Research on the improvement of technical efficiency of China's property insurance industry: a fuzzy-set qualitative comparative analysis

Received 27 January 2020
Revised 10 April 2020
Accepted 19 May 2020

Zhiguang Li, Yaokuang Li and Dan Long
School of Management, Hefei University of Technology, Hefei, China

Abstract

Purpose – From the perspective of cause and effect, the operational processes of property insurance companies can be considered as historical events. The purpose of this study is to measure the operating efficiency of China's property insurance industry, explore the determinants that affect technical efficiency and outline the path to achieving high-quality development.

Design/methodology/approach – We chose 44 Chinese property insurance companies as research objects. The data were obtained from the Chinese Insurance Yearbook and China Statistical Yearbook 2015–2017. First, the data envelopment analysis (DEA) method was used to calculate the technical efficiency of property insurance companies. Then, Tobit regression and quantile regression were adopted to explore the influencing factors of technical efficiency. Finally, the fuzzy-set qualitative comparative analysis (fsQCA) method was employed to summarize the path to improving the operating efficiency of property insurance companies.

Findings – The empirical results in the first stage suggested that the operation efficiency of China's property insurance industry was technically inefficient, and the scale efficiency was relatively better than the pure technical efficiency. In the second stage, we observed that the drivers for firm size, reinsurance rate, claim ratio and equity restriction were important determinants of an insurance firm's efficiency.

Research limitations/implications – We also put forward four applicable, targeted and proven ways to improve the technical efficiency of property insurance companies. These configurations are verified by cases of existing property insurance companies, which can provide practical references for the insurance industry.

Originality/value – Our research enriches the insurance literature and efficiency methods, particularly regarding the specific paths of improving the technical efficiency. The relationship between elements and results is analyzed from a systematic perspective, and the research results are not only more consistent with what logic might imply but also more instructive for the improvement of reality.

Keywords Insurance, DEA, fsQCA, Efficiency, Configuration

Paper type Research paper

1. Introduction

Since China reintroduced its insurance business in 1979, the property insurance industry has made great progress. According to gross written premium income, the premium written in the Chinese property insurance industry increased from 38.323 billion RMB in 1997 to 983.466 billion RMB in 2017, increasing by 25.66 times in 20 years. Therefore, insurance market activity in China, both as a financial intermediary and as a provider of risk transfer and indemnification, has a positive and significant causal effect on economic growth (Arena, 2008). Although the development of Chinese property insurance companies has led to remarkable achievements, the operating efficiency of property insurance companies is low and weak competitiveness is also an indisputable fact (Shujie *et al.*, 2007). With the gradual opening of China's insurance market and the investment of foreign property insurance companies, China's property insurance industry has encountered unprecedented challenges, among which the urgent problem to be solved is how to improve its operating efficiency and

International Journal of Emerging Markets

1746-8809
DOI 10.1108/IJOEM-01-2020-0091

competitiveness. In addition, significant changes have taken place in the external environment faced by commercial insurance companies because of the continuous strengthening of governance standards for insurance companies by the state. These changes include the introduction of the new Value-Added Tax (VAT) program, the merger of the China Banking Regulatory Commission (CBRC) and the China Insurance Regulatory Commission (CIRC), and uncertainty in the international business environment. Therefore, the operating efficiency of Chinese domestic property insurance companies needs to be further verified.

What we know about efficiency measurement is largely based upon empirical studies that investigate the determinants affecting the firm performance in the insurance industry (e.g. Fried *et al.*, 2002; Cummins *et al.*, 2004; Choi and Weiss, 2005; Kao and Hwang, 2008; Huang *et al.*, 2011; Biener *et al.*, 2016; Li *et al.*, 2017; Mazviona *et al.*, 2017). It is noteworthy, however, that the current literature on insurance companies still lacks a systematic and integrated approach to analyze the influences of the external institutional environment and the internal structure of the organization on the operating efficiency, and explain the internal logic and path for the enterprises to achieve the high technical efficiency from the perspective of configuration. In this paper, the data envelopment analysis (DEA) is used to measure the technical efficiency of 44 Chinese property insurance companies from 2015 to 2017, and fuzzy-set qualitative comparative analysis (fsQCA) is used to summarize the paths for improving the technical efficiency. This paper aims to reveal the internal mechanism of the efficient operation of Chinese property insurance companies and provide empirical and theoretical evidence for the causal complexity.

This paper makes three main contributions to the literature. First, to our knowledge, this is the first study that focuses on technical efficiency improvement in Chinese property and casualty insurance companies by using fsQCA. Our paper thus enriches the insurance literature and efficiency methods, particularly the specific paths of improving the technical efficiency. Second, the relationship between elements and results is analyzed from a systematic perspective, and the QCA considers that there can be multiple configurations to achieve the results. In this way, our research results are not only more consistent with what logic might imply but also more instructive for improving the insurance industry. Third, QCA focuses on the asymmetric causal relationship between cause and effect and breaks through the limitation of symmetric thinking based on correlation coefficient in traditional quantitative research.

This article continues with Section 2, which presents the relevant insurance literature on efficiency research. In Section 3, we discuss the methodology and data. Section 4 exhibits the empirical analysis on the operating efficiency of Chinese property insurance companies and Section 5 will examine the determinants that affect technical efficiency. In Section 6, we conduct a fsQCA to explore the configurations of technical efficiency improvement. Conclusions and discussions are presented in Section 7.

2. Literature review

Efficiency can be defined as the extent to which a decision-making unit (DMU) can increase its outputs without increasing its inputs or reduce its inputs without reducing its outputs (Charnes *et al.*, 1978). Recently in the insurance sector, efficiency measurement of insurance firms has attracted great interest from investors, financial market analysts, insurance regulators and researchers alike (Kaffash *et al.*, 2019). The existing literature on efficiency measurement in the insurance industry is extensive and focuses particularly on the application and improvement of efficiency evaluation for DMUs with DEA model.

Firstly, measurement and evaluation of insurance efficiency based on traditional DEA. Cummins *et al.* (2010) estimated cost, revenue and profit efficiency using the DEA method and investigated economies of scope in the US insurance industry from 1993 to 2006. They found that property-liability insurers realized cost economies of scope, but these advantages were more than offset by revenue diseconomies of scope. Life-health insurers, however, realized both cost and revenue diseconomies of scope. Mandal and Dastidar (2014) carried out an efficiency analysis of the Indian general insurance sector using DEA. Findings clearly indicated that the global economic slowdown had severely affected the performance of companies in the private sector, while companies in the public sector exhibited relatively fewer variations in performance levels. Similarly, Zimková (2014) analyzed the technical efficiency and the super-efficiency of Slovakian insurance companies using DEA and found that the insurance institutions with the poorest performances should change their managerial procedures and adopt an enhanced-incentive policy. Alternatively, some cross-country comparisons of efficiency in the insurance industry with traditional DEA also provide valuable insights into the competitiveness of insurers in different countries. For example, Donni and Fecher (1997) measured the technical efficiency levels in 15 OECD insurance industries from 1983 to 1991, and decomposed productivity changes into technical progress and efficiency variations. Results showed that the growth in the productivity observed in all countries was attributable to improvements in technology. Leverty *et al.* (2009) provided new information on the impact of the entry of foreign firms on the financial services industry by examining the Chinese insurance industry during China's accession to the World Trade Organization (WTO). They observed a structural improvement in efficiency after WTO accession. However, geographic and product market restrictions placed on foreign firms reduce these positive effects. Eling and Luhnen (2010) provided new empirical evidence on frontier efficiency measurement in a broad efficiency comparison of 6,462 insurers from 36 countries. They found a steady technical and cost-efficiency growth in international insurance markets from 2002 to 2006, with large differences across countries. Cummins *et al.* (2017) provided evidence from multiple countries on the association between soundness and competition in the life insurance industry. They analyzed ten life insurance markets in the European Union over the post-deregulation period of 1999–2011. The results indicated that competition increased the soundness of EU life insurance markets. Results suggested that efficiency was the mechanism through which competition contributes to insurer solvency. The soundness enhancing effect of competition was greater for weak insurers than for healthy ones.

Secondly, insurance company organizational structures and corporate governance on the efficiency with DEA or stochastic frontier analysis (SFA). Hao and Chou (2005) employed the distribution-free approach (DFA) to estimate the inefficiency of 26 life insurance companies from 1977 to 1999. Results showed that efficiency related to a firm's percentage of market share, product diversification strategy and scale efficiency. Huang *et al.* (2011) examined the relationship between corporate governance and the efficiency of the US property-liability insurance industry from 2000 to 2007. They found a significant correlation between efficiency and corporate governance. Ansah-Adu *et al.* (2012) evaluated the efficiency of insurance companies in Ghana using a two-stage procedure to determine if insurance companies were cost-efficient and to examine their efficiency determinants. The empirical results in the first stage suggested higher average efficiency scores for life insurance business compared to non-life insurance companies. In the second stage, they observed that the drive for market share, firm size and the ratio of equity to total invested assets are important determinants of an insurance firm's efficiency. In a similar vein, Ilyas and Rajasekaran (2019) also employed a two-stage Bootstrap-DEA to estimate the performance of the Indian non-life (general) insurance sector in terms of efficiency, productivity. The results showed that the Indian non-life insurance sector was moderately technical, scale, cost and allocative efficient and the public insurers were more cost-efficient than the private insurers. Moreover, the truncated regression results revealed that size and reinsurance had a statistically significant negative relationship with efficiency. In Alhassan and Biekpe (2016), the SFA technique was used to estimate both the cost and profit efficiency of 80 non-life insurers in South Africa over the period 2007–2012. Their findings indicated high levels of efficiency in cost and low levels in profit. On average, costs were about 20% over the estimated cost frontier while insurers earned 45.71% of their optimum profits. Biener *et al.* (2016) studied the efficiency and productivity of Swiss insurance companies in the life, P&C and reinsurance sectors from 1997 to 2013. They found that productivity and efficiency had improved with regard to P&C and reinsurance. The organizational form had an impact on the success of life and P&C insurers, and high debt ratios were detrimental to insurer efficiency. Eling and Schaper (2017) applied multi-stage DEA to identify the impact of the changing environment on the productivity and efficiency of 970 life insurance companies from 14 European countries. Results showed that the general economic, capital market and insurance market conditions were important drivers of efficiency.

Thirdly, the improvement and application of DEA model. In conventional DEA analysis, DMUs are generally treated as a black-box as internal structures are ignored, and the performance of a DMU is assumed to be a function of a set of chosen inputs and outputs. For example, insurance companies obtain premiums at the underwriting stage, and the premiums enter the investment stage as an intermediate variable again. In this case, Fare and Grosskopf (2000) proposed the Network DEA method, where a network consists of sub-technologies. The general structure of the network model allows us to apply it to a variety of situations, including intermediate products, allocation of budgets or fixed factors and certain dynamic systems (Kao and Hwang, 2008; Lim and Zhu, 2016; Tone and Tsutsui, 2017; Fukuyama and Matousek, 2017; Li *et al.*, 2018a, b). Additionally, Tone (2001) proposed a slacks-based measure (SBM) of efficiency in DEA, which dealt directly with the input excesses and the output shortfalls of the DMU concerned. After that, Tone and Tsutsui (2009) put forward a slacks-based network DEA model, called Network SBM, that can deal with problems involving the radial model, such as the network DEA overestimating an enterprise's efficiency when inputs were redundant or outputs were insufficient (e.g. Shermeh *et al.*, 2016; Li *et al.*, 2018a, b; Sánchez-González *et al.*, 2017). Fried *et al.* (2002) further proposed a new technique for incorporating environmental effects and statistical noise into a producer performance evaluation based on DEA. Throughout the analysis, the emphasis is placed on slacks, instead of radial efficiency scores, as appropriate measures of producer performance. Kao and Hwang (2014) investigated the effects of the operations of individual periods on the overall performance of a DMU with a two-stage structure in the specified period of time. The aggregate model developed by Kao and Hwang (2008) was extended to incorporate the variations in individual periods. This model can not only measure different kinds of efficiencies but also calculate a common-weight global MPI. Recently, Anandarao *et al.* (2019) proposed a two-stage relational DEA model that identified the inefficient stage of the process, where multiple stages were involved and helped the DMU to concentrate on that stage to improve efficiency. However, considering the different frontiers faced by DMU every year (i.e. for the most efficient DMU) the data obtained by calculating efficiency year-by-year are not comparable in different years. Some studies demonstrate a method in which the Malmquist index can be adopted to analyze panel data and propose a dynamic DEA model. For example, Cummins and Xie (2008) analyzed the productivity and efficiency effects of mergers and acquisitions in the US property-liability insurance industry during the period 1994–2003 using the DEA and Malmquist productivity indices. The results provided evidence that mergers and acquisitions in property-liability insurance were value-enhancing. Yao *et al.* (2007) used a panel data set of

22 firms from 1999 to 2004 to evaluate their efficiency scores. They applied a DEA approach and decomposed the productivity growth into technical efficiency improvement and technological progress by constructing a Malmquist Index. They found that firm size, ownership structure, mode of business and human capital were important factors affecting firm performance. Chen *et al.* (2014) investigated changes in productivity of general insurance firms in Malaysia for the period from 2008 to 2011. Moreover, this study found VAIC^{TM}, human capital, structural capital and financial capital and its individual components had significantly positive impacts on changes in productivity.

In summary, much of the available efficiency literature insurance company deals with the question of the firm's measurement and evaluation, improvement and application of DEA. But prior studies have not been able to account for some aspects of the mechanisms and improvements that lead to high technical efficiency. Our study is different from previous studies in the following aspects. Firstly, this study tracks the operating efficiency of Chinese property insurance companies and explores the latest development trends of China's property insurance industry. We also propose combining DEA with quantile regression to further analyze the influencing factors of technical efficiency under different quantiles, so it enriches the literature on insurance efficiency research. Secondly, based on the perspective of cause and effect, this study is the first to use the fsQCA method to reveal the configuration that improves the efficiency of enterprises. This breaks from the traditional regression method used in this field. Finally, we summarize the commonalities between similar cases and propose an operational path to improve the technical efficiency of property insurance companies. This provides significant value for the operation of real-world enterprises.

3. Data and methods

3.1 Data envelopment analysis

DEA is a nonlinear programming model introduced by Charnes, Cooper and Rhodes in 1978, based on the work of Farrell in 1957 (Kaffash and Marra, 2017). When evaluating the relative efficiency of a DMU, analysis can be divided into an input-oriented method and an output-oriented method, according to different assumptions. In this paper, the DEA method is selected to measure the operating efficiency of 44 Chinese property insurance companies. For property insurance companies, production factors are easier to control, so we choose the input-oriented model in the DEA method to measure whether Chinese domestic and foreign invested property insurance companies can achieve linear programming with minimal input under the condition of fixed output. According to the basic principles of DEA, the model set in this paper is as follows.

Let's suppose the number of property insurance companies is n, and every company has a type of inputs and b type of outputs. The a-dimensional vector X_i and b-dimensional vector Y_i represent, respectively, the input and output of the i-th property insurance company. On the basis of relative efficiency, the slack variable S^+, the residual variable S^- and non-Archimedean infinitesimal ε are introduced. The CCR model of a property insurance company based on the constant return to scale is as follows.

$$\min\left[\theta - \varepsilon\left(e_1^T S^- + e^t T_2 S^+\right)\right] = V_{TE}$$

subject to

$$\begin{aligned} \sum_{i=1}^{n} X_i\lambda_i + S^- &= \theta_p X_0 \\ \sum_{i=1}^{n} X_i\lambda_i - S^+ &= Y_0 \end{aligned} \tag{1}$$

where $\lambda_i \geqq 0, i = 1, 2, \ldots, n; S^+ \geqq 0, S^- \geqq 0$. In equation (1), V_{TE} represents technical efficiency; X_0 and Y_0 represent, respectively, the input vector and output vector of the property insurance company i_O. The V_{TE} obtained by solving the linear programming is the total operating efficiency. If $V_{TE} = 1$, the company is generally efficient; If $V_{TE} < 1$, the operation of the company is inefficient.

In order to further explore whether the overall operating inefficiency of a property insurance company is caused by pure technical inefficiency or scale inefficiency, we add a constraint condition to the CRS model and obtain the VRS model based on the assumption of variable returns to scale.

$$\min\left[\theta_c - \varepsilon\left(e_1^T S^- + e_1^t S^- + e_2^T S^+\right)\right] = V_{PTE}$$

subject to

$$\begin{aligned} &\sum_{i=1}^{n} X_i \lambda_i - S^- = \theta_p X_0 \\ &\sum_{i=1}^{n} Y_i \lambda_i - S^+ = Y_0 \\ &\sum_{i=1}^{n} \lambda_i = 1 \end{aligned} \tag{2}$$

where $\lambda_i \geqq 0, i = 1, 2, \ldots, n; S^+ \geqq 0, S^- \geqq 0$. In equation (2), V_{PTE} represents pure technical inefficiency, and technical efficiency is equal to pure technical efficiency times scale efficiency. Therefore, scale efficiency is equal to technical efficiency divided by pure technical efficiency.

3.2 Variables selection: inputs and outputs

A critical issue in conducting the efficiency analysis is defining which variables can be considered inputs and which variables can be considered outputs. To our knowledge, there are two representative viewpoints, namely, insurance companies as manufacturers and insurance companies as financial intermediaries. Cummins and Weiss (1993) argued that insurance companies, as manufacturers, should take incurred claims for the final product, while capital, labor, premium income and investment income should be considered inputs. However, Berger and Humahrey (1997) insisted that an insurance company was a financial intermediary, and inputs were capital, labor and management expenses, while outputs were premium written and investment income.

Given the availability of the data and existing literature reviews, we select the number of employees (Cummins *et al.*, 2004; Cummins and Rubio-Misas, 2006; Eling and Luhnen, 2010; Huang and Eling, 2013), financial capital (Cummins *et al.*, 2010) and management expenses (Nourani *et al.*, 2017) as input variables, while premiums earned (Wanke and Barros, 2016), investment income (Al-Amri *et al.*, 2012) and incurred claims (Leverty *et al.*, 2009; Mandal and Ghosh Dastidar, 2014) are chosen as output variables. Descriptive statistics of input–output variables from 2015 to 2017 are shown in Table 1. All materials and data are derived from the *Chinese Insurance Yearbook* and *China Statistical Yearbook 2015–2017*.

4. Empirical analysis

In this paper, deap2.1 is selected for input–output efficiency analysis, and the traditional CCR model (CRS) and BCC model (VRS) are used to calculate the technical efficiency, pure technical efficiency and scale efficiency of Chinese property insurance companies.

	Variables	Observations	Mean	Std. Dev.	Minimum	Maximum
Inputs	Number of employees	132	11534.46	32893.26	32.00	180078.00
	Financial capital (mil CNY)	132	5392.19	7553.62	200.00	33814.06
	Management expenses (mil CNY)	132	4020.26	9577.24	13.80	55014.96
Outputs	Premiums earned (mil CNY)	132	17659.96	48229.38	−5.44	309735.99
	Investment income (mil CNY)	132	1566.57	3946.92	0.19	21196.34
	Incurred claims (mil CNY)	132	10829.17	30377.90	0.00	199753.43

Note(s): Definitions of input and output variables are as follows. Input variables: (i) labor is the total number of employees; (ii) management expenses are the operating expenses incurred by business services such as legal fees, travel, communications and materials; (iii) financial capital is the sum of share capital and capital reserve. Output variables: (i) premiums earned are the difference among premium income, reinsurance premium and unearned premium reserve; (ii) investment incomes are the benefits from the total financial investments; (iii) incurred claims are the sum of losses/claims paid and funds received by general insurers

Table 1. Summary statistics for inputs and outputs

4.1 Technical efficiency

Technical efficiency is an important index reflecting the comprehensive ability of Chinese property insurance companies in resource allocation and resource utilization. Table A1 shows that the technical efficiency of China's property insurance industry from 2015 to 2017 was 0.609, 0.67 and 0.708 respectively. Obviously, technical efficiency is a rising trend, but the technical efficiency score is still far less than 1, indicating that the operational efficiency has not been optimized and there is a large amount of resource waste. Specifically, five companies have maintained a technical efficiency of 1, accounting for 11.36%. These companies are PICCPIC, CPPIC, TAPIC, GYAIC and CNPCIC. There are also 17 companies whose technical efficiency has been on the rise. Among these 17, the companies that have made the most progress are TKIC, YZPIC and ZYAIC. This is because they are newly established, and their business models and management technology are relatively advanced. However, there is still one company, CPIC, whose technical efficiency has been declining constantly. This is because the company's commission expenses, business and management fees are all rising, and commercial vehicle insurance and personal accident insurance underwriting have suffered substantial losses.

4.2 Pure technical efficiency

Pure technical efficiency is related to the managers' capability to use a property insurance company's given resources. The results in Table A1 (Appendix) reveal that property insurance companies in China are pure technically inefficient with average efficiency scores of 0.678, 0.736 and 0.762 during the period 2015–2017. This result implies that the average property insurance company suffered a 32.2%, 26.4% and 23.8% level of technical inefficiency, and management and technology need to be constantly optimized. However, the pure technical efficiency score increased from 2015 to 2017, implying that the managerial efficiency of the property insurance industry improved during that period. Based on the results in Table A1, PICCPIC, CPPIC, TAPIC, SAMIC, GYAIC, UPIC and CNPCIC attained a pure efficiency of one from 2015 to 2017, accounting for 15.91%. Besides, the pure technical efficiency of the 17 companies had an upward trend, among which HHPIC, YZPIC and ZYAIC made the most progress, with pure technical efficiency increasing by nearly 50%. This is because they have made personnel adjustments to upgrade management skills. However, the pure technical efficiency of CPIC has been declining, which further worsens its technical efficiency.

4.3 Scale efficiency

Scale efficiency is related to exploiting scale economies by operating at constant returns to scale. Table A1 (Appendix) illustrates that the scale efficiency of China's property insurance industry is 0.906, 0.908 and 0.931, respectively, between 2015 and 2017. Compared with pure technical efficiency, improving scale efficiency should be the primary focus of most enterprises. It is also the bottleneck that enterprises will need to break through in the future. Obviously, the scale efficiency of China's property insurance industry is increasing year by year, all exceeding 0.9. However, the returns to scale have not yet been realized, and the production structure needs to be further optimized. Five companies (accounting for 11.36%) have maintained scale efficiency. These include PICCPIC, CPPIC, TAPIC, GYAIC and CNPCIC.

Additionally, another five companies have notably improved their scale efficiency, among which TKIC has seen the fastest development. This is because the company is an Internet insurance company. By using Internet technology, TKIC succeeded in rapidly seizing the online insurance market and realized cross-border integration of Internet and insurance. In addition, the data in Table 2 demonstrate that after 2016, the scale efficiency of some property insurance companies began to decline, and the proportion of enterprises with diminishing returns to scale increased from 13.64% to 31.82%, leading to the shift of China's property insurance industry from capital-intensive to technology-intensive.

As shown in the left side of Figure 1, we conducted statistical analysis on the technical efficiency and pure technical efficiency of 44 companies from 2015 to 2017. Our findings show that the distribution of the business performance of property insurance companies in China was differentiated and generally normal. The horizontal axis on the right side of Figure 1 represents the pure technical efficiency (PTE), while the vertical axis represents the scale efficiency (SE). The reference lines to differentiate more and less efficient insurance companies are set to the mean values of the PTE (0.92) and the SE (0.70), respectively. Accordingly, insurers are classified into four groups, in areas I, II, III, and IV on the right side of Figure 1. We summarize the performance analysis as follows.

Fifteen companies, including PICCPIC, CPPIC, TAPIC, belong to region I. This indicates that their operating efficiency is relatively high. Seventeen companies, including CCPIC, HTPIC and ACPIC, fall in region II, meaning, the pure technical efficiency of these enterprises is relatively low, and management capacity and technical level still need to be strengthened. Nine companies, including ZLPIC, YZPIC and HBPIC, are in region III, indicating that resource inputs and management have a serious impact on their operating efficiency. There are only three companies in region IV. For these companies, operating efficiency is significantly affected by the level of management and technology. In addition, AHPIC, UTIC and JTPIC are located at the boundary of the reference lines and risk falling into region III under poor management. Therefore, there is still plenty of room for improvement in the operational efficiency of China's property insurance industry.

5. The determinants of technical efficiency of the P&C industry in China

Research on technical efficiency is only the first step. More importantly, we will further reveal the factors behind this phenomenon. Tobit regression and quantile regression are adopted to explore the influencing factors of an insurer's technical efficiency.

Table 2. Scale efficiency of Chinese property insurance companies from 2015 to 2017

Year		2015			2016			2017	
Results	drs	irs	cnst	drs	irs	cnst	drs	irs	cnst
Companies	11	25	8	6	31	7	14	22	8
Proportion	25.00%	56.82%	18.18%	13.64%	70.45%	15.91%	31.82%	50.00%	18.18%

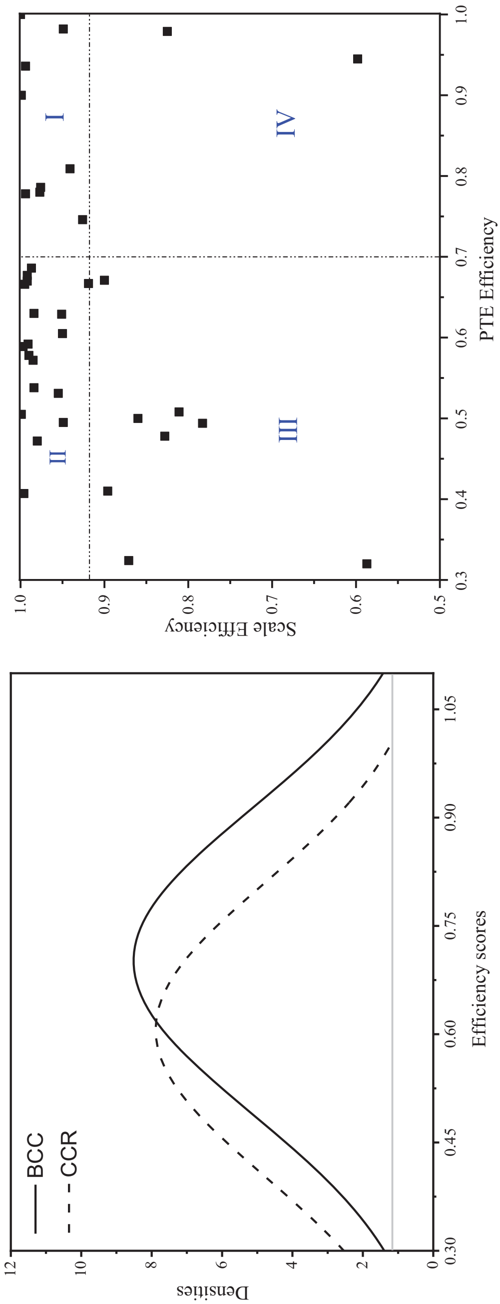

Figure 1.
Distribution of business performance (left) and efficiency scores for decision-making matrix (right)

5.1 Theoretical model and hypothesis development

Productivity can be generally defined as the value of output produced by a unit of labor or capital (Carayannis and Grigoroudis, 2014). Furthermore, higher productivity is equated with improved competitiveness (Wysokińska, 2003). Because enterprises are competitive when their productivity of labor and other production factors grow consistently, they are able to reduce the unit costs of their outputs (Biener *et al.*, 2016). Based on the theory of enterprise competitiveness, this paper constructs a model of key factors that affect the operational efficiency of Chinese property insurance companies. The details are shown in Figure 2.

Enterprise scale is the carrier of enterprise production and operation. The expansion of enterprise scale is a trend in industrial evolution and an inevitable result of competition among enterprises. The mathematical basis of the operation of insurance companies is the law of large numbers and the central limit theorem (Feng and Shimizu, 2016). If other factors remain unchanged, insurance companies with large assets will pool more risk individuals, resulting in a more stable claim ratio and relatively efficient operation. In addition, with a certain level of science and technology, enterprises can reduce long-term average costs by expanding capacity, to achieve economies of scale (Biener *et al.*, 2016).

H1. Enterprise scale is closely related to firm operating efficiency.

The occurrence of risks has the characteristic of volatility, which leads to the operation of insurance companies facing large compensation fluctuations (Gollier, 2018). However, through the amortization mechanism of reinsurance, insurers can effectively improve their operating conditions in years with sudden risks, thus dispersing risks and stabilizing operations. Reinsurance, however, means higher operating costs and lower profits for insurers, and it generates uncertainty in the operating efficiency of enterprises. Similarly, compensation expenses reflect that underwriting risks are released in advance, but will reduce operating profits, thus affecting an insurers' operating efficiency (Mazviona *et al.*, 2017).

H2. Reinsurance rate and claim ratio both have an impact on the operating efficiency of enterprises.

Market Power refers to the use of market forces by economic entities to obtain or maintain a position in the market. Market share denotes the size of market share that an insurance company commands in the sector, as measured by the percentage of a company's gross premium to the total gross premium (Ansah-Adu *et al.*, 2012). When a positive performance–market share relationship arises, firms are able to increase prices as their market power increases (Choi and Weiss, 2005). Increased prices should be reflected in higher profits, so positive signs on the market share variables are expected to improve the operating efficiency of the insurers.

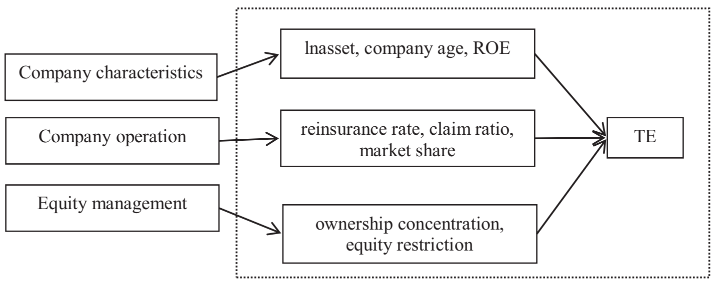

Figure 2.
The determinants of technical efficiency of the Chinese P&C industry

H3. Market share has a positive effect on the operating efficiency of enterprises.

Ownership concentration impacts corporate governance and thus corporate performance. According to the research of Balsmeier and Czarnitzki (2017) and Schmalz (2018), an increased shareholding ratio will cause major shareholders to increase the supervision of a manager's actions and incentivize good behavior, thus improving the company's performance. When company equity is relatively decentralized, free-riding among shareholders is inevitable, which leads to the lack of regulatory motivation and causes managers (agents) to optimize their own benefits at the expense of shareholders (Zhang *et al.*, 2016). If most shareholders hold similar proportions of company equity, there will be a struggle for control, impeding the normal operation of the company. In addition, the decentralized decision-making caused by the prevalence of differing opinions will reduce decision-making efficiency and increase the management costs, thus inhibiting the company's development.

H4. Ownership concentration has a positive effect on the operating efficiency of enterprises

H5. Equity restriction has a negative effect on the operating efficiency of enterprises.

5.2 Study design

Since the efficiency value is contained within [0, 1], the efficiency value can only be observed in a restricted way. If the model is directly regressed by the ordinary least square, the parameter estimation obtained will be biased and inconsistent. In order to solve such problems, we refer to Tobin's Tobit regression model. In this paper, Stata 15 was used to conduct Tobit regression for the data of 44 Chinese P&C companies from 2015 to 2017. Besides, quantile regression is used to study the factors influencing the technical efficiency, to reflect the dynamic effect of the technical efficiency of enterprises and the heterogeneous structure of the relationship between the factors and the sample distribution. The models are constructed as follows:

$$\mathrm{TE}_{i,t} = \alpha_0 + \alpha_1 \ln a_{i,t} + \alpha_2 \mathrm{ca}_{\mathrm{i,t}} + \alpha_3 roe_{i,t} + \alpha_4 \ln rr_{i,t} + \alpha_5 cr_{i,t} + \alpha_6 ms_{i,t} + \alpha_7 oc_{i,t} + \alpha_8 er_{i,t} + \varepsilon_{i,t} \tag{3}$$

where a_0 is an intercept term, i for a DMU, t for time; technical efficiency(TE) is the dependent variable; The logarithm of the total asset (lnasset), company age (ca), reinsurance rate (rr), claim ratio (cr), ROE, market share (mr), ownership concentration (oc), equity restriction (er) are independent variables.

$$Q_{TE_{i,t}}(\tau|x_{i,t}) = x^{\tau}_{i,t}\beta_{\tau} \tag{4}$$

where $Q_{TE_{i,t}}(\tau|x_{i,t})$means the τth quantile of the dependent variable TE, $x^{\tau}_{i,t}$is the vector of explanatory variables for each company i at year t for quantile τ and β_{τ} reflects the slopes of the explanatory variable for quantile τ (Allard *et al.*, 2018).

We set the ownership concentration as the percentage of ownership held by the largest shareholder (Balsmeier and Czarnitzki, 2017), and equity restriction is measured by the ratio of the percentage of shares owned by the second to the fifth-largest shareholders to the largest shareholder in a firm (Xie and Yang, 2016). Descriptive statistics are shown in Table 3.

Before examining the effect of determiners on efficiency, we first test for the presence of strong collinearity among the independent variables using the Pearson correlation matrix. From the estimated correlation coefficients, we observe that all correlation coefficients are below the multicollinearity threshold of 0.70 (Alhassan and Biekpe, 2016). The Pearson correlation matrix is presented in Table 4.

5.3 Regression results

The panel Tobit model (Liu *et al.*, 2017; Chen *et al.*, 2017) is used in this study to explore the influencing factors of technical efficiency. The results are presented in Table 5.

The regression coefficient of lnasset, reinsurance rate and claim ratio are positive, indicating that H1 and H2 are supported. When these variables increased by 1%, the technical efficiency of the enterprise increased by 0.073%, 0.004% and 0.005%, respectively. The enterprise scale was significant at the confidence level of 5%, and the reinsurance rate and loss rate were significant at the confidence level of 1%. This means that P&C insurance companies in China derive significant benefits from economies of scope and scale, and companies with a high reinsurance rate and high claim ratio are more technically efficient. This is because they reduce the uncertainty factors faced by enterprises by transferring risks and enhancing underwriting capacity, thus greatly improving the technological efficiency of the enterprise.

ROE, market share and ownership concentration are not significant in determining the technical efficiency of insurance companies in China, so H3 and H4 are not supported. However, the regression coefficient of equity restriction is negative and significant at the confidence level of 10%. When the variable increases by 1%, the technical efficiency of the enterprise decreases by 0.114%. This shows that when designing the shareholding structure, enterprises need to properly centralize power, otherwise decision-making and operation management will be inefficient, due to excessive decentralization.

Formula (4) is used to study the relationship between indicators and enterprise operation at different technical efficiency levels. Table 5 and Figure 3 show the quantile regression results. The quantile regression coefficient of lnasset and the claim ratio has a high significance below the level of 80 quantiles, while it is not significant at the level of 90 quantiles. Additionally, the regression coefficient of lnasset is relatively stable, while the regression coefficient of claim ratio shows a tendency to increase first and decrease later, from the low to the high, showing that the regression coefficient turns from positive to negative. This indicates that enterprises with a low operational level have a stronger sensitivity to the claim ratio and have a positive promoting effect, while enterprises with a high operation level have a limited restraining effect on the operating efficiency of enterprises.

The quantile regression coefficient of the reinsurance rate and market share is not significant, but the regression coefficient of both is positive. The quantile regression coefficient of the reinsurance rate increases first and then decreases, while the market share shows a declining trend. This shows that the reinsurance rate is the promotion effect of

Table 3.
Descriptive statistics of variables

Variables	Mean	Std. Dev.	Min	Max	Observations
TE	0.662	0.249	0.002	1.000	132
lnasset	8.977	1.560	5.960	13.170	132
Company age	9.841	5.640	1.000	24.000	132
Reinsurance rate (%)	9.633	9.122	0.000	50.320	132
Claim ratio (%)	47.053	15.881	0.000	100.100	132
ROE (%)	42.947	21.242	7.500	99.260	132
Market share (%)	2.150	5.854	0.000	33.500	132
Ownership concentration	0.438	0.320	0.090	1.000	132
Equity restriction	1.622	1.252	0.000	4.000	132

Table 4. The Pearson correlation matrix for listed variables

Variables	TE	lnasset	Company age	Reinsurance rate	Claim ratio	ROE	Market share	Concentration	Restriction
TE	1								
Lnasset	0.660**	1							
Company age	0.596**	0.659**	1						
Reinsurance rate	0.096	0.048	−0.077	1					
Claim ratio	0.573**	0.369**	0.537**	-0.258**	1				
ROE	-0.539**	-0.572**	-0.632**	−0.012	-0.487**	1			
Market share	0.375**	0.694**	0.275**	0.004	0.147	-0.292**	1		
Concentration	0.181*	0.346**	0.174*	0.03	−0.066	−0.152	0.357**	1	
Restriction	-0.308**	-0.332**	-0.238**	−0.05	−0.137	0.199*	-0.331**	-0.861**	1

Note(s): ***, **, and * indicate significant p values at the 1%, 5% and 10% level, respectively. Bootstrap results are based on 1000 bootstrap samples technical efficiency under a low-operating efficiency of enterprises, while the effect is weakened under a high operating level. In the results of the Tobit regression, ownership concentration has no significant influence on the operation level of enterprises. However, through quantile regression, it is discovered that ownership concentration is highly significant at the high quartile level, and its regression coefficient is positive at the low quartile level and negative at the high quartile level. This illustrates that increasing ownership concentration can improve the technical efficiency of enterprises with inefficient operation, although the effect is limited. However, excessive ownership concentration will inhibit the technical efficiency of insurers with good operation level.

In summary, the Tobit regression's conclusion is basically consistent with quantile regression, but its description of details is not as accurate as with quantile regression. This further indicates that enterprises with different characteristics have different development paths, and the sensitivity of the same variable to their influence varies. In light of this finding, we put forward the fsQCA method and outline a specific path to improving the technical efficiency of enterprises.

6. Fuzzy-set qualitative comparative analysis

fsQCA is a new research method that combines fuzzy mathematics with qualitative comparative analysis. By integrating fuzzy set and truth table analysis, the classification of case conditions and results in qualitative comparative analysis is no longer limited to simple binary division. This greatly expands the application scope and applicability of qualitative comparative analysis. At the same time, fsQCA organically combines the advantages of quantitative analysis and qualitative analysis by allowing membership scores between 0 and 1. When conducting fsQCA, cases can be regarded as a combination of a series of conditions and results, and the influence of conditions on the results can be compared to analyze whether

Explanatory Variables	Tobit	10th	20th	40th	50th	80th	90th
lnasset	0.073**	0.043*	0.072***	0.078	0.085***	0.061***	0.061
	(0.017)	(0.024)	(0.022)	(0.025)	(0.032)	(0.024)	(0.028)
Company age	0.003	0.006	0.006	0.003	0	0.006	0.008*
	(0.004)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)	(0.006)
Reinsurance rate	0.004***	0.002	0.002	0.001	0.004	0.007*	0.005
	(0.002)	(0.002)	(0.001)	(0.004)	(0.004)	(0.002)	(0.002)
Claim ratio	0.005***	0.007***	0.007***	0.008	0.008***	0.003*	0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
ROE	−0.001	−0.001	0	0	−0.001	0	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Market share	−0.002	0.007**	0.002	−0.001	−0.003	−0.004	−0.005
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Concentration	−0.002	0.154	0.245	0.185	−0.037	−0.229**	−0.283**
	(0.094)	(0.177)	(0.159)	(0.187)	(0.202)	(0.128)	(0.119)
Restriction	−0.114*	0.035	0.057	0.04	−0.021	−0.071**	−0.092***
	(0.023)	(0.039)	(0.04)	(0.051)	(0.054)	(0.031)	(0.037)
_cons	−0.176	−0.396*	−0.728***	−0.667	−0.433	0.235	0.308
	(0.177)	(0.227)	(0.162)	(0.242)	(0.283)	(0.21)	(0.247)
N	132	132	132	132	132	132	132
Pseudo R^2	0.4719	0.5897	0.5190	0.4370	0.4159	0.3613	0.2527

Note(s): ***, **, and * indicate significant p values at the 1%, 5% and 10% level, respectively. The standard errors, presented in the parentheses, are obtained with a bootstrap of 20

Table 5. Regression results for the determinants of efficiency scores

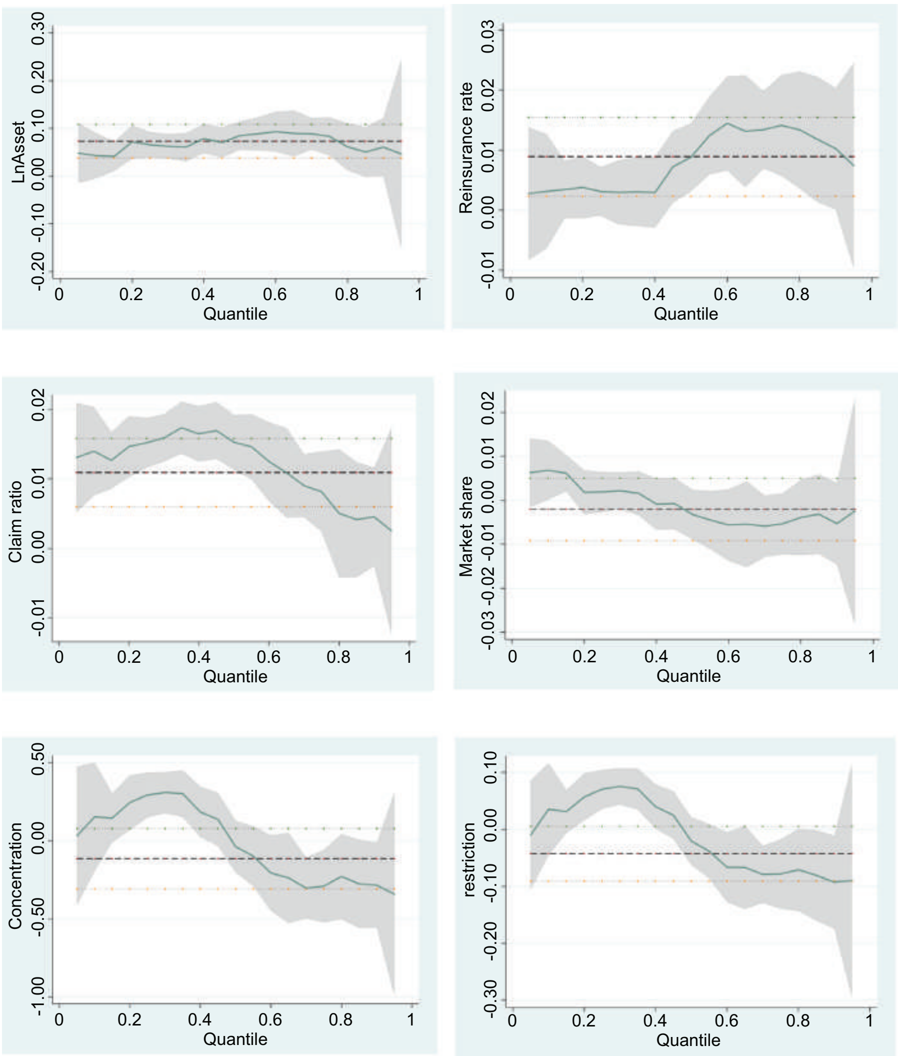

Figure 3.
Dynamic change of quantile regression coefficient

conditions can be considered as sufficient or necessary for the results. If a condition is sufficient enough for the result, it means the condition may be one of the reasons for that result. By testing the consistency of the necessary conditions, we can determine if any individual condition is logically necessary for the outcome. Consistency of the necessary fuzzy subset relationship can be evaluated with the following formula:

$$Consistency(Y_i \leq X_i) = \sum(\min(X_i, Y_i)) \Big/ \sum(Y_i) \quad (5)$$

Generally, the consistency index should be bigger than 0.85 for the model of antecedent conditions to be useful, and the coverage index should be higher than 0.05 (Sun *et al.*, 2018). The fsQCA data analysis process is described as follows.

6.1 Variables selection and descriptive statistical analysis

In this paper, 44 Chinese property insurance companies in 2017 were selected as the research objects, and technical efficiency was taken as the dependent variable. Previous literature had shown that company size (Li *et al.*, 2017; Yu *et al.*, 2019), loss ratio (Alhassan and Biekpe, 2016), reinsurance ratio (Alhassan and Biekpe, 2016), leverage ratio (Huang and Eling, 2013; Lu *et al.*, 2014), premium growth rate (Shim, 2017) and market share (Ansah-Adu *et al.*, 2012; Choi and Weiss, 2005) had a certain impact on the operating efficiency of enterprises. However, relevant studies did not indicate the relationship between the causes and effects. Therefore, we construct solutions to upgrade technological efficiency.

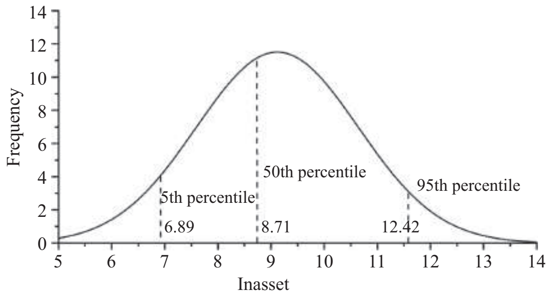

Figure 4.
PDF graphs of condition and outcome variables, with thresholds for 95th percentile, 50th percentile and 5th percentile

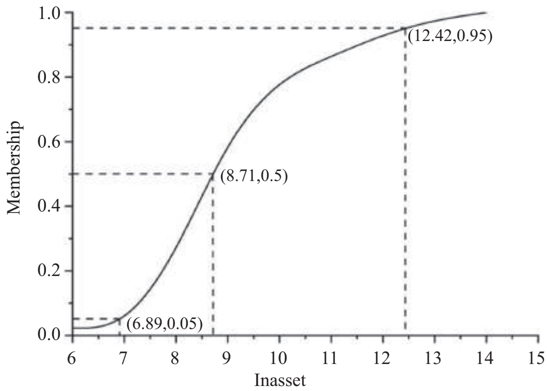

Figure 5.
Plots of degrees of membership to the condition (lnasset) variables using direct method

Table 6.
Summary of the calibration of all variables

Variables	Mean	SD	Non-membership	Crossover point	Full membership
TE	0.71	0.22	0.26	0.58	0.87
Lnasset	9.11	1.53	6.89	8.71	12.42
Reinsurance rate	9.38	7.88	0.93	7.34	22.75
Claim ratio	49.51	11.54	29.10	49.60	71.43
Market share	2.15	5.91	0.26	2.88	13.07
Ownership Concentration	0.44	0.32	0.11	0.31	0.51
Equity restriction	1.62	1.26	0.01	0.45	1.00

6.2 Calibration of variables

Calibration is the process required to transform raw data into set membership scores range from 0 to 1. Generally, there are three anchor points that need to be calibrated. These are full set membership of a case in a set, full non-membership and the crossover with maximum ambiguity between membership and non-membership (An *et al.*, 2020). Evaluation of each variable's three qualitative anchors comes from Beynon *et al.* (2016a, b) and involves the identification of the 5th percentile (lower-threshold), 95th percentile (upper-threshold) and 50th percentile (crossover point) values through building a probability-density function (PDF) graph for each variable (see Figure 4).

We adopt the direct method constructed by Beynon *et al.* (2016a, b). Graphs in Figure 5 represent fuzzy membership score functions for lnasset. Table 6 shows the results of the calibration of all variables.

6.3 Analysis of necessary conditions

A causal condition is necessary when the outcome is its subset. Conventionally, to imply that a condition is necessary or almost always necessary, the consistency score must be greater than 0.9 (Wu *et al.*, 2019). The summary of necessary conditions is shown in Table 7 and the consistency degree of the factors improving technical efficiency as a necessary condition is less than 0.85. That is to say, none of these factors can be considered a necessary condition for improving technical efficiency. The improvement of the technical efficiency of property insurance companies is the result of the combination of various factors, rather than a single factor. This conclusion is consistent with the findings of quantile regression, which perfectly explains the consistency of fsQCA and quantile regression results, while Tobit regression cannot find such a rule.

6.4 Constructing the truth table

To identify combinations of conditions that are logically sufficient for the presence of the outcome, it is necessary to construct a truth table. The truth table represents the property space and lists all logically possible combinations of causal conditions represented in binary states, as well as the number of cases with fuzzy-set membership scores greater than 0.5 (Leischnig and Kasper-Brauer, 2015). To select sufficient truth table rows, we set relatively high consistency thresholds to derive solutions that could unambiguously be considered sufficient for high performance. We used 0.9 as a consistency threshold and we also assessed

Conditions	TE Consistency	TE Coverage
Lnasset	0.697183	0.94586
~ lnasset	0.538229	0.728883
Reinsurance rate	0.586855	0.840942
~ reinsurance rate	0.586184	0.753773
Claim ratio	0.65996	0.905244
~ claim ratio	0.580148	0.777179
Market share	0.250503	0.99733
~ market share	0.81556	0.666119
Concentration	0.622066	0.820796
~concentration	0.501677	0.699065
Restriction	0.708585	0.64598
~restriction	0.332998	0.879539

Note(s): "~" indicates the absence of the condition

Table 7. Analysis summary of necessary conditions

Table 8. Summary of the truth table

lnasset	Reinsurance rate	Claim ratio	Market share	Concentration	Restriction	Cases	TE	Raw consist.	PRI consist.	SYM consist
1	1	0	0	1	0	2	1	1	1	1
0	1	0	0	1	0	1	1	1	1	1
1	1	1	0	1	0	1	1	1	1	1
1	0	0	1	1	0	1	1	1	1	1
1	1	0	1	1	0	1	1	1	1	1
1	1	1	1	1	0	1	1	1	1	1
1	1	0	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	0	1	0	0	1	3	1	0.98	0.95	0.95
1	1	1	0	0	1	2	1	0.98	0.93	0.94
1	0	1	0	1	1	2	1	0.97	0.90	0.90
0	1	1	0	0	1	2	1	0.96	0.90	0.90
0	0	1	0	1	1	1	1	0.95	0.81	0.81
0	1	1	0	1	1	1	1	0.94	0.78	0.78
1	1	0	0	1	1	2	1	0.93	0.79	0.79
1	1	0	0	0	1	1	1	0.92	0.72	0.72
0	0	1	0	0	1	5	0	0.88	0.68	0.69
0	0	0	0	0	1	5	0	0.88	0.67	0.68
1	0	0	0	0	1	2	0	0.87	0.60	0.60
0	1	0	0	1	1	1	0	0.87	0.54	0.54
0	1	0	0	0	1	3	0	0.76	0.40	0.40
0	0	0	0	1	0	3	0	0.75	0.53	0.53

the score of each truth table row where the proportional reduction of inconsistency (PRI) was bigger than 0.7. The truth table is shown as following (Table 8).

6.5 fsQCA findings

After fsQCA analysis, complex solutions, parsimonious solutions and intermediate solutions are generated. These three types of solutions are not only different in complexity but also different in their revelations and universalness. The complex solutions with poor universality are the most rigorous and complicated. The parsimonious solutions with less revelation are the most permissive, but conclusions may conflict with the actual situation. Therefore, we interpret the results with the intermediate solutions, because the conclusions obtained are revelatory and universal.

According to FISS (2011), all the causal conditions appearing in the parsimonious solutions are defined as core causes, and all the causal conditions appearing in the intermediate solutions, but excluded by the parsimonious solutions, are defined as peripheral causes. The results of the intermediate solutions are shown in Table 9. It can be seen from the results of fsQCA that the overall solution consistency of the intermediate solutions is 0.946, which reaches a reasonable level of sufficient condition consistency. At the same time, the consistency of all solutions reached 0.8, indicating that these configurations can be considered as sufficient conditions for improving technical efficiency.

From the results of the intermediate solutions, it can be found that there are four alternative recipes or paths associated with technical efficiency improvement.

6.5.1 Model 1. The configurations of model 1 are "lnasset * reinsurance rate * concentration * ~restriction" and "lnasset * reinsurance rate * concentration * market share." Schemes 1a and 1b illustrate that a large-scale, high reinsurance rate and high centralization are sufficient conditions for improving the technological efficiency of enterprises. Enterprises can achieve scale efficiency by expanding the scale of the company. The improvement of a reinsurance rate can transfer the operational risks of the company and achieve a better risk control level. In addition, a high degree of centralization can strengthen the ability of major shareholders to supervise and incentivize the behavior of managers, in order to effectively improve the performance of the company. Solution 1a also points to a reduction in the company's balance of ownership, while solution 1b calls for expansion of market share.

6.5.2 Model 2. For model 2, we found two paths (solutions 2a and 2b) that were present in 14.02% and 10.5% of all highly efficient firms in the subsample. The core conditions of mode 2 include low claim ratio, high centralization and low restriction. In the path 2a, the peripheral conditions are high reinsurance rate and low market share, and the configuration is "~claim ratio * concentration * ~restriction * reinsurance rate * ~market share". In path 2b, another two peripheral conditions are large scale and high market share and the configuration is "~claim ratio * concentration * ~restriction * lnasset * market share." These insurers reduce the insurance claims caused by moral hazard by enhancing the process of underwriting and claim checking, thus increasing the operating profits of enterprises. At the same time, an enterprise can reduce the management inefficiency caused by dispersed ownership by optimizing the ownership structure, and finally realize an efficient operation.

6.5.3 Model 3. The configurations of model 3 are "~ market share * restriction * ~ concentration * lnasset * ~claim ratio" and "~ market share * restriction * ~ concentration * lnasset * claim ratio." The core conditions leading to the efficient operation of property insurance companies are low market share, high restriction and low concentration. Based on the analysis of the enterprise cases conforming to this configuration, we find that these enterprises are generally medium-sized and large scale. Due to the Pareto distribution of China's property insurance market, about 70% of the market is covered by China PICC P&C Insurance, China Ping An P&C Insurance, China Pacific Property Insurance

Table 9.
Configurations for achieving a high TE

Configuration	Solutions							
	1		2		3		4	
	1a	1b	2a	2b	3a	3b	4a	4b
lnasset	●	●		•	•	•	⨂	⨂
Reinsurance rate	●	●	•		•	⊗	•	
Claim ratio			⨂	⨂	⊗	•	●	●
Market share		•	⊗	•	⨂	⨂	⊗	⊗
Concentration	●	●	●	●	⨂	⨂	⊗	•
Restriction	⊗		⨂	⨂	●	●	●	●
Consistency	1.0000	1.0000	0.9952	1.0000	0.9309	0.9747	0.9425	0.9287
Raw coverage	0.2002	0.1942	0.1402	0.1050	0.2438	0.3236	0.2639	0.2270
Unique coverage	0.0137	0.0181	0.0218	0.0218	0.0288	0.0017	0.0010	0.0001
Companies	CPPIC TGIC HTPIC BOCIC	CLPIC CPICCPIC CCPIC	TKIC TGIC HTPIC	CPAPIC SPIC	CNPCIC DHPIC CPIC	TAPIC YAPIC ACPIC ZKPIC GYAIC	CNPCIC DHPIC CPIC	TAPIC YAPIC ACPIC ZKPIC GYAIC
Overall solution consistency	0.9460							
Overall solution coverage	0.6814							

Note(s): Black circles ("●") indicate the presence of a condition, and circles with a cross-out ("⊗") indicate its absence. Moreover, large circles indicate core conditions, and small circles refer to peripheral conditions. Blank spaces in a solution indicate a "don't care" situation in which the causal condition may be either present or absent. From the results of the intermediate solutions, it can be found that there are four alternative recipes or paths associated with technical efficiency improvement

and China Life P&C Insurance, so the market share of these insurers in model 3 is not high and their claim ratio is relatively low. Since the equity of these companies is relatively balanced, their equity concentration is relatively low, which gives full play to the mutual checks and balances among shareholders. Further analysis shows that the high operating efficiency of these companies is mainly due to their high pure technical efficiency, which also indicates their institutional flexibility and advanced management level.

6.5.4 Model 4. For model 4, we found that there are two paths (solutions 4a and 4b), namely "~lnasset * Claim ratio * restriction* reinsurance rate * ~market share" and "~lnasset * Claim ration * restriction * concentration." Both 4a and 4b require a small-scale, high claim ratio and high restriction at the same time. In the case of highly dispersed equity, the number of shares held by shareholders is similar, and the distribution of power is relatively equal. There is a mechanism of checks and balances among shareholders, which is conducive to the generation of equity restrictions and democratic decision-making.

7. Conclusion and discussion

This study combined the DEA and fsQCA to not only assess the operating efficiency of Chinese P&C insurance companies but also examine the combination of causal conditions that might improve this efficiency. The results are shown as following:

This study's results are first aligned with findings from an initial stream of studies that the poor operational performance of China's property insurance industry is the result of management inefficiency (Yao *et al.*, 2007; Long Kweh *et al.*, 2014). The technical efficiency of China's property insurance industry from 2015 to 2017 is 0.609, 0.67 and 0.708 respectively, which indicates that the operation efficiency has not been optimized and there is a large amount of resource waste. Additionally, we found that property insurance companies in China are pure technically inefficient with average efficient scores of 0.678, 0.736 and 0.762 during the period 2015–2017. This result implies that the average property insurance company suffered a 32.2%, 26.4% and 23.8% level of technical inefficiency respectively, and management and technology need to be constantly optimized. The scale efficiency of China's property insurance industry is 0.906, 0.908 and 0.931 respectively between 2015 and 2017. Thus, the scale efficiency of property insurance companies in China is relatively better than their pure technical efficiency, indicates that the development of companies should be changed from scale orientation to technology orientation.

Second, and similar to other studies (Alhassan and Biekpe, 2016; Shim, 2017; Yu *et al.*, 2019; Balsmeier and Czarnitzki, 2017; Schmalz, 2018), this study's results demonstrated that organizational structures and corporate governance are influential in technical efficiency. In the second stage, we observe that the drivers for firm size, reinsurance rate, claim ratio and equity restriction are important determinants of an insurance firm's efficiency. Market share and ownership concentration also have significant effects on technical efficiency at different quantile levels, fully demonstrating the high theoretical unity of quantile regression and fsQCA. Because the results of fsQCA show that the paths of different insurers contain different combinations of conditions, they further reveal that the performance of enterprise operation is a multiple concurrent causal relationship, rather than a one-way linear relationship of independent variables and causal symmetry. For example, the variation in the impact of company size on technical efficiency is caused by the causal relationship depending on the specific situation and configuration (Ansah-Adu *et al.*, 2012; Alhassan and Biekpe, 2016; Li *et al.*, 2017).

Third, and in accordance with findings from several prior studies (FISS, 2011; Sun *et al.*, 2018; Wu *et al.*, 2019), we found that the reliability and validity of the study were improved through specific case analysis. Because the traditional regression analysis method needs a large number of samples, the fsQCA method is more suitable for the study of medium samples with a sample size of 50–100. This can better improve the reliability and validity of the studies on technical efficiency. In addition, we also put forward four applicable, targeted and proven ways to improve the technical efficiency of property insurance companies. These configurations are verified by the cases of existing property insurance companies, which can provide practical references for the insurance industry.

This study helps to fill in a gap in the literature with regard to research that focuses on corporate governance for P&C insurance companies, and on the configurations that explain their high technical efficiency. Further, our method can be easily extended to many other DEA models. A methodological combination (DEA, Quantile regression model and fsQCA) that is never used in studies in this field was employed. Meanwhile, the calibration with thresholds for full-non-membership, crossover point and full-membership will be more objective and stable by means of probability density function and probability distribution function. Our study also provides important implications for inefficient companies on their shortcomings in operational activities. Companies that scored low in efficiency in the following operation should transform from scale expansion to high-level management. Besides, they should upgrade the quality of their management practices for catching up with the companies with high technical efficiency. In addition, P&C insurance companies in China can adopt different development paths based on their conditions. In the process of scientific management of industrial development, a certain factor does not play a role in corporate governance individually, but must be configured with other elements to form a conditional combination for high operating efficiency. Although the complexity of causality different configurations is explained by case analysis, the fsQCA robustness test (e.g. changing the calibration thresholds, changing the frequency and consistency thresholds.) has not been carried out. Besides, our research has not broken through the static nature and limitations of fsQCA in analyzing a dynamic process of temporal changes. Further theoretical research and applications should focus on incorporating time-series variations into QCA.

References

Al-Amri, K., Gattoufi, S. and Al-Muharrami, S. (2012), "Analyzing the technical efficiency of insurance companies in GCC", *The Journal of Risk Finance*, Vol. 13 No. 4, pp. 362-380.

Alhassan, A.L. and Biekpe, N. (2016), "Determinants of life insurance consumption in Africa", *Research in International Business and Finance*, Vol. 37, pp. 17-27.

Allard, A., Takman, J., Uddin, G.S. and Ahmed, A. (2018), "The N-shaped environmental Kuznets curve: an empirical evaluation using a panel quantile regression approach", *Environmental Science and Pollution Research*, Vol. 25 No. 6, pp. 5848-5861.

An, W., Rüling, C.C., Zheng, X. and Zhang, J. (2020), "Configurations of effectuation, causation, and bricolage: implications for firm growth paths", *Small Business Economics*, Vol. 54, pp. 843-864.

Anandarao, S., Durai, S.R.S. and Goyari, P. (2019), "Efficiency decomposition in two-stage data envelopment analysis: an application to Life Insurance companies India", *Journal of Quantitative Economics*, Vol. 17, pp. 271-285, doi: 10.1007/s40953-018-0148-1.

Ansah-Adu, K., Andoh, C. and Abor, J. (2012), "Evaluating the cost efficiency of insurance companies in Ghana", *Journal of Risk Finance*, Vol. 13 No. 1, pp. 61-76.

Arena, M. (2008), "Does insurance market activity promote economic growth? A cross-country study for industrialized and developing countries", *Journal of Risk and Insurance*, Vol. 75 No. 4, pp. 921-946.

Balsmeier, B. and Czarnitzki, D. (2017), "Ownership concentration, institutional development and firm performance in Central and Eastern Europe", *Managerial and Decision Economics*, Vol. 38 No. 2, pp. 178-192.

Berger, A.N. and Humphrey, D.B. (1997), "Efficiency of financial institutions: international survey and directions for future research", *European Journal of Operational Research*, Vol. 98 No. 2, pp. 175-212.

Beynon, M.J., Jones, P. and Pickernell, D. (2016a), "Country-based comparison analysis using fsQCA investigating entrepreneurial attitudes and activity", *Journal of Business Research*, Vol. 69 No. 4, pp. 1271-1276.

Beynon, M., Jones, P. and Pickernell, D. (2016b), "Country-level investigation of innovation investment in manufacturing: paired fsQCA of two models", *Journal of Business Research*, Vol. 69 No. 11, pp. 5401-5407.

Biener, C., Eling, M. and Wirfs, J.H. (2016), "The determinants of efficiency and productivity in the Swiss insurance industry", *European Journal of Operational Research*, Vol. 248 No. 2, pp. 703-714.

Carayannis, E. and Grigoroudis, E. (2014), "Linking innovation, productivity, and competitiveness: implications for policy and practice", *Journal of Technology Transfer*, Vol. 39, pp. 199-218, doi: 10.1007/s10961-012-9295-2.

Charnes, A., Cooper, W.W. and Rhodes, E. (1978), "Measuring the efficiency of decision making units", *European Journal of Operational Research*, Vol. 2 No. 6, pp. 429-444.

Chen, F.C., Liu, Z.J. and Kweh, Q.L. (2014), "Intellectual capital and productivity of Malaysian general insurers", *Economic Modelling*, Vol. 36, pp. 413-420.

Chen, N., Xu, L. and Chen, Z. (2017), "Environmental efficiency analysis of the Yangtze River Economic Zone using super efficiency data envelopment analysis (SEDEA) and tobit models", *Energy*, Vol. 134, pp. 659-671.

Choi, B.P. and Weiss, M.A. (2005), "An empirical investigation of market structure, efficiency, and performance in property-liability insurance", *Journal of Risk and Insurance*, Vol. 72 No. 4, pp. 635-673.

Cummins, J.D. and Rubio-Misas, M. (2006), "Deregulation, consolidation, and efficiency: evidence from the Spanish insurance industry", *Journal of Money, Credit and Banking*, Vol. 38 No. 2, pp. 323-355.

Cummins, J.D. and Weiss, M.A. (1993), "Measuring cost efficiency in the property-liability insurance industry", *Journal of Banking and Finance*, Vol. 17 Nos 2-3, pp. 463-481.

Cummins, J.D. and Xie, X. (2008), "Mergers and acquisitions in the US property-liability insurance industry: productivity and efficiency effects", *Journal of Banking and Finance*, Vol. 32 No. 1, pp. 30-55.

Cummins, J.D., Rubio-Misas, M. and Zi, H. (2004), "The effect of organizational structure on efficiency: evidence from the Spanish insurance industry", *Journal of Banking and Finance*, Vol. 28 No. 12, pp. 3113-3150.

Cummins, J.D., Weiss, M.A., Xie, X. and Zi, H. (2010), "Economies of scope in financial services: a DEA efficiency analysis of the US insurance industry", *Journal of Banking and Finance*, Vol. 34 No. 7, pp. 1525-1539.

Cummins, J.D., Rubio-Misas, M. and Vencappa, D. (2017), "Competition, efficiency and soundness in European life insurance markets", *Journal of Financial Stability*, Vol. 28, pp. 66-78.

Donni, O. and Fecher, F. (1997), "Efficiency and productivity of the insurance industry in the OECD countries", *The Geneva Papers on Risk and Insurance - Issues and Practice*, Vol. 22 No. 4, pp. 523-535.

Eling, M. and Luhnen, M. (2010), "Efficiency in the international insurance industry: a cross-country comparison", *Journal of Banking and Finance*, Vol. 34 No. 7, pp. 1497-1509.

Eling, M. and Schaper, P. (2017), "Under pressure: how the business environment affects productivity and efficiency of European life insurance companies", *European Journal of Operational Research*, Vol. 258 No. 3, pp. 1082-1094.

Fare, R. and Grosskopf, S. (2000), "Network DEA", *Socio-Economic Planning Sciences*, Vol. 34 No. 1, pp. 35-49.

Feng, R. and Shimizu, Y. (2016), "Applications of central limit theorems for equity-linked insurance", *Insurance: Mathematics and Economics*, Vol. 69, pp. 138-148.

Fiss, P.C. (2011), "Building better causal theories: a fuzzy set approach to typologies in organization research", *Academy of Management Journal*, Vol. 54 No. 2, pp. 393-420.

Fried, H.O., Lovell, C.K., Schmidt, S.S. and Yaisawarng, S. (2002), "Accounting for environmental effects and statistical noise in data envelopment analysis", *Journal of Productivity Analysis*, Vol. 17 Nos 1-2, pp. 157-174.

Fukuyama, H. and Matousek, R. (2017), "Modelling bank performance: a network DEA approach", *European Journal of Operational Research*, Vol. 259 No. 2, pp. 721-732.

Gollier, C. (2018), *The Economics of Risk and Uncertainty*, Edward Elgar Publishing, Cheltenham.

Hao, J.C. and Chou, L.Y. (2005), "The estimation of efficiency for life insurance industry: the case in Taiwan", *Journal of Asian Economics*, Vol. 16 No. 5, pp. 847-860.

Huang, W. and Eling, M. (2013), "An efficiency comparison of the non-life insurance industry in the BRIC countries", *European Journal of Operational Research*, Vol. 226 No. 3, pp. 577-591.

Huang, L.Y., Lai, G.C., McNamara, M. and Wang, J. (2011), "Corporate governance and efficiency: evidence from US property-liability insurance industry", *Journal of Risk and Insurance*, Vol. 78 No. 3, pp. 519-550.

Ilyas, A. and Rajasekaran, S. (2019), "An empirical investigation of efficiency and productivity in the Indian non-life insurance market", *Benchmarking: An International Journal*, Vol. 26 No. 7, pp. 2343-2371, doi: 10.1108/BIJ-01-2019-0039.

Kaffash, S., Azizi, R., Huang, Y. and Zhu, J. (2019), "A survey of data envelopment analysis applications in the insurance industry 1993-2018", *European Journal of Operational Research*, Vol. 284 No. 3, pp. 801-813.

Kaffash, S. and Marra, M. (2017), "Data envelopment analysis in financial services: a citations network analysis of banks, insurance companies and money market funds", *Annals of Operations Research*, Vol. 253, pp. 307-344.

Kao, C. and Hwang, S.N. (2008), "Efficiency decomposition in two-stage data envelopment analysis: an application to non-life insurance companies in Taiwan", *European Journal of Operational Research*, Vol. 185 No. 1, pp. 418-429.

Kao, C. and Hwang, S.N. (2014), "Multi-period efficiency and malmquist productivity index in two-stage production systems", *European Journal of Operational Research*, Vol. 232 No. 3, pp. 512-521.

Leischnig, A. and Kasper-Brauer, K. (2015), "Employee adaptive behavior in service enactments", *Journal of Business Research*, Vol. 68 No. 2, pp. 273-280.

Leverty, J.T., Lin, Y. and Zhou, H. (2009), "WTO and the Chinese insurance industry", *The Geneva Papers on Risk and Insurance - Issues and Practice*, Vol. 34 No. 3, pp. 440-465.

Li, H., Zhang, H., Tsai, S.B. and Qiu, A. (2017), "China's insurance regulatory reform, corporate governance behavior and insurers' governance effectiveness", *International Journal of Environmental Research and Public Health*, Vol. 14 No. 10, p. 1238.

Li, H., Chen, C., Cook, W.D., Zhang, J. and Zhu, J. (2018a), "Two-stage network DEA: who is the leader?", *Omega*, Vol. 74, pp. 15-19.

Li, Y., Shi, X., Emrouznejad, A. and Liang, L. (2018b), "Environmental performance evaluation of Chinese industrial systems: a network SBM approach", *Journal of the Operational Research Society*, Vol. 69 No. 6, pp. 825-839.

Lim, S. and Zhu, J. (2016), "A note on two-stage network DEA model: frontier projection and duality", *European Journal of Operational Research*, Vol. 248 No. 1, pp. 342-346.

Liu, J., Zhang, J. and Fu, Z. (2017), "Tourism eco-efficiency of Chinese coastal cities–Analysis based on the DEA-Tobit model", *Ocean and Coastal Management*, Vol. 148, pp. 164-170.

Long Kweh, Q., Lu, W. and Wang, W. (2014), "Dynamic efficiency: intellectual capital in the Chinese non-life insurance firms", *Journal of Knowledge Management*, Vol. 18 No. 5, pp. 937-951.

Lu, W.M., Wang, W.K. and Kweh, Q.L. (2014), "Intellectual capital and performance in the Chinese life insurance industry", *Omega*, Vol. 42 No. 1, pp. 65-74.

Mandal, S. and Ghosh Dastidar, S. (2014), "A DEA-investigation of efficiency of the Indian general insurance during recession", *Journal of Advances in Management Research*, Vol. 11 No. 1, pp. 115-136.

Mazviona, B.W., Dube, M. and Sakahuhwa, T. (2017), "An analysis of factors affecting the performance of insurance companies in Zimbabwe", *Journal of Finance and Investment Analysis*, Vol. 6 No. 1, pp. 1-21.

Nourani, M., Devadason, E.S., Kweh, Q.L. and Lu, W.M. (2017), "Business excellence: the managerial and value-creation efficiencies of the insurance companies", *Total Quality Management and Business Excellence*, Vol. 28 Nos 7-8, pp. 879-896.

Sánchez-González, C., Sarto, J.L. and Vicente, L. (2017), "The efficiency of mutual fund companies: evidence from an innovative network SBM approach", *Omega*, Vol. 71, pp. 114-128.

Schmalz, M.C. (2018), "Common-ownership concentration and corporate conduct", *Annual Review of Financial Economics*, Vol. 10, pp. 413-448.

Shermeh, H.E., Najafi, S.E. and Alavidoost, M.H. (2016), "A novel fuzzy network SBM model for data envelopment analysis: a case study in Iran regional power companies", *Energy*, Vol. 112, pp. 686-697.

Shim, J. (2017), "An investigation of market concentration and financial stability in property–liability insurance industry", *Journal of Risk and Insurance*, Vol. 84 No. 2, pp. 567-597.

Shujie, Y.A.O., Zhongwei, H.A.N. and Genfu, F.E.N.G. (2007), "On technical efficiency of China's insurance industry after WTO accession", *China Economic Review*, Vol. 18 No. 1, pp. 66-86.

Sun, Y., Garrett, T.C., Phau, I. and Zheng, B. (2018), "Case-based models of customer-perceived sustainable marketing and its effect on perceived customer equity", *Journal of Business Research*, pp. 1-8, doi: 10.1016/j.jbusres.2018.09.007.

Tone, K. (2001), "A slacks-based measure of efficiency in data envelopment analysis", *European Journal of Operational Research*, Vol. 130 No. 3, pp. 498-509.

Tone, K. and Tsutsui, M. (2009), "Network DEA: a slacks-based measure approach", *European Journal of Operational Research*, Vol. 197 No. 1, pp. 243-252.

Tone, K. and Tsutsui, M. (2017), "The dynamic network DEA model", in Tone, K. (Ed.), *Advances in DEA Theory and Applications: With Extensions to Forecasting Models*, Wiley, NJ, pp. 74-84.

Wanke, P. and Barros, C.P. (2016), "Efficiency drivers in Brazilian insurance: a two-stage DEA meta frontier-data mining approach", *Economic Modelling*, Vol. 53, pp. 8-22.

Wu, J., Li, Y. and Zhang, D. (2019), "Identifying women's entrepreneurial barriers and empowering female entrepreneurship worldwide: a fuzzy-set QCA approach", *International Entrepreneurship and Management Journal*, Vol. 15, pp. 905-928.

Wysokińska, Z. (2003), "Competitiveness and its relationships with productivity and sustainable development", *Fibres & Textiles in Eastern Europe*, Vol. 11 No. 3, p. 42.

Xie, C. and Yang, J. (2016), "The effect of separation of cash flow and control rights and check-and-balance ownership structure on information disclosure from the perspective of enterprise life cycle: empirical data from listed companies in Shenzhen stock exchange", *East China Economic Management*, Vol. 30 No. 8, pp. 147-154.

Yao, S., Han, Z. and Feng, G. (2007), "On technical efficiency of China's insurance industry after WTO accession", *China Economic Review*, Vol. 18 No. 1, pp. 66-86.

Yu, Y., Huang, J. and Shao, Y. (2019), "The sustainability performance of Chinese banks: a new network data envelopment analysis approach and panel regression", *Sustainability*, Vol. 11 No. 6, p. 1622.

Zhang, D., Cai, J., Dickinson, D.G. and Kutan, A.M. (2016), "Non-performing loans, moral hazard and regulation of the Chinese commercial banking system", *Journal of Banking and Finance*, Vol. 63, pp. 48-60.

Zimková, E. (2014), "Technical efficiency and super-efficiency of the banking sector in Slovakia", *Procedia Economics and Finance*, Vol. 12, pp. 780-787.

Further reading

Shujie, Y.A.O., Zhongwei, H.A.N. and Genfu, F.E.N.G. (2007), "On technical efficiency of China's insurance industry after WTO accession", *China Economic Review*, Vol. 18 No. 1, pp. 66-86.

Appendix

Table A1.
Operating efficiency of Chinese property insurance companies from 2015 to 2017

Company	DMU	2015 crste	2015 vrste	2015 Scale		2016 crste	2016 vrste	2016 Scale		2017 crste	2017 vrste	2017 Scale	
China PICC P&C Insurance Co., Ltd	CPICCPIC	1	1	1	-	1	1	1	-	1	1	1	-
China Life P&C Insurance Co., Ltd	CLPIC	0.904	1	0.904	drs	0.96	1	0.96	drs	0.967	0.989	0.978	drs
China Pacific Property Insurance Co., Ltd	CPPIC	1	1	1	-	1	1	1	-	1	1	1	-
China Ping An P&C Insurance Co., Ltd	CPAPIC	0.884	0.888	0.996	irs	0.915	0.922	0.993	irs	0.98	0.987	0.993	irs
China Continent P&C Insurance Co., Ltd	CCPIC	0.603	0.615	0.981	drs	0.687	0.687	1	-	0.763	0.765	0.997	drs
Sinosafe General Insurance Co., Ltd	SGIC	0.656	0.683	0.96	irs	0.644	0.687	0.938	irs	0.657	0.695	0.945	irs
Taiping General Insurance Co., Ltd	TGIC	0.6	0.621	0.965	drs	0.788	0.802	0.982	irs	0.819	0.85	0.963	irs
China United Property Insurance Co., Ltd	CUPIC	0.798	0.831	0.96	drs	0.843	0.887	0.95	drs	0.733	0.768	0.953	drs
Sunshine P&C Insurance Co., Ltd	SPIC	0.743	0.757	0.982	irs	0.8	0.822	0.973	irs	0.867	0.887	0.977	irs
Hua Tai P&C Insurance Co., Ltd	HTPIC	0.528	0.531	0.994	irs	0.772	0.788	0.98	irs	0.88	0.883	0.997	drs
Tianan Property Insurance Co., Ltd	TAPIC	1	1	1	-	1	1	1	-	1	1	1	-
Yongan Property Insurance Co., Ltd	YAPIC	0.684	0.689	0.993	drs	0.883	0.893	0.988	irs	0.91	0.911	0.999	drs
Alltrust Property Insurance Co., Ltd	ATPIC	0.669	0.683	0.978	irs	0.562	0.567	0.99	irs	0.606	0.616	0.984	irs
BOC Insurance Co., Ltd	BOCIC	0.851	0.899	0.946	drs	0.864	0.865	0.999	irs	0.838	0.849	0.987	drs
Yingda Taihe Property Insurance Co., Ltd	YTPIC	0.817	0.838	0.975	drs	0.945	0.955	0.989	irs	1	1	1	-
Asia–Pacific P&C Insurance Co., Ltd	APPIC	0.615	0.62	0.992	drs	0.485	0.488	0.993	irs	0.525	0.538	0.977	drs
Bohai Property Insurance Co., Ltd	BHPIC	0.565	0.565	1	-	0.621	0.637	0.974	irs	0.657	0.661	0.993	irs
Dubon P&C Insurance Co., Ltd	DBPIC	0.432	0.439	0.985	drs	0.53	0.534	0.994	irs	0.559	0.561	0.997	irs
Ancheng Property Insurance Co., Ltd	ACPIC	0.625	0.626	0.998	irs	0.579	0.593	0.976	irs	0.713	0.717	0.995	irs
Dinghe Property Insurance Co., Ltd	DHPIC	0.77	0.771	0.999	irs	0.69	0.692	0.998	drs	0.62	0.629	0.986	drs
Zking P&C Insurance Co., Ltd	ZKPIC	0.503	0.506	0.993	drs	0.701	0.717	0.977	irs	0.689	0.69	0.999	-
Anxin Agriculture Insurance Co., Ltd	AXPIC	0.746	0.835	0.894	irs	0.844	0.996	0.847	irs	1	1	1	-
Anhua Agriculture Insurance Co., Ltd	AHPIC	0.578	0.593	0.975	irs	0.537	0.635	0.847	irs	0.978	1	0.978	irs
Sunlight Agriculture Mutual Insurance Co., Ltd	SAMIC	1	1	1	-	1	1	1	-	0.9	1	0.9	irs
Guoyuan Agriculture Insurance Co., Ltd	GYAIC	1	1	1	-	1	1	1	-	1	1	1	-
China Huanong P&C Insurance Co., Ltd	CHNPIC	1	1	1	-	0.672	0.767	0.876	irs	0.697	0.7	0.996	drs
China Coal Insurance Co., Ltd	CCIC	0.456	0.497	0.918	irs	0.468	0.644	0.727	irs	0.45	0.488	0.921	irs
Taishan P&C Insurance Co., Ltd	TSPIC	0.424	0.428	0.991	irs	0.579	0.624	0.927	irs	0.553	0.563	0.983	drs
Jintai P&C Insurance Co., Ltd	JTPIC	0.583	0.601	0.97	irs	0.682	0.74	0.922	irs	0.67	0.752	0.891	irs
Urtrust Insurance Co., Ltd	UTIC	0.716	0.743	0.963	irs	0.718	0.802	0.895	irs	0.616	0.63	0.977	irs
Champion P&C Insurance Co., Ltd	CPIC	0.458	0.473	0.968	irs	0.412	0.42	0.979	drs	0.373	0.378	0.989	drs

(*continued*)

Company	DMU	2015 crste	2015 vrste	2015 Scale		2016 crste	2016 vrste	2016 Scale		2017 crste	2017 vrste	2017 Scale	
Sanguard Automobile Insurance Co., Ltd	SGAIC	0.519	0.629	0.825	irs	0.613	0.924	0.663	irs	0.727	1	0.727	irs
Beibu Gulf P&C Insurance Co., Ltd	BGIC	0.387	0.389	0.995	irs	0.564	0.596	0.947	irs	0.516	0.56	0.922	irs
ZhongAn Online P&C Insurance Co., Ltd	ZAPIC	0.614	0.65	0.945	drs	0.654	0.66	0.992	drs	0.421	0.837	0.502	drs
Fude P&C Insurance Co., Ltd	FDPIC	0.857	0.9	0.951	irs	0.466	0.468	0.995	irs	0.657	0.67	0.98	drs
Zhonglu P&C Insurance Co., Ltd	ZLPIC	0.169	0.416	0.406	irs	0.145	0.444	0.326	irs	0.249	0.379	0.657	irs
Hengbang P&C Insurance Co., Ltd	HBPIC	0.144	0.186	0.775	irs	0.508	0.597	0.851	irs	0.465	0.515	0.903	irs
Union P&C Insurance Co., Ltd	UPIC	0.021	1	0.021	irs	0.165	1	0.165	irs	0.248	1	0.248	irs
Huahai P&C Insurance Co., Ltd	HHPIC	0.121	0.136	0.89	irs	0.347	0.387	0.897	irs	0.573	0.663	0.865	irs
Yanzhao P&C Insurance Co., Ltd	YZPIC	0.048	0.054	0.89	irs	0.292	0.332	0.879	irs	0.495	0.51	0.971	irs
Zhongyuan Agricultural Insurance Co., Ltd	ZYAIC	0.089	0.101	0.881	irs	0.41	0.517	0.794	irs	0.502	0.559	0.899	irs
CNPC Captive Insurance Co., Ltd	CNPCIC	1	1	1	-	1	1	1	-	1	1	1	-
Zheshang P&C Insurance Co., Ltd	ZSPIC	0.631	0.633	0.997	irs	0.528	0.548	0.963	drs	0.554	0.576	0.961	drs
TK.cn Insurance Co., Ltd	TKIC	0.002	1	0.002	irs	0.605	0.752	0.804	irs	0.728	0.751	0.969	irs
	Mean	0.609	0.678	0.906		0.67	0.736	0.908		0.708	0.762	0.931	

Table A1.

About the authors

Zhiguang Li is currently a lecturer at the School of Economics and Management, Anhui University of Chinese Medicine, Hefei 230012, China. He received his B.S. degree in International Economics and Trade from Anhui University of Chinese Medicine, Anhui, China, in 2013, and his M.S. degree in International Finance from Sogang University, Seoul, South Korea, in 2016. Presently, he is a PhD student at the School of Management, Hefei University of Technology, Hefei 230009, China. His research interests are Corporate Governance, Venture Capital and Health Economy.

Yaokuang Li is a professor at the School of Management, Hefei University of Technology, China. He received the Master and PhD degrees in Management from Hefei University of Technology and Tongji University, respectively. His current research interests include entrepreneurship and finance, with focus on the venture capital, business angel, and crowdfunding. He published his research work in many peer-reviewed journals, such as Venture Capital: an International Journal of Entrepreneurial Finance, International Entrepreneurship and Management Journal, International Journal of Entrepreneurial Behavior and Research, Entrepreneurship Research Journal, and Chinese Rural Economy. Yaokuang Li is the corresponding author and can be contacted at: liyaokuang@hfut.edu.cn

Dan Long is an associate professor at the School of Management, Hefei University of Technology, China. She received the Master and PhD degrees in Management from Hefei University of Technology and Nankai University, respectively. Her research interests are entrepreneurship and strategic management. She had published more than 30 papers in journals such as Entrepreneurship Research Journal, International Journal of Entrepreneurial Behavior and Research, and Chinese Management Studies.