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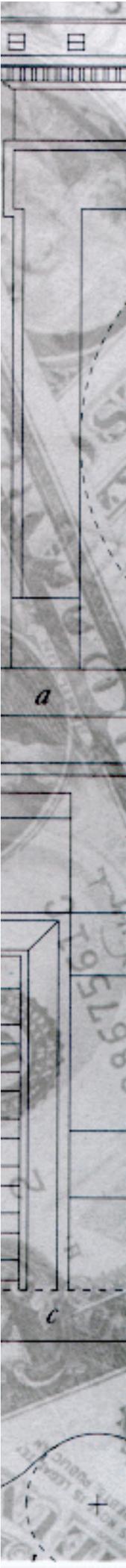
*The Effect of Organizational Structure
on Efficiency: Evidence From the
Spanish Insurance Industry*

**by
J. David Cummins
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Abstract

This paper provides new information on the effects of organizational structure on efficiency by analyzing Spanish stock and mutual insurers over the period 1989-1997. We test the efficient structure hypothesis, which predicts that the market will sort organizational forms into market segments where they have comparative advantages, and the expense preference hypothesis, which predicts that mutuals will be less efficient than stocks. Technical, cost, and revenue frontiers are estimated 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. In cost and revenue efficiency, stocks of all sizes dominate mutuals in the production of stock output vectors, and smaller mutuals dominate stocks in the production of mutual output vectors. Larger mutuals are neither dominated by nor dominant over stocks in the cost and revenue comparisons. Thus, large mutuals appear to be vulnerable to competition from stock insurers in Spain. Overall, the results are consistent with efficient structure hypothesis but are generally not consistent with the expense preference hypothesis.

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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 are potentially affected by agency costs as well as the firm's production process and operating environment (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. The modern theory of the firm 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 and/or in coping with other types of operating challenges.

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, owned by stockholders, and mutual insurers, 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 Spanish insurance industry over the 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

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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 discussion see Cummins and Rubio-Misas (2003).

regulatory changes increased the level of competitiveness in the Spanish insurance market, providing an interesting laboratory for the analysis of organizational form. (3) Because most prior studies of organizational form in insurance have focused on the United States, studying the Spanish market thus provides evidence on whether organizational form hypotheses are also applicable elsewhere.

Agency theory arguments have led to the development of hypotheses about organizational form, based on the observation that stocks and mutuals have comparative advantages in dealing with different types of agency costs. The 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 incentive conflicts among the stakeholders. The stock ownership form is hypothesized to be more effective in controlling conflicts between owners and managers because it provides superior mechanisms for owners to monitor and control managers.[2] Mutuals are hypothesized to succeed where controlling the policyholder-owner conflict is important, because the policyholder and ownership functions are merged in the mutual ownership form. The stock and mutual organizational forms also differ in another important respect – the access to capital – where stocks have a significant advantage. Hence, for mutuals to succeed, their advantage in controlling the owner-policyholder conflict must be strong enough to counteract the stock insurer advantages in controlling the owner-manager conflict and having greater access to capital.

We investigate two primary hypotheses about stocks and mutuals – the *efficient structure hypothesis*, which holds that stocks and mutuals are sorted into market segments where they have comparative advantages in agency and production costs; and the *expense preference hypothesis*, which holds that mutuals fail to minimize costs or maximize revenues due to unresolved agency conflicts. The efficient structure hypothesis predicts that stocks and mutuals will be of approximately equal efficiency, after controlling for production technology and business mix. The expense preference hypothesis, on the other hand, predicts that mutuals will be less efficient than stocks. These hypotheses are not mutually exclusive; e.g., mutuals

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[2]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 (see Mayers and Smith, 1988).

could be more successful in lines where the mutual ownership form has comparative advantages, even though mutual managers exhibit expense preference behavior. This outcome would imply that suboptimal costs or revenues due to managerial opportunism are not sufficient to offset the mutuals' advantage in controlling other agency conflicts.

We test the efficient structure and expense preference hypotheses by using frontier efficiency methodologies to compare the performance of Spanish stock and mutual insurers. Data envelopment analysis (DEA), a non-parametric technique (Cooper, et al., 1999), is used to estimate "best practice" production, cost, and revenue frontiers for a sample consisting of all Spanish insurers with valid data for the period 1989-1997. A production frontier gives the minimum inputs required to produce any given output vector, while the cost and revenue frontiers measure 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, organizational, management, and hierarchical structures, and physical technologies.[3] Firms are hypothesized to design their contracting relationships, management structures, and technologies to optimally serve their operational objectives and market segments. Thus, if the efficient structure 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.

An innovative feature of our analysis that enables us to provide insights into the efficient structure and expense preference hypotheses is the use of *cross-frontier analysis*, whereby we compare each type of

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[3]Prior research has shown that stock and mutual organizational forms are appropriately interpreted as representing alternative production technologies (Mester, 1989; Cummins, Weiss, and Zi, 1999). This point is discussed in more detail below.

firm (stocks and mutuals) to a frontier consisting of the set of firms with the alternative organizational form. This enables us to determine whether the outputs of a specific firm type could be produced more efficiently using the alternative production technology. Efficiencies based on stocks and mutuals treated separately and on all firms in the industry also are estimated and discussed.

Organizational form in the insurance industry has been analyzed using frontier efficiency methods by 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 stocks and mutuals, consistent with the efficient structure hypothesis. Cummins, Weiss, and Zi (CWZ) (1999) provide evidence consistent with both the efficient structure and expense preference hypotheses. The Spanish insurance industry has been studied previously by Fuentes, et al. (2001) and Cummins and Rubio-Misas (2003). The former study analyzes productivity change in the period 1987-1994 and finds low rates of productivity growth in spite of deregulation. The latter paper finds that consolidation in the Spanish insurance industry over the period 1989-1998 was efficiency-enhancing.[4]

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 efficient structure and expense preference hypotheses. This paper utilizes the same methodology as CWZ (1999) but extends 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 (mutual) technology dominates the mutual (stock) technology for producing stock (mutual) output vectors. The stock cost and revenue frontiers dominate the

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[4]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. 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. Because few demutualizations occurred in Spain during our sample period, the Spanish market provides a particularly stable environment for an analysis of organizational structure.

mutual cost and revenue frontiers for stock firms of all sizes. However, the mutual cost frontier dominates the stock cost frontier for mutual output vectors only for the three smallest size quartiles, and the mutual revenue frontier dominates the stock revenue frontier only for the smallest mutuals. Thus, mutuals and stocks have developed dominant technologies for producing their respective output vectors, but many mutuals do not dominate stocks in cost and revenue efficiency.

The remainder of the paper is organized as follows: The hypotheses and estimation methodology are discussed in section 2. Section 3 describes the database, defines 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 by elaborating on the hypotheses to be tested in the paper and relating the hypotheses to the structure and recent evolution of the Spanish insurance market. We then provide a brief overview of frontier efficiency concepts and our hypothesis test procedures. The section concludes with a discussion of the cross-frontier distance function approach used to evaluate the efficiency of Spanish insurers.

Hypotheses and Background on the Spanish Insurance Market

As mentioned above, the *efficient structure hypothesis* holds that stocks and mutuals will be sorted into market segments where they have comparative advantages in minimizing costs and maximizing revenues. Sorting is predicted to occur through the natural operation of the market as firms compete with one another in specific types of activities. Efficient sorting can occur as firms compete in terms of price, risk management and claims settlement services, product offerings, and other product and service dimensions. Stocks and mutuals can gain competitive advantages due to their differential ability to minimize specific types of agency costs, access and deploy capital, and other factors.

The efficient structure hypothesis has both agency-theoretic and non-agency-theoretic components. Agency theory hypothesizes that stocks and mutuals coexist because they have comparative advantages in dealing with the incentive conflicts among the stakeholder groups in the insurance enterprise and predicts that the stock ownership form will be more effective in controlling the owner-manager conflict than the mutual ownership form. This argument leads to the *managerial discretion hypothesis*, which holds that the degree of managerial discretion required to operate in a given line of insurance is an important determinant

of the organizational form likely to succeed in that line (Mayers and Smith, 1988). 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. Stock insurers also are expected to have an advantage in lines of business where the level of product innovation is relatively high, because a high degree of managerial discretion is required to successfully design new products and respond quickly to competitive developments. Mutuals, on the other hand, are expected to be more successful in lines that require less managerial discretion, where the need for individualized pricing and underwriting is relatively low, such as lines with standardized policies and good actuarial tables. Mutuals should also be relatively successful in markets subject to low levels of product innovation. In these relatively predictable lines, mutuals can take advantage of the elimination of the owner-policyholder conflict to provide price stability and high service quality. [5]

In addition to its agency theoretic advantages, the stock ownership form also provides superior access to capital, giving stock insurers an advantage in risky lines and in lines where the level of product innovation is relatively high. Writing risky lines of insurance exposes insurers to loss volatility that can deplete capital and increase leverage ratios. Likewise, a high level of product innovation leads to demands for capital to support research and development expenditures and new technologies required to bring products to market. Raising capital to offset capital shocks and support product development is problematical for mutuals, where retained earnings are the primary source of new capital. Stock insurers, on the other hand, can either raise capital directly in the markets if they are publicly traded or receive capital infusions from publicly traded parents.[6] The access to capital argument predicts that stocks will do better in lines characterized by high levels of innovation, whereas mutuals will do better in more stable and predictable lines.

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[5]Another agency-theoretic 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.

[6]In fact, nearly all Spanish stock insurers are owned by parent stock corporations rather than being traded directly in the stock market. Most of the parent corporations are insurance or non-insurance financial holding companies which have direct access to capital markets and can provide capital infusions for their subsidiaries.

In contrast to the efficient structure hypothesis, the *expense preference hypothesis* predicts that mutuals will be less successful than stocks in minimizing costs or maximizing revenues because of the failure to employ optimal technologies or to choose optimal combinations of inputs or outputs. According to this hypothesis, the costs of managerial opportunism will be higher in the mutual ownership form because the available mechanisms for controlling owner-manager conflicts are relatively weak. One potentially important type of managerial opportunism is "expense preference" behavior, where managers generate unnecessary costs through the consumption of perquisites or otherwise fail to minimize costs or maximize revenues due to opportunistic behavior. However, if market discipline is effective in controlling inefficient managerial practices, both stocks and mutuals may behave primarily as cost minimizers (Mester, 1989).

As mentioned above, a fundamental idea underlying our analysis is that the stock and mutual organizational forms represent different technologies for producing insurance. This parallels the approach taken by Mester (1989), in her study of U.S. stock and mutual savings and loan associations (S&Ls). Mester (1989) rejects the hypothesis that stock and mutual S&Ls have identical cost functions. Interpreting the cost function as the dual of the production function, she argues that stock and mutual S&Ls thus operate with different production technologies. Likewise, Berger, et al. (2000b) found that U.S. insurers specializing in life or property-liability insurance had different cost, revenue, and profit functions than firms offering both major categories of insurance, i.e., specialist and joint firms employ different technologies. A common theme in this literature is that whether categories of firms use different technologies is ultimately an empirical issue. Adopting this perspective, we test the hypothesis of different technologies by conducting statistical tests to determine whether the efficiencies of stocks and mutual insurers are drawn from the same efficiency populations. This approach follows Aly, et al. (1990), Elyasiani and Mehdian (1992), and Isik and Hassan (2002). Rejection of the hypothesis that stocks and mutuals are drawn from the same efficiency populations implies that they are operating on different frontiers and hence employ different production technologies.

To clarify the production technology issue, it is helpful to discuss some of the features of the insurance production process that comprise the technology of the firm. These can be broadly categorized into three groups – the contractual relationships comprising the firm, the firm's management structure and work process design, and the firm's physical capital configuration. Although all insurers have to conduct more

or less the same functions, such as marketing, underwriting, investments, actuarial analysis, accounting and auditing, policy services, and claims settlement, these tasks can be organized in a wide variety of ways, giving rise to different technologies for the production and delivery of insurance services (e.g., Cummins and Santomero, 1999; Hitt, 1999; Martinez, et al., 2001).

Contracting relationships are particularly important in an agency theoretic context, given Jensen and Meckling's definition of the firm as "a nexus for a set of contracting relationships among individuals" (Jensen and Meckling, 1976). This interpretation of the firm extends the definition of technology considerably beyond the production function of neoclassical economics that typically expresses output as a non-stochastic function of the factors of production.[7] The firm's organizational form is likely to lead to significantly different contractual relationships affecting the key employees of the firm and hence to alter the firm's technology. Some of these differences reflect corporate governance. Stock insurers must be structured to respond to their stockholders, who tend to take an active interest in the operation of the firm. The degree of ownership interest and control exercised by the owners of mutuals usually is more remote – for example, in most mutuals policyholders rarely exercise voting rights. Hence, the incentive contracts of managers tend to be designed differently in mutuals than in stock insurers. In addition, mutuals traditionally have had somewhat different objectives than stocks. E.g., a study of stock and mutual insurers in Spain found that mutuals traditionally focused on providing reasonable prices, high quality service, and adequate solvency margins, whereas stocks focused on maximizing profits (Martinez, et al., 2001). Although these objectives can be expected to converge in a competitive market place, the survival of the mutual traditions implies that the incentive structures in mutuals may continue to differ from those in stock insurers.

A second important component of the production technology of an insurance company lies in the management structure and work process design of the firm, i.e., the way in which the tasks to be conducted are organized within the firm. The work conducted by an insurer can be organized in a wide variety of ways, and prior research has shown that there is little uniformity among insurers (Cummins and Santomero, 1999). For example, insurers can adopt relatively flat organizational structures with relatively few layers between

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[7]Of course, even in neoclassical microeconomics, it is recognized that different production functions may be available to produce the same output, and one of the objectives of the firms is to choose the optimal production function for its operations, thereby operating on the best-technology isoquant.

operating managers and top managers or more hierarchical structures with several layers of authority between operating managers and top managers. Factors such as the degree of managerial discretion required in a firm's operations can have a major influence on the hierarchical structure adopted by the firm.

The third important component of a firm's overall technology involves its physical technology choices such as computing and communications equipment as well as quasi-organizational/quasi-physical technology decisions about how offices are configured and work flow is organized. For example, information technology systems can be designed around main-frame computers or as a distributed computing environment, with varying degrees of interface capabilities towards customers and agents (Hitt, 1999). E.g., the Martinez, et al. (2001) study found that Spanish insurers are evolving away from a traditional functional design and towards a customer-integrating organizational design. Firms can also choose to conduct most of their operations out of a single home office or out of geographically distributed regional offices. If the efficient structure hypothesis is correct, one would expect to see firms adopting technological configurations to capitalize on their strengths and maximize their probability of success in lines of insurance where they have a comparative advantage. Or, in other words, one would expect to observe the adoption of different technologies by stock and mutual insurers.

Frontier Efficiency Concepts

To measure efficiency in the Spanish insurance industry, we utilize modern frontier efficiency analysis (Lovell, 1993; Cooper, et al., 1999). 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. 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. Firms achieve cost efficiency by adopting the best practice technology (becoming *technically* efficient) and choosing the optimal mix of inputs (becoming *allocatively* efficient). Because cost efficiency is the product of technical and allocative efficiency, to be 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 efficient structure hypothesis and the expense preference hypothesis. In the context of efficiency, the efficient structure 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 vectors 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 the first part of our efficiency analysis, we estimate efficiency year by year for all stock and mutual firms, leading to *pooled efficient frontiers*. We next treat stocks and mutuals as distinct groups and estimate *own-group frontiers* for the stock and mutual samples, again for each year of the sample period. The pooled and own-group efficiency scores provide the basis for our first set of hypothesis tests. In this phase of the 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 (Aly, et al., 1990). Rejection of this null hypothesis would be consistent with the efficient structure hypothesis in that it would support the view that the two groups of firms are using different 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 (i.e., are not drawn from the same efficiency distribution).

To provide additional information on the hypothesis that firms are sorted into groups with comparative efficiency advantages, we conduct a second set of tests where the null hypothesis is that each group's output vectors 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 vectors and would provide evidence consistent with our efficiency-based interpretation of the efficient structure hypothesis. This set of tests also provides 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 inefficiency). 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.[8]

Methodology

Distance Functions and Efficiency. To analyze production frontiers, we employ input-oriented distance functions (Lovell, 1993). Suppose a producer uses input vector $x = (x_1, x_2, \ldots, x_k)^T \in \Re_{++}^k$ to

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[8]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 Evidence of maintained efficiency differences over time in U.S. insurance and banking are provided by Cummins, Weiss and Zi (1999) and Berger, et al. (2000a). Evidence of similar patterns in the Spanish insurance and banking industries is provided by Cummins and Rubio-Misas (2003) and Grifell-Tatjé and Lovell (1996).

produce output vector $y = (y_1, y_2, \ldots, y_n)^T \in \Re_{++}^n$, where T denotes the vector transpose.[9] A production technology which transforms inputs into outputs can be modeled by an input correspondence $y \to V(y) \subseteq \Re_{++}^k$. 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:

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

The input distance function is the reciprocal of the minimum equi-proportional contraction of the input vector x, given outputs y, i.e., Farrell's 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.[10]

To test our hypotheses, 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. Likewise, $D_M(y_m, x_m)$ represents the own-group input distance function for mutuals, where m = 1, 2, . . ., M, and M = the number of mutual firms.

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

$$D_M(y_s, x_s) = \sup\{\theta : (y_s, \frac{x_s}{\theta}) \in V^M(y_s)\}, \quad s = 1, 2, \ldots, S \qquad (2)$$

where $D_M(y_s, x_s)$ is the input distance function for stock firm s relative to the mutual frontier, and $V^M(y_s)$ is the mutual firms' input correspondence for output vector y_s. $D_S(y_m, x_m)$ is defined similarly. Estimating cross-frontier distance functions enables us to measure the efficiency of the firms with a specific

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

[10]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.

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 $\geq$ 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 ($T(y,x) = 1$). It would be possible for the isoquants to intersect so that the stock technology is optimal for some operating points and the mutual technology is dominant for other operating points. However, to simplify the discussion, Figure 1 has been drawn so that the stock technology is dominant everywhere.

To illustrate the *own-group* frontiers, consider stock firm s, which operates at point c 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 b. Its distance function value with respect to the stock frontier is $D_S(y_s, x_s) = 0c/0b > 1$. Likewise, the own-frontier input distance function value for mutual firm m, operating at point f, is $D_M(y_m, x_m) = 0f/0e > 1$. Figure 1 also illustrates cross-frontier distance function analysis. For example, the distance of stock firm s from the mutual frontier is $D_M(y_s, x_s) = 0c/0b' < 1$. A cross-frontier distance function value < 1 implies that it would be infeasible for a mutual to produce output-input vector (y_s, x_s), i.e., the stock insurers' technology is dominant for this output-input vector. The mutual firm's distance function value relative to the stock firm isoquant is $D_S(y_m, x_m) = 0f/0e' > 1$, with a value greater than 1 implying that the stock frontier dominates the mutual frontier.

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 (represented by subscript T) 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:

$$D_S(y_s, x_s) = D_{T\{S:M\}}(y_s, x_s) \, D_M(y_s, x_s) = \frac{0b'}{0b}\frac{0c}{0b'} = \frac{0c}{0b} \tag{3}$$

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 $D_{T\{M:S\}}(y_m, x_m) = D_M(y_m, x_m)/D_S(y_m, x_m)$. In Figure 1, $D_{T\{S:M\}}(y_s, x_s) = (0c/0b)/(0c/0b') = 0b'/0b$, and $D_{T\{M:S\}}(y_m, x_m) = (0f/0e)/(0f/0e') = 0e'/0e$. Thus, 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.

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. For this reason, $D_{T\{S:M\}}(y_s, x_s)$ and $D_{T\{M:S\}}(y_m, x_m)$ are referred to as *cross-to-own efficiency ratios.* Comparable ratios are also obtained for cost and revenue efficiency.

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, consider the mutual firm operating at point f in Figure 1, where. $D_{T\{M:S\}}(y_m, x_m) = D_M(y_m, x_m)/D_S(y_m, x_m) = 0e'/0e < 1$. 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 such as (y_s, x_s) and (y_m, x_m). The intuition is as follows: If $D_S(y_m, x_m)$ is greater than $D_M(y_m, x_m)$, for example, the operating point (y_m, x_m) is further from the stock frontier than from the mutual frontier, implying that the stock frontier is closer to the origin. Hence, the stock technology would require less inputs to produce y_m than the mutual 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 mutual frontier were dominant for operating point (y_m, x_m), then $D_M(y_m, x_m)$ would be greater than $D_S(y_m, x_m)$, and $D_{T\{M:S\}}(y_m, x_m)$ would be > 1.

We also estimate cross-frontier cost and revenue efficiency, by estimating the 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 technology. Like own-frontier cost efficiency, cross-frontier cost efficiency incorporates both technical and allocative efficiency. 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). Likewise, cross-frontier revenue efficiency, allows firms to be inefficient because of technical inefficiency and/or because of the failure to choose the revenue-maximizing combination of outputs (output allocative inefficiency).

The minimum cost function or cost frontier also is defined using the distance function approach (Lovell, 1993). Let $w_j = (w_{1j}, w_{2j}, \ldots, w_{kj})^T \in \Re_{++}^k$ denote the input price vector corresponding to the input vector x_j. Then the cost frontier is defined as:

$$c_I(y_j, w_j) = \min_x \{ w_j^T \, x_j : (y_j, x_j) \in V^I(y_j) \} \tag{4}$$

where $c_I(y_j, w_j)$ = the cost frontier for output-input vector (y_j, x_j) relative to reference set I . The optimal input vector x_j^* minimizes the costs of producing y_j given the input prices w_j. Cost efficiency for firm j is calculated as the ratio $\eta_j = w_j^T x_j^* / w_j^T x_j$, where x_j represents actual input usage and $0 < \eta_j \le 1$. 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. Let $p_j = (p_{1j}, p_{2j}, \ldots, p_{nj})^T \in \Re_{++}^n$ denote the output price vector corresponding to the output vector y_j. Then the revenue frontier is defined as:

$$r_I(x_j, p_j) = \max_y \{ p_j^T \, y_j : (y_j, x_j) \in V^I(y_j) \} \tag{5}$$

where $r_I(x_j, p_j)$ = the revenue frontier for firm j relative to reference set I. The optimal output vector $\mathbf{y_j}^*$ maximizes revenue conditional on inputs x_j and output prices p_j. Revenue efficiency is calculated as the ratio $\rho_j = p_j^T y_j / p_j^T y^*$, where $0 < \rho_j \le 1$.

We also compute the distance between the production frontiers when measuring cost and revenue efficiency. The cost efficiency decomposition also is illustrated in Figure 1. Figure 1 is similar to the standard Farrell efficiency graph with the exception that there are 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 distance between the cost frontiers, we consider the 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 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 and isocost line: $C_M(y_s, x_s) = (0a′/0c) = (0b′/0c)*(0a′/0b′) = T_M(y_s, x_s)*A_M(y_s, x_s)$. The cross-frontier distance for firm s is the ratio of the cross-frontier efficiency to the own-frontier efficiency,

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

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 Figure 1, $D_{C\{S:M\}}(y_s, x_s)$ = (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.[11]

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

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[11]In practice, the isoquants are not necessarily parallel because the stock and mutual technologies differ; and, moreover, the isocost lines do not need to be parallel, i.e., firms can face different input price ratios. The cross-to-own efficiency ratios continue to measure the distances between frontiers under these conditions.

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). Thus, analogous to the ordinary efficiency case, the distance between the cost frontiers is affected by both technical and allocative efficiencies. We consider the frontier distances based on the cost frontier to be more informative than those based on the technical frontier alone because the cost frontier distances are measured at the cost minimizing operating point rather than at a point that could in general incorporate allocative inefficiency.

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 ratios analogous to (6). The revenue frontier distance, $D_{R\{S:M\}}(y_s,x_s)$ is 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: $A_{R:M}(y_s,x_s)/A_{R:S}(y_s,x_s)$, where output allocative efficiencies measure the firm's success in choosing the revenue maximizing output combinations. As in the cost efficiency case, measuring frontier distances using the revenue rather than the technical frontiers is more informative because the comparison takes place at the revenue maximizing point, reflecting a correction for revenue allocative inefficiency.

DEA efficiency is estimated by solving linear programming problems. The standard own-frontier problem setup is discussed in Cooper, Sieford, and Tone (1999), and the cross-frontier models are discussed in Cummins, Weiss, and Zi (1999) and Cummins and Weiss (2000). The problem specifications are not repeated here to conserve space.

3. The Sample, Outputs, and Inputs

This section first describes our database and then discusses the measurement of the outputs, inputs, and prices used in estimating efficiency. The section concludes with a discussion of summary statistics and an analysis of the role of stocks and mutuals in the Spanish insurance market.

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.[12] The data thus include all insurers in the Spanish market supervised by the Spanish regulatory authority except for social benefit institutions.[13] 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 3,121 observations. The firms in the sample account for an average of 69% of the premiums 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. 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 (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 reduce risk through pooling. The actuarial, underwriting, and related expenses incurred in risk pooling are important components of value 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.

 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.

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[12]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, 2003). 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.

[13]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. The mutuals remaining in the sample are organized according to the same underlying principles of mutuality that govern mutuals in other jurisdictions such as the U.S. and the U.K. (Martinez, et al., 2001).

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).[14] 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. Proxying output by the amount of losses incurred is appropriate because the objective of risk-pooling is to collect funds from the policyholder pool and redistribute them to those who incur losses. The use of losses incurred is also consistent with the economic theory of insurance, which posits that risk averse agents subject to random shocks to wealth are willing to pay more than the expected value of loss to transfer risk to the insurer (e.g., Pratt, 1964; Schlesinger, 2000).[15] 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 intermediation output.

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.[16] 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).

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[14]The use of premiums generally is not considered appropriate because premiums represent price times quantity of output, i.e., insurance revenues (Yuengert, 1993).

[15]For further theoretical discussion of the measurement of output in insurance see Diewert (1995) and Cummins and Weiss (2000).

[16]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, 2000).

Although it would have been desirable to utilize more disaggregated output measures, e.g., further breaking down non-life insurance into specific business lines, more detailed volume-based measures by line of business were not available. However, we were able to obtain 0-1 indicator variables showing insurer participation in each of the major Spanish lines of business, and these variables are utilized in our regression analysis. In addition, we are able to provide some insights into the relative success of stocks and mutuals in the most important lines of business based on aggregate market data, discussed below.

Although losses incurred provide a theoretically sound proxy for insurance output and have been shown to yield reasonable results in many prior studies, losses are subject to random fluctuations and thus potentially create an "errors in variables" problem. To check the robustness of our results to potential randomness in losses, we conduct two robustness checks, which are reported below: (1) We tabulate the volatility of losses in the Spanish insurance market over our sample period and compare this volatility with fluctuations in premiums over the same period. If losses are not much more volatile than premiums, it provides evidence that actual and expected losses are probably not widely divergent over the sample period, indicating that any problem with errors in variables is minimal. (2) We conduct the efficiency analysis using as alternative proxies for insurance output, life and non-life premiums, for one year of the sample period. Even though the theoretical justification for using premiums as output is not as strong as for losses, premiums are highly correlated with expected losses, and hence provide an alternative output measure that is less subject to random fluctuations. Finally, even though we believe it is important to conduct these robustness checks, the regression-analysis of efficiency scores on company characteristics presented below also provides a control for random error in the estimated DEA efficiency scores by capturing any unusual fluctuations in the regression error term.

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.[17] 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, communications, and materials; and we use business services as a second input.[18] 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 Zi, 1998; Cummins, Weiss, and Zi, 1999) 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. Equity capital is an important input in insurance because insurers hold equity to ensure policyholders that claims will be paid even if they exceed expectations and to satisfy regulatory requirements. Debt capital provides another source

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[17]Equation (7) is not a profit measure because administrative and underwriting expenses are not deducted from the numerator and because investment income on equity is not included in revenues. Investment income on reserves is included in gross revenues in order to reflect the firm's net interest margin from intermediation, part of the value-added in insurance. The net interest margin is the difference between the rate of investment return earned on policyholder supplied funds (reserves) and the rate of return implicitly credited to the policyholder in the premium through the discounting of loss and other insurance cash flows. The treatment of the net interest margin is discussed further in Cummins and Weiss (2000).

[18] 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.

of funds, consisting of borrowed funds as well as funds owed to reinsurance companies. Capital costs represent a significant expense for insurers. 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 average rate of total return on the Madrid Stock Exchange Index for the five year period preceding each year of the sample period; and for debt capital we use the one-year Spanish Treasury bill rate.

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, equity capital, and debt capital.

Summary Statistics and Market Overview

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 liquidations (see Cummins and Rubio-Misas, 2003). 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).

Summary statistics are provided in Table 1. 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). 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 includes average efficiencies, although we defer discussion of these results until the following section.

The results shown in Table 1, as well as additional aggregate statistics from other sources (e.g., Esteban-Jodar, 1993; Dirección General de Seguros, 1998; Martinez, et al., 2001) and interviews with

Spanish insurance executives, enable us to draw some conclusions about the efficient structure hypothesis. Table 1 shows that mutuals are relatively more important in non-life insurance than in life insurance. Based on the averages in Table 1, mutuals accounted for about 15.4% of non-life insurance premiums but only 5.9% of life insurance premiums during the sample period.

Further analysis indicates that within the non-life category, mutuals have a relatively high market share (approximately one-third of the market) in automobile insurance but much lower market shares in complex commercial lines such as multiple-peril insurance. The fact that the mutuals' most successful business line is automobile insurance is consistent with the efficient structure hypothesis. Automobile insurance is a relatively stable line with standard policy forms and large numbers of exposure units that is relatively straightforward in terms of underwriting and pricing and hence does not require high levels of managerial discretion. The level of product innovation in automobile insurance is very low, so that unusual capital investments are not required to remain competitive, and the importance of policyholder services (settling claims) is relatively high. Mutuals tend to do well in lines where there are many relatively small buyers that rely on stability of coverage and high quality services because the elimination of the policyholder-owner conflict means that the insurer is more likely to act in the interests of the customer, especially when customers do not possess much market power. The relative lack of success of mutuals in complex commercial non-life lines, where more pricing and underwriting discretion are required, reinforces the argument that the efficient structure hypothesis seems to be supported in Spanish insurance.

The dominance of stock insurers in life insurance also supports the efficient structure hypothesis. The life insurance market in Spain has been evolving rapidly during the past two decades. While non-life insurance remains a traditional insurance market, life insurance has become part of the financial services market, and life insurers increasingly compete with banks and other financial institutions in providing asset accumulation products. The dynamism of the life insurance market has led to significant product innovation, with the introduction of new products that require high levels of technology investment. In addition, life insurers have had to invest heavily in distribution networks to compete with other financial services firms. Stock insurers have an advantage over mutuals in this market because product innovation requires relatively high managerial discretion and because investment in product research and development have required

significant infusions of new capital. Thus, the market positioning of the Spanish mutual and stock insurers in auto insurance and life insurance, respectively, provides support for the efficient structure hypothesis.[19]

4. Efficiency Results

This section presents our results on the relationship between organizational form and efficiency in the Spanish insurance market. We first discuss the 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, the remainder of the analysis is based on the own and cross-frontier efficiencies and the ratio of each group's cross-frontier efficiency to its own frontier efficiency (i.e., the stock and mutual *cross-to-own ratios* $D_{K\{S:M\}}(y_s,x_s) = K_M(y_s,x_s)/K_S(y_s,x_s)$ and $D_{K\{M:S\}}(y_m,x_m) = K_S(y_m,x_m)/K_m(y_m,x_m)$, respectively, where $K_I(y_j,x_j)$ = efficiency of type K (K = T = technical, C = cost, and R = revenue) for firm j with respect to reference set I (I = S = stock firms, M = mutual firms).

Pooled versus Separate Frontiers

In 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 explained above, rejection of the null hypothesis in this case would imply that stocks and mutuals are producing their outputs using different technologies. The specific hypotheses are:[20]

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 Elyasiani and Mehdian (1992) and Isik and Hassan (2002) in conducting a battery of parametric

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[19]There are interesting parallels between the Spanish and U.S. insurance markets. Mutuals are also relatively successful in U.S. personal lines non-life insurance (automobile and homeowners insurance), where they control 42% of premium revenues but are less successful in the more complex commercial non-life market, where they control only 20% of revenues. Traditionally, U.S. life insurance markets were dominated by giant mutual insurers. However, during the past two decades most of these mutuals converted to the stock form of ownership to raise capital in order to compete in the financial services market (Viswanathan and Cummins, 2003).

[20]We also tested the hypothesis that the distribution of the own-frontier mutual efficiency scores is the same as the distribution of the own-frontier stock efficiency scores, for each year and each type of efficiency. These tests too resulted in the rejection of the null hypothesis that the stock and mutual efficiencies are drawn from the same population. This set of tests follows the approach in Aly, et al. (1990).

and non-parametric tests of the null hypotheses.[21] The tests overwhelmingly reject either Hypothesis 1, Hypothesis 2, or both for all types of efficiency in each year.[22] The implication of these tests is 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.

Own and Cross-Frontier Analysis

As discussed above, the market overview statistics suggest that stock insurers are more successful in life insurance and mutuals are more successful in personal non-life lines such as auto insurance. Hence, in analyzing the relative efficiency of the two organizational forms, it is likely to be important to control for line of business participation and other characteristics in a multiple regression context. Accordingly, we briefly discuss the average efficiency results, and then focus most of the discussion on the regressions.

Average Efficiencies and Efficiency Ratios. The average efficiency results are summarized in Table 2, which shows technical, cost, and revenue efficiency. Because the hypothesis that the two groups of insurers operate on the same frontier is rejected in most of our tests, the table reports the own-frontier and cross-frontier results. The efficiencies are estimated separately for each year of the sample period. However, because the efficiency scores and relationships among efficiencies of different types tended to be quite consistent across years, only the 1989-1997 sample period average efficiencies are reported.[23]

We focus first on the own-frontier efficiency results, which are estimated by treating stocks and mutuals as separate samples. Own-frontier technical, cost, and revenue efficiency results are reported in the table cells headed $T_S(y_s,x_s)$ and $T_M(y_m,x_m)$, $C_S(y_s,x_s)$ and $C_M(y_m,x_m)$, and $R_S(y_s,x_s)$ and $R_M(y_m,x_m)$, respectively. The general pattern that emerges is that mutuals are significantly more efficient with respect to the mutual frontier, in comparison with the efficiency of stocks relative to the stock frontier, for all three types of

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[21]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.

[22]The test results are available from the authors.

[23]Results for the individual years are available from the authors.

efficiency. This result 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. The generally lower own-frontier efficiencies for stocks possibly suggest that there is more opportunity for firms to make mistakes that degrade efficiency when operating in more complex lines of business.[24]

Cross-frontier efficiencies, which reflect the efficiency of stocks relative to the mutual frontier and mutuals relative to the stock frontier also are reported in the table, in the cells headed $T_M(y_s,x_s)$ and $T_S(y_m,x_m)$, for technical efficiency, $C_M(y_s,x_s)$ and $C_S(y_m,x_m)$, for cost efficiency, and $R_M(y_s,x_s)$ and $R_S(y_m,x_m)$, for revenue efficiency. The cross-frontier analysis 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. The stock-relative-to-mutual cross-frontier scores ($T_M(y_s,x_s)$, $C_M(y_s,x_s)$, and $R_M(y_s,x_s)$) are consistently larger than the respective mutual-relative-to-stock cross-frontier scores ($T_S(y_m,x_m)$, $C_S(y_m,x_m)$, and $R_S(y_m,x_m)$). The fact that the stock cross-frontier scores are substantially larger than the stock own-frontier efficiencies implies that stocks are further from their own technical, cost, and revenue frontiers than they are from the mutual frontiers, supporting the hypothesis that stocks on average have developed superior technologies for producing stock output vectors. The mutual cross-frontier efficiencies, on the other hand, are significantly smaller than the stock cross-frontier efficiencies, and the mutual cross-frontier efficiencies also are smaller than their own-frontier efficiencies. Thus, based on the averages, mutual technologies generally do not appear to dominate stock technologies, even for the production of mutual output vectors.

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[24]The lower own-frontier efficiency scores for stocks also may be attributable to the larger sample size for stocks than for mutuals. DEA tends to produce lower efficiency scores in larger samples because there are more candidate firms that can potentially determine the peer group (dominating set) for any given firm. Accordingly, as a robustness check we also conducted the analysis using matching samples where the number of stock firms equals the number of mutual firms in each year of the sample period. The matching samples were size stratified by sorting the stock firms for a given year into size quintiles and drawing randomly a number of stock firms from each quintile equal to one-fifth of the total number of mutuals in the sample in that year. The resulting own-frontier efficiency scores for stocks were smaller on average than those for mutuals, although the differences were not statistically significant for the entire sample period, 1989-1997. Cross-frontier efficiency scores and cross-to-own ratios also were calculated based on the matching sample of stock firms. The results of this analysis lead to the same conclusions as the results based on the full-sample of stock firms. We report the full sample results in the tables and text in order to take advantage of the reduced sampling error arising from the larger sample size and so that the reported results better reflect the entire Spanish insurance market.

Average cross-frontier to own frontier (cross-to-own) efficiency ratios also are reported in Table 2. As explained above, the cross-to-own ratios measure the distance between the frontiers at each firm's operating point. If a firm's cross-to-own efficiency ratio is greater than 1, the implication is that its group-specific frontier dominates the frontier of the other organizational form at its output-input vector; and if the firm's cross-to-own efficiency ratio is less than 1, the implication is that the firm's group-specific frontier is dominated by that of the other organizational form. If the ratio is equal to 1, then neither frontier is dominant at that operating point. The cross-to-own efficiency ratios are shown in Table 2 in the cells headed $D_{T\{S:M\}}(y_s,x_s)$ and $D_{T\{M:S\}}(y_m,x_m)$ for technical efficiency, $D_{C\{S:M\}}(y_s,x_s)$ and $D_{C\{M:S\}}(y_m,x_m)$ for cost efficiency, and $D_{R\{S:M\}}(y_s,x_s)$ and $D_{R\{M:S\}}(y_m,x_m)$ for revenue efficiency. For each type of efficiency, the stock cross-to-own ratios significantly exceed the mutual cross-to-own ratios; and, moreover, the stock cross-to-own ratios are significantly greater than 1, whereas the mutual cross-to-own ratios are significantly less than 1.[25] Thus, the stock firms appear to be dominant for producing stock output vectors, but mutuals generally do not appear to be dominant for producing mutual output vectors, based on the <u>average</u> distances between the frontiers. However, we defer discussion of the conclusions to be drawn on the basis of the results, pending the presentation of the regression analysis.[26]

Because the cross-to-own efficiency results measure distances between frontiers, these ratios do not

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[25]The analysis based on the size-matched samples containing the same number of stocks and mutuals supports the same conclusions. However, the differences between the stock and mutual cross-to-own ratios are generally smaller for the matching samples than for the full sample.

[26]As mentioned, we also conducted robustness checks with regard to the measure of output. Specifically, to determine the degree of randomness of losses and premiums, we computed the sample period average, standard deviation, and coefficient of variation for life and non-life premiums and losses. The results show that Spanish insurance losses are not significantly more volatile than Spanish premiums. The coefficients of variation of life insurance losses and premiums are 0.72 and 0.68, respectively, and the coefficients of variation of non-life losses and premiums are 0.22 and 0.23, respectively. Hence, high loss volatility is not a problem for the Spanish data during our sample period. We also computed the efficiency scores for 1995 using life and non-life premiums rather than life and non-life losses as the measures of outputs. Nearly all of the bivariate correlations between the efficiency scores based on losses and those based on premiums exceed 90% and most exceed 95%. The only exception to this general rule is for revenue efficiency, where the correlations are around 75%. The reason for the relatively low correlations for revenue efficiency is that the use of premiums as output leads to an inappropriate output price measure in equation (7), such that the revenue efficiency results based on premiums are less meaningful than those based on losses. Nevertheless, the non-revenue efficiency results are highly robust to the choice of output measure, and the correlations even for revenue efficiency are quite high. Moreover, the alternative efficiency scores lead to the same conclusions about the relative efficiency of stocks and mutuals.

convey information about allocative efficiency. The average allocative efficiency results, shown in Table 1, do not support the expense preference hypothesis. The difference between the cross-frontier allocative efficiencies of stocks and mutuals is small and not statistically significant (0.487 versus 0.49, respectively), and the pooled frontier allocative efficiencies of the two groups of firms also are not statistically different. The own-frontier allocative efficiency of mutuals actually exceeds the own-frontier allocative efficiency of stocks (0.561 versus 0.494, respectively), indicating that relative to their peer group mutuals on average are slightly more allocatively efficient than are stocks relative to their peer group. Thus, there is no evidence that mutuals on average waste more resources than stocks due to being less allocatively efficient.

Regression Analysis. To provide evidence on whether the differences in cross-to-own frontier efficiencies are maintained when we control for firm characteristics, we conduct a multiple regression analysis with cross-to-own frontier ratios (distances between frontiers) as dependent variables and firm characteristics as independent variables. The regressions control for firm size by including eight size-quartile-dummy*ownership-form-dummy variable interaction terms. Specifically, we interact the four size quartile dummy variables with a dummy variable equal to 1 for mutuals and 0 otherwise and also interact the size quartile dummies with a dummy variable equal to 1 for stocks and 0 otherwise.[27] The overall intercept is omitted from the equations to avoid singularity. Omitting the intercept term enables us to interpret the coefficient of a given size-quartile*organizational form interaction variable as the regression intercept coefficient for firms in that size quartile with the specified organizational form.

To control for the line of business participation of the insurers in the sample, we obtained line of business participation indicator variables for all major lines of Spanish insurance, which are set equal to 1 if an insurer participates in a line of business and to 0 otherwise. Eleven line of business indicator variables are included in our regressions.[28] These include indicators for life insurance, automobile insurance (representing about 40% of non-life insurance revenues), health insurance (20% of non-life revenues), and

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[27]The measure of size is total 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.

[28]These variables are not necessarily mutually exclusive. For example, a firm could have a non-zero value for both the life insurance and the auto insurance indicator variables.

accident insurance (7% of non-life revenues).[29] The excluded lines of business primarily represent commercial liability coverages and some property coverages. When dummy variables for these lines were included (always excluding one line to avoid singularity), they were not statistically significant.

The regressions also include two capital structure variables, the ratios of debt capital and 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 primary insurance policies. An important insurance leverage ratio, the ratio of premiums to equity capital is included in the regressions because this ratio has been shown to be related to firm performance in numerous prior studies. The final regression variables are year dummy variables to control for differences in cross-to-own frontier ratios across the years included in the sample period, omitting the variable for 1989 to avoid singularity.

The regression results, with the dependent variables equal to the cross-to-own ratios based on technical, cost, and revenue frontiers, respectively, are presented in Table 3. We first consider the results with the size-quartile*organizational-form interaction variables. The most important conclusion based on Table 3 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 (the technical efficiency cross-to-own ratio) regression, we see that the coefficients of the size-quartile*mutual-dummy interactions are significantly greater than 1 for all four size quartiles, implying that mutual technologies are dominant for producing mutual output vectors for firms of all sizes. The coefficients of the size-quartile*stock-dummy interaction variables in the production frontier regression also are all significantly greater than 1, implying that stock insurers are dominant for producing stock output vectors. Thus, the production frontier regression supports the efficient structure hypothesis for both mutuals and stocks.

Again focusing on the production frontier regression, Wald tests reveal that the coefficient of the size-quartile*stock-dummy interaction for each size quartile is significantly greater than the corresponding coefficient of the size-quartile*mutual-dummy interaction variable for the same size-quartile. In addition,

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[29]The other line of business dummy variables are for mortuary insurance, a basic life insurance policy for funeral expenses, three commercial property coverages (for railroad equipment, aircraft, and ships), caution insurance, which primarily focuses on loss prevention, income loss insurance, and legal defense coverage.

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, but the degree of dominance by stocks for the stock output vectors is significantly higher.

In the cost frontier regression, the coefficients of the size-quartile*stock-dummy interaction variables are all significantly greater than 1, and the coefficients of the size-quartile*mutual interaction variables are also significantly greater than 1 except for the fourth quartile, where the coefficient is not statistically different from 1. Thus, stocks of all sizes are dominant in terms of cost efficiency for the production of stock outputs, and mutuals in the three smallest size quartiles are dominant for the production of mutual outputs, but mutuals in the largest size quartile are neither dominant over nor dominated by stocks for the production of mutual outputs. 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, with the largest difference being in the largest size quartile. Thus, the cost regression provides additional support for the efficient structure hypothesis for stock firms of all sizes and for mutual firms in the three smallest size quartiles and also provides some support for the expense preference hypothesis, i.e., mutuals in the largest size quartile display technical (production frontier) dominance but this dominance does not translate into comparable dominance with respect to the cost frontier.

The results of the revenue cross-to-own regression provide further evidence that mutual technical dominance is not maintained in terms of overall firm performance. Although the first-quartile*mutual interaction variable coefficient is significantly greater than 1, it is much smaller than the comparable coefficient for stock insurers. In addition, coefficients of the other three mutual quartile interaction variables are not significantly different from 1. Thus, even after controlling for line of business participation and other factors, the results generally confirm the findings based on averages (Table 2) that the mutual organizational form generally is not dominant in terms of revenue efficiency. The first-quartile*stock interaction coefficients are all significantly greater than 1.

The revenue efficiency results generally support the efficient structure hypothesis for stocks but also suggest that mutuals in the three largest size quartiles are vulnerable to competitive inroads by stock insurers.

I.e., the fact that the coefficients of the size-quartile*mutual interaction variables are not significantly different from 1 for the three largest size quartiles implies that mutuals and stocks perform about equally well at these operating points. Thus, in terms of revenue efficiency, mutuals in these size groups would seem to be particularly vulnerable to competition from stock insurers, but mutuals in general are dominated in terms of revenue efficiency in market segments where stocks are dominant. These findings suggest that the stronger control mechanisms in the stock ownership form may tend to be more important in larger organizations.

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, whereas variables with coefficients less than zero tend to be associated with smaller distances between the own-group and other-group frontier.

The coefficient of the life insurance indicator variable is significant and positive in the production and cost frontier regressions, suggesting that these 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 profits. The auto insurance dummy variable has negative coefficients in all three regressions, suggesting 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 in the production and cost frontier regressions and statistically significant except for equity capital-to-assets in the technical efficiency case, suggesting that technical and cost 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 tend to have lower insolvency probabilities.

Our final set of tests is designed to provide information on allocative efficiency differences between stocks and mutuals, after controlling for other firm characteristics. The principal dependent variables are the own frontier cost and revenue allocative efficiencies. Recall that cost frontier allocative efficiency measures the success of firms in choosing cost minimizing input combinations and revenue allocative efficiency measures the success of firms in choosing revenue maximizing output combinations. For purposes of comparison, we also conduct regressions where the dependent variables are the cost and revenue allocative efficiencies based on the pooled efficient frontier for all firms in the industry. Even though we reject the hypothesis that stocks and mutuals share a common frontier, the pooled results are included in order to present as much information as possible that might have implications for the expense preference hypothesis.[30]

The allocative efficiency regressions are shown in Table 4. The own-frontier cost and revenue regressions confirm the finding based on averages (Table 1) that mutual allocative efficiencies with respect to their own frontier are generally higher than stock efficiencies relative to the stock frontier The coefficients of the size quartile*mutual dummy variables are larger than the corresponding size quartile*stock dummy variable coefficients for each quartile, and these differences are statistically significant except for the second quartile for cost efficiency and the first quartile for revenue efficiency. Thus, in comparison to their peer group, mutuals do not exhibit a higher degree of allocative inefficiency than stocks. Once again, it is likely that the lower stock own-frontier scores reflect the greater chance of making mistakes in allocative decisions when operating in more complex lines of business. The pooled allocative efficiency regressions generally confirm the findings based on the averages (Table 1) that mutual and stock allocative efficiencies are not significantly different when based on the pooled frontier. The coefficients of the size quartile*mutual

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[30]Regressions also were conducted with cross-frontier allocative efficiencies as the dependent variables. The results are similar to the pooled frontier allocative efficiency regressions and are not shown to conserve space.

dummies tend to be somewhat higher than the coefficients of the size quartile*stock dummies, but these differences are not statistically significant except for quartile 4 in the revenue efficiency regression. Thus, the allocative efficiency regressions do not provide support for the expense preference hypothesis.

5. Conclusions

This paper tests hypotheses about organizational structure by analyzing Spanish stock and mutual insurers over the period 1989-1997. We test two principal hypotheses: The *efficient structure hypothesis* predicts that firms with different organizational forms will be sorted into market segments where they have comparative advantages in dealing with agency costs or in exploiting other differences among organizational forms. Stock firms are predicted to be successful in lines of business requiring relatively high levels of managerial discretion as well as lines of business requiring higher new capital investment because of their superior access to capital. Mutuals are predicted to succeed in lines requiring relatively low levels of managerial discretion and lines requiring less capital investment. We also test the *expense preference hypothesis*, which predicts that mutuals will be less successful than stocks in minimizing costs and maximizing revenues due to the weaker control mechanisms in the mutual organizational form. The efficient structure hypothesis predicts that there will not be significant efficiency differences between stocks and mutuals, while the expense preference hypothesis predicts that mutuals will be less efficient than stocks.

Firm performance is measured using modern frontier efficiency analysis. "Best practice" production, cost, and revenue frontiers are estimated using data envelopment analysis (DEA). The efficient structure hypothesis implies that firms of different types are likely to be characterized by different operating technologies adapted to the market segments where they have comparative advantages. We test for the use of different technologies by stocks and mutuals by estimating efficiencies relative to pooled frontiers consisting of all firms in the sample as well as estimating group-specific frontiers, consisting only of stock and mutual firms. Our tests reject the hypothesis that stocks and mutuals share a common frontier.

Because the hypothesis that stocks and mutuals are operating on a pooled frontier is rejected, we base the analysis on group-specific frontiers for stock and mutual insurers, respectively, and on cross-frontier analysis, where stocks (mutuals) are evaluated relative to a reference set consisting of the mutual (stock) firms in the sample. 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 its organizational form dominates the other organizational form for the production of its own output vector. A key statistic in our analysis is the ratio of each firm's cross-frontier efficiency to its own-frontier efficiency, that is, the distance between the stock and mutual frontiers for each firm's output-input vector. If the cross-to-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-to-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.

Regression analysis of cross-to-own technical efficiency ratios implies 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. The cross-to-own cost frontier regression produces similar results, except that mutuals in the largest size quartile are neither dominant over nor dominated by stocks in cost efficiency. In the cross-to-own revenue efficiency regression, stocks in all size quartiles are dominant in the production of stock outputs, and mutuals in the smallest size quartile are dominant in the production of mutual outputs. However, mutuals in the three largest size quartiles are neither dominated by nor dominant over stocks for the production of mutual output vectors. Thus, the results provide strong support for the efficient structure hypothesis based on technical efficiency but somewhat weaker support for this hypothesis based on cost and revenue efficiency. Mutuals in the largest size quartile appear to be vulnerable to competition from stock insurers in terms of cost efficiency, and mutuals in the three largest size quartiles appear vulnerable to competition from stock insurers in terms of their revenue efficiency performance. Most of the larger mutuals produce both life and non-life insurance but have not been successful in the life insurance market, suggesting the need for refocusing their operations or perhaps undertaking demutualization.

The analysis of allocative efficiency provides no evidence that mutuals are less successful than stocks in choosing cost minimizing input combinations or revenue maximizing output combinations. Thus, the results do not support the expense preference hypothesis in the strict sense of Mester (1989, 1991). However, larger mutuals are not cost or revenue dominant over stocks for producing mutual output vectors, suggesting generally weaker performance of the mutual ownership form in the Spanish market.

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

X_1

w'

w

b'

a'

(y_s, x_s)

c

b

a

(y_m^*, x_m^*)

(y_m, x_m)

(y_s^*, x_s^*)

e

f

e'

d

$L^M(y)$

d'

w

w'

$L^S(y)$

0

X_2
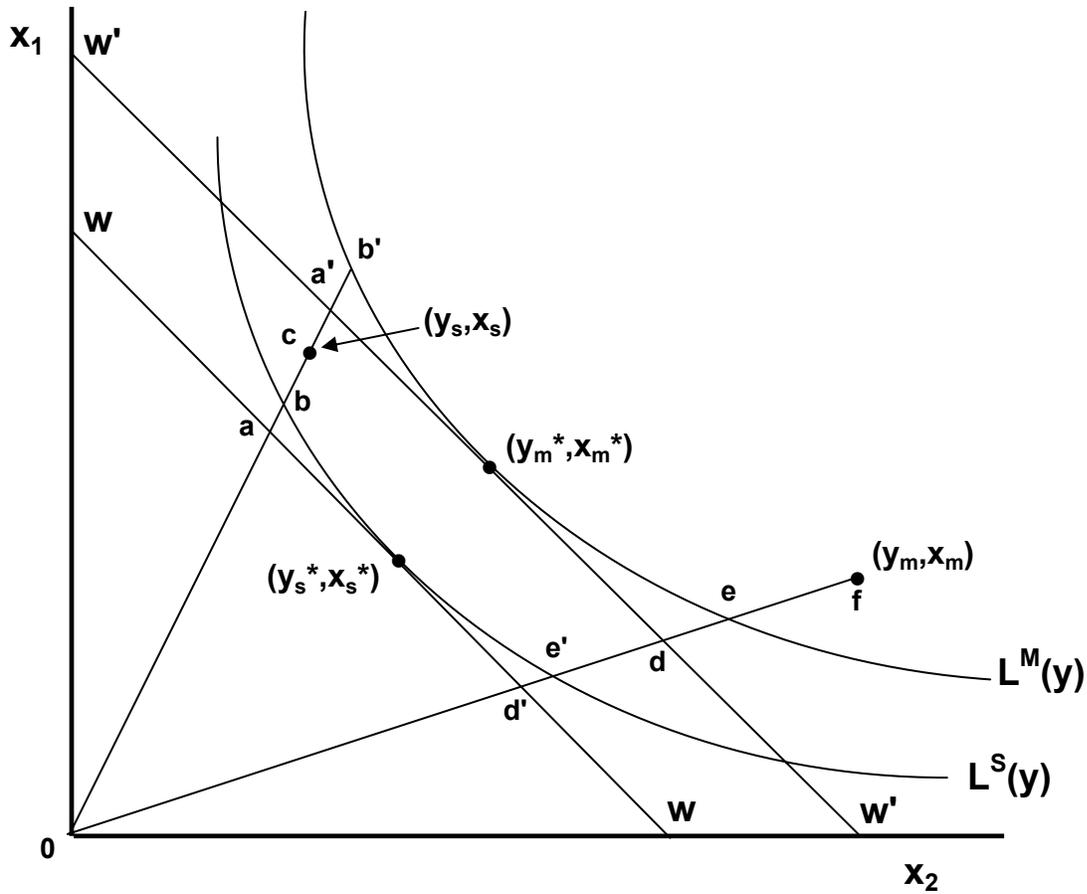
Efficiencies for point (y_s, x_s):

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 $\quad D_{C\{S:M\}}(y_s, x_s) = C_M(y_s, x_s)/C_S(y_s, x_s) = 0a'/0a$

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	3,395	3,335		3,721
Life premiums	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
Pooled Frontier Efficiency				
Technical		0.298	*	0.274
Allocative		0.496		0.505
Cost		0.149	***	0.123
Revenue		0.200	**	0.223
Own Frontier Efficiency:				
Technical		0.310	***	0.408
Allocative		0.494	***	0.561
Cost		0.154	***	0.232
Revenue		0.209	***	0.357
Cross Frontier Efficiency:				
Technical		0.951	***	0.399
Allocative		0.487		0.490
Cost		0.403	***	0.129
Revenue		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.
*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

Table 2: Technical, Cost, and Revenue Efficiency Averages -- 1989-1997

Technical Efficiency	Own $T_S(y_s,x_s)$	Own $T_M(y_m,x_m)$	t-test[1]	Cross $T_M(y_s,x_s)$	Cross $T_S(y_m,x_m)$	t-test[1]	Stock Cross/Own	Mutual Cross/Own	t-test[1]	t-test[2]: Cross/Own-1 Stock	Mutual
							$D_{T\{S:M\}}(y_s,x_s)$	$D_{T\{M:S\}}(y_m,x_m)$			
Mean	0.3098	0.4080	-5.594	0.9506	0.3988	11.306	2.6375	0.8384	33.460	42.433	-4.316

Cost Efficiency	Own $C_S(y_s,x_s)$	Own $C_M(y_m,x_m)$	t-test[1]	Cross $C_M(y_s,x_s)$	Cross $C_S(y_m,x_m)$	t-test[1]	Stock Cross/Own	Mutual Cross/Own	t-test[1]	t-test[2]: Cross/Own-1 Stock	Mutual
							$D_{C\{S:M\}}(y_s,x_s)$	$D_{C\{M:S\}}(y_m,x_m)$			
Mean	0.1543	0.2320	-5.986	0.4033	0.1293	17.120	2.3510	0.6314	52.706	45.825	-26.376

Revenue Efficiency	Own $R_S(y_s,x_s)$	Own $R_M(y_m,x_m)$	t-test[1]	Cross $R_M(y_s,x_s)$	Cross $R_S(y_m,x_m)$	t-test[1]	Stock Cross/Own	Mutual Cross/Own	t-test[1]	t-test[2]: Cross/Own-1 Stock	Mutual
							$D_{R\{S:M\}}(y_s,x_s)$	$D_{R\{M:S\}}(y_m,x_m)$			
Mean	0.2088	0.3574	-9.506	0.4063	0.2976	3.214	1.8729	0.8049	27.883	56.920	-5.559

Note: $E_K(y_i,x_i)$= Efficiency of type "E" (E = T = technical, E = C = cost, E = R = revenue), 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

$D_{T\{S:M\}}(y_s,x_s)$ = 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 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.

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

Table 3: Frontier Distance Regressions: Spanish Insurers 1989-1997

Independent Variables	Production Frontier				Cost Frontier				Revenue Frontier			
	Coefficient	z1-Statistic	z1	z2	Coefficient	z1-Statistic	z1	z2	Coefficient	z1-Statistic	z1	z2
Q1*Mutual	1.7187	10.64	***	***	1.2169	9.48	***	**	1.2418	13.53	***	***
Q2*Mutual	2.0653	11.66	***	***	1.4821	10.53	***	***	1.1046	10.97	***	
Q3*Mutual	2.3055	12.00	***	***	1.5291	10.01	***	***	1.0109	9.25	***	
Q4*Mutual	1.4079	7.20	***	**	0.9280	5.98	***		1.0824	9.74	***	
Q1*Stock	3.2532	23.79	***	***	2.7331	25.15	***	***	1.9926	25.63	***	***
Q2*Stock	3.5607	27.38	***	***	2.8230	27.32	***	***	2.1888	29.60	***	***
Q3*Stock	3.8643	30.08	***	***	2.9464	28.86	***	***	2.3620	32.33	***	***
Q4*Stock	4.0631	28.87	***	***	3.4023	30.42	***	***	2.2540	28.16	***	***
Life Insurance Indicator	2.2866	33.93	***		1.5358	28.68	***		-0.1517	-3.96	***	
Auto Insurance Indicator	-0.4276	-4.61	***		-0.3084	-4.18	***		-0.0819	-1.55		
Accident insurance indicator	-0.3863	-5.52	***		-0.2180	-3.92	***		-0.1266	-3.18	***	
Health insurance indicator	-0.5515	-10.08	***		-0.3148	-7.24	***		0.1765	5.67	***	
Mortuary insurance indicator	-0.3760	-6.36	***		-0.2597	-5.52	***		-0.0883	-2.62	***	
Income loss indicator	-0.2903	-3.37	***		-0.1572	-2.30	**		-0.0115	-0.23		
Railway damages indicator	0.4807	3.85	***		0.2825	2.85	***		0.0073	0.10		
Hull damages indicator	-0.5245	-5.25	***		-0.3097	-3.90	***		-0.0400	-0.70		
Aircraft damages indicator	-0.3410	-2.77	***		-0.2133	-2.18	**		-0.0465	-0.66		
Caution insurance indicator	-0.3195	-3.19	***		-0.2765	-3.48	***		-0.0068	-0.12		
Legal defense indicator	-0.3867	-4.72	***		-0.3662	-5.62	***		0.0145	0.31		
Debt Capital/Assets	-2.6551	-10.35	***		-1.2346	-6.06	***		-0.2042	-1.40		
Equity Capital/Assets	-0.1747	-1.44			-0.5949	-6.18	***		0.2814	4.08	***	
Premiums/Equity Capital	-0.0514	-4.52	***		-0.0422	-4.67	***		0.0234	3.62	***	
D90	-0.4608	-4.71	***		0.0423	0.54			-0.6449	-11.59	***	
D91	-0.3232	-3.31	***		-0.3238	-4.17	***		-0.4699	-8.46	***	
D92	-0.3108	-3.08	***		0.6293	7.86	***		-0.7035	-12.28	***	
D93	-0.2070	-2.08	**		-0.0391	-0.49			-0.5752	-10.15	***	
D94	-0.0181	-0.17			0.1118	1.36			-0.3442	-5.84	***	
D95	-0.4040	-3.84	***		-0.1479	-1.77	*		-0.2580	-4.31	***	
D96	0.1780	1.67	*		0.3187	3.75	***		-0.1245	-2.05	**	
D97	-0.7494	-7.02	***		-0.2257	-2.66	***		-0.3621	-5.96	***	
N	3,084				3,084				3,084			
R^2	0.534				0.519				0.303			
Adjusted R^2	0.530				0.514				0.297			

*** 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 4: Allocative Efficiency Regressions, Spanish Insurers: 1989-1997

Independent Variables	Own: Cost[2] Coeff	z-Stat		Own: Revenue[2] Coeff	z-Stat		Pooled: Cost[1] Coeff	z-Stat		Pooled: Revenue[1] Coeff	z-Stat	
Q1*Mutual	0.6288	28.34	***	0.8020	31.25	***	0.6109	28.93	***	0.7830	30.54	***
Q2*Mutual	0.7075	29.08	***	0.7422	26.37	***	0.7117	30.74	***	0.6697	23.81	***
Q3*Mutual	0.8115	30.73	***	0.7149	23.40	***	0.7329	29.16	***	0.5869	19.23	***
Q4*Mutual	0.8743	32.56	***	0.6891	22.18	***	0.7809	30.55	***	0.6002	19.34	***
Q1*Stock	0.5565	29.62	***	0.7793	35.86	***	0.5834	32.62	***	0.7581	34.91	***
Q2*Stock	0.6713	37.57	***	0.6892	33.35	***	0.6893	40.53	***	0.6660	32.25	***
Q3*Stock	0.7107	40.27	***	0.6066	29.70	***	0.7219	42.96	***	0.5790	28.38	***
Q4*Stock	0.7412	38.33	***	0.5736	25.64	***	0.7570	41.13	***	0.5315	23.78	***
Life Insurance Indicator	-0.0551	-5.96	***	-0.2716	-25.35	***	-0.0551	-6.25	***	-0.2634	-24.60	***
Auto Insurance Indicator	-0.0042	-0.33		0.0983	6.67	***	0.0080	0.66		0.1139	7.73	***
Accident insurance indicator	-0.0157	-1.63		0.0703	6.33	***	-0.0083	-0.91		0.0774	6.96	***
Health insurance indicator	0.0476	6.33	***	-0.0133	-1.52		0.0464	6.49	***	-0.0036	-0.41	
Mortuary insurance indicator	-0.0261	-3.21	***	0.0786	8.36	***	-0.0292	-3.78	***	0.0791	8.42	***
Income loss indicator	-0.0037	-0.31		0.0100	0.73		-0.0067	-0.59		0.0201	1.47	
Railway damages indicator	-0.0252	-1.47		-0.0575	-2.90	***	-0.0304	-1.86	*	-0.0630	-3.18	***
Hull damages indicator	0.0297	2.17	**	0.0750	4.72	***	0.0220	1.68	*	0.0590	3.72	***
Aircraft damages indicator	-0.0288	-1.71	*	0.0233	1.19		-0.0266	-1.65	*	0.0353	1.81	*
Caution insurance indicator	0.0238	1.73	*	0.0340	2.14	**	0.0114	0.87		0.0378	2.38	**
Legal defense indicator	-0.0387	-3.44	***	0.0653	5.01	***	-0.0366	-3.41	***	0.0570	4.38	***
Debt Capital/Assets	0.2613	7.42	***	0.1597	3.92	***	0.2334	6.96	***	0.1807	4.44	***
Equity Capital/Assets	-0.1076	-6.46	***	0.0875	4.54	***	-0.1123	-7.09	***	0.0979	5.09	***
Premiums/Equity Capital	-0.0145	-9.30	***	0.0045	2.51	**	-0.0145	-9.76	***	0.0050	2.76	***
D90	-0.1359	-10.10	***	0.0620	3.99	***	-0.1437	-11.22	***	0.0630	4.05	***
D91	-0.1093	-8.14	***	0.0601	3.87	***	-0.1110	-8.69	***	0.0639	4.11	***
D92	-0.1291	-9.32	***	0.0817	5.10	***	-0.1498	-11.37	***	0.0929	5.80	***
D93	-0.1334	-9.74	***	0.0653	4.12	***	-0.1486	-11.39	***	0.0739	4.67	***
D94	-0.1381	-9.70	***	0.0953	5.79	***	-0.1297	-9.57	***	0.1056	6.42	***
D95	-0.1580	-10.93	***	0.0770	4.60	***	-0.1484	-10.78	***	0.0900	5.38	***
D96	-0.1461	-9.95	***	0.0889	5.23	***	-0.1505	-10.77	***	0.1045	6.16	***
D97	-0.0455	-3.10	***	-0.0382	-2.25	**	-0.1281	-9.18	***	-0.0340	-2.00	**
N	3,084			3,084			3,084			3,084		
R^2	0.224			0.424			0.207			0.432		
Adjusted R^2	0.216			0.419			0.199			0.427		

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

Note: Cost allocative efficiency is defined as cost efficiency divided by technical efficiency and indicates the success of the firm in choosing cost minimizing input combinations. Revenue allocative efficiency is revenue efficiency divided by revenue technical efficiency and indicates the success of the firm in choosing revenue maximizing output combinations.

[1]The dependent variable is the pooled-frontier cost (revenue) allocative efficiency for each firm in the sample.

[2]The dependent variable is the own-frontier cost (revenue) allocative efficiency for each firm in the sample.