ASSESSING THE EFFICIENCY OF AN INSURANCE PROVIDER – A MEASUREMENT ERROR APPROACH

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Abstract

The purpose of this paper is to compare the cost efficiency of private and public property insurance providers in Switzerland. The most commonly used measure for this kind of exercise is the Claims / Premium ratio. We argue that this measure may give strongly biased results. We develop a simple model to test whether the elasticity of premiums with respect to claims is less than unity. We address the fact that premium income is relatively stable across time, while claims are not, using estimation techniques that correct for measurement error. We develop tools to cope with heteroskedasticity in such measurement errors and apply the model to a data set on 19 firms in housing insurance markets in Switzerland. We show that the public insurance providers are about 20 per cent more cost efficient than their private counterparts.

JEL Code: C21, D21, L84.

Keywords: insurance, public and private, cost efficiency, C/P ratio, measurement error, CALS.

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1 Introduction

The purpose of this paper is to compare the cost efficiency of private and public insurance providers on the Swiss property insurance market. The most commonly used indicator to perform this kind of comparison is the claims-premium ratio (C/P ratio, see e.g. Association of British Insurers [1996], Fédération Française des Sociétés d'Assurance [1998] and UNESPA [1994]), i.e. the percentage of premium revenue that the insurer spends on claims payments. The higher this percentage is, the lower the fraction the insurer needs for other purposes such as administrative costs, commissions , reserves or profits. The main advantage of this ratio is its simplicity. It does, however, have a number of drawbacks. First, insurance contracts of small value (e.g. travel luggage insurance) typically require much higher sales and administrative costs per unit insured than contracts where the sum insured is large[1] (e.g. property insurance). This implies that, even for efficient firms, the C/P ratio should vary across insurance products, and hence simple comparison across segments of the industry is not warranted. Second, even within a given type of insurance contract there is no a priori reason why the premium level should increase proportionately with claims. For the problem we wish to address in this paper, this is an empirically important issue. Indeed, on the Swiss property insurance market the private suppliers have average claims levels that are roughly 50% higher than those of the public insurance providers.

At a conceptual level, one can convincingly argue that the elasticity of premiums with respect to claims should be less than unity. To illustrate this we decompose the use made of the premium income of an insurance company into the following three components: a) claims payments, b) reserves and profits and c) administrative costs and commissions. This last component is the most illustrative for our point. As regards the commissions paid to the insurance brokers, there is no good reason why these should increase with claims payments. Quite to the contrary, the effort of an insurance broker is, as a first approximation, independent of the level of claims. One might be tempted to go even further and argue that there should be a negative relationship, as the insurance provider has an incentive to attract "good risks". Similarly, the administrative costs of an insurance company can be decomposed into two parts: first the cost of acquiring customers, which should be

[1] Average C/P ratios for private insurers in Switzerland in the years 1989 to 1994, were 0.49 for legal protection and 0.74 for comprehensive insurance for airplanes, i.e. a difference of 25 percentage points.

independent of the claims level; and second the cost of settling claims, which should increase with the number of claims and presumably decrease with the average size of each claim. These considerations would seem to indicate that a simple linear regression of the level of premiums on the level of claims should have a positive intercept and hence the C/P ratio would vary with the level of claims.

A further issue is that, for many types of insurance, the level of claims can fluctuate substantially from one year to the next. However, it is quite intuitive that the insurance company's actions (e.g. the staff it employs for settling claims and its administrative infrastructure), are a function of the "normal" or "permanent" level of claims payments. Observed payments can be considered as a noisy signal of this "permanent" level. This raises a methodological problem. If we were to regress annual premium rates on annual claims rates, we would obtain a slope coefficient with a strong downward bias, because of measurement error problems. A number of authors (Kirchgässner [1996], Schips [1995] and von Ungern-Sternberg [1994]) have therefore decided to work with ten-year averages rather than annual data. Actually Schips [1995] goes even further, stating that at least ten-year averages need to be taken into account. The use of ten-year averages should reduce the importance of the problems noted above, but not eliminate them. The ten-year average, while being a more precise signal of the underlying level of "permanent" claims, is still a noisy signal. One way to solve this problem would be to resort to Instrumental Variables (IV) techniques.

Note that working with IV does not make use of all the information contained in the data. Specifically, it could be the case that for some insurance companies the variability of claims payments is much greater than for others. It should be possible to use this information to obtain a more precise estimator of the relationship between administrative costs and "normal" claims payments.

We propose to empirically test these issues using data on 19 regionally separated housing insurance markets (cantons) in Switzerland. Each of these markets corresponds to a state owned monopoly (the Cantonal Property Insurance, CPI) with perfectly inelastic demand, since housing insurance is compulsory. We will develop unbiased estimators of the relationship between administrative costs and claims payments on one hand, and premium income and claims payments on the other. As regards premium income, a further distinction will be introduced: The Cantonal Property Insurances spend a large part of their premium income to finance prevention (firefighting). We will thus distinguish between gross premiums (including expenditures on prevention) and net premiums (net of expenditures on prevention).

We will use the estimates we obtain to compare the cost efficiency of the Cantonal Property Insurances with the private insurance providers active in the 7 Cantons that have no state monopoly provider. We come to the conclusion that the cantonal property insurance providers are approximately 20% less expensive than their private counter parts, even if we consider that the difference in claims rates is exogenous. This fraction is considerably larger than the result from the simple comparison of the C/P ratio.

From a methodological point of view, our paper can be seen as a contribution to the (large) literature on measurement error in economics, much of which has been developed around the topic of permanent income (e.g. Abul Naga [2000] on intergenerational mobility). The novelty of our work is the fact that we explicitly use the information we have on the degree of noisiness of the observed signal to obtain a more efficient estimator. This has, to our knowledge, not been done in the literature so far.

The issue of cost efficiency of property insurance providers has been taken up by several authors. Regarding the Swiss market there has been an academic discussion in the middle of the 1990's by Schips [1995], von Ungern-Sternberg [1994, 1995] and Kirchgässner [1996]. Von Ungern-Sternberg took the stand for the public firms, arguing that they produced similar quality of service but at a significantly lower premium rate. Schips in turn took the stand of the private firms, claiming that relative to the observed damage payments the public monopolies had a higher mark-up. Finally, the third contributor to this academic discussion, Kirchgässner, rather favoured the arguments of von Ungern-Sternberg. It is interesting to note that all three authors were interested in the relationship between the level of claims payments and components of costs or premium levels, but reached contradictory results.

Further, it is useful to mention two other studies concerning the German housing insurance market, which experienced an opening of monopoly markets to competition. Felder [1996] compares the price-performance of public monopolies and private firms in Germany. He finds that the monopoly firms have on average significantly lower mark-up than the firms in competitive regions. Epple and Schäfer [1996] in turn look at the transition from public monopoly to competition occurred in Germany after the implementation of the third EU damage guideline. They find that premium rates increased dramatically through this transition.

A more general treatment of issues arising in housing insurance throughout Europe can be found in von Ungern [2003].

The remainder of the paper is structured as follows: Section 2 presents the economic problem we are interested in. Section 3 introduces the model and its assumptions we will use in the empirical part of the paper. It also includes tests whether these assumptions are confirmed within the data set. In Section 4 we present in more detail the data at hand from the housing insurance market in Switzerland. Section 5 presents the estimation techniques used and the discussion of the results. Section 6 presents the results on the comparison between the cost structure of public and private insurance providers. Section 7 concludes.

2 The economic problem

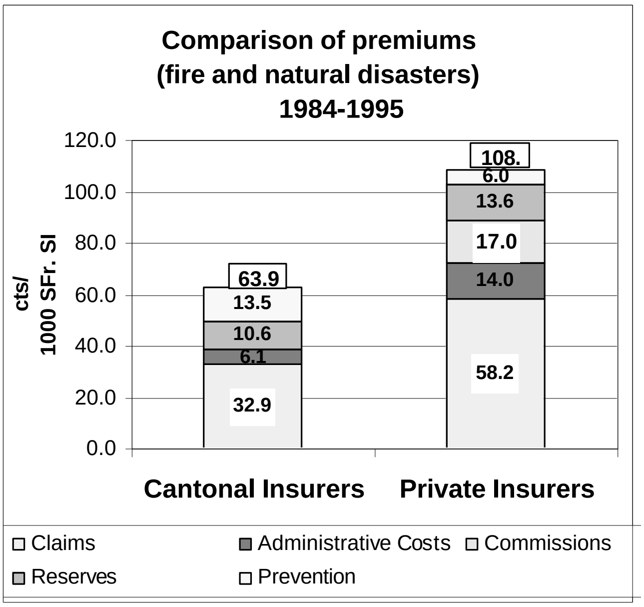
We wish to compare the cost efficiency of public and private insurance providers on the Swiss property insurance market. The structure of the market is as follows: Housing insurance is compulsory for every building. In 19 of the 26 Swiss cantons there is a public state monopoly, the Cantonal Property Insurance (CPI). In the remaining 7 Cantons there is no public supplier, and the owners have to obtain cover from one of several private insurance companies[2].

A first rough comparison of the cost structure of the different types of insurance can be found in Figure 1. Costs are expressed in cts per SFr. 1'000 housing stock insured (SI).

A first important point to note is that the private insurance companies spend substantially more on administrative costs and commissions than their public counterparts. (31 cts vs. 6 cts/SFr. 1'000 SI). This difference is easy to explain. The state monopolies have a very stable customer base (the house owners of their canton) and they have no need to invest into customer acquisition and advertising. This gives them a substantial cost advantage.

[2]Note that the CPI's represent (as of 1990) more than 80% of housing insurance in Switzerland, measured in terms of insured housing stock.

Figure 1



Second one notes that the Cantonal Property Insurances spend important amounts on damage prevention. They devote roughly one quarter of their premium income (14 cts/SFr. 1'000 SI) on such activities. This seems to us an interesting application of the Coase theorem (Coase [1960]). The public insurance companies benefit directly from better prevention. They are thus more likely to devote the necessary resources to such activities. The private insurance companies spend only slightly more than the compulsory 5 cent tax (Löschfünfer) on prevention. Finally one notes that the claims level of the private insurance companies is substantially higher than the one for the CPI. There is some debate in Switzerland, to what extent this difference in claims levels can be attributed to differences in preventive measure.

Given these large cost differences, it is not surprising, that the CPI can work with much lower premium levels. For the period 1984-1995 the premium difference was of the order of 40%. Further, the premiums for the CPI have fallen another 25% between 1995 and 1999. They are now at 46 cts / SFr.

1'000 SI. For the private insurance companies we have no comparable figures, but there is circumstantial evidence that their premium level has remained roughly constant. The premium differential is thus currently of the order of 55%.

3 The Model

The private insurance companies tend to interpret the numbers mentioned above somewhat differently. They would argue that the claims - premium ratio (C/P ratio) of the private insurance companies is equal to 0.53 which is almost the same as that for the CPI (0.52)[3].

This comparison is probably biased, since it implicitly treats the considerable expenses for preventive measures financed by the CPI in the same way as expenditures on, say, advertising and commissions. One ignores the fact that the purpose of preventive measures is to reduce damages. If one were to subtract the expenses on prevention for both types of insurance, the claims ratios would be 0.66 for the CPI and 0.57 for the private insurers, a difference of only about 15%. This raises the question, whether the C/P ratio is indeed an adequate method of comparison.

The underlying assumption of the C/P ratio is that all the other cost components of an insurance provider (in our case administrative costs, commissions and reserves) vary proportionately with the level of claims. This need not necessarily be the case. We argued in the introduction, that there are good reasons to believe that the elasticity of both administrative costs and premiums should be less than one.

Whether this is in fact the case, is an empirical issue. To address this issue we will study a panel data set for the 19 CPI for the time period 1981 to 1999. However, we did not include the year 1999 in our estimation results, since this year is considered to be an outlier (hurricane Lothar). We will analyze how the level of administrative costs, gross premiums and net premiums (net of prevention costs) vary with the level of claims. We will use the results we obtain, to estimate administrative costs, gross premiums and net premiums for a hypothetical CPI, which would have to work with the claims level incurred by the private insurance providers. We shall compare the results

[3]Figures here and below correspond to average claims and premium rates over the period 1984 to 1995.

thus obtained with the cost differential implied by the C/P ratio. We show that the results obtained by the latter measure considerably underestimate the "true" differential obtained from our regression analysis.

The main econometric problem of this approach is the fact that the level of damages in the property insurance market varies considerably from year to year. There are good theoretical reason that the insurance companies' administrative costs and premium levels are more stable than claims payments. Insurance companies will determine their administrative costs and premium not on the basis of annual claims levels but of permanent or expected long run claims levels. When regressing annual premiums or administrative costs on annual claims levels in each of the 19 cantons, the slope coefficients are not significantly different from zero in 35 out of 38 cases[4].

We will therefore work with a model where the annual administrative costs or (gross or net premium) income for a specific firm is a function, not of the annual claims level, but the "permanent" level of claims. In the simplest form of a linear relationship, this can be expressed as follows:

$$yj_{it} = \alpha + \beta x_i^* + u_{it} \tag{1}$$

where yj_{it} is the observed value of firm i in year t for: $j = 1$ administrative cost, $j = 2$ gross premium income and $j = 3$ net premium income. x_i^* is its permanent level of claims and u_{it} is the usual error term. The x_i^*'s are unobserved by the econometrician, but known by the firm when it determines the size of its administrative staff and related actions. The information available to the econometrician is in the form of annual observations on claims payments. The yearly payments can be decomposed into the permanent level of claims (x_i^*) and a stochastic component (v_{it}), which can be thought of as a "measurement error".

$$x_{it} = x_i^* + v_{it} \tag{2}$$

We assume v_{it} to be independent of both x_i^* and u_{it}, and not serially correlated. However, we do not specify explicit assumptions on the variance

[4] Using standard 5% levels of statistical significance.

of the measurement error, allowing for heteroskedasticity[5].

If the true relationship between administrative costs or premium income and the level of claims is given by (1), then an OLS regression based on:

$$y_{it} = \alpha + \beta x_{it} + \varepsilon_{it} \tag{3}$$

will lead to a slope coefficient which is biased towards zero[6]. This well known result comes from the fact that the combined error term ($\varepsilon_{it} = u_{it} - \beta v_{it}$) is correlated with the regressor x_{it}. The (multiplicative) bias can be expressed as a function of the second moments[7] of the variables, and is given by:

$$bias\ b_{OLS} = \frac{\sigma_v^2}{\sigma_{x^*}^2 + \sigma_v^2} \tag{4}$$

which can be described as the noise-to-total-variance ratio.

An alternative to the above model is the use of time averages for each firm, i.e. estimating a model of the following sort:

$$y_i = \alpha + \beta x_i + \varepsilon_i \tag{5}$$

where the variables are now time averages for each firm i. Standard regression delivers a better result in this case, but we still do not obtain a consistent estimate. The bias in this case is given by:

$$bias\ b_{AVE} = \frac{\sigma_v^2/T}{\sigma_{x^*}^2 + \sigma_v^2/T} \tag{6}$$

Note that the estimates of all other parameters in such a model are biased as well. We therefore need different estimation procedures in order to get consistent estimates.

[5]We tested whether we can model the evolution of claims payments as in (2), regressing, for each firm, the annual claims on a constant and a time trend. We observed that for all but two firms the constant is significant but the time trend is not. Breusch-Godfrey tests on serial correlation (of order 2) did not indicate signs of serial correlation However, there are strong indications that the variances of claims payments across firms are different. A test of equality of variances showed that 9 firms had significantly different variances from the mean of the sample.

[6]This is often called attenuation.

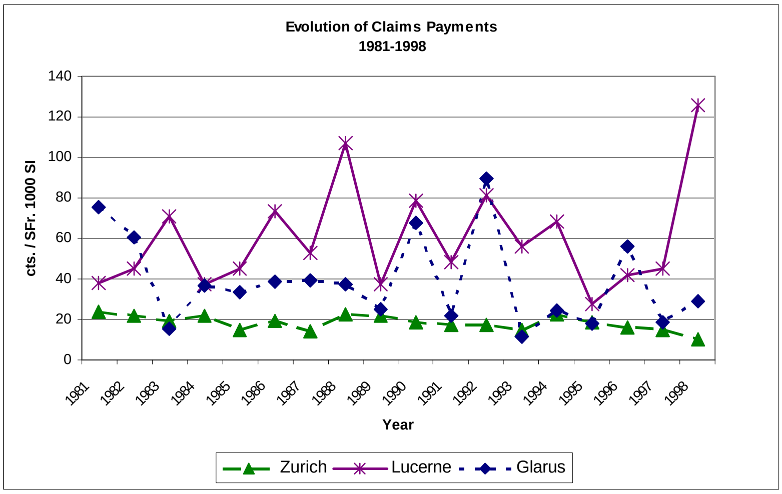
[7]Described by $\sigma_{x^*}^2$ for the permanent level of claims and σ_v^2 for the measurement error. Note that the term "second moment" is not completely correct here if x^* is a fixed number, in that case $\sigma_{x^*}^2$ is a constant.

As was mentioned before, damage occurrences vary greatly across regions. It is not only that the average claims level varies across CPI's, but also the variance of claims among the different CPI's is not the same. Table 1 illustrates this fact. The average claims level for the rural canton Lucerne is more than three times the one for the urban canton Zurich. Similarly, the coefficient of variation of another rural canton, Glarus, is almost triple compared to an urban area (Zurich). Figure 2 shows the evolution of claims in the years 1981 to 1998 for the same areas.

Table 1
Summary Statistics of claims payments
(cts per SFr. 1'000 SI)

Canton	*Obs.*	*Mean*	*Coeff. Var.*	*Min*	*Max*
Lucerne	18	60.04	0.43	27.95	126.09
Glarus	18	38.9	0.57	11.92	89.87
Zurich	18	18.39	0.20	10.48	24.16

Figure 2



We thus wish to introduce into our model the fact that the "measurement" error does not necessarily have the same variance across firms. We denote by σ^2_{vi} the variance in the measurement error of firm i. Clearly, if we have information on σ^2_{vi}, this information should be used, if we wish to obtain an efficient estimator of the coefficients in the model. We will return to these issues in Section 5.

4 The Data

We used a data set on 19 the CPI's in Switzerland over the period 1981 to 1998. For each firm the data available correspond to annual values of: insured housing stock, claims paid (with a distinction between fire and elementary damage), premium income prevention expenses and administrative costs. We express costs and damages per SFr.1'000 insured.

This gives us the following definitions of the variables used:

- $y1_{it}$ premiums per SFr. 1'000 SI for firm i in year t.
- $y2_{it}$ net premiums per SFr. 1'000 SI for firm i in year t, expressed as the difference between premiums and prevention expenses.
- $y3_{it}$ administrative costs per SFr. 1'000 SI for firm i in year t.
- x_{it} claims paid per SFr. 1'000 SI for firm i in year t.

Tables 2 and 3 present summary statistics of these variables. In Table 2 we present the disaggregated data in Table 3 the same data for the 19 (unweighted) cantonal averages. The mean premium income is about 70 cts / SFr. 1'000 SI. From the difference between premium income and net premium income we can infer that average spending on prevention is about 15.5 cts / SFr. 1'000 SI. Claims represent almost 50% of premium income, whereas administrative costs a little over 10%.

Table 2
Summary Statistics
(cts per SFr. 1'000 SI)

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Prem. ($y1_{it}$)	342	70.29	17.12	27.66	109.88
Net Prem. ($y2_{it}$)	342	54.59	18.63	6.56	95.25
Adm. Costs ($y3_{it}$)	342	7.38	2.88	2.88	17.83
Claims (x_{it})	342	34.64	19.90	5.99	126.09

Table 3
Summary Statistics - Cantonal Averages
(cts per SFr. 1'000 SI)

Variable	*Obs.*	*Mean*	*Coeff. Variation*	*Min*	*Max*
Prem. ($y1_{it}$)	19	70.29	0.12	39.29	95.61
Net Prem. ($y2_{it}$)	19	54.59	0.20	29.70	84.30
Adm. Costs ($y3_{it}$)	19	7.38	0.17	3.76	13.51
Claims (x_{it})	19	34.64	0.44	18.39	60.04

From Table 3 we can see that claims payments are more volatile than premiums and administrative costs. Similarly, the coefficient of variation of claims is more than three times higher than the one for premium income. The coefficient of variation for claims is still more than double the ones for net premium income and administrative costs.

5 Estimation & Results

We apply two different estimation techniques to our model: the standard Instrumental Variables (IV) approach, and an alternative technique: Consistent Adjusted Least Squares (CALS). Both techniques yield consistent coefficient estimates and allow us to test to what extent the C/P ratio can be used to assess efficiency of an insurance provider.

Both estimation procedures depart from OLS in that they use additional elements for estimation. In the case of IV it is the use of instruments, whereas in the case of CALS it is the variance of the measurement errors.

Instrumental Variables (IV)

Instrumental Variables (IV) has become the most standard approach to measurement error problems[8]. With suitable instruments it produces consistent estimates. The drawback of the technique is that "good" instruments are not always readily available, so the benefit of getting a consistent result is often obtained at the cost of an increased variance of the estimator.

As shown in Griliches and Hausman [1986], instruments are readily available in a panel data set. Given our assumptions, we can use, for every firm i, any observation at $\tau \neq t$ of the level of claims as an instrument for x_{it}[9]. This allows us to construct the following "valid" instrument[10]:

$$w_{it} = \frac{1}{T-1} \sum_{\tau \neq t} x_{i\tau} \tag{7}$$

Further, to test for weak instruments, we performed a test as outlined in Staiger and Stock [1997]. This test indicated strongly that our instruments are not "weak"[11].

Applying IV will produce a consistent estimator of the parameter values of our model. We further want to take into account heteroskedastic errors in the regression. We do this in a similar way as using robust standard errors with OLS. Following Wansbeek and Meijer [2000], an alternative IV-estimator, based on GMM can be applied in the case of heteroskedasticity of unspecified form. This estimator is based on IV and introduces the adjustment for heteroskedasticity in a two-step estimation procedure. The algebraic expression is:

$$b_{IV-GMM} = (X'W(W'\widehat{\Psi}_{\varepsilon}W)^{-1}W'X)^{-1}X'W(W'\widehat{\Psi}_{\varepsilon}W)^{-1}W'y \tag{8}$$

[8] However, Malinvaud [1980] wrote: "Thus, ..., we must find instrumental variables which are uncorrelated with the errors affecting the variables, but are strictly correlated with the true values of these variables. In practice, these considerations are often contradictory, and this greatly *restricts the usefulness of the method*". (Emphasis from the authors).

[9] Note that the existence of serial correlation in the form of $MA(p)$ would allow to use observations at time $\tau > t + p$ or $\tau < t - p$ as valid instruments.

[10] We thank Mark Watson for suggesting this instrument. Note that we concentrate the available information into one variable, thus reducing the number of instruments to a minimum. However, formulating the instrument in this way does not allow for eventual panel data estimator, since $cor(x_{it}, w_{it}) = -1$ by construction.

[11] The F-statistic for w_{it} in a regression of x_{it} on w_{it} in our sample is 854, which is considerably above a value of 10, proposed as a critical value for possibly weak instruments.

where X and W are the matrix of regressors and instruments, respectively, $\widehat{\Psi}_\varepsilon = diag[e^2]$, and $e^2 = (y - b_{IV}x)^2$ is the squared error from the application of IV. However, since in our case the number of instruments is the same as the number of regressors, $W'X$ is squared and the formula reduces to the standard IV-estimator. Nevertheless, the estimated covariance matrix of b_{IV-GMM} is different and the estimator is asymptotically more efficient (see Wansbeek and Meijer [2000] p. 120).

Consistent Adjusted Least Squares (CALS)

Consistent Adjusted Least Squares (CALS) is an alternative to IV estimation with some interesting features. It relies on the knowledge of the variance of the measurement error, and will allow us to take into account explicitly differences across firms in the accuracy of the observed signal on the permanent level of claims. This technique has been pioneered by Kapteyn and Wansbeek [1984].

The technique is intuitive and can best be illustrated on the slope coefficient (β) of our model. OLS regression of (3) leads to biased results, as shown above. The probability limit of the OLS estimator is given by:

$$plim\ b_{OLS} = \beta \frac{\sigma^2_{x^*}}{\sigma^2_{x^*} + \sigma^2_v} \tag{9}$$

We can see that, with knowledge of the variance of the measurement error (σ^2_v) one can obtain a consistent estimator based on OLS, which we denote by b_{CALS}[12]:

$$b_{CALS} = (1 - \frac{\sigma^2_v}{s^2_x})^{-1} b_{OLS} \tag{10}$$

where $s^2_x = \frac{1}{NT} \sum_i \sum_t x^2_{it}$ is the observed second moment of the level of claims. Note that similar adjustments can be applied to all the other coefficients of the model, in our case to α.

As mentioned before, we can extend this framework to allow for heteroskedastic measurement error. If the variance of the measurement error (σ^2_{vi}) is known, we can rewrite the true model in the following way:

$$\widetilde{y}_i = \widetilde{\alpha} + \beta \widetilde{x}^*_i + \widetilde{u}_i \tag{11}$$

[12] The asymptotic distribution of the estimator of the slope coefficient can be found in Meijer & Wansbeek [2000].

$$\widetilde{x}_i = \widetilde{x}_i^* + \widetilde{v}_i \tag{12}$$

Where $\widetilde{x}_i = \frac{\sqrt{T}}{\sigma_{vi}} \overline{x}_i$ and $\overline{x}_i$ is the sample average over firm i. The other variables are defined analogously. Note that with this transformation we have $E[\widetilde{v}_{it}^2] = 1$, i.e. the measurement error variance is the same across firms and known . Joining (11) and (12) results in the equation to be estimated[13]:

$$\widetilde{y}_i = \widetilde{\alpha} + \beta \widetilde{x}_i + \widetilde{\varepsilon}_i \tag{13}$$

where $\widetilde{\varepsilon}_i = \widetilde{u}_i - \beta \widetilde{v}_i$ is again the combined error term.

This model fits again our measurement error framework as in (3), hence we can apply the CALS framework here as well.

Note that although this estimator is consistent, there might be efficiency considerations to take into account. The fact that the measurement error variance is heteroskedastic translates into the combined error term $\widetilde{\varepsilon}_i$ not having a unique variance across observations, due to the transformation of the equation error terms (u_i). In future research, one could try to obtain robust standard errors for inference.

In order to obtain a feasible version of the CALS estimator one needs a consistent estimator of σ_v^2 or σ_{vi}^2. We used as the estimator for σ_{vi}^2 the sample variance of firm i, whereas the estimator for σ_v^2 was taken as the average over the $\widehat{\sigma}_{vi}^2$'s[14].

Results for the premium-claims relationship

We first present the results concerning the model relating premium income and claims payments. As we have argued before, prevention expenses should not be considered like other cost components such as administrative expenses and commissions. This is why we focused on the relation between net premium and claims payments. It can be argued whether one should include a time trend in the model, as there have been (steadily) important

[13] A similar model could be formulated using all the observations in our data set and not just the firm specific averages. However, the relevant information on x_i^* is contained in the firm specific averages. Using the yearly data, just introduces more noise. Results using all observations revealed to be very sensitive to changes and therefore not reliable.

[14] Note that this estimator for σ_{vi}^2 assumes x_i^* to be non-stochastic. Abul Naga [2000] presents alternative estimators for stochastic x_i^*'s based on the variance of first differences. Using these alternative estimators for the measurement error variance only marginally altered our results.

reductions over time in premium income among the CPI. Including time in the regressions alters the relevant parameters (α and β) only marginally. We therefore opted to present results not including a time trend[15].

In Table 4 we present the results for the different estimation techniques. We performed OLS with average data (b_{AVE}), CALS in the untransformed (b_{CALS}) and transformed model ($\widetilde{b}_{CALS}$), using time averages for each CPI. Further, we performed IV-GMM estimation on all observations. As an illustration of the importance of the measurement error bias, we included the results of performing OLS with all observations (b_{OLS}). Appendix 1 presents the results using the premium data.

Table 4
Results of Estimation
(net premium-claims relationship[16])

$Model$	$\widehat{\alpha}$	$\widehat{\beta}$
b_{AVE}	14.84* 7.38	1.15*** 0.20
b_{CALS}	8.56 8.77	1.33*** 0.24
$\widetilde{b}_{CALS}$	5.04*** 5.12	1.38*** 0.19
b_{IV-GMM}	9.06* 5.15	1.31*** 0.16
b_{OLS}	40.32*** 1.82	0.41*** 0.05

The table confirms the expected results. OLS on all observations yields a very low slope coefficient[17] ($\widehat{\beta}$), whereas the intercept concentrates most of the explanation of the model. In fact, the intercept in the OLS model corresponds to almost 75% of the sample mean of the independent variable (net premium income). When using average data, the situation already changes dramatically. The slope coefficient increases to a level above one and the intercept drops to less than 30% of the sample mean of net premiums. We observe that as theory would suggest b_{AVE},though a better estimate still seems

[15] Results of the regressions including a time trend can be obtained from the authors upon request.

[16] The number of observations are 19 for b_{AVE}, b_{CALS} and $\widetilde{b}_{CALS}$. For b_{IV-GMM} and b_{OLS} they are 342. Estimated standard errors are reported below the coefficient value. * represents statistically significant at 10%, ** at 5% and *** at 1%.

[17] Note that the slope coefficient in the OLS model is about one third than the one obtained using IV.

to be biased. The three consistent estimators (b_{CALS}, $\widetilde{b}_{CALS}$ and b_{IV-GMM}) show slope coefficients of roughly 1.3. Note that the OLS-adjustment on the transformed model ($\widetilde{b}_{CALS}$) leads to the highest slope coefficient and a constant that represents merely 10% of the sample average of the independent variable. Note that $\widetilde{b}_{CALS}$ and b_{IV-GMM} have slope coefficients that are statistically different from one at the 10% level. Finally, the results confirm our concern on heteroskedastic measurement error, in that $\widetilde{b}_{CALS}$ seems to be more robust. It detects a significant and theoretically justified constant, even though its value is the lowest among all the estimators.

Results for the administrative cost-claims relationship

In Table 5 we present the results for the administrative cost-claims payments relationship. We again used OLS with all data, OLS with average data (b_{AVE}), CALS in the untransformed (b_{CALS}) and transformed model ($\widetilde{b}_{CALS}$) and IV-GMM estimation. The estimators of the measurement error variance are the same as in the premium relationship.

Table 5
Results of Estimation
(administrative costs-claims relationship[18])

$Model$	$\widehat{\alpha}$	$\widehat{\beta}$
b_{AVE}	3.06^{*} 1.73	0.12^{***} 0.05
b_{CALS}	2.38 2.00	0.14^{***} 0.06
$\widetilde{b}_{CALS}$	2.10 1.63	0.15^{***} 0.06
b_{IV-GMM}	2.36^{***} 0.74	0.15^{***} 0.02
b_{OLS}	6.18^{***} 0.30	0.03^{***} 0.008

Again we observe that the slope coefficient in the OLS regression is very low, this time the IV coefficient is about 5 times higher. Further, the intercept here corresponds to almost 85% of the sample mean of the independent variable. In the case of administrative costs we observe, as before, that using average data might lead to biased results. Note that the results are very similar to the ones obtained by von Ungern-Sternberg [1994] for a different

[18] The number of observations are 19 for b_{AVE}, b_{CALS} and $\widetilde{b}_{CALS}$. For b_{IV-GMM} and b_{OLS} they are 342. Estimated standard errors are reported below the coefficient value. * represents statistically significant at 10%, ** at 5% and *** at 1%.

time period. However, the results from the consistent estimators suggest that there might still be considerable downward bias (in this case of around 20%) of the slope coefficient using average data. The estimators using CALS or IV present similar results with slope coefficients around 0.15 and the constant represents about 30% of the sample mean of administrative costs. Regarding statistical significance, we can say that the slope coefficient is highly significant for all estimation techniques, whereas the theoretically justified constant is only significant using the instrumental variable technique.

We next turn to the comparison of our results on the CPI's with the private insurance providers.

6 Comparison with private insurance providers

In this section we shall use the results estimated above to extrapolate the level of administrative costs and (net) premiums for a hypothetical CPI with the level of damages of the private insurers. As was mentioned in Section 2, data for the private insurance providers correspond to averages over all firms and cantons for the period 1984 to 1995[19]. Table 6 below presents the results of this exercise. We present comparisons using the estimation results of the instrumental variables estimation and OLS with average data.

Table 6
Comparison with private insurance providers
cts / SFr. 1'000 SI

Comparison	Net Premium	Adm. Costs
Avg. of private	102.8	31.00
Avg. of CPI	49.59	6.10
Avg. claims of priv.	58.19	58.19
Avg. claims of CPI	32.90	32.90
Forecast (IV)	85.56	10.80
Forecast (AVE)	81.65	10.32
Difference (IV)	20.15%	187.05%
Difference (AVE)	25.91%	200.44%

[19] For reasons of comparability, we took the same period for the average values for the CPI's.

Administrative Costs

The true administrative cost level of the CPI is equal to 6 cts / SFr. 1'000 SI. With the damage levels of the private insurers this would increase to slightly more than 10 cts. Hence, only a small fraction of the total difference in administrative and sales costs can be explained by differences in claims levels. Of the initial difference of 25 cts, more than 20 cts remain unexplained. On this market state monopolies clearly lead to a substantial cost saving for the customer. To understand what this cost saving means in absolute numbers, note that the total stock of insured housing capital of the CPI's in 1998 was of the order of 1'500 billion SFr. The saving in administrative and sales cost of 20 cts thus represents a cost saving of around 300 million francs per year.

Net premiums

We obtain similar results when comparing net premiums according to Table 6. The hypothetical net premium rate of a CPI with the damage rate of the private insurers is equal to 86 cts. This implies that the private insurance providers are about 20% more expensive than a CPI would be with similar claims levels. Note that the average damage rate of the three CPI with the highest claims level (Lucerne, Jura and Nidwalden) is equal to 53 cts. This is slightly more than the average of the private providers (50 cts). The average net premium rate of these three CPI is equal to 80 cts as compared to 103 for the private providers. Our results are thus quite plausible.

The estimated difference in net premium levels (103-86=17 cts) is thus only marginally smaller than the difference in costs savings (20 cts) computed in the previous section. The missing 3 cts are due to the fact that cantons with higher claims levels require more reserves than cantons with lower claims levels.

Finally we can observe that the predicted C/P ratio for a CPI with the claims rate of the private insurers is about 68%, whereas the effective C/P ratio for the private insurers is only 57%.

Note that it is not possible to perform comparisons for each canton where housing insurance is offered by private firms. The private insurers have set up a "pool" for elementary damage insurance. For this category of damage, they charge the same premium rate across all cantons even though the effective risk exposition varies substantially. This is an important source of cross-subsidies across cantons. An individual comparison of the cost efficiency by canton is thus not warranted. No such pool exists among the CPI.

Some remarks on damage prevention

The previous analysis was based on the implicit assumption that the reductions in claims due to the higher prevention expenditures were no larger than the preventive expenditures themselves. It is of course interesting to test whether this is the case.

Ideally one would wish to specify an econometric model to estimate the efficiency of expenditures on prevention. Unfortunately we do not have the necessary data of such an exercise. An alternative approach would be to compare the level of claims in two areas that are similar in most respects. We did this for Geneva (private) and Lausanne (CPI).

According to data presented in Schips [1995], the average claims rate for the period 1984 to 1993 in Geneva was 37 cts. The claims rate for the urban area of Lausanne, which has approximately the same urban structure as Geneva is equal to 21 cts. The difference with Geneva is thus 37- 21 = 16 cts. Prevention expenses in the canton Geneva are of the order of 6 cts, in Lausanne they are 13 cts. The difference is thus 7 cts.

The difference in prevention expenditures 7 cts is considerably lower than the difference in the claims 16 cts. These numbers would suggest that the reduction in claims due to better prevention exceeds the increase in prevention expenditures by 16-7 = 9 cts.

In view of these observations it seems fair to assume, that the reduction in damages is probably much larger than the simple difference in preventive expenditures suggests. The comparisons above are thus most probably heavily biased against the CPI's.

7 Conclusions

We set out to compare the cost efficiency of public and private property insurance providers in Switzerland. The public providers (CPI) work with premium rates that are approximately 60% of the ones from private insurers. However, private insurers show claims payments that are almost double the ones observed for the CPI. This implies that the commonly used Claims / Premium ratio is virtually identical between public and private providers. One could therefore argue that, given the similarity in the claims - premium ratio, there is no case for differences in cost efficiency.

We argue that the use of the Claims / Premium ratio can lead to strongly biased results. First, one can observe that the CPI spend considerably higher amounts on prevention than do their private counterparts. These expenses cannot be considered as simple cost components, such as administrative costs and commissions, since they lead to lower damage rates. Working with net (of prevention) premium income is thus more adequate. Further, in order to use the Claims / Premium ratio, one assumes that the elasticity between claims payments and premium income is equal to one. However, there are sound theoretical reasons to believe that this elasticity is in fact less than one. Administrative costs and commissions, as a component of the premium, can be divided conceptually into two parts; one which is independent of the claims level (e.g. the acquisition of new customers), and one which depends on the claims level (e.g. settling claims). Hence, when regressing premium income on claims payments, one would expect a positive intercept.

In order to test these issues, we use a simple model of a linear relationship between premium income (or administrative costs and commissions) and claims. We assume (and the data confirm) that premium rates are a function of the "normal" or "permanent" level of claims. This implies first that premium income (or administrative costs) varies much less over time than do claims, and second that annual observations on claims payments are a noisy signal of the true underlying "permanent" variable.

This setup fits a measurement error framework, and we can use techniques that deal with this issue. An additional feature we include in our model, is the fact that the noisiness of the signal is different across firms, i.e. the measurement errors are heteroskedastic.

We estimate our model using a data set of the 19 CPI in Switzerland over the period 1981 to 1998. We focus on the relationship between net premium income and claims payments and administrative costs and claims payments, using instrumental variables (IV) and consistent adjusted least squares (CALS) estimation procedures.

We find that measurement error bias is an important issue in our data set, even when using average data for each firm. Further, the results indicate that the elasticity between claims payments and premium income is less than one. For net premium income we obtain a coefficient on claims payments of around 1.3, whereas the constant represents around 10% of the sample average. In the case of administrative costs, we obtain a coefficient on claims payments of 0.15, and a constant representing about 30% of the sample average.

We next performed an extrapolation of our estimation results for an hypothetical CPI with a level of damages of the private insurers. This allows to compare the estimated administrative costs and net premium levels with the effectively observed ones for the private firms. We find that private property insurance providers in Switzerland are about 20% more expensive than a CPI with similar damage levels would be. In the case of administrative costs, the data show that the private providers spend around 20 cts per SFr. 1'000 of sum insured than do the CPI's. Only 4 cts of these 20 cts can be explained with differences in the claims level. Given the insured stock of housing capital in the cantons with CPI's this implies annual cost savings of around 300 million francs per year.

Finally, it should be noted that the above results implicitly assume that prevention expenditures do not lead to reductions in claims payments that are higher than the former. A comparison between two similar areas, Geneva (private) and Lausanne (CPI), we see that there is a difference of 16 cts in the claims rates, whereas the difference in the prevention rates is only 7 cts. This suggests that the reductions in damage are probably larger than the differential in prevention expenditures. This suggests that our comparisons are strongly biased against the CPI's.

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Appendix 1

Results of Estimation
(gross premium-claims relationship[20])

$Model$	$\widehat{\alpha}$	$\widehat{\beta}$
b_{AVE}	32.58^{***} 2.21	1.09^{***} 0.06
b_{CALS}	22.26^{*} 11.88	1.39^{***} 0.06
$\widetilde{b}_{CALS}$	16.84^{***} 4.78	1.51^{***} 0.18
b_{IV}	26.92^{***} 4.87	1.25^{***} 0.14
b_{IV-GMM}	26.92^{***} 4.97	1.25^{***} 0.15
b_{OLS}	57.74^{***} 1.69	0.36^{***} 0.04

[20]The number of observations are 19 for b_{AVE}, b_{CALS} and $\widetilde{b}_{CALS}$. For b_{IV}, b_{IV-GMM} and b_{OLS} they are 342. Estimated standard errors are reported below the coefficient value. * represents statistically significant at 10%, ** at 5% and *** at 1%. The number of observations is 342 in all estimations.

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