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Determinants of Insurers' Performance in Risk Pooling, Risk Management, and Financial Intermediation Activities*

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Abstract

Corporate finance theory predicts that firms' characteristics affect agency costs and hence their efficiency. Cummins et al (2006) have proposed a cost function specification that measures separately insurer efficiency in handling risk pooling, risk management, and financial intermediation functions. We investigate the insurer characteristics that determine these efficiencies. Our empirical results show that mutuals outperform stock insurers in handling the three functions. Independent agents and high capitalization reduce the cost efficiency of risk pooling. Certain characteristics such as being a group of affiliated insurers, handling a higher volume of business in commercial lines, assuming more reinsurance, or investing a higher proportion of assets in bonds, do significantly increase insurers' efficiency in risk management and financial intermediation.

Keywords: Risk pooling, risk management, financial intermediation, property-liability insurance, efficiency, agency costs.

JEL codes: D21, D23, G22.

Résumé

La finance corporative prédit que des caractéristiques des entreprises affectent les coûts d'agence et leur efficacité. Cummins et al. (2006) ont proposé une spécification de la fonction de coûts des assureurs qui mesure séparément l'efficacité d'offre d'assurance, de gestion des risques et d'intermédiation financière. Nous analysons les caractéristiques des assureurs qui déterminent ces efficacités. Nos résultats empiriques montrent que les mutuelles dominent les assureurs à capital action dans les trois activités. Les assureurs utilisant des agents indépendants et à forte capitalisation ont des coûts plus élevés d'offre d'assurance. D'autres caractéristiques, comme le fait d'être membre d'un groupe d'assureurs affiliés, d'avoir un plus grand volume d'assurance commerciale, de gérer davantage de réassurance ou d'investir une plus grande proportion des actifs dans des obligations, augmentent l'efficacité des assureurs dans leurs activités de gestion des risques et d'intermédiation financière.

Mots clés : Assurance, gestion des risques, intermédiation financière, assurance responsabilité, efficacité, coûts d'agence.

Classification JEL : D21, D23, G22.

1. Introduction

The efficiency of financial institutions has been studied by many researchers (see the surveys of Berger and Humphrey (1997) for the banking industry and Cummins and Weiss (2000) for the insurance industry). Insurance studies focus on many aspects that may influence the efficiency of this industry, aspects such as its distribution systems (Regan and Tennyson, 2000), its organizational forms (Mayers and Smith, 2000) and insurers' economies of scope (Berger et al, 2000). In the banking industry, interest is more oriented to the effect of regulation; mergers and acquisition; market structure and organization; and, more recently, the effect of capital structure on bank performance (Berger and Bonaccorsi di Patti, 2006).

Cummins et al (2006) have extended this literature significantly, by explicitly considering two major activities as intermediate outputs when estimating the efficiency of insurance firms. They show that risk management and financial intermediation activities improve efficiency for property-liability insurers. They also estimate the shadow prices of these intermediate outputs. On average, shadow prices are positive, indicating that many insurers can still improve the efficiency of their risk pooling activities by increasing the level of their risk management and financial intermediation activities. Finally, their results clearly indicate that adding these two intermediate outputs as inputs in the restricted-cost function will improve its specification as compared to the usual cost function analyses.

The first objective of this study is to identify the determinants of these estimated shadow price distributions. The empirical results of Cummins et al (2006) also indicate that many insurers are far from achieving optimal levels of risk management and financial intermediation activities. Some insurers could reduce their risk pooling costs by increasing these activities, whereas others could lower their costs by reducing the level of these activities. There are many

plausible determinants to explain this difference: membership in a group of insurers versus being a single insurer; being a stock or a mutual insurer; being an independent-agency insurer or a direct-writing insurer; having a different capital structure or business mix. These determinants are discussed in more detail in the literature review below.

We must emphasize that our contribution is the first in the literature to study the determinants of risk management and financial intermediation as activities that increase, on average, the efficiency of insurers in their risk pooling activities or as providers of insurance. Some previous articles (Santomero and Babbel, 1997; Cummins, Phillips and Smith, 2001; and Froot, 2007) have analyzed how insurers engage in a variety of risk management activities to control their asset risks, interest-rate risks, and capital allocation. These studies isolate the determinants of risk management activities that directly increase the firm's value but do not explain how insurers create value by improving the economic efficiency of providing insurance. Nor do they consider the financial intermediation function when analyzing the effect of risk management on firm value. In fact, the estimated benefits attributed to the risk management function may contain some which come from the financial intermediation function. These distinctions are important if the benefits of risk management and financial intermediation are to be properly allocated. Under competition, the benefits of greater economic efficiency have a higher probability of being distributed, at least partially, to the policyholders.

This paper makes another important contribution by showing how a better specification of the cost function will improve the analysis of the relative efficiency of insurance firms. This is important because none of the previous studies on the efficiency of financial institutions (Berger and Humphrey 1997; Cummins and Weiss, 2000) has explicitly considered intermediate outputs (such as risk management and financial intermediation) in their econometric specification. This prevents them from distinguishing between the residual efficiency of producing insurance and the

efficiency derived from intermediate outputs. As we shall see, this can be interpreted as a cost function specification error which may yield biased estimates of the efficiency of risk pooling activities.

In this paper, we explore separately the effect of insurers' characteristics on their efficiency in handling risk pooling, risk management, and financial intermediation activities. Our empirical results indicate that mutuals are more cost efficient than stocks in handling the three activities. Independent agents and higher capitalization reduce the cost efficiency of risk pooling without significantly enhancing insurers' efficiency in handling risk management and financial intermediation activities. Results also show that certain characteristics such as being a group of affiliated insurers, handling a larger volume of business in commercial lines, assuming more reinsurance or investing a higher proportion of assets in bonds, will significantly increase insurers' efficiency in risk management and financial intermediation.

The remainder of the paper is organized as follows. Section 2 reviews the literature on the determinants of insurer efficiency and introduces the main hypotheses tested in this study. The discussion revolves around the three principal determinants discussed in this literature: organizational forms, distribution systems, and capital structure. Section 3 describes how we measure the insurer's relative efficiency in handling risk pooling, risk management, and financial intermediation activities. Section 4 presents the sample used and describes the variables. Section 5 discusses the results and Section 6 concludes.

2. Background and hypotheses

The insurance industry creates value through three principal functions or activities: risk pooling, financial intermediation, and risk management. Corporate finance theory predicts that only the efficient firms which minimize agency costs will remain in business in the long run.

Insurers are subject to two main sources of agency costs: owner/policyholder and owner/manager incentive conflicts. Characteristics such as ownership composition, distribution system, capital structure, and business mix will have their effect on agency costs. The insurance industry is characterised by the co-existence of many different ownership structures and multiple distribution systems. Furthermore, the leverage of insurers is volatile and has shown a slight downward trend since the mid-1980s, mainly because of the growing sensitivity of customers and regulators to the risk of insolvency among insurers. Hence, insurers seeking to minimize agency costs and improve the efficiency of their three principal activities have many characteristics to choose among and combine.

2.1. Organizational form: stock versus mutual

Corporate finance theory (Jensen and Meckling, 1976) stipulates that only organizational forms minimizing agency costs will survive in the long run. However, a variety of organizational forms co-exist in the insurance industry. Organisational forms within the insurance industry include: common stock insurance companies with a standard corporate form, where manager, owner, and customer functions are potentially completely separate; mutuals and reciprocals which are run like cooperatives, where policyholders own the firm; and Lloyds associations which offer insurance contracts from syndicates of individual underwriters. In this research, the focus is on the two most important organizational forms in the US property-liability insurance industry: stock insurers and mutual insurers.

Mayers and Smith (1981, 1988) argue that stocks and mutuals have comparative advantages in dealing with different types of agency costs. The mutual form has the advantage of eliminating the owner/policyholder conflict, by merging the owner and policyholder functions, whereas, in the common stock ownership form, the owner/policyholder conflict is likely to be

severe, since stockholders have an incentive to expropriate value from policyholders by activities such as risk-shifting. Hence, mutual insurers are predicted to be more efficient in business lines with lengthy claim settlement lags (maturity hypothesis) such as those common to liability insurance.

The stock ownership form has the advantage of providing more effective mechanisms for controlling owner/manager conflicts over such things as compensation programs that include stock options or direct ownership of shares, while mutual insurers do not seem to offer their managers any form of such compensation which could tempt them to expand the company by issuing unprofitable policies, engaging in unprofitable acquisitions (free-cash-flow problem) (Jensen, 1986) or generating unnecessary costs through the consumption of perquisites (expense preference hypothesis). Mayers and Smith (1992) and Marx, Mayers, and Smith (2001) show that compensation programs for stock managers are more sensitive to firm performance than compensation programs for mutual managers.

Because control mechanisms differ across organizational forms, the level of managerial discretion approved by owners should also differ. According to the managerial discretion hypothesis (Mayers and Smith, 1988) stock insurers are more efficient in lines of insurance requiring higher managerial discretion in pricing and underwriting, such as commercial lines. Lamm-Tennant and Starks (1993) find that stock insurers are more often involved in riskier business than mutual insurers, where risk is measured by the volatility of the loss ratio.

According to agency theory, the mutual form reduces owner/policyholder conflict, while the stock form offers better control over owner/manager incentive conflicts. Hence, it is unclear which organisation form is the more efficient. Cummins, Weiss, and Zi (1999) use cross-frontier analysis to estimate the relative efficiency of alternative organizational forms in the property-liability insurance industry. They find that mutual and stock insurers operate with distinct

technologies but none of them systematically outperforms the others (efficient structure hypothesis).

In this study, we split overall insurer efficiency into the efficiencies of an insurer's main functions: risk pooling, risk management, and financial intermediation. Because the mutual organizational form eliminates owner/policyholder incentive conflicts, we predict that mutual insurers will be more efficient in risk pooling (after controlling for the insurer's business mix), and because the stock organizational form gives better control over owner/manager incentive conflict, we assume that stock insurers will be more efficient in risk management and financial intermediation (after controlling for the insurer's risk characteristics). In other words, mutual insurers, with low-discretion managers, are more involved in standard business where the underwriting risk is shared efficiently among mutual members. However, in such circumstances, mutual managers have less discretion or incentive to focus on managing residual risks and financial intermediation. Correspondingly, stock insurers, with better mechanisms to control high-discretion managers, are more involved in riskier business where the residual underwriting risk is assumed by stockholders. Stockholders then use their authority to encourage managers to focus on managing residual risks and financial intermediation. In short, our first hypothesis is: Mutual insurers are more efficient in risk pooling, while stock insurers are more efficient in risk management and financial intermediation.

2.2. Distribution system

The insurance industry uses a variety of distribution systems that can be grouped into two main categories, based upon the degree of insurer-agent dependence: direct writing and independent agency. The direct-writing category includes the use of employee sales agents and the use of exclusive agents. The independent agency category includes the use of independent

agents representing more than one insurer and the use of insurance brokers who represent customers and negotiate with multiple insurers. These distribution systems have co-existed in insurance markets for many decades, even though independent agency insurers are known to have higher costs (Joskow, 1973; Cummins and VanDerhei, 1979). However, independent agents offer a wider range of services, e.g. providing policyholders additional assistance with their claim settlements (Regan and Tennyson, 1996) or reducing their search costs (Posey and Tennyson, 1998). Though independent agents charge more, they still survive because their higher fees are associated with higher product quality. Berger, Cummins and Weiss (1997) use frontier efficiency analysis to examine variations in both cost and profit efficiency across different insurance distribution systems. After controlling for the firm's business mix, they find that, though independent agency insurers are less cost efficient than direct writers, there are no significant differences in profit efficiency across the two distribution systems. Thus, independent agency insurers seem to generate higher costs to produce higher quality services which bring in higher revenues. Cummins and Doherty (2006) argue that independent agents are essentially market-makers who match policyholders' insurance needs with insurers who can meet these needs; they also provide empirical evidence that parts of agents' compensations are passed on to policyholders in the premium.

Kim, Mayers and Smith (1996) focus on potential owner/policyholder incentive conflict as the prime determinant guiding the choice of a distribution system. They argue that independent agents should be more effective in monitoring and preventing expropriation by insurers, given these agents' ownership of policyholders list and their relationship with several insurers. Independent agents can credibly threaten to shift their business to another insurer. Independent agents should therefore be more valuable when owner/policyholder conflicts are important, such as with the stock organizational form or when the product mix is complex. Kim et al (1996) find

a significant positive relationship between direct writing and the mutual form of ownership. Regan (1997) also finds that direct writers are associated with lower risk and lower product complexity.

In this study, we investigate what effect the choice of distribution system has on the efficiency of the various services offered by insurers. Because independent agents are more effective in getting insurers to pay legitimate claims promptly and fairly, we expect independent agency insurers to handle the cost of risk pooling less efficiently than direct writers. However, because independent agents reduce information asymmetries between policyholders and insurers, we expect independent agency insurers to be more efficient in risk management and financial intermediation activities. Independent agents can indeed find a better match to meet the risk-adverse policyholder's need for less risky and more diversified insurance policies, for instance. Therefore, our second hypothesis to be tested is as follows: Direct writer insurers are more efficient in risk pooling, while independent agency insurers are more efficient in risk management and financial intermediation

2.3 Capital structure

Corporate theory suggests that capital structure affects agency costs and thereby influences firm performance (Jensen and Meckling, 1976). A higher leverage ratio reduces the agency costs arising from owner/manager conflicts by mitigating the free-cash-flow problem and encouraging managers to act more in the interest of owners (Jensen, 1986; Williams, 1987). However, higher leverage increases the agency costs related to owner/debt-holder conflicts, by reducing incentives (moral hazard), increasing the costs of financial distress, and exacerbating risk-shifting problems (Freixas and Rochet, 1997).

Insurers issue insurance policies and set aside capital in view of honouring their commitments in the event losses are higher than expected or investment returns are lower than expected. Thus, the level of capital needed will depend on the riskiness of the insurer. Cummins and Sommer (1996) provide evidence for a positive relationship between the insurer's capitalization and overall portfolio risk. Insurers writing more commercial line insurance need to hold more capital than firms specialized in personal lines, since commercial lines have a higher loss-ratio volatility than do personal lines. When insurers are large and diversified (either geographically or by line of business), they need less capital, since diversification reduces insurer's overall risk and large insurers are generally more diversified.

Because of the time lag between premium payments and claim settlement, policyholders are sensitive to the financial quality of insurers. If an insurer is under-capitalized, policyholders would expect stockholders to react opportunistically after issuing policies such as risk shifting. As insurers accumulate more capital, for the same policies, their probability of insolvency decreases, thus reducing the expected policyholder/owner incentive conflicts. Sommer (1996) shows that policyholders consider insurance to be a risky debt. Thus, they accept to pay higher premiums to insurers with lower insolvency risks, despite the existence of guaranty funds. Moreover, Cummins and Danzon (1997) give evidence that the demand for insurance is inversely related to the insurer's insolvency risk and is imperfectly price elastic because of the effects of information asymmetries and private information on insurance markets. Under-capitalized insurers are thus penalized by both lower insurance prices and by the loss of customers who perceive their default risk as too high.

Insurers accumulate capital in profitable years to guard against the next underwriting crisis. Their reluctance to distribute equity capital accumulations as dividends is driven by informational asymmetries that make it difficult to raise external capital after loss or investment

shock (Winter, 1994; Cummins and Danzon, 1997). And, because of their limited ability to raise new external capital, mutual insurers keep significantly higher capital-to-asset ratios than do stock insurers, as a cushion for future investment and loss shocks (Harrington and Niehaus, 2002; Viswanathan and Cummins, 2003).

Since the 1980s, the property-liability insurance industry has been characterized by a sharp decrease in leverage ratios. Cummins and Nini (2002) document that the ratio of premiums-to-surplus (equity capital) dropped from 2 in 1985 to less than 1 by 1999, and that the ratio of surplus-to-assets increased from 25 percent in 1985 to 37 percent in 1999. Cummins and Nini (2002) report that capital gains contributed 57 percent to the increase of equity capital over the 1995-1998 period. This could be explained mainly by the bull market in corporate equities. Data from our sample of insurers indicate that the premiums-to-surplus ratio decreased by 25 percent over the1995-2000 period, but it increased by 46 percent over the 2001-2003 period. Thus, we see that this increase in the insurance industry's capitalization was not sustained and was highly affected by financial-market cycles. Cummins and Nini (2002) use a non-parametric technique (DEA) to measure the efficiency of each firm. They find that most insurers make significant over-use of capital equity, an inefficiency for which they incur significant revenue penalties. Berger and Bonaccorsi di Patti (2006) use a stochastic frontier technique coupled with a free-distribution approach to measure efficiency in the U.S. banking industry. They find that higher leverage is significantly associated with higher profit efficiency.

The effect of leverage could be non-monotonic. Lower leverage reduces the agency costs of owner/policyholder conflicts by reducing the insolvency risk. However, if leverage falls very low, owner-manager agency costs will increase because of free-cash-flow problems and could result in higher total agency costs. The optimal leverage level is a trade-off between the marginal benefits of the lower insolvency risk and the marginal costs of the new capital.

In this study, we investigate the effect leverage levels have on the efficiency of insurers' risk pooling, risk management, and financial intermediation functions. From the above results, we expect that insurers who over-use capital to produce the same quantity of insurance policies should be less efficient in risk pooling activities. However, the net effect of higher capitalization on risk management efficiency is ambiguous. A lower insolvency risk will reduce the return required by policyholders, whereas higher capitalization will increase the return required by owners. The role of risk management is to optimize the use of capital in combination with other risk management tools, such as asset-liability management, reinsurance, and derivatives. For example, reinsurance could be considered a substitute for capital since it allows the transfer of claims to reinsurers, thereby reducing the leverage ratio. With an over-capitalized insurance industry, what we expect to find (after controlling for firm-risk characteristics) is that lower leverage will have a negative effect on risk management efficiency. Our third hypothesis is therefore: Higher capitalization has a negative effect on risk pooling efficiency, while its effect on risk management and financial intermediation efficiencies is ambiguous.

3. Estimation of efficiency

Insurance firms produce their own internal risk management and financial intermediation services. These services are used as intermediate inputs to produce insurance services. Because risk management and financial intermediation services are not traded on external markets, their prices are not observable. However, implicit or shadow prices can be estimated. Shadow prices correspond to the total costs saved in the production of insurance services for each unit increase in the use of intermediate inputs.

In Cummins et al (2006), shadow prices of risk management and financial intermediation were estimated using the following cost function:

$$\begin{aligned}\ln C_{it} &= \alpha_i + \sum_v \beta_v^Q \ln Q_{vit} + \beta_i^R \ln R_{it} + \beta_i^F \ln F_{it} \\ &+ \sum_s \beta_s^A \ln P_{sit}^A + \sum_j \beta_j^R \ln P_{jit}^R + \sum_k \beta_k^F \ln P_{kit}^F \\ &+ \beta^Z \ln Z_{it} + second-order\ terms + \sum_t \beta^t D_t + u_{it},\end{aligned} \tag{1}$$

where C are the total costs of producing insurance services; Q are the different output measures for insurance services; R is the level of risk management activities produced internally by the insurance firm; F is the corresponding level of activities for financial intermediation; P are the input prices associated with the different inputs used for the production of insurance services (A), risk management (R), and financial intermediation (F) activities; Z are different control variables; D are time dummy variables; u are random disturbances; and i and t denote, respectively, insurance firms and time. The output of insurance services is defined as the current value of incurred losses in the four principal insurance business lines: long-tail personal, short-tail personal, long-tail commercial and short-tail commercial. The inputs used by insurers are administrative labour services, agent labour services, risk management labour services, debt capital, and equity capital. The level of activities for financial intermediation is measured by the total assets invested and the level of risk management activities is measured by the dollar duration of the surplus. These two variables are treated as endogenous in the econometric model. The cost function was estimated with an unbalanced panel of 613 U.S. property-liability insurers for the period 1995 through 2003 (3,320 observations). All the details regarding the econometric model, the econometric method and data can be found in Cummins et al (2006).

Note that in the above cost function, the intercept and the coefficients associated with the risk management and financial intermediation variables are firm-specific. These coefficients are treated as random for the estimation of the cost function. Once the cost function is estimated, it is possible to assign to each of the insurance firms in the sample a specific intercept and specific

coefficients for both intermediate inputs. In turn, shadow prices for risk management (μ_{it}) and financial intermediation (λ_{it}) are computed by:

$$\mu_{it} = -\frac{\partial \ln C_{it}}{\partial \ln R_{it}} \frac{C_{it}}{R_{it}} \quad \text{and} \quad \lambda_{it} = -\frac{\partial \ln C_{it}}{\partial \ln F_{it}} \frac{C_{it}}{F_{it}} \tag{2}$$

Since both shadow prices are a function of firm and time specific variables (*i*, *t*), it is possible to compute them for each of the 3,320 observations in the sample. However, given that**,** in the cost function**,** the coefficients associated with the risk management and financial intermediation variables are only firm-specific, the mean shadow price is used for each firm in the sample (613 firms). The distribution of the shadow prices are presented in Figures 1 and 2.

[Figures 1 and 2 about here]

The efficiencies of risk management and financial intermediation activities are computed with their respective shadow prices. An insurer is fully efficient in a given activity when the shadow price is nil, meaning that costs can no longer vary with an increase of this activity. To compute the relative efficiency of risk management and financial intermediation activities, we first calculate the monetary value of the shadow prices (MSP), or the monetary value of insurer *i* inefficiency, as:

$$MSP_i^{\theta} = \left[\sum_{t=1}^{T_i} -\frac{\partial C}{\partial \theta_{it}} \times \theta_{it} \right] T_i^{-1} \tag{3}$$

where $\theta_{it} = R_{it}$ for risk management, $\theta_{it} = F_{it}$ for financial intermediation and T_i is the number of observations of insurer *i*. Then, we compute the *Relative shadow price* (*RSP*) as:

$$RSP_i^{\theta} = \frac{MSP_{\max}^{\theta} - MSP_i^{\theta}}{MSP_{\max}^{\theta} - MSP_{\min}^{\theta}}. \tag{4}$$

RSP always lies between 0 and 1. As insurers become more efficient in a given intermediate activity, their corresponding shadow price decreases and their relative shadow price (*RSP*)

increases. The insurer with the lowest shadow price in the sample (most efficient insurer) has a relative shadow price equal to 1, while the insurer with the highest shadow price (less efficient insurer) has a relative shadow price equal to 0.

Using the firm-specific intercept (α_i), the relative risk pooling efficiency of each firm in the sample can also be computed. This is the efficiency that cannot be attributable to any specific input or intermediate outputs. Residual risk pooling efficiency is computed as:

$$RPE_i = \exp(\alpha_{\min} - \alpha_i). \quad (5)$$

This measure of residual efficiency is analogous to the measure proposed by Berger (1993).[1] It defines relative efficiency as the ratio of the minimum costs needed (costs of the fully efficient firm) to the actual costs expended.

4 Variables, data, and summary statistics

4.1 Variables

Dependent variables. The estimation of the cost function as specified by equation (1) allows us to measure separately the efficiency of the three main functions provided by insurers: risk pooling, financial intermediation, and risk management. The relative shadow prices of risk management and financial intermediation as defined by equation (4) are used as the dependent variables in our econometric model. Residual risk pooling efficiency as computed by equation (5) is also used as a dependent variable.

[1] As in Berger (1993), the results for risk pooling efficiency are obtained from truncated measures. We set the top and bottom 5% of α_i to the 5th and 95th percentiles, respectively, of their distribution. The same transformations were also applied to the shadow prices for risk management and financial intermediation. Additional results with other truncation points are available from the authors.

For the purpose of comparison with the results in the literature, we also compute alternative measures of risk pooling efficiency using different cost function specifications. First, we compute the risk pooling efficiency, using a cost function specification without the risk management function and consider the financial intermediation activity as a regular output (*RPE-1*). Second, we compute the risk pooling efficiency, using a cost function specification without the risk management function, but consider the financial intermediation function as an endogenous intermediate output (*RPE-2*). Comparison with the more general model developed in Cummins et al (2006) will highlight the importance of considering both risk management and financial intermediation as endogenous variables in estimating the insurance cost function.

Independent variables. The effects of insurers' characteristics on their efficiencies are investigated. For organizational form, we define the *Stock* dummy variable as equal to 1 if the insurer is organized as a common stock firm; the *Other* dummy variable is equal to 1 if the insurer is organized as reciprocal or Lloyd. For the distribution system, we define the *Independent agents* dummy variable as equal to 1 if the insurer's products are distributed through independent agents or brokers and as equal to 0 if the insurer is a direct writer. To measure insurer capitalisation, we use the *Surplus-to-premiums* ratio, the capitalization ratio most commonly used in the insurance literature, where the surplus is defined as the total admitted assets minus the economic value of liabilities.

In addition to the key variables employed to test specific hypotheses, we control for others factors that might influence insurers' efficiencies. Insurers' affiliation is taken into account by specifying a *Group* dummy variable equal to 1 if the insurer is a group of affiliated insurers and equal to 0 if insurer is a single affiliate, and we also control for insurer size by using the variable *Size* defined as the log of total admitted assets.

To account for business characteristics, we include as independent variables: *Share of* commercial, defined as the percentage of output produced in commercial business lines*; Share of long-tail,* defined as the percentage of output produced in long-tail lines*;* and *Share of premium in regulated states,* measured as the proportion of premiums written in rate regulated states. We control for risk pooling characteristics by including: *Reinsurance ceded,* computed as the proportion of premiums ceded to unaffiliated reinsurers*; Reinsurance assumed,* computed as the proportion of premiums assumed from unaffiliated insurers*; Volatility of economic loss ratio,* defined as the volatility of the ratio of the current value of incurred losses to premium earned; *Line concentration,* computed as the Herfindahl index of the percentage of premiums in each line of business written by the insurer*;* and *Geographic concentration,* computed as the Herfindahl index of the percentage of premiums written by the insurer in each state. A higher Herfindahl index implies that the insurer is concentrated in fewer lines of business or in fewer states.

In order to control for the characteristics of the insurer's portfolio of assets, we include: *Taxable investment income,* measured as the proportion of investment income subject to taxation*; Share of bonds,* defined as the percentage of invested assets allocated for bonds and mortgage loans*; Share of stocks* defined as the percentage of invested assets allocated for stocks and real estates. The reference variable, *Share of cash*, is the percentage of assets allocated for cash and short-term investments.

Finally, we allow for a specific intercept when the shadow prices are negative*,* by including dummy variables equal to 1 if the estimated shadow prices are negative.

4.2 Data

The potential sample of insurers consists of all property-liability insurance firms reporting data to the National Association of Insurance Commissioners (NAIC) for the period 1995

through 2003. From this potential sample, we eliminate reporting firms showing negative surplus, assets, losses or expenses. Because insurers formulate investment and risk management strategies at the overall corporate level, our analysis focuses on groups of insurers under common ownership and unaffiliated single insurance firms. The cost function as specified by equation (1) was estimated by Cummins et al (2006) using only insurers with strictly positive input prices; a strictly positive output quantity in each of the four lines of insurance business: long-tail personal, short-tail personal, long-tail commercial and short-tail commercial***;*** and strictly positive intermediate output quantities. The resulting sample is an unbalanced panel containing 3,320 observations (613 insurers) for the 9-year period. This sample accounts for about 90 percent of total industry premium volume in 2003.

4.3 Summary statistics

Summary statistics for all variables used are reported in Table 1.

[Table 1]

The summary statistics show that, compared to the most efficient firms, insurers are**,** on average, 48 percent as efficient in handling the risk pooling function, 88 percent as efficient in handling the risk management function, and 87 percent as efficient in handling the financial intermediation function. According to Table 1, 58 percent of firms (354 insurers) in the sample are organized as common stock insurance companies, 35 percent (218 insurers) are organized as mutual insurance companies, and 7 percent (41 insurers) have another organizational form such as reciprocal or Lloyd. Table 1 also indicates that 73 percent of the firms (446 insurers) in the sample use independent agents or brokers to distribute their products, while 27 percent of firms (167 insurers) are direct writers. The specific summary statistics for stock and mutual insurers are reported in Table 2.

[Table 2]

In Table 2, we see that mutual insurers, compared to stock insurers, have significantly higher risk pooling efficiency *(RPE* and *RPE-2*), and significantly higher relative shadow prices for risk management and financial intermediation. Table 2 also shows that stock insurers and mutual insurers have comparative advantages in dealing with different types of agency costs. Mutual insurers are more involved in long-tail business where owner/policyholder incentive conflicts are severe (*maturity hypothesis*), while stock insurers are more involved in commercial lines where owner/manager incentive conflicts are severe (*managerial discretion hypothesis*). Mutual insurers are smaller than stock insurers and they are less likely to be organized as a group (*free cash-flow problem*). Moreover, stock insurers are more capitalized and allocate more capital for cash and short-term investment, while mutual insurers invest more in stocks and real estate.

Table 3 presents a breakdown of the summary statistics by type of distribution system: independent-agency insurers versus direct-writer insurers.

[Table 3]

We see that direct-writer insurers display relatively higher risk pooling efficiency (in the case of *RPE* and *RPE*-1)**,** whereas independent-agency insurers have significantly higher shadow prices for risk management and financial intermediation. These results are in line with our hypothesis about distribution systems. Table 3 also indicates that independent agency insurers are more involved in commercial and long-tail business. Thus, independent agents are more associated to business portfolios with a high potential for expropriation by the insurer. The intermediation of an independent third party in the distribution of this business reduces information asymmetries between policyholders and insurers.

[Figure 3]

Figure 3 illustrates the trend in the surplus-to-premiums ratio. It shows that the surplus-to-premiums ratio which increased over the 1995-2000 period has decreased sharply since 2001. The surplus-to-premiums ratio increased from 1.27 in 1995 to 1.7 in 2000 and then decreased to 1.16 in 2003. The average of surplus-to-premiums ratio for our sample of insurers over the period 1995-2003 is 1.5. This average capitalization could be considered as relatively high compared to the historical level of the surplus-to-premiums ratio (Cummins and Nini, 2002).

5. Empirical results

The three regression equations (risk management and financial intermediation relative shadow prices, risk pooling efficiency) are jointly estimated using the seemingly unrelated regression equations (SURE) method. The t-statistics are computed using heteroskedastic robust standard-errors. As discussed above, we regress efficiency estimates on a series of firm characteristics to examine some of the determinants of efficiencies and to test the validity of our hypotheses regarding the organizational form, the distribution system, and the capital structure. Table 4 shows the estimation results for different efficiency measures on firm characteristics.

[Table 4]

We begin by comparing the three risk pooling efficiency equations. The first column (RPE-1) corresponds to the usual estimation in the literature. This measure of efficiency comes from estimating the insurance cost function where risk management is not considered as an intermediate input and where the financial intermediation function is modeled as exogenous. We first observe that the adjusted R-square is significantly improved with the RPE-2 model, where risk pooling efficiency is estimated using a cost function which includes financial intermediation as an endogenous intermediate input (but no risk management variable).

Regarding the explanatory variables, three differences between the first two regressions (RPE-1 and RPE-2) are important for our purpose. Larger insurers and those with larger Surplus-to-premium ratios are less efficient in providing insurance, while groups show themselves to be more efficient. Adding risk management in the third regression (RPE) does not alter these conclusions but shows that stock insurers do become less efficient. It also reveals that those who are involved in selling reinsurance (*Reinsurance assumed*) are no more efficient in providing insurance. These results clearly indicate that if the risk management function is not taken explicitly into account in estimating the insurance cost function, this will significantly affect conclusions concerning risk pooling efficiency. They also indicate that intermediate outputs must be modeled as endogenous intermediate inputs.

The results regarding risk management and financial intermediation functions are even more significant, with higher adjusted R-squares (around 0.58). This was the result expected from our analysis of the descriptive statistics, since the relative shadow prices for both risk management and financial intermediation display greater variability between firms. The higher variability of the two variables makes it easier to identify their determinants at the firm level.

The first hypothesis tested stipulates that mutual insurers are more efficient in risk pooling and stock insurers are more efficient in risk management and financial intermediation activities. The effects of organizational forms are captured in two dummy variables. The first variable, *Stock*, compares the efficiency of stock insurers to the efficiency of mutual insurers and the second variable, *Other*, compares the efficiency of reciprocal, Lloyd and other organizational forms to the efficiency of mutual insurers. Using the traditional approach in measuring risk pooling efficiency (RPE-1), the organizational form does not matter. Neither of the coefficients for *Stock* and *Other* is statistically different from zero. This finding falls in line with results reported by previous studies (Cummins, Weiss, and Zi, 1999). However, using our approach in

measuring risk pooling efficiency (RPE), where we account for risk management and financial intermediation as intermediate inputs, results show that stock insurers are less efficient than mutual insurers. This result is significant only at the ten percent level, however. Thus, separating efficiency in risk pooling activities from efficiency in risk management and financial intermediation shows that the mutual form has a comparative advantage over the stock form in handling risk pooling activities. As discussed above, this advantage is due mainly to the fact that the mutual form eliminates owner/policyholder conflicts.[2] The stock form has a different advantage over the mutual form. The owners of stock insurers have better mechanisms for controlling managers. They are allowed more discretion in writing business and more incentives in managing risks. However, the coefficients for *Stock* in risk management and financial intermediation with regard to shadow price regressions are negative and statistically significant. Nevertheless, the share of business written in commercial lines (*Share of commercial)* is associated with a significant increase in risk management and financial intermediation efficiency (but not risk pooling efficiency). This positive relationship is more acceptable to stock insurers than mutual insurers**,** since they write significantly more business in commercial lines.

Second, we test the hypothesis that direct-writing insurers are more cost efficient in risk pooling**,** while independent agency insurers are more efficient in risk management and financial intermediation activities. Table 4 shows that coefficients for *Independent agents* in the different risk pooling efficiency regressions are negative and statistically significant at the 5 percent level. Thus, independent agents generate more costs than direct writers by providing customers additional assistance during their claim process and this reduces the information asymmetry between insurer and policyholders. This is crucial, since independent-agency insurers write

[2] Another difference, not emphasized in this research, is the nature of insurance contracting (Doherty and Dionne, 1993).

significantly more business in long-tail and commercial lines than do direct-writing insurers. However, the coefficients for *Independent agents* in risk management and financial intermediation relative shadow price regressions are not statistically significant. This may be due partially to the fact that additional services provided by independent agents are passed on to policyholders through higher premiums (Cummins and Doherty, 2006)

Our third hypothesis is concerned with the way capitalization levels affect insurers' efficiency in handling risk pooling, risk management and financial intermediation. Contrary to the non-significant effect of capitalization levels (as measured by *Surplus-to-premiums*) obtained by the traditional approach used to measure insurers' efficiency (RPE-1), our approach, which considers risk management and financial intermediation as intermediate outputs, shows that higher capitalization has a significantly negative impact on risk pooling efficiency (RPE). This result falls in line with our prediction, since over consuming capital to produce the same output should rationally decrease the efficiency of the risk pooling function. However, the effects of surplus-to-premiums on the relative shadow prices of risk management and financial intermediation are more ambiguous. High capitalization reduces insurer/policyholder conflicts by lowering the risk of insolvency but exacerbate owner/managers conflicts by increasing free-cash-flow problems. Table 4 shows that the coefficients for *Surplus-to-premiums* in the risk management and financial intermediation regressions are positive but not statistically significant. Hence, the benefits of stronger capitalization on risk management and financial intermediation are offset by the higher costs of equity capital.

Results concerning the effects of other firm characteristics on insurers' efficiency show that some characteristics, such as *Reinsurance assumed*, *Volatility of economic loss ratio*, *Geographic concentration*, *Line concentration,* and *Share of bonds* in invested assets, do significantly increase risk pooling efficiency (RPE-1), as measured by the traditional approach.

However, using our measures of efficiencies, we find that *Volatility of economic loss ratio* and *line concentration* increase the risk pooling efficiency (RPE) without having any significant impact on risk management and financial intermediation efficiencies. *Share of commercial*, *Reinsurance assumed*, and *Share of bonds* in invested assets are all associated with a significant increase in risk management and financial intermediation efficiencies but have no significant effect on risk pooling efficiency (*RPE*). This illustrates how our measure of efficiencies splits the effect of firm characteristics between the three principal activities of insurers.

6. Conclusion

Corporate finance theory predicts that only firms minimizing agency costs will survive in the long run. However, the U.S. property-liability insurance industry is characterized by the co-existence of different organizational forms (i.e. mutual, stock, reciprocal, Lloyd) and the co-existence of different distribution systems (i.e. direct writing, independent agents, brokers). Moreover, regulators and customers have become more aware and more sensitive to insurers' insolvency risk.

In this article, we propose an important extension to the literature on measuring the efficiency of insurance firms. We pay explicit attention to three major activities instead of just the traditional risk pooling activity. Indeed, we add risk management and financial intermediation activities as intermediate intputs when estimating insurer cost function. We use the estimated shadow prices of these two activities to analyze the relative efficiency of insurers in terms of their organizational forms, distributions systems, and capital structure. We also consider their endogeneity in our estimation of the insurance cost function used to analyze the efficiency of risk pooling.

Our main results indicate, as predicted, that mutual insurers, direct-writing insurers, and more leveraged insurers are more cost efficient in risk pooling. The results for mutuals and more highly leveraged firms are obtained only when an endogenous modelling of intermediate inputs is considered. This new methodology also highlights the difference between group and large insurers: the latter are less efficient than the former in providing insurance. However, results show that neither distribution systems nor capitalization has any significant impact on the relative shadow prices of risk management and financial intermediation. Nevertheless, certain characteristics such as being a group of affiliated insurers, handling a higher volume of business in commercial lines, assuming more reinsurance, or investing a higher proportion of assets in bonds, do significantly increase insurers' efficiency in risk management and financial intermediation.

It seems that commercial customers are more sensitive to insurers' insolvency risk. Hence, the stock form (which affords managers more discretion), independent agents (who reduce information asymmetry), and higher capitalization all give insurers a comparative advantage in commercial lines, but also decrease their efficiency in risk pooling. Insurers can choose among a variety of tools, such as asset-liability management, derivatives, and reinsurance, in managing their risks and reducing the probability of insolvency. Reinsurance should be used more efficiently as a substitute for the costly equity capital that decreases insurers' efficiency in risk pooling activities without enhancing significantly their risk management and financial intermediation efficiencies.

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Table 1

Summary Statistics (613 insurers)

	Mean	Std Dev
Shadow price of risk management	0.0701	0.2378
Shadow price of financial intermediation	0.1768	0.2361
RSP of risk management	0.8841	0.2501
RSP of financial intermediation	0.8731	0.2582
Risk pooling efficiency (RPE)	0.4810	0.2191
RPE-1	0.7409	0.1201
RPE-2	0.5146	0.2103
Surplus-to-premiums	1.5010	1.7621
Stock	0.5775	0.4944
Other	0.0669	0.2500
Independent agents	0.7276	0.4456
Group	0.6264	0.4841
Size (log Assets)	18.9502	2.1086
Share of commercial	0.4693	0.3282
Share of long-tail	0.7174	0.1764
Premium in regulated states	0.6554	0.3604
Reinsurance ceded	0.2321	0.1856
Reinsurance assumed	0.1350	0.2877
Volatility of economic loss ratio	0.1678	0.1841
Geographic concentration	0.5052	0.3733
Line concentration	0.3392	0.1587
Taxable investment income	0.8402	0.1735
Share of bonds	0.6783	0.1760
Share of stocks	0.1895	0.1478
Share of cash	0.1320	0.1286
Dummy=1 if risk management SP<0	0.0489	0.2159
Dummy=1 if financial intermediation SP<0	0.1126	0.3163

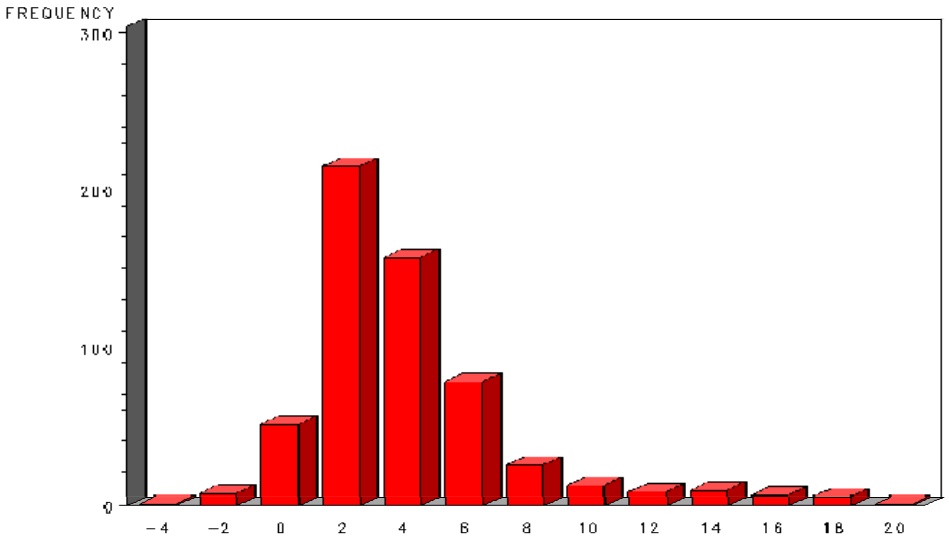

Figure 1. Shadow prices for risk management (10^{-2})

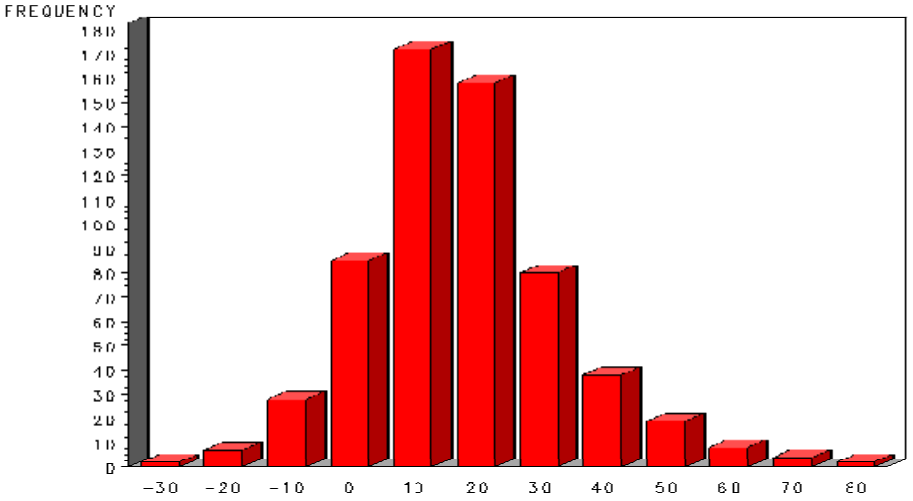

Figure 2. Shadow prices for financial intermediation (10^{-2})

Table 2

Breakdown of Summary Statistics by Organization Form

	Mutual		Stock		t test	
	Mean	Std Dev	Mean	Std Dev	t Value	Pr > |t|
Shadow price of risk management	0.0687	0.2682	0.0698	0.2265	-0.05	0.9576
Shadow price of financial intermediation	0.2244	0.2669	0.1485	0.2192	3.7	0.0002
RSP of risk management	0.9303	0.1757	0.8655	0.2728	3.13	0.0018
RSP of financial intermediation	0.9214	0.1879	0.8548	0.2765	3.14	0.0018
Risk pooling efficiency (RPE)	0.5288	0.2033	0.4568	0.2229	3.88	0.0001
RPE-1	0.7463	0.1026	0.7344	0.1275	1.16	0.2454
RPE-2	0.5449	0.2023	0.5007	0.2113	2.47	0.0138
Surplus-to-premiums	1.0809	0.7244	1.6856	2.1503	-4.01	<.0001
Independent agents	0.7477	0.4353	0.7514	0.4328	-0.1	0.921
Group	0.5413	0.4994	0.6836	0.4657	-3.45	0.0006
Size (log Assets)	18.504	1.8561	19.165	2.1799	-3.72	0.0002
Share of commercial	0.3483	0.265	0.5294	0.3407	-6.7	<.0001
Share of long-tail	0.7398	0.1302	0.706	0.19	2.32	0.0208
Premium in regulated states	0.5863	0.4136	0.69	0.3216	-3.35	0.0009
Reinsurance ceded	0.2025	0.1616	0.253	0.1925	-3.23	0.0013
Reinsurance assumed	0.0305	0.0681	0.1896	0.3448	-6.73	<.0001
Volatility of economic loss ratio	0.1556	0.1812	0.1734	0.1903	-1.11	0.269
Geographic concentration	0.6216	0.3434	0.4354	0.3752	5.95	<.0001
Line concentration	0.3043	0.1275	0.3537	0.1666	-3.75	0.0002
Taxable investment income	0.8437	0.1647	0.8325	0.1788	0.75	0.4528
Share of bonds	0.676	0.1689	0.6715	0.1873	0.29	0.7699
Share of stocks	0.1899	0.1369	0.1595	0.1434	2.51	0.0125
Share of cash	0.0909	0.0978	0.1364	0.1322	-4.4	<.0001
Dummy=1 if risk management SP<0	0.0092	0.0956	0.0763	0.2658	-3.59	0.0004
Dummy=1 if financial intermediation SP<0	0.0367	0.1885	0.1582	0.3654	-4.55	<.0001
Number of insurers	218		354			

Table 3

Breakdown of Summary Statistics by Type of Distribution System

	Direct Writer		Independent Agents		t test	
	Mean	Std Dev	Mean	Std Dev	t Value	Pr > |t|
Shadow price of risk management	0.0661	0.1529	0.0716	0.2627	-0.26	0.7977
Shadow price of financial intermediation	0.1692	0.2143	0.1797	0.244	-0.49	0.6236
RSP of risk management	0.8429	0.2822	0.8995	0.2355	-2.51	0.0124
RSP of financial intermediation	0.8322	0.2903	0.8885	0.2437	-2.41	0.0162
Risk pooling efficiency (RPE)	0.5058	0.2562	0.4718	0.203	1.71	0.087
RPE-1	0.7592	0.134	0.7341	0.1139	2.31	0.0211
RPE-2	0.5354	0.2433	0.5068	0.1962	1.5	0.1342
Surplus-to-premiums	1.587	1.9544	1.4688	1.6857	0.74	0.4601
Stock	0.5269	0.5008	0.5964	0.4912	-1.55	0.1215
Other	0.1437	0.3519	0.0381	0.1917	4.74	<.0001
Group	0.6766	0.4692	0.6076	0.4888	1.57	0.1161
Size (log Assets)	19.316	2.2398	18.813	2.0431	2.64	0.0084
Share of commercial	0.4217	0.3462	0.4871	0.3198	-2.21	0.0278
Share of long-tail	0.6748	0.1916	0.7333	0.1678	-3.69	0.0002
Premium in regulated states	0.6832	0.3455	0.645	0.3657	1.17	0.2438
Reinsurance ceded	0.1999	0.1846	0.2442	0.1847	-2.64	0.0084
Reinsurance assumed	0.1804	0.3613	0.118	0.253	2.4	0.0166
Volatility of economic loss ratio	0.1493	0.1664	0.1748	0.19	-1.53	0.1268
Geographic concentration	0.5028	0.4078	0.506	0.3601	-0.1	0.9242
Line concentration	0.3637	0.1562	0.3301	0.1588	2.35	0.0193
Taxable investment income	0.8093	0.1969	0.8518	0.1626	-2.72	0.0068
Share of bonds	0.6899	0.1716	0.674	0.1776	0.99	0.3209
Share of stocks	0.1747	0.1344	0.195	0.1523	-1.52	0.1298
Share of cash	0.1353	0.1463	0.1308	0.1215	0.38	0.7011
Dummy=1 if risk management SP<0	0.0299	0.1709	0.0561	0.2303	-1.33	0.1827
Dummy=1 if financial intermediation SP<0	0.1138	0.3185	0.1121	0.3159	0.06	0.9538
Number of Insurers	167		446			

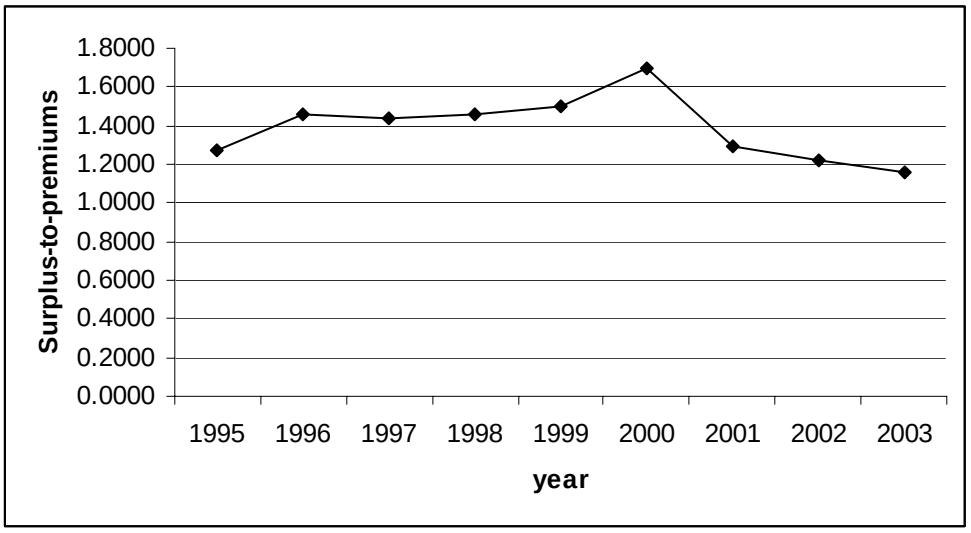

Figure 3. Surplus-to-premiums trend: 1995-2003

Table 4

Estimations of Different Efficiency Measures on Firm Characteristics (613 insurers)

	RPE-1			RPE-2			RPE			Risk Management			Financial Intermediation		
	Estimate		t-stat.	Estimate		t-stat.	Estimate		t-stat	Estimate		t-stat.	Estimate		t-stat.
Intercept	0.6131	***	6.78	1.9114	***	16.52	1.6642	***	11.95	2.5878	***	20.26	2.6005	***	19.79
Surplus-to-premium	0.0044		1.48	-0.0155	***	-4.11	-0.0092	**	-2.02	0.0027		0.65	0.0014		0.32
Stock	-0.0088		-0.75	0.0047		0.32	-0.0333	*	-1.85	-0.0425	**	-2.57	-0.0453	***	-2.67
Other	0.0155		0.72	0.0033		0.12	-0.0339		-1.03	-0.0739	**	-2.44	-0.0898	***	-2.88
Independent agents	-0.0275	**	-2.43	-0.0762	***	-5.26	-0.0748	***	-4.29	0.0127		0.80	0.0122		0.74
Group	-0.0123		-1.01	0.1403	***	9.04	0.1489	***	7.97	0.0928	***	5.41	0.0968	***	5.49
Size (log Assets)	0.0007		0.20	-0.0828	***	-17.74	-0.0679	***	-12.09	-0.1013	***	-19.66	-0.1041	***	-19.65
Share of commercial	0.0053		0.30	0.0086		0.38	-0.0134		-0.49	0.1049	***	4.18	0.1034	***	4.01
Share of long-tail	0.043		1.51	0.0656	*	1.80	0.0541		1.24	0.0280		0.70	0.0418		1.01
Premium in regulated states	-0.0096		-0.68	-0.0247		-1.37	-0.0307		-1.41	-0.0042		-0.21	-0.0067		-0.32
Reinsurance ceded	0.0364		1.24	0.0347		0.93	0.0528		1.17	-0.0461		-1.12	-0.0200		-0.47
Reinsurance assumed	0.0374	*	1.93	0.0547	**	2.21	-0.0018		-0.06	0.0720	***	2.63	0.1081	***	3.84
Volatility of economic loss ratio	0.0781	***	2.85	0.1345	***	3.84	0.1152	***	2.73	-0.0369		-0.95	-0.0319		-0.80
Geographic concentration	0.0367	**	2.13	0.008		0.37	-0.0074		-0.28	0.0279		1.15	0.0309		1.24
Line concentration	-0.063	*	-1.81	-0.1657	***	-3.72	-0.1005	*	-1.88	0.0857		1.75	0.0881		1.75
Taxable investment income	-0.0131		-0.44	0.0447		1.18	0.0566		1.25	-0.0432		-1.04	-0.0559		-1.31
Share of bonds	0.1371	***	3.20	0.1293	**	2.36	0.0566		0.86	0.1618	***	2.68	0.1935	***	3.11
Share of stocks	0.0331		0.63	0.0755		1.12	0.04		0.49	-0.0307		-0.41	-0.0227		-0.30
Dummy=1 if shadow price < 0										0.0573	***	3.82	0.0135		1.27
Adjusted R-square	0.0765			0.5066			0.3421			0.5755			0.5786		

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% confidence level respectively.