Competition and efficiency in the non-life insurance market in South Africa

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Abstract

Purpose – The purpose of this paper is to examine the empirical effect of competition on cost and profit efficiency in the South African non-life insurance market in a three-stage analysis.

Design/methodology/approach – Using annual firm level data on 80 non-life insurance companies from 2007 to 2012, the authors first employ the stochastic frontier analysis (SFA) to estimate cost and profit efficiency scores. In the second stage, the authors measure insurance market competition using the Panzar-Rosse (P-R) *H*-statistics. In the final stage, the authors estimate a fixed-effects panel regression model which controls for heteroskedasticity to examine the effect of competition on the estimated efficiency scores. Firm size, diversification, age, risk, reinsurance and leverage are employed as control variables.

Findings – From the SFA, the authors find average cost and profit efficiency of 80.08 and 45.71 per cent, respectively. This suggests that non-life insurers have high levels of efficiency in cost and low efficiency in profit. The annual estimates of the P-R *H*-statistics also suggest that firms in the market earn revenues under conditions of monopolistic competition. The authors find a positive effect of competition on cost and profit efficiency to validate the "quiet-life" hypothesis which posits that competition improves efficiency.

Practical implications – Regulatory policies should be directed towards enhancing competition to improve on the low profit earning potential of firms in the non-life market.

Originality/value – To the best of the authors' knowledge, this study presents the first application of a non-structural measure of competition to examine the empirical relationship between competition and efficiency in insurance markets.

Keywords South Africa, Insurance, Efficiency, Stochastic frontier analysis, Competition, *H*-statistics, Quiet-life

Paper type Research paper

1. Introduction

This study examines the empirical relationship between competition and efficiency in the non-life insurance market in South Africa. The reference literature that examines the competition-efficiency nexus is the "quiet-life" hypothesis of Hicks (1935) which posits that managers of firms with market power enjoy a "quiet-life" free from competition. The lack of competition results in reduced managerial effort leading to inefficiency. Liebenstein (1966) further argues in his "liquidation hypothesis" that intense competition increases the pressure on management to reduce slack and improve efficiency. On the other hand, competition has the potential to exacerbate the information asymmetry[1] in insurance

JEL Classification — D4, D24, G22, L11

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markets and can result in market failures (Arrow, 1963; Akerlof, 1970; Rothschild and Stiglitz, 1976) and reduced efficiency (De Feo and Hindriks, 2014). For instance, competition in financial services industry has the tendency to shorten long-term relationships (Petersen and Rajan, 1995) between insurers and policy holders. This widens the information gap, increasing the cost of acquiring new information and results in declining efficiency. In addition, the profits enjoyed by firms in less competitive market power serves as incentives for prudent selection of less risky insurance portfolios leading to reduced screening and monitoring costs. These suggest an inconclusive effect of competition on efficiency in insurance markets.

Although the relationship has received considerable attention from researchers in banking markets in both developed and developing countries (Berger, 1995; Goldberg and Rai, 1996; Berger and Hannan, 1998), empirical evidence appears to be scanty in insurance markets. The few recent studies have been restricted to data from Europe and Asia (see Hao and Chou, 2005; Fenn *et al.*, 2008; Kasman and Turgutlu, 2009). As evidenced from the conflicting theories, empirical studies on the effect of competition on efficiency remain inconclusive. To the best of our knowledge, the evidence from insurance markets in Africa and other emerging markets appears non-existent.

This paper focuses on the non-life insurance market in South Africa for the following reasons. Like many other African countries, the financial services industry in South Africa witnessed tremendous changes after 1994[2]. A major development in the insurance industry was the separation of the life businesses from the non-life business with the passage of different legislative Acts[3] for both sub-markets in 1998. Unlike the life insurance market[4], the maturity of the non-life market, measured by the penetration ratio[5], is relatively low. This is reflected by the contribution of the sub-market to gross domestic product (GDP), which averaged less than 5 per cent compared to 16 per cent in the life market in 2012 (Swiss Re, 2012). This indicates a minimal contribution of the non-life business to economic growth. However, compared to the rest of insurance markets in Africa, about 50 per cent non-life insurance premiums underwritten in Africa are generated from the South African market. The non-life market has also witnessed declines in concentration levels among the top ten insurers over time, from 78 per cent in 2007 to 66 per cent in 2012. The implications of the changing structure on efficiency and the pricing behaviour of firms remains unexplored. These dynamics provide an interesting background for this study on the economic performance and competitiveness of the non-life insurance market in Africa. Such analysis is necessary to provide meaningful insights for policy formulation by both management of insurance companies and the regulatory authorities. These policies would be useful for the development of the market and improve its contribution to economic growth.

In order to achieve the objectives of this study, the stochastic frontier analysis (SFA) technique is employed to estimate both cost and profit efficiency of 80 non-life insurers in South Africa from 2007 to 2012. The competitiveness of the non-life insurance market is also analysed by undertaking cross-sectional estimations of the Panzar and Rosse (1987) reduced revenue model to generate annual industry H-statistics. This allows us to distinguish among three forms of market structures in monopolistic, competitive and monopolistic competitive markets. Finally, the effect of competition on estimated efficiency scores is analysed using fixed-effects techniques that accounts for heteroskedasticity. Product line diversification, size, age, underwriting risk, reinsurance usage and leverage are employed as control variables.

This paper contributes to the empirical literature in several ways. First, a major contribution of this paper is the analysis of profit efficiency in the South African insurance market. To the best of the authors' knowledge, this is the first study to examine profit efficiency in an African insurance market[6]. The relevance of estimating profit efficiency lies in the fact that cost efficiency only captures efficiency from the input side (through cost minimization). Managerial ability to concurrently maximize revenue and minimize cost is only captured through the estimation of profit efficiency (De Guevara and Maudos, 2002). This study is also the first to apply the SFA technique[7] to analyse efficiency in an insurance market in Africa. Unlike the deterministic data envelopment analysis (DEA) which attributes all deviations (errors) from the frontier to inefficiency (Coelli *et al.*, 1998), the SFA accounts for measurement errors and statistical noise, and represents a more robust assessment of firm efficiency. All prior efficiency studies in insurance markets in Africa have used the DEA technique (see Eling and Luhnen, 2010b; Ansah-Adu *et al.*, 2012; Barros and Wanke, 2014; Barros *et al.*, 2014; Alhassan *et al.*, 2015; Alhassan and Biekpe, 2015).

The paper also provides the first empirical evidence on the competitiveness of an insurance market in Africa using non-structural measure of market structure. The use of the Panzar-Rosse (P-R) *H*-statistics improves on the limitations of the structural measures of competition employed by prior studies to examine the direct effect of competition on efficiency in insurance markets. The structural measures, which are based on the assumption that concentration reflects lack of competition, have been contradicted by both theoretical and empirical evidence (see Demsetz, 1973; Fernández de Guevara *et al.*, 2005). This is supported by the efficient-structure hypothesis of Demsetz (1973), which argues that competitive markets could still be characterized by high levels of concentration through the exit of inefficient firms. Through cross-sectional estimations of the *H*-statistics, this study examines the evolution of competition over time. This analysis is useful to regulators in assessing the progress towards improving industry competitiveness.

The rest of the paper is structured as follows; Section 2 presents an overview of the non-life insurance market in South Africa; Section 3 reviews the empirical literature on cost and profit efficiency in insurance markets; Section 4 details the empirical strategy employed to test the hypotheses; Section 5 discusses the results and Section 6 concludes the study.

2. Overview of the non-life insurance market

The non-life insurance market in South Africa is regulated by the Short-Term Insurance Act 53 (1998) under the Insurance Department of the Financial Services Board (FSB). As part of broader reforms to the insurance market, insurers in the non-life market are currently preparing towards the adoption and compliance with the requirements of the Solvency and Assessment Management regulatory framework that seeks to enhance the soundness of the insurance market and protect policy holders. Table I shows that, at the end of 2012, there were 100 primary insurers underwriting various business lines in the non-life market. The number of reinsurers however remained unchanged between 2007 and 2012. Firms are registered to underwrite policies in at least one out of the eight business lines. From Table I, more insurers underwrite policies in at least two business lines to reflect a high incidence of premium diversification across multiple business lines. The industry concentration ratios (CR3, CR5, CR8 and CR10) from 2007 to 2012 are also presented in Table I. In 2007, the top 3, 5, 8 and 10 insurers accounted for approximately 51, 62, 73 and 78 per cent of the market's gross premiums, respectively. However, a reduction in concentration levels was observed for the top 3, 5, 8 and 10 insurers to 36, 49, 61 and 66 per cent, respectively, in 2012. This reflects a declining concentration levels and incidence of increasing competitive conditions.

	2007	2008	2009	2010	2011	2012
Number of primary insurers	96	94	100	99	97	100
Number of reinsurers	8	8	10	9	8	8
Single-line insurers	15	17	16	16	17	16
Multi-line insurers	42	58	59	62	62	60
Concentration ratios (%)						
CR3	51	39	39	36	35	36
CR5	62	52	53	48	47	49
CR8	73	65	67	62	60	61
CR10	78	71	73	68	65	66

Notes: Number of single-line and multi-line insurers is authors' estimation from research data. CR3, 3-firm concentration ratio; CR5, 3-5-firm concentration ratio; CR8, 8-firm concentration ratio; CR10, 10-firm concentration ratio
Source: Authors estimates from FSB Data (2007-2012)

Table I. Market characteristics

Table II presents the premium distribution across the eight business lines from 2007 to 2012. Across all periods, we observe that the combined market share of the motor and property business lines account for about 75 per cent of the gross written premiums in the non-life market. The motor business line is however the dominant of the two, accounting 41 per cent of industry premiums compared to 35 per cent for the property business line in 2012. All other business lines individually accounts for less than 10 per cent of the premiums. This suggests that insurance premiums are mostly generated from the motor and property business lines.

Table III shows that by the end of 2012, the total invested assets of non-life insurers was R106, 491 million, generating returns of R5, 499 million. Over the period, the investment yields of the non-life market experienced continuous decline from 2007,

Business lines	2007	2008	2009	2010	2011	2012
Motor	0.345	0.398	0.393	0.421	0.412	0.410
Property	0.352	0.333	0.344	0.346	0.342	0.346
Transportation	0.031	0.030	0.028	0.029	0.028	0.027
Accident and health	0.052	0.060	0.058	0.060	0.060	0.060
Guarantee	0.027	0.027	0.024	0.025	0.027	0.025
Liability	0.049	0.046	0.046	0.045	0.045	0.046
Engineering	0.039	0.048	0.050	0.031	0.037	0.038
Miscellaneous	0.104	0.057	0.058	0.049	0.038	0.038

Source: Authors computation from FSB Data (2007-2012)

Table II. Premium distribution by business lines

	2007	2008	2009	2010	2011	2012
Investment income	8,012	6,550	5,660	4,889	4,417	5,499
Total invested assets	69,376	73,997	79,019	90,481	98,437	106,491
Yield on invested assets (%)	11.5	8.9	7.2	5.4	4.5	5.2

Note: All monetary values in millions of South African rand
Sources: Authors computation from FSB Data (2009 and 2012)

Table III. Investments income and yields before recording a marginal increase in 2012 to 5.2 per cent from 4.5 per cent in 2011. The prolonged low interest rates (Financial Services Board, 2012) that characterize the financial system could partly explain the low yields generated on invested assets.

3. Literature review

Traditionally, the estimation of efficiency has mainly been undertaken with both parametric and non-parametric techniques. The class of parametric techniques specify an efficient frontier in the translog function but differ in the distributional assumptions of the inefficiency and random components (Eling and Luhnen, 2010a). The most widely applied techniques under the parametric approach include the SFA, distribution-free approach (DFA) and thick frontier approach. On the other hand, the non-parametric approaches are mainly based on mathematical programming techniques with no assumptions on the error terms. The DEA and free-disposal hull are the most common non-parametric techniques for estimating efficiency. This section provides a brief overview of empirical studies on efficiency in insurance markets.

From the survey of efficiency studies in insurance markets by Cummins and Weiss (2000) and Eling and Luhnen (2010a), it is observed that majority of the studies are concentrated on developed markets in the USA, Europe and developing Asian markets. In the most recent review by Eling and Luhnen (2010a), only two non-peer reviewed papers examine efficiency in insurance markets in Africa. Similar to majority of studies in developed markets, the two studies focused on technical efficiency. The analysis of cost and profit efficiency has mainly been limited to developed markets.

For instance, Fecher *et al.* (1993) employ both the DEA and SFA to estimate cost efficiency of 243 non-life insurers in France. The authors find an average industry operating cost of 50 per cent above the efficient frontier. In examining the determinants of efficiency in cross-section of 46 insurers in Australia, Worthington and Hurley (2002) find the average cost efficiency of 29.6 per cent. Kader *et al.* (2010) examine the cost efficiency of 26 non-life Takaful insurance firms from 2004 to 2006 across ten countries and find average cost efficiency of 0.70. Board size, ownership concentration, product diversity and firm size are identified as the drivers of cost efficiency in the second-stage analysis.

In the USA, Cummins and Xie (2013) find average cost efficiency of 51 per cent for 781 property and liability insurance companies from 1993 to 2009. Choi and Elyasiani (2011) employ the SFA to identify cost efficiency of 79.8 per cent in US property and liability insurance while Luhnen (2009) uses the DEA to estimate cost efficiency of 48 per cent for the German property and liability insurance market. In a cross-country study, Eling and Luhnen (2010b)[8] find average cost efficiency of 58 per cent for the non-life insurance market in South Africa from 2002 to 2006. From the UK life insurance industry, Hardwick *et al.* (2011) examine effect of board characteristics on profit efficiency in the UK life insurance market. The authors find life insurers to earn 69.1 per cent of their potential earnings using the SFA technique. Following the liberalization towards the establishment of a single European insurance market, Kasman and Turgutlu (2011) analyse the behaviour of cost efficiency in the increased competitive environment between 1995 and 2005. The authors report average cost efficiency of 88.2 per cent to be mainly driven by smaller insurers compared with large insurers. In assessing the relationship between stock returns and efficiency of 399 listed insurance firms in 52 countries between 2002 and 2008, Gaganis *et al.* (2013) find an average cost and profit efficiency of 88.15 and 44.61 per cent, respectively, using the SFA.

In relation to this study, authors such as Hardwick (1997), Noulas (2001), Cummins and Rubio-Misas (2006) and Ennsfellner *et al.* (2004) have also analysed efficiency during periods of deregulation and consolidation in European insurance markets. However, unlike the banking sector (Berger, 1995; Goldberg and Rai, 1996; Berger and Hannan, 1997), very few studies have empirically examined the direct effect of competition on efficiency in insurance markets. For instance, Hao and Chou (2005) provide the first empirical evidence on the effect of competition on efficiency in insurance markets. The authors employ the SFA and DFA techniques on 26 Taiwanese life insurers between 1997 and 1999 to estimate cost efficiency. The results of the random effects estimations suggest that competition (market power) resulted in the decline (improvement) in cost efficiency of life insurers in Taiwan. Fenn *et al.* (2008) also employ data on life and non-life firms in 14 European insurance markets from 1995 to 2001 to estimate cost efficiency using the SFA. Their results reveal that non-life insurers in Europe operate at only 7 per cent above the cost efficient frontier. From the regression analysis, the authors conclude that competition improves cost efficiency in both the life and non-life markets. Both Hao and Chou (2005) and Fenn *et al.* (2008) employed market share as their proxies for market structure. Kasman and Turgutlu (2009) also examine the cost efficiency in the Turkish insurance industry from 1990 to 2004. Using the SFA technique, the authors identified average cost efficiency to range between 63.1 and 81.7 per cent. The authors find evidence to suggest market concentration improves cost efficiency.

In Africa, Munro and Snyman (1995), Theron (2001), Liebenberg and Kamerschen (2008), Olaosebikan (2013) and Akotey *et al.* (2013) have examined various characteristics of insurance markets in different countries[9]. To the best of the authors' knowledge, efficiency-related studies appear to have rarely been examined and limited to studies by Ansah-Adu *et al.* (2012), Barros and Wanke (2014), Barros *et al.* (2014), Alhassan *et al.* (2015) and Alhassan and Biekpe (2015). Since the review by Eling and Luhnen (2010a), efficiency studies on insurance markets in Africa have begun to gain prominence among academics. For instance, Ansah-Adu *et al.* (2012) employ premium income as output variable to examine the cost efficiency of life and non-life insurers in Ghana from 2006 to 2008. They find average cost efficiency of 30 per cent using the DEA in the first-stage analysis. The authors identify market share, size and equity as the significant determinants of cost efficiency. Barros and Wanke (2014)[10] also analyse the technical efficiency and capacity issues in the insurance market in Mozambique using the DEA bootstrapped technique. The authors predict the effect of market share, ownership type and firm origin using neural network. In examining the effect of market structure and efficiency on the profitability of both life and non-life insurance companies in Ghana, Alhassan *et al.* (2015) find evidence in support of the efficient-structure hypothesis that efficiency drives profitability in both markets. The authors also employ the DEA technique in the estimation of efficiency scores. In a comprehensive efficiency analysis of the non-life insurance market in South Africa, Alhassan and Biekpe (2015) provide evidence of high technical inefficiency and technology-driven productivity growth. Drawing from the growth theory of convergence, the authors also conclude that the rate of efficiency catch-up by inefficient insurers over the study period was low.

From this review, this paper identifies the following gaps in the empirical literature on insurance markets. First, there is no evidence on profit efficiency estimates for insurance markets in Africa. Second, we find no literature on the application of the new empirical industrial organisation (NEIO)[11] theory to assess competition in insurance markets in Africa and other emerging markets. Finally, the paper provides the first empirical link between competition and efficiency using the Panzar and Rosse (1987) model which is based on the NEIO as the proxy for competition.

4. Methodology

The empirical investigations are carried out in three stages. The first stage involves the estimation of cost and profit efficiency scores using the SFA. In the second stage, the P-R model for estimating competitive behaviour is discussed. The final stage involves the description of the empirical model and theoretical justifications of the model variables.

4.1 Stage 1: cost and profit efficiency

The concepts of cost and profit efficiency refer to the economic objectives of a firm in cost minimization and profit maximization. Cost efficiency examines the extent of deviation from the "best-practice" firm while profit efficiency represents a much broader concept which examines the ability of firms to achieve the maximum profits given a set of outputs, inputs and their prices. In this study, the parametric SFA technique is favoured over the non-parametric DEA technique to estimate cost and profit efficiency. The SFA technique accounts for measurement errors and statistical noise, unlike the DEA technique, which attributes all deviations (errors) from the frontier to inefficiency (Coelli *et al.*, 1998). The SFA involves the maximum likelihood estimation of a translog cost and profit functions based on distributional assumptions of the error terms. From the comparison between optimum costs or profits and those realised, any deviation from the optimum levels are attributed to inefficiency and random noise (Aigner *et al.*, 1977; Meeusen and van der Broeck, 1977).

To estimate cost efficiency, the total cost of an insurer, C (consists of labour and business services expenses and capital expenses) is defined as a function of output vector y, input prices, w and the error term ε. The error term is decomposed into the inefficiency term, u and random factors, v which account for measurement errors and statistical noise. Based on Aigner *et al.* (1977) specification, the cost function is expressed below as:

$$C_{i,t} = f\left(y_{i,t}, w_{i,t}, \varepsilon_{i,t}\right) \tag{1}$$

where i and t refers to insurance firm and time period, respectively. The two-sided error term, ε is also defined as:

$$\varepsilon_{i,t} = u_{i,t} + v_{i,t} \tag{2}$$

$u_{i,t}$ is the inefficiency component; $v_{i,t}$ the measurement errors and other random factors.

The inefficient component, $u_{i,t}$ is a one-sided non-negative random variables independently distributed with zero truncation while the two-sided random factors $v_{i,t}$ are assumed to have independent and identical distribution with a zero mean and constant variance, σ_v^2.

In line with SFA convention, Equation 1 is log transformed into the following equation:

$$\ln\left(C_{i,t}\right) = f\left(\ln y_{i,t}; \ln w_{i,t}\right) + \ln u_{i,t} + \ln v_{i,t}. \tag{3}$$

In case of profit efficiency, we follow Berger and Mester (1997) and Hardwick *et al.* (2011) and estimate the alternative profit frontier, which assumes[12] uncompetitive inputs markets as opposed to the standard profit frontier. The cost in Equations 1 and 3 are replaced by profit after tax (π) in estimating the alternative profit efficiency in the following equations:

$$\pi_{i,t} = f\left(y_{i,t}, w_{i,t}, \varepsilon_{i,t}\right) \tag{4}$$

$$\ln\left(\pi_{i,t} + \theta\right) = f\left(\ln y_{i,t}; \ln w_{i,t}\right) - \ln u_{i,t} + \ln v_{i,t} \tag{5}$$

where θ is a constant added to the profit of each insurer. The constant is defined as the addition of the minimum absolute value of profits to one. Hence the dependent variable is defined by $\ln(\pi+\min|\pi|+1)$. This is done to obtain positive values to allow for logarithmic transformation of negative profits (Maudos *et al.*, 2002; Hardwick *et al.*, 2011).

Following Hao and Chou (2005) and Fenn *et al.* (2008), this study employs the multi-product translog[13] cost and profit functions based on value-added approach and identify the output variables (y) as net incurred claims and investment income. The input variables (w) considered includes labour and business services cost, debt and equity capital. The translog cost function for non-life insurers in South Africa is modelled on the works of Christensen *et al.* (1973) and Hao and Chou (2005) in Equation 6. Following Maudos *et al.* (2002), we include equity and time trend to capture risk differentials across the sample and the technological changes, respectively, over time. The multi-product translog cost function is presented in the following equation as:

$$
\begin{aligned}
\ln\left(\frac{tc}{w_3}\right)_{i,t} = {} & \alpha_0+\alpha_1\ln y_{1_{i,t}}+\alpha_2\ln y_{2_{i,t}}+0.5\alpha_3\ln y^2_{1(i,t)}+0.5\alpha_4\ln y^2_{2(i,t)} \\
& +\alpha_5\ln y_{1_{i,t}}\ln y_{2_{i,t}}+\beta_1\ln\left(\frac{w_1}{w_3}\right)_{i,t}+\beta_2\ln\left(\frac{w_2}{w_3}\right)_{i,t}+0.5\beta_3\ln\left(\left(\frac{w_1}{w_3}\right)_{i,t}\right)^2 \\
& +0.5\beta_4\ln\left(\left(\frac{w_2}{w_3}\right)_{i,t}\right)^2+\beta_5\ln\left(\frac{w_1}{w_3}\right)_{i,t}\ln\left(\frac{w_2}{w_3}\right)_{i,t}+\gamma_1\ln y_{1_{i,t}}\ln\left(\frac{w_1}{w_3}\right)_{i,t} \\
& +\gamma_2\ln y_{1_{i,t}}\ln\left(\frac{w_2}{w_3}\right)_{i,t}+\gamma_3\ln y_{2_{i,t}}\ln\left(\frac{w_1}{w_3}\right)_{i,t}+\gamma_4\ln y_{2_{i,t}}\ln\left(\frac{w_2}{w_3}\right)_{i,t} \\
& +\delta_1\ln e_{i,t}+\delta_2\ln e^2_{i,t}+\delta_3\ln e_{i,t}\ln y_{1_{i,t}}+\delta_4\ln e_{i,t}\ln y_{2_{i,t}} \\
& +\delta_5\ln e_{i,t}\ln\left(\frac{w_1}{w_3}\right)_{i,t}+\delta_6\ln e_{i,t}\ln\left(\frac{w_2}{w_3}\right)_{i,t}+\tau_1 trend_t+v_{i,t}+u_{i,t}
\end{aligned}
\tag{6}
$$

where ln is the natural logarithm; *tc* is insurers total cost (made up of incurred claims and other operational expenses). In the profit model, we replace *tc* by net profit after tax[14], y_1 the claims incurred; y_2 the investment income; w_1 the prices of labour and business services, w_2 the price of debt capital, w_3 the price of equity capital; e is equity capital. α, β, δ and τ are parameters to be estimated. In line with SFA convention, we impose homogeneity restrictions[15] by normalising tc, $(\pi_{s,t}+\theta)$, w_1 and w_2 by w_3.

In estimating the translog cost and profit functions, we employ the Battese and Coelli (1995)[16] specification, which assumes that the residuals follow truncated normal distributions and a time-varying efficiency term (Battese and Coelli, 1993; Coelli *et al.*, 1998). The maximum likelihood estimation technique is used to estimate the parameters of the translog functions in Equation 6. The existence of inefficiency in the model is defined by the variance ratio[17], $\gamma=\sigma^2_u/\left(\sigma^2_u+\sigma^2_v\right)$ (see Battese and Corra, 1977). γ explains the proportion of error term attributable to the inefficiency term, u other than the random error term, v. The value of γ lies between 0 and 1 with values closer to 1 indicating most of the deviations from the efficient frontier is due to managerial inefficiency. The efficiency scores are predicted using Jondrow *et al.* (1982) estimation. The predicted scores for each firm lies between 0 and 1 with values closer to 1 reflecting higher efficiency.

4.1.1 Output variables. In determining the choice of output variables, we follow the convention in efficiency literature and employ the value-added approach. In line with Yuengert (1993), Luhnen (2009), Hardwick *et al.* (2011), we use incurred claims as proxy for risk-pooling and bearing and financial services function of non-life insurers. This represents the amounts given to policy holders to compensate for losses arising out of specified events. We refrain from the use of earned premiums income since it captures both output quantity and price and not just output (Yuengert, 1993). Due to data unavailability, we use investment income instead of invested assets to proxy as the output of intermediation activities. This is consistent with Klumpes (2007).

4.1.2 Inputs prices. Following the convention in the insurance efficiency literature (Jeng *et al.*, 2007; Huang *et al.*, 2007), we assume non-life insurers employ inputs in labour and business services, debt and equity capital to generate their outputs. We proxy labour and business services input price, *pl* as the ratio of management expenses and commissions paid to total assets[18]. The price of debt capital, *pd*[19] is proxied as the ratio of investment income to total reserves (unearned premiums and outstanding claims). The ratio of net income to equity capital is employed as the price of equity capital, *pk*. Due to the possibility of negative profits; a constant is added to price of equity to allow for logarithmic transformation. All monetary values are deflated by the consumer price index. Table IV presents the summary statistics of untransformed variables used in the translog function models.

4.2 Stage 2: measuring competition

In this study, we employ the Panzar and Rosse (1987) *H*-statistics to examine the pricing behaviour of non-life insurers in South Africa. The P-R model is a reduced-form revenue equation which examines the elasticity of firm revenue to changes in input prices depending on the market structure. The *H*-statistics is defined as the sum of the elasticities of revenue with respect to input prices and valid under the assumption of long-run market equilibrium (Nathan and Neave, 1989). The estimated *H*-statistic identifies three major market structures in monopolistic, monopolistic competition and perfect competitive markets. Following Murat *et al.* (2002), Kasman and Turgutlu (2008)

	Mean	SD	Min.	Max.	*n*
Cost	550,791	452,077	264,868	1,683,939	436
Profit	94,812.15	217,428.5	−100,271	1,500,000	436
Outputs					
y_1	429,843	296,473	240,066	1,136,771	436
y_2	72,913	68,762	265,59	229,580	436
Input prices					
pl	0.1456	0.2138	0.2129	1.8817	441
pk	0.1738	0.3350	−3.2481	1.2446	441
pd	0.3295	1.2163	0.0962	19.5421	434
Risk					
Equity	461,476	931,181	2,833	5,886,037	441

Notes: Cost, operating expenditure; profit, net profit after tax; y_1, incurred claims; y_{12}, investment income; *pl*, price of labour; *pk*, price of equity capital; *pd*, price of debt. All monetary values are in thousands of South African rand

Table IV.
Summary of profit, cost, output and input prices

and Coccorese (2010), the reduced-form revenue equation for an insurer is specified in the following equations:

$$\ln pr_i = \beta_0 + \beta_1 \ln pl_i i + \beta_2 \ln pk_i + \beta_3 \ln pd_i + \beta_4 \ln ta_i + \beta_5 \ln eqr_i + \beta_6 \ln risk_i + \varepsilon_i \quad (7)$$

$$\ln tr_i = \lambda_0 + \lambda_1 \ln pl_i + \lambda_2 \ln pk_i + \lambda_3 \ln pd_i + \lambda_4 \ln ta_i + \lambda_5 \ln eqr_i + \lambda_6 \ln risk_i + \xi_i \quad (8)$$

where i represent an insurer and ln is the natural logarithm. *pr* and *tr* represent insurer's revenue[20] proxied as premium and total revenues[21], respectively. The use of *pr* is to capture the sensitivity of premium income to changes in the prices of insurance inputs. The input prices, *pl*, *pk* and *pd* are defined as in the translog functions. For the purpose of this study, size, equity ratio and underwriting risk are used as control variables. The summation of β_1 to $\beta_3(\beta_1+\beta_2+\beta_3 = H)$ becomes the computed *H*-statistics, together with the standard error, are used to test the significance of the coefficient. A computed *H*-statistics which is less than or equal to zero ($H \leqslant 0$) implies a monopolistic market, where firms experiences reduction in equilibrium output and revenue with increases in input prices. For competitive markets, the *H*-statistics is greater or equal to one ($H = 1$). This suggests that changes in production cost are proportional to changes in inputs prices. A monopolistic competitive market is captured by the *H*-statistics between zero and one ($0 < H < 1$). The validity of the *H*-statistics depends on the existence of long-run market equilibrium. In testing for the equilibrium condition, the dependent variables in Equations 7 and 8 are replaced by return on assets.

4.3 Stage 3: empirical model

To test the "quiet-life" hypothesis of Hicks (1935), we model the relationship between competition and efficiency on the works of Hao and Chou (2005) and Fenn *et al.* (2008) by regressing the estimated *H*-statistics on the predicted cost and profit efficiency scores as shown in the following equation:

$$u_{i,t} = \phi_0 + \phi_1 hs_t + \sum_{J=2}^{K} \beta_{j,it} x_{j,it} + \varpi_{s,t} \quad (9)$$

where subscripts i and t denotes firm and year, respectively. u represents the estimated cost and profit efficiency scores from the SFA. *hs* is the *H*-statistics estimated in Equations 7 and 8. Following Shaffer (1983), Vesala (1995) and Bikker and Haaf (2002a, b), we interpret the estimated *H*-statistics in as a continuous measure of competition in the regression model, with high values reflecting strong competitive behaviour and vice versa. Hence, a positive coefficient for estimated *H*-statistic would indicate that competition improves efficiency while a negative coefficient would suggest that competition is detrimental to efficiency. Equation 9 is expanded to include the control variables to form the following equation:

$$\begin{aligned} u_{i,t} = {} & \phi_0 + \phi_1 hs_t + \phi_2 pdiv_{i,t} + \phi_3 size_{i,t} + \phi_4 age_{i,t} \\ & + \phi_5 cr_{i,t} + \phi_6 reins_{i,t} + \phi_7 lev_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (10)$$

where *pdiv* represents 1-Herfindahl-Hirschman index[22] for product line diversification, *size* is measured as the natural logarithm of total assets, *age* is the natural logarithm of years since insurer was registered as a non-life insurer, *cr* is the ratio of incurred claims to earned premiums, *reins* is the ratio of reinsurance ceded to gross premiums and *lev* is the ratio of debt to equity. The error terms, ε, is decomposed into the unobservable firm-specific effects μ and υ, are the time-varying error terms which are independently and identically distributed. The descriptive statistics of the variables in Equation 10 are presented in Table V.

4.4 Hypotheses development

This section discusses the hypothesized effect of competition and the control variables on the estimated cost and profit efficiency scores.

4.4.1 Competition. The "quiet-life" hypothesis of Hicks (1935)[23] provides the theoretical basis for the relationship between competition and efficiency. Hicks (1935) posits that market power (less competition) results in less managerial efforts to control cost. In concentrated markets, Hicks (1935) contends that firms with market power maximize profits by setting prices above their marginal cost. The monopoly rents enjoyed by such firms allows for inefficient allocation of resources. This is supported by the arguments of Hart (1983) that competitive pressures motivate management to become efficient. From these arguments, we expect competition to be efficiency-enhancing, hence a positive relationship between *H*-statistics and efficiency. However, due to information asymmetry (adverse selection and moral hazards) in insurance markets, competition may have negative effect on firm efficiency. De Feo and Hindriks (2014) show that adverse selection worsens in competitive insurance markets and that concentrated market[24] enables the monopolist to improve efficiency. Hence, a negative relationship between competition and efficiency would also suggest the existence of information asymmetry[25] in insurance markets. Following these two contrasting theories, we hypothesize that:

H1. Competition has a significant relationship with cost and profit efficiency.

4.4.2 Control variables. Taking motivation from the empirical studies of Hao and Chou (2005), Fenn *et al.* (2008), Hardwick *et al.* (2011), Ansah-Adu *et al.* (2012) among several others, this study controls for product line diversification, size, age, underwriting risk, reinsurance ceded and leverage. This section discusses the hypothesized relationship between the explanatory variables and estimated cost and profit efficiency scores.

4.4.2.1 Product line diversification. Insurers that underwrite multiple business lines are able to hedge against the fluctuations in revenues. Additionally, they are able to maximize the use of fixed capital through input sharing in labour and technology (Huberman *et al.*, 1983). Hence, diversified insurers are expected to be more efficient. On the other hand, inefficient internal capital markets could lead to cross-subsidization of inefficient business lines by efficient ones. In such situations, firms with focused

Table V. Summary statistics of control variables of efficiency

Variables	Hypotheses	Measurement	Symbol	Mean	SD
Diversification	Conglomeration	1-Herfindahl index	*pdiv*	0.3756	0.2751
Size	Economies of scale	Ln (total assets)	*size*	12.8652	1.6039
Age	Learning-by-doing	Ln (age)	*age*	2.5381	0.9391
Claims ratio	Bad luck	Claims/premiums	*cr*	0.6692	2.7851
Reinsurance	Risk diversification	Reinsurance/premiums	*reins*	0.4426	0.4448
Leverage	Cash flow	Debt/equity	*lev*	2.1518	4.4684

Source: Authors estimation from Research Data operations are more likely to be more efficient compared to diversified firms. In line with the findings of Alhassan and Biekpe (2015) in the non-life insurance market in South African, Khaled *et al.* (2001) and Luhnen (2009), we expect a positive relationship between product line diversification and efficiency:

H2. Product line diversification has a significant positive relationship with cost and profit efficiency.

4.4.2.2 Firm size. Firm growth is more likely to result in economies of scale advantages (Berger *et al.*, 1993; Yuengert, 1993; Hao and Chou, 2005). Hence, cost and profit efficiency are more likely to improve in large firms because of reduced per unit production cost and increased market share. However, difficulties in monitoring and control of large scale of operations (Fama and Jensen, 1983) could result in wastage and increased cost. The empirical evidence on the size-efficiency relationship in insurance markets remains inconclusive:

H3. Size has a significant relationship with cost and profit efficiency.

4.4.2.3 Firm age. It has been argued that the survival of older firms is influenced by their ability to adjust to their operating environment with time through "learning-by-doing". This suggests that the older firms are more likely to be efficient than new insurers (Arrow, 1962; Jovanovic, 1982). On the other hand, older firms may also be constrained by their inability to adopt modern technology which impacts negatively on their productive capacity (Barron *et al.*, 1994). However, insurance businesses rely on reputation and trusts which are built from long-term relationships. Hence, we expect a positive age-efficiency relationship:

H4. Age has a significant positive relationship with cost and profit efficiency.

4.4.2.4 Underwriting risk. We also control for the effect of risk, measured as the ratio of claims incurred to premiums earned on efficiency. This variable reflects the quality of insurers underwriting policies. Insurers that underwrite risky policies have uncertain cash flow (Fama and Jensen, 1983) resulting from the high variations from claim payments. Risky insurers are expected to have high underwriting losses, hence less efficient. However, the underwriting of less risky portfolio may add to the cost structure of insurers through investments in underwriting processes and monitoring activities. This would explain any positive effect of risk on efficiency:

H5. Risk has a significant relationship with cost and profit efficiency.

4.4.2.5 Reinsurance. Reinsurance activities measure the extent of risk management activities of an insurer. Through the ceding of reinsurance premiums to reinsurers, primary insurers enhance their underwriting capacity (Malhberg and Url, 2003) and reduce the risk of insolvency (Kader *et al.*, 2010). We therefore expect reinsurance to be efficiency enhancing:

H6. Reinsurance activities has a significant positive relationship with cost and profit efficiency

4.4.2.6 Financial risk. Financial risk, proxied as leverage imposes financial cost on firms and increases the probability of financial distress and insolvency. A high insolvency risk, according to Berger *et al.* (2000), is less likely to attract risk-sensitive policy holders, hence decline in revenues. This results in negative leverage-efficiency relationship. However, the binding role of leverage puts pressure on management to perform and reduces managerial slack (Jensen, 1986), hence a positive effect of leverage on efficiency. Following Luhnen (2009) and Kasman and Turgutlu (2009), we expect a positive effect of leverage on efficiency:

H7. Leverage has a significant positive relationship with cost and profit efficiency.

4.5 Data

Annual income and balance sheet data on 100 non-life insurers were obtained from audited financial statements submitted to the insurance department of the FSB. The sample is made up of insurance companies of different sizes and business complexities covering the period[26] from 2007 to 2012. Insurers with negative values for assets and equity capital and missing data for more than three years of the study period were excluded from the final sample employed in the estimations. The final number of insurers employed in the analysis was 80 and covers about 80 per cent of firms in the non-life insurance market. Hence, the results of the analysis are fairly representative of the non-life insurance market. Although 80 firms were employed for the estimation of cost and profit efficiency scores, due to data unavailability for the age variable for some firms, the final sample for the panel data estimations dropped to 75 firms.

5. Empirical results

This section presents the results of analysis undertaken in stages 1 and 2. The parameters of the translog cost and profit functions in Equation 6 estimated using STATA 12 are reported in the Table AI. The value of variance parameter[27] γ (0.997 and 0.998 for cost and profit functions, respectively) indicates that the one-sided inefficiency term dominates the error structure of our models. Hence, the SFA technique better captures the inefficiency of the sample compared with deterministic models. The log likelihood ratio test also supports the use of the translog function over the Cobb-Douglas function.

The results of predicted cost and profit efficiency scores are reported in Table VI. The cost efficiency[28] score of 0.8008 suggests that an average non-life insurer in South Africa spends 19.92 per cent more on costs relative to the best-practice insurers. This represents an improvement on the 58 per cent cost efficiency[29] estimated by Eling and Luhnen (2010b) between 2002 and 2006. For profit efficiency[30], the score of 0.4175 also indicates that non-life insurers earn only 41.75 per cent of their earnings potential compared with best-practiced insurers. The high profit inefficiency could be attributable to output side inefficiencies from mispricing of insurance products (Berger and Hannan, 1998) and low

Table VI. Evolution of efficiency scores

	Cost efficiency		Profit efficiency	
Years	Mean	SD	Mean	SD
2007	0.8241	0.074	0.5847	0.223
2008	0.8194	0.079	0.5432	0.207
2009	0.8095	0.084	0.494	0.209
2010	0.7969	0.09	0.4324	0.207
2011	0.7884	0.094	0.3935	0.187
2012	0.7749	0.099	0.3365	0.178
Average	0.8008	0.089	0.4571	0.217

Source: Estimations from Research Data (see the Table AI for the parameter estimates of the SFA model) returns on premium investments to reflect inefficiency on the revenue side of non-life insurers. As observed in Table III, the relative low yields on investments[31] could partly explain the high levels of profit inefficiency.

The high levels of cost efficiency compared with profit efficiency is consistent with empirical evidence in the insurance (Gaganis *et al.*, 2013) and banking (Berger and Mester, 1997; Maudos *et al.*, 2002; Pasiouras *et al.*, 2009) literature. The observed differences between cost and profit efficiency scores also suggest an imperfect competitive market (Boss and Kool, 2006). Over the study period, we observe relatively higher variations in profit efficiency compared with cost efficiency as indicated by the standard deviations. This could reflect high uncertainties associated with returns on investments of insurance premiums in South Africa. Finally, we also observe a weak correlation[32] between the estimated cost and profit efficiency scores. This suggests that cost efficient insurers are not necessarily profit efficient and consistent with the findings of Gaganis *et al.* (2013). According to Rogers (1998), the greater effect of revenues compared to cost on profit efficiency scores explains the differences.

Due to the high variations in the size[33] of the sample, we examine efficiency differences between large and small insurers. The results of the profit and cost efficiency scores across small and large insurers are presented in Table VII. We observe high cost and profit efficiency for small insurers compared with large insurers. The *t*-test and the Wilcoxon rank test of mean differences suggest significant differences in cost efficiency of small and large insurers at 1 per cent. The relatively high cost inefficiency for large insurers reflects the over-utilization of their scale of operations which results in increased cost. For small insurers, the high levels of cost efficiency could be attributed to the ease of monitoring and controlling small business operation which maximizes resources usage. This suggests that mergers and consolidation which results in the increases in firm size may not be efficiency enhancing.

The estimates of annual *H*-statistics[34] over the study period are presented in Table VIII. Across all periods[35], the *H*-statistics (under the two specifications of the insurance revenue in premium revenue, HS-PR and total revenue, HS-TR) lies between 0 and 1 and significantly different from 0 and 1. This indicates that non-life insurers earn revenues under conditions of monopolistic competition. As a continuous measure of competition, the smaller estimated *H*-statistics (closer to 0 than 1) suggest that the competitive pressures in the market are not very strong. On the evolution of competition, we observe a relatively greater competitive pressure in 2008 under both forms of insurance revenue. A decline in competitive pressures is observed after 2008 till 2011, after which competitive conditions increased in 2012.

Before examining the effect of competition 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 (Kennedy, 2008). Hence,

	Small ($n = 214$)	Large ($n = 215$)	Mead diff	*t*-test	*z*-test
Cost efficiency	0.8252	0.7765	0.0486	5.876***	5.525***
Profit efficiency	0.4681	0.4462	0.0219	1.042	1.333

Notes: Small, small non-life insurers; large, large non-life insurers. The tests were conducted under an unequal variance assumption. *H0*, mean (small)-mean (large) = 0; *H1*, mean (small)-mean (large) ≠ 0. ***Significant differences at 1 per cent

Table VII. Efficiency scores and insurer size

Table VIII. Evolution of competitive behaviour

Years	Premium revenue (HS-PR) *H*-stat	*H* = 0	*H* = 1	Total revenue (HS-TR) *H*-stat	*H* = 0	*H* = 1	*n*
2007	0.3548	3.16*	10.45***	0.2907	3.08*	18.31*	57
2008	0.4753	9.17***	11.18***	0.4586	10.81***	15.06***	75
2009	0.4349	7.8***	13.17***	0.4052	8.86***	19.10***	75
2010	0.3538	6.67**	22.27***	0.3436	7.67***	27.97***	78
2011	0.2480	2.67	24.58***	0.2551	3.39*	28394***	79
2012	0.4285	7.47***	13.3***	0.4189	8.70***	16.75***	77

Notes: $H=0$ and $H=1$ tests the null hypothesis that *H*-statistics is significant different from 0 and 1, respectively; *n*, number of cross-sectional observations (refer to the Table AII for parameter estimates of the Panzar-Rosse, 1987 model estimations)

multicollinearity is not observed among the control variables. However, the two proxies of competition, HS-PR and HS-TR, have a correlation coefficient of 0.944. Hence, we introduce the two proxies of competition into the regression model in a stepwise manner to avoid the possibility of multicollinearity biases. The Pearson correlation matrix is presented in Table IX.

5.1 Regression results

Presented in Table X are the panel regression results on the relationship between efficiency and competition. The proxies for insurance market competition are the Panzar and Rosse (1987) *H*-statistics for premium revenue (HS-PR) and total revenue (HS-TR). Based on the Hausman (1978) specification test, the models were estimated using the fixed-effects technique. The dependent variable in Models 1 and 2 is cost efficiency while Models 3 and 4 have profit efficiency as the dependent variable. All estimations are heteroskedastic and autocorrelated consistent[36].

In Models 1 and 2, the coefficients of competition, HS-PR and HS-TR are positive and significant at 1 per cent. This indicates that competition leads to improvements in cost efficiency. This supports the "quiet-life" hypothesis which suggests that competitive pressures motivate managers to perform closer to the efficient frontier and consistent with the findings of Fenn *et al.* (2008). The relationship between profit efficiency and competition is also positive and significant at 1 per cent in Models 3 and 4.

	HS-PR	HS-TR	*pdiv*	*size*	*age*	*cr*	*reins*	*lev*
HS-PR	1.000							
HS-TR	0.944***	1.000						
pdiv	0.016	0.013	1.000					
size	−0.043	−0.030	0.283***	1.000				
age	−0.013	−0.012	0.264***	0.513***	1.000			
cr	0.012	0.005	−0.021	0.040	0.030	1.000		
reins	−0.025	−0.009	0.178***	−0.114**	0.080	−0.065	1.000	
lev	0.004	−0.013	0.292***	0.222***	0.056	−0.028	0.091*	1.000

Notes: HS-PR, *H*-statistics based on premium revenue as dependent variable; HS-TR, *H*-statistics based on total revenue as dependent variable; *size*, ln (total assets); *pdiv*, 1-Herfindahl index for product line diversification; age, ln(the number of years in operation); *cr*, incurred claims to premiums ratio; *reins*, ratio of reinsurance ceded to gross premiums; lev, ratio of liabilities to equity. ***, **,*Significant at 1, 5 and 10 per cent, respectively

Table IX. Correlation matrix

Table X. Fixed-effects results

	Cost efficiency				Profit efficiency			
	Model 1		Model 2		Model 3		Model 4	
Dependent variables	*Coef.*	*t*	*Coef.*	*t*	*Coef.*	*t*	*Coef.*	*t*
Constant	1.051 (0.063)***	16.61	1.080 (0.065)***	16.51	1.873 (0.237)***	7.9	2.011 (0.244)***	8.25
HS-PR	0.040 (0.005)***	8.02			0.190 (0.025)***	7.68		
HS-TR			0.014 (0.003)***	4.76			0.064 (0.015)***	4.29
pdiv	0.005 (0.014)	0.38	0.006 (0.015)	0.44	0.048 (0.059)	0.81	0.053 (0.060)	0.89
size	−0.016 (0.006)***	−2.73	−0.016 (−2.73)***	−2.73	−0.087 (0.02)***	−4.31	−0.090 (0.021)***	−4.24
age	−0.030 (0.008)***	−3.94	−0.031 (0.008)***	−4.01	−0.168 (0.028)***	−5.96	−0.176 (0.03)***	−5.92
cr	0.0002 (1E−04)***	4.49	0.00024 (6E−05)***	4.25	0.002 (2E−04)***	6.81	0.0016 (3E−04)***	6.28
reins	−0.006 (0.004)	−1.28	−0.00606 (0.004)	−1.38	0.004 (0.018)	0.22	0.0014 (0.019)	0.08
lev	0.0002 (0.0002)	1.02	0.00026 (0.00026)	0.99	0.003 (0.001)*	1.94	0.0026 (0.0015)*	1.78
F-test	31.13***		21.85***		48.89***		32.26***	
R^2	0.4277		0.4068		0.5592		0.5375	
Hausman χ^2	437***		513***		287.67***		380.67***	
Insurers	75		75		74		74	
Observations	394		394		392		392	

Notes: HS-PR, *H*-statistics based on premium revenue as dependent variable; HS-TR, *H*-statistics based on total revenue as dependent variable; *size*, ln (total assets); *pdiv*, 1-Herfindahl index for product line diversification; *age*, ln (the number of years in operation); CR, incurred claims to earned premiums ratio; *reins*, ratio of reinsurance ceded to gross premiums; LEV, ratio of liabilities to equity. Figures in parentheses are heteroskedastic and autocorrelated consistent SEs. ***,**,* Significant at 1, 5 and 10 per cent, respectively

This indicates that competitive pressures improve profit earning potential of non-life insurers in South Africa. Hence, the market power hypothesis which posits that concentration improves profit efficiency is rejected[37]. In a comparison of the coefficients of the competition under the cost and profit efficiency models, we find higher coefficients in the profit models compared with the cost models. This suggests that improving industry competitiveness would be more beneficial in improving on the high profit inefficiencies in the market. Overall, the positive effect of competition on both cost and profit efficiency does not support the existence of adverse selection in the non-life insurance market in South Africa.

On the control variables, we find size to be negatively related to cost efficiency at 1 per cent across all estimations. This suggests that large insurers have high cost inefficiency and reflects the monitoring difficulties and resource duplication which characterizes large operations. A negative relationship between size and profit efficiency at 1 per cent in Models 3 and 4 also reflects the existence of diseconomies of scale for large insurers in the non-life insurance market. These results support our earlier observations in Table VII.

Age of insurers is also negatively related to both cost and profit efficiency at 1 per cent. This implies older insurers have high cost and profit inefficiency. Underwriting risk proxied as the CR is positively related to cost and profit efficiency at significance levels of 1 per cent. This indicates that high-risk insurers are more cost and profit efficient. This result from additional cost incurred to underwrite low risk insurance pools (low CR). The cost involves investments to improve underwriting practices and monitoring activities, resulting in increased production cost and lower profit margin.

Leverage is also positively related to both cost and profit efficiency. The relationship is only significant with profit efficiency at 10 per cent in Model 4. This indicates that high leverage leads to higher profit efficiency, ceteris paribus. This result confirms the over-utilization of equity capital as an input by insurers (Cummins and Nini, 2002). Luhnen (2009) and Kasman and Turgutlu (2009) find similar results in the German property and liability and Turkish insurance market, respectively. However, we do not find any evidence to support either the conglomeration or the strategic focus hypotheses in respect of the non-life insurance market. The relationship between reinsurance usage and efficiency was also found to be insignificant.

6. Conclusions and policy recommendations

Empirical studies on the efficiency of financial institutions in Africa have mainly been limited to banking markets. In this paper, we extend the existing literature by empirically examining the effect of competition on cost and profit efficiency in the non-life insurance market in South Africa. The SFA is employed to estimate cost and profit efficiency of 75 non-life insurers from 2007 to 2012. Insurance market competition is analysed by cross-sectional estimations of the Panzar-Rosse (1987) revenue model. The findings indicate high levels of efficiency in cost and low levels in profit. On the average, costs are about 20 per cent over the estimated cost frontier while insurers earn 45.71 per cent of their optimum profits. The results of ordinary least squares estimations of the P-R models indicate a monopolistic competitive non-life insurance industry.

In the third-stage analysis, we employ a fixed-effects panel regression analysis to examine the effect of competition and other contextual variables on cost and profit efficiency. We find a positive effect of competition on cost efficiency to supports the "quiet-life" hypothesis of Hicks (1935) which suggests that competitive insurance markets leads to improvements in cost efficiency. The positive relationship between competition and profit efficiency also indicates that competition improves profit efficiency to invalidate the market power hypothesis. These findings suggest the absence of information asymmetry in the non-life markets. Our findings also suggest that small insurers are more efficient in controlling cost and maximizing profits compared to large insurers. This reflects the monitoring and control difficulties associated with the management of large-scale operations. Older insurers were also found to be less cost and profit efficient. Against expectation, we find underwriting risk to improve cost and profit efficiency. This result from cost incurred by insurers in reducing the risk associated with insurance pool. Non-life insurers were also found to over-utilize their equity from the positive effect of leverage on profit efficiency.

The findings of this study have implications for the regulation and management of insurance companies. To help reduce the high profit inefficiencies and maximize the earning potential of non-life insurers, regulatory authorities should seek to improve the competitive conditions as a means of strengthening managerial efforts to reduce resource misuse and wastages. For management of insurance companies, the effect of firm level characteristics on efficiency provides insights on the focal areas of their insurance operation that need improvements.

Although the results are suggestive of the non-existence of information asymmetry in the market, we also recommend that formalized test developed in literature could also be employed to test for the robustness of our findings. Future studies could also examine the reverse causality between competition and efficiency. The differences in the nature of business in both life and non-life market implies that the findings of this study may not be applicable to the life market. Hence, similar analysis could also be undertaken for the life insurance market.

Notes

1. Through adverse selection, high-risk individual are more likely to purchase insurance policies and result in more than expected losses.
2. This covers the period after the first democratic elections in South Africa.
3. The Short-Term Insurance Act (Act 53 of 1998) regulates the activities of the non-life insurance business.
4. According to reports by Swiss Re in 2012 and 2013, the life insurance market has experienced strong growth in premiums compared to the non-life market. Our focus on the non-life insurance market is partly influenced by the weak performance of the market. The stability of the market is very critical to ensure the continuity of businesses. The needed investments required to promote economic growth could be made possible if an effective risk management system exist to provide cover for business uncertainties.
5. This is defined as the ratio of gross written premiums to GDP.
6. From a survey of 95 efficiency studies by Eling and Luhnen (2010a) in insurance markets, very few studies evaluated profit efficiency in developed insurance markets.
7. The only exception was Eling and Luhnen (2010b) which covered a small sample of insurance companies in South Africa.
8. The estimations included a total of 72 observations for the non-life insurance market in South Africa.
9. Barros *et al.* (2008) provided the first reported evidence efficiency on insurance market in Africa. The authors analysed the productivity changes in the insurance market in Nigeria.

10. Similar analysis was conducted by Barros *et al.* (2014) in the Angolan insurance market.
11. The NEIO infers competition from the pricing behaviour of firms.
12. Hardwick *et al.* (2011) also makes similar assumptions for the life insurance market in UK.
13. The use of the Translog function instead of the Cobb-Douglas function is supported by the test of functional form. The result is presented in the parameter estimates of the both the cost and profit functions.
14. For profit efficiency, the inefficiency term u changes to $-u$.
15. The input share equations based on Shepherd's Lemma restrictions are omitted in line with the arguments of Rai (1996), Berger and Mester (1997) and Beccalli *et al.* (2006).
16. While the two-step procedure is heavily biased by presence of heteroskedasticity (Wang and Schmidt, 2002), our attempts to employ the single-step estimation of Battese and Coelli (1995) in which the inefficiency effects in the composed error term are expressed as an explicit function of the firm-specific variables produced erratic results. In all instances, the standard errors of the explanatory variables are not generated by system. However, the use of the two-stage procedure is consistent with studies by Liadaki and Gaganis (2010) and Gaganis *et al.* (2013).
17. Based on the Battese and Corra (1977) parameterization, the variance is given by $\sigma^2 = \sigma_u^2 + \sigma_v^2$.
18. The number of employees has normally been used as the denominator. In this study, we were constrained by data limitations.
19. The convention in literature is the use of expected investment income which excludes those attributable to equity capital as the numerator. The data does not allow for the separation of investment income into its main sources. Hardwick *et al.* (2011) employs similar proxy for price of debt capital.
20. Several arguments have been exposed on the use of scale revenue as the dependent variable. In this study, we follow Bikker *et al.* (2006) and used an unscaled specification of the revenue term.
21. This is made up of premium income and investment income.
22. The HHI is computed as the sum of the square of the market share of premium from each business line to gross premiums for all business lines for each insurer.
23. The efficient-structure hypothesis of Demsetz (1973), however proposes a reverse causality between efficiency and competition. The central theme behind ES is that concentration not implies less competition. The argument is that efficient firms will produce at lower cost and increase market share at the expense of inefficient. For the purposes of this study, we limit the discussions in this study to the testing the Hicks (1935) "quiet-life" theory.
24. The market power hypothesis of Bain (1951) and Baumol (1982) and also supports a negative relationship between competition and efficiency. Choi and Weiss (2005) developed a formal test for the market power hypothesis.
25. It should, however, be noted that formal tests have been developed and employed to examine the existence of information asymmetry in insurance markets.
26. The period is constrained by data availability. The inclusion of data prior to 2007 will reduce the sample from 80 to less than 30 and have an adverse effect on the statistical power.
27. We refrain from discussing the parameters of the translog functions for brevity. From the variance parameters, we find the coefficients of γ of 0.997 and 0.998 for cost and profit efficiency, respectively. This indicates that inefficiency accounts for greater deviations from the efficient frontier at 1 per cent. The test that $\lambda = 0$ is rejected at 1 per cent in both the cost and profit equations.

28. Kader *et al.* (2010) find CE of 0.70 for Takaful non-life insurers; Hardwick *et al.* (2007) find CE of 0.66 for UK non-life insurance market while Wang *et al.* (2007) find 0.72 CE by for the non-life insurance market in Taiwan.
29. The differences could be attributed to differences in sample period and size.
30. This is lower than the 0.691 found by Hardwick *et al.* (2011) in the UK life insurance market but similar to the 39.62 per cent found by Gaganis *et al.* (2013) for 399 listed insurance firms in 52 countries.
31. As at the end of 2012, approximately 33 per cent of investments of non-life insurers were in shares and stocks.
32. This was obtained from a correlation analysis. A correlation coefficient of 0.2654 was insignificant.
33. Size defined as the natural logarithm of total assets. Insurers with mean value of size less than 12.8652 are classified as small and those above as large insurers.
34. The estimation results are attached as the Table AII. The equilibrium conditions for all the periods were met but unreported. The results are available on request from the authors.
35. The only exception was in 2011 were the hypothesis of monopoly was not rejected under the premium income.
36. As robustness test, we employ the Tobit estimation which assumes the efficiency scores to be censored between zero (0) and one (1). The results, which are consistent with FE estimations in Table V, are also unreported but available on request.
37. The improved cost efficiency in competitive markets leads to increased market share for efficient firms. Hence, high sales revenue results in increased profit efficiency. This is in line with the efficient-structure hypothesis of Demsetz (1973).

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Appendix 1

	Parameters	Cost efficiency Coef.	z	Profit efficiency Coef.	z
Constant	α_0	−17.701	−4.36***	135.433	6.1***
y_1	α_1	0.011	0.07	−4.474	−5.09***
y_2	α_2	1.719	10.15***	−0.376	−0.46
$0.5y_1y_1$	α_3	0.004	3.84***	0.034	5.62***
$0.5y_2y_2$	α_4	0.024	12.96***	−0.006	−0.73
y_1y_2	α_5	−0.040	−4.23***	−0.030	−0.57
wl	β_1	−0.389	−0.47	34.504	6.69***
wd	β_2	3.656	5.31***	3.788	1.32
$0.5wlwl$	β_3	−0.006	−0.07	0.078	0.14
$0.5wdwd$	β_4	0.039	2.83***	0.002	0.06
$wlwd$	β_5	0.381	3.47***	0.676	0.84
y_1wl	γ_1	−0.882	−10.56***	−2.433	−5.25***
y_1wd	γ_2	−0.293	−4.78***	−0.069	−0.33
y_2wl	γ_3	1.002	12.92***	−0.480	−1.41
y_2wd	γ_4	−0.009	−0.24	−0.218	−1.47
e	δ_1	0.633	9.01***	−1.864	−4.28***
e_2	δ_2	0.008	2.96***	0.057	4.21***
y_1e	δ_3	−0.008	−0.94	0.081	2.28**
y_2e	δ_4	−0.035	−4.58***	0.000	0.00
wle	δ_5	0.204	8.14***	0.197	1.69*
wde	δ_6	0.050	2.55**	0.008	0.160
years	τ	0.006	3.13***	−0.031	−3.64***
Variance parameters					
μ		−4.653	–	−23.227	−7.05***
σ_u		0.563	23.37***	2.606	99.05***
σ_v		0.030	6.64***	0.120	10.45***
λ		19.006	693.84***	21.761	752.84***
σ^2		0.318		6.807	
γ		0.997		0.998	
Test of functional form: H = 0: Cobb-Douglas					
Wald χ^2		42.58		46.37	
Prob > χ^2		0.000		0.000	
Wald χ^2 (21)		243,011.8***		1,633.77***	
Log likelihood		565.128		−24.1989	
Insurers		80		80	
Observations		434		434	

Notes: ***,**,*Significant at 1, 5 and 10 per cent, respectively

Table AI. Cost and profit efficiency frontier estimates

Appendix 2

Table AII. Annual estimates of Panzar-Rosse H-statistics

	2007		2008		2009	
	PR	TREV	PR	TREV	PR	TREV
Dependent variables	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*
Constant	−1.632 (1.300)	−0.934 (1.079)	−2.970 (1.001)***	−2.213 (0.890)**	−2.074 (0.984)**	−1.375 (0.860)
pl	0.449 (0.170)**	0.339 (0.141)**	0.710 (0.130)***	0.613 (0.115)***	0.627 (0.121)***	0.529 (0.106)***
pd	−0.144 (0.083)*	−0.089 (0.069)	−0.268 (0.096)***	−0.186 (0.085)**	−0.252 (0.102)**	−0.181 (0.089)**
pk	0.050 (0.031)	0.041 (0.026)	0.034 (0.026)	0.031 (0.177)	0.060 (0.023)**	0.057 (0.02)***
size	1.112 (0.119)***	1.065 (0.099)***	1.237 (0.090)***	1.188 (0.080)***	1.179 (0.085)***	1.135 (0.075)***
EQT	−0.181 (0.142)	−0.138 (0.118)	−0.079 (0.123)	−0.078 (0.11)**	−0.019 (0.140)	−0.003(0.122)
risk	0.075 (0.092)	0.069 (0.076)	0.098 (0.079)	0.078 (0.070)	0.088 (0.096)	0.105 (0.084)
H-statistics	0.3548^{MC}	0.2907^{MC}	0.4753^{MC}	0.4586^{MC}	0.4349^{MC}	0.4052^{MC}
$H=0$: F	3.16	3.08	9.17	10.81	7.8	8.86
Prob > F	0.0815	0.0856	0.0035	0.0016	0.0068	0.004
$H=1$: F	10.45	18.31	11.18	15.06	13.17	19.1
Prob > F	0.0022	0.0001	0.0013	0.0002	0.0005	0.0000
F	51.7	74.44	64.58	78.33	53.86	68.7
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.8612	0.8993	0.8507	0.8736	0.8261	0.8584
Adj. R^2	0.8445	0.8872	0.8375	0.8624	0.8108	0.8459
Root MSE	0.66789	0.55467	0.65845	0.58541	0.67178	0.5871
Observations	57	57	75	75	75	75

(*continued*)

Table AII.

	2010		2011		2012	
	PR	TREV	PR	TREV	PR	TREV
Dependent variables	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*
Constant	−1.646 (0.873)*	−1.273 (0.791)	−1.457 (0.890)	−1.104 (0.813)	−1.590 (0.955)	−1.236 (0.865)
pl	0.602 (0.105)***	0.542 (0.096)***	0.536 (0.104)***	0.495 (0.095)***	0.641 (0.114)***	0.589 (0.103)***
pd	−0.305 (0.088)***	−0.249 (0.08)***	−0.404 (0.108)***	−0.338 (0.099)***	−0.260 (0.105)**	−0.211 (0.095)**
pk	0.057 (0.024)**	0.051 (0.022)**	0.117 (0.034)***	0.098 (0.031)***	0.047 (0.031)	0.040 (0.028)
size	1.129 (0.075)***	1.110 (0.068)***	1.113 (0.075)***	1.094 (0.068)***	1.139 (0.081)***	1.116 (0.073)***
EQT	0.023 (0.110)	0.033 (0.100)	0.268 (0.143)*	0.240 (0.130)*	0.047 (0.139)	0.028 (0.126)
risk	0.079 (0.093)	0.088 (0.084)	0.078 (0.082)	0.071 (0.075)	0.166 (0.083)**	0.134 (0.075)*
H-statistics	0.3538^{MC}	0.3436^{MC}	0.2480^{MP}	0.2551^{MC}	0.4285^{MC}	0.4189^{MC}
$H=0$: F	6.67	7.67	2.67	3.39	7.47	8.7
Prob > F	0.0118	0.0072	0.1063	0.0695	0.0079	0.0043
$H=1$: F	22.27	27.97	24.58	28.94	13.3	16.75
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0005	0.0001
F	57	69	55.23	64.47	49.76	58.47
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.8281	0.8536	0.8215	0.8431	0.8101	0.8337
Adj. R^2	0.8136	0.8412	0.8066	0.83	0.7938	0.8194
Root MSE	0.64992	0.589	0.67907	0.6199	0.72406	0.65595
Observations	78	78	79	79	77	77

Notes: PR, premium revenue, TREV, total revenue, dependent variable; *pl*, price of labour; *pd*, price of debt, *pk*, price of equity capital; *size*, natural logarithm of total assets; *EQT*, ratio of total equity to total assets; *risk*, ratio of claims incurred to net earned premiums; *MC* and *MP*, monopolistic competitive and monopolistic markets, respectively. Robust SE in parenthesis. ***,**,*Significant at 1, 5, and 10 per cent, respectively