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* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

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De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

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Jacob A. Bikker[1], Michiel van Leuvensteijn[2] and Jeroen J. Meringa[1]

Abstract

This paper adds to the literature by analysing for the first time the functioning of the Dutch pension funds market from a competition or efficiency perspective. Of course, competition is severely limited on this highly regulated market. The analyses focus on a key property of well-functioning markets: the reward of efficiency. The conclusion can be drawn that in the market for pension funds efficiency is indeed rewarded, up to a certain level. New regulations on cost transparency and on the quality of pension boards, and the ongoing consolidation among pension funds may be explanations for this development over time. At the same time, the level at which efficiency is rewarded is very low compared to other financial sectors such as the life insurance and banking sector.

JEL codes: D4, H55 en G22, G23, G28

Key words: Competition, efficiency, net investment returns, market shares, pension funds

1. Introduction

Competition in markets is ultimately about the welfare that markets create for humanity. Markets allocate resources to firms that produce goods and services. The more efficient this allocation is, the more welfare will be created. This allocation process can be influenced by structural elements and the conduct of firms. Important structural elements are entry and exit barriers, the number of firms in the market, and transaction and information costs. On the conduct side, firms may try to eliminate their competitors by, for example, taking over upstream firms that provide their competitors with essential goods.

Measurement of competition is a complex matter as competition is not directly observable. The literature provides different strands that vary in complexity and theoretical underpinning (Bikker and Bos, 2008, Bikker and Van Leuvensteijn, 2014, Bikker and Spierdijk, 2017). One strand is focused on structural measures of competition and another on non-structural measures. Examples of structural measures are static concentration measures, and dynamic measures, such as entry and exit rates, and the Structure-Cost-Performance (SCP) model. Non-structural measures of competition are based on the conduct of firms. Examples are indicators developed by the New Empirical Industrial Organisation literature (NEIO). The most applied performance measures are price mark-ups (Lerner index, Elzinga and Mills, 2011; Giocoli, 2012), correlations of output prices with input costs (H-statistic, Panzar and Rosse, 1982, 1987) and the conjectural variation parameter λ of the Bresnahan (1982) or Lau (1982) models.

This paper draws on the framework of Hay and Liu (1997) and Boone (2008), who show that when substitutionability of products increases, or when entry barriers diminish, the elasticity between profits and efficiency increases. In a more competitive market, therefore, inefficient firms are taken over by more efficient firms, are pushed out of the market or have to adjust and become more efficient so that

[1] De Nederlandsche Bank, P.O. Box 98, 1000 AB, Amsterdam, the Netherlands. Email: jabikker@hotmail.com.
[2] Ministry of Social Affairs and Employment. The views expressed here are solely those of the authors and do not in any way represent the views of affiliated institutions. The authors are grateful to Maurice Bun for helpful comments.

the relationship between efficiency and profits is strengthened. This measure of Hay and Liu and Boone (elasticity between profits and efficiency) has the advantage of having a clear theoretical underpinning which is directly related to the efficient allocation of resources in a market. Further, it uses little data compared to alternatives such as the Bresnahan model.

The main contribution of this paper is its application of this measure to pension funds. Bikker and Van Leuvensteijn (2008) investigate this measure for life insurance companies, and Van Leuvensteijn *et al.* (2011) apply it to the loan markets of banks. Life insurance companies and banks operate in markets in which risk is highly regulated: life insurance companies are subject to the Solvency II framework and banks to the Basel III Accord. Risk regulation is less intensive for pension funds, where – within limits – the risk profile varies according to their risk appetite, depending, among others, on the average age of their members.

More than for life insurance products, the product of pension funds is very homogenous, i.e. lifelong pension benefits for their members. In principle, this makes it easier to measure competition. However, competition between pension funds in the Netherlands is severely limited because employees of companies (in the case of the company pension funds) or industries (in case of industrywide pension funds) cannot choose between pension funds, the so-called great obligation (‘*grote verplichtstelling*’). Still, competition between pension funds may occur when company pension funds merge or are taken over, or when industrywide pension funds are not mandatory for firms from that industry (when they are mandatory, we speak of small obligation, ‘*kleine verplichtstelling*’). Furthermore, pension funds compete for the best asset managers. Up to a certain level, our approach also may reflect competition between pension funds service providers, such as pension administration offices and external investment companies, as their costs are included in the costs that pension funds report (“look through principle”).

Our analysis of competition among pension funds is to our knowledge the first of its kind, and the level of competition has thus far been unknown. Our *ex ante* expectation was, of course, that the pension industry competition level is lower than in the life insurance industry, because there is no competition for customers. Given this lack of competition for customers the result could well be that competition is absent altogether and the mechanisms for competition described above are too weak to measure. In this sense, this paper is an experiment.

The structure of this paper is as follows. Section 2 provides a literature overview on competition measurement, section 3 sketches the pension system in the Netherlands, the following three sections present the model, the data used, and the empirical results. Section 7 presents our conclusions.

2. Literature overview

The Structure Conduct Performance (SCP) framework is the basis of most of the measures of competition on a market level. The idea is that structural properties of the markets define the conduct of firms in terms of price and quantity decisions, and result in the performance of the markets in terms of profits, profit margins or market share. Structural measures of competition include the level of concentration in the market, entry and exit barriers and transaction and information costs, for instance. The Herfindahl-Herschman index of concentration is often used in the competition literature. The New Empirical Industrial Organisation literature also focuses on the conduct of firms considering non-structural measures like the Lerner index (Genesove and Mullin, 1998) and the divergence between price and marginal revenue, the Bresnahan measure (Bresnahan, 1982, and Lau, 1982). Another example of measuring conduct is the H-Statistic as developed by Panzar-Rosse (1987). In this measure, the transmission of costs to prices is central. Markets in which changes in costs are strongly related to changes in prices are more competitive than markets in which the pass-through is sluggish. In competitive markets, firms are price takers with little pricing power.

A last strand of literature is devoted to measuring the X-efficiency of firms. X-efficiency reflects the managerial ability to reduce costs, controlled for production volumes and input prices. X-efficiency is defined as the difference in costs between a firm and the best practice firms of similar size and input prices (Leibenstein, 1966). The expectation is that competition in the market would diminish the X-efficiency of firms, i.e. the degree of efficiency maintained by firms under conditions of imperfect competition.

This paper uses the indicator based on the framework of Hay and Liu, and Boone which focuses on the relationship between profits and efficiency. The idea is that in a more competitive market, the relationship between profits and efficiency is stronger because inefficient firms are pushed out of the market, are taken over by more efficient firms or adjust and become more efficient. In all these cases, the relationship between profits and efficiency becomes stronger. Boone (2008) shows that there is a monotonic positive relationship between relative efficiency and relative profits. In Bikker and Van Leuvensteijn (2014) we renamed this approach the Performance Conduct Structure (PCS) indicator: efficiency (or profit) in a competitive market leads to a change in its structure as more efficient firms grow. It is the opposite view of the well-known Structure Conduct Performance (SCP) framework, which postulates causal relationships between the structure of a market, the conduct of firms in that market and their economic performance.

The advantage of this PCS indicator is that it requires relatively little data compared to, for example, the Bresnahan model. Furthermore, this measure does not suffer from the shortcomings of the Lerner index. In general, more competition may reduce the Lerner index as it reduces the price-cost margin, and a low Lerner index would indicate high competition. Competition may result in more efficient firms where some of them may decide to have a higher price cost margin, which is possible due to their lead in efficiency. Finally, Corts (1999) critised the (elasticity adjusted) Lerner index because efficient collusion could not be distinguished from Cournot competition.

The PCS indicator has been used for various segments of the financial sector. Bikker and Van Leuvensteijn (2008) implemented it for the life-insurance market, Van Leuvensteijn *et al*. (2011) applied this measure to the loan markets of Europe, US and Japan, while Bikker (2017) and Bikker and Bekooij (2024) adopted it to the health insurance industry. For the pension fund industry, measuring the X-efficiency provides an initial indication of market competitiveness. Alserda *et al.* (2018) show large economies of scale for pension fund administrations, but modest economies of scale for investment activities, and find that many pension funds have substantial X-inefficiencies for both administrative and investment activities.

3. The pension system in the Netherlands

The institutional structure of the Dutch pension system is made up of three pillars, similar to the situation in most other developed countries. The first pillar consists of a public pension scheme and is financed on a pay-as-you-go basis. It offers a basic flat-rate pension to all retirees and aims to link the benefit level to the legal minimum wage. The pension benefit age moved gradually from 65 years until 2012 to 67 years in 2024 (dynamically linked to life expectancy). The second pillar provides former employees with additional income from a collective, contribution-based supplementary scheme. The prescribed pension age is 68 years. The third pillar is composed of tax-deferred personal savings, which individuals undertake at their own initiative and expense. The supplementary or occupational pension system in the Netherlands is typically organised as a funded defined-benefit (DB) or collective defined contributions (CDC) scheme. The benefit entitlement is determined by years of service and a reference wage, which in more recent years has been linked to wages over the years of service. The second pillar takes the public scheme benefits into account, while the third pillar's tax deduction takes the sum of the benefits from the first two pillars into account. Supplementary schemes are usually managed collectively by pension funds. Three types of pension funds exist. The first is the *industry* pension fund, which is organised for a specific industry sector (*e.g.* construction, healthcare, transport). Participation in an industry pension fund is mandatory for all employers in the relevant sector, with a few exceptions. An employer may opt out if it establishes a *corporate* pension fund that offers a better pension plan to its employees. Where a supplementary scheme is agreed by employers and employees, managed by either a corporate pension fund or an industry pension fund, employee participation is mandatory, governed by collective labour agreements. The third type of pension fund is the *professional group* pension fund, organised for a specific group of professionals, such as the medical profession or notarial profession. The Dutch pension fund system is comprehensive. In 2022, almost 89% of the employees are covered, but self-employed people need to arrange their own retirement savings. In that year, total pension fund assets in the Netherlands amounted to some €1,512 billion, or 158% of GDP, ranking the Dutch pension system, in terms of the assets-to-GDP ratio, as the largest in the industrial world. The government, employees and employers have agreed to transform the pension system into a kind of defined contribution system, resulting into the Future Pensions Act. This law revises the Dutch pension system and came into effect on 1 July 2023. Pension funds currently have until 2028 to switch to the new system. This system may have a collective buffer to soften setbacks, at the choice of the pension funds.

4. The Performance Conduct Structure (PCS) model

4.1. The theoretical PCS model

The PCS model is based on two notions. First, more efficient firms, i.e., firms with lower marginal costs, gain higher market shares or profits. Second, this effect is stronger in more competitive markets (Van Leuvensteijn *et al.*, 2011). The PCS indicator is the empirical operationalisation of a theoretical model developed by Boone (2008) who shows that there is a continuous and monotonically increasing relationship between profit differences and the level of competition if firms are ranked by decreasing efficiency. In other words, there is a negative relationship between efficiency, measured in terms of marginal costs, and profits. The more intense this negative relationship is, the more competitive markets will be.

So, in practice, a negative sign between marginal costs and profits is expected. This elasticity is called the PCS indicator The fact that this relationship is both continuous and monotonic is the main advantage over more traditional measures of competition such as the H-statistics and Lerner index. Another advantage is that the PCS indicator is not dependent on assumptions about the type of competitive model, as in the cases of Bertrand or Cournot.

Following Boone (2008) and Xu *et al.* (2016), we consider an industry where each firm *i* produces one product q_i (or portfolio of products), which faces a demand curve of the form:

$$p(q_i, q_{j\neq i}) = a - bq_i - d\sum_{j\neq i} q_j \tag{1}$$

and has constant marginal costs mc_i. This firm maximises profits $\pi_i = (p_i - mc_i)q_i$ by choosing the optimal output level q_i. We assume that $a > mc_i$ and $0 < d \leq b$.[3] The first-order equilibrium condition for a Cournot-Nash equilibrium can then be written as:

$$a - 2bq_i - d\sum_{j\neq i} q_j - mc_i = 0 \tag{2}$$

When *N* firm produce positive output levels, we can solve the *N* first-order conditions (2), where mc_i = $1/\eta_i$, yielding:

[3] d ≤ b follows from the assumptions of Boone (2008), where he shows how a decline in entry costs strengthens the relationship between efficiency and profits.

$$q_i(\eta_i) = \frac{(2b/d-1)a-(2b/d+N-1)(1/\eta_i)+\sum_j(1/\eta_j)}{(2b+d(N-1))(2b/d-1)} \quad (3)$$

The argument of function q_i, η_i, is efficiency, the inverse of marginal costs. We define profits π_i as variable profits excluding entry costs ε. Hence, a firm enters the industry if, and only if, $\pi_i \geq \varepsilon$ in equilibrium.[4] Note that Eq. (3) provides a relationship between output and marginal costs. From $\pi_i(mc_i) = (p_i - mc_i)q_i$, it follows that profits depend on efficiency in a quadratic way, i.e.

$$\pi_i(\eta_i) = \frac{(2b/d-1)a-(2b/d+N-1)(\frac{1}{\eta_i})+\sum_j(\frac{1}{\eta_j})}{[(2b+d(N-1))(2b/d-1)]}\left(p_i - (\frac{1}{\eta_i})\right) \quad (4)$$

The Relative Profit Differences is then defined as $RPD = \frac{\pi(\eta^{**})-\pi(\eta)}{\pi(\eta^{*})-\pi(\eta)}$ for any three firms with $\eta^{**} > \eta^{*} > \eta$. The Relative Profit Differences provides the relative profits of a firm with efficiency η^{*} to the profits of the most efficient firm with efficiency η^{**} and the profits of the least efficient firm with efficiency η. In this market, competition can increase in two ways. First, competition increases when the services produced by the various firms become closer substitutes, that is, *d* increases (keeping *d* below *b*). Second, competition increases when entry costs ε decline. Boone (2008) proves that RPD is an increasing function of interaction among existing firms ($\frac{dRPD}{dd} > 0$) and a decreasing function of entry costs ($\frac{dRPD}{d\varepsilon} < 0$). In other words, RPD increases when competition intensifies, i.e., fiercer competition increases profits of more efficient firms by larger amounts than those of less efficient firms.

4.2. The empirical PCS model

4.2.1. Profits

Following Xu *et al.* (2016) and Bikker and Van Leuvensteijn (2008), we adjust for the particular nature of the profits of pension funds. The relationship between profits and marginal costs in logarithms is central. However, the model has to be adjusted in two ways. First, profits from asset management are strongly affected by risk. The more investment risk is taken, the more return on assets can be expected, on average. This relationship is not considered in the original PCS indicator model. Therefore, the volatility of the investment portfolio of the pension funds is included in the PCS equation. Second, we define the marginal costs as the investment management costs expressed as a percentage of assets.[5] We assume that management costs should be as low as possible, the traditional interpretation of cost as 'waste'. Of course, additional costs may lead to better investment decisions; i.e. the return on management costs may be non-linear. We treat performance fees as a separate class of costs. These costs are costs that materialise after profits are known, and should be treated separately from other costs that have to be taken in advance. They indicate co-investments by private equity parties and are therefore strongly related to the risk profile of pension funds. We expect a different – possibly positive – relation with profits. The model becomes:

$$\ln(\text{profits}_{it}) = c + \beta \ln(\text{mc}_{it}) + \alpha \ln(\text{perff}_{it}) + \zeta \ln(\text{risk}_{it}) + u_{it} \quad (5)$$

[4] The model does not have a time dimension, so as long as the profits in the considered time period is higher than the entry costs, a firm will enter.

[5] For practical reasons, we ignore constant costs. In Bikker and Van Leuvensteijn (2008) we show that the effect of ignoring on the estimations is negligible.

where *profits* is the net return on assets in euro, *mc* is marginal investment management costs, *perff* are performance fees and *risk* is the volatility of the portfolio, for i=1,…,N firms and t=1,…,T periods. The key hypothesis to be tested is: $\beta = 0$ against the alternative $\beta < 0$.

We split the sample period into two subperiods. An increase over time of β, in absolute terms, would indicate an increase in competition.

As a robustness test, we also estimate a model with cross-terms to take correlations between the explanatory variables into account. In this model the first derivative varies between pension funds, but the competitiveness of the average pension fund can be derived. The model is as follows:

$$\ln(profits_{it}) = \beta \ln(mc_{it}) + \alpha \ln(perff_{it}) + \zeta \ln(risk_{it}) + \gamma_1 \ln(perff_{it}) \ln(risk_{it}) + \gamma_2 \ln(risk_{it}) \ln(mc_{it}) + \gamma_3 \ln(perff_{it}) \ln(mc_{it}) + c_t \quad (6)$$

4.2.2. Market shares

Most applications of the PCS model are performed on market shares instead of on profits (*e.g.* Hay and Liu, 1997). Apart from a constant, profit is the product of market shares and profit margins. More efficient firms may increase their market shares through lowering their prices, that is, by passing on a part – or the whole – of their efficiency lead to their (potential) customers. Increasing market shares of efficient firms is a clear signal that competition functions well. The role of profit margins is more complicated. Fierce competition may force efficient firms to pass on all their cost advantage to their (potential) customers, at the cost of their profits.

The PCS model for market shares reads as:

$$\ln(market\ shares_{it}) = \beta \ln(mc_{it}) + \alpha \ln(perff_{it}) + \zeta \ln(risk_{it}) + c_t \quad (7)$$

The variable marginal costs is approximated by either the sum of investment and administrative cost margins or by each of the two components of this cost margin.

5. Data used

This paper is based on unique and extended quarterly reports of 280 pension funds over 2012Q1–2023Q1 to their prudential supervisor, De Nederlandsche Bank (DNB). Pension funds with less than one hundred members (in 2022 only four funds) and funds which did not report all the items needed for our research have been excluded. At year-end 2022, the selected funds together managed 97.9% of the total pension investments of €1,433 billion. Key variables are net returns, investment costs and risk. Table 1 presents the data for the entire period, as well as two sub periods, in order to show developments over time.

Average net returns over pension funds and time are expressed in annual figures. Over the entire sample period that return is 5.9%, higher in the earlier years (8.7%) compared to the later ones (2.9%). In our central log-linear model we use only positive net returns, a subsample of around 70%, but we release this restriction in one of the robustness tests. Investment costs are, on average, 0.56%, falling over time from 0.61% to 0.50%. Investment costs are split into three components: management costs, performance fees and transactions costs. Management costs fall over time (from 0.46% to 0.39%), where performance fees increase (from 0.10% to 0.14%). Annual administrative costs also decline, from 0.41% to 0.29%. As the number of pension funds decrease rapidly (from 270 to 206), particularly due to the fall in the number of company funds, the average market share increases (from 0.37% to 0.49%). Volatility is defined as the average percentual change in quarterly returns. For the entire investment portfolio, it was 6.0% over the full sample period, hardly changing across the two subperiods. Finally, we present the asset allocation across investment categories. We observe a slight increase of risky assets over time.

Table 1. Survey over our data set

	2012Q1-2023Q1	2012Q1-2017Q2	2017Q3-2023Q1
Avg annual net returns over pension funds and time (mln euro)	293	355	221
Idem, in %	5.94	8.71	2.59
Avg annual positive net returns over pension funds and time (mln euro)	770	509	1,033
Avg annual negative net returns over pension funds and time (mln euro)	-998	-505	-1,380
Avg annual management costs over funds and time in %	0.43	0.46	0.39
Idem, performance fees in %	0.10	0.10	0.10
Avg investments costs over pension funds and time in %	0.56	0.61	0.50
Avg market shares based on total assets over pension funds and time in %	0.42	0.37	0.49
Avg annual administrative costs over funds and time in %	0.34	0.41	0.27
Avg number of pension funds over time in %	237	270	206
Avg share of industry sector pension funds in %	20	17	22
Avg share of company pension funds in %	71	75	67
Avg share of professional group pension funds in %	4	3	4
Avg quarterly volatility over pension funds and time in %	5.95	5.88	6.04
Avg volatility fixed income in %	7.76	9.27	6.04
Idem shares	10.81	8.38	12.59
Idem real estate	8.32	5.48	10.20
Idem private equity	8.52	7.28	9.45
Idem hedge funds	9.76	8.51	11.89
Idem commodities	14.49	12.26	18.28
Avg share of fixed income over pension funds and time in %	62.02	63.10	60.73
Idem shares	30.34	29.43	31.40
Idem real estate	6.21	5.94	6.51
Idem private equity	2.78	2.65	2.88
Idem hedge funds	2.90	2.98	2.71
Idem commodities	2.88	2.95	2.74

Source: DNB, own calculations. Since 2015, private equity has been called an alternative investment, due to a minor change in the definition.

6. Empirical results

6.1 Profits

We apply our PCS competition model from Eq. (5) to pension fund net profits, that is positive net returns on investment, from our data set over 2012Q1-2023Q1. We observe positive returns in more than 70% of the quarters. Roughly speaking, returns are positive in quarters where the share index increases. Of course, this data selection may affect the results, therefore, we also apply two alternative approaches which include all observations. We present clustered standard errors (CSE), where each pension fund defines a cluster. Estimation results are presented in Table 2, upper panel. All explanatory variables have highly significant coefficients with signs as expected. Management cost, the waste type cost, has a negative coefficient at -0.48 (first panel, full period), which is in line with the PCS model theory: the lower pension funds' costs, the higher their net returns. This is not the direct costs effect, as the returns are taken net of costs. Hence, this negative cost effect describes typically an increase in market shares, as we will also demonstrate below in Section 6.2. Efficiency contributes to pension fund grows as a consequence of some pressure, possibly of competition, despite the limited competitive pressure in the Dutch pension market, or principal agent types of relationships, such as checks and balances in the pension market and pressure of participants instead of shareholders. Poorly performing pension funds may have higher probability of being taken over by better performing pension funds. Industry sector funds which underperform may lose their mandatory status, enabling companies in that sector to transfer their pension capital to another pension fund. We observe that the strength of the costs-returns relationship, at -0.48, is weak, as this value is smaller in absolute terms than in other financial industries such as banking and insurance.

Table 2. Log-linear model of net returns of pension funds.

	2012Q1-2023Q1		2012Q1-2017Q2		2017Q3-2023Q1	
	Coeff.	*(CSE)*	*Coeff.*	*(CSE)*	*Coeff.*	*(CSE)*
First panel: no scale corrections						
Constant	0.02	(1.48)	-0.22	(1.67)	0.36	(2.19)
Log(Management cost in %)	-0.48	(0.17)	-0.33	(0.18)	-0.70	(0.26)
Log(Performance fees in %)	0.33	(0.04)	0.28	(0.04)	0.43	(0.04)
Log(Volatility returns, in %)	1.28	(0.10)	1.19	(0.13)	1.41	(0.07)
R^2, adjusted	26.3		22.1		34.7	
Number of observations	7,290		4,356		2,934	
F-test on model	871		411		518	
Second panel: Management costs corrected for scale economies						
Constant	-3.48	(0.78)	-2.90	(1.08)	-4.25	(0.64)
Log(Management cost in %)*	-0.03	(0.17)	0.13	(0.17)	-0.04	(0.27)
Log(Performance fees in %)	0.30	(0.04)	0.25	(0.04)	0.38	(0.05)
Log(Volatility returns, in %)	1.31	(0.08)	1.24	(0.11)	1.41	(0.07)
R^2, adjusted	24.9		21.3		32.2	
Number of observations	7,290		4,356		2,934	
F-test on model	805		394		465	
Third panel: Management costs and performance fees corrected for scale economies						
Constant	-3.36	(0.68)	-2.65	(1.08)	-4.18	(0.65)
Log(Management cost in %)*	0.47	(0.17)	0.59	(0.16)	0.30	(0.15)
Log(Performance fees in %)*	-0.05	(0.06)	-0.21	(0.06)	0.15	(0.09)
Log(Volatility returns, in %)	1.36	(0.07)	1.26	(0.11)	1.47	(0.07)
R^2, adjusted	14.4		14.2		16.9	
Number of observations	7,290		4,356		2,934	
F-test on model	407		240		199	

Notes: CSE stands for clustered standard errors. * Refers to correction for scale.

Although economies of scale in investment cost are fairly limited (Bikker and Meringa, 2022), the efficiency effect on profits may be related to these economies of scale. If this would be the case, that would, in principle, not change the interpretation of the observed management cost effect as measure of competition. Indeed, under competition, scale economies (may) lead to consolidation, *e.g.* the aircraft manufacturing industry.[6] To investigate this we correct management cost for scale economies using auxiliary regressions, see Appendix. The second panel presents the results. We see that the management effects now disappear. Apparently, the statistically significant effects of management costs on returns were mainly caused by scale economies: effects of possible efficiency differences across pension funds of the same size seem absent. We obtain the same result – i.e. no longer any effect of management costs on returns – when we estimate Eq. (5) with fixed effects for pension funds, or in first differences (results not shown), two approaches which also eliminate scale economy effects.

The second explanatory variable, performance fees, has a positive effect. In contrast to what has been claimed by Broeder *et al.* (2019), investment services delivered by investment advice companies (in return of the performance fees) increase net profits. Possibly, this observed effect is indirect: performance fees may indicate the use of more complex and rewarding investment categories as chosen by the larger pension funds which raises net returns. In the third panel we also correct

[6] Scale may also indicate an indirect effect: larger pension funds invest more in risky assets which may contribute to higher net returns. Such effect would undermine the competition interpretation of the results. In Bikker and Meringa (2024a,b) we find that – surprisingly enough – larger pension fund had over the current estimation period, and on average, no higher returns than small pension funds. In any case, our ‘market share’ (instead off ‘returns’) approach in Section 6.2, does not suffer from such indirect effect.

performance fees for scale economies and that approach indeed erases this effect. Hence, we do not draw any conclusion with respect to the question whether investment advice earns back its own costs.

Finally, we observe that taking risk is rewarded, statistically significant in any model in Table 2. This is in line with financial theory: higher volatility of returns goes with higher returns, and with what we have seen in Bikker and Meringa (2024a,b), where more investments in risky asset classes resulted in higher net returns.

We split the sample into two subperiods to see how these effects may change over time. We observe that the cost variables all have larger coefficients and higher t-values in later years compared to the earlier period. This may indicate that the pension industry has become more competitive. An underlying explanation for the observed developments may be that required qualifications of board members have become more stringent over time, which has affected smaller pension funds in particular, and stimulated mergers and acquisitions of smaller institutions.

As a first robustness test, we expand our model with cross-terms, see Eq. (6), and present the estimation results in Table 3. Such cross-terms allows for different management cost effects for varying levels of performance fees or volatility, and similarly for the other two model variables. The direct effects of Columns 1-2 are difficult to interpret, so we calculate the respective total effect in Columns 3-4 by calculating the model's first derivative to, respectively, management costs, performance fees and volatility (all in logarithms), evaluated for the average pension fund. The total effect results are fairly similar to the corresponding results in Table 2, be it that the total effects are slightly (performance fees) or substantially (management costs) stronger at similarly high levels of significance.

Table 3. Log-linear model for net returns of pension funds with cross terms (2012Q1-2023Q1)

	Model coefficients		**Total effects**	
	Coeff.	*(CSE)*	*Coeff.*	*(CSE)*
Column	1	2	3	4
Constant	-9.53	(3.29)		
Log(Management cost in %)	0.90	(0.38)	-0.79	(0.23)
Log(Performance fees in %)	0.33	(0.41)	0.34	(0.05)
Log(Volatility returns, in %)	2.26	(0.35)	1.51	(0.08)
Log Management x Log Volatility	-0.14	(0.04)		
Log Performance x Log Volatility	0.05	(0.03)		
Log Performance x Log Management	-0.07	(0.05)		
R^2, adjusted	27.6			
Number of observations	7,290			
F-test on model	463			

Note: CSE stands for clustered standard errors.

As a second robustness test, we use all observations of net returns, hence both positive and negative net returns. For each pension fund we take the largest loss and add its absolute value to each of the net returns of that fund, so that all observations are positive (except the 'largest loss' which is zero). In addition, we add the average value of the ten smallest rescaled net returns to each of the observations, so that all returns are positive. Table 4 presents the corresponding estimation results.

We see exactly the same pattern in this extended sample of net returns: (i) management cost has a statistically significant negative coefficient, which is in line with the PCS model theory: the lower pension funds' costs, the higher their net returns. This effect becomes insignificant when corrected for scale economies as in Table 2, (ii) performance fees have a significant positive effect: investment services delivered by the corresponding investment advice companies increase net returns. This effect also becomes insignificant when corrected for scale economies, not shown here, and (iii) taking risk has been rewarded (but less significantly during 2017Q3-2023Q1).

Table 4. Log-linear model of net returns of pension funds after rescaling.

	2012Q1-2023Q1		2012Q1-2017Q2		2017Q3-2023Q1	
	Coeff.	*(CSE)*	*Coeff.*	*(CSE)*	*Coeff.*	*(CSE)*
First panel: no scale corrections						
Constant	11.43	(1.23)	8.57	(0.71)	15.99	(1.69)
Log(Management cost in %)	-0.65	(0.15)	-0.47	(0.08)	-0.80	(0.21)
Log(Performance fees in %)	0.35	(0.04)	0.31	(0.01)	0.41	(0.04)
Log(Volatility returns, in %)	0.42	(0.04)	0.56	(0.04)	0.10	(0.05)
R^2, adjusted	18.6		15.8		27.2	
Number of observations	10,148		5,618		4,530	
F-test on model	775		353		565	
Second panel: Management costs corrected for scale effects						
Constant	6.81	(0.46)	5.04	(0.53)	10.60	(0.49)
Log(Management cost in %)*	-0.12	(0.16)	0.03	(0.17)	-0.32	(0.21)
Log(Performance fees in %)	0.32	(0.04)	0.28	(0.05)	0.39	(0.05)
Log(Volatility returns, in %)	0.45	(0.04)	0.60	(0.05)	0.11	(0.05)
R^2, adjusted	15.7		14.2		23.1	
Number of observations	10,148		5,618		4,530	
F-test on model	630		310		453	

Note: CSE stands for clustered standard errors. * Refers to correction for scale.

We have also run the robustness test without taking logarithms of the net returns. The results, not shown here, are fairly similar to those of Table 4.

6.2 Market shares

We apply the traditional PCS model in this section to market shares (instead of net returns): a lower marginal costs value generates a higher market share. Our market shares are based on total assets of pension funds while, in our 'model 1', costs are the sum of investment and administrative costs margins. The costs effect is large, in absolute terms, and negative (as it should be in a competitive market) and highly significant; see the upper, left side of Panel I of Table 5. Economies of scale is the main driving force, as become clear when we correct the cost margins for scale effect, see first model in the upper, left side of Panel II. Alserda *et al.* (2018) have demonstrated that the economies of scale in administrative costs are still very large (though declining over time), while Bikker and Meringa (2022) show that investment cost provides less economies of scale. Volatility has no effect on market shares, as expected, in contrast to the net return model.

We conclude that the market share results confirm what we have found in the net return approach, namely that scale economies in marginal costs drive the consolidation process in the pension sector. Indeed, under competition, scale economies (may) lead to consolidation. Effects of possible efficiency differences across pension funds of the same size seem absent also here.

We have various robustness tests. First, we split the administrative and investment costs margins. Administrative costs are 'waste' costs, while part of the investment costs (i.e. performance fees) are the consequence of chosen investments strategies which might be successful ('Model I'). We observe indeed that administrative costs have a highly significant negative impact on market shares, whereas investment costs have a positive effect. Therefore, we next divide investment costs into the waste part, management cost, and the 'investment' part, performance fees ('Model II'). We observe that the waste type managements costs indeed do not help to achieve greater market shares (negative coefficient) but that performance fees do contribute to growth.

Second, we re-estimate the models for the subperiods 2012Q1-2017Q2 and 2017Q3-2023Q1. All results are also found in each of these two subperiods, see Panel 1. This conclusion also holds for

Panel II where cost efficiency is corrected for scale, but there the significant effects all disappear after correction.

Table 5. Log-linear model for market shares of pension funds

	2012Q1-2023Q1		2012Q1-2017Q2		2017Q3-2023Q1	
	Coeff.	*(CSE)*	*Coeff.*	*(CSE)*	*Coeff.*	*(CSE)*
Panel 1: no scale corrections						
Model 1						
Constant	-6.54	(0.26)	-7.05	(0.18)	-6.11	(0.23)
Log(Inv. + admin. costs in %)	-1.41	(0.11)	-1.32	(0.04)	-1.55	(0.17)
Log(Volatility returns, in %)	0.06	(0.06)	-0.03	(0.04)	0.13	(0.04)
R^2, adjusted	25.1		26.5		22.0	
Number of observations	10.529		5.837		4.692	
F-test on model	1764		1056		664	
Model 2						
Constant	-8.22	(0.20)	-8.17	(0.11)	-8.16	(0.22)
Log(Investment costs in %)	0.24	(0.10)	0.25	(0.03)	0.28	(0.16)
Log(Admin. costs in %)	-1.12	(0.11)	-1.19	(0.03)	-1.05	(0.18)
Log(Volatility returns, in %)	0.02	(0.04)	0.03	(0.03)	0.04	(0.04)
R^2, adjusted	40.7		45.0		35.2	
Number of observations	10,352		5,705		4,647	
F-test on model	2365		1555		841	
Model 3						
Constant	-11.40	(1.22)	-11.74	(0.41)	-11.64	(1.74)
Log(Management costs in %)	-0.36	(0.11)	-0.32	(0.04)	-0.43	(0.17)
Log(Performance fees in %)	0.20	(0.07)	0.09	(0.02)	0.29	(0.07)
Log(Admin. costs in %)	-0.61	(0.13)	-0.56	(0.03)	-0.66	(0.15)
Log(Volatility returns, in %)	0.15	(0.05)	0.18	(0.05)	0.06	(0.05)
R^2, adjusted	32.9		28.9		37.1	
Number of observations	4,118		2,459		1,659	
F-test on model	506		251		245	
Panel II: Corrections for economies of scale						
Model 1						
Constant	-8.05	(0.51)	-9.01	(0.65)	-6.97	(0.46)
Log(Inv. + admin. costs in %)*	0.02	(0.12)	-0.16	(0.23)	0.50	(0.35)
Log(Volatility returns, in %)	-0.11	(0.12)	-0.30	(0.16)	0.10	(0.11)
R^2, adjusted	0.1		1.3		1.9	
Number of observations	10,529		5,837		4,692	
F-test on model	6		39		47	
Model 2						
Constant	-7.30	(0.53)	-7.68	(0.60)	-6.95	(0.48)
Log(Investment costs in %)*	0.12	(0.12)	0.05	(0.14)	0.27	(0.13)
Log(Admin. costs in %)*	-0.02	(0.21)	-0.29	(0.17)	0.42	(0.30)
Log(Volatility returns, in %)	0.05	(0.13)	-0.02	(0.14)	0.08	(0.12)
R^2, adjusted	0.3		0.9		3.7	
Number of observations	10,097		5,530		4,567	
F-test on model	10		17		57	
Model 3						
Constant	-7.63	(0.49)	-8.05	(0.57)	-7.35	(0.43)
Log(Management costs in %)*	0.11	(0.11)	0.02	(0.13)	0.25	(0.11)
Log(Performance fees in %)	-0.14	(0.02)	-0.14	(0.02)	-0.15	(0.02)
Log(Admin. costs in %)*	-0.21	(0.15)	-0.29	(0.16)	-0.01	(0.20)
Log(Volatility returns, in %)	0.09	(0.12)	0.03	(0.14)	0.11	(0.10)
R^2, adjusted	13.2		12.7		16.5	
Number of observations	10,060		5,512		4,549	
F-test on model	381		200		224	

Notes: CSE stands for clustered standard errors. * Refers to correction for scale.

Finally, we estimate the market share variant of Eq. (5) with fixed effects for pension funds, or in first differences, two approaches which also eliminate scale economy effects (results not shown). The administration cost margin effects on market shares, however, remain negative and statistically significant.

7. Conclusions

This paper sheds light on the functioning of the pension fund market in the Netherlands. Pension funds are shielded from fierce competition by the so called Great Obligation (‘*grote verplichtstelling*’), which ensures a mandatory participation by employees in their company’s or industrial sector’s own pension fund. However, some competition remains due to mergers between pension funds and take-overs of smaller pension funds, and the competition for asset managers. The Dutch supervisory authority may play an important role through regulation of pension funds, for example by setting more stringent requirements for pension board members over time.

The literature tells us that properly functioning markets are those markets in which efficiency among firms is rewarded by profitability, that is in terms of net investment returns. Therefore, we look at the relationship between efficiency and profitability of pension funds and find that this relationship is statistically significant, but the strength of the relationship is (at a β of -0.48) relatively weak, as can be derived from the low value of β compared to the results for the life insurance and banking sectors. This is in line with the fact that pension funds are shielded from fierce competition compared to these sectors. To achieve this result, we correct for the investment risk that pension funds take. Here, too, we find a positive effect of risk on profits, indicating that risk taking is rewarded.

The observed efficiency-profitability relationship depends fully on scale economies in efficiency. In that sense we describe the consolidation process in the pension fund market where larger pension funds are more attractive as merger partner due to cost economies.

The relationship between efficiency and profits has strengthened over time, indicating that the increased regulation of transparency of costs has borne fruit, and may have provided incentives to reduce unnecessary costs. The increased quality of the pension fund boards and the increased professionalism of asset managers due to consolidation among pension funds may have contributed to this result. Also, competition among pension fund service providers, such as administration offices, may be reflected in the increase of the pension fund efficiency and net profit relationship.

When we repeat our estimations for market shares instead off profits, we obtain similar results. Our overall conclusion is that in the pension fund market efficiency has been rewarded in the last decade and that this functioning has improved over time, although considerable room for improvement remains, given the low impact of efficiency on profits (or market shares) compared to *e.g.* the life insurance industry and the banking sector.

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Appendix. Corrections for scale effects

Table A.1 presents estimates of auxiliary regressions which are used to correct for possible scale effects of the cost margins in the models for net returns and market shares (Tables 2-5). Pension fund sizes are measured by their amounts of total assets. The residuals of these auxiliary regressions have been used as corrected cost margins. Management costs have small but statistically significant scale effects of roughly -5%. Larger pension funds have lower management cost margins. This is in line with the economy of scale effects which have been found in Bikker and Meringa (2022). Performance fees do not reflect economy of scale effects: on the contrary, they increase significantly with pension fund size. Investment costs, that is the sum of management costs and performance fees, have no significant relationship with pension fund size. Scale effects in administration costs are huge with -39%, in line with the economies of scale estimates of Alserda *et al*. (2018). The scale effect of the total cost margin, investment costs and administration costs, is, at -18%, in between the investment (-0.02) and administration (-0.39) effects.

Table A.1. Auxiliary regressions to correct for scale effects (2012Q1–2023Q1)

	Log(Assets)	**Number of observations**
Table 2-4		
Log(Management costs in %)	-0.05 (0.02)	10,315
Log(Performance fees in %)	0.20 (0.05)	4,118
Table 5		
Model I		
Log(Inv. + admin. costs in %)	-0.18 (0.02)	10,529
Model II		
Log(Investment costs in %)	-0.02 (0.02)	10,352
Log(Administration costs in %)	-0.39 (0.03)	10,274

Note: Clustered standard errors are between brackets.

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De Nederlandsche Bank N.V.
Postbus 98, 1000 AB Amsterdam
020 524 91 11
dnb.nl