Criteria for the future division of labor between private and social health insurance

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Abstract
This article's point of departure is that the individual has to manage three stochastic assets, namely health, wealth, and wisdom (skills), which tend to be positively correlated. It shows that the unexpected components of insurance payments should be negatively correlated for minimizing total asset volatility. The empirical finding is that in the United States, Japan, and Germany, the lines of social insurance contribute less to diversification than do those of private insurance. The article concludes with suggestions for new, umbrella-type insurance contracts that in the future should help individuals in the efficient management of their assets.
Criteria for the Future Division of Labor between Private and Social Health Insurance

Peter Zweifel

This article’s point of departure is that the individual has to manage three stochastic assets, namely health, wealth, and wisdom (skills), which tend to be positively correlated. It shows that the unexpected components of insurance payments should be negatively correlated for minimizing total asset volatility. The empirical finding is that in the United States, Japan, and Germany, the lines of social insurance contribute less to diversification than do those of private insurance. The article concludes with suggestions for new, umbrella-type insurance contracts that in the future should help individuals in the efficient management of their assets. Key words: health insurance, insurance, portfolio theory

Introduction

At present, private and social insurance jointly take roughly one-third of a worker’s pay in industrial countries. In spite of this expense, little is known about the performance of the insurance system as a whole from the point of view of the insured individual. This performance presumably also depends on the division of labor between its private and social component. This contribution purports to come up with a rough but simple test that may indicate whether or not the existing division of labor could be improved.

The basis of the test is a simple portfolio argument. The individual has to manage three assets: health, wealth, and wisdom (skills). The available evidence suggests that these three assets may be positively correlated prior to insurance. Ideally, insurance coverage is comprehensive, with fully compensating payment in the event that the asset in question loses in value due to an exogenous shock. Thus, asset values would be non-stochastic after insurance, which would also eliminate their positive correlation. However, insurance benefits contain a stochastic element even if there is no risk of insolvency. Not only are there copayment provisions, but the contract often contains clauses that are not fully understood by the consumer. Therefore, a loss may turn out to be only partially insured or entirely excluded from coverage, causing assets to still contain some residual stochastic variation. Minimization of this residual stochastic variation will serve as the benchmark of performance for the insurance system as a whole in this article.

This contribution is structured as follows. In the next section, theoretical arguments are adduced for justifying the assumption that the three assets under the control of an individual are positively correlated prior to insurance. The section “Managing the Risks Associated with Three Assets and a Test”

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is devoted to the derivation of a test indicating the presence of excessive total asset variance. "Application of the Test, with Special Emphasis on Health Insurance" presents results for three countries, with special emphasis on the role of health insurance. Criticisms and qualifications are also presented in this section. Since the test suggests a restructuring of insurance, a few steps toward a future new division of labor between private and social insurance are sketched in the conclusion.

A Portfolio Characterization of the Three Assets of the Individual

In this section, the argument is limited to those risks that give rise to personal insurance. While the analysis applies to business insurance as well, the separation of lines has been repealed in business insurance for some time. Therefore, the scope for product innovation may not be as marked in business insurance as in personal insurance. In the light of portfolio theory as the guide to optimal asset allocation, each individual has three assets to manage: health, wealth, and wisdom.\(^2\)\(^3\) The first is an asset whose return consists of healthy time; the second consists of financial capital and real property; and the third asset is skills that yield labor income. These three assets enable the individual to not only buy consumption goods, but also to enjoy them and to obtain a labor income that suffices for consumption in old age. They are subject to several impulses that result in volatility in total assets.* These impulses emanate from events such as sickness, death, accidents, or unemployment.

Table 1. Hypothesized correlations between impulses

<table>
<thead>
<tr>
<th></th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Illness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+?</td>
</tr>
<tr>
<td>12: Accident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13: Disability</td>
<td></td>
<td></td>
<td></td>
<td>+?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14: Old age</td>
<td></td>
<td>+?</td>
<td></td>
<td>+?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15: Unemployment</td>
<td>+?</td>
<td></td>
<td>+?</td>
<td></td>
<td>+?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16: Increase of family size</td>
<td></td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>+?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17: Death of the main breadwinner</td>
<td>+?</td>
<td>+?</td>
<td>+?</td>
<td>+?</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Systematic changes due to capital accumulation, human capital accumulation, and aging (in the case of health capital) are abstracted.
several assets in the same way. For example, bad health not only results in a loss of health capital, but frequently in skills ("wisdom"), if only because bad health prevents the individual from participating in continued education. Vice versa, health capital is not only lost in the event of illness, but also of accident and not least of unemployment. These relationships are even reinforced by feedbacks from assets to impulses. In particular, a spell of bad health may well increase the probability of becoming unemployed.

Combining Tables 1 and 2, one sees that the three assets are likely to be positively correlated. The case of ill health may again serve as an example. It not only reduces health capital, but also makes the affected individual lose his or her skills. This loss in its turn has a negative impact on earnings capacity and hence ceteris paribus on financial wealth. These relationships are also confirmed by empirical research:

- positive correlation between health and wisdom
- positive correlation between health and wealth
- positive correlation between health and wisdom

**Conclusion 1:** A majority of the seven impulses impinging on the individual’s health, wealth, and wisdom are likely to be positively correlated, and they often affect more than one asset in a similar way. Thus, the three assets should be positively correlated, a prediction borne out by available empirical evidence.

**Managing the Risks Associated with the Three Assets and a Test**

In this section, two out of the three assets are considered. Let $X$ be health, transformed into monetary units. Since both changes in the probability of survival and in the quality of life can be valued using willingness-to-pay and time trade-off techniques, the asset “health” can be made commensurable to the other asset, $Y$. Let this asset $Y$ be skills; their value can be ascertained from wage differentials on the labor market.

Insurance is now introduced as a means of risk transfer. The alternative would be diversification through the capital market. However, neither $X$ nor $Y$ are marketable, leaving financial assets $Z$ for this purpose. In the following, it is assumed that $Z$ adjusts in a way as to keep the individual on the efficient frontier (defined by maximum expected return on the sum of the three assets for a given total variance).

Within the insurance system, the respective contribution of the private and social component to the performance of the individual’s portfolio is at issue. Expected returns of private insurance (from the point of
view of purchaser of insurance) is on the long run linked to the market portfolio because
the insurer places its assets there. The benchmark of performance will be at the minimum
variance portfolio for simplicity. This means that the relevant rate of return for private insurance
must be close to the risk-free real interest rate.

As is well known, social security also has a rate of return, given by the growth of the
real labor income from which benefits for the retired are paid. Benefits of social
disability insurance tend to change in step with labor income as well. To the extent that
social health insurance is financed through a payroll tax, its benefits develop very much in
line with wage income, too (assuming a balanced budget).

In all, the expected rate of return of private insurance can be approximated by the
risk-free interest rate \( r_f \), while that of social insurance, to the growth of wage
income \( W \). Over a longer-run horizon, these two rates have not differed markedly (see
Table 3). For example, between 1960 and 1990, the average nominal long-term interest
rate on government bonds (a proxy for \( r_f \)) was 7.3% in the United States, while nomi-
nal hourly earnings (a conservative estimate of \( W \) which also reflects growth of employ-
ment) grew by 5.4%. However, during the later 1970s, \( W \) exceeded \( r_f \). In Japan, \( W \)
has been greater than \( r_f \) throughout, whereas the two rates of return are approximately
equal in Germany. Thus, the expected rates of return on private and social insurance may
be set equal as a first approximation.

This allows the analysis of comparative performance to be limited to the variance
component. Finally, since premiums and contributions to private and social insurance
are predictable in most situations, they are treated as nonstochastic quantities in what
follows, which permits focusing on the properties of the payment side.

Specifically, denote by \( X^a + x \) the final value of health capital, with \( X^a \) the asset
value after expected payment by insurance. (Insurance premiums and contributions to
social insurance are considered nonstochastic and therefore disregarded.) Under ideal
circumstances, with medical care always able to restore the health stock to its optimal
value, \( X^a \) would be a fixed quantity. This would require the absence of financial con-
straints limiting the consumption of medical care. Thus, health insurance would have to
be comprehensive in two ways. First, it must not exclude any causes of the variation in
the health stock. Second, there must be no copayment. Clearly, neither of these condi-
tions are satisfied. First, insurance contracts contain a measure of ambiguity for the pur-
chaser. Some events turn out not to be insured after the fact, while others turn out to
be included, depending on the accommodation policy of the insurer. Second, the result-
ing copayment can be higher or lower than expected. This gives rise to the unexpected
variation (denoted by \( x \)) which derives

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**Table 3. Comparison of nominal rates of return, in percent**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( r_f )</td>
<td>( W )</td>
</tr>
<tr>
<td>United States</td>
<td>7.3</td>
<td>5.4</td>
</tr>
<tr>
<td>Japan*</td>
<td>6.7</td>
<td>9.1</td>
</tr>
<tr>
<td>Germany</td>
<td>7.5</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Notes: \( r_f \) = Long-term interest rate; \( W \) = Percentage change of nominal hourly earnings in manufacturing.
from the incompleteness of the insurance contract.

Likewise, the total value of skills can be split into \( Y^a \) (after expected insurance benefits) and \( y \) (unexpected variation in benefits). Unexpected benefit variation even occurs in social insurance. For example, a beneficiary may learn that a degree of negligence was found on his or her part in a workplace accident, causing workers’ compensation to be curtailed. Conversely, benefits may be higher than expected because the presence of a child triggers a supplementary benefit.

Under these circumstances, total asset variance is given by

\[
\text{Var}(X^a + x + Y^a + y) = \text{Var}(X^a) + \text{Var}(x) + \text{Var}(Y^a) + 2 \text{Cov}(X^a, x) + 2 \text{Cov}(X^a, Y^a) + 2 \text{Cov}(Y^a, x) + 2 \text{Cov}(x, y)
\]

This makes \( \text{Cov}(X^a, Y^a) > 0 \). The one term related to insurance that can be used for minimizing total asset variance therefore is \( \text{Cov}(x, y) \). The more strongly negative the covariance between unexpected deviations from expected benefits, the smaller total asset variance.

**Conclusion 2:** In order to minimize total asset variance for efficient asset allocation, the unexpected components of insurance benefits \( \text{Cov}(x, y) \) should be perfectly negatively correlated.

Thus, the performance of the insurance system as a whole from the point of view of a purchaser of insurance can be gauged by the direction and amount of correlation in its unexpected benefit components. This simple test will be applied in the following section.

**Application of the Test, with Special Emphasis on Health Insurance**

In this section, Conclusion 1 will be applied to the lines of private insurance, social insurance, and the interplay between private and social insurance in three countries: the United States, Japan, and Germany. By fitting the time series of the benefits to quadratic time trends, residuals can be calculated that reflect unexpected deviations of benefits from their expected value, roughly corrected for inflation. These residuals are then used to determine correlation coefficients \( \rho_{x,y} \) between two lines of insurance. For a given pair of standard errors \( \{\sigma_x, \sigma_y\} \), this coefficient indicates the size of \( \text{Cov}(x, y) \) [see equation (2)].

Special emphasis will be on health insurance for the following reason. Even if health insurance was comprehensive and without
any copayment provisions, the individual’s health stock would still suffer from stochastic shocks because medical care does not always bring the health stock back to its desired level. Thus, in equation (1), the term \( \text{Var}(X^a) \) (with \( X \) denoting health as before) is bound to be a prominent part of total asset variance. The covariance term of interest should also be large when health is involved because

\[
\text{Cov}(x, y) = \rho_{x,y} \cdot \sigma_x \cdot \sigma_y \tag{2}
\]

with \([\sigma_x, \sigma_y]\) symbolizing the standard errors of unexpected insurance payments for losses of health and skills, respectively. Now a large standard error of the health asset \( X \) is likely to translate into an unexpectedly high amount of medical care expenditure and (given less than comprehensive insurance coverage) into a large value of the standard error of insurance payment \( \sigma_x \). However, for a given value of the correlation coefficient \( \rho_{x,y} \), a high value of \( \sigma_y \) indicates a sizable contribution to total asset variance. Therefore, the correlations of the unexpected component in health insurance benefits with those of other insurance lines merit special attention.

**Conclusion 3:** Deviations from expected payments in health insurance are of particular importance because they serve to increase individuals’ total asset variance disproportionately.

**Lines of private insurance**

This section is devoted to an application of the efficiency test formulated in Conclusion 2 to private insurance. In the case of the United States (Table 4), four lines of personal insurance can be distinguished. There is only one significantly positive correlation out of six, between unexpected benefit variations in death payments and annuity payments [cell (1, 3) of Table 4]. One may argue that these are two types of a benefit triggered by one impulse; rather than being paid a capital, the beneficiary may have opted for an annuity. However, this is an argument explaining positive correlation of expected benefits, not unexpected deviations. This emphasis on the difference between expected benefits and unexpected deviations will come up repeatedly; it will be qualified below. Deviations in disability payments, having one significantly negative (at the 5 percent confidence level) and a second almost significantly negative correlation, definitely contribute to risk diversification within private insurance. Thus, private personal insurance in the United States cannot be charged with bolstering total asset variance.

**Table 4. Correlations of trend deviations in the benefits of U.S. private insurance, 1972–1992**

<table>
<thead>
<tr>
<th></th>
<th>PLDE (1)</th>
<th>PLDI (2)</th>
<th>PAP (3)</th>
<th>PHI (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLDE (1)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLDI (2)</td>
<td>-0.41</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAP (3)</td>
<td>0.76*</td>
<td>-0.45*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PHI (4)</td>
<td>0.28</td>
<td>0.11</td>
<td>0.35</td>
<td>1</td>
</tr>
</tbody>
</table>

* Correlation coefficient significantly different from zero (5% significance level or better)

PLDE Life insurance: death payments
PLDI Life insurance: disability payments
PAP Annuity payments
PHI Health insurance

Sources: a) Life Insurance Facts Update, b) Source Book of Health Insurance Data.
Table 5. Correlations of trend deviations in the benefits of Japanese private insurance, 1970–1993

<table>
<thead>
<tr>
<th></th>
<th>PLI (1)</th>
<th>PAI (2)</th>
<th>PWC (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLI (1)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAI (2)</td>
<td>-0.54*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PWC (3)</td>
<td>0.11</td>
<td>-0.28</td>
<td>1</td>
</tr>
</tbody>
</table>

* Correlation coefficient significantly different from zero (5% significance level or better)
PLI Life insurance
PAI Accident insurance (general and long-term)
PWC Workers’ compensation
Source: Insurance Yearbook.

Table 6. Correlations of trend deviations in the benefits of German private insurance, 1975–1993

<table>
<thead>
<tr>
<th></th>
<th>PLI (1)</th>
<th>PHI (2)</th>
<th>PDI (3)</th>
<th>PGI (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLI (1)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHI (2)</td>
<td>0.37</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDI (3)</td>
<td>-0.19</td>
<td>-0.41</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PGI (4)</td>
<td>0.54*</td>
<td>0.76*</td>
<td>-0.40</td>
<td>1</td>
</tr>
</tbody>
</table>

* Correlation coefficient significantly different from zero (5% significance level or better)
PLI Private life insurance
PHI Private health insurance
PDI Private disability insurance
PGI Private general liability insurance
Source: Annual reports of the German Federal Regulatory Agency for Insurance (Bundesaufsichtsamt für Versicherung).

For Japan, the data are even more aggregated, to a mere three lines. However, zero out of three coefficients is positive, while one is significantly negative [cell (2, 1) of Table 5]. What limited evidence is available therefore suggests that Japanese private accident insurance may contribute to a reduction of total asset variance through its compensation of shortfalls in private life insurance.

As for Germany, statistics for four lines of private personal insurance are available. Here, two out of six coefficients are significantly positive [cells (4, 1) and (4, 2) of Table 6]; on the other hand, three are nonsignificantly negative. Specifically, unexpected deviations in benefits from life and health insurance tend to be reinforced rather than neutralized by general liability insurance. One may again argue that the three lines share a common trigger, in particular traffic accidents. However, a common trigger should result in simultaneous movements of expected insurance benefits, leaving open the question of why unexpected deviations from expected payments should be positively correlated as well. There is no apparent reason why someone suffering a traffic accident should receive exceptionally high insurance payments under several titles.

With regard to health insurance in particular, unexpected deviations are uncorrelated in the United States, whereas no evidence is available in the case of Japan (see also Table 13). The evidence is mixed for Germany, where private health insurance appears to make up to some degree for shortfalls in disability payments (the correlation coefficient of -0.41 in Table 6 is just below the 5 percent significance level). As stated above, the deviations of health insurance payments and those of general liability insurance exhibit strongly positive correlation, distracting from German private health insurance as an instrument of risk diversification.

Conclusion 4: Only one out of six unexpected components of major lines in private personal insurance in the United States and
zero out of three in Japan are positively correlated. Private personal insurance (including health insurance) in these two countries thus serves rather well as a vehicle for risk diversification. The performance of German private insurance is inferior according to this measure, in particular in the domain of health insurance.

The last statement of this conclusion is also supported by the first column of Table 13, showing that 33 percent of correlations are positive in German private insurance, of which 17 percent are due to health insurance.

**Lines of social insurance**

According to the philosophy of social insurance, a beneficiary should always be able to count on a minimum level of consumption (which corresponds to a minimum of total assets). On these grounds, a better record in terms of variance reduction might be expected than in private insurance.

The results for the three countries are displayed in Tables 7–9 (see also Table 13). Somewhat surprisingly, the evidence does not point to a superior performance of social insurance. In the case of the United States, unexpected variations in benefits correlate positively in five and negatively in three out of 21 cases (Table 7). One prominent instance of positive correlation is Medicaid in its relationship with unemployment insurance and workers’ compensation [cells (5, 2) and (6, 2)]. In this way, important parts of U.S. social insurance seem to expose rather vulnerable individuals to excessive asset variance.

This holds true of Japanese social insurance as well (Table 8), where no less than seven out of 15 correlations are significantly positive. In particular, whenever welfare payments are below their expected

---

**Table 7. Correlations of trend deviations in benefits of U.S. social insurance, 1972–1992**

<table>
<thead>
<tr>
<th></th>
<th>SOAS (1)</th>
<th>SDI (2)</th>
<th>SMCHI (3)</th>
<th>SMCSM (4)</th>
<th>SMA (5)</th>
<th>SUI (6)</th>
<th>SWC (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOAS (1)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDI (2)</td>
<td>-0.41</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMCHI (3)</td>
<td>0.82*</td>
<td>-0.21</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMCSM (4)</td>
<td>-0.29</td>
<td>0.16</td>
<td>-0.31</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMA (5)</td>
<td>-0.55*</td>
<td>0.93*</td>
<td>0.40</td>
<td>0.33</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUI (6)</td>
<td>0.02</td>
<td>0.70*</td>
<td>0.28</td>
<td>0.29</td>
<td>0.63*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SWC (7)</td>
<td>-0.64*</td>
<td>0.77*</td>
<td>-0.65*</td>
<td>0.31</td>
<td>0.84*</td>
<td>0.24</td>
<td>1</td>
</tr>
</tbody>
</table>

*Correlation coefficient significantly different from zero (5% significance level or better)*

SOAS  Old-age and survivors insurance
SDI  Disability insurance
SMCHI  Medicare: hospital insurance
SMCSM  Medicare: supplementary medical insurance
SMA  Medicaid
SUI  Unemployment insurance
SWC  Workers’ compensation

*Source: Social Security Bulletin.*
Table 8. Correlations of trend deviations in benefits of Japanese social insurance, 1970–1993

<table>
<thead>
<tr>
<th></th>
<th>SS (1)</th>
<th>SWA (2)</th>
<th>SPE (3)</th>
<th>SUI (4)</th>
<th>SFA (5)</th>
<th>SWE (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS (1)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWA (2)</td>
<td>0.88*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPE (3)</td>
<td>-0.79*</td>
<td>-0.88*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SUI (4)</td>
<td>0.89*</td>
<td>0.83*</td>
<td>-0.70*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFA (5)</td>
<td>-0.67*</td>
<td>-0.91*</td>
<td>0.82*</td>
<td>-0.61*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SWE (6)</td>
<td>0.99*</td>
<td>0.91*</td>
<td>-0.80*</td>
<td>0.92*</td>
<td>-0.70*</td>
<td>1</td>
</tr>
</tbody>
</table>

*Correlation coefficient significantly different from zero (5% significance level or better)

SS  Sickness and child birth
SWA  Work-related accident
SPE  Pensions
SUI  Unemployment insurance
SFA  Family allowances
SWE  Welfare (public assistance and social welfare)


value, there is a shortfall of sickness benefits [cell (6, 1)] and very often in workplace accident and unemployment benefits, too [cells (6, 2) and (6, 4)]. On the other hand, both pensions and family allowances exhibit four negative correlation coefficients (out of five), suggesting that wage earners with children and pensioners can derive a good measure of security from the system.

Germany is of special interest in this comparison because it has a body of law (codices of social law, Sozialgesetzbücher) that seeks to systematically specify conditions of access to and of eligibility for benefits of the schemes of social insurance. Thus, one might expect German social insurance to contribute to the minimization of asset volatility to a particularly high degree. However, as evidenced in Table 9, no less than five out 15 observed correlations are significantly positive. Only employee benefits (for old age) consistently contribute to risk diversification, with three negative coefficients (item 2). Interestingly, this component does not even officially belong to social insurance because it is not (fully) compulsory!

Turning to health insurance in particular, one notes that social (or public) health insurance consists of three programs in the
United States, namely Medicare hospital, Medicare supplementary medical, and Medicaid (items 3–5 of Table 7). The beneficiaries of the first two programs are the aged, with considerable overlap between the two groups. The third program is targeted to the poor, with hardly any overlap in beneficiaries with the Medicare programs. Within the two Medicare programs, deviations from expected benefits at least do not reinforce each other \( \rho(4, 3) = -0.31 \), non-significant. With regard to Medicaid, the salient point is the almost perfect correlation with disability insurance \( \rho(5, 2) = 0.93 \). Again, it bears repeating that a high degree of correlation in the expected payments of the two lines would not be a cause of concern. Disability often causes poverty, which in turn makes the individual eligible for Medicaid. But here, the correlation refers to unexpected components, creating the suspicion of double windfalls and double shortfalls.

Similar mechanisms seem to be at work in Japan: when social insurance is unexpectedly scanty with payments under the health title (item 1 in Table 8), it also appears stingy under the work-related accidents (item 2) and under the unemployment (item 4) titles. In particular, deviations in social health insurance and welfare payments go perfectly hand in hand. Thus, an individual who gets “overly bad treatment” by Japanese social health insurance must expect to get the same from the welfare department.

Finally, German social health insurance (item 3 of Table 9) contributes to risk diversification to a very limited degree. Out of four observed correlations, two are significantly positive. These two are again due to correlation with accident insurance (item 4) and unemployment insurance (item 5), as in Japan. Therefore, unexpected shortfalls in payments by social health insurance appear to be aggravated by shortfalls in two other lines that have a considerable overlap in terms of beneficiaries.

**Conclusion 5:** With positive correlations between unexpected components of lines accounting for up to one half of the total, social insurance in the United States, Japan, and Germany seems to achieve less risk diversification across its lines than does private insurance. Within the realm of social health insurance, the two U.S. Medicare programs have a diversifying effect, but not the Medicaid program. Social health insurance seems to expose individuals to excessive asset variance especially in Japan and Germany.

The last statement of this conclusion is also supported by the second column of Table 13, stating that 47 and 50 percent of correlations are positive in Japanese and German social insurance respectively.

**The interplay of private and social insurance**

The comparison of Conclusions 4 and 5 points to an advantage of private insurance as a vehicle of risk diversification that could justify a changed division of labor between private and social insurance. However, a full assessment of the performance of an insurance system as a whole must go beyond an isolated examination of its private and social parts. For the individual concerned, risk diversification could also be achieved by private insurance filling unexpected gaps left by social insurance and vice versa.

As for the United States, Table 10 juxtaposes the four private insurance lines
Table 10. Correlations of trend deviations, U.S. private and social insurance, 1972–1992

<table>
<thead>
<tr>
<th></th>
<th>SOAS (5)</th>
<th>SDI (6)</th>
<th>SMCHI (7)</th>
<th>SMCSM (8)</th>
<th>SMA (9)</th>
<th>SUI (10)</th>
<th>SWC (11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLDE (1)</td>
<td>0.74*</td>
<td>-0.50*</td>
<td>0.47*</td>
<td>-0.33</td>
<td>-0.64*</td>
<td>-0.37</td>
<td>-0.49*</td>
</tr>
<tr>
<td>PLDI (2)</td>
<td>-0.35</td>
<td>0.90*</td>
<td>-0.13</td>
<td>0.13</td>
<td>0.80*</td>
<td>0.58*</td>
<td>0.70*</td>
</tr>
<tr>
<td>PAP (3)</td>
<td>0.73*</td>
<td>-0.58</td>
<td>0.58*</td>
<td>-0.45*</td>
<td>-0.74*</td>
<td>-0.38</td>
<td>-0.59*</td>
</tr>
<tr>
<td>PHI (4)</td>
<td>0.67*</td>
<td>0.08</td>
<td>0.62*</td>
<td>0.02</td>
<td>-0.10</td>
<td>0.34</td>
<td>-0.19</td>
</tr>
</tbody>
</table>

*Correlation coefficient significantly different from zero (5% significance level or better)

PLDE Life insurance: death payments
PLDI Life insurance: disability payments
PAP Annuity payments
PHI Health insurance
SOAS Old age and survivors insurance
SDI Disability insurance
SMCHI Medicare: hospital insurance
SMCSM Medicare: supplementary medical insurance
SMA Medicaid
SUI Unemployment insurance
SWC Workers’ compensation

Sources: see Tables 4 and 7.

...distinguished with the seven lines of social insurance. Out of 28 correlation coefficients, 10 are significantly positive and 6 significantly negative. This count may still paint a too favorable picture since payments from Medicaid and payments from private insurance go to groups with little if any overlap. Indeed, deleting item 9 of Table 10 (Medicaid) from the count results in nine positives and four negatives out of 24. On the whole, then, private and social insurance fail to complement each other in a way that would contribute to a maximum reduction of total asset variance.

In the case of Japan, six out of a total of 18 correlations in Table 11 are significantly positive, while three are significantly negative. Thus, the interplay between the two main components of insurance again contributes little to variance reduction. Especially noteworthy is the (statistically significant) coefficient of 0.45 between private life insurance and social pensions [cell (1, 6) of Table 11]. Since the sums involved and their standard errors \( \{\sigma_x, \sigma_y\} \) are large, this coefficient translates into considerable asset covariance in view of equation (2). Interpreted at the level of the individual, this means that unexpected generosity and lack of generosity go together in the two largest components of both private and social insurance. Thus, elderly Japanese in particular are exposed to a rather high amount of total asset variance.

German private and social insurance might complement each other to a higher degree, too. Out of 20 correlations in Table 12, five are significantly positive, while only one comes out negative. As evidenced in Table 12, this still makes Germany the country where the interplay between the two insurance components is the most favorable, followed by Japan and the United States.

Turning specifically to health insurance once more, one finds for the United States one coefficient of +0.62 between private health insurance and hospital insurance...
Table 11. Correlations of trend deviations, Japanese private and social insurance, 1970–1993

<table>
<thead>
<tr>
<th></th>
<th>SS (4)</th>
<th>SWA (5)</th>
<th>SPE (6)</th>
<th>SUI (7)</th>
<th>SFA (8)</th>
<th>SWE (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLI (1)</td>
<td>−0.31</td>
<td>−0.65*</td>
<td>0.45*</td>
<td>−0.38</td>
<td>0.71*</td>
<td>−0.34</td>
</tr>
<tr>
<td>PAI (2)</td>
<td>0.92*</td>
<td>0.96*</td>
<td>−0.83*</td>
<td>0.86*</td>
<td>−0.84*</td>
<td>0.94</td>
</tr>
<tr>
<td>PWC (3)</td>
<td>−0.13</td>
<td>−0.25</td>
<td>0.24</td>
<td>−0.12</td>
<td>0.48*</td>
<td>−0.14</td>
</tr>
</tbody>
</table>

* Correlation coefficient significantly different from zero (5% significance level or better)

PLI  Life insurance
PAI  Accident insurance (general and long-term)
PWC  Workers’ compensation
SS   Sickness and child birth
SWA  Work-related accident
SPE  Pensions
SUI  Unemployment insurance
SFA  Family allowances
SWE  Welfare (public assistance and social welfare)

Sources: see Tables 5 and 8.

payments by Medicare [cell (4, 7) of Table 10]. Once again, it is tempting to argue that both types of benefit should be paid simultaneously, being occasioned by a health loss. However, this should result in a positive correlation between expected values, whereas deviations from unexpected values are measured here, which need not be positively correlated.

In the case of Japan, the data do not permit a detailed assessment of the interplay between social and private health insurance. All one can say is that deviations in payments by its social component correlate

Table 12. Correlations of trend deviations in the benefits of German private and social insurance, 1975–1993

<table>
<thead>
<tr>
<th></th>
<th>SOAS (5)</th>
<th>SEB (6)</th>
<th>SHI (7)</th>
<th>SAI (8)</th>
<th>SUI (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLI (1)</td>
<td>0.27</td>
<td>−0.08</td>
<td>0.26</td>
<td>0.39</td>
<td>0.25</td>
</tr>
<tr>
<td>PHI (2)</td>
<td>0.79*</td>
<td>−0.72*</td>
<td>0.56*</td>
<td>0.92*</td>
<td>0.63*</td>
</tr>
<tr>
<td>PAI (3)</td>
<td>−0.41</td>
<td>0.28</td>
<td>−0.15</td>
<td>−0.41</td>
<td>−0.26</td>
</tr>
<tr>
<td>PGI (4)</td>
<td>0.43</td>
<td>−0.25</td>
<td>0.16</td>
<td>0.54*</td>
<td>0.08</td>
</tr>
</tbody>
</table>

* Correlation coefficient significantly different from zero (5% significance level or better)

PLI  Private life insurance
PHI  Private health insurance
PGI  Private general liability insurance
PAI  Private accident insurance
OAS  Old age and survivors insurance
SEB  Employee benefits
SHI  Social health insurance
SAI  Social accidents insurance
SUI  Unemployment insurance

Sources: see Tables 6 and 9.
positively and very strongly with those in private accident insurance \([\text{cell (2, 4) of Table 11}]\).

Finally, Germany stands out as the country where higher than expected benefits in private health insurance (item 2 of Table 12) go along with higher than expected payments in four out of five lines of social insurance, among them also social health insurance. Conversely, social health insurance (item 7) is uncorrelated with deviations in three out of four private insurance lines—the only exception being private health insurance. Thus, it appears that private health insurance is the line that is most responsible for excessive total asset variance in Germany (see column 3 of Table 13, where the 25 percent share of positive correlations is shown to come from 20 percent due to health insurance).

**Conclusion 6:** In all three countries considered, the interplay between private and social insurance gives rise to an amount of total asset variance that could still be reduced. Health insurance is responsible for this to a small degree in the United States, to a presumably considerable degree in Japan, and to a large degree in Germany.

This conclusion creates the impression that modifying the division of labor between private and social insurance may generate important efficiency gains in terms of risk diversification. It also points to health insurance as a particularly promising area of reform. It is silent however about whether the private or the social component should expand. It is by invoking Conclusions 4 and 5 (which point to a superior diversification effect of the private component) that one is led to suggest that the modification may well favor private insurance if efficiency is the objective. However, this suggestion derives from the particular approach used here, which is open to criticism to be discussed in the next section.

### Three Criticisms of the Approach

Up to this point, the correlations based on aggregate data were interpreted as though they permitted immediate inference with regard to correlations at the individual level. However, there is considerable scope for aggregation bias.

For example, let two individuals \((1\ \text{and } 2)\) experience deviations from expected payments \(x_1\) and \(x_2\) with regard to asset \(X\) and \(y_1\) and \(y_2\) with regard to \(Y\), all deviations having

<table>
<thead>
<tr>
<th>Country</th>
<th>Private(^*) (1)</th>
<th>Social(^*) (2)</th>
<th>Private(^*) vs. Social (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>17 (0)</td>
<td>29 (19)</td>
<td>36 (14)</td>
</tr>
<tr>
<td>Japan</td>
<td>0 (n.a.)</td>
<td>47 (20)</td>
<td>33 (n.a.)</td>
</tr>
<tr>
<td>Germany</td>
<td>33 (17)</td>
<td>50 (20)</td>
<td>25 (20)</td>
</tr>
</tbody>
</table>

\* Figures in parentheses denote percentage points due to health insurance.
zero expectation. The aggregate covariance of these deviations is then given by

\[
\text{Cov}(x_1 + x_2, y_1 + y_2) \\
= E(x_1 + x_2)(y_1 + y_2) \\
= \text{Cov}(x_1, y_1) + \text{Cov}(x_2, y_2) \\
+ \text{Cov}(x_1, y_2) + \text{Cov}(x_2, y_1). \quad [3]
\]

This formula can be used to discuss three types of effects that may cause aggregation bias.

1. **Positive correlation induced by macroeconomic factors.** Insurance with regard to \( X \) and \( Y \) may well be perfect at the individual level in the sense that the first two ("within individuals") covariances in equation (3) are zero or even negative. However, there could be factors influencing both individuals in the same way and resulting in positive values for the last two terms of equation (3) ("across individuals"). A typical instance would be a recession or a burst of inflation. However, it should be noted that (under the assumption that the unexpected components of insurance payments are correctly filtered from the data, see point 3 below), it is not sufficient for insurance benefits to be subject to such a common macroeconomic factor to create a problem of aggregation. For example, in an economic recession there will be increased losses both with regard to skills (unemployment) and health, causing a positive correlation between expected benefits. Once more, this correlation must spill over into unexpected deviations to be relevant here. This could happen if both unemployment and health insurance payments must be financed out of a given common budget for social insurance, with a budget cut forcing a negative deviation both in payment \( x_1 \) to individual 1 and payment \( y_2 \) to individual 2. Thus, \( \text{Cov}(x_1, y_2) > 0 \) while \( \{ \text{Cov}(x_1, y_1) = 0, \text{Cov}(x_2, y_2) = 0 \} \) as before. This is possible but not very likely.

2. **Numbers effect of macroeconomic factors.** To the extent that the first two terms of equation (3) are positive not only for the two individuals considered but generically for all claimants, macroeconomic factors may increase the total covariance by adding similar terms for additional individuals \( (3, 4, \ldots, n) \). Again, this argument turns out to be not quite convincing. In the case of the United States, aggregate deviations in unemployment insurance (the leading proxy of a macro influence) are correlated with deviations in private insurance (at the 5 percent significance level) in just one out of four instances (item 10 of Table 9). Similar ratios are obtained for Japan and Germany; they do not point to an overwhelming importance of macroeconomic shocks for the findings presented here.

3. **Failure to filter out nonexpected components.** As constructed, nonexpected components, being regression residuals, are orthogonal to a (quadratic) time trend. They should be orthogonal to expected insurance benefits, which need not follow a smooth time trend perfectly. Thus, unexpected deviations as estimated may contain elements of expected benefits, which would have to be positively correlated whenever they share a common triggering event. This may account for
the very high positive correlation of deviations in disability and Medicaid payments \( [\rho = 0.93, \text{cell } (5, 2) \text{ of Table 7}] \) or private and social disability insurance in the United States \( [\rho = 0.90, \text{cell } (2, 6) \text{ of Table 10}] \). On the other hand, benefits from Medicare supplementary hospital insurance and those from private health insurance \( [\text{cell } (4, 8) \text{ of Table 10}] \) certainly share a common triggering event; yet the positive correlation of their expected payments does not spill over into a positive correlation between nonexpected payments \( [\rho = 0.02] \). Thus, failure to precisely estimate nonexpected components cannot be decisive in all cases.

**Conclusion 7:** There are three major difficulties with the interpretation of the findings at the aggregate level in terms of effects at the individual level, namely positive correlation induced by macroeconomic factors, numbers effects of macroeconomic factors, and failure to filter out nonexpected components. However, none of these effects provides a consistent explanation of the observed phenomena.

Clearly, Conclusion 7 still leaves open the possibility that the three problems in their conjunction invalidate inferences drawn from aggregate data. To fully answer this concern, individual panel data would be needed. Ideally, they should register the occurrence of losses making an impact on the three assets distinguished, indicate the amount of benefits that could be expected in the light of the individual’s characteristics and the provisions of private and social insurance, and determine excesses and shortfalls of actual relative to expected benefits. Such a research program would also reveal a dimension that has been entirely disregarded in this paper, that is the importance of lags. While unexpected deviations may exhibit strong positive correlation during a given year, this correlation may taper off or even turn negative in the course of subsequent periods. The speed with which zero or even negative correlations are attained should enter the assessment of an insurance system’s performance as well.

**Conclusion**

In this contribution, a simple approach for gauging the overall performance of the insurance system of a country is proposed. At any given expected rate of return, a risk-averse individual aims at minimizing total asset variance. An ideal insurance system would neutralize the shocks imparted to each asset as to make its post-coverage value a constant. However, actual benefits paid are not always equal to their expected values; specifically, less than comprehensive coverage and deviations between actual and expected benefits cause total asset variance to remain positive. It can be shown that unexpected deviations in insurance payments should be perfectly negatively correlated across lines to minimize this variance.

Using time series data from the United States, Japan, and Germany, unexpected deviations from expected insurance payments were calculated as deviations from a quadratic time trend. These deviations were subjected to a correlation analysis across the different lines of insurance. In private insurance, only one out of six correlation coefficients was significantly positive in the United States, zero out of three in Japan, and two out of six in Germany, pointing to scope
for improvement in Germany (see first column of Table 13). In social insurance, a full six out of 21 (United States), seven out of 15 (Japan), and five out of 10 (Germany; see the percent ratios in the second column of Table 13) correlation coefficients were significantly positive, pointing to a smaller diversification effect than in private insurance. The design of Japanese social insurance in particular seems to burden its beneficiaries with a good deal of uncertainty. Finally, the interplay between private and social insurance can also be described by correlations between payment deviations. Again, there seems a good deal of excessive asset variance in the United States and Japan due to a lack of risk neutralization between private and social insurance lines (see third column of Table 13).

Health insurance in particular was found to contribute to excess asset variance, especially in Germany where deviations in private health insurance are positively correlated with four out of five deviations in social insurance payments (see second column of Table 13). Since health insurance does not cover losses in health stock as such, these positive correlations cause a particularly large increase in total asset variance.

However, suggestive as these findings may be, they are based on aggregate data, and inference from the aggregate to the individual level is fraught with difficulties. First, macroeconomic influences such as downswings in the economy may affect individuals similarly, thus making deviations that are uncorrelated for each individual look positively correlated in the aggregate. Second, such a downswing may simply increase the number of beneficiaries across the different lines of insurance, causing deviations at the aggregate level to be positively correlated.

Third, deviations from a time trend might not proxy too well for deviations from expected payments. Closer scrutiny of the results, however, suggests that none of these errors and aggregation biases offers a fully consistent explanation of the observed phenomena.

In spite of these qualifications and shortcomings, this paper thus gives reason to suspect that the overall performance of insurance could be improved in the three countries considered. Specifically, social insurance appears to withhold benefits unexpectedly from beneficiaries in more than one of its lines, thus subjecting individuals to an excessive amount of total asset variance. Restrictions on eligibility and line-specific conditions with regard to benefits may cumulatively have such an effect. The available evidence (which is very scanty in the case of Japan) points to the possibility that private insurance is more successful in avoiding positive correlation between unexpected deviations in benefits. Therefore, shifting the division of labor between the two components in favor of more private insurance could result in an improvement in terms of efficiency. However, such a shift might cause private insurers to step up their efforts to eschew unfavorable risks, who are exposed to perfect positive correlation of benefits as soon as they are rejected in more than one line of insurance. Thus, incentives to cream skim need to be neutralized by regulation (see the high risk pooling proposal for health insurance).

One way to avoid positive correlation between unexpected shortfalls in benefits is to offer umbrella policies of the stop-loss type. These policies would make the insured pay a deductible regardless of the cause of the loss. Beyond the deductible, losses are covered, again regardless of cause,
subject to coinsurance only to the extent that moral hazard is a problem [this idea goes as far back as Arrow\textsuperscript{13}]. Private insurers traditionally have hesitated to develop such umbrella policies, fearing positive correlations between the risks covered. However, today they have additional hedging opportunities in the capital market (through the securitization of portfolios) or through international diversification.

For a risk-averse individual, transferring all risks to one insurer may be advantageous at least as long as the insurer’s risk of insolvency is very small. Transferring all risks to one monopoly organization in social insurance seemingly could achieve the same efficiency gains. However, such an organization would have to be tied to consumer preferences. One important means to achieve this could be the threat to transfer risks back to private insurance, in reversal of the long run trend in favor of social insurance. Alternatively, one might rely on competing public providers of social insurance, which however would also raise the issue of cream skimming mentioned above.

Any change in the division of labor between private and social insurance will raise equity issues as well. Under the pressure of competition, a private insurer cannot differentiate premiums or benefits according to income. However, a subsidization scheme could enable poor individuals to purchase coverage at the market premium [see the early analysis by Pauly\textsuperscript{14} (ch. 2)]. Tax revenues would thus be increasingly used for redistribution purposes. In view of the progressivity of income taxes, wealthy taxpayers would have to share some of the efficiency gains they can reap from the improved risk diversification properties of the insurance system as a whole. Future research must determine whether these efficiency gains are large enough to outweigh the disadvantages of an increased tax burden falling on a subset of the voting population.

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10. D. Kenkel, “Health behavior, health