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Abstract

This contribution starts out by noting a conflict of interest between consumers and insurers. Consumers face positive correlation in their assets (health, wealth, wisdom, i.e. skills), causing them to demand a great deal of insurance coverage. Insurers on the other hand eschew positively correlated risks. It can be shown that insurance contributes to a reduction of their asset volatility only if unexpected deviations of payments from expected value correlate negatively across lines of insurance. Analyzing deviations from trend in aggregate insurance payments, one finds the following for the United States and Switzerland. Private U.S. but not Swiss insurance has a hedging effect for consumers, while both social insurance schemes expose consumers to excess asset volatility. In the insurance systems of both countries, the private component fails to offset deviations in the social component (and vice versa). As to the supply of insurance, cointegration analysis indicates the absence of common trends. Therefore, insurance companies could offer combined policies to the benefit of consumers, hedging their underwriting risks both domestically and internationally.

JEL Classification: G22, G15, G11, D14, C22

Keywords: Insurance, Portfolio Theory, International Diversification, Combined Contracts

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1 Introduction

This paper deals with a potential conflict between consumers and insurers which arises from their respective risk management objectives. Individuals as the potential purchasers of insurance need to manage three assets over their life cycle, health, wealth, and wisdom (skills of value in the labor market). Impulses impinging on these three assets tend to be positively correlated, serving to boost demand for insurance by risk-averse individuals. However, to the extent that benefits paid deviate from expected value (due to clauses in the small print on the one hand and customer accommodation policy on the other), these deviations should be negatively correlated across the different types of insurance held by an individual.

Insurers on their part shy away from covering risks that are positively correlated. While diversified shareholders might opt for the increase in total variance of underwriting results, they likely are concerned with the demand reaction of existing policyholders who dislike the increased risk of insolvency (Cummins and Sommer [1996]). Moreover, profitability may suffer because of the need for additional reserves to maintain solvency. Finally, management (having most of their wealth and wisdom tied to the company) seeks to limit underwriting risk.

This paper purports to find out whether deviations of actual from expected insurance payments are indeed positively correlated across lines of insurance, which would serve to enhance demand but hamper supply, thus creating a conflict of interest between consumers and insurers. As in earlier work by Zweifel [2000] and Zweifel and Lehmann [2001], the investigation is carried out at the aggregate level. Deviations from expected value are associated with differences between observed and trend values of insurance payments. The countries studied are the United States and Switzerland for maximum contrast. Apart from the fact that the U.S. economy is 35 times bigger than the Swiss, there are important institutional differences. While private insurance in the United States has been rather competitive, a tight cartel imposed uniform products and premiums in Switzerland until 1992. In turn, Swiss social health insurance is individually contracted whereas U.S. employers (except small businesses) are mandated to offer health insurance policies as a fringe benefit to their workers. Compared to earlier research, the present contribution has a much longer observation period (22 years or more), permitting improved tests for long-term trends. The absence of common trends in insurance payments would indicate a possibility for insurers to hedge their underwriting portfolio domestically or even across countries.

The next section (section 2) presents the relevant literature regarding demand for insurance in the presence of multiple risks and develops a test showing whether insurance payments reduce or increase volatility of personal assets. Section 3 describes the data, while section 4 explains the empirical approach. Section 5 shows the short-term and sections 6 and 7 the long-term results. Section 8 concludes.

2 Multiple risks: theory and stylized facts

2.1 Multiple risks in insurance economics

Multiple risks are of relevance for both the demand and supply of insurance. On the demand side, the classics by Arrow [1971] and Mossin [1968] show the conditions for demand for coverage to be positive if the relevant loss is associated with just one source of risk. Ideally, the contract would cover every possible loss regardless of its cause. However, both problems of asymmetric information (potential for both adverse selection and moral hazard) and regulation have prevented the writing of such contracts. The result is that markets for insurance are incomplete; see e.g. Doherty and Schlesinger [1983b], Mayers and Smith, Jr. [1983], Schlesinger and Doherty [1985], as well as Gollier and Schlesinger [1995] for an analysis of such markets.

Doherty and Schlesinger [1983b] and Eeckhoudt and Kimball [1992] show that independent insurance payments are suboptimal from the viewpoint of the consumer even in the case where losses are independent of each other. With two positively correlated losses, demand for insurance coverage is higher than in the case of independent losses, as demonstrated by Doherty and Schlesinger [1983a].

For insurers on the other hand, hedging their underwriting risks by combining lines of insurance that are negatively correlated seems natural. Positive correlation requires additional reserves for solvency and thus limits the supply of insurance. However, this argument overlooks three facts. First, assuming that insurers want to limit volatility, they can still hedge by holding assets that are positively correlated with their liabilities. After all, investment income importantly contributes to the bottom line of most companies. Second, as long as increased risk goes along with increased profitability, an insurance company may still be attractive to investors. The CAPM applied to insurance indicates that the underwriting beta is of crucial importance (Zweifel and Eisen [2003, ch. 6.2]; Zweifel and Auckenthaler [2006]). Finally, it is not clear that the owners of a company want management to eschew risk. Shareholders hold a call option whose value increases with the variance of the underlying, and it is the negative demand response of (informed) insurance purchasers that exerts a counter influence. However, Cummins and Sommer [1996] present empirical evidence suggesting that this counter effect is strong enough to cause insurers to limit their risk exposure. In sum, positive correlation of risks makes consumers increase their demand for insurance coverage but insurers to reduce their supply. These contradicting responses point to a conflict of interest.

2.2 How are assets of individuals correlated?

Individuals own three assets, health, wealth and wisdom (skills generating labor income). They are subject to impulses that lead to variations in the total value of their portfolios.

Table 1 presents the seven impulses that are typically distinguished in (social) insurance, along with their hypothesized correlations. The impulses considered are illness, accident, disability, old age, unemployment, increase of family size, and death of the main breadwinner. Table 1 can be read as follows. Given that someone is old (I4), there is probably a negative effect on increase in family size (I6). This points to a negative partial correlation. Family size in turn does not affect age; therefore, total correlation is negative. If on the other hand someone is sick at home in bed (I1), he or she is unlikely to cause an accident (I2), a negative partial correlation. However, it could also be that bad health is a result of an accident, a positive partial correlation. It is hypothesized that total correlation tends to be negative in this case since the first effect probably dominates.

Table 1: Impulses and their hypothesized correlations

	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**
I1: Illness							
I2: Accident	-?						
I3: Disability	-	+					
I4: Old age	+	+	+?				
I5: Unemployment	+	+?	+?	+?			
I6: Increase in family size	+?	0	0	-	+?		
I7: Death of main breadwinner	-	-	-	+	0?	0	

+ positive correlation; - negative correlation; 0 no correlation; ? unclear correlation

Table 2 matches the seven impulses considered to the three assets affected. For instance, disability (I3) is assumed to have a strong influence on all three assets, while old age (I4) is hypothesized to influence health and wisdom but not wealth due to the fact that after retirement, wealth varies little with age (retired individuals consuming just about their pension).

Combining the entries in table 1 and table 2, one sees that the three assets are likely to be positively correlated. Empirical research appears to support this notion. Bartel and Taubman [1979], Mitchell [1990], and Ettner [1996] establish a positive correlation between health and wealth. Rosen and Taubman [1982] and Ashenfelter and Rouse [1998] find a positive relationship between wealth and wisdom, whereas Grossman [1975] and Kenkel [1991] present empirical evidence to the effect that wisdom and health are positively correlated.

Table 2: Impacts of impulses on individual assets

	Health	**Wealth**	**Wisdom**
I1: Illness	**	**	**
I2: Accident	**	**	**
I3: Disability	**	**	**
I4: Old age	*	0	*
I5: Unemployment	*	**	*
I6: Increase in family size	*	**	*
I7: Death of main breadwinner	*	**	0

** strong effect; * medium effect; 0 no effect

Positive correlations between assets can lead to vicious cycles. Absent insurance, a person suffering a health loss will not only experience a drain on financial wealth but also have less opportunity to maintain the level of wisdom (through professional training). An optimal insurance system should avoid such vicious cycles by offsetting these losses. It is therefore important to determine how payments of insurance are correlated.

2.3 An application of portfolio theory

Since the seminal contribution of Markowitz [1959], it is accepted that risk-averse individuals seek to maximize expected return (μ) on their portfolio subject to a given amount of volatility (σ), i.e. attaining their efficient portfolio frontier in (μ, σ)-space. Now the different private and social insurance policies held by consumers can be viewed as assets constituting a portfolio. Since premiums are non-stochastic by and large, they will be ignored in the following. Payments, on the other hand contain a stochastic element for the insured. For example, ignored or forgotten clauses in the small print in private insurance and missing contribution years or change of employers in social insurance may cause payments to be below expected value. Conversely, consumer accommodation policy sometimes results in benefits that are higher than could be expected. In sum, there is reason for volatility in payments ($\sigma > 0$).

Turning to expected returns (μ), there could considerably be differences between the different lines of insurance and particularly between private and social insurance. The rate of return on private insurance policies can be equated to the risk-free rate of interest on the capital market, while the one on social insurance can be approximated by the growth in wages, in keeping with the seminal argument by Samuelson [1958]. However, no systematic difference between the two rates before tax can be inferred from table 3. During the period 1960 - 2007, Switzerland,

Table 3: Comparison of nominal rates of return on private and social insurance

	1960-2007		**1974-1979**	
	Private r_f	*Social* l_w	*Private* r_f	*Social* l_w
United States	6.92	6.98	8.07	10.03
Switzerland	4.27	2.49[a]	4.90	*n.a.*
Sweden	8.22	7.69	9.62	11.87
Denmark	10.01	7.70[b]	16.38	13.17
United Kingdom	8.58	8.55	13.01	17.04
Austria	7.09[c]	6.23[d]	8.83	10.49
Japan	5.25[e]	8.33	7.90	13.46

Source:OECD Economic Outlook, 2006
r_f = Nominal long-term yield on government bonds; l_w = Annual growth in wages and salaries
[a]1990-2007
[b]1966-2007
[c]1965-2007
[d]1970-2007
[e]1967-2007

Sweden, Denmark, and Austria exhibit long-term rates of interest that exceed the growth of labor incomes, while the opposite holds true for Japan. However, during 1974 - 1979, the rate of interest was below the growth rate of wages and salaries both in Sweden and Austria. As an approximation, it seems legitimate to infer equality between the rates of return on private and social insurance. The (μ, σ)-criterion can therefore be reduced to volatility (σ). Accordingly, an ideal insurance system therefore should minimize total asset variance to which consumers are exposed.

Suppose there are two impulses, death of main breadwinner and accidents, affecting assets X and Y (e.g. health and wealth). Asset values in money terms, including expected payments for claims, are labelled X^a and Y^a (e.g. life insurance and accident insurance). Unexpected deviations from expected benefits are symbolized by x and y, respectively. Total asset variance then amounts to

$$\mathrm{Var}(X^a + x + Y^a + y) = \begin{cases} \underbrace{\mathrm{Var}(X^a)}_{+} + \underbrace{\mathrm{Var}(x)}_{+} + \underbrace{\mathrm{Var}(Y^a)}_{+} + \underbrace{\mathrm{Var}(y)}_{+} + \\ \underbrace{2 \cdot \mathrm{Cov}(X^a, Y^a)}_{+} + \underbrace{2 \cdot \mathrm{Cov}(X^a, x)}_{0} + \underbrace{2 \cdot \mathrm{Cov}(X^a, y)}_{0} + \\ \underbrace{2 \cdot \mathrm{Cov}(Y^a, x)}_{0} + \underbrace{2 \cdot \mathrm{Cov}(Y^a, y)}_{0} + \underbrace{2 \cdot \mathrm{Cov}(x, y)}_{?} \end{cases} \tag{1}$$

Four out of the six covariances can be set to zero for the following reasons. In the case of $\text{Cov}(X^a, x)$ and $\text{Cov}(Y^a, y)$, this is due to the very definition of unexpected deviations (x, y). In addition, $\text{Cov}(X^a, y)$ and $\text{Cov}(Y^a, x)$ are (close to) zero because normally insurance covers just one type of loss, regardless of the occurrence of another impulse. For example, premature death usually does not trigger a payment under the title of accident insurance. As to $\text{Cov}(X^a, Y^a)$, it is positive as long as the policies feature cost-sharing provisions because the two impulses still result in lowered asset values. In all, the sign of $\text{Cov}(x, y)$ proves crucial for total asset variance. If this covariance is negative, it reduces the total amount of asset variance, if positive, increases it. Thus, to the extent that correlations between unexpected deviations in insurance payments are positively correlated, they expose consumers to excess asset volatility, preventing them from reaching the efficient frontier in (μ, σ)-space.

In sum, positive correlations between stochastic deviations in insurance payments cause inefficiencies in the insurance system as a whole. This conclusion forms the basis of the empirical tests to be carried out in sections 4 to 7 below.

3 Data

The analysis deals with yearly data for insurance claims paid in the United States and Switzerland. They cover the period 1970 - 2004 in the case of the United States for private insurance and from 1980 - 2001 for social insurance. The data is taken from the *Life Insurers Fact Book 2003* and *2005*, published by the American Council of Life Insurers. They are complemented by information from *National Health Expenditures 2003 and 2004* published by the U.S. Department of Health & Human Services for the years 1960 - 2004. The data on social insurance come from the OECD Social Expenditure Database 2004, covering 1980 to 2001.

In the case of Switzerland, the source is *Die privaten Versicherungseinrichtungen in der Schweiz*, published by the Federal Agency for Private Insurance (Bundesamt für Privatversicherung) for the years 1975 - 2004. Data on benefits paid by social insurance again come from the OECD Social Expenditure Database 2004, covering the years 1980 - 2001. Explanations and labels for lines of insurance distinguished are given in the appendix.

The information on GDP was taken from the national accounts statistics' published by the OECD, who revised the pre- 1989 figures for Switzerland. The data for the Swiss GDP is estimated from 1989 backwards. Comparison with the data provided by the Swiss Statistical Office shows them to be almost identical. To keep matters simple, all data was taken from one source; they are in millions of national currency throughout.

4 Econometric specification

The most simple way to obtain time series estimates of unexpected short-term deviations from expected values is to define them as deviations from trend. Aggregate insurance payments increase progressively over time due to inflation. The estimation procedure therefore includes a linear and a quadratic time trend to accept for inflation. The same regression equation is used for all insurance lines,

$$I_{i,t} = \beta_{i,1} + \beta_{i,2} \cdot T_t + \beta_{i,3} \cdot T_t^2 + \epsilon_{i,t}, \tag{2}$$

where I is payment in insurance line i, t denotes the year of observation, T_t is the time trend, and $\epsilon_{i,t}$ is the error term.

The first objective is to identify short-term correlations between regression residuals since individuals as well as insurers try to avoid positive correlations. In Zweifel [2000] as well as Zweifel and Lehmann [2001], positive correlations between payments prevail for the period 1975 - 1993. A regression system for private, social, and both private and social insurance is estimated. This amounts to three regression systems for each country. Since numbers of observations differ, longer time series are reduced to the length of the shortest one. For the case of U.S. private insurance, the system reads,

$$\begin{pmatrix} PLID_t \\ PLIDI_t \\ PLAI_t \\ PHI_t \\ PHI2_t \end{pmatrix} = \begin{pmatrix} \beta_{1,PLID} & \beta_{2,PLID} & \beta_{3,PLID} \\ \beta_{1,PLIDI} & \beta_{2,PLIDI} & \beta_{3,PLIDI} \\ \beta_{1,PAI} & \beta_{2,PAI} & \beta_{3,PAI} \\ \beta_{1,PHI} & \beta_{2,PHI} & \beta_{3,PHI} \\ \beta_{1,PHI2} & \beta_{2,PHI2} & \beta_{3,PHI2} \end{pmatrix} \cdot \begin{pmatrix} 1 \\ T_t \\ T_t^2 \end{pmatrix} + \begin{pmatrix} \epsilon_{PLID,t} \\ \epsilon_{PLIDI,t} \\ \epsilon_{PAI,t} \\ \epsilon_{PHI,t} \\ \epsilon_{PHI2,t} \end{pmatrix}, \tag{3}$$

with $E(\epsilon\epsilon') = \Omega$. A Breusch-Pagan chi-square test indicates that Ω cannot be considered diagonal; therefore, the error terms are correlated across equations.

Next, each equation is estimated individually for each line of insurance in order to maximize the number of observations. The calculation of pairwise correlations between residuals indicates whether unexpected negative (positive) deviations from trend in one line occur along with negative (positive) deviations from trend in another line of insurance within a given year. This is interpreted as positive short-term correlation at the level of the individual insured; for a discussion of possible errors of aggregation, see Zweifel [2000].

To analyze the common long-term trends that may characterize insurance payments, a cointegration analysis using the GDP as the cointegration variable is performed [Greene, 2003, ch. 20.4.3]. First, time series need to be tested for their stationarity. Usually, one uses first differences; however, the objective here is to identify common trends rather than avoiding spurious correlation in a specifying a model explaining the development of claims paid. Therefore, the variables are left in levels. Next, since two time series can only be cointegrated if they are of the same order, the integration order of each series is checked and reported. Finally, an augmented Engle-Granger test that accepts the null hypothesis of no cointegration will be sufficient to conclude that the two variables have no common trend. Critical values are taken from Davidson and MacKinnon [1993, ch. 20.6]. If on the other hand the null hypothesis is rejected, then cointegration may be inferred even though strictly speaking it has not been verified [Greene, 2003, pg. 656]. So whenever the residuals of equation (4) below exhibit stationary properties, a common trend can be said to exist:

$$I_{i,t} = \gamma_1 + \gamma_2 \cdot GDP_t + \mu_{i,t}, \tag{4}$$

with $\mu_{i,t}$ assumed i.i.d. This choice can be justified for two reasons. First, with income elasticities above one and rate elasticities low for major lines of insurance [SwissReinsurance [1989]], I_t is likely to be dominated by movements in GDP_t. Second, testing for cointegration with GDP is far easier than using one, several, or all remaining lines of insurance as variables of cointegration (however see section 7 below). The residuals serve as input to the augmented test based on a specification without a trend variable. The auxiliary regression then reads (dropping the i subscript for simplicity),

$$(\hat{\mu}_t - \hat{\mu}_{t-1}) = \varphi_2 \cdot \hat{\mu}_{t-1} + \varphi_3 \cdot (\hat{\mu}_{t-1} - \hat{\mu}_{t-2}) + \nu_t, \tag{5}$$

with ν_t assumed i.i.d. Estimated parameters φ_2 and φ_3 provide an indication of whether I_t and GDP_t show some form of common trend. If this should be the case for several lines of insurance, then their payments would tend to move parallel in the longer term, permanently subjecting the insured to extra volatility of their assets. In addition, insurers would have no opportunity to combine the lines affected in order to hedge their underwriting risk within the country considered.

However, increasingly insurance companies operate internationally, which provides them with opportunities for global diversification. Therefore, as a last step, an additional cointegration analysis involving the private lines of U.S. and Swiss insurance is performed in section 7. If unexpected deviations of payments show a common trend across countries, then global diversification within the same line of insurance is possible. Since social insurance will continue to be national schemes for some time to come, this last step applies to private insurance in the United States and Switzerland only.

5 Analysis of short-term correlations

The short-term analysis tries to ascertain whether deviations from expected value of claims paid are positively or negatively correlated across different lines of insurance within the same country (see equation 1). Section 5.1 deals with the United States, while section 5.2 is devoted to Switzerland.

5.1 United States

The evidence for the United States derived from the trend estimations are presented in tables 4 to 6. In private insurance (table 4), four out of ten correlations are significantly negative and just two are positive. Interestingly, it is payments of private health insurance as reported by the U.S. Department of Health & Human Services (PHI2), which cover the years 1960 - 2004 (rather than 1970 - 2004 as in the case of (PHI)) that correlates negatively with three of the other private insurance lines, viz. private life insurer's death payments (PLID), health insurance written by life insurers (PHI), and their annuity payments (PLAI). Disability payments (PLIDI) and annuity payments (PLAI) provided by life insurers also correlate negatively with each other.

Table 4: Correlations of trend deviations in U.S. private insurance, 1965 - 2004

	PLID	**PLIDI**	**PLAI**	**PHI**	**PHI2**
PLID	1.000				
PLIDI	−0.0534	1.000			
	(0.7435)				
PLAI	−0.0227	−0.3417*	1.000		
	(0.8896)	(0.0282)			
PHI[a]	0.4830**	0.1358	0.4584**	1.000	
	(0.0033)	(0.4366)	(0.0056)		
PHI2[b]	−0.3514*	0.2105	−0.4383**	−0.5516**	1.000
	(0.0262)	(0.1922)	(0.0047)	(0.0006)	

*,** coefficient significant at the five and one percent level, respectively
Note: The time series PHI and PHI2 refer to the same type of payments; only the source of data differs. Therefore, the negative correlation between the two is puzzling.
[a]1970 - 2004
[b]1960 - 2004

On the other hand, deviations in payments for health insurance by private life insurers (PHI) correlate positively with those in death (PLID) and annuity (PLAI) payments. This indicates a part of insurance business where consumers would benefit from risk diversification. One way could be to offer them combined policies; however, insurers appear to be unwilling to write such policies. On the whole, however, U.S. purchasers of private insurance are exposed to little excessive risk.

Table 5: Correlations of trend deviations in U.S. social insurance, 1980 - 2004

	SDCB	**SWCB**	**SOACB**	**SPSB**	**SSB**	**SFCB**	**SUB**	**SHB**
SDCB	1.000							
SWCB	0.9336**	1.000						
	(0.0000)							
SOACB	0.3033	0.0989	1.000					
	(0.1700)	(0.6615)						
SPSB	0.3115	0.3846	0.3477	1.000				
	(0.1582)	(0.0771)	(0.1128)					
SSB	0.7867**	0.6613**	0.4395*	−0.1444	1.000			
	(0.0000)	(0.0008)	(0.0407)	(0.5215)				
SFCB	0.7769**	0.7101**	0.2728	−0.0626	0.8888**	1.000		
	(0.0000)	(0.0002)	(0.2193)	(0.7821)	(0.0000)			
SUB	0.6085**	0.6291**	0.4030	0.5833**	0.3508	0.2444	1.000	
	(0.0027)	(0.0017)	(0.0629)	(0.0044)	(0.1094)	(0.2730)		
SHB	0.9443**	0.8588**	0.3194	0.1141	0.8884**	0.8863**	0.4690*	1.000
	(0.0000)	(0.0000)	(0.1473)	(0.6132)	(0.0000)	(0.0000)	(0.0277)	

*,** coefficient significant at the five and one percent level, respectively

In U.S. social insurance, the picture is quite different, as evidenced in table 5. Social disability benefits (SDCB), worker's compensation (SWCB), survivor's (SSB) and health (SHB) benefits show five significant positive correlations. Old age (SOACB), paid sick leave (SPSB), family cash (SFCB) and unemployment (SUB) benefits all show at least one significant positive correlation. In total 15 (or 54 percent) out of 28 correlations are significantly positive, the coefficients ranging from 0.44 to 0.94. Just two correlations indicate a negative relationship. U.S. social insurance thus seems to contribute little to asset stability for consumers. This result is in keeping with findings reported in Zweifel [2000], whose data base did not include OECD sources.

Table 6 shows the cross-correlations between private and social insurance. The only line of private insurance showing significant (positive) correlation is health insurance (PHI2) as reported by the U.S. Department of Health and Human Services. Therefore, while U.S. private insurance fails to consistently make up for unexpected shortfalls in the benefits of its social counterpart (and vice versa), it at least does not cause much excess asset volatility for consumers.

In sum, U.S. private insurance seems to considerably reduce the volatility of personal assets, contrary to social insurance which may well expose consumers to excess volatility. The interplay between private and social insurance does not alleviate the problem, leaving asset volatility unaffected.

Table 6: Correlations of trend deviations in U.S. private and social insurance, 1980 - 2004

	PLID	**PLIDI**	**PLAI**	**PHI**	**PHI2**
SDCB	0.1436	0.2790	−0.1358	0.2016	0.5015*
	(0.5239)	(0.2086)	(0.5467)	(0.3682)	(0.0174)
SWCB	−0.0211	0.3357	−0.1055	0.1521	0.5314*
	(0.9256)	(0.1266)	(0.6403)	(0.4993)	(0.0109)
SOACB	−0.0268	0.0604	−0.2457	−0.2593	0.2701
	(0.9058)	(0.7895)	(0.2704)	(0.2440)	(0.2240)
SPSB	−0.3367	−0.1628	−0.3591	−0.4135	0.4683*
	(0.1255)	(0.4690)	(0.1007)	(0.0558)	(0.0280)
SSB	0.2115	0.3337	0.0304	0.3112	0.2641
	(0.3447)	(0.1290)	(0.8931)	(0.1586)	(0.2349)
SFCB	0.1113	0.3175	0.0619	0.3054	0.2840
	(0.6218)	(0.1500)	(0.7845)	(0.1670)	(0.2003)
SUB	−0.3437	0.0431	−0.3343	−0.3070	0.5746**
	(0.1173)	(0.8488)	(0.1284)	(0.1647)	(0.0052)
SHB	0.2407	0.3455	−0.1405	0.3005	0.3582
	(0.2806)	(0.1152)	(0.5330)	(0.1743)	(0.1017)

*,** coefficient significant at the five and one percent level, respectively

5.2 Switzerland

For Switzerland, the evidence is reported in tables 7 to 9. In private insurance, there are three (out of six) significant correlations, all positive and ranging from 0.42 to 0.72 (table 7). Two of them are due to life insurance (PLID), one to general liability insurance (PGI). Since all the remaining correlations suggest a positive relationship as well, it must be said that payments by Swiss private insurance tend to increase rather than reduce the volatility of consumers' assets. Again, this finding is in accord with those of Zweifel [2000], although the time series used here cover ten more years.

Table 7: Correlations of trend deviations in Swiss private insurance, 1975 - 2004

	PLID	**PGI**	**PAI**	**PHI**
PLID	1.000			
PGI	0.5262**	1.000		
	(0.0028)			
PAI	0.1507	0.4153*	1.000	
	(0.4266)	(0.0225)		
PHI	0.7223**	0.3252	0.1763	1.000
	(0.0000)	(0.0795)	(0.3514)	

*,** coefficient significant at the five and one percent level, respectively

Table 8: Correlations of trend deviations in Swiss social insurance, 1980 - 2004

	SDCB	**SOIB**	**SOACB**	**SPSB**	**SSB**	**SFCB**	**SHTB**	**SUB**	**SHB**
SDCB	1.000								
SOIB	0.1408	1.000							
	(0.6624)								
SOACB	−0.1789	0.2374	1.000						
	(0.4257)	(0.4576)							
SPSB	0.1936	−0.1700	−0.0032	1.000					
	(0.5465)	(0.5973)	(0.9921)						
SSB	−0.3090	0.0542	0.9725**	0.0035	1.000				
	(0.1617)	(0.8670)	(0.0000)	(0.9913)					
SFCB	0.4735*	0.1712	0.5982**	−0.1026	0.4949*	1.000			
	(0.0260)	(0.5947)	(0.0033)	(0.7510)	(0.0192)				
SHTB	−0.2508	0.2524	0.9443**	0.0692	0.9304**	0.5912**	1.000		
	(0.2602)	(0.4288)	(0.0000)	(0.8309)	(0.0000)	(0.0038)			
SUB	0.4595*	0.3374	0.6886**	0.0035	0.5797**	0.9617**	0.6652**	1.000	
	(0.0314)	(0.2835)	(0.0004)	(0.9914)	(0.0047)	(0.0000)	(0.0007)		
SHB	−0.2371	0.4868	0.7714**	0.2653	0.7536**	0.3740	0.7299**	0.5109*	1.0000
	(0.2881)	(0.1085)	(0.0000)	(0.4047)	(0.0001)	(0.0864)	(0.0001)	(0.0151)	

*,** coefficient significant at the five and one percent level, respectively

Social insurance in Switzerland again shows a less favorable picture than in the United States. No less than 16 out of 36 correlations are significantly positive, with a maximum value as high as 0.97. The main source of the problem is unemployment insurance (SUB), whose benefits exhibit a significant relationship with six other insurance lines. This reinforces the findings of Zweifel and Lehmann [2001], who report 6 positive out of 10 correlations for the period 1970 to 1990. Therefore, Swiss social insurance seems to cause consumers to be rather far away from their efficient frontier in (μ, σ)-space.

Table 9 shows the cross-correlations between Swiss private and social insurance. Whereas only one correlation coefficient is significantly negative, 6 out of 36 are clearly positive, with a maximum of 0.75. The responsibility for this lies mainly with the benefits of private accident insurance (PAI), which accounts for five positive relationships. Similar results were found by Zweifel and Lehmann [2001]; they reinforce the impression that the United States insurance system does a much better job than its Swiss counterpart when it comes to filling unexpected shortfalls in the benefits paid by either private or social insurance.

Table 9: Correlations of trend deviations in Swiss private and social insurance, 1980 - 2004

	PLID	**PGI**	**PAI**	**PHI**
SDCB	−0.2741	−0.3367	−0.1105	−0.3242
	(0.2171)	(0.1255)	(0.6244)	(0.1411)
SOIB	0.4159	0.2214	0.4621	0.4739
	(0.1788)	(0.4892)	(0.1304)	(0.1196)
SOACB	−0.0075	0.3053	0.6116**	−0.1704
	(0.9735)	(0.1671)	(0.0025)	(0.4482)
SPSB	−0.2479	0.3025	0.2886	−0.0850
	(0.4372)	(0.3392)	(0.3630)	(0.7928)
SSB	−0.0279	0.3226	0.5258*	−0.1856
	(0.9018)	(0.1431)	(0.0120)	(0.4082)
SFCB	−0.3094	−0.1032	0.2932	−0.5406**
	(0.1612)	(0.6477)	(0.1854)	(0.0094)
SHTB	−0.0529	0.3570	0.5803**	−0.2590
	(0.8151)	(0.1029)	(0.0046)	(0.2445)
SUB	−0.2500	−0.0132	0.4251*	−0.4167
	(0.2619)	(0.9535)	(0.0486)	(0.0537)
SHB	0.1230	0.5396**	0.7491**	0.1940
	(0.5855)	(0.0096)	(0.0001)	(0.3869)

*,** coefficient significant at the five and one percent level, respectively

In all, the insurance system of Switzerland offers vast opportunity for efficiency improvements both in its private and its social components. Regarding the interplay between the two, the insurance system of both Switzerland and the United States fail to fill the gaps in one component by extra payments in the other.

6 Long-term analysis

Especially for the insurer, year-to-year movements of claims are of limited relevance. When looking for hedging opportunities in their underwriting business, they need to know whether claims tend to move parallel in the longer term. This issue calls for cointegration analysis.

Table 10: Order of integration as indicated by the standard Dickey-Fuller test

	USA		**Switzerland**	
	t	I(1)?	t	I(1)?
PLID	-3.859^{***}	I(1)	-3.425^{**}	I(1)
PLIDI	-10.683^{***}	I(1)		
PLAI	-6.034^{***}	I(1)		
PHI	-4.714^{***}	I(1)	-2.847^{*}	I(1)
PHI2	-6.699^{***}	I(1)		
PGI			-6.737^{***}	I(1)
PAI			-4.485^{***}	I(1)
SDCB	-1.480	not I(1)	-3.877^{***}	I(1)
SWCB	-1.991	not I(1)		
SOACB	-3.557^{*}	I(1),trend	-4.049^{***}	I(1)
SPSB	-2.974^{*}	I(1)	-3.411^{**}	I(1)
SSB	-2.756^{*}	I(1)	-4.148^{***}	I(1)
SFCB	-4.109^{***}	I(1)	-2.665^{*}	I(1)
SUB	-4.087^{***}	I(1)	-2.768^{*}	I(1)
SHB	0.033	not I(1)	-1.816	not I(1)
SOIB			-2.890^{*}	I(1)
SHTB			-4.723^{***}	I(1)
GDP	-4.035^{**}	I(1),trend	-3.019^{**}	I(1)

*,**,*** coefficient significant at 10, 5, 1 percent level

In cointegration analysis, the time series need to be of the same order of integration. A standard Dickey-Fuller (DF) test applied to first differences without a time trend suggests that most of the series are I(1) (see table 10; the critical values are based on Fuller [1976] after interpolation).

If this test rejects the null hypothesis of a unit root, then this is reported in table 10 as I(1). If the null hypothesis is not rejected, pointing to a higher order of integration, then an additional DF test with a time trend is performed. In all, three U.S. and only one Swiss time series cannot be said to be integrated of order one, i.e. I(1).

Table 11: Results of cointegration (cointegration vairable: GDP)

	United States, 1975 - 2004		**Switzerland, 1975 - 2004**	
	φ_2	Cointegrated?	φ_2	Cointegrated?
PLID	−0.2409	***No***	−0.1441	No
PLIDI	−0.4669	No		
PLAI	−0.2128	No		
PHI	−0.3648	No	−0.1063	No
PHI2	−0.3092	No		
PGI			-0.7146^{a}	No
PAI			−0.5706	No
SDCB	-0.3024^{*}	***Yes***	−0.0963	No
SWCB				
SOACB	-0.6347^{*}	Yes	−0.1532	No
SPSB	−0.2626	***No***	-0.7492^{**}	Yes
SSB	−0.2970	No	−0.3212	No
SFCB	−0.2712	No	−0.2777	No
SUB	−0.6139	No	−0.4035	No
SHB	−0.3082	***No***		
SOIB			−0.7511	No
SHTB			−0.2793	No

*,**,*** coefficient significant at 5, 2.5, 1 percent level
[a]significant at the 10 percent level

Additionally, the more powerful Dickey-Fuller GLS test (accounting for autocorrelation in the error term) as proposed by Elliot et al. [1996] is carried. The results are presented in the appendix; they largely coincide with those of table 10. Whenever the conclusion of both tests is that a series is not I(1), it is excluded from the analysis below. If just one test indicates the differenced series to have a unit root, then it is still analyzed but the results appear in bold italics in table 11 to indicate that they need to be interpreted with caution. This testing strategy results in the exclusion or qualification of U.S. life insurance (PLID) as well as workers' compensation (SWCB), health insurance (SHB), disability cash benefits (SDCB), and paid sick leave benefits (SPSB) in U.S. social insurance. In the case of Switzerland, social health insurance (SHB) had to be dropped.

As can easily be seen from table 11, none of the remaining lines of private insurance are cointegrated with the GDP of the respective country. This means that there is an absence of common trends, creating hedging possibilities. Specifically, private U.S. health insurers might consider writing umbrella-type policies covering several risks. Turning to social insurance, one notes that possibly disability benefits (SDCB) and definitely old age benefits (SOACB) exhibit a common trend with GDP. The scope for hedging thus is more limited. In the case of Switzerland, private insurers could also create combined products that would serve to reduce asset volatility for consumers. The same is true of social insurance, with the sole exception of paid sick leave (SPSB), whose benefits are clearly trending with the Swiss GDP.

Finally, the question needs to be addressed of whether certain lines of private insurance are more amenable to hedging than others. This calls for performing a cointegration analysis with one of the other lines of insurance rather than GDP serving as the cointegration variable. In tables 12 and 13, only domestic alternatives are considered. In the United States (table 12), not a single line of business is cointegrated with any other, with the one possible exception of health insurance combined with life insurers' death payments. In Switzerland (table 13), accident insurance (PAI) and general liability insurance (PGI) share a significant common trend; otherwise there is no trace of parallel long-term movements.

In conclusion, payments of private insurance are predominantly devoid of common trends both in the United States and Switzerland, providing ample opportunity to offer combined insurance contracts. In social insurance, a few common trends can be identified which limit somewhat the scope for umbrella-type policies.

7 Possibilities of international diversification

Increasingly, insurance companies operate globally. Therefore, it is natural to ask whether claims development in the United States and Switzerland permit a degree of global hedging (which of course must be of limited extent in view of the much smaller Swiss market). Again, cointegration tests serve to provide evidence on this issue; however, contrary to section 6, they involve the same line of business in the United States and Switzerland. If the two time series turn out not to be cointegrated, there exists the possibility of international hedging for private multinational insurers. For example, they could offer life insurance both in the United States and Switzerland, benefiting from the fact that the two claims processes exhibit different trends. This choice is not available to social insurers for some time to come, motivating this investigation to be performed

Table 12: Cointegration of private insurance in the U.S.A.

	PLID		**PLIDI**	
	φ_2	Cointegrated?	φ_2	Cointegrated?
PLID				
PLIDI	−0.2330	No		
PLAI	−0.2796	No	−0.0980	No
PHI	−0.5080[a]	No	−0.1378	No
PHI2	−0.0691	No	−0.4320	No
	PLAI		**PHI**	
	φ_2	Cointegrated?	φ_2	Cointegrated?
PLID				
PLIDI				
PLAI				
PHI	−0.3604	No		
PHI2	−0.2353	No	−0.4397	No

[a]coefficient significant at the 10 percent level
*,**,*** coefficient significant at 5, 2.5, 1 percent level

Table 13: Cointegration of private insurance in Switzerland

	PLID		**PHI**		**PGI**	
	φ_2	Cointegrated?	φ_2	Cointegrated?	φ_2	Cointegrated?
PLID						
PHI	−0.5001	No				
PGI	−0.1457	No	−0.1770	No		
PAI	−0.1499	No	−0.1224	No	−0.8913*	Yes

*,**,*** is significant at 5, 2.5, 1 percent level

for private insurance only.

Throughout, the U.S. variable is used as the regressor. As shown in table 14, all but one line of business (payments for death by Swiss life insurance PLID-CH, with U.S. life insurance annuity payments PLAI-US) are not cointegrated. These two lines of insurance are the only ones that should not be used for diversifying the companies' underwriting risk.

In the case of the United States and Switzerland, international diversification of the underwriting risk by private insurers therefore is entirely possible. These hedging opportunities go some

Table 14: Cointegration tests of Swiss and U.S. lines of insurance

	PLID-US		**PLIDI-US**		**PLAI-US**	
	φ_2	Cointegrated?	φ_2	Cointegrated?	φ_2	Cointegrated?
PLID-CH	−0.2520	No	−0.2349	No	-0.3268^{*}	Yes
PHI-CH	−0.1986	No	−0.2213	No	−0.1813	No
PGI-CH	−0.3960	No	−0.2371	No	-0.5823^{a}	No
PAI-CH	−0.1750	No	−0.2155	No	−0.3738	No

	PHI-US		**PHI2-US**	
	φ_2	Cointegrated?	φ_2	Cointegrated?
PLID-CH	−0.3683	No	−0.4906	No
PHI-CH	−0.2278	No	−0.2903	No
PGI-CH	−0.4479	No	−0.5736	No
PAI-CH	−0.2853	No	−0.2051	No

[a]significant at the 10 percent level
*,**,*** is significant at 5, 2.5, 1 percent level

way towards mitigating the conflict of interest between consumers (who would like to transfer positively correlated risks) and insurers (who eschew these risks) of the same country.

8 Conclusion

The starting point of this contribution is the argument that insurance payments contain a stochastic element. To the extent that these elements are positively correlated, they expose consumers to excess asset volatility. At the same time, insurers shy away from underwriting positively correlated risks. Equating these stochastic elements to trend deviations in aggregate insurance payments, the contribution of insurance to the reduction of consumers' asset volatility is reflected by the degree of negative correlation between the deviations in the different lines of private and social insurance. However, at least in the case of the United States and Switzerland, these deviations are found to often correlate positively, especially in Swiss social insurance. To overcome this inefficiency, insurers in the two countries could write combined policies. However, for this to be feasible in the long term, the claims processes must not exhibit common trends. Cointegration tests show this to be the case almost without exception. Finally, multinational insurers have the additional option of hedging a line of their business in the United States by underwriting the same type of risk in another country (Switzerland for example). This again proves to be possible with very few exceptions.

In sum, this research suggests that consumers both in the United States and Switzerland fail to reach their efficient frontiers in (μ, σ)-space as far as their assets 'insurance policies' are concerned. It also finds scope for additional hedging by private insurers, domestically as well as globally. However, some open questions need to be addressed in future research. First, similar investigations should be carried out for additional countries to check whether truly global hedging opportunities exist in the underwriting of personal insurance. Second, analysis of individual data would be extremely valuable. As already discussed in Zweifel [2000], aggregation creates the danger of finding positive correlations in the aggregate that do not exist at the individual level. Likewise, the results of the cointegration tests reported here need not carry over to individual insurance companies. However, the results presented in this paper do seem to raise issues of considerable importance worthy of additional research effort.

9 Appendix

Table 15: Labels for insurance benefits, with sources

United States	(P= private, S=social)
PLID	Life insurer's death payments; Life Insurers Fact Book
PLIDI	Life insurer's disability payments and retained assets; Life Insurers Fact Book
PLAI	Life insurer's annuity payments; Life Insurers Fact Book
PHI	Health insurance; Life Insurers Fact Book
PHI2	Health insurance; U.S. Department of Health and Human Services
SDCB	Disability cash benefits; OECD Social Expenditure Database
SWCB	Worker's compensation cash benefits; OECD Social Expenditure Database
SOACB	Old age cash benefits; OECD Social Expenditure Database
SPSB	Paid sick leave benefits; OECD Social Expenditure Database
SSB	Survivor's benefits total; OECD Social Expenditure Database
SFCB	Family cash benefits; OECD Social Expenditure Database
SUB	Unemployment benefits; OECD Social Expenditure Database
SHB	Health benefits; OECD Social Expenditure Database
Switzerland	(P= private, S=social)
PLID	Life insurance; Bundesamt für Privatversicherungen
PGI	General liability insurance; Bundesamt für Privatversicherungen
PAI	Accident insurance; Bundesamt für Privatversicherungen
PHI	Health insurance; Bundesamt für Privatversicherungen
SDCB	Disability cash benefits; OECD Social Expenditure Database
SOIB	Accident insurance (disability and survivors); OECD Social Expenditure Database
SOACB	Old age cash benefits; OECD Social Expenditure Database
SPSB	Paid sick leave benefits; OECD Social Expenditure Database
SSB	Survivor's benefits total; OECD Social Expenditure Database
SFCB	Family cash benefits; OECD Social Expenditure Database
SHTB	Housing benefits total; OECD Social Expenditure Database
SUB	Unemployment benefits; OECD Social Expenditure Database
SHB	Health benefits; OECD Social Expenditure Database

Table 16: GLS cointegration: optimal lags and order of integration

	United States			Switzerland		
	opt.lag	TS^a	I(?)	opt.lag	TS^a	I(?)
PLID	9	−1.840	not I(1)	3	−4.425***	I(1),trend
PLIDI	1	−5.382***	I(1),mean		−−	–
PLAI	5	−2.917*	I(1),trend		−−	–
PHI	0	−5.307***	$I(1)^b$,trend	5	−2.629*	I(1),trend
PHI2	0	−9.074***	$I(1)^b$,trend		−−	–
PGI		−−	–	1	−5.384***	I(1),trend
PAI		−−	–	1	−2.383*	I(1),mean
SDCB	4	−3.231**	I(1),trend	0	−4.976***	$I(1)^b$,trend
SWCB	0	−1.991	not I(1)		−−	–
SOACB	0	−3.557*	$I(1)^b$,trend	0	−4.074**	$I(1)^b$,trend
SPSB	6	2.400	not I(1)	0	−3.411**	$I(1)^b$,mean
SSB	7	−4.786***	I(1),trend	0	−4.083**	$I(1)^b$,mean
SFCB	0	−4.134**	$I(1)^b$,trend	0	−2.665*	$I(1)^b$,mean
SUB	7	−4.483***	I(1),trend	0	−2.768*	$I(1)^b$,mean
SHB	3	−3.378**	I(1),trend	0	−2.195	not I(1)
SOIB		−−	–	0	−3.554*	$I(1)^b$,trend
SHTB		−−	–	0	−4.704***	$I(1)^b$,trend
GDP	0	−4.035**	$I(1)^b$,trend	0	−3.091**	$I(1)^b$,mean

*,**,*** coefficient significant at 10, 5, 1 percent level

[a]TS = test-statistic

[b]Zero lag length indicated by Ng-Perron sequential t (1995); standard Dickey-Fuller test with interpolated critical values according to Fuller (1976)

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