensed by physicians, drugs dispensed by pharmacies, inpatient care, home care, nursing home care, and other expenditure.

The regression results appear in Table 2, with its first three columns showing age and gender effects, while its last two columns contain the estimates pertaining to the remaining regressors. Since the normality assumption does not hold in view of skewness, distribution-free Tchebycheff significance levels are also indicated.

Table 2: Individual HCE net of deductible and coinsurance, 2000

	female	male	constant	-354 **°
26 - 30	492 **°	reference cat.	HCE 97	0.109 **°
31 - 35	386 **°	28	HCE 98	0.080**°
36 - 40	229 *	102	physician services 99	0.540 **°
41 - 45	181 *	122	drugs doctors 99	0.947 **°
46 - 50	227 *	229 *	drugs pharmacies 99	0.977 **°
51 - 55	321 **°	275 **	inpatient care 99	0.347 **°
56 - 60	310 **°	424 **°	home care 99	0.936 **°
61 - 65	472 **°	592 **°	nursing home care 99	0.626 **°
66 - 70	643 **°	1042 **°	other HCE 99	0.626 **°
71 - 75	1108 **°	1307 **°	deductible 230	589 **°
76 - 80	1602 **°	1725 **°	deductible 400	297 **°
81 - 85	2156 **°	2072 **°	deductible 600	86
86 - 90	2886 **°	2666 **°	deductible 1200	79
91+	2580 **°	2267 **°	deductible 1500	reference cat.

$R^2 = 0.481$, $R_{adj}^2 = 0.481$, F = 3750.2 (df=40) **, n = 182'529,
* $p \leq 0.05$, **$p \leq 0.01$, ° Tchebycheff-significance level 10%

Except for the constant which is negative, all coefficients have the expected signs. For women, HCE attains a maximum (ceteris paribus) in the 26 – 30 age group (due to maternity), but rises consistently between ages 41 – 45 and 86 – 90. Beyond age 90 (men 85) age coefficients go down. Otherwise, men display a consistent increase of HCE with age.

In a second step, individual HCE in 2004 is predicted using the 1997 – 1999 values of explanatory variables for lack of better alternatives, with exception of age. Negative predicted values (occurring among about 5 percent of insured) are replaced by zeroes. The third step consists in interpolating between the predicted 2004 and the observed 1999 values, in accordance with eq. (5). This procedure can be justified by noting that observed HCE contains transitory components, while the 2004 values are purged of them. A natural assumption for the insurer is that the transitory component loses importance as time goes by. Using exponential decay, the formula reads:

$$(5) \qquad E[HCE_{i,t}] = E[HCE_{i,2004}] - (0.5)^{t-1999}\left(E[HCE_{i,2004}] - HCE_{i,1999}\right)$$

4.3 The risk adjustment schemes

Current Swiss risk adjustment does not use a prospective formula of the type shown in table 2. Rather, it is retrospective, being based on observed HCE in sex – age cells according to the first three columns of table 2. For the four formulas to fit Swiss risk adjustment practice, payments must sum to zero, and no individual data must be known to the regulator. They do meet these requirements (see Beck et al. 2006, ch. 4.2 for proof).

(0) No risk adjustment

The first scenario is a benchmark with no risk adjustment scheme in place.

(1) Demographic risk adjustment

Current Swiss risk adjustment uses age and gender groups (26-30, 31-35 …91+), as in Table 2. While these age groups are purely arbitrary, they are established in the market. The possibility of optimizing them for risk adjustment will therefore not be considered here. Also, payments are calculated regionally. To avoid small sample problems in the top age groups of small cantons, this detail is neglected by treating Switzerland as one region.

(2) Demographic risk adjustment augmented by prior hospitalization

This formula is part of a reform currently (i.e. 2006) discussed in Swiss parliament. Retaining current age and gender groups, it includes a dummy variable indicating hospitalization during the previous year. Empirical evidence presented by Beck (1998) and Holly et al. (2003) shows HCE to be substantially higher for individuals with hospital stays[5] during the previous year. However, insurers might have an incentive to encourage short-term hospitalizations with the mere aim of receiving payments from the risk adjustment scheme. Therefore, only inpatient stays of three or more days are considered to be a hospitalization. Note that it is not cost of the inpatient stay itself that is taken into account but only the increased predicted HCE during the year that follows the stay. Therefore any manipulation of this adjuster would pay off only if this extra HCE were to exceed the cost of the hospitalization itself, which is very unlikely in the case of long stays.

(3) Demographic risk adjustment augmented by prior hospitalization and PCGs

The final alternative to be considered is to augment existing demographic risk adjustment by both the indicator for prior hospitalization and Pharmaceutical Cost Groups (PCGs). There are 13 PCGs which are similar to those developed by Lamers and Van Vliet (2003). They were adapted to Swiss data by a team at CSS (Beck et al. 2006, ch. 4.2).

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[5] Inpatient stays related to maternity are excluded.

As with all patient classification systems, the issue of how to deal with patients belonging to more then one class has to be addressed. Here, the sorting algorithm used by Pope et al. (2000) is employed by first calculating mean HCE by PCG for the entire sample and assigning the PCG with the highest value rank one and excluding its members from further calculations. Then mean HCE is recalculated for the reduced sample, giving the PCG with the highest value rank two, and so on. Finally, patients with more than one chronic condition are assigned to the PCG with the highest rank.

Table 3: Ranking of Pharmaceutical Cost Groups in terms of HCE

Rank	PCG	Population share, in percent	Average excess HCE, in CHF per month
1	Renal disease, ESRD	0.06	3.484
2	HIV / AIDS	0.11	1.529
3	Transplantations	0.15	1.291
4	Malignancies	0.13	970
5	Diabetes insulin-dep.	0.75	558
6	Morbus Parkinson	0.38	440
7	Epilepsy	0.89	280
8	Respiratory illness & Asthma	2.16	248
9	Morbus Crohn, Colitis ulcerosa	0.23	215
10	Diabetes non insulin-dep.	2.40	180
11	Rheumatologic conditions	2.85	165
12	Acid peptic disease	0.59	142
13	Cardiac disease	3.96	114
0	None	85.33	-

1 CHF ≈ 0.8 $

4.4. Applying the risk adjustment formulas

The predictive power of the four risk adjustment formulas is shown in Table 4. The R^2 values are high, mainly for two reasons: First, Swiss health insurers only pay roughly one-half of inpatient HCE, in keeping with the Law of Health Insurance of 1994. One-half of the bill is funded by cantonal governments, who heavily subsidize public hospitals. Since very high HCE are almost always due to hospitalizations, outliers do not fully show in the data, which serves to increase goodness-of-fit. Second, the marked increase in R^2 from variant (2) to variant (3) can be explained by the fact that little prediction is involved because the observations on PCGs pertain to the same year as those on HCE. Table 4 also shows that even with PCG information included, the regulator cannot catch up with the health insurers, who dispose of a good deal of additional information which can be used to increase R^2 to 0.48.

Table 4: The four risk adjustment formulas compared

Formula No.	**R^2**
(0) None	0.00
(1) Age, gender	0.11
(2) Age, gender, prior hospitalization	0.21
(3) Age, gender, prior hospitalization, PCG	0.30
Benchmark: Insurer's own model	0.48

The risk adjustment subsidies are easiest to predict for the demographic scheme because risk group membership is known in advance. With more elaborate formulas, the insurer has to predict not only the amount of the subsidy but the risk group each individual is attached to. This is true specifically of those with inpatient stays, whose share was roughly 12 percent in 1999. For simplicity, they are assumed to be identical with the most expensive 12 percent, making them eligible for an extra risk adjustment subsidy in the following year. For the PCGs, the insured keep their 2000 values because these codes describe chronic conditions.

4.4 Probability of death

Estimating the probability of death ($p_{i,h}^{death}$) specifically for this population turned out to be impossible because of the small number of deceased in the sample. Instead, life tables provided by the Federal Statistical Office have been used, which are grouped by age and gender. However, high HCE have been found to be strongly related to death by e. g. Zweifel et al. (2004). The probability of death is therefore certainly underrated for high-cost individuals, since they are more likely than others to drop out of the sample in the course of the forecasting period, expected HCE are overestimated.

4.5 Probability to opt-out

To estimate the probability of an insured switching to a competitor ($p_{i,k}^{switch}$), a logistic regression model is used (Beck 2004, ch. 9). It comprises age, years of CSS membership, number of supplementary insurance products, and premium relative to the market average as explanatory variables. Age has a negative effect, accounting for the decreased mobility of older individuals. Duration of membership also has a negative impact on the propensity to switch because loyal members tend to remain loyal. Insured with several supplementary insurance products have more difficulty switching because the open enrollment requirement holds only for the compulsory component of coverage. Legally, it is possible to buy compulsory and supplementary coverage from different insurers, but consumers are afraid of insurers haggling over their obligation to pay, which easily results in delayed reimbursement. Finally, a high CSS premium relative to the market average encourages consumers to switch. However, construction of this variable in the present context would have required modeling the premium development of competitors (which in turn would depend also on payment into and from the risk adjustment scheme). Therefore, this ratio is set equal to one to avoid this complication.

5. Results

5.1. Risk adjustment and the distribution of expected profits

The choice of the risk adjustment scheme has a strong impact on the distribution of expected profits and losses, $E[\pi_{i,j}]$. Because of the zero-profit requirement, the mean of $E[\pi_{i,j}]$ is zero in all scenarios when calculating premiums. Without risk adjustment (0), its distribution is heavily skewed to the right, and exhibiting a marked tail of very sizeable losses (Figure 1, tail cut at -20.000). With a risk adjustment scheme including prior hospitalization and PCGs (3) the distribution of $E[\pi_{i,3}]$is almost symmetrically centered at zero (Figure 2), with its median value equal to CHF 489, down from CHF 5,985 with no risk adjustment. However, there is a heavy tail of very profitable consumers, who (in expectation) seem to be overpaid by the risk adjustment scheme.

FIGURES 1 AND 2 ABOUT HERE

However, the objective of risk adjustment is to neutralize insurers' incentive for risk selection given that premiums are regulated not to reflect true risk. It therefore should affect the composition of the risk pool in terms of the subsets A' through D' distinguished in section 2 above. Indeed, variant (3) causes the share of risks in subgroup A' (expected profits > CHF 1,000 p.a.) to drop from 56 percent (no risk adjustment) to a minimum of 20 percent. However, since the left tail is not thinned out completely (compare figures 1 and 2), the share of individuals in the unfavorable group D' decreases only slightly from 21 to 18 percent. Table 5 exhibits the full set of estimates. However, as will be shown in the next section, risk adjustment causes the composition of these groups to change completely.

Table 5: Effect of risk adjustment on the size of the four subgroups A' – D'

	Calculated shares in percent			
Risk adjustment	A'	B'	C'	D'
(0) None	56	14	9	21
(1) Age, gender	40	27	14	18
(2) Age, gender, prior hospitalization	26	34	23	17
(3) Age, gender, prior hospitalization, PCG	20	35	27	18

With A' : $E[\pi_{i,j}] > 1.000$; B': $0 < E[\pi_{i,j}] < 1.000$; C': $0 > E[\pi_{i,j}] > -1.000$; D': $E[\pi_{i,j}] < -1.000$

5.2 Effect of risk adjustment on the composition of subgroups

Risk adjustment may have an important effect on the composition of the subgroups making up the risk pool. This effect seems to have been largely neglected in the literature. However, the political acceptance of a risk adjustment scheme strongly depends on its distributional impacts. Since incomes are not known, the analysis of this section is limited to age and two indicators of health status, viz. HCE prior to risk adjustment and membership in one or more PCG.

Without risk adjustment (0), profitable members (A') are pretty much the usual suspects: younger than average, low net HCE and rare PCG membership, indicating absence of chronic illness (see Table 6). Unsurprisingly, demographic risk adjustment (1) changes this picture strongly in terms of age, causing mean age in subgroup A' to increase from 46 to 62 years. Conversely, average age drops by as much as 20 years in subgroups B' and C' while it still decreases by 11 years in subgroup D'. At the same time, HCE (net of cost sharing) more than doubles in subgroup A', while membership in at least one PCG more than triples, reaching 11 percent (not far below the overall share of 15 percent). This indicates that even mere demographic risk adjustment can turn some chronically ill into profitable customers. However, the D' subgroup continues to have by far the highest average HCE and share of PCG members.

Table 6: Effect of risk adjustment (RA) on composition of subgroups

Risk Adjustment	Mean age in category, 2000 Overall average: 54				Mean net HCE per month, 2000 (CHF, prior to RA) Overall mean: 291				Share of individuals in ≥ 1 PCG, 2000 (percent) Overall mean: 15			
	A'	B'	C'	D'	A'	B'	C'	D'	A'	B'	C'	D'
(0) None	46	59	64	67	77	211	320	910	3	16	27	40
(1) Age, gender	62	44	44	56	175	130	197	856	11	8	14	33
(2) Age, gender, prior hospitalization	70	49	45	51	328	138	176	713	20	8	11	26
(3) Age, gender, prior hospitalization, PCG	71	51	46	51	441	132	159	631	47	7	4	10

When prior hospitalization is included in the type (2) risk adjustment scheme, characteristics of the subgroups change again. Average age in the A' group even increases to 70, exceeding the value implied by the demographic formula (1). Because morbidity is higher among the elderly, they are more likely to get a morbidity-related subsidy, making them attractive risks to the insurer. The change in the composition with regard to health status is even more striking. Average net HCE in the subgroup A' now is CHF 328, above the overall mean of CHF 291. Likewise, A' now contains 20 percent individuals who are in some PCG (overall mean, 15 percent). Put the other way round, many ill people can contribute to expected profit even if their expected HCE is above average, while the very healthy are transformed into average risks because they are loaded with payments to the risk adjustment scheme.

When PCGs are also included into the scheme (type 3), average age remains roughly the same in all subgroups. However, average net HCE in the A' group increases, while those of the unfavorable D' group decrease once more, to CHF 631 (which is still more than twice the overall mean of CHF 291). The most amazing change, however, is in PCG membership. The A' subgroup now consists of 47 percent chronically ill, more than the 40 percent contained in the D' group without risk adjustment.

In sum, this analysis offers important insights into the workings of risk adjustment schemes (2) and (3). By collecting transfers from healthy people, they transform them (on average) from very favorable into medium risks from the insurer's point of view. The ill on the other hand come with a subsidy, making some of them very profitable. These profits indicate an overpayment by the risk adjustment scheme, which can be explained as follows. While the subsidy equalizes average expected contributions across risk groups, a majority of individuals within a group has HCE below average because the distribution of HCE is skewed to the right, with a long tail towards high values.

Before turning to the financial benefits attainable by risk selection, two points should be mentioned. First, a morbidity-based risk adjustment makes it more difficult to recognize risks. With no or only demographic risk adjustment, it is sufficient for insurers to gather information about prior utilization and personal well being, whereas with schemes of type (3), they will have to establish precisely those chronic conditions that yield the highest contributions – a far more complex task. The second point concerns risk selection through quality of services covered. As pointed out by e.g. Newhouse (1982) and van de Ven and Ellis (2000), insurers may try to stave off unfavorable risks by e. g. incorporating lower quality care for the chronically ill (always on the premise of community rating combined with imperfect risk adjustment). This form of selection hurts some of the weakest. Moreover, it is difficult to contain because service quality cannot easily be regulated (Marcheand et al. 2004). The authors cited agree in their expectation that morbidity-related risk adjustment of the types (2) and (3) are a suitable tool to prevent this type of selection. The present analysis supports this notion by showing that scheme (3) causes the most favorable risk group to contain a large number of chronically ill individuals, who are missed out by insurers who offer them benefits of lower quality. Conversely, insurers with a small market share (and therefore little influence on mean HCE) may benefit by attracting the chronically ill through special programs. In the Netherlands, where morbidity indicators are included in the risk adjustment scheme, an insurer in fact developed a disease management program for diabetes patients (van de Ven et al. 2006).

5.3. Estimating the financial incentive for risk selection

In this section, we derive an estimate of the financial benefits of risk selection by calculating ex post profits associated with the strategies described. According to equation (2), these profits are a function of the risk adjustment schemes (0) to (3). Because of the zero-profit constraint, benefits are expressed as the ability to offer a lower premium, which almost certainly leads to a favorable market position in view of strong price competition. From the moment an insured in our sample dies or switches to another insurer, her cash flow drops to zero, as in real life. All figures are in prices of 2000.

First, the strategy of deterring expectedly unfavorable risks (D') is evaluated. An insurer capable of getting rid of all expectedly unfavorable risks (D') could reduce its average premium level as shown in Table 7.

Table 7: Reduction of average premium thanks to deterring D'-rated risks, in percent

Risk adjustment	Possible premium reduction
(0) None	46
(1) Age, gender	32
(2) Age, gender, prior hospitalization	19
(3) Age, gender, prior hospitalization, PCG	16

Clearly, this strategy pays off most when there is no risk adjustment at all. Introducing age and gender as risk adjusters already serves to reduce the potential for premium reductions by one third. The most elaborate variant (3) achieves a reduction of two thirds, to 16 percent.

The other strategy is to attract risks that are expected to be favorable (A'). Let x denote the factor by which the number of A' – rated costumers is increased, the number of risks in all other subgroups held constant. If x goes to infinity, the risk portfolio consists only of A' rated customers. Because many Swiss insurers are rather small, $4 \leq x \leq 6$ are considered realistic values. Without risk adjustment, this strategy permits a lowering of the premium level of about 50 percent ($x = 6$, in table

8). Demographic adjustment (1) reduces this figure to 38 percent. However, it takes schemes (2) and (3) involving prior hospitalization and PCGs, to largely reduce to financial benefit of “chasing the good risks”.

Table 8: Financial advantage of attracting A'-rated risks, in percent

Risk adjustment	$x = 2$	$x = 4$	$x = 6$	$x = \infty$
(0) None	23	41	48	66
(1) Age, gender	17	32	38	57
(2) Age, gender, prior hospitalization	7	15	19	31
(3) Age, gender, prior hospitalization, PCG	6	14	18	34

The entries of tables 7 and 8 indicate that even in the long run, “regression to the mean” does not equalize risk profiles. Without risk adjustment, both deterring unfavorable and attracting favorable risks are highly profitable strategies. However, adding the crude morbidity indicator prior hospitalization works surprisingly well to neutralize these gains. A possible explanation is the fact that hospitalization is a good proxy for HCE in earlier years, which are used for prediction by the insurers.[6] It is well known that risk adjustment schemes work best if they predict cost as well as insurers themselves.

The contribution of PCGs on the other hand is somewhat disappointing, raising doubts whether the administrative expense for establishing them is worthwhile. However, table 6 shows that the risk adjustment formula (3) including PCGs excels in directing subsidies specifically to individuals with consistently high HCE. The incentive to skimp on the quality of care for the chronically ill is certainly the weakest with this formula.

5.4 Risk adjustment and uncertainty

Depending on the risk adjustment scheme, a health insurer engaging in risk selection may not only face different expected values of contribution to profit but also different degrees of uncertainty surrounding these values. Assuming risk aversion, such a relationship could enhance or undermine the effectiveness of the scheme, a fact that seems to have been overlooked in the existing literature. Private companies are generally assumed to be risk neutral because their shareholders are sufficiently diversified for not being harmed by the company’s insolvency, with management working in their best interest (Zweifel and Eisen 2003, ch. 5.2). Yet, in Swiss social health insurance, these assumptions do not apply. Insurers are organized as cooperatives owned by the insured most of whom have few assets and are little diversified. In addition, the insured as owners have very limited

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[6] We thank Erik Schokkaert for pointing this out.

influence on management. Managers in turn have every interest in acting in risk-averse manner (in accordance with the preference of most of the owners), their main assets being human capital which is invested with the health insurer. Hence, it is reasonable to assume risk aversion.

The assignment of risk categories A' and D' is subject to uncertainty because in the course of time (2000 to 2004 in the present instance), the insured may change to another subgroup. As shown in table 9, misclassification is likely to occur, its extent clearly depending on the risk adjustment scheme implemented. For example, an insurer trying to attract favorable risks is predicted to assign 56 percent of its insured population to subgroup A'. However, only 40 percent of the population will in fact turn out to be true A types (denoted by A'A), while 14 percent are average (A'B, A'C), and 2 percent even constitute unfavorable risks (A'D). Overall, approximately 7 percent (4 out of 56) of A'-rated insured in fact yield negative profits. Interestingly, the probability of misclassification increases when risk adjustment is introduced. While with type (1), about 15 percent (6/40) of A'-rated consumers turn out to be unprofitable, this ratio increases to 23 percent (6/26) with type (2) and even to 25 percent (5/20) with type (3). Similar effects obtain if the insurer seeks to eschew D'-rated risks (table 10).

For both strategies, the certainty equivalents of the payoffs to risk selection effort therefore lie below the expected value, especially if the adjustment formula is complemented by an indicator of prior hospitalization [types (2) and (3)]. These variants therefore prove quite effective in neutralizing insurers' incentive for risk selection.

Table 9: Frequency of misclassification of A'-rated risks

Risk adjustment	Total A'	A'A	A'B	A'C	A'D
(0) None	56	40	12	2	2
(1) Age, gender	40	27	7	2	4
(2) Age, gender, prior hospitalization	26	16	4	2	4
(3) Age, gender, prior hospitalization, PCG	20	12	3	2	3

Table 10: Frequency of misclassification of D'-rated risks

Risk adjustment	Total D'	D'D	D'C	D'B	D'A
(0) None	21	13	3	3	2
(1) Age, gender	18	10	3	3	2
(2) Age, gender, prior hospitalization	17	7	4	4	2
(3) Age, gender, prior hospitalization, PCG	18	7	4	5	2

6. Conclusions

There is a broad consensus that given managed competition with community-rated premiums, risk adjustment becomes a necessary regulation of health insurance markets. However, while there is a common agreement that a demographic formula is insufficient, the precise specification of the risk adjustment formula has remained controversial. Most of the empirical literature describes and tests for the relationships between different morbidity indicators and HCE within one year. This short time horizon is in accordance with the fact that managed competition is usually combined with annually open enrollment. However, such a short time horizon is not in accordance with the strong incentive for insurers to keep their members in long-term contracts in view of considerable cost of acquisition. Moreover, consumers likely would think twice before signing up with an insurer whose planning horizon is as short as one year. Given a longer-term perspective, insurers' optimizing is influenced by two empirical facts, regression to the mean and decreasing precision of forecasts.

Risk selection calls for estimating expected net present value. The longer the time horizon, the more difficult this task becomes. Forecasting errors result in the miscalculation of future HCE and hence misclassification of risks. This is true not only of a favorable risk that turns out to be an unfavorable one, but also of a seemingly unfavorable one that was made to switch and has to be acquired back at considerable expense later.

Expected gains from risk selection were estimated based on predicted HCE net of copayments, premiums and risk adjustment payments, discounted to present value and weighted by the probabilities of death and of switching to a competitor. These calculations are performed for four different risk adjustment schemes, viz. (0) no risk adjustment, (1) demographic risk adjustment, (2) demographic risk adjustment complemented with prior hospitalization as a simple morbidity indicator, and (3) scheme (2) complemented with pharmaceutical cost groups.

For a sample of some 180,000 Swiss individuals, expected net present values conditioned on the risk adjustment scheme were calculated. However, these values must exceed the variable cost associated with risk selection effort in order to trigger action on the part of the insurer. Since this cost is unknown, an arbitrary but not unrealistic value of +/- CHF 1,000 ($ 800) serves as a threshold. Thus, the insurer is assumed to be indifferent with regard to risks whose contributions to expected profit fall within this interval.

The risk adjustment schemes distinguished modify incentives for risk selection according to expectations. The better they reflect morbidity, the smaller the share of the insured population that constitutes favorable and unfavorable risks, respectively. Adjustment using only age and sex (type 1) causes the share of favorable risks to drop from 56 to 40 percent, the share of unfavorable ones from 21 to 18 percent. With schemes of type (2) and (3) the figures for the favorable risks drop to 26 and 20, for the unfavorable to 17 and 18 percent, respectively. However, it should be noted that the composition of these subgroups changes dramatically with type of risk adjustment. Average age of favorable customers increases from 46 (type 0) to 71 years (type 3), while the share of those belonging to one or more PCG (in indicator of chronic illness) increases from 3 to 47 percent.

Given the zero profit constraint imposed on social health insurers, the success of risk selection efforts is reflected by their ability to lower premiums and hence gain market share. Despite regression to the mean, risk selection has a substantial impact on the premium in the absence of risk adjustment. Deterring all unprofitable risks is estimated to result in a 46 percent premium reduction, averaged over five years. This competitive advantage is reduced to 16 percent under type (3) risk adjustment, which takes into account both prior hospitalization and membership in a PCG. Interestingly, this figure is in the same range as the premium reductions that may be offered for participation in a managed care alternative, which constitutes a product innovation. Thus, it may be argued that type (3) risk adjustment is effective enough to redirect insurers' efforts from risk selection to product innovation.

Since there is reason to assume Swiss health insurers to be risk averse, uncertainty surrounding risk selection matters. Indeed, the risk of misclassification is a mere 28 percent for an insurer "chasing the good risk" as long as there is no risk adjustment but increases to 40 percent under scheme (3). Refined risk adjustment therefore becomes even more effective than expected contribution to profit would suggest because it exposes the insurer to increased uncertainty.

In conclusion, this research suggests that risk adjustment can be designed in a way as to be in accordance with the longer term planning horizon of insurers while using easily available information such as prior hospitalization and membership in pharmaceutical cost groups. The evaluation of different risk adjustment schemes based on their ability to predict HCE of just one year fails to reflect true incentives in favor of risk selection. It does take refinements of the type considered in this work to make risk adjustment sustainable and effective enough to redirect insurers' efforts away from risk selection in favor of product innovation.

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Table 1: Assumed risk selection strategies, 1 CHF ≈ 0.8 $

Risk type	Characterization	Strategy
A’	Expected profit > 1000 CHF p. a.	Attract
B’	Expected profit ≤ 1000 CHF p. a.	Passive
C’	Expected loss ≤ 1000 CHF p. a.	Passive
D’	Expected loss > 1000 CHF p. a.	Deter

Table 2: Individual HCE net of deductible and coinsurance, 2000

	female	male	constant	-354 **°
26 - 30	492 **°	reference cat.	HCE 97	0.109 **°
31 - 35	386 **°	28	HCE 98	0.080**°
36 - 40	229 *	102	physician services 99	0.540 **°
41 - 45	181 *	122	drugs doctors 99	0.947 **°
46 - 50	227 *	229 *	drugs pharmacies 99	0.977 **°
51 - 55	321 **°	275 **	inpatient care 99	0.347 **°
56 - 60	310 **°	424 **°	home care 99	0.936 **°
61 - 65	472 **°	592 **°	nursing home care 99	0.626 **°
66 - 70	643 **°	1042 **°	other HCE 99	0.626 **°
71 - 75	1108 **°	1307 **°	deductible 230	589 **°
76 - 80	1602 **°	1725 **°	deductible 400	297 **°
81 - 85	2156 **°	2072 **°	deductible 600	86
86 - 90	2886 **°	2666 **°	deductible 1200	79
91+	2580 **°	2267 **°	deductible 1500	reference cat.

$R^2 = 0.481$, $R_{adj}^2 = 0.481$, $F = 3750.2$ (df=40) **, n = 182’529,
* p ≤ 0.05 , **p ≤ 0.01, ° Tchebycheff-significance level 10%

Table 3: Ranking of Pharmaceutical Cost Groups in terms of HCE

Rank	PCG	Population share, in percent	Average excess HCE, in CHF per month
1	Renal disease, ESRD	0.06	3.484
2	HIV / AIDS	0.11	1.529
3	Transplantations	0.15	1.291
4	Malignancies	0.13	970
5	Diabetes insulin-dep.	0.75	558
6	Morbus Parkinson	0.38	440
7	Epilepsy	0.89	280
8	Respiratory illness & Asthma	2.16	248
9	Morbus Crohn, Colitis ulcerosa	0.23	215
10	Diabetes non insulin-dep.	2.40	180
11	Rheumatologic conditions	2.85	165
12	Acid peptic disease	0.59	142
13	Cardiac disease	3.96	114
0	None	85.33	-

1 CHF ≈ 0.8 $

Table 4: The four risk adjustment formulas compared

Formula No.	R^2
(0) None	0.00
(1) Age, gender	0.11
(2) Age, gender, prior hospitalization	0.21
(3) Age, gender, prior hospitalization, PCG	0.30
Benchmark: Insurer’s own model	0.48

Table 5: Effect of risk adjustment on the size of the four subgroups A' – D'

	Calculated shares in percent			
Risk adjustment	A'	B'	C'	D'
(0) None	56	14	9	21
(1) Age, gender	40	27	14	18
(2) Age, gender, prior hospitalization	26	34	23	17
(3) Age, gender, prior hospitalization, PCG	20	35	27	18

With A' : $E[\pi_{i,j}] > 1.000$; B': $0 < E[\pi_{i,j}] < 1.000$; C': $0 > E[\pi_{i,j}] > -1.000$; D': $E[\pi_{i,j}] < -1.000$

Table 6: Effect of risk adjustment (RA) on composition of subgroups

Risk Adjustment	Mean age in category, 2000 Overall average: 54				Mean net HCE per month, 2000 (CHF, prior to RA) Overall mean: 291				Share of individuals in ≥ 1 PCG, 2000 (percent) Overall mean: 15			
	A'	B'	C'	D'	A'	B'	C'	D'	A'	B'	C'	D'
(0) None	46	59	64	67	77	211	320	910	3	16	27	40
(1) Age, gender	62	44	44	56	175	130	197	856	11	8	14	33
(2) Age, gender, prior hospitalization	70	49	45	51	328	138	176	713	20	8	11	26
(3) Age, gender, prior hospitalization, PCG	71	51	46	51	441	132	159	631	47	7	4	10

Table 7: Reduction of average premium thanks to deterring D’-rated risks, in percent

Risk adjustment	Possible premium reduction
(0) None	46
(1) Age, gender	32
(2) Age, gender, prior hospitalization	19
(3) Age, gender, prior hospitalization, PCG	16

Table 8: Financial advantage of attracting A'-rated risks, in percent

Risk adjustment	$x = 2$	$x = 4$	$x = 6$	$x = \infty$
(0) None	23	41	48	66
(1) Age, gender	17	32	38	57
(2) Age, gender, prior hospitalization	7	15	19	31
(3) Age, gender, prior hospitalization, PCG	6	14	18	34

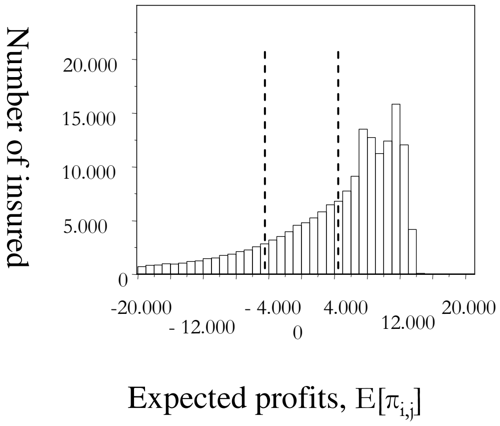
Table 9: Frequency of misclassification of A'-rated risks

Risk adjustment	Total A'	A'A	A'B	A'C	A'D
(0) None	56	40	12	2	2
(1) Age, gender	40	27	7	2	4
(2) Age, gender, prior hospitalization	26	16	4	2	4
(3) Age, gender, prior hospitalization, PCG	20	12	3	2	3

Table 10: Frequency of misclassification of D'-rated risks

Risk adjustment	Total D'	D'D	D'C	D'B	D'A
(0) None	21	13	3	3	2
(1) Age, gender	18	10	3	3	2
(2) Age, gender, prior hospitalization	17	7	4	4	2
(3) Age, gender, prior hospitalization, PCG	18	7	4	5	2

Figure 1: Expected profits without risk adjustment (0)



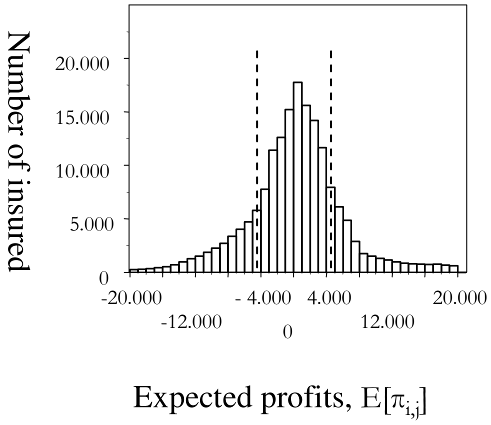
Mean: 0, Std. deviation: 20.018

1\. - 3. quartile: -2.095, 5.985, 9.900

Interquartile range: 11.995

$E[\pi_{i,j}] < -20.000$: 15.029 individuals

Figure 2: Expected profits with risk adjustment (3)



Mean: 0, Std. deviation: 14.536

1\. - 3. quartile: -2.798, 489, 3.543

Interquartile range: 6.341

$E[\pi_{i,j}] < -20.000$: 4.767 individuals

$E[\pi_{i,j}] > 20.000$: 7.019 individuals