The Effect of Organizational Structure on Efficiency: Evidence From the Spanish Insurance Industry

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Abstract

This paper provides new information on the effects of organizational structure on efficiency by analyzing the Spanish insurance industry over the period 1989-1997. Two types of firms co-exist in the industry – stock insurers, owned by shareholders, and mutual insurers, owned by policyholders. We test the managerial discretion hypothesis, which predicts that the market will sort organizational forms into market segments where they have comparative advantages in minimizing the costs of production and maximizing revenues. We estimate technical, cost, and revenue frontiers using data envelopment analysis. The results indicate that stocks and mutuals are operating on separate production, cost, and revenue frontiers and thus represent distinct technologies. We find that the stock technology dominates the mutual technology for producing stock output vectors for firms of all sizes and the mutual technology dominates the stock technology for producing mutual output vectors for firms in the three smallest size quartiles. However, the degree of stock dominance in producing stock insurance outputs is greater than the mutual dominance for producing mutual outputs.

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1. Introduction

In the modern theory of the firm, agency costs provide an explanation for the structure of organizations, with the organizations that succeed in a given industry being the ones that minimize costs and maximize revenues, where both costs and revenues may be sub-optimal due to agency conflicts (e.g., Jensen and Meckling, 1976). Agency costs, including excessive operating costs and lost revenues, are generated because the various stakeholder groups comprising the firm often have conflicting interests. The costs of resolving these incentive conflicts, including the residual agency costs remaining due to the failure to eliminate such costs completely, comprise a firm's agency costs. Agency theory explains the co-existence of alternative organizational forms in an industry in terms of their relative success in dealing with specific types of incentive conflicts.

The insurance industry provides a particularly interesting environment for studying agency theoretic hypotheses because two principal types of organizations coexist in the industry – stock insurers, which are owned by stockholders, and mutual insurers, which are owned by policyholders. These ownership forms are present in most industrialized economies worldwide, including those in North America, Europe, and Japan (Swiss Re 1999). The purpose of the present paper is to test hypotheses about organizational structure by studying the experience of the Spanish insurance industry over the sample period 1989-1997. We test hypotheses relating organizational form to efficiency, where the efficiency of each firm is measured relative to "best practice" efficient frontiers consisting of the most efficient firms in the industry.

The Spanish insurance market provides an interesting case study in insurance organizational structure for three primary reasons: (1) Spanish government policy during the 1980s led to a significant restructuring of the industry, resulting in the removal from the market of many small, undercapitalized insurers. (2) The adoption of the European Union's (EU) Third Generation Insurance Directives in 1994 effectively deregulated the EU insurance market, with the exception of solvency regulation.[1] The Spanish and EU regulatory changes increased the level of competitiveness in the

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[1] The First Generation Insurance Directives (introduced in 1964, 1973, and 1979) and Second Generation Directives (1988 and 1990) were more limited in scope than the Third Generation Directives. For further

Spanish insurance market, providing an interesting laboratory for the analysis of organizational form. (3) Most prior studies of organizational form in insurance have focused on the United States. Studying the Spanish market permits us to provide evidence on whether the principal organizational form hypotheses are also applicable elsewhere. The prior literature is discussed below.

Agency theory arguments have led to the development of hypotheses about organizational form, stemming from the observation that stocks and mutuals have comparative advantages in dealing with different types of agency costs. The principal argument is based on the observation that there are three principal stakeholder groups in an insurance enterprise – managers, owners, and policyholders – and that stocks and mutuals coexist because they have comparative advantages in dealing with the incentive conflicts among the three stakeholder groups. The stock ownership form is hypothesized to be more effective in controlling the owner-manager conflict because the stock form of ownership provides several mechanisms for owners to monitor and control managers. These mechanisms exist primarily because stock firms have alienable ownership claims, giving rise to control techniques such as proxy fights, hostile takeovers, and executive stock options that can reduce opportunistic behavior by managers. The control mechanisms available to mutual owners are much weaker. However, the mutual ownership form effectively eliminates the policyholder-owner conflict by merging the policyholder and ownership functions. These arguments give rise to the hypothesis that stock insurers will succeed where the owner-manager conflict is relatively strong and that mutuals will succeed where the owner-policyholder conflict is relatively important.

Perhaps the most influential agency theoretic hypothesis about stocks and mutuals is the *managerial discretion hypothesis* (e.g., Mayers and Smith 1988). According to this hypothesis, the degree of managerial discretion required to operate in a given line of insurance is the primary determinant of the organizational form likely to succeed in that line. The hypothesis predicts that the stock ownership form will be dominant in lines of insurance where managers must be given a relatively large amount of discretion in pricing and underwriting, such as commercial coverages, and in operating over wider geographical areas. The stock form of ownership is likely to have a

discussion see Cummins and Rubio-Misas (2001).

comparative advantage in more complex or risky operations because of its superior mechanisms for owners to control managers. Mutuals, on the other hand, are likely to be more successful in lines that require less managerial discretion such as personal lines, where the need for individualized pricing and underwriting is relatively low. Where the need for managerial discretion is limited, the elimination of the owner-policyholder conflict is likely to give mutuals a comparative advantage over stocks.

Because the available mechanisms for controlling owner-manager conflicts in the mutual ownership form are relatively weak, the costs of managerial opportunism in the mutual ownership form are expected to be higher than in the stock ownership form. One potentially important type of managerial opportunism is "expense preference" behavior, where managers generate unnecessary costs through the consumption of perquisites or fail to maximize revenues due to opportunistic behavior. According to the *expense preference hypothesis,* mutuals are expected to be less successful than stocks in minimizing costs or maximizing revenues because of higher perquisite consumption or, more generally, the failure to choose optimal combinations of inputs or outputs (Mester 1991).[2]

These hypotheses are not mutually exclusive; e.g., mutuals could be more successful in low managerial discretion lines of insurance, even though mutual managers exhibit expense preference behavior. This outcome would imply that higher costs or lower revenues due to managerial opportunism are not sufficient to offset the mutuals' advantage from eliminating the policyholder-owner conflict.

The managerial discretion hypothesis predicts that firms with different organizational forms will be sorted into market segments where they have comparative advantages in minimizing production and agency costs. According to this hypothesis, one would not necessarily observe differences in efficiency among organizational forms after controlling for production technology and business mix. The expense preference hypothesis, on the other hand, predicts that mutual firms will have higher costs and/or lower revenues than stock firms after controlling for other characteristics.

[2]A third hypothesis, the maturity hypothesis, predicts that mutuals will be more successful than stocks in lines of insurance where contracts cover relatively long periods of time. Lengthy contract periods give stock managers more opportunity to behave opportunistically, reducing the value of policyholder claims on the firm. Hence, the mutual ownership form is likely to be more successful because of its elimination of the owner-policyholder conflict. We do not test this hypothesis in the present paper because of data limitations.

In this paper, we test these agency theoretic hypotheses by using frontier efficiency methodologies to compare the efficiency of Spanish stock and mutual insurers. Our analysis is based on non-parametric, "best practice" production, cost, and revenue frontiers estimated for a sample consisting of all Spanish insurers with valid data for the period 1989-1997. We estimate efficiency using data envelopment analysis (DEA), a non-parametric technique (see Cooper, et al. 1999). A production frontier gives the minimum inputs required to produce any given output vector, while the cost and revenue frontiers measure respectively the minimum costs and maximum revenues that can be attained by each firm. Efficiency, which is measured for each firm in the sample in each year, ranges from 0 to 1, with firms operating on the frontiers measured as fully efficient (efficiency of 1), and firms not operating on the frontiers measured as inefficient (efficiency between 0 and 1).

The fundamental idea behind our hypothesis tests is that the stock and mutual organizational forms represent different technologies for producing insurance, where technology is defined as including the contractual relationships comprising the firm as well as physical technology choices. If the managerial discretion hypothesis is correct, stocks and mutuals should operate with different production, cost, and revenue frontiers. Furthermore, the stock technology should dominate the mutual technology for producing stock outputs; and the mutual technology should dominate the stock technology for producing mutual outputs. If the expense preference hypothesis is correct, mutuals are expected to be less successful than stocks in minimizing costs and/or maximizing revenues.

The principal papers that analyze organizational structure in the insurance industry using frontier efficiency methods are Fecher, et al. (1993) (French life and non-life insurers), Gardner and Grace (1993) (U.S. life insurers), Fukuyama (1997) (Japanese life insurers), Cummins and Zi (1998) (U.S. life insurers), and Cummins, Weiss, and Zi (1999) (U.S. non-life insurers). The first four of these studies do not find significant efficiency differences between stock and mutual insurers, consistent with the managerial discretion hypothesis. Cummins, Weiss, and Zi (CWZ) (1999), using a methodology similar to the one employed in the present paper, find that stock production frontiers dominate mutual frontiers for the production of stock outputs and that mutual production frontiers dominate stock frontiers for the production of mutual outputs, but mutuals are less successful in minimizing costs than are stock insurers. Thus, their study provides evidence consistent with both the managerial discretion and expense preference hypotheses.

There have been two prior efficiency studies of the Spanish insurance industry – Fuentes, Grifell-Tatjé, and Perelman (2001) and Cummins and Rubio-Misas (2001). The former study analyzes productivity change in the period 1987-1994 and finds very low rates of productivity growth in spite of deregulation. The latter paper studies consolidation in the Spanish insurance industry over the period 1989-1998 and finds that consolidation was efficiency-enhancing because many small, inefficient firms were eliminated from the market due to insolvency or liquidation.[3]

Our analysis extends the prior literature by providing the first frontier efficiency analysis of organizational form in the Spanish insurance industry. Our study extends Fecher, et al. (1993) and Fukuyama (1997) by analyzing cost and revenue efficiency as well as technical efficiency, measuring the efficiency of stocks and mutuals relative to the other group's production and cost frontiers (cross-frontier analysis), and explicitly testing the managerial discretion and expense preference hypotheses. This paper utilizes the same methodology as CWZ (1999) to estimate efficiencies and conduct hypothesis tests. The present paper goes beyond CWZ (1999) in analyzing a different national insurance market and estimating revenue efficiency as well as technical and cost efficiency.

By way of preview, we find that the stock technology dominates the mutual technology for producing stock output vectors for firms of all sizes and the mutual technology dominates the stock technology for producing mutual output vectors for firms in the three smallest size quartiles. The results thus are consistent with the managerial discretion hypothesis except for mutuals in the largest size quartile. Our principal finding is obtained using a multi-variate regression analysis with efficiency-derived statistics as the dependent variables and firm characteristics as independent variables. Based on averages alone, stocks consistently dominate mutuals. Thus, it is important to

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[3]Demutualization played an important role in the restructuring of the Spanish insurance market prior to our sample period. However, the main demutualization wave had ended by the time our sample period begins. Excluding social benefit institutions, an organizational form not considered in this study, there were only four completed demutualizations during our sample period, although three other firms initiated the dumutualization process towards the end of our sample period. Hence, the number of demutualizations is not sufficient to support a statistical analysis of demutualized firms. Because few demutualizations occurred in Spain during our sample period, the Spanish market provides a particularly stable environment for an analysis of organizational structure.

control for differences in firm characteristics when analyzing Spanish insurers. Nevertheless, it is also useful to discuss the averages to provide intuition into the interpretation of the cross-frontier results.

The remainder of the paper is organized as follows: The hypothesis test procedures and the data envelopment analysis (DEA) technique utilized to estimate efficiency are discussed in section 2. Section 3 describes the database, defines insurance industry inputs and outputs, and presents summary statistics. The efficiency results are presented in section 4, and section 5 concludes.

2. Hypotheses Test Procedures and Methodology

This section begins with a brief overview of frontier efficiency concepts. We then turn to a discussion of hypothesis test procedures and, finally, discuss the data envelopment analysis (DEA) methodology used to estimate efficiency for Spanish insurers.

Frontier Efficiency Concepts

To measure efficiency in the Spanish insurance industry, we utilize modern frontier efficiency analysis (Lovell 1993, Grosskopf 1993). This technique involves measuring the performance of each firm in the industry relative to "best practice" efficient frontiers consisting of the dominant firms in the industry. Efficiency scores vary between zero and 1, with fully efficient firms having efficiencies equal to 1 and inefficient firms having efficiencies between zero and 1.

We estimate efficient production, cost, and revenue frontiers, providing measures of technical, allocative, cost, and revenue efficiency for each firm in our sample. *Technical efficiency* for a given firm is defined as the ratio of the input usage of a fully efficient firm producing the same output vector to the input usage of the firm under consideration. *Cost efficiency* for a given firm is defined as the ratio of the costs of a fully efficient firm (i.e., a firm operating on the efficient cost frontier) with the same output quantities and input prices to the given firm's actual costs. One minus a firm's cost efficiency ratio provides a measures of the proportion by which costs could be reduced if the firm were operating on the cost frontier. Firms achieve cost efficiency by adopting the best practice technology (becoming *technically* efficient) and choosing the optimal mix of inputs (becoming *allocatively* efficient). Cost efficiency can be shown to equal the product of technical and allocative efficiency. Therefore, to be fully cost efficient, a firm must be both technically and allocatively efficient.

Revenue efficiency is defined as the ratio of the revenues of a given firm to the revenues of a fully efficient firm producing the same output vector with the same output prices. Firms can be revenue inefficient because they produce less than fully efficient firms using the same quantity of inputs (*output technical inefficiency*) or because they choose to produce an inefficient combination of outputs (*output allocative inefficiency*). Estimating both cost and revenue efficiency is important because the objective of the firm is profit maximization. Thus, to be fully efficient (i.e., to maximize profits), the firm must be both cost efficient and revenue efficient.

Hypothesis Test Procedures

As discussed above, the principal null hypotheses in this study are the managerial discretion hypothesis and the expense preference hypothesis. In the context of efficiency, the managerial discretion hypothesis implies that stocks and mutuals will tend to succeed in lines of insurance where they have comparative advantages in minimizing agency costs. Thus, the hypothesis predicts that stocks and mutuals will be relatively successful in different types of insurance (i.e., will produce different output vectors) but each set of firms will produce its output vector efficiently in the sense that its input utilization or production costs are less on average than those that would be experienced if the same output vector were produced by the other type of firm. Likewise, each group is expected to earn higher revenues than if its outputs were produced by the other type of firm. In this sense, mutuals and stocks are interpreted as using different technologies, where technology is defined as including all of the contractual relationships that constitute the firm as well as physical technology choices.

Mutuals might be relatively successful in low managerial discretion lines because they employ a different mix of capital (e.g., computers) and labor, employ different types of capital and labor, utilize different intra-firm hierarchical structures to organize work and monitor employees, or adopt different types of incentive contracts to motivate managers and workers. A mutual firm focusing on personal automobile insurance might be expected to use more capital (e.g., expert systems technology) and less labor (human underwriters) than a stock firm writing complex commercial lines. Furthermore, the labor employed by mutuals (e.g., underwriters) is likely to be less skilled than the labor required to operate in more complex types of insurance where stocks are predicted to dominate.

We test two versions of the null hypothesis that stocks and mutuals are equally efficient in activities where they have comparative agency-cost advantages. In the first level of analysis, we test the null hypothesis that stock and mutual insurers are operating on the same frontier against the alternative hypothesis that they operate on different frontiers. Rejection of this null hypothesis would be consistent with the managerial discretion hypothesis in that it would support the view that the two groups of firms are using different technologies. If markets are competitive, a reasonable inference is that market forces have driven the firms to adopt these respective technologies. The rejection of the null hypothesis on this set of tests also would imply that a comparison of efficiencies based on the pooled frontier would be misleading; i.e., we should not measure relative efficiencies of the two groups of firms based on the pooled frontier if in fact they are operating on separate frontiers.

To provide additional information on the hypothesis that firms are sorted into groups with comparative efficiency advantages, we conduct a second set of tests. In this set the null hypothesis is that each group's output vector could be produced with equal efficiency using the other group's production technology. This involves estimating the efficiency of the firms in each group with reference to the other group's frontier. Rejection of this null hypothesis for both groups would imply that stocks and mutuals have developed dominant technologies for producing their respective output combinations. This would provide evidence in favor of our efficiency-based interpretation of the managerial discretion hypothesis. Our second set of tests also permits us to provide evidence on which frontier is dominant for each observation in the sample by measuring the distance between the stock and mutual frontiers for each firm’s operating point (vector of inputs and outputs).

Measuring both production and cost frontiers provides evidence on the expense preference hypothesis by separating the effect on costs of the choice of production technology from the choice of input mix, conditional on the technology. Even if stocks and mutuals are sorted into market segments where they have technological advantages, such advantages could be eroded if firms fail to choose cost minimizing combinations of inputs, an outcome that has been interpreted as expense preference behavior (Mester 1991). By also estimating revenue efficiency, we provide evidence on whether mutual managers exhibit sub-optimal revenue performance. E.g., mutual managers could fail to maximize revenues by producing less output than stocks, conditional on input quantities, and/or by choosing sub-optimal combinations of outputs (output allocative efficiency).

Sub-optimal behavior with respect to cost minimization or revenue maximization could coexist with the sorting of firms into efficient groups based on technology. For example, mutual managers could consume higher costs up to the point where the mutuals' cost advantage over stocks due to their superior technology is nearly eliminated. Persistent failure to minimize costs or maximize revenues would require some limitation on competition in the industry that permits the survival of inefficient firms, at least for some period of time. Limitations on competition could arise due to regulation, search costs (Dahlby and West 1986), slow diffusion of information in insurance markets (Berger, Kleindorfer, and Kunreuther 1989), or private information that allows firms to capture economic rents (D'Arcy and Doherty 1991).[4] If deregulation and consolidation lead to increases in market competition, differences in inefficiency between mutuals and stocks can be expected to decline over time as inefficient firms become more competitive or exit the market.

Methodology

Distance Functions and Efficiency. To analyze production frontiers, we employ input-oriented distance functions (Shephard 1970, Lovell 1993). Suppose producers use input vector $\boldsymbol{x} = (x_1, x_2, \ldots, x_k)^T \in \Re^k_{++}$ to produce output vector $\boldsymbol{y} = (y_1, y_2, \ldots, y_n)^T \in \Re^n_+$, where T denotes the vector transpose.[5] A production technology which transforms inputs into outputs can be modeled by an input correspondence $y \rightarrow V(y) \subseteq \Re^k_{++}$. For any $y \in \Re^n_{++}$, V(y) denotes the subset of *all* input vectors $x \in \Re^k_{++}$ which yield at least y. The input-oriented distance function for a specific decision making unit (DMU) is then:

$$D(y,x) = \sup\{\theta : (y, \frac{x}{\theta}) \in V(y)\} = (\inf\{\theta : (y, \theta x) \in V(y)\})^{-1} \quad \textbf{(1)}$$

The input distance function is the reciprocal of the minimum equi-proportional contraction of the

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[4]Evidence of maintained differences in efficiency over time in U.S. insurance and banking are provided by Cummins and Weiss (1993) and Berger, et al. (2000). Evidence of similar patterns in the Spanish insurance and banking industries is provided by Cummins and Rubio-Misas (2001) and Grifell-Tatjé and Lovell (1996).

[5]Decision making unit (DMU) subscripts have been suppressed to simplify the notation. However, the analysis should be understood to apply firm-by-firm.

input vector x, given outputs y, i.e., Farrell's (1957) measure of input technical efficiency T(y,x), where T(y,x) = 1/D(y,x). The quantity D(y,x) must be ≥ 1, and T(y,x) is ≤ 1.

Distance functions can be estimated with respect to frontiers characterized by constant returns to scale (CRS), variable returns to scale (VRS), and non-increasing returns to scale (NIRS). In this paper, we work exclusively with CRS frontiers. This is the approach used most commonly in the literature because it represents the optimal outcome from an economic perspective, i.e., with CRS, firms are not consuming unnecessary resources because they are too large or too small (Aly, et al., 1990). The CRS approach measures departures from optimal scale as inefficiency.

To test the hypotheses investigated in this study, we estimate distance functions for stock and mutual insurers with respect to several reference sets. In the following discussion, subscripts on D indicate the reference set of firms used to construct the frontier. For example, $D_S(y_s, x_s)$ denotes the input distance function for stock firm s, measured with respect to a reference frontier consisting only of stock firms, where s = 1, 2, . . ., S, and S = the total number of stock firms in the sample. Likewise, $D_M(y_m, x_m)$ represents the input distance function for mutuals, where m = 1, 2, . . ., M, and M = the number of mutual firms. The pooled distance function for stock and mutual firms is denoted $D_P(y_s, x_s)$, s = 1, 2, . . ., S, and $D_P(y_m, x_m)$, m = 1, 2, . . ., M, where the reference set P consists of all stock and mutuals.

We can also define a minimum cost function or cost frontier using the distance function approach (Lovell, 1993). Let $w = (w_1, w_2, \ldots, w_k)^T \in \Re^k_{++}$ denote the input price vector corresponding to the input vector **x**. Then the cost frontier is defined as:

$$c(y, w) = \min\{w^T x : D(y, x) \geq 1\} \quad \textbf{(2)}$$

where c(y,w) = the cost frontier. The optimal input vector x^* minimizes the costs of producing y given the input prices w. Cost efficiency is calculated as the ratio $\eta = w^T x^* / w^T x$, where x represents actual input usage and $0 < \eta \leq 1$. With estimates of cost efficiency and technical efficiency, we can back out estimates of allocative efficiency using the relationship C(y,x) = T(y,x)*A(y,x), where C(y,x) is cost efficiency, T(y,x) is technical efficiency, and A(y,x) is allocative efficiency.

The maximum revenue function or revenue frontier is defined analogously to the cost function, also using the distance function approach (Lovell 1993). Let $p = (p_1, p_2, \ldots, p_n)^T \in \Re^n_{++}$ denote the output price vector corresponding to the output vector **y**. Then the revenue frontier is defined as:

$$r(x,p) = \max\{p^T\ y : D(y,x) \geq 1\} \tag{3}$$

where **r(x,p)** = the frontier. The optimal output vector $\mathbf{y}^*$ maximizes revenue conditional on inputs **x** and output prices **p**. Revenue efficiency is calculated as the ratio $\rho = \mathbf{p}^T\mathbf{y}/\mathbf{p}^T\mathbf{y}^*$, where $0 < \rho \leq 1$.

We also compute distances of mutuals from the stock frontier and distances of stocks from the mutual frontier, i.e., each group of firms is used as the reference set for the other group. This method requires the estimation of *cross-frontier* distance functions. For example:

$$D_M(y_s, x_s) = \sup\{\theta : (y_s, \frac{x_s}{\theta}) \in V(y_m)\}, \quad s = 1, 2, \ldots, S \tag{4}$$

where $D_M(y_s, x_s)$ is the input distance function for stock firm s relative to the mutual frontier. $D_S(y_m, x_m)$ is defined similarly. Estimating cross-frontier distance functions enables us to measure the efficiency of the firms with a particular organizational form relative to a best practice frontier based on the alternative organizational form. Whereas the distance function values for firms relative to their own group must be ≥ 1, the distances relative to the other group's frontier can be >, =, or < 1.

Cross-frontier analysis is illustrated in Figure 1, which shows production isoquants for hypothetical firms producing a single output with two inputs. The isoquant for stocks is labeled $L^S(y)$, and the isoquant for mutuals is labeled $L^M(y)$. The isoquants represent the best technology for the respective groups of firms, i.e., firms operating on the isoquants are on the production frontier and thus are fully efficient (T(y,x) = 1). In this case, the isoquants have been drawn to intersect so that the stock technology is optimal for some operating points and the mutual technology is dominant for other operating points. However, it is possible that one isoquant could be dominant for all operating points.

To illustrate the *group-specific* or *own-group* frontiers, consider stock firm s, which operates at point b with output-input vector (y_s, x_s). This firm could reduce its input usage by moving to the stock isoquant $L^S(y)$ and operating at point a. Its distance function value with respect to the stock frontier is $D_S(y_s, x_s) = 0b/0a > 1$, and its distance from the mutual frontier is $D_M(y_s, x_s) = 0b/0c < 1$. A cross-frontier distance function value < 1 implies that it would be infeasible for a mutual produce output-input vector (y_s, x_s), i.e., the stock insurers' technology is dominant for this output-input vector.

Likewise, the own-frontier input distance function value for mutual firm m, operating at point f, is $D_M(y_m,x_m)$ = 0f/0d > 1. The mutual firm's distance function value relative to the stock firm isoquant is $D_S(y_m,x_m)$ = 0f/0e > 1. It would be feasible for a mutual firm to improve substantially in comparison with point f. In fact, it is feasible for mutuals to operate on the line segment (d,e), which would be infeasible for stock firms. However, because this mutual firm is inefficient, its distance function value is > 1 with respect to both the stock and mutual isoquants.

Figure 1 also suggests that it is possible to measure the distance between the frontiers at each operating point and also to decompose a firm's group-specific frontier distance into the product of the distance between the frontiers and its distance from the frontier applicable to the other group of firms. We use the notation $D_{T\{S:M\}}(y_s,x_s)$ to represent the distance between the production frontiers with respect to the stock firm's operating point (y_s,x_s), and likewise $D_{T\{M:S\}}(y_m,x_m)$ to represent the distance between the production frontiers with respect to the mutual firm's operating point (y_m,x_m). The stock firm's distance function value relative to the stock frontier can then be decomposed as follows:

$$\boldsymbol{D_S(y_s,x_s) = D_{T\{S:M\}}(y_s,x_s)\, D_M(y_s,x_s) = \frac{0c}{0a}\frac{0b}{0c} = \frac{0b}{0a}} \qquad \textbf{(5)}$$

This formulation enables us to estimate the distance between the stock and mutual frontiers for each operating point by dividing the own-frontier distance function value by the cross-frontier distance function value, i.e., $D_{T\{S:M\}}(y_s,x_s) = D_S(y_s,x_s)/D_M(y_s,x_s)$, and $D_{T\{M:S\}}(y_m,x_m) = D_m(y_m,x_m)/D_S(y_m,x_m)$.

Because Farrell technical efficiency is the reciprocal of the distance function value, the cross-frontier distance functions also can be expressed as: $D_{T\{S:M\}}(y_s,x_s) = T_M(y_s,x_s)/T_S(y_s,x_s)$, for stock firms, and $D_{T\{M:S\}}(y_m,x_m) = T_S(y_m,x_m)/T_m(y_m,x_m)$ for mutual firms. I.e., the frontier distance for any given operating point is the ratio of the cross-frontier technical efficiency to the own-group (own-frontier) technical efficiency. In discussing the results, it will often be convenient to consider efficiencies rather than distance function values.

Notice that the distance between the frontiers for any given operating point is > 1 if that firm's group-specific frontier dominates the other group's frontier and is < 1 if the firm's group-specific frontier is dominated by the other group's frontier. To illustrate, assume that a stock firm is operating at point f in Figure 1, with output-input vector $(y_{s'},x_{s'})$. Here we would have $D_{T\{S:M\}}(y_{s'},x_{s'})$ = $D_S(y_{s'},x_{s'})/D_M(y_{s'},x_{s'})$ = (0f/0e)/(0f/0d) = 0d/0e < 1. Thus, whether the distance function value $D_{T\{S:M\}}(y_{s'},x_{s'})$ or $D_{T\{M:S\}}(y_m,x_m)$ is greater or less than 1 determines whether the stock or mutual frontier is dominant for operating points $(y_{s'},x_{s'})$ and (y_m,x_m), respectively.

The intuition is as follows: If $D_M(y_m,x_m)$ is greater than $D_S(y_m,x_m)$, for example, the operating point (y_m,x_m) is further from the mutual frontier than from the stock frontier, implying that the mutual frontier is closer to the origin. Hence, the mutual technology requires less inputs to produce the output y_m than would the stock technology and $D_{T\{M:S\}}(y_m,x_m) = D_m(y_m,x_m)/D_S(y_m,x_m) > 1$. On the other hand, if the stock frontier is dominant at a given mutual operating point, $(y_{m'},x_{m'})$, then $D_M(y_{m'},x_{m'})$ would be less than $D_S(y_{m'},x_{m'})$, and $D_{T\{M:S\}}(y_{m'},x_{m'})$ would be < 1.

Using $D_{T\{S:M\}}(y_s,x_s)$ and $D_{T\{M:S\}}(y_m,x_m)$ has the effect of projecting each firm's operating point to its own frontier, i.e., treating this firm as if it were fully efficient, and then measuring the distance between the frontiers for a fully efficient firm with the same output vector. For example, for the stock firm (y_s,x_s) in Figure 1, technical efficiency $TE(y_s,x_s) = 1/D_S(y_s,x_s)$ = 0a/0b. Equation (5) implies that this ratio can be decomposed into the product of the technical efficiency of point c relative to the stock isoquant $(L^S(y))$, i.e., 0a/0c, and the technical efficiency of point b relative to the mutual isoquant $(L^M(y))$, i.e., 0c/0b. Thus, when point b is projected to the stock frontier (i.e., converges to point a), technical efficiency is equal to 1 and 0c/0a measures the distance between the frontiers.

We also estimate cross-frontier cost and revenue efficiency. This is done by estimating cost (revenue) efficiency of stocks relative to the reference technology set represented by mutuals and also estimating cost (revenue) efficiency of mutuals relative to the stock reference set. Cross frontier cost efficiency incorporates both technical and allocative efficiency, similarly to cost efficiency estimated using the firm's own-group reference set. Hence, it allows firms to be inefficient both due to technical inefficiency (not operating on the production frontier) and allocative inefficiency (failure to choose the cost minimizing combination of inputs). Like own-frontier revenue efficiency, cross-frontier revenue efficiency, allows firms to be inefficient because they do not operate on the production frontier (technical inefficiency) and because they fail to choose the revenue-maximizing combination of outputs (output allocative inefficiency).

We also compute the distance between the production frontiers when measuring cost efficiency. This is similar to the decomposition illustrated in Figure 1, except that we must incorporate input prices when considering costs. The decomposition in the cost efficiency case is illustrated in Figure 2, where the stock isoquant, $L^S(y)$ has been drawn to always dominate the mutual isoquant, $L^M(y)$ to simplify the discussion. A similar decomposition could be accomplished with intersecting isoquants.

Figure 2 is similar to the standard Farrell efficiency graph with the exception that there are now two isoquants rather than the single isoquant in the usual Farrell diagram. The optimal operating points for stocks and mutuals respectively are (y_s*,x_s*) and (y_m*,x_m*), representing the points of tangency of the isoquants, $L^S(y)$ and $L^M(y)$, and the isocost lines ww and w'w', respectively.

To illustrate the decomposition, we consider a stock firm operating at point c, with output-input vector (y_s,x_s). This firm's own-group frontier cost efficiency $C_S(y_s,x_s)$ is 0a/0c, which is obtained as the product of its own-group technical efficiency, $T_S(y_s,x_s)$ = 0b/0c, and its own-group allocative efficiency, $A_S(y_s,x_s)$ = 0a/0b. The firm's cross-frontier efficiencies are obtained similarly, based on the mutual isoquant: $C_M(y_s,x_s) = (0a'/0c) = (0b'/0c)*(0a'/0b') = T_M(y_s,x_s)*A_M(y_s,x_s)$. The cross-frontier distance for this firm's operating point is obtained as the ratio of the cross-frontier efficiency to the own-frontier efficiency, i.e.,

$$D_{C\{S:M\}}(y_s,x_s) = \frac{C_M(y_s,x_s)}{C_S(y_s,x_s)} = \frac{T_M(y_s,x_s)}{T_S(y_s,x_s)} \frac{A_M(y_s,x_s)}{A_S(y_s,x_s)} \qquad (6)$$

where $D_{C\{S:M\}}(y_s,x_s)$ = the distance between the stock and mutual production frontiers with respect to operating point (y_s,x_s) after correcting for both technical and allocative inefficiency. In terms of Figure 2, $D_{C\{S:M\}}(y_s,x_s)$ = [(0b′/0c)*(0a′/0b′)]/[(0b/0c)*(0a/ob)] = (0a′/0c)/(0a/0c) = (0a′/0a). Based on technical efficiency alone, we would have measured the distance between the frontiers as (0b′/0b). Thus, when using cost efficiency the interpretation of $D_{C\{S:M\}}(y_s,x_s)$ is the same, i.e., the distance between the production frontiers, but the distance is measured at different places along the frontier.

In fact, when based on cost efficiency, the distance is measured precisely at the optimum operating point where allocative and technical efficiency both equal 1. This is the distance between the parallel iso-cost lines that are tangent to the mutual and stock isoquants.

It is apparent from (6) that the distance between the frontiers when costs are taken into account can be equal to, greater than, or less than the distance based on technical efficiency alone. The technical and cost distance measures will be equal if the firm being evaluated has the same allocative efficiency with respect to both the stock and mutual frontiers. In this case, the ratio $A_M(y_s,x_s)/A_S(y_s,x_s)$ will equal 1, so that (6) gives $D_{C\{S:M\}}(y_s,x_s) = (0b'/0b)$. Otherwise, the two measures will not be equal, with the difference determined by the value of the factor $[A_M(y_s,x_s)/A_S(y_s,x_s)]$ in equation (6). In Figure 2, this factor is equal to $[(0a'/0b')/(0a/0b)]$. If the own frontier allocative efficiency (0a/0b) is smaller than the cross-frontier allocative efficiency (0a′/0b′) the cost-frontier distance will be measured as larger than the technical frontier difference. We interpret this result as implying that there is more improvement from correcting allocative inefficiency when we project the operating point (y_s,x_s) to the stock optimum (y_s^*,x_s^*) than there is when we project (y_s,x_s) to the mutual optimum (y_m^*,x_m^*).

Denote the allocative efficiency factor in (6) as $D_{A\{S:M\}}(y_s,x_s) = [A_M(y_s,x_s)/A_S(y_s,x_s)]$. If $D_{A\{S:M\}}(y_s,x_s) < 1$, an intuitive interpretation is that allocative efficiency would be higher if the output-input vector (y_s,x_s) were produced by a stock firm; and if $D_{A\{S:M\}}(y_s,x_s) > 1$, allocative efficiency would be higher if the vector were produced by a mutual firm. Hence, if $D_{A\{S:M\}}(y_s,x_s) < 1$, we can infer that the stock firm is more allocatively efficient than a hypothetical mutual producing the same outputs using the same inputs, and if $D_{A\{S:M\}}(y_s,x_s) > 1$, we can infer that allocative efficiency would be higher if the output vector were produced by the hypothetical mutual. This interpretation enables us to provide evidence on the expense preference hypothesis by observing whether the frontier distances based on technical efficiency are greater or less than those based on cost efficiency.

The analysis with respect to revenue efficiency is directly analogous to the cost efficiency case and thus is not presented in detail. The primary difference is that the optimal operating points would be determined by the tangency of iso-output-price lines and production possibilities curves (Lovell 1993). The frontier difference is measured in this case by projecting the actual operating points to the optimal points and computing ratios analogous to (6). This would give the revenue frontier distance, $D_{R\{S:M\}}(y_s,x_s)$ as the product of the technical frontier distance ratio, $T_M(y_s,x_s)/T_S(y_s,x_s)$, and the output allocative ratio: $R_M(y_s,x_s)/R_S(y_s,x_s)$, where output allocative efficiencies are interpreted in terms of the firm's success in choosing the revenue maximizing combination of outputs. Analogous to the cost efficiency case, if $D_{R\{S:M\}}(y_s,x_s) > D_{T\{S:M\}}(y_s,x_s)$, the interpretation is that revenue allocative efficiency would be improved if the output vector y_s were produced by a mutual and if $D_{R\{S:M\}}(y_s,x_s) < D_{T\{S:M\}}(y_s,x_s)$, then the inference is that the revenue allocative efficiency of the stock firm under consideration is superior to that of a hypothetical mutual. The latter result would be consistent with opportunistic, i.e., non-revenue maximizing, decision-making by the mutual's management – an analogy to expense preference behavior on the revenue side.

Estimating Efficiency. DEA efficiency is estimated by solving linear programming problems. For example, the technical efficiency with respect to the pooled frontier is estimated by solving the following problem, for each firm, i = 1, 2, ..., S+M, in each year of the sample period:

$$[D_P(y_i,x_i)]^{-1} = TE_P(y_i,x_i) = \min \theta_i$$

$$\begin{aligned} \textit{subject to}: \quad & Y_P\lambda_i \geq y_i \\ & X_P\lambda_i \leq \theta_i x_i \\ & \lambda_i \geq 0 \end{aligned}$$

where $\mathbf{Y_P}$ is an N x (S+M) output matrix for all stock and mutual firms in the sample, and $\mathbf{X_P}$ a K x (S+M) input matrix for all firms in the sample, y_i is an N x 1 output vector and x_i a K x 1 input vector for firm i, and λ_i is an (S+M) x 1 intensity vector. Efficiencies for the stock and mutual samples, $T_S(x_s,y_s)$ and $T_M(x_m,y_m)$ are estimated similarly except that the reference output and input matrices Y_S and X_S for stocks and Y_M and X_M for mutuals consist of all stock and mutual firms in the sample, respectively. Constraining the λ_i only to be non-negative imposes constant returns to scale.

Cross-frontier technical efficiencies of stock firms with respect to the mutual reference set are obtained by solving the following linear programming problem for each stock firm in each time period:

$$[D_M(y_s,x_s)]^{-1} = TE_M(y_s,x_s) = \min \theta_s$$

$$\textit{subject to}: \quad Y_S \lambda_m \geq y_m$$
$$X_S \lambda_m \leq x_m$$
$$\lambda_m \geq 0$$

where $\mathbf{Y}_M$ is an N x M output matrix and $\mathbf{X}_M$ a K x M input matrix for all *mutual* firms, y_s is an N x 1 output vector and x_s a K x 1 input vector of the *stock* firm s, and λ_s an M x 1 intensity vector of mutuals with respect to stock firm s. The efficiency $TE_S(y_m,x_m)$ is estimated similarly.

For technical efficiency, we estimate two input distance functions ($D_S(y_s,x_s)$ and $D_M(y_s,x_s)$) for stock firms and two input distance functions ($D_M(y_m,x_m)$ and $D_S(y_m,x_m)$) for mutual firms. The pooled distance function $D_P(x_i,y_i)$, i = S, M, is also estimated to test our first null hypothesis.

The following problem is solved as the first step to obtain the cross-frontier cost efficiency of mutual firm m with respect to the stock frontier:

$$\underset{x_m}{Min} \quad w^T x_m$$

$$\textit{subject to}: \quad Y_S \lambda_m \geq y_m$$
$$X_S \lambda_m \leq x_m$$
$$\lambda_m \geq 0$$

where Y_S and X_S are output and input matrices for all stock firms, y_m and x_m are output and input vectors for mutual firm m, m = 1, 2, . . ., M, and λ_m is an intensity vector for stocks relative to the mutual firm m. The solution x_m* is the cost-minimizing input vector for firm m. The second step is to calculate cost efficiency $\eta_m = w^T x_m^* / w^T x_m$. The cross-frontier revenue efficiency problem for stock firm s relative to mutuals is:

$$\underset{y_s}{Max} \quad p^T y_s$$

$$\textit{subject to}: \quad Y_M \lambda_s \geq y_s$$
$$X_M \lambda_s \leq x_s$$
$$\lambda_s \geq 0$$

Denoting the optimal output vector by y_s*, revenue efficiency is equal to $\rho_s = p^T y_s / p^T y_s^*$. The own-frontier problems substitute the reference matrices Y_S and X_S for stocks and Y_M and X_M for mutuals.

3. The Sample, Outputs, and Inputs

This section first describes our data base and discusses the measurement of the outputs, inputs, and prices used in estimating efficiency. The section concludes with a discussion of summary statistics for the firms in the sample.

The Database

The database for our study consists of all insurers operating in Spain over the period 1989-1997 that report to the Spanish regulatory authority, the Dirección General de Seguros, Ministerio de Economía y Hacienda.[6] The data base thus includes all insurers in the Spanish market supervised by the Spanish regulatory authority except for social benefit institutions.[7] Some firms were eliminated from the sample because of data problems such as zero or negative premiums or net worth, i.e., because they are not viable operating entities. The final sample used in the analysis consists of an average of 298 stocks and 49 mutuals in each year of the sample period, a total of 3121 observations. The firms in the sample account for an average of 69 percent of the premium volume in the Spanish insurance market during the sample period 1989-1997.

Outputs, Inputs, and Prices

Insurers are analogous to other financial firms in that their outputs consist primarily of services, many of which are intangible. Consistent with most of the recent literature on financial institutions, we adopt a modified version of the value-added approach to output measurement, which counts as important outputs those that have significant value added, as judged using operating cost allocations (Berger and Humphrey 1992). Because insurance outputs are mostly intangible, we define proxies for the principal services provided by insurers. These services are as follows:

Risk-pooling and risk-bearing. Insurance provides a mechanism through which consumers and businesses exposed to losses can engage in risk reduction through pooling. The actuarial, underwriting, and related expenses incurred in risk pooling are important components of value

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[6]The sample primarily consists of Spanish insurers and Spanish subsidiaries of insurers licensed in other EU countries. As in other EU nations, the primary method for foreign insurers to enter the Spanish market has been through the formation of Spanish-licensed and regulated subsidiaries rather than through branches or agencies (Cummins and Rubio-Misas 2001). Consequently, the sample consists of firms writing the vast majority of insurance sold in Spain. A small number of branches of EU licensed firms are included in the sample from 1989-1994, but such branches did not have to report to the Spanish regulatory authority after 1994. A few branches of non-EU firms, which are required to report to the Spanish regulator, also are included in the sample. Conducting the analysis without the branches does not materially change the results.

[7]Social benefit institutions (mutualidades de prevision social) are non-profit private mutual insurers providing coverage complementary to social security schemes. We omitted these firms because of their specialized objective and because we wanted to focus on the for-profit segment of the insurance market.

added in the industry. Insurers also add value by holding equity capital to bear the residual risk of the pool.

"Real" financial services relating to insured losses. Insurers provide a variety of real services for policyholders including financial planning, risk management, coverage design, loss prevention, and the provision of legal defense in liability disputes. By contracting with insurers to provide these services, policyholders take advantage of insurers' specialized expertise to reduce the costs associated with managing risks.

Intermediation. Insurers are financial intermediaries who borrow funds from policyholders, analogous to bank deposits, and invest the borrowed funds in financial assets until they are needed to pay claims or fund withdrawals. For life insurers, financial intermediation is a principal function, accomplished through the sale of asset accumulation products such as annuities. For non-life insurers, intermediation is an important but incidental function, resulting from the collection of premiums in advance of claim payments. Insurers' value added from intermediation is reflected in the net interest margin between the rate of return earned on invested assets and the rate credited to policyholders. Policyholders receive a discount in their premiums to compensate for the opportunity cost of the funds held by the insurer, analogous to interest payments on corporate debt, and also receive dividends in some types of insurance.

Transactions flow data such as the number of policies issued, the number of claims settled, etc. are not publicly available for Spanish insurers. However, a satisfactory proxy for the amount of risk-pooling and real insurance services provided is the value of real incurred losses, defined as current losses paid plus additions to reserves (Yuengert 1993, Cummins, Tennyson, and Weiss 1999).[8] Losses paid represent current expenditures for covered loss events and other benefits, whereas additions to reserves represent the insurer's best estimate of claims and other benefits to be paid in the future as a result of the current year's insurance coverage and contributions to asset accumulation products. Because the objective of risk-pooling is to collect funds from the policyholder pool and redistribute them to those who incur losses, proxying output by the amount of losses incurred seems quite appropriate. Losses incurred are also a good proxy for the amount of real services provided, since the amount of claims settlement and risk management services also is highly correlated with loss aggregates. Because the current year's activities will add incrementally to expected future payments on long-tail non-life insurance policies and asset-accumulation life insurance products, the net additions to reserves also provide a satisfactory proxy for the current year's net intermediation output.

[8]The use of premiums generally is not considered appropriate because premiums represent price times quantity of output, i.e., insurance revenues (Yuengert 1993). However, robustness checks conducted in prior studies reveal that the efficiency estimates are not materially affected by the use of alternative output proxies such as premiums (Cummins, et al. 1999).

Because the types of services provided differ between the principal types of insurance, we use as separate output measures the value of life and non-life insurance losses incurred.[9] Losses incurred and all other monetary values used in the study are expressed in 1989 monetary units by deflating by the Spanish Consumer Price Index (Indice de Precios al Consumo, from the Instituto Nacional de Estadística (INE).

Because our output variables incorporate both risk pooling and intermediation services, the output prices also must be defined to include both types of services. The following pricing definition includes the value-added from risk-pooling and intermediation:

$$P_i = \frac{(G_i + r\,R_i) - L_i}{L_i} \tag{7}$$

where P_i = price for output i, i = L = life insurance, i = N = non-life insurance, G_i = premiums for line i, r = the company's rate of return on invested assets, R_i = policy reserves for line i, and L_i = losses incurred for line i. In the numerator, the value of output (losses incurred) is subtracted from the gross revenues for line i, which includes premiums for the line plus investment income on reserves for the line. Gross inflows minus output equals total value-added for the line. This amount is then divided by output to obtain value-added per monetary unit of output. As a result, the product of price and quantity of output, i.e., $P_i * L_i$ = net revenues for the line of business.

Inputs and Input Prices. We follow the recent insurance efficiency literature in defining four inputs – labor, business services (including materials and physical capital), financial debt capital, and equity capital. Labor is the most important non-interest expense for the Spanish insurance industry, accounting for about two-thirds of total non-loss expenses. The price of labor is the average monthly wage for employees in the Spanish insurance sector, provided by the Instituto Nacional de Estadística (INE). Most of the remainder of insurer expenses are for business services such as legal fees, travel,

[9]More specifically, non-life losses incurred are defined as loss payments + additions to loss reserves + additions to other technical reserves for non-life insurance. For life insurance, losses incurred is defined as loss payments + additions to loss reserves + additions to mathematical reserves + additions to other technical reserves for life insurance. Technical and mathematical reserves are estimates of future loss and other benefit payments the company expects to make in the future. All loss payment and reserve changes are net of reinsurance, consistent with prior insurance efficiency research (e.g., Cummins and Weiss 1993, Berger, et al. 1997).

communications, and materials; and we use business services as a second input.[10] The Spanish business services deflator compiled by the INE is used as the price of business services.

Because data on the number of employees or hours worked in the Spanish insurance industry are not available, we follow other insurance efficiency researchers (e.g, Cummins and Weiss 1993, Berger, et al. 1997, Cummins and Zi 1998) in measuring the quantity of labor by dividing labor expenditures by the insurance sector wage rate. The quantity of business services is defined similarly.

Our other inputs are the quantity of financial equity capital and debt capital (borrowed funds). Financial equity capital is an important input in insurance because insurers must hold equity to ensure policyholders that they will receive payment if claims exceed expectations and to satisfy regulatory requirements. Debt capital provides another source of funds, consisting of borrowed funds as well as deposits from reinsurance companies to guarantee the reinsurers' promise to pay claims on ceded risks. Capital costs represent a significant expense for insurers. However, measuring the cost of capital in the Spanish insurance industry is difficult because few insurers have traded shares. As a proxy for the cost of equity capital, we use the rate of total return on the Madrid Stock Exchange Index for each year of the sample period; and for debt capital we use the one-year Spanish Treasury bill rate.[11]

Summary. To summarize, we use two outputs and four inputs. The outputs are life and non-life insurance losses incurred. The inputs are labor, business services, debt capital, and equity capital.

Sample Size and Summary Statistics

The number of firms in the sample trended downwards over the sample period – between 1989 and 1997, the number of stock firms declined from 342 to 262 and the number of mutuals declined from 57 to 46. The decline in the number of firms resulted from acquisitions, insolvencies, and voluntary

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[10] Only a small fraction of expenses are for physical capital such as computers. Consequently, we do not define physical capital as a separate input but include it in the business services category.

[11] It would be preferable to vary both the cost of equity and the cost of debt capital by insurer depending upon capital structure and portfolio risk. However, the data to do this are not available. As a robustness check, we also estimated efficiency by creating three tiers of insurers, with differing costs of debt capital based upon their capital to asset ratios, giving insurers with lower capital to asset ratios higher costs of debt. The results indicated that the efficiency scores and efficiency rankings are not substantially affected by the choice of interest rate assumption. As additional controls for cost of capital differences in capital structure among firms, we include the ratios of equity and debt capital to assets in our regression analysis, as explained below.

liquidations (see Cummins and Rubio-Misas 2001). The proportionate decline in the number of stock firms exceeded the decline in mutuals because Spanish regulatory policy earlier in the 1980s led to the removal of many small, under-capitalized mutuals from the market prior to our sample period (Esteban-Jodar 1986, 1993).

Stock insurers in Spain are larger on average than mutuals – the average assets for stock firms is 10.7 billion pesetas, compared to 9.6 billion for mutuals, although this difference is not statistically significant. Stocks have significantly larger life insurance premiums than mutuals (4.1 billion versus 1.6 billion pesetas). However, the average non-life insurance premiums are not significantly different for stocks and mutuals, suggesting that mutuals are relatively more important in non-life insurance than in life insurance. Mutuals have higher ratios of net income to equity and net income to assets, reflecting generally higher profit margins in the non-life segment of the Spanish market where mutuals play a relatively important role. Stocks have lower ratios of reserves to assets and higher ratios of debt capital to assets than mutuals, but total leverage (the sum of reserves to assets and debt capital to assets) is not significantly different between stocks and mutuals. Thus, stock insurers rely more heavily on financial debt than mutuals, probably because of stocks' better access to capital markets. Stock insurers likewise have significantly higher ratios of equity capital to assets than mutuals.

Table 1 also shows that stock insurers have lower own-frontier (own-group) technical, cost, and revenue efficiency than mutuals. Thus, stocks are less efficient on average based on the own-frontier analysis, but this does not necessarily mean that they are less efficient than mutuals. The latter comparison is the subject of a more detailed analysis presented below. Table 1 also shows that the average cross-frontier technical, cost, and revenue efficiencies of stocks are significantly larger than the average cross-frontier efficiencies of mutuals, suggesting that stocks on average are closer to the mutual frontiers than mutuals are to the stock frontiers. That is, based on the averages the stock frontiers appear to dominate the mutual frontiers.

4. Efficiency Results

This section presents our results on the relationship between organizational form and efficiency in the Spanish insurance market. We first provide a graphical overview of the efficiencies of stocks and mutuals to provide an intuitive interpretation of the role of the group-specific frontiers (called "own" frontier for convenience) and pooled frontiers. This is followed by a discussion of formal statistical tests of the null hypotheses that the group-specific frontiers are not statistically different from the pooled frontier. Because these hypotheses are rejected for the technical, cost, and revenue frontiers, we conduct the remainder of the analysis based on the own and cross-frontiers and the relationships among them as represented by the ratio of each group's cross-frontier efficiency to its own frontier efficiency (i.e., the ratios $D_{T\{S:M\}}(y_s,x_s) = T_M(y_s,x_s)/T_S(y_s,x_s)$ and $D_{T\{M:S\}}(y_m,x_m) = T_S(y_m,x_m)/T_m(y_m,x_m)$ and the similar ratios for cost and revenue efficiency discussed above).

Pooled versus Separate Frontiers

The first part of our analysis, we test the null hypothesis that stocks and mutuals are characterized by the same technical, cost, and revenue frontiers versus the alternative hypothesis that they are operating on different frontiers. As mentioned above, rejection of the null hypothesis in this case would imply that stocks and mutuals are producing their outputs using different technologies, where technology is defined as including the contractual relationships comprising the firm as well as physical technology choices.

To provide some intuition into the frontier efficiency tests, we begin by presenting Figures 3 and 4, which plot, respectively, the average mutual and stock own-frontier versus pooled-frontier efficiency scores for technical, cost, and revenue efficiency. The mutual results, presented in Figure 3, show that the mutuals' own-frontier efficiencies are greater than their pooled frontier efficiencies, based on pairwise comparisons by type of efficiency in each year. E.g., in 1989, the own-frontier technical efficiency for mutuals is about 43 percent, whereas the mutuals' technical efficiency relative to the pooled frontier is only about 28 percent. Likewise, in 1994, the mutuals' own-frontier revenue efficiency is about 42 percent, whereas its pooled frontier revenue efficiency is about 25 percent.

The intuitive interpretation of these results is that if mutuals on average are closer to their own frontier than to the pooled frontier, then the mutual frontier is generally dominated by the pooled frontier, which must be primarily determined by the group of firms omitted in calculating the mutuals' own-frontier efficiencies, i.e., the Spanish stock insurers. This inference is confirmed by the stock own-frontier and pooled-frontier average efficiency scores plotted in Figure 4. This figure shows that the stocks' own-frontier efficiencies are very close to the stocks' pooled-frontier efficiencies for all three types of efficiency in all years, except 1997, when own and pooled-frontier efficiencies diverge for technical and cost efficiency. Thus, except in 1997, it appears that stock firms are primarily determining the technical, cost, and revenue frontiers.

We also conduct a more formal test of the null hypothesis that stocks and mutuals are operating on the same frontier, i.e., that they use the same production technology. This test, based on Elysiani and Mehdian (1992), actually tests two null hypotheses for each type of efficiency:

> **Hypothesis 1:** The stock firms' group-specific ("own") efficient frontier for efficiency type i is identical to the pooled frontier.
>
> **Hypothesis 2:** The mutual firms' group-specific ("own") efficient frontier for efficiency type i is identical to the pooled frontier.

We follow Elysiani and Mehdian (1992) in conducting a battery of parametric and non-parametric tests of the null hypotheses. The parametric test, analysis of variance, tests the hypothesis that the mean of the group specific efficiency scores is equal to the mean of the pooled frontier efficiency scores. Five non-parametric tests based on linear rank statistics also are conducted – the two-sample median test, the Wilcoxon rank-sum test, the Kruskall-Wallace (chi-square) test, the Van der Waerden test, and the Savage test. Several tests are conducted because they have somewhat different properties depending upon the distribution of the underlying data.

The test results are shown in detail in Appendix Tables A.1, A.2, and A.3, respectively, for the technical, cost, and revenue frontiers. The tests overwhelmingly reject either Hypothesis 1, Hypothesis 2, or both for all types of efficiency in each year of the sample period. In the majority of cases, the tests reject Hypothesis 2, i.e., the mutual frontier is found to differ significantly from the pooled frontier. For technical efficiency in 1997, Hypothesis 1 is rejected but Hypothesis 2 is not rejected; and for cost and revenue efficiency in 1997, both hypotheses are rejected. Taken as a whole, the tests imply that efficiency comparisons should be based on separate stock and mutual frontiers rather than on the pooled frontier. The test results also suggest that cross-frontier comparisons are likely to be informative, i.e., that stocks and mutuals may have developed superior technologies for producing their respective output vectors. Hence, in the remainder of the paper, we focus on own-frontier and cross-frontier efficiencies.

Own and Cross-Frontier Analysis

Average Efficiencies and Efficiency Ratios. The technical efficiency scores based on separate mutual and stock frontiers are shown in the columns headed $T_S(y_s,x_s)$ and $T_M(y_m,x_m)$ in Table 2.[12] Mutuals are significantly more efficient with respect to the mutual frontier, in comparison with the efficiency of stocks relative to the stock frontier, in every year of the sample period except 1997 when stock and mutual efficiencies are not statistically different. The generally lower own-frontier efficiencies for stocks suggests more dispersion in operating efficiency within the stock segment of the market, possibly because the greater incentive to compete provided by the stock ownership form leads to a wider gap between the most successful and the less successful firms. These results cannot be interpreted as implying that the output of stock insurers would be produced more efficiently by mutuals, however, because the firms are using different technologies, reflected in different production frontiers – mutuals could be closer on average to their own frontier than stocks, but the stock frontier could generally dominate the mutual frontier.

We also compute the technical efficiencies of the mutuals relative to the stock frontier and the technical efficiencies of stocks relative to the mutual frontier, i.e., the *cross-frontier efficiencies*. This provides evidence on the hypothesis that each group of firms is dominant on average in producing the output vectors chosen by members of the group. These results are shown in the columns of Table 2 headed $T_M(y_s,x_s)$ and $T_S(y_m,x_m)$, respectively. The stock relative-to-mutual-frontier scores ($T_M(y_s,x_s)$) average 0.95 for the period as a whole, are at least 0.9 in seven of nine years, and exceed 1.0 in two years. Recall that a cross-frontier score greater than 1 for one type of firm for a given output-input vector (operating point) implies that production at this operating point is infeasible for the other type of firm. Thus, in two years of the sample period, it would have been infeasible on average for mutuals to produce stock output-input combinations. Moreover, the fact that the stock cross-frontier scores

[12]Asterisks between pairs of columns give the results of significance tests for differences between the results in the corresponding cells of the two columns. Reported significance levels are based on analysis of variance (ANOVA). Non-parametric tests, including the Kruskal-Wallis, Van der Waerden, and Savage tests, produced similar results.

($T_m(y_s,x_s)$) are substantially larger than the stock own-frontier efficiencies ($T_s(y_s,x_s)$) implies that stocks are further from their own frontier than they are from the mutual frontier. This result supports the hypothesis that stocks on average have developed technologies that are superior to the mutual technology for producing stock output vectors. We provide more information on this point below.

The mutual cross-frontier efficiencies, shown in the column of Table 2 headed $T_s(y_m,x_m)$, are significantly smaller than the cross-frontier efficiencies for stocks both for the period as a whole and for all individual years. The mutual cross-frontier efficiencies also are smaller than their own-frontier efficiencies for the period as a whole and in five of nine years. Thus, mutual technologies generally do not appear to dominate stock technologies, even for the production of mutual output vectors. However, both the own-frontier and cross-frontier measures compound technical dominance (inferiority) with inefficiency. We next attempt to resolve this ambiguity by separating these two effects.

It was argued above that a firm's distance function value relative to its group-specific frontier can be decomposed into the product of its distance from the other group's frontier and the distance between the frontiers. For example, for a mutual firm the decomposition is as follows: $D_M(y_m,x_m) = D_{T\{M:S\}}(y_m,x_m)\ D_S(y_m,x_m)$. For the illustrative mutual firm at point f in Figure 1, the decomposition is: $D_{T\{M:S\}}(y_m,x_m)*D_S(y_m,x_m) = (0e/0d)*(0f/0e) = 0f/0d = D_M(y_m,x_m)$. This decomposition implies that we can eliminate the inefficiency and focus only on the difference between the frontiers with respect to point (y_m,x_m) by dividing the own-frontier distance function value by the cross-frontier distance function value to obtain: $D_{T\{M:S\}}(y_m,x_m) = D_M(y_m,x_m)/D_S(y_m,x_m) = 0e/0d$. Equivalently, the result can be stated in terms of efficiency: $D_{T\{M:S\}}(y_m,x_m) = T_S(y_m,x_m)/T_M(y_m,x_m)$, i.e., the distance estimate is the ratio of the cross-frontier technical efficiency to the own-frontier technical efficiency. It will be convenient to refer to ratios such as $D_{T\{M:S\}}(y_m,x_m)$ as *cross/own efficiency ratios*.

Notice that the value $D_{T\{M:S\}}(y_m,x_m) = 0e/0d$ is greater than 1 because the mutual frontier dominates the stock frontier at this operating point. Intuitively, this firm is more efficient relative to the stock frontier than it is relative to its own frontier, implying that $D_{T\{M:S\}}(y_m,x_m) > 1$, i.e., that the mutual frontier is dominant. Suppose instead that a stock firm s' with output-input vector $(y_{s'},x_{s'})$ were operating at point f in Figure 1, in the region where the mutual frontier is dominant. The decomposition in this case would be: $D_{T\{S:M\}}(y_{s'},x_{s'}) = T_M(y_{s'},x_{s'})/T_S(y_{s'},x_{s'}) = (0d/0f)/(0e/0f) = 0d/0e < 1$. Because the mutual frontier is dominant for operating point f, the frontier distance is measured as less than 1 for a stock firm at point f. This implies that a mutual firm could produce the stock firm's output vector using proportionately less inputs even if the stock firm were fully efficient relative to its own frontier.

Another way of interpreting the decomposition is to say that we project each firm to its own frontier (eliminate its inefficiency) and then measure the distance between the frontiers for its specific operating point. Thus, in this part of the discussion, we are not specifically concerned with efficiency (the position of a firm relative to a frontier) but rather with technology (the relative placement of the frontiers under consideration).

The average technical frontier distances for the stock and mutual firms in our sample are given in the columns headed "Stock Cross/Own" and "Mutual Cross/Own" in Table 2. Recall that for each firm, its group-specific frontier is dominant if the distance function value ($D_{T\{S:M\}}(y_s,x_s)$ or $D_{T\{M:S\}}(y_m,x_m)$) exceeds 1 and that the other group's frontier is dominant if the distance function value is less than 1. For Spanish stock insurers, the average cross/own distance function estimates in Table 2 are significantly greater than 1 on average for the sample period as a whole and in each individual year. For mutual insurers, on the other hand, the cross/own distance function values are significantly less than 1 for the period as a whole and in five of nine years and significantly greater than 1 in only one year. The difference between the average stock and mutual cross/own distance function values also is significantly positive for the period as a whole and for each individual year. Thus, the stock firms appear to be dominant for producing stock output vectors, but mutuals generally do not appear to be not dominant for producing mutual output vectors, based on the average distances between the production frontiers. However, as shown below, the averages are driven in part by business mix and other characteristics of the two types of firms.

The cost efficiency results, presented in Table 3 lead to similar conclusions. That is, based on the averages, stocks are dominant on average for producing stock output vectors and mutuals generally are not dominant for producing their own output vectors. The stock insurers' average cross/own frontier ratios are significantly greater than 1 for the period as a whole and for each individual year, implying stock dominance for producing stock output vectors. The mutual cross/own frontier ratios are significantly less than 1 for the period as a whole and for each individual year except 1997, when the mutual ratio is significantly greater than 1. Therefore, based on the averages, mutuals do not appear to be dominant in terms of the cost frontier for producing mutual output vectors.

The patterns are similar for revenue efficiency (see Table 4). The average cross-frontier efficiencies also are generally larger for stocks than for mutuals, and these differences are statistically significant for the entire sample period and for all individual years except 1990-1992. The average cross/own frontier ratios for stock insurers are significantly greater than the mutual cross/own frontier ratios for the sample period as a whole and all individual years except 1992, where the stock ratio is greater but not significantly so. The stock cross/own efficiency ratios are significantly greater than 1 in all cases, but the mutual cross/own ratios are significantly less than 1 overall and for all years except 1990-1992. The revenue efficiency results thus reinforce the general conclusion that stocks are dominant on average for stock output vectors and mutuals are not dominant for mutual output vectors. However, the mutual cross/own ratios are generally closer to the stock cross/own ratios for revenue efficiency than they are for technical or cost efficiency, suggesting that some of the differences in the technical and cost frontiers may represent additional expenditures on product quality that are valued by buyers (e.g., see Berger, et al. 1997).

As discussed above, evidence on allocative efficiency is provided by comparing the stock (respectively, mutual) cross/own cost (revenue) efficiency ratios with the corresponding technical frontier cross/own ratios. For convenience, the cross/own efficiency ratios based on technical, cost, and revenue efficiency from Tables 2, 3, and 4, respectively, are summarized in Table 5, along with t-tests for differences between the means of the stock (respectively, mutual) technical versus cost efficiency cross/own ratios and the technical versus revenue cross/own efficiency ratios.

We focus first on the cost and technical efficiency sections of Table 5. For the period as a whole and in six of nine years, the technical efficiency cross/own ratios for the stock firms significantly exceed the cost efficiency cross/own ratios for the stock firms. As discussed above, having cost efficiency cross/own ratios that are lower than the technical efficiency cross/own ratios implies that stocks on average do a better job of choosing optimal input combinations for the production of stock output vectors than would the mutual firms in the sample. Moving from the technically efficient operating point to the cost efficient operating point reduces the distance between the frontiers because a larger allocative efficiency correction is made for mutuals than for stocks.

The mutual cross/own ratios based on cost efficiency are lower than their cross/own ratios based on technical efficiency for the sample as a whole and in seven of nine years, and these differences are statistically significant in four of the seven years. However, the cost ratio significantly exceeds the technical ratio for mutuals in 1997. Consequently, mutuals on average appear to be more effective than stock firms would be in choosing optimal input combinations for producing mutual output vectors, but the evidence is somewhat weaker than for stocks, perhaps providing some support for the expense preference hypothesis.

Evidence on output allocative efficiency is provided by comparing the stock (respectively, mutual) cross/own revenue efficiency ratios in Table 5 with the corresponding technical cross/own ratios. For the period as a whole and in all nine individual year comparison, the technical cross/own ratios exceed the revenue cross/own ratios for the stock firms, with all comparisons statistically significant at the 5 percent significance level or better. As discussed above, this provides evidence that stocks on average do a better job of choosing optimal output combinations at the stock operating points than would the mutual firms in the sample. The mutual cross/own ratios based on revenue efficiency are not statistically different from their cross/own technical efficiency ratios for the sample period as a whole and in eight of nine individual year comparisons. Thus, based on the averages, mutuals do not appear to have an advantage over stock firms in choosing optimal output combinations at mutual operating points.

Regression Analysis. The results in Tables 2 through 5 are based on averages of our samples of stock and mutual insurers. However, differences among firms in characteristics such as size, business mix, and capital structure may affect the measured efficiencies for the sample firms. To provide evidence on whether the differences in cross/own frontier efficiencies are maintained when we control for differences in firm characteristics, we conduct a multiple regression analysis with cross/own frontier ratios (distances between frontiers) as dependent variables and firm characteristics as independent variables.

To determine whether the differences between stocks and mutuals in cross/own efficiency ratios are consistent across size groups, we include eight size-quartile-dummy*ownership-form-dummy variable interaction terms in the regressions. Specifically, we interact the four size quartile dummy variables with a dummy variable equal to 1 for mutuals and zero otherwise and interact the size quartile dummies with a dummy variable equal to 1 for stocks and zero otherwise.[13] The overall intercept term is omitted from the equations to avoid singularity. Omitting the intercept term enables us to interpret the coefficient of a given size-quartile*mutual-dummy interaction variable as the regression intercept coefficient for mutuals in that size quartile, and likewise to interpret the coefficients of the size-quartile*stock-dummy interactions as the intercept coefficients for stock firms in each quartile.

In addition to the size-quartile*organizational-form interaction variables, we also include indicator variables set equal to 1 for firms that write life insurance, commercial non-life insurance, and auto insurance, respectively, and equal to zero otherwise.[14] These lines were chosen because they are among the most important in the Spanish insurance market and were considered most likely to introduce significant heterogeneity into the sample. Finally, we include two capital structure variables, the ratio of debt capital to assets and the ratio of equity capital to assets. The omitted balance sheet variable is the ratio of insurance liabilities to assets, i.e., debt capital includes borrowed funds but not debt related to insurance policies. The final variables included in the equations are year dummy variables to control for differences in cross/own frontier ratios across the years included in the sample period, omitting the variable for 1989 to avoid singularity. Although the independent variables in the regressions are primarily designed to serve as control variables rather than to test hypotheses, we

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[13]The measure of size is total insurance output. Quartile 1 includes the smallest firms and quartile 4 the largest. Quartiles were formed based on the overall sample rather than the stock and mutual samples so that the proportions of stocks and mutuals in each quartile are not equal across quartiles.

[14]These variables are not necessarily mutually exclusive. For example, a firm could have a non-zero value for both the life insurance and the commercial non-life insurance indicator variables. We could not include continuous variables based on revenue measures such as premiums, because by line data of this type are not publicly available for Spanish insurers during the sample period of this study.

provide an economic interpretation of some variables, particularly those relating to capital structure.

The regression results, with the dependent variables equal to the cross/own ratios based on technical, cost, and revenue frontiers, respectively, are presented in Table 6. We first consider the results with the size-quartile*organizational-form interaction variables. The most important conclusion based on Table 6 is that the mutual firms appear to be more competitive in the technical, cost, and revenue efficiency sense after controlling for other firm characteristics than they do when the analysis is based solely on averages. Focusing first on the production frontier (technical efficiency cross/own ratio) regression, we see that the coefficients of the size-quartile*mutual-dummy interactions are significantly greater than 1 for the first three size quartiles, implying that mutual technologies are dominant for producing mutual output vectors for firms in all but the largest size quartile. However, the coefficient of the largest size-quartile(Q4)*mutual dummy interaction is not statistically different from 1, implying that the largest mutuals generally are not dominant for producing mutual output vectors. The coefficients of the size-quartile*stock-dummy interaction variables in the production frontier regression are all significantly greater than 1, implying that stock insurers are dominant for producing stock output vectors. Thus, the regression results provide support for the managerial discretion hypothesis for mutuals in the three smallest size quartiles and for stocks in all size quartiles.

Again focusing on the production frontier regression, Wald tests reveal that the coefficient of the size-quartile*stock-dummy interaction for a given size quartile is significantly greater than the coefficient of the size-quartile*mutual-dummy interaction variable for the same size-quartile, and this ordering relation holds for all four quartiles. In addition, Wald tests reject the hypothesis that the vector of size-quartile*mutual-dummy interaction coefficients is equal to the vector of size-quartile*stock-dummy interaction coefficients. Thus, mutuals are technically dominant for producing their own output vectors, provided that they are in the three smallest size quartiles, but the degree of dominance by stocks for the stock output vectors is significantly higher.

The results with the size-quartile*organizational-form interaction variables in the cost frontier regression support similar conclusions. The size-quartile*mutual-dummy interactions are significantly larger than 1 for the three smallest size quartiles, but the size-quartile*mutual-dummy interaction for the largest size quartile is significantly less than 1. The size-quartile*stock-dummy interaction variables are all significantly greater than 1. Thus, the cost regression thus provides additional support for the managerial discretion hypothesis for stock firms of all sizes and for mutual firms in the three smallest size quartiles. Once again, the coefficients on the size-quartile*mutual interactions are significantly smaller than the coefficients of the size-quartile*stock interactions for each quartile and as vectors.

The results of the revenue cross/own regression provides support for the managerial discretion hypothesis for both organizational forms in all size quartiles. All four size-quartile*mutual-dummy interaction variable coefficients are significantly larger than one, indicating that mutuals have a revenue efficiency advantage over stocks in producing mutual outputs in all four quartiles. This would be consistent with mutuals providing services that are valued by their members, leading to higher revenues relative to stock insurers with respect to mutual output vectors. Again, however, the coefficients of the size-quartile*mutual interactions are smaller than the coefficients of the size-quartile*stock interactions.

To interpret the coefficients of the remaining variables in the regressions, recall that the dependent variable is greater than 1 for any given observation if that firm's group-specific frontier dominates the frontier for the other group of firms at that operating point. Thus, variables with coefficients greater than zero tend to be associated with wider distances between the own-group and the other-group frontier at that operating point, whereas variables with coefficients less than zero tend to be associated with smaller distances between the own-group and other-group frontier at a given point. Larger frontier differences at a given operating point suggest that dominant firms are less likely to be vulnerable to competition from the other type of firm at that operating point, and smaller differences imply that dominant firms are more vulnerable to competition from the other group at a given point.

The coefficient of the life insurance indicator variable is significant and positive in the production and cost frontier regressions, suggesting that the frontiers are further apart for life insurance than for other types of insurance. On the other hand, the sign of the life insurance variable is negative in the revenue efficiency regression. This pattern would be consistent with the hypothesis that the life insurance market is more competitive than the markets for other types of insurance in Spain, due to the entry of banks and new stock firms into the market, increasing the advantage of dominant firms on the technical and cost side but placing downward pressures on profit margins.

The commercial non-life and auto insurance dummy variables have negative coefficients in all three regressions and are statistically significant in all cases except for the auto insurance variable in the revenue regression. This suggests smaller distances between the stock and mutual frontiers for these lines of insurance, implying that stocks and mutuals are likely to be more competitive in these lines. This could help to explain the relatively strong position of mutuals in the Spanish non-life insurance market segment as compared to the their much weaker position in the life insurance market segment.

The coefficients of the debt-to-assets and equity capital-to-assets variables are negative and significant in the production and cost frontier regressions, suggesting that frontier differences are reduced for firms with relatively high ratios of debt and equity capital to assets. This would be consistent with a market penalty for firms with high debt capital ratios and with costs of capital for both types of financing that tend to reduce the advantage of firms in producing their own output vectors. In the revenue regression, on the other hand, the debt capital ratio is insignificant and the equity capital ratio has a significant positive sign. This would be consistent with a market reward in terms of revenues for firms that hold relatively more equity capital and hence are likely to have lower insolvency probabilities.

The coefficients of the year dummy variables in Table 6 are mostly significant. There is no clear pattern in the coefficient magnitudes across years in the production and cost frontier regressions. However, in the revenue regression there is a general downward trend in the coefficients for the more recent years, suggesting a greater vulnerability of firms to competition from firms of the other type later in the sample period. Such a pattern would be consistent with an increase in competition. An F-test rejects the null hypothesis that the coefficients in the first four years of the sample period (pre-deregulation) are equal to the coefficients in the last four years of the sample period (post-deregulation), suggesting that the distance between the stock and mutual frontiers declined following deregulation..

Our final set of tests is designed to provide information on allocative efficiency differences between stocks and mutuals, after controlling for other firm characteristics. In this case, the dependent variables are, respectively, the difference between the technical cross/own efficiency ratios and the cost (respectively, revenue) cross/own efficiency ratios. Recall that positive values for the difference between the technical and cost cross/own ratios for a given organizational form category imply that this category of firms does a better job in choosing cost minimizing output combinations than would the other type of firm if it produced at the same operating point. Positive values for the difference between the technical and revenue cost/own ratios convey similar implications regarding the ability of firms in a given organizational form category to choose revenue maximizing output combinations. The independent variables in this regression analysis are the same as those appearing in Table 6.

The allocative efficiency regressions are presented in Table 7. In the cost efficiency regression all size-quartile*organizational-form interaction variables are positive and statistically significant. This implies that stocks (respectively, mutuals) in all size categories have superior performance in selecting cost-minimizing input combinations than would the firms in the other category. I.e., stocks of all sizes do a better job of cost minimization than would mutuals producing at the same operating points, and mutuals of all sizes do a better job of cost minimization than would stocks producing at the mutual operating points. This result supports the managerial discretion hypothesis – that stocks and mutuals are sorted into market segments where they have comparative advantages – but is not consistent with the expense preference hypothesis.

In the revenue efficiency regression in Table 7, all size-quartile*organizational-form interaction variables are positive and statistically significant except for the fourth-quartile*mutual-dummy interaction variable, which is negative and statistically significant. This implies that stock firms in all size quartiles and mutual firms in the three smallest size quartiles do a better job in selecting revenue maximizing output combinations than would firms of the same size and opposite organizational form. However, mutuals in the largest size quartile actually do *worse* than would stock insurers in choosing revenue maximizing output combinations. Thus, the managerial discretion hypothesis is supported for stocks in all size groups and for mutuals in the three smallest size quartiles. However, for mutuals in the largest size quartiles there is evidence of sub-optimal performance in revenue maximization relative to stocks in the same size group, a result that would be consistent with expense preference behavior.

5. Conclusions

The purpose of this paper is to test hypotheses about organizational structure by analyzing Spanish stock and mutual insurers over the sample period 1989-1997, an average of 298 stock insurers and 49 mutuals per year. We test two principal hypotheses: The *managerial discretion hypothesis* predicts that stock firms will be relatively successful in lines of business requiring relatively high levels of managerial discretion due to the superior mechanisms for owners to monitor and control managers in the stock organizational form. Mutuals are predicted to be relatively successful in lines requiring relatively low levels of managerial discretion, particularly where policyholder-owner incentive conflicts are relatively important. Our second hypothesis is the *expense preference hypothesis* which predicts that mutuals will be less successful than stocks in minimizing costs and maximizing revenues because mutual managers behave opportunistically due to the weaker mechanisms for owners to control managers in the mutual ownership form. The managerial discretion hypothesis predicts that firms with different organizational forms will be sorted into market segments where they have comparative advantages in minimizing costs and maximizing revenues. According to this hypothesis, one would not necessarily observe differences in efficiency among organizational forms after controlling for production technology and business mix. The expense preference hypothesis, on the other hand, predicts that mutual insurers will have higher costs and/or lower revenues than stock insurers.

We use modern frontier efficiency analysis to measure firm performance. "Best practice" production, cost, and revenue frontiers are estimated using data envelopment analysis (DEA). The production frontier provides evidence on the technical efficiency of firms in the sample, i.e., about their success in operating with state-of-the-art technology. Cost efficiency incorporates technical efficiency and also includes allocative efficiency, i.e., the success of firms in choosing cost-minimizing combinations of inputs. Revenue efficiency incorporates technical efficiency and output allocative efficiency, i.e., the success of firms in choosing revenue maximizing combinations of outputs.

The agency theoretic view of the firm implies that firms of different types are likely to be characterized by different operating technologies adapted to the market segments in which they have comparative advantages. We test for the use of different technologies by stocks and mutuals by estimating efficiencies relative to a pooled frontier consisting of all firms in the sample as well as estimating efficiencies relative to group-specific frontiers, consisting only of stock and mutual firms. Our tests reject the hypothesis that stocks and mutuals are operating relative to a pooled frontier.

Because the hypothesis that stocks and mutuals are operating on a common frontier is rejected, we base the remainder of the analysis on two types of frontiers – group-specific frontiers for stock and mutual insurers, respectively, and cross-frontiers, where stocks (mutuals) are evaluated relative to a reference set consisting of the mutual (stock) firms in the sample. Intuitively, if a firm of a given organizational form is more efficient relative to the cross-frontier comparison than it is relative to its group-specific comparison, the implication is that this organizational form type dominates the other organizational form for the production of its own output vector. I.e., the firm would have to achieve larger efficiency gains to reach its group-specific frontier than to reach the frontier formed by the firms of the alternative organizational form.

The key statistic in our analysis is the ratio of each firm's cross-frontier efficiency to its own-frontier efficiency. This ratio is shown to represent the distance between the stock and mutual frontiers for each firm's output-input vector (operating point). If the cross/own efficiency ratio is greater than 1 for a given firm, the implication is that this firm's organizational form is dominant in producing its output vector, but if the cross/own efficiency ratio is less than one, this firm is dominated by firms of the alternative organizational form with respect to the production of its output vector.

Cross/own efficiency ratios are estimated based on the technical, cost, and revenue frontiers. In each case, the ratio measures the difference between the stock and mutual production frontiers, but at different operating points. The cross/own ratio for technical efficiency measures the distance between the stock and mutual frontiers by projecting the firms' current operating points radially to the production frontier. In this comparison, no adjustment is made for allocative inefficiency, i.e., the failure of firms to choose cost-minimizing input combinations or revenue-maximizing output combinations. The cross/own ratio for cost efficiency measures the distance between the production frontiers at the cost-minimizing point, i.e., after correcting for both technical and input allocative inefficiency. Analogously, the cross/own revenue efficiency ratio measures the distance between the stock and mutual production frontiers at the revenue maximizing point, i.e., after correcting for technical and output allocative inefficiency.

We also analyze the difference between the cross/own ratios for technical and cost efficiency and the difference between the cross/own ratios for technical and revenue efficiency. If the difference between the cross/own technical efficiency ratio and the cross/own cost efficiency ratio is positive for a firm of a given organizational type, the implication is that this firm's organizational type does a better job in choosing cost-minimizing input combinations than would a firm of the other type at the same operating point. Likewise, if the difference between the cross/own technical and revenue efficiency ratios is positive for a firm of given type, this firm's organizational form is superior in choosing optimal output combinations than a firm of the other type operating at the same point.

We find that it is important to control for firm characteristics other than organizational form in order to isolate the relationships between organizational form and efficiency. This is accomplished by conducting multiple regression analysis with efficiency measures as dependent variables and other firm characteristics, including organizational form, as regressors. Two sets of regressions are conducted – one set with dependent variables equal to the cross/own technical, cost, and revenue efficiency, respectively, and another set with dependent variables equal to the difference between the cross/own technical efficiency ratio and the cross/own cost and revenue efficiency ratios, respectively. In the regressions, we include interactions between size-quartile and organizational-form dummy variables in order to measure efficiency differences between stocks and mutuals in different size categories.

The cross/own technical efficiency ratio regressions imply that the stock production frontier dominates the mutual frontier for the production of stock output vectors in all size quartiles and that the mutual production frontier dominates the stock production frontier for the production of mutual output vectors for mutual firms in the three smallest size quartiles. The cross/own cost frontier regression produces similar results. However, in the cross/own revenue efficiency regression, stocks in all size quartiles are dominant in the production of stock outputs and mutuals in all size quartiles are dominant in the production of mutual outputs. Consequently, the results support the managerial discretion hypothesis with respect to the production and cost frontiers for stocks in all size quartiles and for mutuals in the three smallest size quartiles; whereas the managerial discretion hypothesis is supported for both organizational forms in all size quartiles with respect to revenue efficiency. Consequently, only for mutual firms in the largest size category is there clear evidence of sub-optimal performance relative to the other organizational form. However, the coefficients of the size-quartile*mutual-dummy interactions are consistently smaller than those of the size-quartile*stock-dummy interactions, implying that the mutuals' advantage over stocks in producing their own output vectors is significantly less than the corresponding stock advantage over mutuals. This could be consistent with expense preference behavior in the sense that mutuals may be less successful than stocks in developing or exploiting technological superiority in producing the mutual output vectors.

The final set of tests involves regressions with dependent variables equal, respectively, to the difference between the cross/own technical and cost efficiency ratios and between the cross/own technical and revenue efficiency ratios. The results support the hypothesis that stocks in all size quartiles are more successful in choosing cost-minimizing input combinations than hypothetical mutual firms at the same operating points and that mutuals in all size quartiles are more successful in choosing cost-minimizing input combinations that hypothetical stock firms at the mutual operating points. The revenue efficiency regressions support the same conclusions except for the largest size quartile, where mutuals are dominated by stocks in terms of allocative efficiency. In these regressions the coefficients of the mutual and stock size-quartile*organizational-form interactions are of roughly similar magnitude when positive, i.e., when a given organizational form is allocatively dominant for producing its own outputs. Because allocative inefficiency reflects expense preference behavior, the results are not consistent with the expense preference hypothesis, except for mutuals in the largest size quartile.

Overall, we believe that the results strongly support the managerial discretion hypothesis, i.e., that mutuals and stocks have been sorted into market segments where their respective technologies tend to be dominant. The primary exception to this general conclusion is for mutual firms in the largest size quartile which do not dominate stocks for producing their own output vectors in terms of technical and cost efficiency and which also exhibit inferior performance in terms of output allocative efficiency. Thus, except for the largest mutuals, there is only weak support for the expense preference hypothesis.

References

Aly, Hassan Y., Richard Grabowski, Carl Pasurka, Nanda Rangan, 1990, "Technical, Scale, and Allocative Efficiencies in U. S. Banking: An Empirical Investigation," *Review of Economics and Statistics* 72: 211-218.

Berger, Allen N., Seth D. Bonime, Daniel M. Covitz, and Diana Hancock, 2000, "Why Are Bank Profits So Persistent? The Roles of Product Market Competition, Informational Opacity, and Regional/macroeconomic Shocks," *Journal Of Banking And Finance* 24: 1203-1235.

Berger, Allen N., J. David Cummins, and Mary A. Weiss, 1997, "The Coexistence of Multiple Distribution Systems for Financial Services: The Case of Property-Liability Insurance," *Journal of Business* 70: 515-546.

Berger, Allen N. and David B. Humphrey, 1997, "Efficiency of Financial Institutions: International Survey and Directions for Future Research,"*European Journal of Operational Research* 98: 175-213.

Berger, Allen N., and David B. Humphrey, 1992, "Measurement and Efficiency Issues in Commercial Banking," in Z. Griliches, ed., *Output Measurement in the Service Sectors*, National Bureau of Economic Research, Studies in Income and Wealth, V 56, U. of Chicago Press (Chicago, IL): 245-79.

Berger, Lawrence A., Paul R. Kleindorfer, and Howard Kunreuther, 1989, "A Dynamic Model of the Transmission of Price Information in Auto Insurance Markets," *Journal of Risk and Insurance* 56: 17-33.

Cooper, William W., Lawrence M. Seiford, and Kaoru Tone, 1999, *Data Envelopment Analysis* (Norwell, MA: Kluwer Academic Publishers).

Cummins, J. David and Maria Rubio-Misas, 2001, "Organizational Choice and Efficiency: Evidence from the Spanish Insurance Industry,"working paper, Wharton Financial Institutions Center, Philadelphia, PA, USA.

Cummins, J. David, Sharon Tennyson and Mary A. Weiss, 1999, "Efficiency, Scale Economies, and Consolidation in the U.S. Life Insurance Industry," *Journal of Banking and Finance* 23: 325-357.

Cummins, J. David and Mary A. Weiss, 1993, "Measuring Cost Efficiency in the Property-Liability Insurance Industry," *Journal of Banking and Finance* 17: 463-481.

Cummins, J. David, Mary A. Weiss, and Hongmin Zi, 1999, "Organizational Form and Efficiency: An Analysis of Stock and Mutual Property-Liability Insurers," *Management Science* 45: 1254-1269.

Cummins, J. David and Hongmin Zi, 1998, "Comparison of Frontier Efficiency Methods: An Application to the U.S. Life Insurance Industry, *Journal of Productivity Analysis* 10: 131-152.

Dahlby, Bev and Douglas S. West, 1986, "Price Dispersion in an Automobile Insurance Market," *Journal of Political Economy* 94: 418-438

D'Arcy, Stephen P. and Neil A. Doherty, 1991, "Adverse Selection, Private Information, and Lowballing in Insurance Markets," *Journal of Business* 63: 145-164.

Elyasiani, Elyas and Seyed M. Mehdian, 1992, "Productive Efficiency Performance of Minority and Nonminority-owned Banks: A Nonparametric Approach," *Journal of Banking and Finance* 16: 933-948.

Esteban-Jodar, Lorenzo, 1993, "El Mercado Español de Seguros," *Información Comercial Española*, no. 715.

Esteban-Jodar, Lorenzo, 1986, "La Estructura del Sector Seguros Privado Español: Análisis y Cifras," *Hacienda Pública Española*, no. 98.

Farrell, Michael J., 1957, "The Measurement of Productive Efficiency," *Journal of the Royal Statistical Society* A 120: 253-281.

Fecher, F., D. Kessler, S. Perelman, and P. Pestieau, 1993, "Productive Performance of the French Insurance Industry," *Journal of Productivity Analysis* 4: 77-93.

Fuentes, Hugo, Emili Grifell-Tatjé, and Sergio Perelman, 2001, "A Parametric Distance Function Approach for Malmquist Productivity Index Estimation," *Journal of Productivity Analysis* 15 (2): 79-94.

Fukuyama, Hirofumi, 1997, "Investigating Productive Efficiency and Productivity Changes of Japanese Life Insurance Companies," *Pacific-Basin Finance Journal* 122:

Gardner, Lisa A. and Martin F. Grace, 1993, "X-Efficiency in the U.S. Life Insurance Industry," *Journal of Banking and Finance* 17: 497-510.

Grosskopf, Shawna, 1993, "Efficiency and Productivity," in H.O. Fried, C.A.K. Lovell, and S.S. Schmidt, eds., *The Measurement of Productive Efficiency* (New York: Oxford University Press).

Grifell-Tatjé, Emili and C. A. Knox Lovell, 1996, "Deregulation and Productivity Decline: The Case of Spanish Savings Banks," *European Economic Review* 40: 1281-1303.

Jensen, Michael C. and William Meckling, 1976, "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," *Journal of Financial Economics* 3: 305-360.

Lovell, C. A. Knox, 1993, "Production Frontiers and Productive Efficiency," in H.O. Fried, C.A.K. Lovell, and S.S. Schmidt, eds., *The Measurement of Productive Efficiency* (New York: Oxford University Press).

Mayers, David and Clifford W. Smith, Jr., 1988, "Ownership Structure Across Lines of Property-Casualty Insurance," *Journal of Law and Economics* 31: 351-378.

Mester, Loretta J., 1991, "Agency Costs Among Savings and Loans," *Journal of Financial Intermediation* 1: 257-278.

Shephard, Ronald W., 1970, *Theory of Cost and Production Functions* (Princeton, N.J.: Princeton University Press).

Swiss Re, 1999, "Are Mutual Insurers an Endangered Species?" *Sigma*, no. 4 of 1999.

Swiss Re, 1996, "Deregulation and Liberalization of Market Access: The European Insurance Industry on the Threshold of a New Era in Competition," *Sigma*, no. 7 of 1996.

Yuengert, Andrew, 1993, "The Measurement of Efficiency in Life Insurance: Estimates of a Mixed Normal-Gamma Error Model," *Journal of Banking and Finance* 17: 483-96.

Appendix Table A.1

Significance Tests: Own-Frontiers versus the Pooled Frontier -- Technical Efficiency

Year		ANOVA (F) (P-value)	Median(z) (P-value)	Wilcoxon (z) (P-value)	K-W (chi^2) (P-value)	V-W (z) (P-value)	Savage (z) (P-value)
1989	Stock	0.132	0.403	0.742	0.551	0.78	0.332
		(0.716)	(0.687)	(0.458)	(0.458)	(0.435)	(0.74)
	Mutual	12.091	1.839	1.945	3.784	2.083	3.586
		(0.001)	(0.066)	(0.052)	(0.052)	(0.037)	(0.)
1990	Stock	0.253	0.675	0.913	0.833	0.878	0.513
		(0.615)	(0.5)	(0.361)	(0.361)	(0.38)	(0.608)
	Mutual	10.631	1.447	2.126	4.523	2.129	3.358
		(0.001)	(0.148)	(0.033)	(0.033)	(0.033)	(0.001)
1991	Stock	0.568	1.302	1.139	1.297	1.191	0.648
		(0.451)	(0.193)	(0.255)	(0.255)	(0.234)	(0.517)
	Mutual	8.01	2.212	1.964	3.858	1.9	3.056
		(0.005)	(0.027)	(0.05)	(0.05)	(0.057)	(0.002)
1992	Stock	0.093	0.469	0.667	0.446	0.706	0.248
		(0.761)	(0.639)	(0.505)	(0.504)	(0.48)	(0.804)
	Mutual	7.552	1.862	1.732	3.001	1.823	3.171
		(0.006)	(0.063)	(0.083)	(0.083)	(0.068)	(0.002)
1993	Stock	0.312	1	0.971	0.944	1.026	0.547
		(0.576)	(0.317)	(0.331)	(0.331)	(0.305)	(0.585)
	Mutual	5.349	0.938	1.129	1.277	1.169	2.467
		(0.021)	(0.348)	(0.259)	(0.259)	(0.243)	(0.014)
1994	Stock	0.347	0.329	0.733	0.538	0.876	0.481
		(0.566)	(0.742)	(0.463)	(0.463)	(0.381)	(0.631)
	Mutual	7.826	1.89	1.773	3.147	1.58	2.835
		(0.005)	(0.059)	(0.076)	(0.076)	(0.114)	(0.005)
1995	Stock	0.596	0.588	0.92	0.846	1.048	0.686
		(0.44)	(0.557)	(0.358)	(0.358)	(0.294)	(0.493)
	Mutual	11.792	1.931	1.988	3.955	1.827	3.08
		(0.001)	(0.053)	(0.047)	(0.047)	(0.068)	(0.002)
1996	Stock	0.414	0.637	0.786	0.618	0.828	0.597
		(0.52)	(0.524)	(0.432)	(0.432)	(0.408)	(0.551)
	Mutual	9.146	2.828	2.211	4.891	2.117	2.895
		(0.003)	(0.005)	(0.027)	(0.027)	(0.034)	(0.004)
1997	Stock	6.188	2.519	2.498	6.242	2.704	2.461
		(0.013)	(0.012)	(0.025)	(0.013)	(0.007)	(0.014)
	Mutual	0.134	0	-0.365	0.134	-0.485	0.094
		(0.714)	(1.)	(0.716)	(0.715)	(0.628)	(0.345)

Note: The upper entry for each organizational type/year is the test statistic. The lower entry in each case is the P-value. Low P-values indicate rejection of the null hypothesis that the efficiency of each firm type based on its own-frontier is the same as its technical efficiency relative to the pooled frontier.

Appendix Table A.2

Significance Tests: Own-Frontiers versus the Pooled Frontier -- Cost Efficiency

Year		ANOVA (F) (P-value)	Median(z) (P-value)	Wilcoxon (z) (P-value)	K-W (chi^2) (P-value)	V-W (z) (P-value)	Savage (z) (P-value)
1989	Stock	0.084	0.255	0.321	0.215	0.539	0.305
		(0.772)	(0.799)	(0.643)	(0.643)	(0.590)	(0.760)
	Mutual	11.759	1.556	1.563	2.446	1.828	3.32
		(0.001)	(0.120)	(0.118)	(0.118)	(0.068)	(0.001)
1990	Stock	0.026	0.075	0.053	0.003	0.068	-0.173
		(0.871)	(0.940)	(0.958)	(0.958)	(0.946)	(0.863)
	Mutual	31.201	2.739	3.338	11.149	3.592	5.009
		(0.000)	(0.006)	(0.001)	(0.001)	(0.000)	(0.000)
1991	Stock	0.078	0.184	0.379	0.143	0.564	0.298
		(0.779)	(0.854)	(0.705)	(0.705)	(0.573)	(0.766)
	Mutual	10.892	2.212	2.32	5.387	2.233	3.315
		(0.001)	(0.027)	(0.020)	(0.020)	(0.026)	(0.001)
1992	Stock	0.072	-0.078	0.329	0.109	0.455	0.255
		(0.789)	(0.938)	(0.742)	(0.742)	(0.649)	(0.798)
	Mutual	21.804	2.169	2.846	8.106	2.919	4.227
		(0.000)	(0.030)	(0.004)	(0.004)	(0.004)	(0.000)
1993	Stock	0.034	0.006	0.362	0.124	0.54	0.15
		(0.855)	(0.939)	(0.725)	(0.725)	(0.590)	(0.881)
	Mutual	18.941	1.552	2.17	4.712	2.245	3.965
		(0.000)	(0.121)	(0.030)	(0.030)	(0.025)	(0.000)
1994	Stock	0.086	-0.247	0.374	0.14	0.556	0.246
		(0.770)	(0.805)	(0.709)	(0.709)	(0.578)	(0.806)
	Mutual	7.221	1.89	1.452	2.112	1.279	2.731
		(0.008)	(0.059)	(0.146)	(0.146)	(0.201)	(0.006)
1995	Stock	0.166	-0.252	0.392	0.154	0.523	0.393
		(0.684)	(0.801)	(0.695)	(0.695)	(0.601)	(0.694)
	Mutual	4.839	1.609	1.635	2.677	1.48	2.305
		(0.028)	(0.108)	(0.102)	(0.102)	(0.139)	(0.021)
1996	Stock	0.256	0.296	0.477	0.228	0.56	0.5
		(0.613)	(0.768)	(0.633)	(0.633)	(0.575)	(0.617)
	Mutual	5.696	2.495	1.963	3.858	1.956	2.587
		(0.018)	(0.013)	(0.050)	(0.050)	(0.051)	(0.010)
1997	Stock	15.667	4.702	4.77	22.751	4.626	4.183
		(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
	Mutual	0.083	0.475	-0.633	0.401	-0.815	0.314
		(0.774)	(0.635)	(0.527)	(0.527)	(0.415)	(0.753)

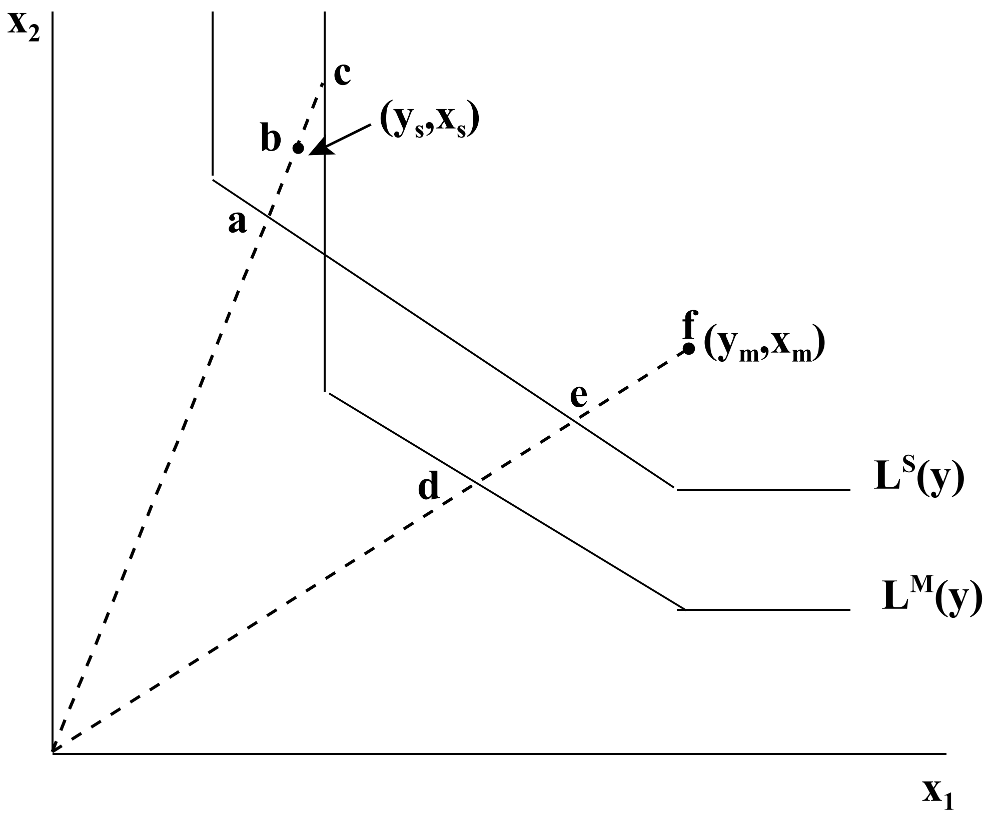
Note: The upper entry for each organizational type/year is the test statistic. The lower entry in each case is the P-value. Low P-values indicate rejection of the null hypothesis that the efficiency of each firm type based on its own-frontier is the same as its technical efficiency relative to the pooled frontier.

Appendix Table A.3
Significance Tests: Own-Frontiers versus the Pooled Frontier -- Revenue Efficiency

Year		ANOVA (F) (P-value)	Median(z) (P-value)	Wilcoxon (z) (P-value)	K-W (chi^2) (P-value)	V-W (z) (P-value)	Savage (z) (P-value)
1989	Stock	0.002	0.623	0.51	0.261	0.511	0.006
		(0.969)	(0.530)	(0.610)	(0.610)	(0.609)	(0.995)
	Mutual	51.698	1.839	3.184	10.143	3.873	6.54
		(0.000)	(0.060)	(0.002)	(0.001)	(0.000)	(0.000)
1990	Stock	0.177	0.975	0.978	0.958	0.912	0.544
		(0.674)	(0.329)	(0.328)	(0.328)	(0.362)	(0.586)
	Mutual	23.006	2.59	3.062	9.378	3.164	4.647
		(0.000)	(0.010)	(0.002)	(0.002)	(0.002)	(0.000)
1991	Stock	0.362	0.854	1.043	1.088	1.083	0.627
		(0.548)	(0.393)	(0.297)	(0.297)	(0.279)	(0.531)
	Mutual	23.582	2.212	3.125	9.771	3.196	4.723
		(0.000)	(0.027)	(0.002)	(0.002)	(0.001)	(0.000)
1992	Stock	0.03	0.078	0.368	0.136	0.352	-0.137
		(0.863)	(0.938)	(0.713)	(0.713)	(0.725)	(0.891)
	Mutual	19.741	2.477	2.676	7.164	2.926	4.61
		(0.000)	(0.013)	(0.007)	(0.007)	(0.003)	(0.000)
1993	Stock	0.071	0.231	0.669	0.447	0.754	0.303
		(0.790)	(0.817)	(0.504)	(0.504)	(0.451)	(0.762)
	Mutual	19.008	2.166	2.364	5.589	2.452	4.013
		(0.000)	(0.030)	(0.018)	(0.018)	(0.014)	(0.000)
1994	Stock	0.06	0.329	0.485	0.235	0.617	0.177
		(0.806)	(0.742)	(0.628)	(0.628)	(0.537)	(0.860)
	Mutual	18.149	2.52	2.517	6.337	2.566	4.23
		(0.000)	(0.012)	(0.012)	(0.012)	(0.010)	(0.000)
1995	Stock	0.219	0.42	0.766	0.587	0.852	0.45
		(0.640)	(0.675)	(0.444)	(0.444)	(0.394)	(0.653)
	Mutual	33.713	1.931	3.003	9.022	3.249	5.34
		(0.000)	(0.053)	(0.003)	(0.003)	(0.001)	(0.000)
1996	Stock	0.055	0.38	0.52	0.271	0.528	0.23
		(0.815)	(0.704)	(0.603)	(0.603)	(0.598)	(0.818)
	Mutual	24.979	3.161	3.303	10.918	3.483	4.881
		(0.000)	(0.002)	(0.001)	(0.001)	(0.000)	(0.000)
1997	Stock	6.22	2.183	2.534	6.423	2.643	2.375
		(0.013)	(0.029)	(0.011)	(0.013)	(0.008)	(0.018)
	Mutual	22.797	1.894	2.642	6.985	2.751	5.677
		(0.000)	(0.058)	(0.008)	(0.008)	(0.006)	(0.000)

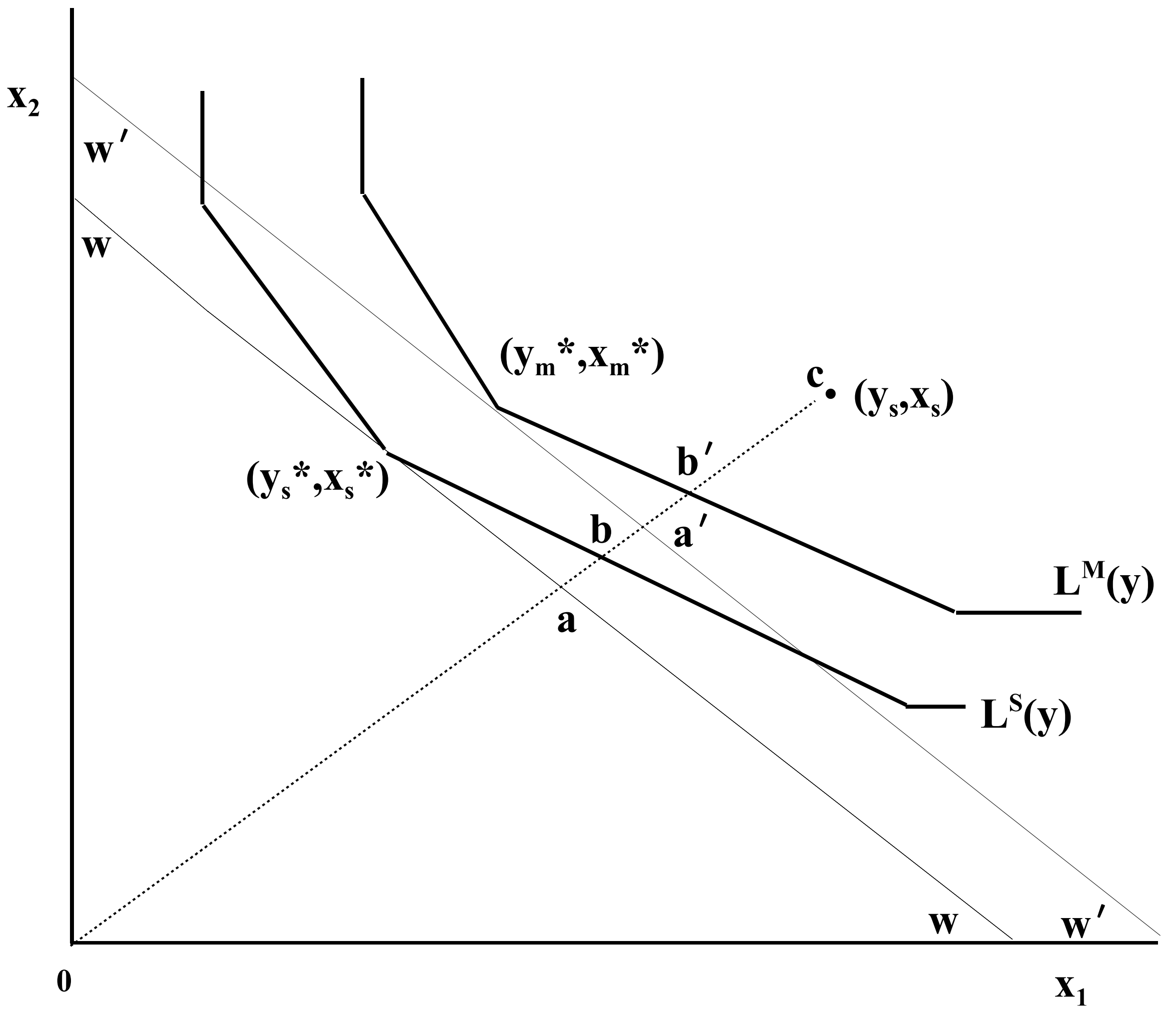
Note: The upper entry for each organizational type/year is the test statistic. The lower entry in each case is the P-value. Low P-values indicate rejection of the null hypothesis that the efficiency of each firm type based on its own-frontier is the same as its technical efficiency relative to the pooled frontier.

Figure 1
Stock and Mutual Isoquants: One-Output, Two-Input Firm



Stock Own Frontier:	$D_S(y_s, x_s) = 0b/0a > 1$
Stock Cross Frontier:	$D_M(y_s, x_s) = 0b/0c < 1$
Mutual Own Frontier:	$D_M(y_m, x_m) = 0f/0d > 1$
Mutual Cross Frontier:	$D_S(y_m, x_m) = 0f/0e > 1$
Stock Cross/Own:	$D_{T\{S:M\}}(y_s,x_s) = 0c/0a > 1$
Mutual Cross/Own:	$D_{T\{M:S\}}(y_m,x_m) = 0e/0d > 1$

Figure 2
Stock and Mutual Isoquants: One-Output, Two-Input Firm



Own Frontier Technical:	$T_S(y_s, x_s) = 0b/0c$
Own Frontier Allocative:	$A_S(y_s, x_s) = 0a/0b$
Own Frontier Cost:	$C_S(y_s, x_s) = 0a/0c$
Cross Frontier Technical:	$T_M(y_s, x_s) = 0b'/0c$
Cross Frontier Allocative:	$A_M(y_s, x_s) = 0a'/0b'$
Cross Frontier Cost:	$C_M(y_s, x_s) = 0a'/0c$
Cross/Own:	$D_{C\{S:M\}}(y_s,x_s) = C_M(y_s, x_s)/C_S(y_s, x_s) = 0a'/0a$

Figure 3: Mutual Efficiencies: Own Frontier vs. Pooled Frontier

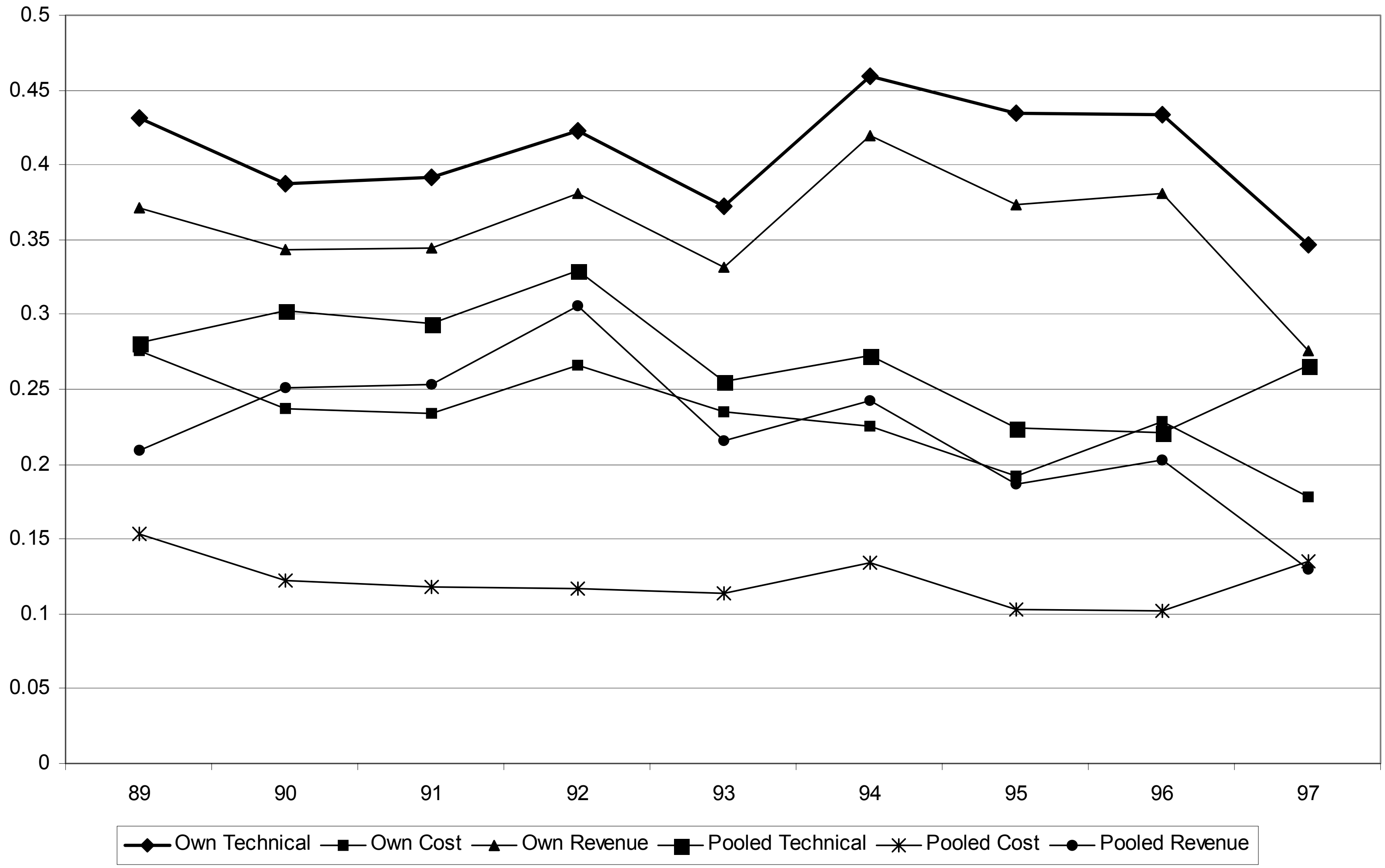


Figure 4: Stock Efficiencies: Own Frontier vs. Pooled Frontier

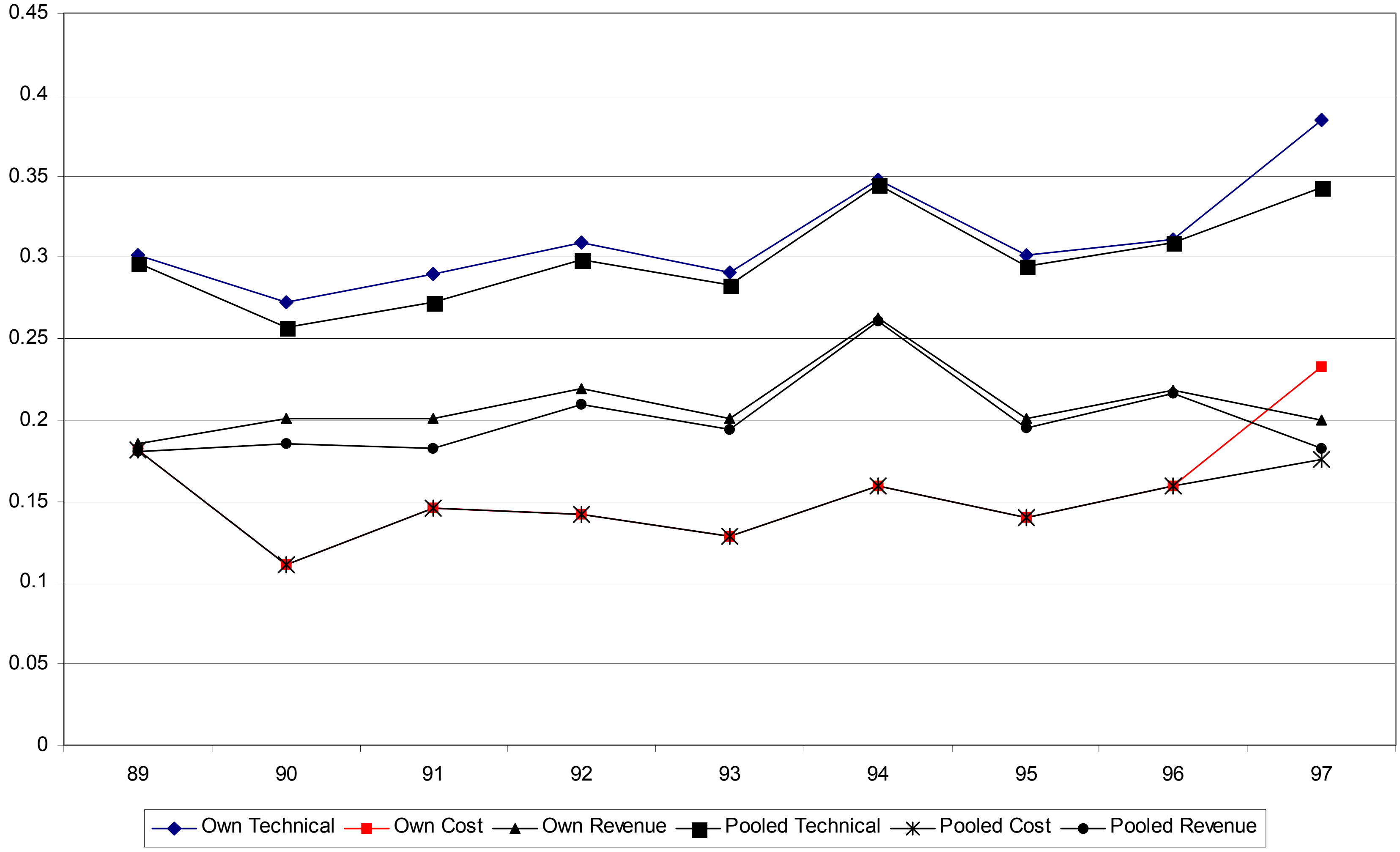


Table 1

Summary Statistics: Spanish Stock and Mutual Insurers: Averages 1989-1997

Variable Definition	Sample Means Pooled	Stock	t-test	Mutual
Number of observations	3,121	2,682		439
Total output	3,456	3,491		3,242
Non-life output[1]	2,355	2,265		2,845
Life output[1]	4,517	4,761	***	2,135
Price of non-life output	1.040	0.992	***	1.331
Price of life output	0.648	0.644		0.669
Labor input	852	893	***	605
Materials input	320	329		263
Equity capital input	1,537	1,499		1,768
Debt capital input	1,038	1,037		1,044
Price of labor input	1.133	1.133		1.132
Price of materials input	1.170	1.170		1.170
Price of equity capital input	0.273	0.274		0.273
Price of debt capital input	0.104	0.104		0.104
Total costs	1,864	1,910		1,587
Total assets	10,545	10,695		9,627
Non-life premiums[1]	3,395	3,335		3,721
Life premiums[1]	3,807	4,054	***	1,552
Net Income	109	90	***	228
Reserves/Total assets	0.444	0.439	**	0.473
Net Income/Equity capital	0.068	0.061	***	0.108
Debt capital/Total assets	0.125	0.128	***	0.109
Equity capital/Total assets	0.424	0.428	*	0.403
Net Income/Total assets	0.020	0.017	***	0.035
Own Frontier Efficiency:				
Technical	0.324	0.310	***	0.408
Cost	0.165	0.154	***	0.232
Revenue	0.230	0.209	***	0.357
Cross Frontier Efficiency:				
Technical	0.873	0.951	***	0.399
Cost	0.365	0.403	***	0.129
Revenue	0.391	0.406	***	0.298

Note: Monetary variables are in millions of Pesetas, deflated to 1989 price levels using the Spanish consumer price index. In calculating averages, the ratios of net income to equity capital and net income to total assets were truncated at the 1st and 99th percentiles to give a better representation of central tendency due to the skewness of these variables.

[1]Average calculated including only those insurers with non-zero values for this variable.

Table 2: Technical Efficiency Results -- 1989-1997

		Own	Own		Cross	Cross		Stock	Mutual		t-test[2]: Cross/Own-1	
		$T_S(y_s,x_s)$	$T_M(y_m,x_m)$	t-test[1]	$T_M(y_s,x_s)$	$T_S(y_m,x_m)$	t-test[1]	Cross/Own	Cross/Own	t-test[1]	Stock	Mutual
								$D_{T\{S:M\}}(y_s,x_s)$	$D_{T\{M:S\}}(y_m,x_m)$			
1989-1997	Mean	0.3098	0.4080	-5.594	0.9506	0.3988	11.306	2.6375	0.8384	33.460	42.433	-4.316
	Std. Dev.	0.2622	0.3525	***	1.5027	0.8223	***	1.9985	0.7845	***	***	***
	N	2682	439		2682	439		2682	439			
1989	Mean	0.3014	0.4310	-2.547	0.9637	0.3203	6.660	2.8079	0.6643	18.193	16.354	-8.234
	Std. Dev.	0.2562	0.3696	**	1.4947	0.3993	***	2.0444	0.3078	***	***	***
	N	342	57		342	57		342	57			
1990	Mean	0.2727	0.3868	-2.342	0.6893	0.4753	1.801	2.2987	0.9954	9.993	13.465	-0.052
	Std. Dev.	0.2458	0.3504	**	1.0840	0.7688	*	1.7495	0.6570	***	***	
	N	329	56		329	56		329	56			
1991	Mean	0.2900	0.3919	-1.974	0.8309	0.6779	0.620	2.4938	1.1000	5.732	16.052	0.445
	Std. Dev.	0.2690	0.3602	**	1.3233	1.7176	0.000	1.7033	1.6354	***	***	
	N	335	53		335	53		335	53			
1992	Mean	0.3093	0.4228	-2.066	0.9863	0.5284	2.655	2.5957	0.9196	9.069	11.929	-0.630
	Std. Dev.	0.2650	0.3659	**	1.6712	0.9943	***	2.3362	0.8835	***	***	
	N	305	48		305	48		305	48			
1993	Mean	0.2904	0.3728	-1.605	0.9491	0.2963	6.301	2.7394	0.7108	14.369	13.170	-5.796
	Std. Dev.	0.2466	0.3423		1.5451	0.3890	***	2.3440	0.3457	***	***	***
	N	315	48		315	48		315	48			
1994	Mean	0.3473	0.4591	-2.009	1.1791	0.3570	6.009	2.9194	0.6689	15.470	16.056	-3.994
	Std. Dev.	0.2716	0.3608	**	1.6436	0.6382	***	1.9788	0.5622	***	***	***
	N	274	46		274	46		274	46			
1995	Mean	0.3009	0.4346	-2.352	0.9117	0.2609	6.791	2.5565	0.6586	18.166	17.651	-6.094
	Std. Dev.	0.2630	0.3612	**	1.2965	0.3521	***	1.4328	0.3716	***	***	***
	N	264	44		264	44		264	44			
1996	Mean	0.3111	0.4338	-2.155	1.2280	0.2633	7.150	3.0881	0.5996	18.339	17.199	-6.606
	Std. Dev.	0.2648	0.3486	**	1.8863	0.4200	***	1.9425	0.3881	***	***	***
	N	256	41		256	41		256	41			
1997	Mean	0.3847	0.3461	0.769	0.9039	0.3475	4.922	2.1947	1.1645	6.593	9.135	1.924
	Std. Dev.	0.2676	0.3215		1.4820	0.4496	***	2.1170	0.5799	***	***	*
	N	262	46		262	46		262	46			

Note: $T_K(y_i,x_i)$= Technical Efficiency for frontier (reference set) K; K=P=pooled frontier; K=S=stock frontier; K=M=mutual frontier;
y_s,x_s = output and input vectors for stock firms respectively; y_m,x_m = output and input for mutual firms respectively

[1] t-tests for differences between stock and mutual means: *** Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

[2] t-tests for whether stock and mutual means are > or < 1.

Table 3: Cost Efficiency Results -- 1989-1997

		Own	Own		Cross	Cross		Stock	Mutual		t-test[2]: Cross/Own-1	
		$C_S(y_s,x_s)$	$C_M(y_m,x_m)$	t-test[1]	$C_M(y_s,x_s)$	$C_S(y_m,x_m)$	t-test[1]	Cross/Own	Cross/Own	t-test[1]	Stock	Mutual
								$D_{C\{S:M\}}(y_s,x_s)$	$D_{C\{M:S\}}(y_m,x_m)$			
1989-1997	Mean	0.1543	0.2320	-5.986	0.4033	0.1293	17.120	2.3510	0.6314	52.706	45.825	-26.376
	Std. Dev.	0.1722	0.2630	***	0.7367	0.1538	***	1.5268	0.2928	***	***	***
	N	2682	439		2682	439		2682	439			
1989	Mean	0.1815	0.2758	-2.332	0.4433	0.1536	6.435	2.2034	0.6136	20.327	15.891	-19.765
	Std. Dev.	0.1878	0.2954	**	0.7199	0.1707	***	1.4005	0.1476	***	***	***
	N	342	57		342	57		342	57			
1990	Mean	0.1115	0.2373	-3.406	0.2567	0.1224	4.855	2.3341	0.5307	30.945	23.292	-43.626
	Std. Dev.	0.1294	0.2713	***	0.3705	0.1397	***	1.0389	0.0805	***	***	***
	N	329	56		329	56		329	56			
1991	Mean	0.1455	0.2341	-2.326	0.2609	0.1179	5.516	1.9395	0.4913	77.305	55.957	-61.213
	Std. Dev.	0.1829	0.2676	**	0.2995	0.1464	***	0.3073	0.0605	***	***	***
	N	335	53		335	53		335	53			
1992	Mean	0.1416	0.2656	-2.979	0.5442	0.1169	7.247	3.0828	0.4662	24.209	19.385	-45.322
	Std. Dev.	0.1630	0.2809	***	0.9810	0.1240	***	1.8764	0.0816	***	***	***
	N	305	48		305	48		305	48			
1993	Mean	0.1286	0.2352	-2.666	0.3086	0.1133	6.643	2.3172	0.4906	48.450	35.817	-61.378
	Std. Dev.	0.1445	0.2711	***	0.4053	0.1283	***	0.6527	0.0575	***	***	***
	N	315	48		315	48		315	48			
1994	Mean	0.1596	0.2256	-1.799	0.4237	0.1343	6.030	2.4298	0.6709	14.183	11.734	-14.262
	Std. Dev.	0.1515	0.2409	*	0.7128	0.1438	***	2.0170	0.1565	***	***	***
	N	274	46		274	46		274	46			
1995	Mean	0.1400	0.1922	-1.497	0.3744	0.1031	6.425	2.2066	0.5931	22.368	17.272	-22.643
	Std. Dev.	0.1566	0.2221	0.000	0.6257	0.1150	***	1.1351	0.1192	***	***	***
	N	264	44		264	44		264	44			
1996	Mean	0.1594	0.2283	-1.592	0.5714	0.1016	6.876	2.6443	0.5244	21.774	17.142	-28.568
	Std. Dev.	0.1892	0.2667	0.000	1.0588	0.1088	***	1.5348	0.1066	***	***	***
	N	256	41		256	41		256	41			
1997	Mean	0.2331	0.1783	1.474	0.5110	0.1952	4.191	2.0585	1.3496	4.341	6.791	7.174
	Std. Dev.	0.2098	0.2364		1.0681	0.2469	***	2.5231	0.3305	***	***	***
	N	262	46		262	46		262	46			

Note: $T_K(y_i,x_i)$= Technical Efficiency for frontier (reference set) K; K=P=pooled frontier; K=S=stock frontier; K=M=mutual frontier;

y_s,x_s = output and input vectors for stock firms respectively; y_m,x_m = output and input vectors for mutual firms respectively

[1] t-tests for differences between stock and mutual means: *** Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

[2] t-tests for whether stock and mutual means are > or < 1.

Table 4: Revenue Efficiency Results -- 1989-1997

		Own	Own		Cross	Cross		Stock	Mutual		t-test[2]: Cross/Own-1	
		$R_S(y_s,x_s)$	$R_M(y_m,x_m)$	t-test[1]	$R_M(y_s,x_s)$	$R_S(y_m,x_m)$	t-test[1]	Cross/Own	Cross/Own	t-test[1]	Stock	Mutual
								$D_{R\{S:M\}}(y_s,x_s)$	$D_{R\{M:S\}}(y_m,x_m)$			
1989-1997	Mean	0.2088	0.3574	-9.506	0.4063	0.2976	3.214	1.8729	0.8049	27.883	56.920	-5.559
	Std. Dev.	0.1765	0.3196	***	0.4855	0.6810	***	0.7942	0.7354	***	***	***
	N	2682	439		2682	439		2682	439			
1989	Mean	0.1853	0.3712	-4.105	0.4737	0.2354	4.559	2.3027	0.6240	23.616	21.593	-10.003
	Std. Dev.	0.1359	0.3373	***	0.5860	0.3137	***	1.1157	0.2838	***	***	***
	N	342	57		342	57		342	57			
1990	Mean	0.2013	0.3429	-3.171	0.3240	0.3722	-0.557	1.5356	0.9068	7.666	16.621	-1.236
	Std. Dev.	0.1850	0.3253	***	0.4537	0.6184	0.000	0.5845	0.5645	***	***	
	N	329	56		329	56		329	56			
1991	Mean	0.2006	0.3445	-3.119	0.3563	0.5822	-1.032	1.7686	0.9248	6.422	25.662	-0.588
	Std. Dev.	0.1881	0.3274	***	0.4224	1.5844	0.000	0.5482	0.9314	***	***	
	N	335	53		335	53		335	53			
1992	Mean	0.2195	0.3808	-3.133	0.3195	0.2799	0.698	1.4612	1.2755	0.856	15.516	1.282
	Std. Dev.	0.1966	0.3482	***	0.4107	0.3582	0.000	0.5191	1.4885		***	
	N	305	48		305	48		305	48			
1993	Mean	0.2008	0.3317	-2.822	0.3613	0.2483	1.972	1.6945	0.7054	16.326	20.526	-5.862
	Std. Dev.	0.1743	0.3141	***	0.5102	0.3435	**	0.6005	0.3482	***	***	***
	N	315	48		315	48		315	48			
1994	Mean	0.2628	0.4197	-3.004	0.5457	0.3148	2.389	1.9797	0.6579	15.187	32.221	-4.195
	Std. Dev.	0.2190	0.3427	***	0.5502	0.6156	**	0.5033	0.5531	***	***	***
	N	274	46		274	46		274	46			
1995	Mean	0.2007	0.3738	-3.518	0.4565	0.2137	4.374	2.0803	0.6674	20.083	25.539	-5.916
	Std. Dev.	0.1635	0.3194	***	0.5329	0.2971	***	0.6873	0.3729	***	***	***
	N	264	44		264	44		264	44			
1996	Mean	0.2178	0.3812	-3.255	0.5062	0.2408	3.773	2.2423	0.6087	23.080	33.045	-6.525
	Std. Dev.	0.1744	0.3137	***	0.4755	0.4081	***	0.6015	0.3840	***	***	***
	N	256	41		256	41		256	41			
1997	Mean	0.1995	0.2760	-2.182	0.3465	0.1393	9.120	1.8808	0.8328	9.120	12.175	-1.873
	Std. Dev.	0.1214	0.2324	**	0.2956	0.0918	***	1.1710	0.6055	***	***	*
	N	262	46		262	46		262	46			

Note: $R_K(y_i,x_i)$= Technical Efficiency for frontier (reference set) K; K=P=pooled frontier; K=S=stock frontier; K=M=mutual frontier;
y_s,x_s = output and input vectors for stock firms respectively; y_m,x_m = output and input for mutual firms respectively
[1] t-tests for differences between stock and mutual means: *** Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.
[2] t-tests for whether stock and mutual means are > or < 1.

Table 5: Comparison of Frontier Distances Based on Technical, Cost, and Revenue Efficiency

		Technical Efficiency		Cost Efficiency		Technical vs. Cost		Revenue Efficiency		Technical vs. Revenue	
		Stock	Mutual	Stock	Mutual	Stock	Mutual	Stock	Mutual	Stock	Mutual
		Cross/Own	Cross/Own	Cross/Own	Cross/Own	t-test[1]	t-test[2]	Cross/Own	Cross/Own	t-test[3]	t-test[4]
		$D_{T\{S:M\}}(y_s,x_s)$	$D_{T\{M:S\}}(y_m,x_m)$	$D_{C\{S:M\}}(y_s,x_s)$	$D_{C\{M:S\}}(y_m,x_m)$			$D_{R\{S:M\}}(y_s,x_s)$	$D_{R\{M:S\}}(y_m,x_m)$		
1989-1997	Mean	2.6375	0.8384	2.3510	0.6314	5.900	5.180	1.8729	0.8049	18.413	0.653
	Std. Dev.	1.9985	0.7845	1.5268	0.2928	***	***	0.7942	0.7354	***	
1989	Mean	2.8079	0.6643	2.2034	0.6136	4.511	1.121	2.3027	0.6240	4.011	0.727
	Std. Dev.	2.0444	0.3078	1.4005	0.1476	***		1.1157	0.2838	***	
1990	Mean	2.2987	0.9954	2.3341	0.5307	-0.316	5.254	1.5356	0.9068	7.504	0.765
	Std. Dev.	1.7495	0.6570	1.0389	0.0805		***	0.5845	0.5645	***	
1991	Mean	2.4938	1.1000	1.9395	0.4913	5.862	2.708	1.7686	0.9248	7.418	0.678
	Std. Dev.	1.7033	1.6354	0.3073	0.0605	***	***	0.5482	0.9314	***	
1992	Mean	2.5957	0.9196	3.0828	0.4662	-2.839	3.540	1.4612	1.2755	8.279	-1.425
	Std. Dev.	2.3362	0.8835	1.8764	0.0816	***	***	0.5191	1.4885	***	
1993	Mean	2.7394	0.7108	2.3172	0.4906	3.080	4.353	1.6945	0.7054	7.664	0.076
	Std. Dev.	2.3440	0.3457	0.6527	0.0575	***	***	0.6005	0.3482	***	
1994	Mean	2.9194	0.6689	2.4298	0.6709	2.868	-0.023	1.9797	0.6579	7.618	0.095
	Std. Dev.	1.9788	0.5622	2.0170	0.1565	***		0.5033	0.5531	***	
1995	Mean	2.5565	0.6586	2.2066	0.5931	3.110	1.113	2.0803	0.6674	4.869	-0.111
	Std. Dev.	1.4328	0.3716	1.1351	0.1192	***		0.6873	0.3729	***	
1996	Mean	3.0881	0.5996	2.6443	0.5244	2.868	1.196	2.2423	0.6087	6.655	-0.107
	Std. Dev.	1.9425	0.3881	1.5348	0.1066	***		0.6015	0.3840	***	
1997	Mean	2.1947	1.1645	2.0585	1.3496	0.669	-1.881	1.8808	0.8328	2.100	2.683
	Std. Dev.	2.1170	0.5799	2.5231	0.3305		*	1.1710	0.6055	**	***

Note: The numbers of observations (N) have been omitted to save space but are the same as in Tables 2, 3, and 4.

$D_{T\{S:M\}}(y_s,x_s)$ = distance between stock and mutual frontiers for stock operating point (y_s,x_s) based only on technical efficiency. $D_{T\{M:S\}}(y_m,x_m)$ = distance between stock and mutual frontiers for mutual operating point (y_m,x_m) based only on technical efficiency.

$D_{C\{S:M\}}(y_s,x_s)$ = distance between stock and mutual frontiers for stock operating point (y_s,x_s) based on cost efficiency. $D_{C\{M:S\}}(y_m,x_m)$ = distance between stock and mutual frontiers for mutual operating point (y_m,x_m) based on cost efficiency.

$D_{R\{S:M\}}(y_s,x_s)$ = distance between stock and mutual frontiers for stock operating point (y_s,x_s) based on revenue efficiency. $D_{R\{M:S\}}(y_m,x_m)$ = distance between stock and mutual frontiers for mutual operating point (y_m,x_m) based on revenue efficiency.

[1] t-tests for differences between means of the stock insurers cross/own technical efficiency ratios and the stock cross/own cost efficiency ratios.

[2] t-tests for differences between means of the mutual insurers cross/own technical efficiency ratios and the mutual cross/own cost efficiency ratios.

[3] t-tests for differences between means of the stock insurers cross/own technical efficiency ratios and the stock cross/own revenue efficiency ratios.

[4] t-tests for differences between means of the mutual insurers cross/own technical efficiency ratios and the mutual cross/own revenue efficiency ratios.

*** Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

Table 6
Frontier Distance Regressions: Spanish Insurers 1989-1997

	Production Frontier				Cost Frontier				Revenue Frontier			
Independent Variables	**Coefficient**	**z1-Statistic**	**z1**	**z2**	**Coefficient**	**z1-Statistic**	**z1**	**z2**	**Coefficient**	**z1-Statistic**	**z1**	**z2**
Q1*Mutual	1.7425	10.38	***	***	1.2137	9.27	***	*	1.3045	14.35	***	***
Q2*Mutual	2.0746	11.45	***	***	1.4784	10.45	***	***	1.2037	12.26	***	**
Q3*Mutual	2.1289	11.31	***	***	1.3849	9.43	***	***	1.1976	11.74	***	**
Q4*Mutual	0.9200	4.91	***		0.5639	3.86	***	***	1.3030	12.84	***	***
Q1*Stock	2.7907	20.20	***	***	2.4153	22.41	***	***	2.0977	28.04	***	***
Q2*Stock	2.9403	23.79	***	***	2.3982	24.86	***	***	2.3424	34.99	***	***
Q3*Stock	3.3197	27.41	***	***	2.5722	27.21	***	***	2.5210	38.42	***	***
Q4*Stock	3.1614	25.59	***	***	2.7791	28.82	***	***	2.4555	36.69	***	***
Life Insurance Indicator	2.3994	36.42	***		1.6228	31.57	***		-0.2100	-5.88	***	
Commercial P/L Indicator	-0.5829	-7.60	***		-0.3623	-6.06	***		-0.1944	-4.68	***	
Auto Insurance Indicator	-0.8338	-9.78	***		-0.5757	-8.65	***		-0.0722	-1.56		
Debt Capital/Assets	-2.6892	-10.05	***		-1.2363	-5.92	***		-0.1536	-1.06		
Equity Capital/Assets	-0.3326	-2.71	***		-0.6591	-6.89	***		0.2754	4.15	***	
D90	-0.4194	-4.05	***		0.0713	0.88			-0.6578	-11.74	***	
D91	-0.3125	-3.03	***		-0.3171	-3.93	***		-0.4804	-8.58	***	
D92	-0.3162	-2.97	***		0.6193	7.45	***		-0.7130	-12.36	***	
D93	-0.2070	-1.97	**		-0.0458	-0.56			-0.5859	-10.29	***	
D94	-0.0674	-0.62			0.0718	0.84			-0.3590	-6.08	***	
D95	-0.4390	-3.97	***		-0.1809	-2.10	**		-0.2704	-4.52	***	
D96	0.1527	1.37			0.2897	3.33	***		-0.1436	-2.38	**	
D97	-0.7583	-6.81	***		-0.2465	-2.84	***		-0.3898	-6.47	***	
N	3,084				3,084				3,084			
R^2	0.477				0.479				0.290			
Adjusted R^2	0.474				0.475				0.285			

*** Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

z1 = significanlty different from 0, based on a two-tail test. z2 = significantly greater or less than 1 based on a one-tail test.

Note: The dependent variable is the ratio of the efficiency of each stock (mutual) firm relative to the mutual (stock) frontier to the efficiency of each stock (mutual) firm relative to its own frontier. This is a measure of the distance between the stock and mutual frontiers for the ith firm's input-output vector.

Table 7
Allocative Efficiency-Adjustment Regressions
Spanish Insurers: 1989-1997

	Cost Frontier[1]			Revenue Frontier[2]		
Independent Variables	**Coefficient**	**z-Statistic**		**Coefficient**	**z-Statistic**	
Q1*Mutual	0.5288	4.23	***	0.4380	2.39	**
Q2*Mutual	0.5962	4.42	***	0.8709	4.40	***
Q3*Mutual	0.7439	5.31	***	0.9313	4.53	***
Q4*Mutual	0.3561	2.55	**	-0.3830	-1.87	*
Q1*Stock	0.3754	3.65	***	0.6930	4.59	***
Q2*Stock	0.5420	5.89	***	0.5979	4.43	***
Q3*Stock	0.7475	8.29	***	0.7987	6.04	***
Q4*Stock	0.3823	4.15	***	0.7059	5.23	***
Life Insurance Indicator	0.7766	15.83	***	2.6093	36.26	***
Commercial P/L Indicator	-0.2206	-3.86	***	-0.3885	-4.64	***
Auto Insurance Indicator	-0.2581	-4.07	***	-0.7616	-8.18	***
Debt Capital/Assets	-1.4528	-7.29	***	-2.5356	-8.67	***
Equity Capital/Assets	0.3265	3.58	***	-0.6079	-4.54	***
D90	-0.4907	-6.37	***	0.2384	2.11	**
D91	0.0046	0.06		0.1678	1.49	
D92	-0.9355	-11.80	***	0.3968	3.41	***
D93	-0.1612	-2.06	**	0.3790	3.30	***
D94	-0.1392	-1.71	*	0.2916	2.45	**
D95	-0.2581	-3.13	***	-0.1685	-1.40	
D96	-0.1370	-1.65	*	0.2963	2.43	**
D97	-0.5118	-6.17	***	-0.3685	-3.03	***
N	3,084			3,084		
R^2	0.184			0.401		
Adjusted R^2	0.179			0.397		

*** Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

[1]The dependent variable is the difference between the cross/own frontier technical efficiency ratio and the cross/own frontier cost efficiency ratio for each firm in the sample.

[2]The dependent variable is the difference between the cross/own frontier technical efficiency ratio and the cross/own frontier revenue efficiency ratio for each firm in the sample.

Note: Positive coefficients on a given Qi*Organizational-Form variable indicates that a firm in this size-organizational form category has higher allocative efficiency than would a firm with the alternative organizational form in the same size quartile producing at the same operating point.