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Conversion and Efficiency Performance Changes: Evidence from the U.S. Property-Liability Insurance Industry

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This study investigates whether the conversion of U.S. property-liability insurers improves their efficiency performance before and after the conversion. We estimate relative efficiency of converting insurers and control insurers using data envelopment analysis. The Malmquist analysis is also used to measure changes in efficiency pre- and post-conversion. The evidence shows that converting insurers experience larger gains in cost efficiency and total productivity change than mutual control insurers before conversion. In addition, the empirical results indicate that converting insurers improve efficiency after conversion. These results are robust with respect to both the value-added and the financial intermediary approaches. The overall results support the efficiency hypothesis proposed by Mayers and Smith (1986).
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Introduction

Mutual-to-stock conversion, a process known as demutualization, has been occurring in the U.S. insurance markets for many decades. These conversions have raised much attention from insurance regulators, policyholders, and academics and have become an important issue in the insurance literature. To understand why insurers demutualize, we need to ask: Which form of organizational structure, mutual or stock, is more efficient? A number of studies have explored this issue and provide many meaningful insights. Spiller (1972), Frech (1980), Cummins *et al.* (1999a), Brockett *et al.* (2004, 2005) among others examine the efficiency issue of stock vs. mutual insurers. Mayers and Smith (1986, 2002), McNamara

and Rhee (1992), and Cagle *et al.* (1996) further examine the performance issue for insurers who go through the conversion process.

Mayers and Smith (1986) suggest two competing hypotheses to explain why mutual insurers convert: the expropriation hypothesis and the efficiency hypothesis. The expropriation hypothesis alleges that conversions may be used as a mechanism to transfer wealth from policyholders to officers and directors of converting insurers and policyholders may be harmed through the conversion process. The efficiency hypothesis, on the other hand, suggests that the purpose of conversion is to improve financial and operational performance of the converting insurer. Based on agency theory, there are many disadvantages of mutual insurers. Mutual insurers are less effective in monitoring and controlling management than stock insurers. In other words, the conflict between the policyholder and the managers is much higher for mutual insurers. Moreover, mutual insurers are less effective in operation because of their restricted access to capital and inability to diversify their operations. Thus, the efficiency hypothesis states that mutual insurers convert into stock insurers in an effort to improve efficiency.

A few studies have examined the performance changes during conversion period. For example, McNamara and Rhee (1992) examine the performance of converting life insurance companies by examining the product variables, financial variables, and management welfare variables. Their empirical evidence suggests that converting life insurers did improve their performance after conversion. Cagle *et al.* (1996) further investigate the results of conversion for property-liability insurers and they find that the converting insurers experience no change in accounting profitability.

McNamara and Rhee (1992) and Cagle *et al.* (1996) shed insight on the efficiency issue, but they use conventional financial ratios and operational ratios as proxies for "performance" and do not examine efficiency from the input/output efficiency perspective. More recently, Jeng *et al.* (2007) utilize input/output efficiency to examine the efficiency performance changes of converting life insurers but not property-liability insurers. In fact, there is no study investigating the input/output efficiency performance change of converting property-liability insurers. This paper helps to fill this gap in the literature.

The main purposes of this paper are to evaluate the pre- vs. post-conversion efficiency performance of property-liability insurers and to test the efficiency hypothesis proposed by Mayers and Smith (1986). We utilize the data envelopment analysis (DEA) approach to evaluate the efficiency changes of converting insurers. Both the value-added approach and the financial intermediary approach of the DEA method are used. Malmquist index analyses are employed to examine the productivity changes of converting insurers over the sample period. Our results are based on the overall sample period from 1990 to 2001.

This paper makes several contributions. First, this study is the first to utilize the DEA to examine the efficiency performance change resulting from conversions in the U.S. property-liability insurance industry. Prior studies do not consider this type of efficiency analysis. The DEA method measures the efficiency performance from both input and output perspectives. Second, we analyse efficiency performance change by using the Malmquist methodology, which further separates total productivity change into technical change and technical efficiency change. The additional two measures can provide more direct information on the efficiency hypothesis. Another advantage of the DEA and Malmquist methods is that they produce a uniform efficiency score so that comparisons among insurers are possible. Finally, this study provides evidence supporting the efficiency hypothesis developed by Mayers and Smith (1986).

The evidence shows that converting insurers improve their efficiency relative to mutual control insurers before and after conversion when both value-added and financial intermediary approaches are used. When compared to stock control insurers, the results of both approaches indicate converting insurers improve their performance after conversion, except deterioration in total factor productivity change using value-added approach. The regression evidence using both approaches also shows that converting insurers improve their performance relative to their control insurers after conversion. The evidence generally suggests that converting insurers improve their efficiency relative to mutual control insurers after conversion, supporting the efficiency hypothesis.

The rest of the paper proceeds as follow. First, research questions are reviewed and data and methodology are described. Next, we present the results of the efficiency performance changes by using the value-added approach and further conduct a regression analysis of the relationship between efficiency performance and insurer characteristics. Similar analyses are then performed using the financial intermediary approach. Finally, the important findings are summarized and conclusions are offered.

Research questions

Our first research question is whether converting insurers improve their efficiency performance and productivity before conversion. Please note that it is not the intention of this paper to investigate the motivations for demutualization. Viswanathan and Cummins (2003) examined the motivations for conversion in the insurance industry. But they have not looked into the issue of efficiency changes using the DEA method. Our second research question is whether converting insurers improve their efficiency performance and productivity after conversion. The answer to this question will shed new light on the efficiency hypothesis proposed by Mayers and Smith (1986).

Data and methodology

Data

We examine recent property-liability conversions that occurred during the 1993–1998 period. See Appendix for a list of the sample insurers. Only insurers that have complete data during the sample period are included in this paper. There are two reasons for the short sample period. First, we can evaluate the efficiency performance change of converting insurers based on homogeneous economic conditions (see Viswanathan and Cummins, 2003). Second, for each converting insurer we identify 30 mutual/stock control insurers by matching their asset size (total admitted assets) and thus need to rely on NAIC (National Association of Insurance Commissioners) data tapes rather than hand-collected data.

Because of the capital infusion received by converting insurers during the conversion process, we select the control mutual insurers using admitted assets of converting insurers at one year before conversion (i.e. year -1 where the notation "year $-t$" refers to the tth year prior to the year of conversion). For the stock control insurers, we use admitted asset at the year of conversion (i.e. year 0) because there is no capital infusion problem. The overall sample period is from 1990 to 2001.

Methodology

There are two major classes of efficiency estimation methods: the econometric (parametric) approach and the mathematical programming (non-parametric) approach.[1] The main disadvantages of the parametric approach are the possibility of specification error and the difficulty of separating efficiency into different components. In this paper, we utilize the DEA, a non-parametric approach, to avoid the above disadvantages (see Färe *et al*. 1985, 1994).

Two different DEA methods are used in this paper: the value-added approach and the financial intermediary approach. In addition, we use Malmquist index analysis to track the efficiency changes and evolution of productivity growth over the sample period. Malmquist index evaluation can also provide more detailed estimates of technical efficiency change, technical change, and total factor productivity change over a given period. Cummins and Weiss (2000) provide an excellent review of the DEA methodology and Malmquist index analysis, and discuss several major efficiency studies in the insurance industry.

[1] The advantages and disadvantages of the two methods are well summarized and discussed in Cummins and Weiss (2000).

We choose the DEA approach for the following four reasons. First, the DEA has been used extensively in estimating efficiency in the banking and insurance literature. Second, this non-parametric approach allows us to avoid an inappropriate assumption about the distribution of error terms used in the parametric approach. Third, the DEA separately evaluates the efficiency of every decision-making unit relative to its reference set, thus providing a more meaningful measurement of efficiency. Specifically, we estimate relative efficiency of each converting firm which is compared to a reference set consisting of converting insurers and control insurers, enabling us to determine whether converting insurers improve their efficiency relative to control insurers after conversion. Finally, the use of the DEA enables us to provide consistent analysis since the Malmquist index is also DEA-based. We next discuss the input/output variables used in this study for the DEA and efficiency measurement. Both the value-added and financial intermediary approaches are used.

The value-added approach

We first evaluate the efficiency performance of insurance companies using the value-added approach, which considers asset or liability categories that have the most value added important outputs, as judged by operating cost allocation (see Berger and Humphrey, 1992). We identify the input/output measures according to Cummins and Weiss (1993), Berger *et al.* (1997), Cummins *et al.* (1999a), and Jeng and Lai (2005).

Outputs The output variables include the loss payments for different product lines and total invested assets. Cummins and Weiss (1993) suggest that insurers provide consumers with services associated with insured losses, risk-pooling, and risk-bearing. Following Cummins and Weiss (1993), Cummins *et al.* (1999a), and Cummins *et al.* (2004), we use incurred losses for different product lines as proxies for outputs. The rationale for choosing the incurred loss as an output is that insurers collect premiums from policyholders and redistribute the premiums to the insured who incurred losses. The amount of incurred loss could relate to the risk-bearing function, risk-pooling function, and real service provided by insurers. We further separate the losses into four categories: losses incurred in short-tail personal lines ($y1$), losses incurred in long-tail personal lines ($y2$), losses incurred in short-tail commercial lines ($y3$) and losses incurred in long-tail commercial lines ($y4$). Based on Berger *et al.* (1997), we also include invested assets ($y5$) as an output variable to capture the insurer's function of financial intermediation. All output numbers are deflated using the Consumer Price Index (CPI).[2]

[2] The base year is 1997.

Inputs The inputs used in measuring the efficiency performance include labour ($x1$), business services ($x2$), equity capital ($x3$), and debt capital ($x4$). The labour input is labour cost divided by average weekly employee wages. We measure the price of labour ($p1$) as average weekly wages for insurance agents (Standard Industrial Classification (SIC) Class 6411) using U.S. Department of Labor data. The second input, business services, consists of agent commissions and loss adjustment expenses. The price of business services ($p2$) is the average weekly earnings of workers in SIC Code 7300. The business services, price of labour, and price of business services variables are deflated to the base year 1997. The third input is equity capital. We use policyholder surplus as the proxy for equity capital. To avoid the problem of improper estimates, we do not take the insurer's return on equity as the cost of equity capital because insurers with poor performance are more likely to have negative return and price cannot be negative. Consequently, we utilize the debt/equity ratio of the insurer as the price of equity ($p3$).[3] Following Cummins *et al.* (1999a), and Cummins *et al.* (2004), we consider debt capital as an input variable. The debt capital is funds borrowed from policyholders. The debt capital include loss reserves, loss adjustment expenses, and unearned premium reserves. The price of debt ($p4$) is the ratio of total expected investment income minus expected investment income attributed to equity capital divided by average debt capital.

Table 1 reports the descriptive statistics for both the inputs and outputs that are used in the value-added approach. Because converting insurers were mutual insurers before conversion and became stock insurers after conversion, we compare converting insurers with mutual insurers in year -3 and year 0 and with stock insurers in year 0 and year 3 in Table 1. One interesting result is that some outputs of the converting insurers are smaller than those of the mutual control insurers in three of the four lines (short-tail and long-tail personal lines, and short-tail commercial lines) before conversion. In addition, some inputs of converting insurers (e.g., labour cost, business service, and equity) are also smaller than those of the mutual control insurers. This means that we are not able to tell whether converting insurers or mutual control insurers are more efficient by simply examining the outputs or inputs. This is also applied to the comparison between converting insurers and stock insurers.

The financial intermediary approach

Following Jeng and Lai (2005) and Jeng *et al.* (2007), we use both value-added approach and the financial intermediary approach.[4] The financial intermediary

[3] Price of equity should be a function of a firm's debt/equity ratio. Please see Jeng and Lai (2005) for detailed discussions.

[4] The value-added approach and the financial intermediary approach provide different research insights. The selection of the approaches affects the output and input choices to evaluate

approach has been used both in the bank and insurance literature (Brockett *et al.*, 2004, 2005; Jeng and Lai, 2005; Kwan, 2006). Brockett *et al.* (2004) suggest that, compared with other financial intermediaries, an insurer plays a different role because its future obligations are intangible and the policyholders' claims are contingent on future losses. Thus, the ability to pay the claims and the financial health of an insurer are important and should be considered in evaluating firm performance. We also employ the financial intermediary approach to examine the efficiency performance change of the converting insurers from the financial perspective because financial intermediation is one of the major services provided by insurers. Moreover, since the inputs and outputs of the financial intermediary approach are different from those of the value-added approach, the results using the financial intermediary approach may provide different insights about the insurers' efficiency changes.

Outputs Following Brockett *et al.* (2004, 2005), we employ a set of performance ratios and the IRIS (Insurance Regulatory Information System) ratios as insurer outputs. The rationale for the use of these variables to proxy for insurance output is that these measurements reflect the solvency, the quality of investment, and the claim paying ability. The IRIS ratios were established by the NAIC to investigate the solvency status and performance for the insurers. Hence, the IRIS ratios are likely to be associated with the claim paying ability and should be considered as an output of insurers.

These six output variables include: change in policyholder surplus[5] ($y1$), capitalization ratio[6] ($y2$), change in invested assets ($y3$), investment yield ($y4$), change in net premiums ($y5$), and the ratio of liquid assets to liabilities ($y6$). In addition, we also use return on assets ($y7$) as one output because one of the major objectives of managers is to maximize the shareholders' profits.

Inputs The first input is policyholders' surplus. We further divide surplus into surplus of previous year ($x1$) and change in surplus ($x2$) because the amount of surplus supplied by the policyholders can be invested during any period of time. The prices for surplus of previous year and for change in surplus are the

insurance company performances. Specifically, the financial intermediary approach considers more on overall financial strengths (e.g., change in policyholder surplus, the capitalization ratio, and liquidity) and profit of the insurers, whereas the value-added approach focuses more on underwriting performance (e.g., losses incurred in different line of business).

[5] The change in policyholder surplus is the difference between the surplus of last year and current year and is divided by the surplus of last year.

[6] The capitalization ratio is the ratio of the current surplus to the total assets.

Table 1 Descriptive statistics for outputs/inputs using the value-added approach

	Year t = −3		*Year t = 0*			*Year t = 3*		
	Converting insurer	*Mutual control insurer*	*Mutual control insurer*	*Converting insurer*	*Stock control insurer*	*Mutual control insurer*	*Converting insurer*	*Stock control insurer*
Output								
*Y*1 = Losses incurred in short-tailed personal lines	1,082,400	1,656,636	2,032,255	1,195,088	1,712,320	2,354,942	1,474,007	2,398,955
*Y*2 = Losses incurred in long-tailed personal lines	3,391,965	5,175,595	5,184,981	3,237,806	3,790,128	5,266,439	3,712,627	4,690,707
*Y*3 = Losses incurred in short-tailed commercial lines	799,450	1,016,041	1,033,551	816,452	1,065,899	1,008,964	953,349	1,579,505
*Y*4 = Losses incurred in long-tailed commercial lines	2,668,168	2,435,150	2,673,298	1,951,084	2,570,598	3,158,502	2,966,631	3,888,287
*Y*5 = Total invested assets	29,260,309	30,327,681	32,955,756	37,020,115	34,782,223	37,535,958	38,596,253	43,604,950
Input								
X1 = Labour	3,719	5,628	5,376	4,053	4,976	5,784	3,995	6,166
X2 = Business service	13,947	14,379	13,675	12,726	13,002	13,610	12,330	13,934
X3 = Equity	9,080,032	12,800,947	15,383,358	15,520,216	14,336,456	19,307,354	16,268,088	18,322,608
X4 = Debt capital	20,425,411	18,978,915	19,495,043	20,608,244	22,232,293	20,739,364	21,923,281	27,953,184
Input price								
P1 = Price of labour	364.04	364.04	399.415	399.415	399.415	423.286	423.286	423.286
P2 = Price of business service	234.177	234.177	239.550	239.550	239.550	262.325	262.325	262.325
P3 = Price of equity	2.006	1.417	1.309	1.258	1.504	1.250	1.250	1.542
P4 = Price of debt	0.091	0.064	0.065	0.100	0.067	0.067	0.471	0.061

Notes: This table shows the means of output, input, and input price variables of converting insurers, mutual control insurers, and stock control insurers for the U.S. property and liability insurers during the conversion period. Data are gathered from the National Association of Insurance Commissioners from 1990 to 2001. All monetary variables are deflated using the 1997 Consumer Price Index.

ratio of debt to equity for the previous year ($p1$) and the ratio for current year ($p2$). The reason for using the leverage ratio as the input price for surplus was discussed previously. The third input considers underwriting and investment expenses ($x3$). The underwriting expenses arise from the function of risk-bearing and risk-pooling provided by insurance firms. The investment expenses are incurred because they are needed for the productive usage of capital to provide policyholders with reasonable assurance of investment income and repayment of the principle. Both underwriting and investment expenses are considered as inputs for performing the insurer's risk management and intermediary functions in this paper. We use average weekly employee wages as the proxy for input price ($p3$). Another input is debt capital, consisting of loss reserves, loss adjustment expenses, and unearned premium reserves. Different lines of business may incur different underwriting risks, and thus need different maturities of debt capital. We further separate the debt capital into short-term and long-term debt capital ($x4$, $x5$).[7] We use the U.S. treasury rates as the proxy for the price of debt capital. The prices for short-term and long-term debt capital are the interest rates of one-year and five-year U.S. Treasury rates ($p4$, $p5$), respectively.

Table 2 reports the descriptive statistics for both inputs and outputs used in the financial intermediary approach. In the year of conversion, change in policyholder surplus of converting insurers (0.830) becomes significantly higher than that of the mutual control insurers (0.081) and stock control insurers (0.165), respectively. In addition, change in surplus of converting insurers ($4,634,360) becomes higher than that of the mutual control insurers ($1,346,006) and stock control insurers ($1,082,988), respectively. This result is expected because converting insurers received a capital infusion during the conversion process. Another interesting result is that change in invested assets of converting insurers is significantly higher than that of their stock control insurers in year 0, but it becomes smaller than those of stock control insurers in year 3.

Empirical results

The analysis of empirical results in this section is separated into two parts: the value-added approach section and financial intermediary approach section.

[7] The short-term debt capital equals the product of debt capital and the short-term lines of business position. The short-term line of business position is the ratio of short-term lines net premium to total net premium. The "short-term" or "long-term" signify the length between the policy issuing and payment dates.

Table 2 Descriptive statistics of outputs/inputs using the financial intermediary approach

	Year t = −3		*Year t = 0*			*Year t = 3*		
	Converting insurer	*Mutual control insurer*	*Mutual control insurer*	*Converting insurer*	*Stock control*	*Mutual control insurer*	*Converting insurer*	*Stock control*
Output								
Y1 = Change in policyholder surplus	−0.002	0.059	0.081**	0.830	0.165**	0.035	0.114	0.075
Y2 = Capitalization ratio	0.39	0.463	0.474	0.468	0.439	0.489	0.481	0.432
Y3 = Change in invested assets	0.05	0.056	0.060***	0.241	0.122	0.041	0.007	0.065*
Y4 = Investment yield	0.063	0.052	0.051	0.051	0.058	0.046	0.059	0.055
Y5 = Change in net premiums	0.04	0.09	0.063	0.099	0.255*	0.082	−0.06	0.101*
Y6 = Liquid assets to liabilities	5.604	2.295	2.295	3.222	2.071	2.35	2.361	2.043
Y7 = ROA	0.014	0.013	0.018	0.006	0.025	0.012	0.025	0.021
Input								
X1 = Surplus previous year	8,459,289	12,193,969	14,037,352	10,885,856	13,253,468	18,641,641	15,759,843	17,317,123
X2 = Change in surplus	620,743	606,978	1,346,006	4,634,360	1,082,988*	665,712	508,244	1,005,485
X3 = Underwriting + Investment expenses	5,936,830	7,052,025	7,282,517	6,690,482	6,678,364	8,108,506	6,750,473	8,724,097
X4 = Short-term debt capital	16,740,479	14,825,800	15,236,629	17,063,102	16,735,134	16,167,874	18,085,250	20,239,981
X5 = Long-term debt capital	3,684,932	4,153,115	4,258,414	3,545,142	5,497,160	4,571,490	3,838,030	7,713,203
Input price								
P1 = Debt/equity for previous year	1.964	1.591	1.499	2.612	1.921	1.279	1.598	1.692
P2 = Debt/equity for current year	2.257	1.607	1.469	1.499	1.744	1.423	1.481	1.799
P3 = Price of labour	364.04	364.04	399.415	399.415	399.415	423.286	423.286	423.286
P4 = One-year treasury constant maturities	5.388	5.388	5.148	5.148	5.148	5.147	5.147	5.147
P5 = Five-year treasury constant maturities	6.69	6.69	5.96	5.96	5.96	5.637	5.637	5.637

***Statistically significant difference at the 1 per cent level.

**Statistically significant difference at the 5 per cent level.

*Statistically significant difference at the 10 per cent level.

Notes: This table shows the means of output, input, and input price variables of converting insurers, mutual control insurers, and stock control insurers for the U.S. property and liability insurers during the conversion period. Data are gathered from the National Association of Insurance Commissioners from 1990 to 2001. All monetary variables are deflated using the 1997 Consumer Price Index.

Efficiency results of the value-added approach

This section discusses the empirical results of the value-added approach including the DEA scores and Malmquist indices. We estimate converting insurers' and control insurers' DEA scores based on the pooled frontier consisting of all converting insurers and their control insurers. Thus, the efficiency scores for the control mutual (stock) insurers are calculated by the best practice frontier consisting of all converting insurers and their mutual (stock) control insurers. The efficiency scores and Malmquist indices indicate whether insurers improve their performance. We also examine converting/control insurer efficiency ratios to compare the performance differences between the converting insurers and their control insurers during conversion period. Converting insurer efficiency *is* defined as the average efficiency score for converting insurers and converting/control insurer efficiency ratio *is* equal to the ratio of efficiency score of converting insurers to that of control insurers. The ratio indicates whether converting insurers perform better or worse than the control insurers.

DEA efficiency score calculation

We first focus on the analyses of the efficiency change before conversion. Panel A of Table 3 reports the comparison between the converting insurers and mutual control insurers. The top section of Panel A of Table 3 indicates that technical efficiency and cost efficiency scores of converting insurers increase before demutualization. For example, the technical (cost) efficiency score for converting insurers increases from 0.947 (0.874) in year –3 to 0.973 (0.882) in year –1. Consistent results are found when we examine the converting/mutual control insurer efficiency ratio. For example, the converting/mutual control insurer ratio of technical efficiency also increases from 1.010 in year −3 to 1.037 in year −1, suggesting converting insurers improve their efficiency relative to mutual control insurers during the pre-conversion period. One possible explanation is that the converting insurers need to seek the regulatory and the policyholder approval of demutualization plan before conversions. Converting insurers may try to improve efficiency before conversion, and thus increasing the probability of success for demutualization plan.

We next examine the efficiency scores after demutualization. Panel A of Table 3 shows that the converting/control insurers ratios of technical efficiency and cost efficiency increase from 1.017 (1.000) in year 0 to 1.036 (1.010) in year 3, implying that the converting insurers become more efficient relative to mutual control insurers after conversion. This is consistent with the prediction of the efficiency hypothesis that the financial and operational efficiency improvement motivates the conversions for these converting insurers in the sample period.

Table 3 DEA efficiency score results using the value-added approach

Year	*Technical efficiency*			*Allocative efficiency*			*Cost efficiency*		
	Converting insurer efficiency	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*
Panel A: Converting insurers vs. mutual control insurers									
−3	0.947	0.938	1.010	0.922	0.922	1.000	0.874	0.866	1.009
−2	0.959	0.938	1.022	0.908	0.898	1.011	0.870	0.842	1.033
−1	0.973	0.938	1.037	0.906	0.874	1.037	0.882	0.819	1.077
0	0.955	0.939	1.017	0.880	0.896	0.982	0.840	0.840	1.000
1	0.963	0.941	1.023	0.884	0.902	0.980	0.851	0.849	1.002
2	0.974	0.952	1.023	0.899	0.901	0.998	0.876	0.858	1.021
3	0.976	0.942	1.036	0.845	0.867	0.975	0.825	0.817	1.010
Panel B: Converting insurers vs. stock control insurers									
−3	0.942	0.926	1.017	0.922	0.907	1.017	0.869	0.840	1.035
−2	0.918	0.898	1.022	0.903	0.888	1.017	0.828	0.796	1.040
−1	0.941	0.910	1.034	0.889	0.861	1.033	0.837	0.781	1.072
0	0.908	0.893	1.017	0.795	0.808	0.984	0.722	0.720	1.003
1	0.924	0.902	1.024	0.856	0.875	0.978	0.791	0.789	1.003
2	0.944	0.919	1.027	0.895	0.888	1.008	0.846	0.816	1.037
3	0.961	0.922	1.042	0.861	0.869	0.991	0.827	0.801	1.032

Notes: This table provides the averages of DEA efficiency scores using the value-added approach. Panel A (B) provides the results based on the pooled frontier of the converting insurers and mutual (stock) control insurers. Converting/Control Insurer is the ratio of converting score to control insurer score. The year with a minus (positive) sign in front refer to the pre (post) -converting years. Year 0 is the converting year.

One may argue that the frontier for converting insurers may change after conversion because converting insurers have changed their organizational structure from the mutual form to the stock form. Thus, we also conduct the analyses based on best practice pooled frontier of converting insurers and stock control firms. Panel B of Table 3 shows the comparison between the converting insurers and stock control insurers. Specifically, Panel B shows that technical efficiency, allocative efficiency, and cost efficiency of converting insurers increase from year 0 to year 3 and they also improve their efficiency relative to their control stock insurers, consistent with the prediction of the efficiency hypothesis.

Malmquist index analysis

We utilize the Malmquist index approach to further analyze the evolution of productivity growth over the sample period. The Malmquist index of total factor productivity change consists of technical efficiency change and technical change. The value of the technical efficiency change >1 implies that the insurer is closer to the production frontier in year t than in year $t-1$, and value of the technical change >1 implies technical progress. Table 4 reports the results of Malmquist analysis using the value-added approach. Panel A presents the Malmquist indices based on the pooled production frontier of the converting insurers and mutual control insurers. The top section of each panel shows the year-to-year Malmquist indices. Panel A shows the value of technical efficiency change for converting insurers in year -2 is 1.020, suggesting the converting insurers on average improved efficiency by 2 per cent between year -3 and year -2.

The bottom section of Panel A presents the cumulative results. The cumulative results for a certain year are the product of the index at the start of the year and the index the end of the year. For example, the bottom section of Panel A shows the cumulative index for total factor productivity change for converting insurers in year -1 (1.038), is the product of the -3 to -2 index (0.990) and -2 to -1 index (1.048). We utilize cumulative index to examine the consecutive productivity change from year -1 to 3. The cumulative technical efficiency change, technical change, and total factor productivity change for converting insurers are greater than one in year -1, suggesting that converting insurers have achieved total factor productivity growth before conversion by improving their technology and by becoming more efficient. After conversion, we find that converting insurers outperform their mutual control insurers after conversion. The cumulative converting/mutual control insurer ratios of technical efficiency change, technical change, and total factor productivity change increase from year 0 to year 3. For instance, the cumulative converting/mutual control insurer ratios of total factor productivity change increase from 1.004 in year 0 to 1.073 in year 3.

Table 4 Malmquist analysis using the value-added approach

Year	*Technical efficiency change*			*Technical change*			*Total factor productivity change*		
	Converting insurer efficiency	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*
Panel A: Converting insurers vs. mutual control insurers									
−2	1.020	1.007	1.013	0.970	0.990	0.980	0.990	0.996	0.994
−1	1.002	0.993	1.009	1.044	1.013	1.031	1.048	1.005	1.043
0	0.989	1.003	0.986	0.978	0.998	0.980	0.970	1.001	0.969
1	1.006	1.007	0.999	1.014	0.998	1.016	1.020	1.005	1.015
2	1.006	1.002	1.004	1.073	0.996	1.077	1.079	0.998	1.081
3	1.009	1.000	1.009	0.979	1.015	0.965	0.988	1.015	0.973
Cumulative results									
−1	1.022	1.000	1.022	1.013	1.003	1.010	1.038	1.001	1.037
0	1.011	1.003	1.008	0.990	1.001	0.990	1.006	1.002	1.004
1	1.017	1.010	1.007	1.004	0.999	1.005	1.027	1.007	1.019
2	1.023	1.012	1.011	1.078	0.995	1.083	1.108	1.005	1.102
3	1.032	1.012	1.020	1.055	1.010	1.045	1.094	1.020	1.073
Panel B: Converting insurers vs. stock control insurers									
−2	1.006	0.992	1.014	0.988	1.018	0.971	0.994	1.010	0.984
−1	1.001	1.006	0.995	1.050	0.994	1.056	1.054	0.999	1.055
0	0.975	0.996	0.979	0.980	1.003	0.977	0.959	0.999	0.960
1	1.007	0.996	1.011	1.019	1.020	0.999	1.027	1.015	1.012
2	1.002	0.992	1.010	1.137	1.034	1.100	1.139	1.026	1.110
3	1.007	1.008	0.999	1.015	1.493	0.680	1.022	1.500	0.681
Cumulative results									
−1	1.007	0.998	1.009	1.037	1.012	1.025	1.048	1.009	1.038
0	0.982	0.994	0.988	1.017	1.015	1.002	1.005	1.008	0.997
1	0.989	0.990	0.999	1.036	1.035	1.001	1.032	1.023	1.009
2	0.991	0.982	1.009	1.178	1.070	1.100	1.175	1.050	1.120
3	0.998	0.990	1.008	1.196	1.598	0.748	1.201	1.575	0.763

Notes: This table provides the averages of Malmquist indices using the value-added approach. Panel A (B) provides the results based on the pooled frontier of the converting insurers and mutual (stock) control insurers. Converting/Control Insurer is the ratio of converting score to control insurer score. The year with a minus (positive) sign in front refer to the pre (post) -converting years. Year 0 is the converting year.

Panel B presents the Malmquist indices based on the pooled frontier of the converting insurers and stock control insurers. The cumulative converting/control insurer ratio of technical efficiency change increases from year 0 to year 3, indicating that converting insurers become more efficient relative to stock control insurers after conversion. However, the cumulative converting/control insurer ratio of technical change and total factor productivity change decrease from year 0 to year 3, indicating that converting insurers experience deterioration in total factor productivity relative to stock control insurers after conversion.

Efficiency results of financial intermediary approach

As mentioned previously, the financial intermediary approach considers more on overall financial strengths whereas the value-added approach focuses more on underwriting performance. We believe our analyses in this section provide additional insights into the efficiency performance change with respect to "financial condition" before and after the demutualization. We report only the final results because the analysis is similar to that of the value-added approach.

Table 5 reports the DEA efficiency scores using the financial intermediary approach. Panel A shows that converting/control insurer efficiency ratio of the allocative efficiency and cost efficiency increase from year –3 to year –1, implying that converting insurers improve their efficiency relative to mutual control insurers before conversion. These results are consistent with those in Table 3. The results of both approaches show that the converting insurers become more efficient relative to their control insurers before conversion. A possible explanation is that converting insurers improve their efficiency to maximize the existing policyholders' (future stockholders') wealth. Other things being equal, a more efficient insurer is able to offer shares at a higher IPO price because efficiency usually translates to profitability. Thus, a more efficient insurer would be able to command a higher IPO price. Another possible explanation is that converting insurers seek the regulatory and policyholder approval for conversions plans by improving their efficiency before conversion.

We next analyse the post-conversion results. When the indices are based on the pooled frontier of converting insurers and stock insurers, we find converting insurers improve their efficiency after the conversion (Panel B, Table 5). The technical efficiency, allocative efficiency, and cost efficiency scores for converting insurers and for converting/stock control insurer ratios increase from year 0 to year 3. This result is consistent with the results in Panel B of Table 3.

The Malmquist analysis using the financial intermediary approach is presented in Table 6. In Panel A, both cumulative technical change and total

Table 5 DEA efficiency score results using the financial intermediary approach

Year	*Technical efficiency*			*Allocative efficiency*			*Cost efficiency*		
	Converting insurer efficiency	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*
Panel A: Converting insurers vs. mutual control insurers									
−3	0.909	0.884	1.028	0.597	0.639	0.934	0.544	0.573	0.949
−2	0.934	0.910	1.026	0.615	0.650	0.946	0.578	0.600	0.963
−1	0.921	0.900	1.023	0.625	0.658	0.950	0.581	0.603	0.964
0	0.905	0.899	1.007	0.665	0.651	1.022	0.610	0.596	1.023
1	0.913	0.857	1.065	0.621	0.668	0.930	0.578	0.597	0.968
2	0.883	0.836	1.056	0.640	0.654	0.979	0.578	0.565	1.023
3	0.905	0.867	1.044	0.660	0.653	1.011	0.613	0.588	1.043
Panel B: Converting insurers vs. stock control insurers									
−3	0.908	0.883	1.028	0.610	0.640	0.953	0.560	0.581	0.964
−2	0.910	0.895	1.017	0.549	0.579	0.948	0.510	0.534	0.955
−1	0.895	0.848	1.055	0.570	0.628	0.908	0.521	0.556	0.937
0	0.856	0.843	1.015	0.388	0.387	1.003	0.343	0.344	0.997
1	0.861	0.792	1.087	0.652	0.703	0.927	0.571	0.581	0.983
2	0.865	0.817	1.059	0.390	0.418	0.933	0.351	0.360	0.975
3	0.921	0.896	1.028	0.496	0.475	1.044	0.467	0.438	1.066

Notes: This table provides the averages of DEA efficiency scores using the financial intermediary approach. Panel A (B) provides the results based on the pooled frontier of the converting insurers and mutual (stock) control insurers. Converting/Control Insurer is the ratio of converting score to control insurer score. The year with a minus (positive) sign in front refer to the pre (post) -converting years. Year 0 is the converting year.

factor productivity change for converting insurers in year −1 are greater than 1, suggesting that converting insurers experience technical innovation and achieve total factor productivity growth relative to mutual control insurers before conversion. The cumulative converting/mutual control insurer ratios of technical efficiency change and total factor productivity change increase from year 0 to year 3, indicating that converting insurers experienced technical efficiency improvement and total factor productivity growth relative to mutual after conversion. Panel B shows, compared to stock insurers, converting insurers improve their technical change (innovation) and enjoy total factor productivity growth after conversion. The cumulative converting/control insurer ratios of technical change and total factor productivity change increase from year 0 to year 3.

Regression analysis

The univariate analyses of DEA scores and Malmquist indices provide evidence of efficiency changes. We further use ordinary least square regression analysis to examine efficiency and productivity changes between the converting insurers and control insurers.[8] Specifically, we examine whether converting insurers outperform or underperform control insurers. The dependent variables are various efficiency scores and cumulative Malmquist indices and the independent variables are firm characteristics.

We use four sets of dependent variables for efficiency change. The first set of dependent variables (cost efficiency, technical efficiency, and allocative efficiency) is the DEA efficiency scores in 1 year before the conversion ($t=-1$) to those in 3 years before the conversion ($t=-3$). The second set of dependent variables is the DEA efficiency scores 3 years after conversion ($t=3$) to those in the conversion year ($t=0$). The third set of dependent variables is cumulative Malmquist indices (technical efficiency change, technical change, and total factor productivity change) before the conversion, measured in the same way as the DEA efficiency scores. Finally, the last set of dependent variables is cumulative Malmquist indices after the conversion.

Based on Cummins *et al.* (1999b), we choose some insurer's financial/operational characteristics as independent variables, such as firm size, Herfindahl index for lines of business, per cent of premiums in long-tail lines,

[8] Previous literature often uses Tobit regression models to analyse the efficiency because the value of dependent variable of the efficiency score is from zero to one. In this paper, the dependent variable is the ratio of efficiency score before conversions to the efficiency score after conversion. Thus, the value of dependent variable does not range from zero to one. Hence, we use ordinary least square regression model for our analyses.

Table 6 Malmquist analysis using the financial intermediary approach

Year	*Technical efficiency change*			*Technical change*			*Total factor productivity change*		
	Converting Insurer Efficiency	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*	*Converting insurer efficiency*	*Control insurer efficiency*	*Converting/ control insurer*
Panel A: Converting insurers vs. mutual control insurers									
−2	0.994	0.982	1.012	1.019	1.012	1.007	1.013	0.994	1.019
−1	0.977	0.982	0.995	1.020	1.015	1.005	0.996	0.997	0.999
0	0.977	1.004	0.973	1.040	0.991	1.049	1.017	0.995	1.022
1	1.009	0.923	1.093	1.043	1.094	0.953	1.086	0.996	1.090
2	0.972	0.996	0.976	1.018	1.024	0.994	0.986	1.010	0.976
3	1.030	1.040	0.990	0.949	0.979	0.969	0.972	1.015	0.958
Cumulative results									
−1	0.971	0.964	1.007	1.039	1.027	1.012	1.009	0.991	1.018
0	0.949	0.968	0.980	1.081	1.018	1.062	1.026	0.986	1.041
1	0.957	0.894	1.071	1.127	1.114	1.012	1.114	0.982	1.135
2	0.931	0.890	1.045	1.148	1.140	1.006	1.099	0.992	1.108
3	0.958	0.926	1.035	1.089	1.116	0.976	1.068	1.007	1.061
Panel B: Converting insurers vs. stock control insurers									
−2	1.023	1.020	1.003	0.982	0.959	1.024	1.004	0.978	1.027
−1	0.968	0.961	1.007	1.038	1.040	0.998	1.001	1.001	1.000
0	0.984	0.975	1.009	1.023	1.029	0.994	1.007	1.003	1.004
1	1.024	0.960	1.067	1.010	1.028	0.982	1.051	0.987	1.065
2	1.062	1.156	0.919	0.945	0.880	1.074	0.996	1.003	0.993
3	0.981	0.976	1.005	1.056	1.046	1.010	1.037	1.021	1.016
Cumulative results									
−1	0.990	0.980	1.010	1.019	0.997	1.022	1.005	0.979	1.027
0	0.974	0.956	1.020	1.043	1.026	1.016	1.012	0.982	1.031
1	0.998	0.917	1.088	1.053	1.055	0.998	1.064	0.969	1.098
2	1.060	1.061	0.999	0.995	0.928	1.072	1.059	0.972	1.090
3	1.040	1.035	1.004	1.051	0.971	1.082	1.099	0.992	1.107

Notes: This table provides the averages of Malmquist indices using the financial intermediary approach. Panel A (B) provides the results based on the pooled frontier of the converting insurers and mutual (stock) control insurers. Converting/Control Insurer is the ratio of converting score to control insurer score. The year with a minus (positive) sign in front refer to the pre (post) -converting years. Year 0 is the converting year.

the ratio of agents' balances to direct premiums written, and the reinsurance ratio. Note that these variables serve as control variables for insurers' different characteristics.

The reasons for choosing these control variables are explained as follows. First, the previous literature on scale efficiency shows that the median-sized firms is more cost efficient than either small firms or large firms (e.g. Berger 1993). Hence, it is hypothesized that the cost efficiency may vary with firm size. We take the natural logarithm of total assets as the proxy for firm size. Second, Cummins *et al.* (1999b) study the efficiency change associated with ownership structure change and find that more concentrated firms experience smaller changes in the efficiency performance than more diversified firms. Hence, the business concentration may relate to the efficiency performance. We take the Herfindahl index as the proxy for the concentration measurement to examine the relation between the concentration of lines of insurance and efficiency change. Third, because the underwriting risk, service intensity, and level of market competition may vary with different lines of business,[9] the strategic focus of different lines of insurances may lead to different efficiency performance. This efficiency difference could be revealed by examining the relation between the business mix and efficiency change. We disaggregate business mix into two categories: the long-tail lines and the short-tail lines[10] and use the premium percentage in two categories as proxy for the business mix position. To avoid multicollinearity problem in regression analysis, we only keep the long-tail business mix in the regression model. Fourth, agent's balance asset account indicates the amount of money that should be forwarded to the insurer but still in the hands of the insurance agent. The agent's balance relates to the financial liquidity strain or cash management since it is difficult to convert the agent's balance into cash (Viswanathan and Cummins, 2003). Hence, we predict that the level of agent's balance may affect the efficiency change of the insurers, especially in the cost efficiency and allocative efficiency. Finally, reinsurance plays an important role in the property liability insurance industry. The reinsurance company provides both the real risk management service and financing function to the primary insurers. Since the reinsurance ease the financial constraints of the insurers, we predict that the level of reinsurance may affect the efficiency performance change of the insurers. A detailed discussion of independent variables and models will be presented in the empirical results section.

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[9] See Cummins *et al.* (1999a, b).

[10] The long-tail and short-tail line refer to the length of the period between the issue date of the insurance contract and the claim paying date.

The regression model is as follows:

$$Efficiency\ Change = \beta_0 + \beta_1 DEMU + \beta_2 NA + \beta_3 HI + \beta_4 LP + \beta_5 AD + \beta_6 RE + \varepsilon.$$

The independent variables include a conversion dummy (*DEMU*, equal to 1 if the insurer is a converting insurer and zero for control insurer), firm size (*NA*, log of total assets), Herfindahl index (*HI*), per cent of premiums in long-tail lines (*LP*), the ratio of agents' balances to direct premiums written (*AD*), and the reinsurance ratio (*RE*). The values used in independent variables in the regression analysis are for 1 year before conversion. Table 7 presents the summary statistics for variables that are included in the regression models.[11] The results show that the total assets of converting insurers are higher after conversion. This is due to the infusion of capital during the conversion. We also find that the ratios of agents' balances to direct premiums written for converting insurers are significantly lower than those of their control insurers before and after conversion, implying that the amount of premiums that are due to be received by converting insurer from its agents is smaller than those of the control insurers.

Regression results of the value-added approach

Table 8 reports the results of regression analysis for the value-added approach. Panel A of Table 8 shows that the coefficient of the constant and conversion dummy (DEMU) variables in cost efficiency, technical efficiency, and allocative efficiency model are significant and positive, indicating that converting insurers improve their efficiency performance and perform better than the mutual control group before conversion. The evidence is consistent with the result of the DEA analysis in Panel A of Table 3. However, there is no evidence that the converting insurers improve their efficiency relative to mutual control insurers after conversion (Panel B).

The control variables show that large insurers experience significantly larger gains in efficiency than do small insurers during converting period (Panels A and B). The results of Herfindahl index show that concentrated firms experienced smaller efficiency changes than diversified firms during converting period (Panels A and B). This finding suggests that diversification across multiple product lines resulted in greater efficiency changes than a more focused strategy. The positive and significant coefficients of per cent of

[11] The original value of dependent variables has been reported in Tables 3-6.

Table 7 Summary statistics for converting insurers and mutual control insurers

Variables	*Panel A: Summary statistics one year before conversion*			*Panel B: Summary statistics in the conversion year*		
	Mutual control insurers mean	*Converting insurers mean*	*Stock control insurers mean*	*Mutual control insurers mean*	*Converting insurers mean*	*Stock control insurers mean*
Total admitted assets (millions)	53.038	52.904	62.072	58.106	61.806	61.807
	(84.864)	(83.247)	(86.584)	(92.074)	(91.336)	(88.012)
Herfindahl index	0.360	0.455	0.417	0.359	0.468	0.423
	(0.168)	(0.353)	(0.239)	(0.168)	(0.343)	(0.240)
Per cent of premiums in long-tail lines	0.694	0.693	0.671	0.695	0.710	0.668
	(0.226)	(0.299)	(0.251)	(0.230)	(0.296)	(0.256)
Agents balances/Direct premium written	0.103***	0.032	0.130***	0.109***	0.034	0.131***
	(0.085)	(0.083)	(0.139)	(0.085)	(0.051)	(0.140)
Reinsurance ratio	0.309	0.318	0.407	0.300	0.299	0.411
	(0.220)	(0.252)	(0.288)	(0.222)	(0.216)	(0.286)

***Statistically significant difference at the 1 per cent level.
**Statistically significant difference at the 5 per cent level.
*Statistically significant difference at the 10 per cent level.
Notes: Reinsurance ratio = (Reinsurance ceded)/(Direct premiums written + Reinsurance assumed). Standard deviation is in parentheses.
This table reports the averages of the financial and operational characteristics of converting insurers and control insurers.

premiums in long-tail lines (LP) in Panel A imply that mutual insurers with more business in long-tail lines experience greater efficiency gains before conversion. However, the coefficients of LP in the cost and allocative efficiency equation have the opposite signs after conversion. Finally, the results of Panel B show that mutual insurers with higher ratio of agents' balances to direct premiums written achieved significantly lower cost efficiency and technical efficiency growth than firms with lower agents' balance ratio after conversion. A possible explanation for this result could be that higher agents' balance ratio could lead to insurers' cash management problems and/or liquidity problems because it is difficult to convert into cash. Mutual insurers with higher agents' balance ratio may be less efficient than those with lower agents' balance ratio due to cash management problems and/or liquidity problems.

Panels C and D of Table 8 present the regression results of the cumulative Malmquist indices before and after conversion, respectively. Panel C shows that conversion dummy is positively related to technical change and total productivity change, suggesting that converting insurers outperform the control mutual insurers before conversion. In Panel D, the coefficient of the

Table 8 Regression analysis using the value-added approach - mutual control insurers

Variables	*Panel A: Efficiency one year before/three years before conversion*			*Panel B: Efficiency three year after conversion/ efficiency in the conversion year*		
	CE	*TE*	*AE*	*CE*	*TE*	*AE*
Constant	0.4122***	1.0016***	0.4081***	0.6621***	0.8847***	0.7767***
	(8.03)	(38.42)	(9.27)	(11.17)	(24.79)	(15.49)
Demutualization (DEMU)	0.0706***	0.0283***	0.0416**	0.0042	0.0176	−0.0122
	(3.47)	(2.75)	(2.39)	(0.19)	(1.34)	(−0.67)
Natural log of total assets (NA)	0.0307***	−0.0007	0.0315***	0.0218***	0.0089***	0.0130***
	(10.44)	(−0.47)	(12.46)	(6.48)	(4.39)	(4.57)
Herfindahl index (HI)	−0.0745***	0.0050	−0.0766***	−0.0064	−0.0282*	0.0211
	(−3.31)	(0.44)	(−3.97)	(−0.26)	(−1.94)	(1.03)
Per cent of premiums in long-tail lines (LP)	0.0658***	0.0174*	0.0489***	−0.0503***	−0.0146	−0.0355**
	(3.60)	(1.88)	(3.12)	(−2.64)	(−1.27)	(−2.20)
Agents balances/Direct premium written (AD)	0.0193	−0.0273	0.0502	−0.1146**	−0.0511*	−0.0635
	(0.39)	(−1.09)	(1.18)	(−2.24)	(−1.66)	(−1.47)
Reinsurance ratio (RE)	−0.0123	−0.0077	−0.0042	−0.0095	−0.0108	−0.0008
	(−0.68)	(−0.83)	(−0.27)	(−0.47)	(−0.89)	(−0.05)
Adjusted *R*-square	0.2936	0.0161	0.3547	0.0933	0.0536	0.0444

Variables	*Panel C: Cumulative malmquist indices before conversion*			*Panel D: Cumulative malmquist indices after conversion*		
	Efficiency change	*Technical change*	*Total productivity*	*Efficiency change*	*Technical change*	*Total productivity*
Constant	0.9997***	0.9714***	1.0115***	1.0182***	1.0771***	0.9936***
	(34.95)	(23.84)	(15.15)	(38.97)	(14.86)	(6.72)
Demutualization (DEMU)	0.0102	0.0372***	0.0466**	0.0101	−0.0238	0.0899*
	(1.07)	(2.73)	(2.09)	(1.17)	(−0.99)	(1.84)
Natural log of total assets (NA)	−0.0015	0.0024	−0.0003	−0.0010	−0.0016	0.0052
	(−0.94)	(1.05)	(−0.08)	(−0.70)	(−0.38)	(0.62)
Herfindahl index (HI)	0.0272**	−0.0188	−0.0038	0.0015	−0.0007	0.0135
	(2.30)	(−1.11)	(−0.14)	(0.15)	(−0.02)	(0.23)
Per cent of premiums in long-tail lines (LP)	0.0070	0.0171	−0.0046	−0.0018	−0.0596**	−0.1032**
	(0.74)	(1.25)	(−0.21)	(−0.21)	(−2.52)	(−2.14)
Agents balances/Direct premium written (AD)	0.0513*	0.0343	0.0950	0.0106	0.1250*	0.2804**
	(1.97)	(0.92)	(1.56)	(0.45)	(1.90)	(2.10)
Reinsurance ratio (RE)	−0.0048	−0.0322**	−0.0400	−0.0032	−0.0291	−0.0995*
	(−0.46)	(−2.14)	(−1.63)	(−0.35)	(−1.12)	(−1.88)
Adjusted *R*-square	0.0172	0.0373	0.0071	0.0070	0.0264	0.0344

***Significant at the 1 per cent level.
**Significant at the 5 per cent level.
*Significant at the 10 per cent level.
Note: DEMU = 1 if the firm is converting insurer and 0 if the firm is mutual control insurer; Reinsurance ratio = (Reinsurance ceded)/(Direct premiums written + Reinsurance assumed). Independent variable values are for year −1. *T*-statistics are in parentheses.

DEMU variables in total productivity change model is statistically positive after conversion, implying that converting insurers perform better than the mutual control group in total productivity change after the conversion. This finding is consistent with the univariate results shown in Table 4. The line of business Herfindahl index is positive in efficiency change equation, suggesting that concentrated insurers experienced larger gains in technical efficiency change before conversion. To save space, we do not provide the discussion of the control variables for the rest of analyses, but these results are available from the authors.

Since the converting insurers operate under the stock organizational structure after demutualization, we also compare the difference in the efficiency performance between converting insurers and stock control insurers after conversion. The results presented in Panels A and B of Table 9 indicate that the coefficients of the constant and the conversion dummy variable in the cost efficiency equation are significantly positive, suggesting that converting insurers outperform their stock control group before and after the conversion. This result is consistent with the finding in Panel B of Table 3. The results on cumulative technical change and total productivity in Panel C also show that converting insurers perform better than stock control insurers before conversion. However, in Panel D, there is no evidence that converting insurers improve efficiency performance relative to stock control insurers after conversion.

Regression results of the financial intermediary approach

We also conduct regression analyses to examine efficiency performance changes using the financial intermediary approach and report the results in Tables 10 and 11. The financial intermediary approach considers overall financial strength (e.g., change in policyholder surplus, the capitalization ratio, and liquidity) and profit of insurers, whereas the value-added approach focuses on underwriting performance (e.g., losses incurred).

Panel A of Table 10 shows no relationship between conversion dummy variable and efficiency performance before conversion. Panel B shows that the conversion dummy variables are positive and significant in the cost efficiency and technical efficiency models. These results are consistent with the results shown in Panel A of Table 5 of univariate analysis and indicate that converting insurers improve efficiency relative to mutual control insurers after conversion, providing support for the efficiency hypothesis.

Panels C and D of Table 10 display the regression results for the cumulative Malmquist indices before conversion and after conversion. Panel C shows that the converting insurers experience more favourable technical change than mutual control insurers before conversion. We next present the regression

results of converting insurers and stock control insurers in Table 11. There is no significant evidence that converting insurers improve efficiency performance relative to stock control insurers before or after conversion.

In summary, the overall regression results support the efficiency hypothesis. The evidence implies that the purpose of conversion is to improve financial and operational performance of the converting insurers.

Summary and conclusion

This study investigates the efficiency and productivity changes of the converting insurers before and after conversion in the U.S. property-liability industry. For robustness, we provide various DEA scores (cost efficiency, technical efficiency, and allocative efficiency scores), Malmquist indices (technical efficiency change, technical change, and total factor productivity index), and regression results of the value-added approach and the financial intermediary approach before and after conversion. Given the breadth of the analysis, a summary table is necessary. The results of univariate analysis and regression models are summarized in Table 12. Our summary table focuses on the cost efficiency score and total factor productivity index because they are the two most important measures.[12] The empirical results are discussed below.

First, we find converting insurers improve their efficiency performance relative to control insurers before conversion using both the value-added and the financial intermediary approaches. One possible reason is that the converting insurers may improve performance before conversion to receive both regulatory and policyholder approval and to maximize the existing policyholders' (stockholders after conversion) wealth.

Second, the evidence shows that converting insurers improve their efficiency performance relative to mutual and stock control insurers after the conversion using both approaches with one exception. We find that there is deterioration in total factor productivity change relative to stock control insurers using value-added approach. One possible explanation for the converting insurers' deterioration in total productivity relative to stocks is that converting insurers may need time to adjust to the stock organizational form to achieve a desired level of operation in the initial years after the conversion, and thus they do not have significant improvement in productivity growth relative to stock control insurers in the initial years after conversion. Converting insurers experience

[12] Cost efficiency can be decomposed into technical efficiency and allocative efficiency, and total factor productivity change can be decomposed into technical efficiency change and technical change. Results for the stock control insurers before conversion are not summarized because converting insurers were mutuals before conversion.

Table 9 Regression analysis using the value-added approach - stock control insurers

Variables	*Panel A: Efficiency one year before/three years before conversion*			*Panel B: Efficiency three year after conversion/ efficiency in the conversion year*		
	CE	*TE*	*AE*	*CE*	*TE*	*AE*
Constant	0.1329**	0.8546***	0.2568***	1.8361***	1.1605***	1.6481***
	(2.04)	(15.62)	(4.42)	(21.13)	(17.54)	(24.02)
Demutualization (DEMU)	0.0452*	0.0263	0.0176	0.0528*	0.0273	0.0243
	(2.26)	(1.56)	(0.98)	(1.81)	(1.23)	(1.05)
Natural log of total assets (NA)	0.0496***	0.0069**	0.0438***	−0.0386***	−0.0038	−0.0336***
	(13.40)	(2.21)	(13.26)	(−7.87)	(−1.01)	(−8.68)
Herfindahl index (HI)	−0.0415**	0.0174	−0.0516***	−0.0517**	−0.0388**	−0.0070
	(−2.15)	(1.07)	(−2.99)	(−2.04)	(−2.01)	(−0.35)
Per cent of premiums in long-tail lines (LP)	−0.0341*	−0.0210	−0.0131	−0.0424*	−0.0345*	−0.0051
	(−1.83)	(−1.34)	(−0.79)	(−1.79)	(−1.92)	(−0.27)
Agents balances/direct premium written (AD)	−0.0114	0.0532*	−0.0653**	0.0012	−0.0445	0.0536
	(−0.31)	(1.71)	(−1.98)	(0.03)	(−1.32)	(1.53)
Reinsurance ratio (RE)	−0.0186	0.0249*	−0.0433***	−0.0016	−0.0189	0.0166
	(−1.13)	(1.80)	(−2.95)	(−0.07)	(−1.13)	(0.96)
Adjusted *R*-square	0.3692	0.0188	0.3656	0.1381	0.0202	0.1458

Variables	*Panel C: Cumulative malmquist indices before conversion*			*Panel D: Cumulative malmquist indices after conversion*		
	Efficiency change	*Technical change*	*Total productivity*	*Efficiency change*	*Technical change*	*Total productivity*
Constant	0.8939***	1.1078***	0.8971***	1.1562	−4.6297	−5.3720
	(17.80)	(15.32)	(8.39)	(19.28)	(−0.65)	(−0.72)
Demutualization (DEMU)	−0.0012	0.0619***	0.0529**	0.0006	−0.1442	0.0536
	(−0.10)	(3.57)	(2.06)	(0.04)	(−0.08)	(0.03)
Natural log of total assets (NA)	0.0069**	−0.0073*	0.0082	−0.0080	0.2766	0.3379
	(2.47)	(−1.80)	(1.38)	(−2.42)	(0.70)	(0.82)
Herfindahl index (HI)	0.0163	−0.0633**	−0.0524	−0.0023	−0.6994	−0.7881
	(0.96)	(−2.58)	(−1.45)	(−0.12)	(−0.29)	(−0.32)
Per cent of premiums in long-tail lines (LP)	−0.0231	0.0614***	−0.0212	−0.0021	1.1486	0.8554
	(−1.47)	(2.71)	(−0.63)	(−0.11)	(0.52)	(0.37)
Agents balances/direct premium written (AD)	0.0229	0.0431	0.0334	0.0800	−0.0724	−0.2265
	(0.77)	(1.01)	(0.53)	(2.16)	(−0.02)	(−0.05)
Reinsurance ratio (RE)	−0.0056	−0.0318	−0.0128	−0.0360	1.6715	1.6340
	(−0.42)	(−1.64)	(−0.45)	(−2.23)	(0.87)	(0.82)
Adjusted *R*-square	0.0334	0.0974	0.0113	0.0552	0.0129	0.0119

***Significant at the 1 per cent level.
**Significant at the 5 per cent level.
*Significant at the 10 per cent level.
Note: DEMU = 1 if the firm is converting insurer and 0 if the firm is stock control insurer; Reinsurance ratio = (Reinsurance ceded)/(Direct premiums written + Reinsurance assumed). Independent variable values are for year −1. *T*-statistics are in parentheses.

Table 10 Regression analysis of the property-liability conversion using the financial intermediary approach - mutual control insurers

Variables	*Panel A: Efficiency one year before/three years before conversion*			*Panel B: Efficiency three year after conversion/ efficiency in the conversion year*		
	CE	*TE*	*AE*	*CE*	*TE*	*AE*
Constant	0.4537***	1.1408***	0.2886*	1.0529***	1.6263***	0.2365**
	(2.72)	(30.75)	(1.86)	(10.24)	(28.66)	(2.03)
Demutualization (DEMU)	−0.0370	−0.0031	−0.0363	0.0689*	0.0592***	−0.0177
	(−0.56)	(−0.21)	(−0.59)	(1.83)	(2.84)	(−0.41)
Natural log of total assets (NA)	0.0235**	−0.0077***	0.0339***	−0.0012	−0.0430***	0.0550***
	(2.46)	(−3.61)	(3.81)	(−0.20)	(−13.36)	(8.31)
Herfindahl index (HI)	0.2439***	−0.0057	0.2294***	0.0153	0.0884***	−0.1060**
	(3.34)	(−0.35)	(3.38)	(0.37)	(3.82)	(−2.23)
Per cent of premiums in long-tail lines (LP)	0.1114*	0.0234*	0.0687	−0.0765**	0.0243	−0.1130***
	(1.87)	(1.77)	(1.24)	(−2.31)	(1.33)	(−3.01)
Agents balances/direct premium written (AD)	−0.1624	−0.0094	−0.1447	0.1029	0.1162**	−0.0139
	(−1.01)	(−0.26)	(−0.97)	(1.16)	(2.37)	(−0.14)
Reinsurance ratio (RE)	0.2052***	−0.0217	0.2261***	0.0338	0.0318*	−0.0046
	(3.46)	(−1.65)	(4.10)	(0.97)	(1.66)	(−0.12)
Adjusted *R*-square	0.0499	0.0203	0.0665	0.0092	0.3481	0.1632

Variables	*Panel C: Cumulative malmquist indices before conversion*			*Panel D: Cumulative malmquist indices after conversion*		
	Efficiency change	*Technical change*	*Total productivity*	*Efficiency change*	*Technical change*	*Total productivity*
Constant	1.0442***	0.9311***	1.0234***	1.1961***	0.3228***	0.8604***
	(21.60)	(54.77)	(20.17)	(18.80)	(4.45)	(8.63)
Demutualization (DEMU)	−0.0100	0.0111*	0.0205	−0.0203	−0.0061	0.0159
	(−0.62)	(1.95)	(1.21)	(−0.96)	(−0.26)	(0.48)
Natural log of total assets (NA)	−0.0046*	0.0058***	−0.0022	−0.0123***	0.0397***	0.0036
	(−1.69)	(6.05)	(−0.76)	(−3.40)	(9.66)	(0.63)
Herfindahl index (HI)	0.0481**	−0.0478***	−0.0093	0.0801***	−0.0731**	0.0045
	(2.40)	(−6.77)	(−0.44)	(3.12)	(−2.49)	(0.11)
Per cent of premiums in long-tail lines (LP)	0.0098	0.0051	0.0265	0.0358*	−0.0238	0.0284
	(0.61)	(0.89)	(1.56)	(1.72)	(−1.00)	(0.87)
Agents balances/direct premium written (AD)	−0.0104	−0.0015	−0.0235	−0.0169	0.2376***	0.3788***
	(−0.24)	(−0.10)	(−0.51)	(−0.29)	(3.62)	(4.20)
Reinsurance ratio (RE)	−0.0229	−0.0059	−0.0352*	0.0084	−0.0312	0.0117
	(−1.28)	(−0.94)	(−1.88)	(0.37)	(−1.20)	(0.33)
Adjusted *R*-square	0.0243	0.2775	0.0031	0.0701	0.3554	0.0597

***Significant at the 1 per cent level.
**Significant at the 5 per cent level.
*Significant at the 10 per cent level.
Note: DEMU = 1 if the firm is converting insurer and 0 if the firm is mutual control insurer; Reinsurance ratio = (Reinsurance ceded)/(Direct premiums written + Reinsurance assumed). Independent variable values are for year −1. *T*-statistics are in parentheses.

Table 11 Regression analysis of the property-liability conversion using the financial intermediary approach - stock control insurers

Variables	*Panel A: Efficiency one year before/three years before conversion*			*Panel B: Efficiency three year after conversion/ Efficiency in the conversion year*		
	CE	*TE*	*AE*	*CE*	*TE*	*AE*
Constant	1.1447***	1.8744***	0.1107	−0.1500	0.0927	0.8283**
	(5.07)	(32.26)	(0.46)	(−0.33)	(0.93)	(2.08)
Demutualization (DEMU)	0.0065	0.0263	−0.0207	0.1606	0.0183	0.1136
	(0.09)	(1.47)	(−0.28)	(1.04)	(0.55)	(0.85)
Natural log of total assets (NA)	−0.0158	−0.0584***	0.0516***	0.0944***	0.0612***	0.0258
	(−1.23)	(−17.70)	(3.78)	(3.66)	(10.90)	(1.14)
Herfindahl index (HI)	0.1458**	0.0815***	0.0659	−0.0232	−0.1338***	0.1421
	(2.18)	(4.73)	(0.92)	(−0.17)	(−4.61)	(1.22)
Per cent of premiums in long-tail lines (LP)	−0.1327**	0.0344**	−0.1583**	0.0221	0.0371	−0.0232
	(−2.06)	(2.08)	(−2.31)	(0.18)	(1.37)	(−0.21)
Agents balances/Direct premium written (AD)	0.0113	0.0735**	−0.0366	0.2032	−0.0148	0.2426
	(0.09)	(2.23)	(−0.27)	(0.87)	(−0.29)	(1.19)
Reinsurance ratio (RE)	0.1845***	0.0190	0.1701***	−0.0617	−0.0577**	0.0367
	(3.24)	1.8744	(2.80)	(−0.53)	(−2.29)	(0.36)
Adjusted *R*-square	0.0303	0.5207	0.0461	0.0309	0.2920	0.0111

Variables	*Panel C: Cumulative malmquist indices before conversion*			*Panel D: Cumulative malmquist indices after conversion*		
	Efficiency change	*Technical change*	*Total productivity*	*Efficiency change*	*Technical change*	*Total productivity*
Constant	1.2814***	0.6596***	0.9783***	1.1885***	0.8983***	1.0719***
	(16.28)	(7.03)	(4.52)	(13.42)	(11.76)	(8.11)
Demutualization (DEMU)	−0.0001	0.0134	0.0515	0.0047	0.0003	0.0055
	(−0.01)	(0.59)	(0.99)	(0.22)	(0.01)	(0.17)
Natural log of total assets (NA)	−0.0175***	0.0229***	0.0016	−0.0141***	0.0068	−0.0056
	(−4.02)	(4.40)	(0.13)	(−2.87)	(1.61)	(−0.77)
Herfindahl index (HI)	−0.0161	0.0186	−0.0045	0.0502*	−0.0415	0.0212
	(−0.61)	(0.59)	(−0.06)	(1.70)	(−1.64)	(0.48)
Per cent of premiums in long-tail lines (LP)	0.0275	−0.0253	0.0051	−0.0192	0.0678***	0.0480
	(1.13)	(−0.87)	(0.08)	(−0.70)	(2.90)	(1.18)
Agents balances/direct premium written (AD)	0.0333	−0.0380	−0.1024	0.0996*	−0.0256	−0.0863
	(0.68)	(−0.65)	(−0.77)	(1.82)	(−0.54)	(−1.06)
Reinsurance ratio (RE)	−0.0347	−0.0036	−0.0406	0.0108	−0.0190	−0.0536
	(−1.64)	(−0.14)	(−0.70)	(0.45)	(−0.93)	(−1.51)
Adjusted *R*-square	0.0566	0.0662	0.0124	0.0389	0.0430	0.0282

***Significant at the 1 per cent level.
**Significant at the 5 per cent level.
*Significant at the 10 per cent level.
Note: DEMU = 1 if the firm is converting insurer and 0 if the firm is stock control insurer; Reinsurance ratio = (Reinsurance ceded)/(Direct premiums written + Reinsurance assumed). Independent variable values are for year −1. *T*-statistics are in the parenthesis.

Table 12 Summary of empirical results

	Before conversion		*After conversion*			
	Mutual control insurers		*Mutual control insurers*		*Stock control insurers*	
	CE	*TFPC*	*CE*	*TFPC*	*CE*	*TFPC*
Panel A: Results of DEA scores and malmquist indices						
Value-added approach	+	+	+	+	+	–
Financial intermediary approach	+	+	+	+	+	+

	Mutual control insurers		*Mutual control insurers*		*Stock control insurers*	
	CE	*TFPC*	*CE*	*TFPC*	*CE*	*TFPC*
Panel B: Results of regression analysis						
Value-added approach	+	+	●	+	+	●
Financial intermediary approach	●	●	+	●	●	●

+Positive and significant at the 10 per cent level or less.
–Negative and significant at the 10 per cent level or less.
●Not significant.
This table provides a summary of empirical results for Table 3 through Table 11. CE is cost efficiency scores and TFPC is total factor productivity change.

larger gains in cost efficiency after conversion, supporting the efficiency hypothesis developed by Mayers and Smith (1986).

It should be noted that the regression results examine whether the converting insurers outperform control insurers, whereas the DEA scores and Malmquist indices examine whether converting insurers improve their performance. Thus, we should give more weight to the DEA scores and Malmquist indices when we examine the efficiency hypothesis. Panel B of Table 12 shows the summarized regression results which examine whether the converting insurers outperform or underperform the control insurers. Again, we only summarize the results of models where the dependent variables are cost efficiency and total factor productivity index. The evidence shows that the converting insurers improve cost efficiency and total factor productivity growth relative to control mutual insurers before conversion when value-added approach is used. In addition, there is some evidence that converting insurers experience cost efficiency improvement and total factor productivity growth relative to control insures after conversion.

Overall, based on all of the evidence, the results generally support the efficiency hypothesis proposed by Mayers and Smith (1986). The evidence

implies that the purpose of conversion is to improve financial and operational performance of the converting insurer. We believe the empirical results shed additional light on the efficiency hypothesis.

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Appendix

Table A1 Converting property-liability insurers

Company name	*Demutualization year*
Minnesota Mutual Fire &Casualty Co.	1993
Union Automobile Indemnity Association	1993
Pioneer Mutual Insurance Co.	1993
Delaware Mutual Insurance Co.	1994
Georgia Mutual Insurance Co.	1994
Union Mutual Insurance Co. of Providence	1994
Mutual Fire Insurance Co. of Saco	1995
Interstate Bankers Mutual Casualty Co.	1995
Farm Family Mutual Insurance Co.	1996
Preferred Physicians Mutual RRG	1996
Allegheny Mutual Casualty Co.	1997
Goschenhoppen-Home Mutual Insurance Co.	1997
National Chiropractic Mutual Insurance Co.	1997
Old Guard Mutual Fire Insurance Co.	1997
Patrons Oxford Mutual Insurance Co.	1997
Old Guard Mutual Insurance Co.	1997
Southern Michigan Mutual Insurance Co.	1998
FCCI Mutual Insurance Co.	1998