The structure of the global reinsurance market: An analysis of efficiency, scale, and scope

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A R T I C L E   I N F O

A B S T R A C T

We estimate economies of scale and scope as well as cost and revenue efficiency to explain the structure of the global reinsurance market, where large reinsurers dominate but both diversified and specialized reinsurers are competitive. The costs and benefits of size and product diversification are particularly relevant to the reinsurance industry, as risk diversification is central to the industry's business model. We find that reinsurers with total assets less than USD 2.9 billion exhibit scale economies, while those with total assets greater than USD 15.5 billion do not. Large reinsurers are characterized by high cost efficiency, while small reinsurers exhibit superior efficiency only when specialized. Large reinsurers also exhibit revenue scope economies when operating both life and nonlife reinsurance. Moreover, the evidence is in line with the efficient structure hypothesis: cost-efficient reinsurers can charge lower prices without sacrificing profitability.

1. Introduction

Reinsurers function as shock absorbers and risk bearers of last resort for the insurance industry and global economy. They provide services to primary insurers in terms of underwriting, pricing, claim management, and consultancy, enabling primary insurers to protect policyholders against risks, such as natural catastrophes, terrorism, and longevity. It has been shown that reinsurance also performs important strategic functions in insurance markets by supporting primary insurers to grow and to increase market share (Upreti and Adams, 2015). Moreover, reinsurers are a reliable source of alternative capital to primary insurers and to the global economy because of their large and long-term investment portfolios.

The reinsurance industry has undergone significant change in the 21st century, preceded by a number of large-scale catastrophes, the 2008 financial crisis, new competition from alternative risk transfer schemes, and new sources of capital from hedge funds and pension funds (Butt, 2007; Cummins and Weiss, 2009). These factors have resulted in consolidation (Cummins and Weiss, 2000; Cole and McCullough, 2006) and structural change in the global reinsurance market.

Economies of scale and scope, as sources of diversification, are particularly relevant to the structure of the reinsurance market. The advantages offered by scale economies motivate market consolidation because large firms tend to be more scale efficient than small firms. Scope economies exist when more product diversified firms exhibit cost efficiency advantages relative to specialized firms (Clark, 1988; Elango et al., 2008; Panzar and Willig, 1977, 1981). Alternatively, Borch (1960, 1962) takes a different perspective and argues that the global reinsurance market should be structured around optimal risk allocation. He predicts that, in market equilibrium, all reinsurers hold a proportional share of the "market portfolio" that pools all risks. Borch's equilibrium implies the complete diversification of risks through a market portfolio. The theories involving economies of scale and scope, as well as Borch's equilibrium, focus on two key features of the reinsurance business, size (scale) and product diversification[1] (scope), and thus provide

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[1] This paper focuses on product diversification, an aspect not yet studied in the context of the global reinsurance market. Regarding geographical or international diversification in the reinsurance market, we refer to Cole, Lee, and McCullough (2007), Ma and Elango (2008), and Outreville (2012a). We also highlight poten-

a basis for analyzing their empirical validity and consequences for market structure. Reinsurance is a persuasive context to analyze market structure, not only because of the variety of recent corporate strategic changes (Klarner and Raisch, 2013), but also because of industry-specific features, such as the risk allocation problem (Borch, 1960, 1962), potentially motivating diversification. Moreover, its intangible and regulated nature may create entry barriers and limit options for diversification.

To date, academic research on reinsurance has focused on reinsurance demand, contract design, pricing, and reinsurance decisions (Bernard, 2013; Kader et al., 2010). However, the reinsurance market itself, especially the performance of reinsurers, has not received sufficient attention. Most literature on reinsurance performance applies traditional accounting indicators, such as return on equity (ROE), return on assets (ROA), or underwriting ratios (e.g., Chen and Hamwi, 2000; Cole et al., 2010; Cole and McCullough, 2008; Outreville, 2012a, 2012b). Cummins and Weiss (2000) provide the first piece of evidence on reinsurer efficiency regarding the tradeoff between the mean and standard deviation of ROE. Their approach is between the accounting performance measurement and the frontier efficiency performance measurement, because they include only one input and one output. In our view, the research gap in reinsurance can partially be attributed to the difficulty of consistently identifying reinsurers and combining datasets for a comprehensive picture of the global reinsurance market. Moreover, efficiency analysis in the financial services industry is challenging and has attracted less attention than the manufacturing industries for which output can be more clearly quantified.

This paper makes four contributions. First, we estimate reinsurer cost efficiency using data envelopment analysis (DEA) based on multiple inputs and outputs. Second, we analyze economies of scale and scope based on DEA frontier efficiency measures to explain the structure of the global reinsurance market. Third, we derive an optimal size range for reinsurers by uncovering thresholds at which scale economies are exhausted. Fourth, we test the efficient structure (ES) hypothesis in the global reinsurance market that predicts efficient firms to be more competitive due to their ability to charge lower prices without sacrificing profitability. To the best of our knowledge, none of these analyses has been conducted previously.

Our empirical results on scale efficiency suggest an optimal size range of reinsurers between USD 2.9 and 15.5 billion in total assets (inflation adjusted to 2012). Scale diseconomies of the largest reinsurers are offset by their strong X-efficiency, which is defined as the part of cost efficiency that cannot be explained by scale efficiency. Hence, the largest reinsurers are, in general, most cost efficient. Some small reinsurers are also able to employ the best available technology and exhibit high pure technical efficiency in their specialized fields, thus partially offsetting their scale inefficiencies. Product diversification (i.e., scope) decreases X-efficiency of small reinsurers. Our findings support the ES hypothesis in the sense that cost-efficient reinsurers can charge lower prices at comparable levels of profitability. Our results explain the current structure of the global reinsurance market, in which large reinsurers dominate but both diversified and specialized reinsurers persist.

Our research contributes to finance and insurance research by exposing the organization of the global market for risk transfer. The results illustrate the tradeoff between scale diseconomies and gains in X-efficiency, which is relevant for decisions about mergers and acquisitions and about firm growth in industries that are becoming more global. Hence, our work contributes to the ongoing discussion of the performance and efficiency of insurance

companies (Eckles, et al., 2014), cross-country insurance operations (Pasiouras and Gaganis, 2013), and the systemic relevance of the reinsurance sector (Cummins and Weiss, 2014; Park and Xie, 2014).

This paper is organized as follows. In Section 2, we detail the theoretical foundation used to derive our hypotheses. In Section 3, we describe our data and methodology. In Section 4, we present the empirical results and check their robustness. Finally, we conclude and discuss future research topics in Section 5.

2. Hypothesis development

2.1. Economies of scale

The theory of economies of scale implies a potential optimal firm size and thus an optimal market structure. Scale economies (diseconomies) occur when a marginal proportional increase in the scale of inputs leads to a more (less) than proportional increase in outputs (Clark, 1988; Mansfield, 1970). Hence, competition is Pareto efficient if scale economies become exhausted at an output level that is a small portion of the market. However, when scale economies are significant and unexhausted at the full extent of the market, a monopoly firm may be able to minimize industry costs and prevent market entry (Panzar and Willig, 1977).

Economies of scale may exist in the reinsurance industry due to expensive IT systems, claim settlement operations, and risk management activities (Cummins and Xie, 2013), thus motivating market consolidation (Cummins et al., 1999; Cummins and Weiss, 2000; Lonkevich, 1995). However, large firm size can also lead to inefficiencies in the reinsurance industry due to agency problems, communication costs, and duplication efforts (Cummins and Weiss, 2013). Therefore, scale diseconomies may be present when the disadvantages of scale exceed the advantages. This tradeoff leads to our first hypothesis:

- *H1A: Reinsurer size has an inverse U-shaped relationship with scale efficiency.*

H1A implies that small reinsurers are more likely to operate under increasing returns to scale (IRS), medium-sized reinsurers are more likely to operate under constant returns to scale (CRS), and the largest reinsurers are more likely to operate under decreasing returns to scale (DRS). Similar relationships between firm size and scale efficiency are documented for many industries, for example, primary insurance (Bikker and Gorter, 2011; Cummins and Xie, 2013; Katrishen and Scordis, 1998) and banking (Berger and Humphrey, 1991; Noulas, Ray, and Miller, 1990). The presence of an inverse U-shaped relationship between reinsurer size and scale efficiency also implies an optimal size range, which we aim to identify.

2.2. Scale impact on cost efficiency

Cost efficiency contains aspects that cannot be explained by economies of scale (i.e., scale efficiency). To capture these aspects, we introduce the concept of X-efficiency (Berger, 1995; Cummins et al., 2010; Weiss and Choi, 2008),[2] defined as cost efficiency divided by scale efficiency, or pure technical efficiency multiplied by allocative efficiency. Therefore, we may observe the impact of

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[2] The concept of X-efficiency was proposed by Leibenstein (1966) to capture all sources of unspecified inefficiencies that are not allocative efficiency. Berger (1995) follows the original intention of X-efficiency and defines it as the differences in costs that cannot be explained by differences in scale or other observable characteristics. Cummins et al. (2010) and Weiss and Choi (2008) go on to define X-efficiency for the insurance context; we follow their definition and employ X-efficiency as cost efficiency divided by scale efficiency or pure technical efficiency times allocative efficiency.