Chrysovalantis Gaganis – Iftekhar Hasan – Fotios Pasiouras

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Chrysovalantis Gaganis[1], Iftekhar Hasan[3,4*], Fotios Pasiouras[2,5]

[1]Department of Economics, University of Crete, Greece
[2] Surrey Business School, University of Surrey, UK
[3] Schools of Business, Fordham University, USA
[4]Bank of Finland, Finland
[5] Financial Engineering Laboratory, Technical University of Crete, Greece

[*]Corresponding author. Tel: 1 646 312 8278. E-mail: c.gaganis@econ.soc.uoc.gr; ihasan@fordham.edu; f.pasiouras@surrey.ac.uk
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Efficiency and stock returns: Evidence from the insurance industry

Abstract

This study investigates whether the capital market values the efficiency of firms. After tracing stock returns and efficiency changes of 399 listed insurance firms in 52 countries during the 2002-2008 period, the paper reports a positive and statistically significant relationship between profit efficiency change and market adjusted stock returns. However, there is no robust evidence that cost efficiency change is associated with stock returns.

Keywords: Efficiency, insurance, stock returns.

JEL: C22 C34 G22

1. Introduction

There are numerous studies in the accounting and finance literature that examine the association between stock prices and publicly available information. Although the majority of these studies focus on the relationship between stock prices and accounting earnings, more recent work has explored the use of certain items that are supplemental to the balance sheet or the employment of alternative measures of performance. Such examples include the use of accruals (e.g., DeFond and Park, 2001), revenues (e.g., Jegadeesh and Linvat, 2006), economic value added (Biddle et al., 1997), net operating assets (Papanastasopoulos et al., 2011), technological progress (Lin, 2012), financial constraints, research and development (Li, 2011), and efficiency (Frijns et al., 2012). Our study falls into the last category, and we aim to add to the literature by examining for the first time the relationship between efficiency change and stock returns in the insurance industry.

There are three main reasons for which we focus on efficiency measures. First, as mentioned in Cummins and Xie (2009), while there are some studies that relate bank efficiency and stock returns, no such studies exist in the insurance literature.[1] In their study, Cummins and Xie (2009) make a first attempt to link efficiency and market-value performance in the insurance industry; however, they focus on the stock market reaction to acquisitions and divestitures in the U.S. We differentiate our study in two important respects. Instead of examining the returns around acquisitions, we follow recent studies from the banking (e.g., Liadaki and Gaganis, 2010; Avkiran and Morita, 2010) and non-financial industries (Nguyen and Swanson, 2009; Frijns et al.,

[1] In recent years, studies on the efficiency of insurance firms have examined numerous issues, such as regulations (e.g., Weiss and Choi, 2008), initial public offerings (e.g., Xie, 2010), organizational structure (e.g., Brockett et al., 2005), competition (e.g., Bikker and van Leuvensteijn, 2008), bank-assurance (e.g., Fiordelisi and Ricci, 2011), risk management (Cummins et al., 2009), and the relationship between cost efficiency and profitability (Greene and Segal, 2004; Karim and Jhantasana, 2005). Most of these studies focus on single countries, while a few others provide cross-country evidence (e.g., Eling and Luhnen, 2010a).

2012), and we provide direct evidence on the association between annual changes in efficiency and annual stock returns. Furthermore, we provide cross-country evidence by considering 399 insurance firms operating in 52 countries between 2002 and 2008.

Second, after an exhaustive review of the literature, Kothari (2001) concludes that the results from studies that rely on alternative performance measures that have evolved voluntarily in an unregulated environment indicate that they are more likely to be incrementally informative than those mandated by regulation.

Third, numerous studies emphasize that efficient frontier approaches seem to be superior when compared to the use of traditional financial ratios (e.g., Berger and Humphrey, 1997; Bauer et al., 1998). For example, Thanassoulis et al. (1996) mention that the advantage of efficiency frontier techniques is that they take into account simultaneously all inputs and all outputs of a firm. Additionally, Berger and Humphrey (1997) argue that frontier approaches offer an overall objective numerical score and ranking, as well as an efficiency proxy to comply with the economic optimization mechanism.

Our results reveal a positive and statistically significant relationship between current and past profit efficiency changes and market adjusted stock returns. However, we fail to find robust evidence that cost efficiency changes are associated with stock returns.[2] Security analysts, firm managers, and investors devote a great deal of attention to firms' reported earnings and their association with stock returns. Within this context, our results could be of particular interest to all these stakeholders since the efficiency performance measures appear to offer more information—as

[2] Greene and Segal (2004) find that cost inefficiency in the U.S. life insurance industry is substantial relative to earnings, and that inefficiency is negatively associated with profitability measures such as the return on equity. Karim and Jhantasana (2005) also report a negative association between cost inefficiency and profitability ratios in the case of Thai life insurance firms. On the basis of these results, one could expect a statistically significant association between stock returns and cost efficiency. However, we fail to find such evidence.

compared to traditional indicators—regarding firms' abilities to maintain and improve their profits relative to their peers. Moreover, we find robust evidence that this is reflected in stock returns. The results could also be of interest to numerous researchers working on firm efficiency, as our approach provides a market based test of the efficiency methodologies themselves and of the concepts underlying efficiency measurement (Alam and Sickles, 1998).

The rest of the paper is structured as follows. Section 2 presents the data, variables, and methodology. Section 3 discusses the results. Section 4 concludes.

2. Methodology and Data

2.1. Methodology

To examine the impact of changes in efficiency on stock returns we follow a three-stage procedure. First, we obtain estimates of efficiency. Then, we calculate market adjusted stock returns over a twelve-month period window. Finally, we regress the stock returns on the yearly changes in efficiency. In the sub-sections that follow we discuss our procedure in more detail.

2.1.1. Step 1 – Cost and Profit Efficiency

One has to account for country-specific differences in the environments in which firms operate in order to make a global frontier meaningful. This issue has been highlighted in the banking literature (e.g., Dietsch and Lozano-Vivas, 2000), but it has been neglected in most insurance studies that use cross-country datasets (e.g., Diacon et al., 2002; Fenn et al., 2008). In the present study we measure efficiency using the approach of Battese and Coelli (1995; hereafter BC-95), which allows the single-step estimation of efficiency while controlling for macroeconomic conditions and the institutional and regulatory environments.[3,4]

In its general form, the cost model estimated with the BC-95 approach can be written as follows:

$$\ln C_{i,t} = C(q_{i,t}, w_{i,t}; \beta) + u_{i,t} + v_{i,t} \qquad , \ i = 1,2,...,N; \ t = 1,2,...,T \quad (1)$$

where: $TC_{i,t}$ is the total operating cost of firm *i* at time *t* [5]; $q_{i,t}$ is a vector of outputs and quasi fixed inputs; $w_{i,t}$ denotes a vector of values of input prices associated with a suitable functional form; β is a vector of unknown scalar parameters to be estimated; $v_{i,t}s$ are random errors, assumed to be i.i.d. and have $N(0,\sigma_v^2)$; $u_{i,t}s$ are the non-negative inefficiency effects in the model which are assumed to be independently (but

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[3] The first advantage of estimating a global frontier is that it increases the number of available observations. Berger and Humphrey (1997) argue a second advantage: "a frontier formed from the complete data set across nations would allow for a better comparison across nations, since the banks in each country would be compared against the same standard" (p. 187-188). As mentioned by an anonymous referee, an alternative methodology would be the construction of meta-frontiers that allow the calculation of technology gaps across countries and the estimation of adjusted efficiency scores (e.g., Battese et al., 2004; Bos and Schmiedel, 2007; O'Donnell et al., 2008; Kontolaimou and Tsekouras, 2010). This approach is quite interesting; however, it can be applied only to those countries for which a sufficiently large number of observations are available (Bos and Schmiedel, 2007; p. 2088). In the present study we focus on listed insurance firms, which reduces the number of firms per country and rules out the possibility of using meta-frontiers. Nonetheless, as we discuss in the text, in an attempt to control for broad differences in technology we include in our global frontier a dummy variable that distinguishes between developed and developing countries.

[4] This approach originates from stochastic frontier analysis, or SFA (Aigner et al., 1977; Meeusen and van den Broeck, 1977). In general, SFA assumes that inefficiencies follow an asymmetric half-normal distribution and that random errors follow a symmetric standard normal distribution; however, other distributions such as the truncated normal or the gamma distributions can also be assumed (e.g., Cummins and Zi, 1998). Studies on insurance efficiency have also employed alternative techniques like the distribution free approach, or DFA, the thick frontier approach, or TFA, and data envelopment analysis, or DEA. The DFA assumes that the efficiency of firms is stable over time, whereas random error tends to average out to zero over time. The TFA assumes that deviations from predicted costs within the lowest average cost quartile in a size class represent random error, whereas deviations in predicted costs between the highest and lowest quartiles represent inefficiencies. In contrast to the other three techniques, DEA is a non-parametric method that is based on mathematical programming. The advantage of DEA is that it does not require any assumption to be made about the distribution of inefficiency, and it does not require a particular functional form of the data in determining the most efficient firms. However, one of its disadvantages is that it assumes that data are free of measurement error.

[5] Following past studies (e.g., Hao and Chou, 2005; Hao, 2007), we define total operating cost as the summation of management expenses, commission expenses, and claims (non-life) or benefits (life).

not identically) distributed, such that $u_{i,t}$ is obtained by truncation (at zero) of the $N(m_{i,t}, \sigma_u^2)$ distribution where the mean is defined by:

$$m_{i,t} = z_{i,t}\delta \quad (2)$$

where $z_{i,t}$ is a $(1xM)$ vector of observable explanatory variables that influence the inefficiency of insurer *i* at time *t*; and δ is an $(Mx1)$ vector of coefficients to be estimated (which would generally be expected to include an intercept parameter). The parameters of equations (1) and (2) are estimated in one step using maximum likelihood.[6]

In the case of the profit frontier model, we replace TC by the profit before taxes (*PBT*) and we change the sign of the inefficiency term ($-u_{it}$). Thus, following many banking studies, as well as recent insurance studies (e.g., Berger et al., 2000; Fiordelisi and Ricci, 2011), we estimate an "alternative profit" function, which ignores output price data by assuming imperfect competition.[7] Additionally, since some firms in the sample exhibit negative profits (i.e., losses), the nominator of the dependent variable in the profit model is transformed to $\left(PBT + \left|(PBT)^{\min}\right| + 1\right)$, where $\left|(PBT)^{\min}\right|$ is the minimum absolute value of PBT over all banks in the sample.

The individual firm (in)efficiency scores are calculated from the estimated frontiers as $CE_{kt} = exp(u_i)$ and $PEF_{kt} = exp(-u_i)$, the former taking a value between one and infinity and the latter taking a value between zero and one. However, to make our results comparable we calculate the index of cost efficiency as follows: $CEF_{kt} = 1/$

[6] See Battese and Coelli (1995) for further details.
[7] Berger and Mester (1997) and DeYoung and Hasan (1998) outline a number of cases under which the alternative profit function may be more appropriate than the standard one. Furthermore, based on these arguments, Maudos et al. (2002) and Kasman and Yildirim (2006) point out that in international comparisons with a diverse group of countries and competition levels it seems more appropriate to estimate an alternative rather than a standard profit function.

CE_{kt}. Hence, in both cases our efficiency scores will be between 0 and 1, with values closer to 1 indicating a higher level of efficiency.

There is a debate in the literature as to the selection of inputs and outputs in insurance studies. In a recent review of the literature, Eling and Luhnen (2010b) mention that out of the 80 studies that use the value-added approach, 46 specify output as claims (property liabilities)/benefits (life), whereas another 32 specify output as premiums/sums insured; however, there is no clear trend over time as to whether either of the two main proxies is preferred in the literature.[8] Possibly this is due to the fact that each one of these approaches has its advantages and disadvantages.

For example, the drawback of premiums is that they represent prices times quantity of output (Yuengert, 1993). However, using claims/benefits as an output may be subject to even more serious drawbacks. For example, as Diacon et al. (2002) mention: (i) it is difficult to understand why the managers of insurance firms would seek to maximize the value of insurance claims, and (ii) this approach violates the principle output characteristics identified by Cooper et al. (2002), stating that more output should be preferred to less. Furthermore, as discussed in Rai (1996), it appears to be more appropriate to use claims/benefits as an input since they form an integral and important part of annual expenses for insurance firms.[9] This is of particular relevance to our study, as stockholders would like their firms to minimize expenses and maximize their returns, an outcome that should be reflected in higher stock returns.

[8] Yuengert (1993) suggests the use of additions to reserves as an alternative output. However, Green and Segal (2004) point out that the major problem with this measure is that reserves change when policies age, regardless of whether new policies are sold. In addition, the change in reserves measures the change in liabilities, rather than the output of the selling effort.

[9] Yao et al. (2007) mention that even if payment and benefits are to be seen as an output variable, they actually constitute a bad output and consequently should be treated as an input.

For the purposes of the present study we use two outputs. To proxy for the risk-pooling/risk-bearing function of insurers we use insurance premiums (Q1), consistent with Gardner and Grace (1993), Rai (1996), Diacon et al. (2002), Worthington and Hurley (2002), and Bikker and van Leuvensteijn (2008), among others. The second output variable (Q2), which proxies for the intermediation function of insurance firms, is the value of invested assets (e.g., Worthington and Hurley, 2002; Eling and Luhnen, 2010a).

We use two variable inputs and two quasi-fixed inputs. Following past empirical studies, we include the price of the former and the quantity of the latter in the estimations. The price for management and commission cost is calculated as the summation of commission and management expenses over total assets (W1).[10] The price for claims is calculated as net claims/benefits over total assets (W2). Using claims/benefits as an input is consistent with Rai (1996), Yang (2006), Wu et al. (2007), Hao and Chou (2005), Hao (2007), Yao et al. (2007).

In following—among others—Fenn et al. (2008) and Fiordelisi and Ricci (2011), we also include equity (EQ) and technical reserves (RES) as quasi fixed inputs.[11] There are two reasons for their inclusion as inputs. First, insurers must set aside adequate levels of equity and technical reserves to meet the promise to cover claims and to satisfy regulatory requirements. Second, their inclusion in the analysis allows us to control for risk preferences (Cummins and Weiss, 1998; Mester, 1996). We consider them to be quasi fixed inputs rather than variable inputs because they relate to stocks which have been built up over a long time and are difficult to adjust

[10] Ideally, we would divide the commission and management expenses by the number of employees. However, such data were not available in our case. Therefore, we follow many banking studies and divide management and commission expenses by total assets (e.g., Maudos et al., 2002; Lozano-Vivas and Pasiouras , 2010) as the best alternative proxy.
[11] Numerous studies in banking also use equity and/or loan loss provisions as quasi fixed inputs (e.g., Altunbas et al., 2000; Hasan and Marton, 2003; Lozano-Vivas and Pasiouras, 2010).

quickly (Fenn et al., 2008). In other words, this approach accounts for the fact that these two inputs are not under management control in the short run, in the sense that managers cannot quickly adapt their quantity in reaction to market fluctuations.

To account for changes in technology over time, we include year dummies in the frontier (e.g., Rai, 1996). Furthermore, we include dummy variables to distinguish differences in the production technology between different types of insurance firms.[12] LIFE takes the value of 1 in the case of life insurers and zero otherwise. NLIFE takes the value of 1 in the case of non-life insurers and zero otherwise. Combined firms form the reference category. Finally, to control for differences in the technology across different levels of development, we include a dummy variable that takes the value of 1 in the case of firms from developed countries, and zero otherwise (DEVEL).

To impose linear homogeneity restrictions we normalize the dependent variables and our input prices by W2. We also normalize the dependent variables, the two outputs, and technical reserves by equity. Berger et al. (2000) point out that the normalization by equity capital controls for heteroskedasticity, reduces scale biases in estimation, provides the grounds for a more economic interpretation, and controls for financial leverage.

There are a number of alternative functional forms, such as the linear, the Cobb-Douglas, the quadratic, the normalised quadratic, the translog, and the fourier flexible (e.g., Coelli et al., 2005). In general, most of the empirical studies in the

[12] The use of industry/sector dummies to account for different characteristics in production technology has been employed in various studies. For example, Rai (1996) uses this approach in the case of insurance firms. Bos et al. (2009) use it to account for heterogeneity across different types of banks, whereas Hu et al. (2005) rely on this approach in the case of non-financial firms drawn from various industries. As discussed in Lovell (1993), the inclusion of dummies in the frontier model "…allows the comparison of performance across categories and also permits a determination of the ability of members of each category to keep up with best practice in their own category" (p. 7). In the robustness analysis in section 3.2.2. we take this further by including these dummies simultaneously in the frontier and the inefficiency term. Bos et al. (2009) follow a similar approach in their banking study.

insurance and banking literature use the translog form followed by the fourier flexible. Berger and Mester (1997) show that these two functional forms yield essentially the same average level and dispersion of efficiency, and that they both rank the individual firms in almost the same order. However, Altunbas and Chakravarty (2001) compare the fourier flexible and translog specifications and urge caution regarding the increase in usage of the fourier flexible. In the present study we use the tranlog specification as in several other recent studies.[13] Thus, our empirical cost frontier model is specified as follows:

$$\begin{aligned}
\ln\frac{TC}{W2*EQ} &= \beta_0 + \beta_1 \ln(\frac{Q1}{EQ}) + \beta_2 \ln(\frac{Q2}{EQ}) + \beta_3 \ln(\frac{RES}{EQ}) + \beta_4 \ln\left(\frac{W1}{W2}\right) + \beta_5 \frac{1}{2}(\ln(\frac{Q1}{EQ}))^2 \\
&+ \beta_6 \ln(\frac{Q1}{EQ})\ln(\frac{Q2}{EQ}) + \beta_7 \ln(\frac{Q1}{EQ})\ln(\frac{RES}{EQ}) + \beta_8 \frac{1}{2}(\ln(\frac{Q2}{EQ}))^2 + \beta_9 \ln(\frac{Q2}{EQ})\ln(\frac{RES}{EQ}) \\
&+ \beta_{10} \frac{1}{2}(\ln(\frac{RES}{EQ}))^2 + \beta_{11} \frac{1}{2}\left(\ln\left(\frac{W1}{W2}\right)\right)^2 + \beta_{12} \ln(\frac{Q1}{EQ})\ln\left(\frac{W1}{W2}\right) + \beta_{13} \ln(\frac{Q2}{EQ})\ln\left(\frac{W1}{W2}\right) \quad (3) \\
&+ \beta_{14} \ln(\frac{RES}{EQ})\ln\left(\frac{W1}{W2}\right) + \beta_{15} D02 + \beta_{16} D03 + \beta_{17} D04 + \beta_{18} D05 + \beta_{19} D06 + \beta_{20} D07 \\
&+ \beta_{21} DEVEL + \beta_{22} LIFE + \beta_{23} NLIFE - u_{i,t} + v_{i,t}
\end{aligned}$$

To control for the impact of country-specific characteristics on cost inefficiency, m_{it} in Equation (2) is defined as:

$$m_{it} = \delta_0 + \delta_1 ENFIND + \delta_2 \ GDPGR + \delta_3 \ INF + \delta_4 FINFREE \quad (4)$$

Where ENFIND, GDPGR, INF, and FINFREE are controls for the institutional, macroeconomic, and regulatory environment. To be more detailed, ENFIND is an enforcement index that is calculated by taking the average of three aspects of

[13] Insurance studies that use the translog function include Bikker and van Leuvensteijn (2008), Eling and Luhnen (2010a), and Fiordelisi and Ricci (2011).

enforcement, namely: rule of law, regulatory quality, and absence of corruption (Li et al., 2006). Theoretically, this index takes values between -2.5 and 2.5, with higher values corresponding to better outcomes in terms of institutional development. GDPGR is the real GDP growth and INF is the inflation rate. FINFREE is an indicator of the extent of government regulation of financial services (banking, insurers, capital markets), the extent of state intervention, the difficulty of opening and operating financial services firms (for both domestic and foreign individuals), and government influence on the allocation of credit. It takes values between 0 and 100, with higher values indicating lower government intervention.[14]

2.1.2. Step 2 – Market Adjusted Returns

Market adjusted returns (MARs) are calculated as the 12-month stock specific return less the corresponding 12-month market-wide return in the country where the firm operates.[15] Considering that there is a lag between the closing date of the financial results and their disclosure to the public, we calculate MARs for a 12-month period ending three months (MAR.3) after the fiscal year-end (e.g., Kormendi and Lipe, 1987; Fiordelisi and Molyneux, 2010). For example, for changes in efficiency between December 2002 and December 2003, we calculate MAR.3 using data

[14] For example, a score of 100 indicates that: independent central bank supervision and regulation of financial institutions are limited to enforcing contractual obligations and preventing fraud; credit is allocated on market terms; the government does not own financial institutions; financial institutions may engage in all types of financial services; banks are free to issue competitive notes, extend credit and accept deposits, and conduct operations in foreign currencies; and foreign financial institutions operate freely and are treated the same as domestic institutions. In contrast, a score equal to zero indicates, among other factors, that: credit allocation is controlled by the government; bank formation is restricted; foreign financial institutions are prohibited; supervision and regulation are designed to prevent private financial institution; the central bank is not independent; and so on.

[15] The market wide return refers to the return of the general or the most representative index of the stock exchange where the insurer is listed (e.g., UK: FTSE All Share index; Germany: DAX Index; USA: Dow Jones Industrial or Nasdaq Composite Index).

between end March 2003 and end March 2004. In its general form, the equation that we use can be written as follows:

$$\boldsymbol{MAR_{i,c,t}} = \left(\frac{\boldsymbol{P_{i,c,t} - P_{i,c,t-1}}}{\boldsymbol{P_{i,c,t-1}}} - \frac{\boldsymbol{M_{c,t} - M_{c,t-1}}}{\boldsymbol{M_{c,t-1}}}\right) \times \mathbf{100} \quad (5)$$

Where $MAR_{i,c,t}$ is the stock market adjusted return of firm *i*, operating in country *c*, for the twelve months period ending in *t;* $P_{i,c,t}$ and $P_{i,c,t-1}$ correspond to the stock price of firm *i*, operating in country *c*, at time *t*, and time *t-1*, respectively. $M_{c,t}$ and $M_{c,t-1}$ correspond to the value of the stock market index in country *c*, at time *t* and *t-1*, respectively.

2.1.3. Step 3 – Regressions of MARs and efficiency change

To investigate the relationship between efficiency and stock performance, the market-adjusted stock returns are regressed against the changes in efficiency estimates and selected firm-specific control variables.

The estimated model is:

$$MAR_{i,c,t} = \beta_0 + \beta_1 EFCH_{i,c,t} + \beta_2 SOLVCH_{i,c,t} + \beta_3 LNTA_{i,c,t} + \beta_4 ROECH_{i,c,t} + \beta_{5-9} YearDummies + \varepsilon_{i,c,t} \quad (6)$$

Where for firm *i*, operating in country *c*, for the twelve months period ending in *t*: $MAR_{i,c,t}$ is the stock market adjusted return; $EFCH_{i,c,t}$ is the annual % change in cost (CEFCH) or profit (PEFCH) efficiency; $SOLVCH_{i,c,t}$ is the annual % change in the solvency ratio (i.e., equity to assets); $LNTA_{i,c,t}$ is the natural logarithm of total assets;

$ROECH_{i,c,t}$ is the annual % change in return on equity.[16] We also include year dummies to control for the impact of time effects on stock returns.

Since we have a panel dataset, OLS will most likely yield inefficient estimates and invalid standard errors, with fixed effects regressions and random effect regressions being the two main alternative approaches to overcome this problem. To establish the appropriate estimation method the test statistic proposed by Hausman (1978) is used. The chi-square is statistically significant at the 1% level in all the estimations, indicating that the fixed effects regressions should be preferred.

2.2. Data

Data for the present study are collected from various sources. Firm specific financial data (converted in U.S. dollars) and stock prices are collected from OSIRIS database of Bureau van Dijk. Data for the stock market indices are obtained from Bloomberg and the World Federation of Stock Exchanges. The macroeconomic indicators (GDPGR, INFL) are obtained from the Global Market Information Database. The enforcement index is calculated using information from the World Bank Worldwide Governance Indicators database. The financial freedom index is obtained from the Heritage Foundation. Finally, we rely on information from the International Monetary Fund to classify countries as developed or developing.

In the first stage of our analysis, we estimate the frontier function using data from firms for which we have stock prices for at least one year. To be more detailed, taking into account the fact that efficiency is a relevant performance measure, we include these firms when financial data are available for more years than the stock

[16] The simultaneous inclusion of EFCH and ROECH provides a strong test for our hypothesis, since it assesses whether efficiency changes provide any valuable information when traditional financial performance indicators are already included in the analysis.

prices in our analysis over the entire period to obtain more representative estimates.[17] Thus, the dataset that we use in the first stage is unbalanced and consists of 2,069 observations from 399 publicly quoted insurance firms operating in 52 countries between 2002 and 2008.[18] Due to missing values for stock prices and the calculation of annual changes, the dataset used in the fixed effects regressions consists of 1,325 observations from the period 2003-2008.

Table 1 presents descriptive statistics. Panel A corresponds to the variables used in the estimation of efficiency (i.e., equations 3 and 4). Although the inputs and outputs of the frontier function are used in natural logarithms, we present the mean, median, and standard deviations in levels to be more informative. The average insurer in our sample has total operating costs of $5.012 billion, net premium written equal to $4.313 billion, and profits of $433 million. While it appears surprising that firms can make profits while operating costs exceed net premium written, this can be explained by the fact that the average firm in our sample has an additional net investment income of $1.076 billion. In our analysis, this is captured by the second output that we use in the frontier function, namely the value of invested assets (average of $28.448 billion). As expected, technical reserves are much higher than equity, with the averages being $23.468 billion and $3.226 billion, respectively. Panel B presents descriptive statistics of the variables used in the second stage regressions (i.e.,

[17] Cummins and Xie (2009) take this argument even further and mention that in cases where the interest lies on traded firms, one should also include non-traded firms to obtain more representative estimates of efficiency. While such an exercise could form an intersecting robustness test, OSIRIS contains information only for publicly listed (and delisted) firms.

[18] The sample consists of 433 yearly observations from life insurers, 1251 observations from non-life insurers, and 385 from combined firms. In terms of country coverage, the distribution of the yearly observations is as follows: Australia (28), Austria (15), Bahrain (12), Canada (81), Chile (7), China (15), Croatia (2), Cyprus (5), Denmark (13), Egypt (5), Finland (2), France (22), Germany (87), Greece (12), Hong Kong (2), Iceland (5), Indonesia (21), Ireland (5), Israel (15), Italy (49), Japan (61), Jordan (31), Korea (58), Kuwait (24), Luxembourg (5), Malaysia (53), Malta (5), Morocco (9), Netherlands (4), New Zealand (4), Norway (10), Oman (9), Pakistan (5), Peru (7), Philippines (5), Poland (14), Portugal (6), Qatar (15), Russia (2), Singapore (11), South Africa (45), Spain (10), Sri Lanka (7), Sweden (3), Switzerland (43), Taiwan (41), Thailand (122), Tunisia (10), Turkey (36), United Arab Emirates (74), UK (115), USA (822).

equation 6).[19] Further information by type of insurer and country development status is available in Appendix I. Table 2 presents the correlation coefficients of the variables used in the fixed effects regressions of the second stage.

[Insert Tables 1 and 2 Around Here]

3. Results

3.1. Efficiency estimates

The full parameter estimates from equations (3) and (4) are presented in Appendix II. The γ that is used to parameterize the log-likelihood is relatively high, showing that a large proportion of the variation in the composite error term is due to the inefficiency component.[20]

Table 3 presents the efficiency estimates by year, type of insurance, and development status. The average cost efficiency over the entire sample is equal to 0.8815. The corresponding figure in the case of profit efficiency equals 0.4461, indicating that there is room for important improvements. In other words, the average firm in the sample should reduce (improve) its costs (profits) by approximately 11.85% (55%) to match the best practice firm. Thus, the results indicate that firms experience much higher profit inefficiency than cost inefficiency, confirming the findings of previous studies in insurance (e.g., Fiordelisi and Ricci, 2011) and banking (e.g., Pasiouras et al., 2009).

While the profit efficiency estimated in the present study is lower than the one reported in Fiordelisi and Ricci (2011) for Italian bancassurance firms and in Klumpes

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[19] All the variables used in the second stage regressions were capped at the 5th and 95th percentile to reduce the impact of outliers, while keeping all the observations in the sample. The results remain the same when we cap the variables at the 1st and 99th percentile.

[20] The Battese and Coelli (1995) model utilizes the parameterization of Battese and Corra (1977), who replace σ_V^2 and σ_U^2 with $\sigma^2=\sigma_V^2+\sigma_U^2$ and $\gamma=\sigma_U^2/(\sigma_V^2+\sigma_U^2)$.

(2004) for UK life insurance firms, the obtained average figure is not far from U.S. studies in banking, reporting average profit efficiencies below 50% (e.g., Berger and Mester, 1997; DeYoung and Hasan, 1998) as well as Maudos et al. (2002), who report an average profit efficiency between 21.7% and 52% for ten EU banking sectors.

[Insert Table 3 Around Here]

A more in depth investigation is obviously necessary to draw conclusions regarding the impact of the financial crisis; however, we do observe a decrease in profit efficiency over the most recent years of our analysis. When looking at the yearly averages we observe an increase from 0.3962 in 2002 to 0.4711 in 2006, followed by a slight decrease to 0.4625 in 2007 and a more severe decrease to 0.4193 in 2008. In contrast, the variation in cost efficiency is smaller, with the highest average cost efficiency being recorded in 2004 (0.8900) and the lowest one being recorded in 2008 (0.8746).

Consistent with past studies in insurance and banking, we observe that the most cost efficient firms are not necessarily the most profit efficient ones, and vice versa.[21] The calculation of the mean efficiency by type of insurance firms reveals that the non-life firms are the most profit efficient ones, whereas life insurers are the most cost efficient ones. Furthermore, insurers in developed countries are more cost efficient but less profit efficient. The latter is consistent with recent international studies in banking (e.g., Pasiouras et al., 2009), and could be potentially explained by the ability of firms in developing countries to earn higher profits due to lower market competition or higher economic growth. In contrast, firms in developed countries are

[21] Fiordelisi and Ricci (2011) find that joint venture insurers are the most cost efficient but less profit efficient types of firms in their sample. Similarly, Guevara and Maudos (2002) estimate cost and profit efficiency in EU banking sectors, showing that the "other bank institutions" group is the most cost efficient but also the most profit inefficient. Furthermore, Berger and Mester (1997) and Rogers (1998) report a negative correlation between cost efficiency and profit efficiency in the US.

able to operate with higher cost efficiency due to either technological advances or better management of expenses. A correlation analysis of the cost and profit efficiency estimations confirms that the scores and the relative firm rankings do not necessarily move together.[22] The differences in the results could be explained by the possibility that the profit efficiency is more likely driven by revenues rather than costs (Rogers, 1998).

3.2. MARs and efficiency change

3.2.1 Base results

Table 4 presents the regressions results.[23] We find that both measures of efficiency carry a positive sign; however, only profit efficiency change is statistically significant. The insignificance of cost efficiency is consistent with studies in banking which reveal a positive association between stock returns and profit efficiency but not cost efficiency (Ioannidis et al., 2008; Liadaki and Gaganis, 2010). As discussed in these studies, this could be explained by the belief that shareholders are expected to be ultimately interested in the generation of profits rather than the management of costs, since it is the former that determines future dividend payments and associated stock prices fluctuations.

[Insert Table 4 Around Here]

[22] The Pearson's correlation coefficient equals -0.005 while the Spearman's rho equals 0.016.
[23] We drop solvency change from the regressions with cost efficiency change due to a positive and statistically significant correlation between the two variables (correlation coefficient of 0.371, statistically significant at the 1% level) that appears to distort the results. To be more detailed, when we include both variables in the analysis, CEFCH carries a negative coefficient that is statistically significant at the 10% level. A univariate regression confirms that CEFCH has a positive but insignificant impact on market adjusted returns that is consistent with the results presented in Table 4.

We also observe that the coefficient of PECH is much higher than that of ROECH. This finding may be due to some fundamental differences between profit efficiency and traditional accounting ratios like the return on equity. Profit efficiency takes into account input and output considerations simultaneously via economic optimization mechanisms, and reveals how efficiently a firm operates relative to its peers. Therefore, as mentioned in Ioannidis et al. (2008), profit efficiency indicators may be in a better position to capture the "*quality of earnings*" and the "*persistency of earnings*." This is of particular importance because previous studies have shown that stock returns react more strongly to persistent earnings (Kormendi and Lipe, 1987; Nichols and Wahlen, 2004), and that there are going concerns about the quality of earnings (Chan et al., 2006).[24]

3.2.2. Further Analysis

In this section, we present further analysis to examine the robustness of our results. These tests deal with: (i) the simultaneous inclusion of dummies for the type of insurer in both the frontier function and the inefficiency term; (ii) the estimation of frontiers by the type of insurer; (iii) the use of lagged efficiency changes; (iv) the formation of portfolios. We discuss these tests in more detail below.

[Insert Table 5 Around Here]

As shown in equation (3), the results discussed in the previous section refer to a common frontier where we include dummy variables for the type of insurer in the

[24] Destefanis and Sena (2007) offer additional explanations as to why efficiency indicators may be of interest to shareholders. First, profitability ratios like the return on equity may underrepresent the value of the firm due to the investment myopia problem, which is not the case for efficiency estimates. Additionally, when managers engage in myopic behavior, long-term investment should be expected to decrease, leading to lower efficiency. Finally, due to the separation between management and ownership, managers may have incentives to invest in projects that grant power and prestige but that do not result in an improvement in efficiency and productivity.

frontier function (i.e., life, non-life, combined insurers). As an additional test we simultaneously include these variables in equation (4). Thus, their inclusion in equation (3) accounts for parallel shifts of the frontier, while their inclusion in equation (4) controls for systematic different deviations from the frontier.[25] The results remain the same.

As an alternative test we estimate type-specific frontiers for: (i) non-life and (ii) other firms (i.e., life and combined firms).[26] The so far obtained results are robust to the use of the type-specific efficiency change in the second stage regressions.

Considering that investors might value not only the current firm performance (i.e., the most recent efficiency change) but also the past values of firm performance, we re-estimate our base specification by adding the efficiency change lagged by one year. The results show that both the current and past profit efficiency changes have a positive impact on the market adjusted stock returns.[27]

Finally, following Alam and Sickles (1998), we also compare the stock returns of the top and bottom performers in terms of efficiency change. Insurers are first ranked according to the annual change in their efficiency. We then form two portfolios and test for differences in the means. The first portfolio includes the top insurers in terms of efficiency change, defined as the ones falling in the 10^{th} percentile; the second portfolio includes the bottom insurers, defined as the ones falling in the 90^{th} percentile. The hypothesis to be tested can be stated as follows:

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[25] Including the same variables in the inefficiency model (i.e., equation 4) and in the stochastic frontier (i.e., equation 3) does not violate the assumption of the independence when the equations are estimated simultaneously as in the Battese and Coelli (1995) model. As Battese and Coelli (1995) note, "The explanatory variables in the inefficiency model may include some input variables in the stochastic frontier" (p. 327). It should be mentioned that the idea of using common variables in the stochastic frontier and in the inefficiency model is not unique to this paper (e.g., Coelli and Battese, 1996; Bos et al., 2009; Lozano-Vivas and Pasiouras, 2010, among others).

[26] Considering the small sample of life (433 yearly observations) and combined firms (385 yearly observations) we pool these two types together and estimate a common frontier with a dummy variable that distinguishes between these firms.

[27] The correlation coefficient between the current and lagged efficiency change is 0.150 in the case of profit and -0.033 in the case of cost. Thus, there is no problem with their simultaneous inclusion in the model.

H_0: The average market adjust stock return of the top performers' portfolio is not significantly different from the average return of the bottom performers' portfolio ($MAR_{top} = MAR_{bottom}$)

H_a: The average market adjust stock return of the top performers' portfolio is significantly higher than that of the bottom performers' portfolio ($MAR_{top} > MAR_{bottom}$)

The average market adjusted return for top performers and bottom performers are: 6.192 and 0.531 in the case of profit efficiency, and 6.226 and 0.728 in the case of cost efficiency. The t-test for means differences indicates that we can reject H_0 in both cases with p-values being 0.032 (profit efficiency), and 0.062 (cost efficiency).[28]

4. Conclusions

The relationship between stock returns and publicly available information has attracted considerable attention in the literature. Chen and Zhang (2007) point out that the majority of the existing studies on accounting information and stock returns focus on earnings, which are applicable only under special economic settings, and that these studies fail to consider the role of balance sheet data. Therefore, more recent studies examine other firm specific characteristics such as accruals, revenue surprises,

[28] The reported figures were obtained using the same values as the ones used in the regressions (i.e., capped at 5^{th} and 95^{th} percentiles). We also calculated the corresponding figures using the original values (i.e., non-capped). In this case, the average market adjusted return for top performers and bottom performers are: 5.654 and 0.158 in the case of profit efficiency, and 10.419 and 0.481 in the case of cost efficiency. The p-value equals 0.055 and 0.021 in the case of profit and cost efficiency change, respectively. However, these figures should be treated with caution as they include some extreme values. Profit efficiency change varies from -100% to 332% and cost efficiency change varies from -50.64% to 132.19%. The market adjusted returns that were included in the portfolios range between -113.44% and 94.62% in the case of profit efficiency and between -96.78% and 253.17% in the case of cost efficiency.

and economic value added. A handful of studies also examine the relationship between efficiency measures obtained from frontier techniques and stock returns, providing evidence from the banking sector (Liadaki and Gaganis, 2010), the airline industry (Alam and Sickles, 1998), and other non-financial sectors (Frijns et al., 2012).

The present study provides a first attempt to examine whether there is a relationship between stock returns and efficiency in the insurance industry. In the first stage of the analysis we use stochastic frontier analysis to obtain estimates of the profit efficiency of 399 listed insurance firms over the period 2002-2008 while controlling for country-specific characteristics. Afterwards, we regress annual efficiency changes on annual stock returns. The results indicate a positive and statistically significant relationship between current and past profit efficiency changes and market adjusted stock returns. In contrast, there is no robust evidence that cost efficiency changes are related to stock returns.

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Table 1 – Descriptive Statistics

	Mean	Median	Standard Deviation
Panel A: Variables used in the estimations of efficiency			
TC	5,011,543	592,971	13,240,587
PBT	432,776	54,000	2,863,965
Q1	4,312,774	624,221	11,004,897
Q2	28,448,406	1,613,100	95,777,773
RES	23,468,156	1,202,700	72,263,955
EQ	3,225,830	484,500	9,232,527
W1	10.786	7.773	11.433
W2	21.842	14.541	29.313
ENFIND	1.175	1.468	0.650
GDPGR	3.449	2.900	2.401
INF	3.376	2.700	3.321
FINFREE	69.889	80.000	20.413
Panel B: Variables used in the regressions of stock returns			
MAR.3	3.330	0.295	27.080
PEFCH	0.789	-0.797	12.945
CEFCH	0.246	0.191	3.729
SOLVCH	-0.071	-0.185	14.282
LNTA	15.033	15.119	2.367
ROECH	-16.689	-5.271	92.878

Notes: TC=Total operating cost (th. US dollars); PBT = Profit before tax (th. US dollars); Q1 = Net premium written (th. US dollars); Q2= Total investments (th. US dollars); RES = Net technical reserves (th. US dollars); EQ = Equity (th. US dollars); W1= Commission & Management expenses / Total assets (%);W2 = Net claims/Total assets (%), ENFIND = Enforcement index; GDPGR = Real GDP Growth (%); INF = Inflation (%), FINFREE = Financial Freedom Index; MAR.3: 12-months market adjusted return from end-March to end-March; CEFCH: Annual % change in cost efficiency; PEFCH: Annual % change in profit efficiency; SOLVCH: Annual % change in solvency ratio; LNTA: Natural logarithm of total assets; ROECH: Annual % change in return on equity

Table 2 – Correlation coefficients of variables used in the regressions of stock returns

	PEFCH	CEFCH	SOLCH	LNTA	ROECH	PEFCH(-1)	CEFCH(-1)
PEFCH	1.000						
CEFCH	-0.014	1.000					
SOLCH	-0.011	0.371***	1.000				
LNTA	0.019	-0.035	0.016	1.000			
ROECH	0.103***	0.047*	0.119***	0.020	1.000		
PEFCH(-1)	0.150***	-0.034	0.096***	0.122***	0.056**	1.000	
CEFCH(-1)	-0.019	-0.033	0.031	-0.046	0.008	-0.018	1.000

Notes: *Statistically significant at the 10% level, ** Statistically significant at the 5% level, *** Statistically significant at the 1% level, CEFCH: Annual % change in cost efficiency; PEFCH: Annual % change in profit efficiency; SOLVCH: Annual % change in solvency ratio; LNTA: Natural logarithm of total assets; ROECH: Annual % change in return on equity; PEFCH(-1): One year lagged PEFCH; CEFCH(-1): One year lagged CEFCH

Table 3 –Efficiency estimates

Panel A: Averages by year	Cost efficiency	Profit efficiency
2002 (N= 207)	0.8811	0.3962
2003 (N = 228)	0.8821	0.4191
2004 (N = 322)	0.8900	0.4674
2005 (N = 329)	0.8825	0.4564
2006 (N = 342)	0.8797	0.4711
2007 (N = 342)	0.8799	0.4625
2008 (N = 299)	0.8746	0.4193
Panel B: Averages by Type of Insurance		
Life (N = 433)	0.8982	0.4156
Non-life (N = 1,251)	0.8710	0.4600
Combined (N = 385)	0.8967	0.4350
Panel C: Averages by Development Status		
Developed (N = 1,539)	0.8828	0.3955
Developing (N= 530)	0.8776	0.5930
Panel D: Total Sample		
Total Sample (N = 2,069)	0.8815	0.4461

Table 4– Fixed effects regressions: Base model
(Dependent variable: 12- month market adjusted stock returns)

	Cost	Profit
CEFCH	0.182	---
	(0.800)	
PEFCH	---	0.237***
		(3.015)
SOLVCH	---	0.456***
		(7.743)
LNTA	-7.960*	-7.524
	(-1.684)	(-1.649)
ROECH	0.027***	0.022**
	(2.902)	(2.524)
Constant	123.508*	114.564*
	(1.762)	(1.694)
Year Dummies	YES	YES
Adjusted R-sq.	0.096	0.152
F-stat.	1.388***	1.652***
No. Firms	356	356
No. obs	1325	1325

Notes: t-statistics in parentheses; *Statistically significant at the 10% level, ** Statistically significant at the 5% level, *** Statistically significant at the 1% level, CEFCH: Annual % change in cost efficiency; PEFCH: Annual % change in profit efficiency; SOLVCH: Annual % change in solvency ratio; LNTA: Natural logarithm of total assets; ROECH: Annual % change in return on equity

Table 5 – Fixed effects regressions: Additional estimations
(Dependent variable: market adjusted stock returns)

	(1)		(2)		(3)	
	Cost	Profit	Cost	Profit	Cost	Profit
CEFCH	0.209	---	0.157	---	0.444*	---
	(0.909)		(0.634)		(1.686)	
CEFCH(-1)	---	---	---	---	0.409	---
					(1.487)	
PEFCH	---	0.246***	---	0.319**	---	0.211**
		(3.175)		(2.331)		(2.261)
PEFCH(-1)	---		---	---	---	0.221**
						(2.529)
SOLVCH	---	0.456***	---	0.444***	---	0.444***
		(7.743)		(7.558)		(6.589)
LNTA	-7.901*	-7.659*	-7.584*	-6.847	-9.661	-11.381*
	(-1.672)	(-1.679)	(-1.807)	(-1.499)	(-1.531)	(-1.872)
ROECH	0.027***	0.022**	0.026***	0.024***	0.035***	0.027**
	(2.904)	(2.497)	(2.876)	(2.657)	(3.266)	(2.574)
Constant	122.640*	116.634*	118.433*	105.779	152.118	184.962**
	(1.750)	(1.725)	(1.881)	(1.562)	(1.586)	(2.001)
Year Dummies	YES	YES	YES	YES	YES	YES
Adjusted R-sq.	0.096	0.153	0.097	0.149	0.120	0.174
F-stat.	1.389***	1.656***	1.392***	1.636***	1.434***	1.669***
No. Firms	356	356	356	356	309	309
No. obs	1325	1325	1325	1325	1010	1010

Notes: t-statistics in parentheses; *Statistically significant at the 10% level, ** Statistically significant at the 5% level, *** Statistically significant at the 1% level, CEFCH: Annual % change in cost efficiency; CEFCH(-1): One year lagged CEFCH; PEFCH: Annual % change in profit efficiency; PEFCH(-1): One year lagged PEFCH; SOLVCH: Annual % change in solvency ratio; LNTA: Natural logarithm of total assets; ROECH: Annual % change in return on equity; Specification 1: Efficiency estimates obtained from base model with dummies for type of insurer included in both the frontier and inefficiency functions, Specification 2: Efficiency estimates obtained from type-specific frontiers, Specification 3: Base Model with lagged efficiency estimates

Appendix I – Descriptive Statistics by firm type and country development status

	Developed		Developing		Life		Non-life		Combined	
	Average	St. dev	Average	St. dev	Average	St. dev	Average	St. dev	Average	St. dev
TC	6,586,475	15,008,918	438,298	1,496,014	6,141,560	10,972,056	2,179,264	6,281,165	12,943,710	24,282,005
PBT	551,951	3,303,970	86,719	407,567	572,748	1,065,308	266,587	1,177,428	815,358	6,174,496
Q1	5,630,531	12,445,433	486,305	1,844,216	4,917,845	9,407,906	1,906,574	4,189,393	11,450,852	20,619,201
Q2	37,377,363	109,433,656	2,520,739	11,739,175	36,340,206	59,680,991	6,065,405	18,223,685	92,302,913	196,275,235
RES	30,846,980	82,337,958	2,041,721	9,245,201	33,436,142	53,989,710	4,523,240	13,503,418	73,816,082	142,924,614
EQ	4,175,589	10,463,657	467,945	2,157,895	3,280,442	4,793,838	2,045,860	7,908,643	6,998,547	14,518,434
W1	10.507	12.069	11.593	9.305	7.926	13.148	13.358	11.377	5.642	5.547
W2	22.786	32.878	19.103	14.354	21.767	42.428	24.666	27.403	12.753	6.997
ENFIND	1.492	0.332	0.252	0.427	1.419	0.479	1.123	0.671	1.067	0.681
GDPGR	2.479	1.371	6.265	2.528	2.623	1.422	3.687	2.510	3.604	2.700
INFL	2.450	1.045	6.063	5.497	2.792	1.534	3.653	3.867	3.132	2.718
FINFREE	77.784	16.004	46.962	13.274	77.991	15.779	69.944	20.871	60.597	19.630
MAR.3	4.272	25.964	0.347	30.192	0.263	25.922	4.843	27.407	2.761	27.286
PEFCH	0.747	13.855	0.921	9.519	1.141	13.295	0.749	12.498	0.471	13.780
CEFCH	0.234	3.563	0.285	4.218	-0.232	3.033	0.560	4.067	-0.065	3.401
SOLVCH	0.412	14.486	-1.601	13.524	-0.845	13.993	-0.010	14.083	0.702	15.177
LNTA	15.786	1.999	12.651	1.801	16.357	1.826	14.050	2.068	16.223	2.426
ROECH	-18.196	93.761	-11.916	90.002	-17.762	85.131	-15.391	96.987	-19.084	90.193

Notes: TC=Total operating cost (th. US dollars); PBT = Profit before tax (th. US dollars); Q1 = Net premium written (th. US dollars); Q2= Total investments (th. US dollars); RES = Net technical reserves (th. US dollars); EQ = Equity (th. US dollars); W1= Commission & Management expenses / Total assets (%);W2 = Net claims/Total assets (%), ENFIND = Enforcement index; GDPGR = Real GDP Growth (%); INF = Inflation (%), FINFREE = Financial Freedom Index; MAR.3: 12-months market adjusted return from end-March to end-March; CEFCH: Annual % change in cost efficiency; PEFCH: Annual % change in profit efficiency; SOLVCH: Annual % change in solvency ratio; LNTA: Natural logarithm of total assets; ROECH: Annual % change in return on equity

Appendix II – Parameters of the cost and profit function

	Cost function		Profit function	
	Coefficient	t-value	Coefficient	t-value
Frontier function				
Constant	1.480	113.156	9.049	36.215
ln(Q1/EQ)	0.057	7.881	-1.167	-5.915
ln(Q2/EQ)	0.145	13.652	0.103	0.424
ln(RES/EQ)	0.426	61.201	0.626	2.396
ln(W1/W2)	0.481	66.919	0.903	6.784
[ln(Q1/EQ)^2]/2	0.016	4.730	0.148	2.378
ln(Q1)ln(Q2)	0.005	0.520	0.948	3.396
ln(Q1)ln(RES)	-0.025	-3.673	-0.456	-2.055
[ln(Q2/EQ)^2]/2	0.135	11.238	0.644	1.224
ln(Q2)ln(RES)	-0.111	-10.928	-0.834	-1.699
[ln(RES/EQ)^2]/2	0.220	18.760	0.711	1.725
[ln(W1/W2)^2]/2	0.192	67.256	0.263	5.033
ln(Q1/EQ)ln(W1/W2)	0.009	3.335	-0.112	-2.142
ln(Q2/EQ)ln(W1/W2)	0.037	4.802	-0.094	-0.531
ln(RES/EQ)ln(W1/W2)	-0.032	-5.752	0.182	1.341
D02	-0.012	-1.462	0.635	3.454
D03	-0.011	-1.388	0.451	2.548
D04	-0.003	-0.385	0.059	0.318
D05	-0.011	-1.507	0.015	0.084
D06	-0.009	-1.234	-0.145	-0.805
D07	-0.008	-1.121	-0.193	-1.101
LIFE	-0.051	-7.551	0.537	3.954
NLIFE	-0.084	-13.173	0.827	6.777
DEVEL	0.014	2.346	-1.789	-10.988
Inefficiency Term				
Constant	-6.782	-4.726	1.821	2.294
ENFIND	1.273	4.971	0.512	1.324
GDPGR	0.157	4.908	-0.586	-4.751
INF	0.126	5.438	-0.265	-2.614
FINFREE	-0.002	-2.258	-0.013	-1.293
Sigma-squared (σ^2)	0.625	4.951	5.282	8.572
Gamma (γ)	0.997	1702.696	0.625	9.410
Log-likelihood function	1546.310		-3964.918	
LR test of the one-sided error	859.308		102.124	

Notes: Q1= Net premium written; Q2 = Total investments; RES = Net technical reserves; EQ = Equity; W1 = Commission & Management Expenses / Total assets; W2 = Net claims / Total assets; D02 = Dummy for 2002; D03 = Dummy for 2003; D04 = Dummy for 2004; D05=Dummy for 2005; D06 = Dummy for 2006; D07 = Dummy for2007 (omitted: 2008); DLIFE = Dummy for life insurers; DNLIFE = Dummy for non-life insurers (omitted: combined insurers); ENFIND = Enforcement index; GDPGR = Real GDP Growth (%); INF = Inflation (%), FINFREE = Financial Freedom Index; $\sigma^2=\sigma_V^2+\sigma_U^2$; $\gamma=\sigma_U^2/(\sigma_V^2+\sigma_U^2)$; Estimations of the frontier function and the inefficiency term were obtained in a single step with the use of the Battese and Coelli (1995) model. In the case of the variables used in the inefficiency term, a coefficient with a positive (negative) sign indicates a positive (negative) effect on the inefficiency component and a negative (positive) relationship with efficiency.

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