Analysing the Performance of the Pension Fund Industry with a Stochastic Frontier Model: A Case Study for Portugal

Carlos Pestana Barros and Maria Teresa Medeiros Garcia

Instituto Superior de Economia e Gestão, Technical University of Lisbon, Rua Miguel Lupi, 20, Lisbon 1249-078, Portugal.

E-mails: Cbarros@iseg.utl.pt, mtgarcia@iseg.utl.pt

The enhanced role of occupational and personal pension plans in providing retirement income raises issues concerning efficiency and performance.¹ This paper evaluates the performance of Portuguese pension fund management companies from 1994 to 2003, using a Cobb–Douglas stochastic cost frontier model to generate their efficiency scores. We conclude that the price of labour, the price of capital-management services and the price of capital-premises, as well as profits, the number of participants, the number of closed funds and the decision whether or not to manage open funds all play a major role in the efficiency of such companies. We also find that the efficiency scores are mixed. The managerial implications of these results are derived.

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Introduction

The financial sustainability of the social security system is of crucial importance to European countries today, due to the increase in life expectancy and declining fertility rates.² The strengthening of the second pillar based on enterprise funding and of a further development of third pillar resources, based on individual funding – given the issue of the future financing of pensions – has brought to the forefront questions as to the regulation and supervision of pension funds, the administrative costs of pension funds, and the investment performance of pension funds.³ Privately managed schemes are usually not required to accept below-market returns, having incentives to allocate capital to stocks and bonds that offer the best risk–yield combinations, whether these securities are public or private. They can benefit from international diversification of investments and international managerial expertise.⁴ However, some problems may appear, in particular workers and employers might not have enough information at their disposal in order to choose capable investment managers, misallocating capital

¹ World Bank (1994).

² Davis (2004).

³ World Bank (1994), Holzmann and Stiglitz (2001), and OECD (2001, 2003).

⁴ Davis (1995).

and leaving some of the elderly with inadequate pensions. To avoid this problem, privately managed pension funds must be regulated by government.⁵ Another problem is that privately managed funds may have higher marketing costs and may not benefit from economies of scale as much as publicly managed funds. By contrast, public funds may have less incentive to achieve cost efficiency than their private counterparts.

In this paper, we use an econometric frontier model to analyse the efficiency performance of Portuguese pension fund management companies. Using accounting data obtained from the supervisory authority for insurance and pension funds in Portugal, the Portuguese Insurance Institute (ISP), the paper expands on previous research by comparing the efficiency scores of pension fund management companies with the aid of a stochastic cost frontier model. Previous research into the efficiency of this industry has relied either on DEA⁶ or on a stochastic cost frontier model,⁷ but these models have some caveats, which will be referred to in the literature survey. Generally speaking, considering the contemporary importance of these institutions, there has been scant research in this area.

The motivation for the present research stems from several issues related to the management of pension funds. Firstly, comprising a variable number of institutions involved in pension fund management, this sector has embarked on a wave of mergers and acquisitions (M&A) which has not yet reached its conclusion. Such dynamics signify that the market has not yet matured, and therefore that competition is strong. Efficiency is thus a major issue in terms of competition in this industry.⁸

Secondly, the units operating in the field are highly heterogeneous, due to such factors as ownership status (public versus private) and their size, measured by the number, value and type of pension funds managed. Such heterogeneity means that there are different management strategies with different market rewards.⁹ These characteristics may affect the efficiency of the industry.

Third, the taxation of long-term and retirement savings products has changed substantially in recent years, because of Portugal's public deficits and the European Union's restrictions on public debt and budget deficits. This policy directly affects pension fund management companies and may therefore affect the relative efficiency of pension funds.

Finally, pension funds are usually evaluated on the basis of their stock returns,¹⁰ a procedure that cannot be used in the present case, as the management funds companies analysed are not quoted on the stock market. Therefore, for non-quoted pension funds, frontier models are a way to overcome the difficulty in benchmarking them.

The relative efficiency of pension funds may also be affected by differences in the structural characteristics of such funds within the industry, leading to differences in performance due to different strategies¹¹ or different resources.¹²

⁵ OECD (2003).

⁶ Barrientos and Boussofiane (2005).

⁷ Braberman *et al.* (1999).

⁸ Barrientos and Boussofiane (2005).

⁹ Garcia (2004).

¹⁰ Bauer *et al.* (2005).

¹¹ Caves and Porter (1977).

¹² Barney (1991).

Apart from the paper by Braberman *et al.*,¹³ we are not aware of any other paper using stochastic frontier models to analyse pension fund management companies. The procedure adopted in this paper allows for the handling of the multiple outputs involved in the activity of pension fund management companies, namely labour, capital, profits and the type of fund under their management. In addition, it overcomes the problems that usually occur in the measurement of administrative costs and the efficiency/effectiveness of a pension scheme.¹⁴

The paper is organised as follows: in the following section, we describe the institutional setting; in the next section, we survey the literature on the topic; then we present the theoretical framework; in the following section, the data is characterised; in the penultimate section, the results and the efficiency rankings are presented; and, finally, in the last section, we discuss the results and present the conclusions. In an appendix, we present an algebraic formulation of the theoretical framework.

Institutional setting

The Portuguese fund management companies are similar to other pension fund management institutions elsewhere in Europe and therefore we restrict the contextual setting description to specific issues. A detailed characterisation of the Portuguese pension funds market can be found in Garcia.¹⁵

Pension funds have now been in existence in Portugal for almost 20 years. The growth registered since then has been considerable. Consequently, pension funds have assumed a powerful position as one of the major sources of institutional investment, playing a leading role in the process of long-term capital formation, in view of the time lag before the liquidation of future pensions. Indeed, the composition of their asset portfolios reflects this fact, in spite of the obligation to abide by the rules on portfolio composition stipulated by law. In fact, the pension fund industry represented 12.4 per cent of Portugal's GDP in 2003.

The recognition that the maintenance of a high level of social protection must be based on a multi-pillar system has led, in Portugal as in many OECD countries, to the creation of conditions for the development of privately managed occupational pension plans and personal saving accounts.¹⁶ Additionally, to ensure the system's financial sustainability beyond 2050, it seems necessary to implement further-reaching modifications including the introduction of a mandatory complementary pension scheme, to be entered into either individually or in groups, combined with the establishment of a ceiling for the State pension.¹⁷ Working beyond the age of 60 has also been recommended, although this solution has caused lively debate in several EU Member States.¹⁸

The first legislation governing pension funds was passed in 1985, establishing the legal regime and empowering the ISP with the control and supervision of such funds.

¹³ Braberman *et al.* (1999).

¹⁴ World Bank (1994) and Holzmann and Stiglitz (2001).

¹⁵ Garcia (2004).

¹⁶ World Bank (1994).

¹⁷ Silva *et al.* (2004).

¹⁸ Reday-Mulvey (2005).

Table 1 Number of fund management institutions

<i>Fund management institutions</i>	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total	26	28	31	29	33	32	31	30	28	27
<i>Number of insurance companies</i>	11	12	14	12	17	17	17	17	15	14
% of insurance companies in total	42%	43%	45%	41%	52%	53%	55%	57%	54%	52%
Number of pension funds managed by insurance companies	81	81	81	82	86	89	90	86	80	75
% of pension funds managed by insurance companies in total	37%	36%	34%	35%	37%	37%	37%	36%	35%	33%
<i>Specialist fund managers</i>	15	16	17	17	16	15	14	13	13	13
% of specialist fund managers in total	58%	57%	55%	59%	48%	47%	45%	43%	46%	48%
Number of pension funds managed by specialist fund managers	136	145	156	155	147	149	154	150	151	154
% number of pension funds managed by specialist fund manager in total	63%	64%	66%	65%	63%	63%	63%	64%	65%	67%

Source: Boletins de Fundos de Pensões, 1995–2003, ISP.

During this 20-year period, pension fund regulation has aimed to consolidate the funds' role as the privileged vehicle for the private complementary financing of the costs of covering the social risks associated with retirement, as well as to respond to the needs of the fund management institutions in their various functions and the concerns of all those involved in the process. In Table 1, we present the number of pension fund management companies over a 10-year period from 1994.

The number of funds has remained relatively stable in the period.

When considering the value of all pension funds under management, we can observe that specialist fund managers play a dominant role in the activity in comparison with insurance companies (Table 2). They were responsible for funds worth 15.719 thousand million euros in 2003.

Ensuring financial soundness of occupational and personal plans is a major concern of government regulation.¹⁹ In Portugal, investment portfolios are regulated to prevent excessively risky investments and problems of moral hazard. The pension funds' asset portfolio composition shows the large proportions held in government securities, bonds and shares²⁰ and reflects the ceilings and rules established (Table 3).

¹⁹ World Bank (1994) and Holzmann and Stiglitz (2001).

²⁰ The former are viewed as an important component, both as an appropriate instrument with which to guard against inflation and as a source of growth in the fund's value, while the latter enjoy advantages of diversification of systematic risk.

Table 2 Amounts in pension funds by type of fund management institution

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Amounts in pension funds	4,923,749	6,906,406	8,231,896	10,060,399	11,577,827	12,911,158	13,766,550	14,808,000	15,880,000	16,283,000
Managed by insurance companies	478,252	489,271	280,075	368,562	385,685	517,099	532,210	510,000	521,000	564,000
%	10%	7%	3%	4%	3%	4%	4%	3%	3%	4%
Managed by specialist fund managers	4,445,496	6,417,135	7,951,821	9,691,838	11,192,137	12,394,057	13,234,340	14,298,000	15,358,000	15,719,000
%	90%	93%	97%	96%	97%	96%	96%	97%	97%	96%

Unit: thousand euros.

Source: Boletins de Fundos de Pensões, 1995–2003, ISP.

Table 3 Asset composition of pension funds

<i>Composition of assets</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1997</i>	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>
1 – Assets in Portuguese currency	4,797,388	6,509,607	7,945,591	9,292,006	9,654,553	11,714,523	12,523,757	13,814,541	14,872,681	15,024,270
%	100%	96%	96%	94%	86%	92%	91%	93%	96%	93%
1.1 – Government securities	1,842,455	2,573,413	2,971,748	3,177,921	2,964,954	2,625,441	2,968,391	3,962,227	4,029,168	3,415,374
%	38%	38%	36%	32%	26%	21%	22%	27%	26%	21%
1.2 – Treasury bills and CLIPs	0	326,802	195,145	144,197	154,019	0	0	0	0	0
%	0.0%	4.8%	2.4%	1.5%	1.4%	0%	0%	0%	0%	0%
1.3 – Bonds/commercial paper ^a	1,383,072	1,959,508	2,398,160	2,747,479	2,720,409	3,153,371	3,154,233	3,182,171	3,607,801	3,119,244
%	29%	29%	29%	28%	24%	25%	23%	21%	23%	19%
1.4 – Investment fund participation units	166,678	165,825	435,705	686,226	703,086	857,376	1,452,649	1,698,252	1,667,501	2,459,009
%	3%	2%	5%	7%	6%	7%	11%	11%	11%	15%
1.5 – Shares/participated securities	498,853	566,325	779,621	1,460,241	1,990,623	3,198,683	2,725,472	2,576,281	2,337,448	2,972,555
%	10%	8%	9%	15%	18%	25%	20%	17%	15%	18%
1.6 – Loans	145	3,931	209	200	214	144	241	143	285	77
%	0.0%	0.1%	0.0%	0.0%	0.0%	0%	0%	0%	0%	0%
1.7 – Land and buildings	192,471	259,535	315,121	345,592	430,552	553,965	694,584	870,563	1,365,290	1,591,588
%	4%	4%	4%	3%	4%	4%	5%	6%	9%	10%
1.8 – Deposits, cash, other ^b	713,715	654,268	849,882	730,150	690,695	1,325,544	1,528,185	1,524,905	1,865,187	1,466,423
%	15%	10%	10%	7%	6%	10%	11%	10%	12%	9%
2 – Assets in foreign currency	0	261,789	353,688	633,254	1,632,585	1,072,320	1,242,697	1,011,740	679,131	1,146,359
%	0%	4%	4%	6%	14%	8%	9%	7%	4%	7%
Total	4,797,388	6,771,396	8,299,279	9,925,260	11,287,138	12,786,843	13,766,453	14,826,281	15,551,812	16,170,629
%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Unit: thousands euros.

^aIncluding bonds quoted and non-quoted on OECD Member-States' stock exchanges.

^bIncluding venture capital funds.

Source: Boletins de Fundos de Pensões, 1995 to 2000, ISP.

Portfolio distribution and the fund management process are the key determinants of returns to pension funds. On the other hand, high administrative costs of pension funds reduce investment returns, thus lowering the pension in the case of defined-contribution funds and increasing the cost to the sponsor for defined benefit.²¹ Data both on rates of return and on administrative costs of pension funds are not available for many countries, including Portugal.

Although the number of specialist management companies varied over the period 1994–2003, it is still possible to consider a balanced sample of 12 companies. Table 4 displays some characteristics of the selected sample used in the analysis.

The companies considered here are the result of merger and acquisition processes. In the period considered, we registered the events listed in Table 5.

On the other hand, only two companies manage pension funds that represent the assets of public enterprise pension plans. These are SGFP do Banco de Portugal, S. A. and CGD Pensões – SGFP, S. A. In addition, during the period studied, several amendments were introduced into the system of taxation. Initially, the contributions made by sponsors enjoyed substantially favourable fiscal treatment: they were entitled to twice the amount of their contributions as tax-deductible expenses. Since then, this possibility for tax deduction has been greatly reduced.

Literature survey

The evaluation of the performance of pension funds is currently based on the measurement of investment performance ratios, which provide information on a variety of issues: how well a fund is doing in meeting its investment goals; whether current investment policy is helping to meet the goals of the pension plan; insights into the general competence of an investment manager; and how to improve the performance of pension schemes.²² Such evaluation further entails calculating the return on investment, judging the correct ways to measure and adjust for risk, assessing how benchmarks should be chosen or constructed, and deciding the components of the investment portfolio.²³ Investment return calculations are sensitive to the various choices that the analyst or presenter of the data may make, namely the time period chosen, the timing of cash inflows and outflows and the use of a time-weighted rate of return or value-weighted rate of return. These estimates of returns must be combined with estimates of risk, such as the Sharpe measure,²⁴ the Treynor measure,²⁵ or the Jensen measure.²⁶ Frequently, the use of a standard benchmark is not necessarily the best solution. Additionally, in order to understand

²¹ Davis (1995).

²² Logue and Rader (1998).

²³ The exposure of the fund to various market segments, the quality of the selection of assets, and the timing of capital movements between asset classes (Brinson *et al.*, 1991).

²⁴ Sharpe (1992, 1966).

²⁵ Treynor (1965).

²⁶ Jensen (1969).

Table 4 Management companies in 2003

<i>Management companies</i>	<i>Number of funds managed</i>	<i>Participants/ beneficiaries (%)</i>	<i>Value of pension funds/number of workers (euros)</i>	<i>Ratio profits/ stock in 2002 (euros) (%)</i>
Banif Açor Pensões – SGFP, S. A.	8	658	62,683.53	1.0
BBVA Fundos – SGFP, S. A.	6	744	54,120.46	17.1
BPI Pensões – SGFP, S. A.	28	144	116,611.1	40.1
CGD Pensões – SGFP, S. A.	10	211	265,500.8	40.7
ESAF – SGFP, S. A.	12	262	44,123.52	6.8
Futuro – SGFP, S. A.	17	552	30,422.34	155.1
Pensõesgere – SGFP, S. A.	43	219	141,871.5	4.1
Previsão – SGFP, S. A.	3	127	69,438.55	13.4
Santander Pensões – SGFP, S. A.	4	105	434,819.7	9.0
SGF – SGFP, S. A.	13	569	5,478.498	0.3
SGFP do Banco de Portugal, S. A.	1	79	26,874.33	6.0
Unipensão – SGFP, S. A.	8	218	14,157.21	2.8

Source: Relatório do Sector Segurador e Fundos de Pensões, 2003, ISP.

Table 5 Merger and acquisition processes in 1994–2003

<i>Year</i>	<i>Event</i>	<i>Type</i>
2002	Winterthur Pensões	Ends activity
2002	Pedro Arroja – SGFP, S. A. ^a	New company that only manages one retirement pension plan
2000	Santander Pensões – SGFP, S. A. = Santander Pensões – SGFP, S. A. + BSN	Acquisition
2000	Winterthur Pensões ^b	New company that only manages one retirement pension plan and one stock pension plan
1999	Banif Açor Pensões – SGFP, S. A. = Açor Pensões + SGM	Merger
1999	Pensõesgere – SGFP, S. A. = Pensõesgere – SGFP, S. A. + Mello Activos Financeiros	Acquisition
1999	Santander Pensões = MC Pensões	New name
1998	BPI Pensões – SGFP, S. A. = BPI Pensões – SGFP, S. A. + Fungest	Acquisition
1997	Pensõesgere – SGFP, S. A. = Vanguarda + Praemium	Merger
1998	MC pensões = Totta Pensões	New name
1997	Mello Activos Financeiros = M Reforma	New name
1995	BSN	New company
1995	Totta Pensões	New company

^aNot included in our sample.

^bNot included in our sample.

actual performance, it is necessary to determine the components of funds: exposure to a benchmark, market timing, or selection of securities.

Although improving the performance of a pension fund can increase the likelihood that the promised or expected benefits will materialise, reducing the financial burden borne by the sponsor in the case of DBPs, there are some important limitations in the measurement of performance. Survivorship bias²⁷ is one of these. On the other hand, data suggests that actively managed pension funds have not performed as well as unmanaged passive portfolios, or as well as actively managed mutual funds.²⁸ Investment performance may also be a consequence of regulatory incentives. Del Guercio²⁹ offers evidence to support the contention that the constraints imposed by prudent investor laws bias pension funds towards investing in what the courts have found to be prudent investments, because of the fear of litigation.

Some evidence shows important patterns in the management of pension funds. The costs, including operating and investment management costs, are higher for small funds than large, and for defined-benefit relative to defined-contribution;³⁰ the costs of personal pensions are much higher than company plans, given lack of economies of scale, expenses of advertising, commission costs, and market power of providers.³¹

The evidence on the average performance of pension funds relative to external benchmarks has been disappointing.³² On the other hand, pension funds seem to follow very similar investment strategies, so that identifying out-performance is difficult.³³ Recent evidence, taking performance persistence into consideration, suggests that there appears to be a role for the active fund management of pension funds.³⁴ However, no allowance for the costs of fund management was made.

As expected, portfolio distribution and risks and returns on assets can be used to derive estimates of returns and risks on portfolios.³⁵ On the other hand, transactions and management costs are ignored. Fund management is a service involving management of an investment portfolio on behalf of a client. This raises principal-agent problems, although some features of fund management might reduce them. All these aspects justify why technical efficiency analysis in the pension funds industry becomes so relevant.

As far as we know, scant research has been done in relation to evaluating the technical efficiency of pension fund management companies with frontier models. Considering that pension fund management companies perform important functions (collecting contributions into a pension fund, investing this fund in a range of financial assets, arranging pension benefits for those retiring and providing a range of supporting services), it seems crucial to measure and evaluate technical efficiency. This

²⁷ Brown and Goetzmann (1995).

²⁸ Berkowitz *et al.* (1988), and Ippolito and Turner (1987).

²⁹ Del Guercio (1996).

³⁰ Turner and Beller (1989), Andrews (1993) and Hannah (1986).

³¹ Blake (1994) and Hurd (1990).

³² Ippolito and Turner (1987) and Coggin *et al.* (1993).

³³ Thomas and Tonks (2001).

³⁴ Tonks (2005).

³⁵ Davis (1995).

has been done in the case of pension fund managers in Argentina with a cost frontier estimation³⁶ and in Chile with DEA.³⁷

In a paper that is more closely related to our present study, Braberman *et al.*³⁸ analyse the Argentinian pension fund management institutions with a Cobb–Douglas cost frontier model, based on quarterly data from the second quarter of 1997 to the first quarter of 1998 and a changing number of pension fund management institutions: 24 in the first two quarters, 20 till the second semester of 1997, 18 till the first quarter of 1998 and 16 till the end of the period. Operating costs are regressed in relation to three variables: firstly, the number of members/participants; secondly, the positive transfers/turnover (participants switching from one management institution to another) corrected in accordance with the proportion of participant employees of the pension fund management institution; thirdly, the profitability of the fund. This is clearly an ill-specified empirical cost function without the price of factors (labour and capital).³⁹ Two dummy variables were included to take into account the changes in regulations after November 1997. They found that while regulation increased total costs, it did not significantly affect relative efficiency.

Barrientos and Boussofiane⁴⁰ analyse Chilean pension fund management companies with the use of a two-stage procedure. In the first stage, they calculate DEA-CCR and DEA-BCC efficiency scores and in the second stage, they investigate the determinants of technical efficiency by regressing variables capturing market structure, regulation, and market segmentation, in relation to CCR efficiency scores. The inputs and outputs used in the DEA stage adopted the production approach used in banking.⁴¹ The authors 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. The independent variables of the regression include the market share of fund managers, the sales spending per-contributor, the ratio of contributors to affiliates and the revenue per-contributor. They conclude that there is no continuous trend towards an improvement in technical efficiency. Analysis of the determinants of efficiency showed that an increase in market share contributes positively to technical efficiency. Sales and marketing costs are detrimental.⁴² The use of a regression model in the second stage is a caveat of this paper, since it is recognised that the efficiency scores are censored at one end and that, therefore, a Tobit model should have been used to allow for the censored observations.⁴³ Moreover, it is recognised in the DEA literature that the efficiency scores obtained in the first stage are correlated with the explanatory variables used in the second term, so that the

³⁶ Braberman *et al.* (1999).

³⁷ Barrientos and Boussofiane (2005).

³⁸ *Ibid.*

³⁹ Varian (1987).

⁴⁰ Barrientos and Boussofiane (2005).

⁴¹ Ferrier and Lovell (1990).

⁴² Bernstein and Micco (2002) provide a framework for the notion that sales agents promote the desirability of switching between plans even when it is not socially efficient, increasing the administrative cost of the system.

⁴³ Coelli *et al.* (1998).

second-stage estimates will be inconsistent and biased.⁴⁴ A bootstrap procedure is needed to overcome this problem.⁴⁵

Despite the identified caveats, these two papers are clearly insufficient for such an important economic field. With the present research, we seek to draw the attention of researchers to this neglected area.

Theoretical framework

In this paper, we adopt the stochastic econometric frontier approach. This approach, first proposed by Farrell⁴⁶ based on cost functions, came to prominence in the late 1970s as a result of the work of Aigner *et al.*,⁴⁷ Battese and Corra,⁴⁸ and Meeusen and Van den Broeck.⁴⁹ The adequacy of a cost or production function depends on the environment in which the units analysed behave. In an environment in which the ultimate objective is to maximise sales and profits, producers face exogenously determined input prices and output prices and attempt to allocate inputs and outputs so as to maximise sales. Assuming this is the main strategy in the pension fund industry, the production frontier is the most suitable model for analysing efficiency.⁵⁰ However, when we have several outputs, it is more appropriate to adopt a cost frontier, relying on the duality theory.⁵¹

In a cost frontier, the units on the frontier are efficient and the units above the frontier are inefficient. The zone below the frontier is unattainable, since the most efficient production unit is on the frontier. Broadly speaking, frontier models normalise the efficiency scores in order for them to be equal to one for the best-performing unit, and less than one for the inefficient frontier. The econometric frontier estimates the frontier econometrically and measures the difference between the inefficient units and the frontier by the residuals. This is an intuitive approach. However, when we assume that the residuals have two components (noise and inefficiency), we have the stochastic frontier model. Therefore, the main issue in econometric frontier models is the decomposition of the error terms (see a formal presentation of the model in the appendix).

Data

In order to estimate the cost frontier, we used balanced panel data on Portuguese pension fund management companies for the years 1994–2003 (12 companies × 10 years=120 observations).

⁴⁴ Simar and Wilson (2000).

⁴⁵ Simar and Wilson (1999).

⁴⁶ Farrell (1957).

⁴⁷ Aigner *et al.* (1977).

⁴⁸ Battese and Corra (1977).

⁴⁹ Meeusen and Van den Broeck (1977).

⁵⁰ Kumbhakar (1987).

⁵¹ Cornes (1992).

Table 6 Descriptive statistics of the data

<i>Variable</i>	<i>Description</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>Standard deviation</i>
Log Cost	Logarithm of operating costs in Euros at constant prices 1999 = 100.	0.577	3.317	2.252	0.672
Log PL	Logarithm of the price of workers, measured by dividing total wages by the number of workers.	−0.330	2.015	1.232	0.515
Log PK1 – management services	Logarithm of the price of capital-management services, ^a measured by dividing commissions by the value of the pension funds under management.	−2.164	1.039	−1.346	0.341
Log PK 2 – premises	Logarithm of the price of capital-premises, measured by dividing the expenditure on equipment and premises by the book value of assets.	−3.152	2.052	−1.161	0.737
Log Profit	Logarithm of the profit in Euros at constant prices 1999 = 100.	0.155	3.709	2.251	0.745
Log Participants	Logarithm of the number of participants.	3.001	5.024	4.029	0.529
Log Closed	Logarithm of the number of closed funds.	1.811	5.879	4.572	0.875
Open	Dummy variable, which is one if there are open funds under management and zero elsewhere.	0	1	0.675	—
M&A	Dummy variable, which is one if the pension fund has been involved in mergers and acquisitions in the period and zero elsewhere.	0	1	0.462	—

^aOr services rendered.

Frontier models require the identification of inputs (resources) and outputs (transformation of resources). Several criteria can be used. One empirical criterion is the availability of data. Secondly, the literature survey is a way of ensuring the validity of the research and therefore represents another criterion to be taken into account. The last criterion for measurement selection is the professional opinions of managers in the industry. In this paper, we follow these three criteria. Table 6 presents the characteristics of the variables used in the analysis.

We can see that the range is narrow, indicating that the pension fund management companies in the sample are of similar sizes in terms of inputs and outputs. The rationale for using capital-management services and capital-premises requires a justification. Funds use commissions and premises to develop their activity. Therefore, in order to capture the specificity of this activity, we need to disentangle these two types of capital.

Results and efficiency rankings

Based on the data span available, we estimate a generalised stochastic Cobb–Douglas cost function with three input prices (one price of labour and two prices of capital), and four outputs (profits, number of participants, number of closed funds and the

existence or not of open funds under management). This is the cost frontier model, known as the Error Components Model in Coelli *et al.*,⁵² because it accounts for the causes of efficiency controlled by the management (labour, capital, profit, participants, closed funds and open funds). The model is as follows:

$$\begin{aligned} \text{Log}\left(\frac{C_{nt}}{PK2_{nt}}\right) = & \beta_0 + \beta_1 \text{Log}\left(\frac{PL_{nt}}{PK2_{nt}}\right) \\ & + \beta_2 \text{Log}\left(\frac{PK1_{nt}}{PK2_{nt}}\right) \\ & + \beta_3 \text{Log}\left(\frac{\text{profits}_{nt}}{PK2_{nt}}\right) \\ & + \beta_4 \text{Log}(\text{participants}_{nt}) \\ & + \beta_5 \text{Log}(\text{Closed}_{nt}) \\ & + \beta_6 \text{Open}_{nt} \\ & + \beta_7 M\&A + (V_{nt} + U_{nt}) \end{aligned} \quad (1)$$

where *PL* is the price of labour, *PK1* the price of capital-management services, and *PK2* the price of capital-premises. The variables are defined and characterised in Table 6. We adopt the traditional log–log specification to allow for the possible non-linearity of the frontier. Linear homogeneity in input prices is imposed by dividing monetary values by the input price of capital-premises.⁵³ Table 7 presents the results obtained for the stochastic frontier, using Frontier 4.1 from Coelli⁵⁴ and using a half-normal distribution specification.

We confirm that the Cobb–Douglas cost function specified above fits the data well, as the *R*-squared from the initial ordinary least-squares estimation that was used to obtain the starting values for the maximum-likelihood estimation is in excess of 90 per cent and the overall *F*-statistic is 325.12. We also note that the variables have the expected signs, with the operating cost increasing with the price of labour and the price of capital-management services. Moreover, the total cost decreases with profits and increases with the number of participants and closed funds, signifying that it is expensive to increase these latter two outputs. However, the closed funds variable is found to be statistically insignificant. Finally, the total cost decreases with open funds and M&A activities. The frontier parameters are all statistically significant and the inefficient error term (γ) amounts to 60.6 per cent of total variance.

Table 8 below presents the time-invariant efficiency scores computed from the residuals.

Technical efficiency is achieved, in a broad economic sense, by the unit that allocates resources without waste and thus the concept 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 efficiency score recorded. For example, the waste of the

⁵² Coelli *et al.* (1998).

⁵³ Cornes (1992).

⁵⁴ Coelli (1996).

Table 7 Stochastic Cobb-Douglas panel data costfrontier (the dependent variable is the log of total cost)

<i>Variables</i>	<i>Coefficients (t-ratio)*</i>
Constant (β_0)	-3.104 (-3.152)
Log PL(β_1)	1.693 (30.509)
Log PK1 (β_2)	0.238 (2.655)
Log Profits (β_3)	-0.009 (-3.225)
Log Participants (β_4)	0.748 (2.363)
Log Closed funds (β_5)	0.252 (0.596)
Dummy Open funds (β_6)	-0.159 (-2.316)
Dummy M&A (β_7)	-0.328 (-3.128)
$\sigma^2 = \sigma_V^2 + \sigma_U^2$	0.163 (2.741)
$\gamma = \sigma_U^2 / \sigma^2$	0.606 (2.255)
Log (likelihood)	-288.088
LR	6.393
Observations	120

t-statistics in parentheses are below the parameters, those followed by *are significant at the 1% level.

Table 8 Efficiency scores

<i>Pension fund management companies</i>	<i>Efficiency scores</i>
BanifAçor	1.000
BBV Fundos	0.982
BpiPensões	0.953
Unipensão	0.942
Pensõesgere	0.910
Previsão	0.895
SGF	0.873
Banco de Portugal	0.870
CGD Pensões	0.800
ESAF	0.785
Futuro	0.774
Santander	0.753
Mean	0.878
Median	0.884
Std. dev.	0.084

poorest performing pension fund management company, Santander, is ($1 - 0.753 = 0.247$). This is the relative quantity of waste that should be eliminated in order for this institution to upgrade its performance.

We note that the mean score is 87.8 per cent. This score suggests that pension fund management companies can reduce their output cost by 12.2 per cent without decreasing their inputs, which, in this case, are the price of labour, the price of capital-premises and the price of capital-management services. The maximum efficiency score was naturally 1, which was achieved by Banif Açor, while the minimum efficiency score was 75.3 per cent, achieved by Santander. The median was 88.4 per cent and the standard deviation was 8.4 per cent. These efficiency scores are average in comparison with

those found in other activities, such as insurance.⁵⁵ High efficiency scores are consistent with efficient and more competitive organisations, such as those observed in financial markets.

Discussion

How should these results be interpreted? It has been seen that costs increase with all factors of production, with the exception of profits, open funds, and M&A. In the case of profits, this signifies that financial success is a major factor in cost control. This is an intuitive result. As far as open funds are concerned, it means that this type of fund contributes towards a decrease in costs. A rationale for this result is the flexibility of the open funds relative to the close funds. In the case of M&A, it signifies that this type of managerial decision is beneficial for efficiency, a result related to the importance of scale economies in the management of pension funds companies.

Scale in a Cobb–Douglas function is defined as the sum of the parameters, and, in the present case, the output elasticity is equal to 0.504 in the sample mean, signifying increasing returns to scale. Thus, a 10 per cent increase in outputs leads to a decrease in costs of approximately 50.4 per cent. The reverse of this is higher than unity, indicating increasing returns to scale on production. This result means that scale is a major issue in the Portuguese pension funds industry, with funds generally being too large to take full advantage of the market. Scale size should decrease when decreasing returns to scale prevail. We also draw attention to the high statistical significance and value of labour costs, signifying that this is a major issue in the management of pension funds.

It was noted that there are a variety of factors that encompass almost all possible situations. For example, companies that have public funds under management (SGFP do Banco de Portugal and CGA Pensões) do not perform well, compared with private companies. How can we explain this situation? It should be pointed out that SGFP do Banco de Portugal manages only one fund. This result confirms prior research, which highlights that small funds have higher costs.⁵⁶ Moreover, public companies are subject to the principal-agent relationship.⁵⁷ The principal-agent relationship relates to the difficulty of controlling those empowered as managers to act on behalf of the government (the owner). The job tenure usually enjoyed by public-sector senior managers may encourage the development of principal-agent problems.

Overall, we noted that Portuguese pension fund management companies are, on average, efficient. Nevertheless, there is room for upgrading this level of efficiency, specifically in the case of those companies below the mean. This is an intuitive result based on the high level of scrutiny of this type of organisation. Given the scrutiny that customers, investors and other stakeholders place on the pension funds' financial performance, managers are constantly under pressure to show positive financial results. The key to this lies in improved efficiency. Therefore, despite the observation of some failures, it is fair to say that this is a much more closely scrutinised industry than many others, a fact which should result in a high level of efficiency.

⁵⁵ Cummins and Zi (1998).

⁵⁶ Turner and Beller (1989), Andrews (1993), and Hannah (1986).

⁵⁷ Jensen and Meckling (1976).

How do we explain the different signs in the parameters of closed and open funds? With a positive coefficient, closed funds contribute towards an increase in costs, signifying that the production of closed funds is costly. However, with a negative coefficient, open funds contribute towards a decrease in total costs. One possible explanation for this difference is the rigidity that exists in the management of closed funds.

What are the causes of the inefficiency identified? Based on the estimated cost frontier, we can see that inefficiencies are derived principally from the costs of production factors. Too much expenditure on these factors adds to inefficiency, specifically when this expenditure is not converted into profits.

How do we explain the different efficiency scores displayed by the pension fund management companies analysed? Different efficiency scores are the result of the different strategies adopted by Portuguese pension fund management companies. Different strategies stem from the existence of strategic groups and their differences in terms of resources. Firstly, the existence of strategic groups⁵⁸ leads to differences in the structural characteristics of units within an industry, which in turn lead to differences in performance. In the case of pension funds, units with similar asset configurations pursue similar strategies with similar results in terms of performance.⁵⁹ While there are different strategic options to be found among the different sectors of an industry, because of mobility impediments, not all options are available to each industry, causing a spread in the efficiency scores of the industry. Secondly, the differences in resources available to funds⁶⁰ mean that pension fund 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, resulting in a competitive advantage for the best-performing pension fund management company.

Purchasable assets cannot be considered to represent sources of sustainable profits. Indeed, critical resources are not available on the market. Instead, they are built up and accumulated on the pension fund'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 imitation⁶¹ and in the pension funds managers' 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 management company.⁶²

Accordingly, pension fund management companies may achieve high levels of competitiveness by using vast amounts of resources and thus perform inefficiently, or they may achieve low levels of competitiveness and perform efficiently. Different strategic responses to exogenous shocks, including taxation shocks, and different responses to the M&A process, result in different efficiency scores among the units analysed.

⁵⁸ Caves and Porter (1977).

⁵⁹ Porter (1979).

⁶⁰ Barney (1991), Rumelt (1991), and Wernerfelt (1984).

⁶¹ Rumelt (1991).

⁶² Teece *et al.* (1997).

The general conclusion is that performance in the pension funds industry is a main driver in terms of cost control, together with scale, thus confirming the importance of the market-driven strategies. Managerial skills are also important and explain part of the behaviour observed. The role played by managerial skills in pension funds is linked to financial performance in the pensions market, decreasing costs and increasing pension performance in order to perform better.

A policy for overcoming the identified inefficiencies should start with an analysis of the scale of activities and the adoption of a competitive strategy, based on the observed fact that the main causes of inefficiency are the conditions prevailing in the market. However, we conclude indirectly that there are certain elements intrinsic to the management of the pension funds that make some of them more efficient than others. Therefore, managers of inefficient pension funds should adopt a benchmark management procedure in order to evaluate their relative position and to adopt appropriate managerial procedures for catching up with the frontier of “best practices”. They should also pursue market-oriented strategies, which increase outputs and decrease inputs. In addition, an efficient incentive reward should be adopted, based on benchmarking.

The regulatory agency has an important role to play in improving the efficiency of pension funds, publishing data on individual companies in order to introduce greater transparency into the market resulting in increased competition, and enforcing the rules (composition of the portfolio) relating to the companies themselves. For example, these institutions should be quoted on the stock market, in order to increase scrutiny. Moreover, the regulatory authority should abandon complacency in its regulation of pension fund management institutions.

Conclusions

This article has proposed a simple framework for the evaluation of the Portuguese fund management institutions and the rationalisation of their performance. The analysis is based on a stochastic frontier model. Benchmarks are provided for improving the operations of sub-optimal performing funds. Several and interesting insights and implications from the study are raised. For the least efficient funds, adjustment is needed in order to achieve the efficient frontier.

The general conclusion is that pension funds have different efficiency scores. Scale is a main driver in cost control, together with control of the cost factors, confirming the importance of a sound managerial strategy. More investigation is needed to clarify the determinants factors of inefficiency among the Portuguese fund management institutions.

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Appendix

The general frontier cost function, dual to the production function proposed by Aigner *et al.*⁶³ and Meeusen and Van den Broeck⁶⁴ is as follows:

$$C_{nt} = Y(P_{int}, Y_{int}) \cdot e^{V_{nt} + U_{nt}} \quad i = 1, 2, \dots, N; t = 1, 2, \dots, N \quad (2)$$

where C_{nt} represents a scalar cost of the n th pension funds management company in

⁶³ Aigner *et al.* (1977).

⁶⁴ Meeusen and Van den Broeck (1977).

the t th period; P_{int} is a vector of the i th input prices of the n th pension fund management company in the t th period, and Y_{int} is a vector of the i th output descriptors of the n th pension fund management company observed in the t th period.

The error term V_{nt} is the traditional error term of econometric models, assumed to be independently and identically distributed, representing the effect of random shocks (noise) and independent of U_{nt} .

The inefficient term U_{nt} represents technical inefficiencies and is assumed to be positive and distributed normally with zero mean and variance σ_U^2 . The U_{nt} positive disturbance is reflected in a half-normal independent distribution truncated at zero, signifying that each unit's production must lie on or below its production frontier, but above zero. This says that two effects, the V effect, which is a random shock, and the U effect, which is a management shock controlled by the pension fund management company, lead to deviation from the frontier.

Total variance is defined as: $\sigma^2 = \sigma_V^2 + \sigma_U^2$. The contribution of the error term to total variance is as follows: $\sigma_V^2 = \sigma^2 / (1 + \lambda^2)$. The contribution of the inefficient term is as follows: $\sigma_U^2 = \sigma^2 \lambda^2 / (1 + \lambda^2)$, where σ_V^2 is the variance of the error term V , σ_U^2 is the variance of the inefficient term U and λ is defined as $\lambda = \sigma_U / \sigma_V$, providing an indication of the relative contribution of U and V to ε .

Because estimation procedures of Eq. (1) yield merely the residual ε , rather than the inefficiency term U , this term in the model must be observed indirectly.⁶⁵

In the case of panel data, such as the set used in the present paper, Battese and Coelli⁶⁶ used the conditional expectation of U_{nt} , dependent on the realised value of the error term $\varepsilon_{nt} = (V_{nt} + U_{nt})$, as an estimator of U_{nt} . In other words, $E[U_{nt} / \varepsilon_{nt}]$ is the mean productive inefficiency for the n th pension fund management company at any time t . Under the half-normal assumption:

$$E[U_n / \varepsilon_{n1}, \dots, \varepsilon_{nt}] = \mu_n^* + \sigma_n^* \left[\frac{\phi(\mu_n^* / \sigma_n^*)}{\phi(-(\mu_n^* / \sigma_n^*))} \right] \quad (3)$$

where $\mu_n^* = \gamma_n \mu_n + (1 - \gamma_n)(-\varepsilon_n)$, $\gamma_n = 1 / (1 + (\lambda / Tn))$ and $\sigma_n^* = \sqrt{\sigma_U^2 / 1 + \lambda Tn}$. Furthermore, μ is the mean value of the distribution, T is the time period of the panel, ϕ is the standard normal distribution and ϕ the respective cumulative distribution function.⁶⁷ Based on the panel data, the maximum likelihood estimators of model (1) are presented in Table 8.

About the Authors

Carlos Pestana Barros is Assistant Professor of Microeconomics at the Instituto Superior de Economia e Gestao from the Technical University of Lisbon with tenure. He is an applied economist. His research interests centre on insurance, banking and pension funds.

⁶⁵ Greene (2003).

⁶⁶ Battese and Coelli (1988).

⁶⁷ See Kumbhakar and Lovell (2000) and Coelli *et al.* (1998) for details.

Maria Teresa M. Garcia is Assistant Professor of Economics at Instituto Superior de Economia e Gestão, Technical University of Lisbon (UTL), teaching financial economics, financial intermediaries economics, monetary economics and policy, and pension economics. She has a Ph.D. and master's degree in economics from UTL. She is a researcher at the UTL Centre for Research on Financial Economics and a consultant for the Consumer Institute, Portugal. She is also Chairman of the accreditation board of actuaries for pension funds at the Portuguese insurance and pension funds supervisory authority, Instituto de Seguros de Portugal.