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Technical Efficiency and Heterogeneity of Argentina Pension Funds

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Abstract

This paper examines the technical efficiency of Argentinean pension funds management companies using a random stochastic frontier model to rank the pension funds management companies, taking into account heterogeneity in the data. The empirical findings reveal that efficiency measures have a significant effect on pension funds efficiency. The implications for managers and policy makers are discussed.

Keywords: Argentina, pension funds, efficiency, stochastic frontier models

JEL classification: G23

1. Introduction

Pension funds efficiency depends strongly on competition and the regulation environment, which may result in incentives for consolidation and portfolio restrictions. Active investment management helps to keep markets efficient and to ensure the flow of funds to the most successful enterprises, as well as playing a major role in the allocation of resources within the economy (see Bauer, Koedijk and Otten, 2005). Pension funds management companies are particularly important in this respect in contemporary economies given the increase in the size of the aged and retired populations and the consequent problems in guaranteeing the financial sustainability of social security (Davis, 1995).

In this paper, we analyse the technical efficiency of Argentinean pension funds management companies using quarterly data from 1996Q2 to 2007Q1 with a random stochastic frontier model. Stochastic frontier models are common in contemporary research, Farsi, Filippini and Kuenzle (2005), Kim and Lee (2006), Delgado and Álvarez (2007), Peng and Wang (2007), Kraft, Hofler and Payne (2006), Berg and Lin (2007) and Giannakas, Tran and Tzouvelekas (2003) among others.

Previous research on the performance of pension fund management companies has relied on Data Envelopment Analysis (DEA) models or homogenous frontier models, including the studies by Barrientos and Boussofiane (2005), who apply the DEA-CCR and DEA-BCC models to Chilean data; Barros and Garcia (2007), who analyse Portuguese data using a homogeneous stochastic frontier model, and Barros and Garcia (2006), who estimate four DEA models of Portuguese pension funds. The paper contributes to this area of the literature by estimating a stochastic frontier model for the Argentinean case which enables us to take into account heterogeneity in the data. The advantages of this approach are twofold. First, it allows for an error term combining different statistical distributions, which is an improvement on alternative specifications that rely on one specific distribution. Second, it allows for random parameters (that is, parameters that describe characteristics not linked to observed characteristics, unlike the traditional frontier that allows for variations related to observed characteristics). This procedure may be more effective at achieving results than the traditional procedure, which considers all pension funds to be homogeneous. Therefore, the aim of the paper is to estimate a stochastic frontier model disentangling heterogeneous and homogeneous explanatory variables to identify those variables which can be managed homogeneously and those that must be managed by segments.

Our analysis is motivated by some interesting features of Argentinean pension funds management companies. Firstly, mergers and acquisitions (M&A) are present in the market during the period under examination, which indicates a constant effort by these companies to increase their market share. Secondly, regulation restricts their discretionary power, trying to influence their adoption of efficient procedures. Regulation could be understood as a mimic of competition in these markets, where the asymmetry of information demands intervention. In other regulated industries, such as utilities in developed and developing countries, price caps are set periodically. They work as a double-edged device: first they protect consumers in non-competitive markets, and second they guarantee producers the stability to improve their efficiency via cost reductions that they can appropriate as profits until the next price setting. One procedure adopted for improving competitiveness is benchmarking, based on research of an industry's best practices and on the idea that the widespread application of these practices can lead to improved performance throughout the industry. Benchmarking is currently not applied in the pension management industry, but it could be, as we suggest in the next section, since the price (commission) cap in the Argentinean market has recently been set.

The paper is organised as follows. Section 2 describes the institutional setting. Section 3 surveys the relevant literature on this topic, while Section 4 presents the theoretical framework. Section 5 discusses the data and the empirical findings. Section 6 considers the implications of this study for managers and policy makers, and concludes.

2. Contextual Setting

Major changes in pension funds were implemented in a dozen Latin American countries following the Chilean reform in 1981. The new arrangements share a mandatory fully funded pillar organized in individual accounts, which in some cases replaced and in others supplemented reformed pay-as-you-go systems (Mesa-Lago, 2004).

Argentina reformed its old pay-as-you-go system in 1994 and introduced a mixed system, comprising a new pay-as-you-go scheme and a fully funded one. Pension Funds Management Companies (PFMC) administer closed-end pension funds, where individuals hold their savings until retirement. The PFMC compete for new affiliates who are free to choose between both systems (pay-as-you-go and fully funded), and also compete for the affiliates within the fully funded system since regular contributors can switch PFMC twice a year. Until recently, commissions were deregulated. The funds at the time of retirement could be employed to buy an annuity from an insurance company or to structure a phased withdrawal. A public universal benefit is common to pay-as-you-go and fully funded schemes, and the recognition of contributions to the old system is made by means of a supplemental benefit (instead of a recognition bond as in Chile and other Latin American countries). A recent reform in 2007 restored the possibility (closed in 1996) for active workers to choose between the two systems, and established the default option for pay-as-you-go for new entrants into the labour market, who are undecided about their affiliation. The system also provides disability and survivor benefits, until recently through collective life insurance and since 2008 through a mutual arrangement between PFMC (Ferro, 2003 and Law 26222/07).

The PFMC are heavily regulated, as in other Latin American reforms (Demaestri and Ferro, 2004). The portfolios of the pension funds face several constraints on their composition, and a minimum return rule (0.7 times the average of the system) must be accomplished. A ceiling of 20 per cent on foreign assets is mandatory. One half of the portfolio is allocated to local public debt. At February of 2008, the ten PFMC in the market managed about 20 billion euros of eleven million workers. The Argentinean government defaulted on its debt in 2002, and a "haircut" of about 40 per cent was applied on public securities in the PFMC portfolios in a swap operation (Ferro and Romero, 2006).

The market of pension funds currently has 11 PFMC, but it registered 25 when it began to function in July 1994. Sixteen firms merged with other PFMC, and just one new entrant initiated operations after the introduction of the fully funded system.

The expenditures of PFMC include staff (some administrative but fundamentally commercial), software, premises, marketing, custody services, and a fee to the Federal Tax Administration for collection services. Until the reform of 2007, they also had to buy collective insurance for disability and survivor benefits from insurers insurance firms, but this arrangement was changed to a scheme whereby all PFMC apply a uniform fee of 0.3 per cent monthly on accumulated funds, and the risk is covered on a mutual basis. The commission for funds management remains, as in the 13 initial years of the reform, as a percentage of salary flows (which contributes 11 per cent monthly). Commissions were set at 1 per cent of wage flows in the reform of 2007 and the Executive Power can reduce this figure, but the law is imprecise about the commission resetting methodology.

The efficiency frontier analysis can be a useful tool for collecting efficiency gains and pass through these gains to the affiliates, using a similar process to the X factor in utilities industries in several countries (Sibley, 1989).

3. Literature Review

Although the existing literature is vast, only a small number of papers examine technical efficiency in pension funds, Garcia (2004). Braberman *et al*. (1999) analyse Argentinean pension funds management institutions using a Translog cost frontier model applied to quarterly data from 1997Q2 to 1998Q1**.** A changing number of pension funds management institutions are used in the analysis. Operating costs are regressed on three independent variables: the number of members/participants; the positive transferences/turnover (participant switching from one management institution to another) corrected in accordance with the proportion of participant employees of the pension funds management institution; and the profitability of the fund. Two dummy variables were included to take into account the changes in regulations after November 1997. Regulation was found to increase total costs but not to affect significantly relative efficiency.

Barrientos and Boussofiane (2005) analyse Chilean pension funds management companies carrying out Data envelopment analysis (DEA), and adopting a two-stage procedure. In the first stage, the DEA efficiency scores are calculated, and, in the second stage, they are regressed on appropriate variables. Specifically, they used two outputs (total revenue and the number of contributors), and three inputs (marketing and sales costs, office personnel and executive pay, and administration and computing costs). In the second stage, they estimated a regression of the DEA scores on a constant, market share, sales, the ratio of contributors to affiliates, and revenue. They concluded that there is no continuous trend towards an improvement in technical efficiency. An analysis of the determinants of efficiency shows that an increase in market share contributes positively to technical efficiency, whilst sales and marketing costs are detrimental.

Barros and Garcia (2006) analyse the same sample with four DEA models, concluding that traditional DEA models are unable to discriminate adequately between Portuguese pension funds. Finally, Barros and Garcia (2007) analyse the efficiency of a sample of Portuguese pension funds with a homogeneous stochastic frontier model. Therefore, the present paper, based on a stochastic frontier model, represents an original contribution to this area of literature. As explained above, the advantages are the disentangling of homogenous and heterogeneous variables in the frontier model.

A related literature on pension funds are Olivares ((2008), Marti, Matallín and Fernandez (2008) Dominguez-Barrero and López – Laborda (2007).

4. Theoretical Framework

Our framework is based on two strands of the literature: models of industry efficiency and stochastic frontier models.

4.1. Models of Industry Efficiency

Two competing models of industry efficiency exist in the literature. The strategic-group theory (Caves and Porter, 1977) explains differences in efficiency scores as being due to differences in the structural characteristics of units within an industry, which in turn lead to differences in performance. In the case of the pension funds management company, units with similar asset configurations pursue similar strategies with similar results in terms of performance (Porter, 1979). As there are different strategic options to be found in the different sectors of an industry, because of mobility impediments, not all options are available to each pension funds management company, causing a spread in the efficiency scores of the industry. By contrast, the resource-based theory (Barney, 1991; Rumelt, 1991; Wernerfelt, 1984) accounts for different efficiency scores in terms of heterogeneity of resources and capabilities on which retailers base their strategies. These may not be perfectly mobile across the industry, resulting in a competitive advantage for the best-performing retailers.

Purchasable assets cannot be considered to represent sources of sustainable efficiency. Indeed, critical resources are not available in the market. Rather, they are built up and accumulated on the pension funds management company's premises, their non-imitability and non-substitutability being dependent on the specific traits of their accumulation process. The difference in resources thus results in barriers to imitation (Rumelt, 1991) and in the pension fund managers' inability to alter their accumulated stock of resources over time. In this context, unique assets are seen as exhibiting inherently different levels of efficiency; sustainable profits are ultimately a return on the unique assets owned and controlled by the pension funds management company (Teece *et al*., 1997).

4.2 Stochastic Frontier Models

We adopt the stochastic cost frontier approach. This approach, first proposed by Farrell (1957), came into prominence in the late 1970s as a result of the work of Aigner, Lovell and Schmidt (1977), Battese and Corra (1977) and Meeusen and Van den Broeck (1977).

The frontier is estimated econometrically, and the difference between the inefficient units and the frontier is measured by the residuals. This is an intuitive approach based on traditional econometrics. By assuming that the residuals have two components (noise and inefficiency), we can obtain the stochastic frontier model. Therefore, the main issue is the decomposition of the error terms. Let us present the model more formally. The general frontier cost function proposed by Aigner *et al*. (1977) and Meeusen and van den Broeck (1977) is the following:

$$C_{it} = C(\mathbf{x}_{it}).e^{v_{it}+u_{it}} \; ; \;\; \mathrm{i}=1,2,\ldots \mathrm{N}, \mathrm{t}=1,2,\ldots T \qquad (1)$$

where C_{it} and $\mathbf{x}_{it}$ represent a scalar cost and a vector of variables including the input prices and the output descriptors present in the cost function of the decision-unit *i* under analysis in the *t*-th period, respectively. The error term $\varepsilon_{it} = v_{it} + u_{it}$ has two components: u_{it}, representing technical inefficiencies and assumed to be positive and normally distributed with zero mean and variance σ_u^2, and v_{it}, namely the traditional error term of econometric models, assumed to be independently and identically distributed, representing the effect of random shocks (noise) and being independent of u_{it}. The positive disturbance u_{it} has a half-normal independent distribution truncated at zero, indicating that the cost for each funds management company must lie on or above its cost frontier. This implies that any deviation from the frontier is caused by management factors controlled by the pension funds management company.

Using σ_v^2 and σ_u^2 to denote the variance of the traditional error term *v* and the inefficiency term *u*, respectively, the total variance of the error term is given by $\sigma^2 = \sigma_v^2 + \sigma_u^2$. The contributions of the error and inefficiency terms to the total variance are $\sigma_v^2 = \sigma^2 /(1+\lambda^2)$ and $\sigma_u^2 = \sigma^2 \lambda^2 /(1+\lambda^2)$, respectively, where λ provides an indication of the relative contribution of *u* and *v* to $\varepsilon = u + v$ and is defined as the ratio of the standard deviations of *u* and *v*, $\lambda = \frac{\sigma_u}{\sigma_v}$.

Because estimation procedures of equation (1) yields only the residual, ε, but not the inefficiency term *u,* the latter must be calculated indirectly (Greene, 2003). In the case of panel data, as in this paper, Battese and Coelli (1988) use the conditional expectation of u_{it}, conditioned on the realised value of the error term, $\varepsilon_{it} = (v_{it} + u_{it})$, as an estimator of u_{it}. In other words, $E\lfloor u_{it} / \varepsilon_{it} \rfloor$ is the mean productive inefficiency for the *i*th pension funds management company at any time *t*.

However, inefficiency can also be due to heterogeneity of the firms. To take this into account, we consider the following random effects model:

$$c_{it} = (\beta_0 + w_i) + \mathbf{\beta' x}_{it} + v_{it} + u_{it} \qquad (2)$$

where the variables are in logs and w_i is a time invariant, a firm-specific random term that captures company heterogeneity. To estimate the model, the identification condition requires the random components of the coefficients to be uncorrelated with the explanatory variables. A second issue concerns the stochastic specification of the inefficiency term *u*. For the latter, we assume a Half-Normal distribution. For the estimation of the parameters, we construct the likelihood function using the approach proposed by Greene (2004, 2005).

Under the previous assumptions, the conditional density of c_{it} given w_i is:

$$f(c_{it} \mid w_i) = \frac{2}{\sigma}\phi\left(\frac{\varepsilon_{it}}{\sigma}\right)\Phi\left(\frac{\lambda\varepsilon_{it}}{\sigma}\right) \ , \ \varepsilon_{it} = c_{it} - (\beta_0 + w_i) - \boldsymbol{\beta}'\mathbf{x}_{it} \quad (3)$$

where ϕ is the standard normal density function, and Φ the respective cumulative distribution function. The parameters λ and σ^2 were defined before.

Conditional on w_i, the T observations for company i are independent and, therefore, the joint density for the T observations is

$$f(c_{i1},...,c_{iT} \mid w_i) = \prod_{t=1}^{T}\frac{2}{\sigma}\phi\left(\frac{\varepsilon_{it}}{\sigma}\right)\Phi\left(\frac{\lambda\varepsilon_{it}}{\sigma}\right) \quad (4)$$

The unconditional joint density is obtained by integrating the heterogeneity out of the density,

$$L_i = f(c_{i1},...,c_{iT}) = \int_{w_i}\prod_{t=1}^{T}\frac{2}{\sigma}\phi\left(\frac{\varepsilon_{it}}{\sigma}\right)\Phi\left(\frac{\lambda\varepsilon_{it}}{\sigma}\right)g(w_i)dw_i \quad (5)$$

The log likelihood, $\sum_i \log L_i$, is then maximised with respect to the parameters β_0, $\boldsymbol{\beta}$, σ, λ and any parameters appearing in the distribution of w_i. The integral in (5) will be intractable. However, if we rewrite equation (5) in the equivalent form:

$$L_i = f(c_{i1},...,c_{iT}) = E_{w_{ii}}\left[\prod_{t=1}^{T}\frac{2}{\sigma}\phi\left(\frac{\varepsilon_{it}}{\sigma}\right)\Phi\left(\frac{\lambda\varepsilon_{it}}{\sigma}\right)\right] \quad (6)$$

we can compute the log likelihood by simulation. Averaging the function given by (6) over sufficient draws from the distribution of w_i will produce a sufficiently accurate estimate of the integral in (5) to allow estimation of the parameters (see Gourieroux and Monfort, 1996 and Train, 2003). The simulated log likelihood is

$$\log L_s(\beta_0, \mathbf{\beta}, \lambda, \sigma, \theta) = \sum_{i=1}^{N} \log \frac{1}{R} \sum_{r=1}^{R} \left[\prod_{t=1}^{T} \frac{2}{\sigma} \phi\left(\frac{\varepsilon_{it} \mid w_{ir}}{\sigma} \right) \Phi\left(\frac{\lambda \varepsilon_{it} \mid w_{ir}}{\sigma} \right) \right] \qquad (7)$$

where θ includes the parameters of the distribution of w_i and w_{ir} is the *r*th draw for observation *i* (see Kumbhakar and Lovell, 2000).

5. Data and results

5.1 Data

To estimate the cost frontier, we used a sample of Argentinean pension funds companies, organized in a balanced panel with quarterly data from 1996Q2 to 2007Q1 (10 companies × 43 quarterly observations = 430 observations). Frontier models require the identification of inputs (resources) and outputs (transformation of resources). Several criteria can be used. One empirical criterion is data availability. Literature surveys can also be taken into account. The last criterion for measurement selection is the professional opinions of managers in the industry. In this paper, we adopt all three criteria.

Using the available data, we estimate a stochastic Translog cost function (see Varian, 1987). We have transformed the variables according to the description column in Table 2. We adopt the traditional log-log specification to allow for the possible non-linearity of the frontier.

PLACE TABLE 1 HERE

The rationale for using prices of capital-management services and capital-premises ones is the following: pension funds management companies use information to increase the return on their portfolios by shifts in its composition, and premises to develop their administrative and commercial activity. Therefore, to capture the specificity of this activity, we need to disentangle these two types of capital.

5.2 Results

We estimate a stochastic Translog cost function with three input prices (one price of labour and two prices of capital), and two outputs (the number of participants and the value of the funds managed). M&A is a dummy variable that is one for pension funds management companies that were involved in mergers and acquisitions in the period and zero otherwise. Share is the market share of the unit analyzed.

This cost frontier model is specified as an Error Components Model, following Coelli, Rao and Battese (1998), to account for causes of efficiency controlled by the management (labour, capital, the number of participants, the value of funds, and commissions). The regularity conditions require that the cost function be linearly homogeneous, non-decreasing and concave in input prices (Cornes, 1992). The model specification, Brown *et al*. (1979) is the following:

$$\ln(Cost_{it}) = \tau_0 + \tau_1 t + \frac{1}{2}\tau_2 t^2 + \sum_{k=1}^{m}\alpha_k \ln y_{kit} + \sum_{j=1}^{n}\beta_j \ln w_{jit} +$$
$$\frac{1}{2}\left[\sum_{k=1}^{m}\sum_{r=1}^{m}\pi_{kr}\ln y_{kit}\ln y_{rit} + \sum_{j=1}^{n}\sum_{s=1}^{n}\delta_{js}\ln w_{jit}\ln w_{snt}\right] + \sum_{k=1}^{m}\sum_{j=1}^{n}\theta_{kj}\ln y_{kit}\ln w_{jit} + (V_{it} - U_{it})$$
(8)

The specification of the cost function follows microeconomic theory (Varian, 1987). The costs are regressed in input prices (w) and output descriptors (y), *t* is a time trend, *v* is a random error which reflects the statistical noise and is assumed to follow a normal distribution centred at zero, while *u* reflects inefficiency and is assumed to follow a half-normal distribution. This is the cost frontier model, known in Coelli, Rao and Battese (1998) as the Error Components Model, as it accounts for causes of efficiency controlled by management.

We have chosen a flexible functional form to avoid imposing unnecessary *a priori* restrictions on the technologies to be estimated. Each explanatory variable is divided by its geometric mean. In this way, the Translog can be considered an approximation to an unknown function and the first order coefficients can be interpreted as the cost elasticities evaluated at the sample geometric mean.

Table 2 presents the results obtained for the stochastic frontier, under the assumption of a Half-Normal distribution. For comparative purposes a non-stochastic frontier model and a traditional cost function are estimated. A GAUSS program was used for the estimation.

PLACE TABLE 2 HERE

Having estimated two competing Translog models — the homogeneous Translog frontier model and the heterogeneous Translog frontier model — the Likelihood test enables the selection of the most adequate functional form, which is the heterogeneous frontier model in the present case. The Likelihood test is a statistical test of goodness of fit between two competing models. It compares models with a different number of parameters. Comparing the models, the Likelihood test has a chi-square distribution higher for the heterogeneous frontier than the standard frontier. Therefore, we can conclude that the Heterogeneous frontier model better describes the data set than the Translog model.

We also compute the Chi-square statistic that serves as a general specification test of adding variables to model. Therefore, we can conclude that the addition of variables by the Heterogeneous frontier model is supported by the test, signifying that the Heterogeneous frontier better describes the data set. Finally, to decide whether the frontier model is better than the cost function, the sigma square and lambda variables of the cost frontier model are statistically significant, which means that a traditional cost function is unable to capture adequately all dimensions of the data set.

Moreover, the random cost function specified above fits the data well, as both the R-squared value and the overall F-statistic from the initial ordinary least-squares estimation used to obtain the starting values for the maximum-likelihood estimation are higher than the standard cost function, presented for comparative purposes.

The variables have the expected signs since all price elasticities are positive. The costs increase with the trend, but at a decreasing rate, signifying that there were no technological improvements driving the costs down during the period. However, instead of imposing homogeneity in prices, we have tested it and the hypothesis that the cost function is homogeneous in prices is accepted for both estimated cost frontiers. Furthermore, the cost increases with the price of factors and with the outputs. These are statistically significant coefficients. However, the price of capital-premises despite being positive is statistically insignificant on the standard frontier, but turns out to be statistically significant in the random frontier models. Thus, the random frontier better captures the dynamics in this data set. The significant random parameters vary across the sample. The identification of the mean values of random parameters means that the price of capital-premises and the number of participants are heterogeneous and, therefore, a policy to control costs has to take into account the heterogeneous characteristic of the sample. So, a common policy can be defined for the sample based on the average values of the homogeneous variables, but no common policy can achieve all clusters identified in heterogeneous variables.

5.3 Efficiency Scores

Table 4 presents the results of the time-invariant efficiency scores computed from the residuals. Technical efficiency is achieved, in a broad economic sense, by the unit which allocates resources without waste, and thus refers to a situation on the frontier. Units with a score equal to one are on the frontier, while those with a score lower than one are above the cost frontier of best practices. The value of waste is measured by the difference between one and the score.

The cost efficiency is defined as the ratio between the minimum cost and the actual cost, so it is defined between 0 and 1. Therefore, the closer to 1, the more efficient the pension funds are. Since the dependent variable is in logarithms, it is calculated as:

$$EC = exp(-\hat{u}) \qquad (9)$$

where the estimated value of the inefficiency ($\hat{u}$) is separated from the random error term ($\hat{v}$) using the Jondrow *et al*. (1982) formula.

PLACE TABLE 3 HERE

The Heterogeneous frontier model displays slightly higher efficiency scores than the homogenous frontier, signifying that the homogenous frontier confounds heterogeneity with efficiency, Greene (2004, 2005).

6. Discussion and Conclusion

This paper has adopted a random frontier model (Greene 2004, 2005) to analyse the technical efficiency of the Argentinean pension funds with a balanced panel and quarterly data from 1996Q2 to 2007Q1. The main innovation in our analysis is to take into account heterogeneity in the model. Two types of heterogeneity are presented in the random frontier model — the observed heterogeneity, related to observed attributes of pension funds management companies, and the unobserved heterogeneity, related to unobserved attributes. The observed heterogeneity is captured by entering the relevant attributes of the pension funds management company in the cost function and the unobserved heterogeneity is captured entering random terms. This procedure improves both efficiency of estimation and inference. Benchmarks are obtained for improving the operations of pension funds management companies that perform poorly.

Our empirical findings suggest the following: first, different policies for the different segments of the Argentinean pension funds by heterogeneous variables are needed. The model does not identify how many clusters exist in the sample and only identifies their heterogeneous nature. However, the Orea and Kumbhakar (2004) latent frontier model can be applied to identify the clusters. Second, the cost parameters (factor prices and output descriptors) have the theoretical expected estimates (Varian, 1976). Third, the price of capital-premises and the number of participants are heterogeneous among the Argentinean pension funds management companies. Fourth, M&A is positive and statistically significant, meaning that embarking on mergers and acquisitions increases costs. This is an intuitive result. Fifth, Share is negative and statistically significant, meaning that market share contributes to decreasing costs, probably owing to the economies of scale related to it. Finally, the rankings are displayed for the companies analysed.

How do we explain these rankings? The rankings are explained by the relative performance of the companies analysed in terms of inputs and outputs used. While there are different strategic options among sectors of an industry, mobility impediments imply that not all options are available to every industry, inducing a spread of the efficiency scores in the industry. However, the mobility barriers between the pension funds affect the degree of competition within the industry and in this way, the structure within the industry influences pension funds performance (Porter, 1979), inducing the spread of efficiency scores. The resource-based view (Rumelt, 1991; Wernerfelt, 1984) holds that pension funds management companies are heterogeneous in relation to the resources and capabilities on which they base their strategies. These resources and capabilities may not be perfectly mobile across the industry, which results in a competitive advantage for the best-performing companies (Barney,1991). Purchasable assets cannot constitute sources of sustainable profits because critical resources are not available in the market. Critical resources are those which are built and accumulated on the premises of the pension funds management companies, their non-imitability and non-substitutability being dependent on specific traits of their accumulation process. The difference in resources thus results in barriers to imitation (Rumelt, 1991) and companies' inability to alter their accumulated stock of resources over time. In this context, unique assets are seen as exhibiting inherently differentiated levels of efficiency; sustainable profits are ultimately a return on the unique assets owned and controlled by the pension funds management companies. Therefore, we can conclude that different theoretical frameworks can explain the spread of efficiency scores among the Argentinean pension funds management companies analysed.

Policy implications arising from the results are that benchmarking analyses are needed to encourage the Argentinean pension funds management companies to increase relative efficiency. The improvement should be based on the balance of inputs and outputs and increased market share.

This paper has one limitation related to the data set. As far as the data set is concerned, the use of quarterly data samples from Argentinean pension funds companies is questionable. Moreover, the data set is short so the conclusions are limited. For the latter to be more generalized, a larger panel data set would be necessary. Further research would confirm the present results.

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Table 1: Descriptive Statistics of the Data: 1996Q2 to 2007Q1

Variable	Description	Minimum	Maximum	Mean	Standard deviation
Log Cost	Logarithm of operational costs in pesos at constant prices 1999=100	4.649	7.100	5.673	0.510
Log PL	Logarithm of price of labour, measured by dividing total wages by the number of workers	3.251	4.153	3.766	0.167
Log PK1 - management services	Logarithm of price of capital-management services, measured by dividing the fixed plus variable commissions by the value of the pension funds under management	0.0009	0.033	0.007	0.006
Log PK2 - premises	Logarithm of price capital-premises, measured by dividing the expenditure on equipment and premises by the number of premises	3.461	5.721	4.687	0.454
Log participants (affiliates)	Logarithm of the number of participants who are all participants including those who are currently not contributing because of unemployment or for another reason;	4.311	6.369	5.527	0.536
Log fund	Logarithm of the value of the funds at constant pesos	7.230	10.217	8.966	0.689
M&A	Dummy variable which is one for companies involved in Mergers and Acquisitions during the period	0	1	0.31	0.46
Share	Market share of the companies	0.001	0.27	0.08	0.07

Table 2: Stochastic Translog Panel Cost Frontier of Argentinean Pension Fund Management Companies, 1996Q2 to 2007Q1 (dependent variable: Log Cost)

Variables	Random Frontier model	Non-Random Frontier Model
Non-random parameters	Coefficients (t-ratio)	Coefficients (t-ratio)
Constant	1.038 (5.480)	1.218 (4.219)P
Trend	0.197 (3.219)*	0.1523 (2.945)*
Log PL	0.249 (4.610)*	0.286 (3.219)*
Log PK1	—	0.318 (1.216)*
Log PK2	0.203 (3.219)*	0.167 (4.034)*
Log Participants (affiliates)	—	0.037 (3.073)*
Log Fund	0.728 (3.219)	0.543 (2.963)*
1/2Trend^2	-0.338 (-3.256)	-0.138 (1.054)
1/2Log PL^2	0.680 (2.232)**	0.582 (3.219)*
1/2Log PK1^2	0.138 (1.219)	0.143 (1.037)
1/2Log PK2^2	0.219 (1.035)	0.175 (1.012)
1/2Log participants^2	0.136 (3.032)*	0.128 (4.219)*
1/2Log Fund^2	0.057 (3.214)*	0.031 (2.567)**
Trend*Log Pl	0.021 (1.247)	0.023 (2.535)**
Trend*log PK1	0.004 (1.014)	(0.005 (0.028)
Trend*Log PK2	0.002 (2.021)	0.001 (1.043)
Trend*Log Participants	0.012 (3.218)*	0.022 (3.216)*
Trend*Log Fund	0.035 (1.218)	0.027 (2.214)
Log PL*Log Pk1	0.136 (1.893)	0.127 (1.031)
Log PL*Log PK2	-0.219 (-2.126)**	-0.167 (-3.023)*
Log PL*Log Participants	-0.128 (-0.129)	-0.118 (-1.021)
Log PL*Log Fund	0.197 (2.219)**	0.174 (1.195)
LogPK1*LogPK2	0.129 (4.129)*	0.269 (2.045)
LogPK1*Log Participants	0.271 (4.219)*	0.319 (3.127)*
LogPK1*Log Fund	-0.571 (-1.712)**	-0.484 (-1.032)
LogPK2*log Participants (see caveat above)	-0.257 (-2.783)*	-0.319 (-1.784)
LogPK2*Log Fund	0.217 (3.129)*	0.417 (2.985)*
Log Participants* Log Fund	1.214 (2.219)**	1.028 (3.127)*
M&A	0.028 (3.731)*	0.067 (4.894)*
Share	-0.026 (-3.051)	-0.019 (-3.954)
Mean for Random Parameters		
Log PK1	0.4401 (5.141)*	—
Log Participants	0.0228 (3.680)*	—
Scale Parameters for Dists. Of Random Parameter		
Log PK1	0.251 (3.672)	—
Log Participants	0.532 (4.512)	—
$\sigma = \left[\sigma_V^2 + \sigma_U^2\right]^{1/2}$	0.222 (4.237)	0.673 (3.894)*
$\lambda = \sigma_U / \sigma_V$	0.522 (12.321)	0.618 (4.219)
Log likelihood	84.741	81.342
Chi Square (prob.)	169.48 (0.001)	158.31 (0.001)
Observations	430	430

t Statistics in parentheses fall below the parameters; those followed by * are significant at 1% level.

Table 3. Average Cost Efficiency of Argentinean Pension Fund Management Companies across the Quarterly Periods Analysed (1996Q2 to 2007Q1)

Nobs	Units	Heterogeneous Scores	Homogenous Scores
1	Arauca Bit	0.757	0.612
2	Consolidar	0.927	0.812
3	Profesión	0.931	0.845
4	Futura	0.951	0.902
5	Previsol	0.963	0.922
6	Máxima	0.964	0.925
7	Nación	0.976	0.912
8	Orígenes	0.996	0.932
9	Prorrenta	0.999	0.943
10	Unidos	1	1
—	Mean	0.946	0.881
—	Median	0.964	0.917
—	Std. Dev	0.072	0.108