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Have scale effects on cost margins of pension fund investment portfolios disappeared?

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Abstract
Investment costs of pension funds are crucial for their returns. Consolidation in the pension fund market proceeds continuously, often with cost savings as the main argument. Unused economies of scale in the pension fund investment costs, however, have declined over the years to values close to zero, except for the very small pension funds. This paper investigates investment economies of scale in the Netherlands and pays special attention to the non-linear relationship between investment costs and sizes of pension funds. Furthermore, investment cost margins are disaggregated into three cost types and into six asset categories. Scale economies on investment cost still, ranging from 10% for the smaller pension funds to 5% for the largest ones. Performance fees are in particular paid for complex asset categories held by large pension funds. They show strong diseconomies of scale and reduce the traditional scale economy results for the entire portfolio

Keywords: Scale economies; cost elasticity; pension funds; investment costs; efficiency; non-linear cost-size relationship;

JEL classification:G23, L10

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1. Introduction

The costs of pension funds' investments have a direct impact on their net returns. More than ever, these costs affect current and future pension benefits: now pension premiums are high, with pension premiums in the Netherland between 25% and 30% of salaries, little room exists to increase them further. In recent years, a large number of smaller pension funds are terminated and taken over by other pension funds or life insurers. Annually, this concerns more than 110.000 participants and over 6 billion euro. A major argument for these mergers is lower costs per invested euro, due to scale economies. But are these scale economies still substantial? Research on scale effects in investment costs of pension funds reveals, however, a remarkable development over time. At outset, large unused scale economies were found for the Netherlands of, on average, 22% during 1992-2004 (Bikker and De Dreu, 2009) and 20% in 1992 (Bikker, 2013). However, in the last decennium there seems to be an absence of any economies of scale: 0% in 2009 (Bikker, 2013) and 0% over 2002-2013 (Alserda, Bikker and Van der Lecq, 2018). This contrasts sharply with the continuing and significant economies of scale in administration costs of pension funds as observed in the same studies, even though these followed a downwards trend: from 36% in 1992-2004, to 29% in 1992-2009, to 10% in 2002-2013. A decline in the mean economies of scale is plausible: three quarters of the pension funds in 1992, particularly the smaller ones, have since been discontinued. But the complete elimination of scale economies, as apparently seems the case with investments, is counter-intuitive.

Broeders *et al.* (2016), investigate more precise disaggregated data on investment costs, reported only since 2012. For 2013, they do find economies of scale, for the entire investment portfolio, as well as for a number of separate investment categories. These at first sight contrary results raise the question as to whether scale effects on cost margins of pension fund investments still exist. The primary objective of this paper is to thoroughly investigate the recent and current behaviour of pension fund investment costs, where we distinguish three cost types (management cost, performance fees and transaction cost) and six investment categories (fixed income, stocks, real estate, hedge funds, commodities, and private equity). Our results reveal large differences in behaviour across cost types and across asset categories.

The three studies cited in the first paragraph use a model with a non-linear relationship: more economies of scale for small pension funds and fewer for the large ones. Classic economic theory proposes for the short term U-shaped economies of scale between unit costs and size: in the left leg when size increases declining per unit cost until the cost margin is constant and thereafter in the right leg, when size increases further, increasing costs. Strong economies of scale for small enterprises are quite obvious as – when growing – fixed costs can be allocated over larger production. We refer to this phenomenon as the left leg effect. Numerous studies also point to higher inefficiency for larger firms, contributing evidence to the 'right leg effect'. Key factors are managerial problems in large and complex firms: 'bureaucracy', 'additional layers of management and over hiring' (Chatterton *et al.*, 2013), and increasing luxury in terms of buildings and salaries, extra costs due to scarcity of qualified staff and additional costs related to overconfidence (Griffin and Tversky, 1992). Bauer *et al.* (2010) mention increasing costs of communication between the different sections of the company and the costs involved in monitoring employees, including managers. The motivation and commitment of employees may be lower in a large organization, as they contribute relatively little to the overall success of the organization, resulting in lower productivity (Canback *et al.*, 2006). Lack of a clear overview of budget and liquidity in a large firm may cause inefficient spending with respect to recruitment, equipment or offices (Canback *et al.*, 2006). Pension funds with large amounts of assets are unable to respond quickly to changes in the market, particularly when capital markets are stressed (McKenna and Kim, 1986; Bauer *et al*., 2010; Andonov, Bauers and Cremers, 2011), and therefore face market impact costs when buying or selling (Bikker *et al*., 2007, 2008, 2010). The key question is whether such large firm inefficiencies outweigh the basic effect of the monotonically declining fixed costs.

Shaffer (1998) investigates functional forms to model costs and explains that many models are too restrictive to describe both (right and left leg) aspects of scale economy changes in relation to firm size: the outcomes are forced in one or another direction. Broeders' model is prone to this criticism as his model can only describe monotonically declining fixed costs. Hence, the second goal of this paper is to thoroughly investigate the optimal functional form of the pension fund cost model in order to distinguish the two main drivers of scale economies and pension fund size relationship for the various cost types and investment categories.

This paper fits the new disaggregated data in 2012-2019 to a model that encompasses all mentioned and other theoretical relationships between costs and size and, hence, allows for a possible strong non-linear relation. That enables us to shed light on the puzzle of declining or even disappearing economies of scale in the costs of pension investments. Section 2 provides a literature survey and Section 3 describes the pension system in the Netherlands. Section 4 presents the (disaggregated) data of pension fund costs and the next section the methodology of measuring economies of scale. Section 6 shows the empirical results for total costs and their components as well as by asset class; furthermore a large number of robustness tests are presented. The last section presents conclusions.

2. Literature on scale economies in investment costs

Our definition of investment costs is: the sum of management cost, performance fees and transaction costs, where management costs comprise expenses for market analysis research, risk management, and consulting fees. In practice, particularly in the past, not all cost components are reflected in the reported costs, as sometimes cost items are deducted from gross returns. Specially, when investment is outsourced, the hidden costs may not even be known by the pension fund. A number of studies consider total operating expenses of pension funds, which also include administration costs besides investment cost: Caswell (1976), Mitchell and Andrews (1981), Bateman and Mitchell (2004) and Dobronogov and Murthi (2005). Particularly in earlier years, administration costs dominated investment cost. As these studies are less informative for our purposes, we consider here only the investment-cost-only studies. Bikker and De Dreu (2009), Bikker (2013) and Alserda *et al*. (2018) investigate investment cost of Dutch pension funds, separately from their administrative costs. These studies provide economies of scale which gradually decline towards zero, as said above. In contrast, Broeders *et al*. (2016) do find statistical significant scale economies for the Netherlands. For the US, Bauer, Cremers and Frehen (2010) observe strong economies of scale in costs in domestic equity investments. Costs vary across equity categories and are also higher for small cap portfolios compared to large caps, and for portfolios which are actively managed or externally managed compared to those internally managed. Both Andonov *et al*. (2011) and Dyck and Pomorski (2011) investigate investment costs as well as returns of an international sample of large pension funds. They observe significant economies of scale for both costs and returns. Most of the higher returns come from large pension funds' increased allocation to alternative investments (mainly private equity) and realizing greater returns in this asset class. Other possible explanations are the greater bargaining power of larger pension funds (Andonov *et al*., 2011), and their possible advantages of internationalization (Dyck and Pomorski, 2011).

The investment operations of pension funds are similar to those of mutual funds and many pension funds invest assets through mutual funds. Therefore, the – extended – literature on the investment costs of mutual funds may provide meaningful insights into the investment operations of pension funds as well.[1] Empirical evidence suggests the existence of substantial cost-related economies of scale in the mutual fund industry, which decrease as the fund size increases and become zero as soon as the optimal size has been reached, see Malhotra and McLeod (1997), Collins and Mack (1997) and Indro, Jiang, Hu, and Lee, (1999). Of course, mutual funds may incur higher costs in hunting for higher returns. Ippolito (1989) compares the expenses and returns of mutual funds and index funds and found that mutual funds offset higher expenses with better results. Possibly, however, this outcome may be sensitive to the particular benchmark used, or can be explained by survivorship bias (*e.g.* Malkiel, 1995). Many other studies have found that higher costs are not related to superior performance relative to the risk-adjusted rate of return (*e.g.* Jensen, 1968, Malkiel, 1995, and Malhotra and McLeod, 1997). Thus, the evidence suggests that, in general, higher costs incurred by mutual

[1] Note that mutual fund expenses and investment costs of pension funds are different. For example, marketing costs and administration costs are important cost categories in the mutual fund industry. Pension funds have little if any marketing costs and administration costs are nowadays reported separately. Also, pension funds have to take the duration of their investment portfolio into account, given their liabilities. Finally, mutual funds often focus on investments in one asset class (*e.g.* stocks, bonds), while pension funds generally invest in various asset classes.

funds do not lead to higher returns. Since the investment operations of pension funds and mutual funds are similar, it seems reasonable to expect this result to hold for pension funds as well.[2]

We may therefore conclude that, *ceteris paribus*, stakeholders are likely to be best served by pension funds with low investment costs. Furthermore, on the investment market, scale economies tend to exist but, according to some studies, only as long as institutions are below the optimal scale.

3. The pension system in the Netherlands

The institutional structure of the Dutch pension system is made up of three-pillars, similarly as in most other developed countries. The first pillar consist of the 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. Its pension benefit age moved gradually from 65 years until 2012 to 66.3 years in 2020 and will go up to 67 years in 2024. 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 organized as a funded defined-benefit (DB) or collective defined contributions (CDC) plan. The benefit entitlement is determined by years of service and a reference wage, which is in more recent years 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 organized for a specific industry sector (*e.g.* construction, health care, transport). Participation in an industry pension fund is mandatory for all employers operating in the 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, participation by the workers is mandatory, governed by collective labour agreements. The third type of pension fund is the *professional group* pension fund, organized for a specific group of professionals, such as the medical profession or notaries.

The Dutch pension fund system is comprehensive, covering as much as 81% of the active labour force in 2019. Almost all employees are covered, but the self-employed need to arrange their own old-age savings. At the end of 2019, total pension fund assets in the Netherlands amounted to some € 1,471 billion, or 182% of GDP, ranking the Dutch pension system, in terms of the assets-to-

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[2] Lakonishok, Schleifer, and Vishny (1992) report that the pension fund industry has consistently underperformed the market. The authors posit that pension fund managers may trade excessively, incurring large execution and transaction costs, and may be unlucky with their timing.

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, which will come in force in 2022 beginning with a transition period of five years. This system may have a collective buffer to soften setbacks, at the choice of the pension funds.

4. Disaggregated data of pension fund investment costs

This paper is based on unique and extended reports of 280 pension funds of investment costs over 2012-2019 to their financial supervisor De Nederlandsche Bank (DNB). Data of funds discontinued before January 1, 2019 have been deleted for all years. The choice of this filter prevents the possible so-called selection bias problem in the estimations.[3] When figures of a pension fund are in any year incomplete, than this funds is deleted for that year. In 2019 the selected funds together manage 94.6% of the total pension investments of € 1.471 billion. Investment costs are split into three components: management, performance and transactions, and available for each of six investments categories: fixed income, stocks, real estate, hedge funds*,* commodities and private equity. Since 2015, private equity is called alternative investments, due to a minor change in the definition. We stick to the old name, as private equity is the dominant category of alternative assets. There is a residual item 'other investments' which is not analysed further as a separate asset class, as costs of other investment also includes general cost, such as liquidity costs, CEM benchmarking, as well as currency and interest rate derivatives, as far as not directly related to investment categories.

Table 1 presents the investment costs margins by investment category and cost type. The upper panel shows that the total costs decline from 0.54% in 2012 to 0.49% in 2019. This decline also holds for the costs of all asset classes, except private equity. Management costs fall by even a quarter, and such a decrease is observed for all six asset classes. Developments in performance fees and transaction costs over time vary across the asset categories.

Investment cost margins are much higher for complex investment types compared to fixed income and stocks. In 2019, private equity investments are 23 times as expensive as those in fixed income. Management costs are also higher (16 times), but the majority of cost differences across asset types are related to performance fees. Commodities have high investment costs. This is a more speculative investment asset with more frequent buying and selling. These observations highlight the differences across asset categories.

The middle panel of Table 1 presents key data for the class of the sixth largest pension fund (covering 59% of all investments) and the lower panel for the class of the 91st smallest pension fund (holding 5% to 6% of all assets). For the largest funds the cost margins of particularly fixed income, stocks and real estate are lower than those of the smallest pension funds, reflecting economies of scale.

[3] For instance: non-viable pension funds may behave differently.

The largest funds have many more investments in the expensive complex categories (hedge funds, commodities and private equity), so that their average cost margin is still higher than that of the class of smaller funds.

Table 1. Investments and cost margin by investment category (2012 and 2019)

	Investments (billion €)		Costs (in percentages)							
			Total		*Management*		*Performance*		*Transactions*	
	2012	2019	2012	2019	2012	2019	2012	2019	2012	2019
	All pension funds									
Fixed income	441	815	0.19	0.16	0.11	0.10	0.01	0.00	0.07	0.06
Stocks	251	438	0.28	0.23	0.21	0.14	0.03	0.03	0.04	0.05
Real estate	79	136	0.92	0.72	0.82	0.53	0.06	0.12	0.03	0.07
Hedge funds	26	26	3.38	2.68	1.84	1.43	1.52	0.83	0.02	0.42
Commodities	2	4	2.45	2.24	1.69	1.26	0.30	0.07	0.46	0.90
Private equity	40	71	3.08	3.70	1.90	1.60	1.18	1.96	0.00	0.14
Total [a]	*838*	*1,471*	*0.54*	*0.49*	*0.36*	*0.27*	*0.13*	*0.14*	*0.06*	*0.08*
	Largest pension funds									
Fixed income	235	431	0.17	0.14	0.10	0.07	0.02	0.00	0.11	0.06
Stocks	152	264	0.22	0.20	0.18	0.12	0.03	0.04	0.03	0.04
Real estate	56	92	0.95	0.68	0.84	0.49	0.07	0.15	0.07	0.05
Hedge funds	22	22	3.62	2.69	1.90	1.44	1.70	0.83	0.07	0.41
Commodities	0	4	7.92	2.10	5.53	1.19	1.44	0.07	1.51	0.84
Private equity	34	67	3.12	3.71	1.88	1.53	1.23	2.04	0.00	0.13
Total [a]	*492*	*864*	*0,65*	*0.58*	*0.42*	*0.29*	*0.19*	*0.21*	*0.08*	*0.08*
	Smallest pension funds									
Fixed income	34	51	0.28	0.23	0.15	0.16	0.02	0.00	0.16	0.07
Stocks	15	22	0.38	0.31	0.29	0.22	0.07	0.02	0.07	0.08
Real estate	3	4	1.10	0.71	1.01	0.52	0.01	0.10	0.11	0.15
Hedge funds	1	0	1.30	1.01	0.97	0.79	1.12	0.11	0.03	0.11
Commodities	1	0	0.74	6.83	0.64	3.50	0.02	0.00	0.11	3.34
Private equity	1	1	1.96	3.58	1.83	1.66	0.09	2.42	0.03	0.11
Total [a]	*54*	*77*	*0.39*	*0.33*	*0.27*	*0.22*	*0.04*	*0.08*	*0.13*	*0.08*

Source: DNB.

[a] Residual item 'other investments' has not been shown. Private equity is called 'alternative investment' since 2015. For the all pension funds sample, the total cost margin is the sum of the management, performance and transaction cost margins (horizontal aggregation). The total cost margins follow from the investment category margins, but each category weighted with its own share, see Tables A.1 and A.2 in the appendix (vertical aggregation).

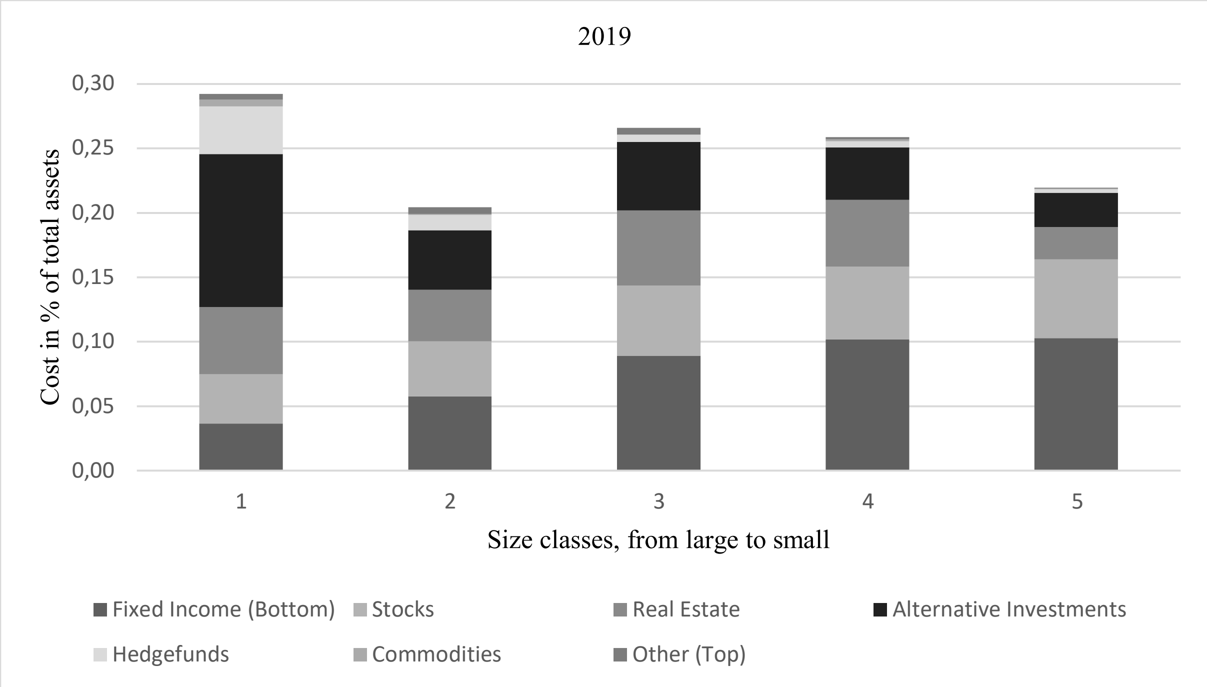
The higher costs of complex products are expenses which are 'compensated' by higher expected returns: costs contribute to benefits. We split the costs into two fictitious components: 1. costs which we consider waste*,* of which we want to know possible economies of scale. These costs are related to all necessary activities for investments which are roughly the same for all investments – comparable to pension funds' administration costs – which should be as low as possible; and 2. Costs which exclusively relate to the higher risk and the higher complexity of particular categories – related to risk management and market analyses – which are offset by expected higher returns. For our analysis it is of great importance to correct for the latter type of product-related costs. We do so in the model presented below.

The composition of the management costs in terms of asset categories and the impact of the size of pension funds is illustrated in Figure 1. Five size classes from large to small show for 2012 and

2019 that the costs are highest for the large pension funds. The main drivers are their high costs of private equity and hedge funds. increase when the institution became smaller, reflecting the existence of scale economies, while for the really large funds the specific costs of real estate and hedge funds are much higher. This graph is representative for most of the years. In 2019, however, the costs are roughly equal for all size classes. The economies of scale of larger pension funds, clearly present by fixed income and stocks, are offset by the relative high costs of hedge funds and private equity.

Figure 1. Management costs of pension funds in basis points, and the asset allocation, by five size classes[4]

[4] The comma in the numbers on the axis of (all) the figures should be read as decimal point.



Note: The general 'other costs' (among which covering of interest- and exchange risk) are here allocated to the tiny item 'other investments'.

5. Methodology of measuring economies of scale

This section discusses the functional form of cost models and their underlying assumptions with respect to the shape of the average cost per unit curve, which determines the magnitude of scale economies. In the literature, the translog cost function (TCF) to describe costs dominates other model specifications. Christensen *et al.* (1976) proposed the TCF as a second-order Taylor expansion, usually around the mean, of a generic function with all variables appearing as logarithms. This TCF is a flexible functional form that has proven to be an effective tool for the empirical assessment of efficiency, both in banking and elsewhere (Christensen *et al*., 1976; Dietsch, 1993; Nauriyal, 1995; Edirisuriya *et al*., 2001). It is an extension of the Cobb-Douglas function which is capable of fitting the theoretical U-shaped short-term unit cost functions.[5] A simple TCF is as follows:

$$\ln IC_{it} = c + \alpha\,(\ln TA_{it}) + \beta\,(\ln TA_{it} - \overline{lnTA})^2 \tag{1}$$

with *IC* for investment costs and '*TA*' for total assets or investments, as the measure of size. Subscripts *i* and *t* refer to, respectively, pension fund *i* and year *t*. Note that, in the squared term, we take the logarithm of *TA* in deviation from its geometric mean (denoted by the bar above the variable), in line

[5] For shortcomings of the TCF, see Shaffer (1998, p. 91).

with the Taylor expansion.[6] Unused scale economies exist where $\alpha < 0$, while concavity, or a U-shaped unit cost function, requires $\beta > 0$.

Shaffer (1998, page 94) proves that for a sample of monotonically declining unit costs, the TCF would estimate a concave function with an optimal scale, so that the existence of an optimal size and diseconomies of scale for larger firms is (incorrectly) imposed.[7] Indeed, the left leg of the TCF can be fitted to the hyperbolically declining average costs, with the optimal scale in the right-hand tail of the sample, or beyond the largest observation. Therefore, Shaffer (1998) suggests cost functions to estimate scale economies which do not impose this U-shaped average-cost function. The main alternative is the unrestricted Laurent function (ULF), which is similar to the TCF, but with two inverse terms added:

$$\ln IC_{it} = c + \alpha \ln TA_{it} + \beta (\ln TA_{it} - \overline{\ln TA})^2 + \gamma / \ln TA_{it} + \delta / (\ln TA_{it})^2 \qquad (2)$$

The ULF can describe monotonically declining average cost, does not impose an optimal scale and allows different degrees of concavity for smaller and larger pension funds. For the concave properties to hold, the coefficients γ and δ should both be positive, next to β. Under $\gamma = \delta = 0$, Equation (2) would become equal to the TCF.

Cost elasticity (*CE*) is defined as the proportional increase in cost as a result of a proportional increase in output. In mathematical terms this results in the following expression for elasticity: $CE_{it} = \partial \ln OC_{it} / \partial \ln TA_{it}$. Using Equation (2), this is equal to:

$$CE_{it} = \alpha + 2\beta (\ln TA_{it} - \overline{\ln TA}) - \gamma / (\ln TA_{it})^2 - 2\delta / (\ln TA_{it})^3 \qquad (3)$$

The second term of *CE* becomes zero when the *CE is* evaluated around the mean of the sampled logarithms of TA_{it}, that is: $\overline{\ln TA}$. The *CE* is then equal to the sum of α and the last two terms which depend on the sample observations. The scale economies (*SE*) can easily be calculated from the above by subtracting EC from unity: $SE = 1 - CE$. If the calculated *CE* has a value larger than one, this indicates diseconomies of scale; a value smaller than one indicates economies of scale and a value of exactly one indicates constant returns to scale.

Our empirical model for investments costs (*IC)* reads as:

$$\ln IC_{it} = c + \alpha \ln TA_{it} + \beta (\ln TA_{it} - \overline{\ln TA})^2 + \gamma / \ln TA_{it} + \delta / (\ln TA_{it})^2 + \textstyle\sum_k \varepsilon_k IP_{ikt}/TA_{it} + \sum_j \varphi_j R_{ijt}$$
$$+ \nu\, TA_{it}/P_{it} + u_{it} \qquad (4)$$

[6] White (1980) and Shaffer (1998, p. 95) explain that this specification also helps to avoid multicollinearity. Note that $\overline{\ln TA}$ is the arithmetic average of the *logarithms* of output measure TA_{it}.

[7] Except possibly over limited ranges of scale within which marginal costs are steeply declining.

The IP_{ikt} stands for investment products or categories k (as listed in Table 1), as each product brings its own investment costs. In general it holds that greater risk is attached to higher costs of risk management market analyses. The coefficient ε_k denotes the extra costs attached to investments in category k, compared to fixed income. In this way, costs are corrected for the varying composition of the investment portfolio and, particularly, for the fact that larger pension funds have more risky and costly investment products. R_{ijt} denotes rating class j of the fixed income investments of pension fund i in year *t, as* the rating of bonds are also attached to cost: the lower the rating, the more risky they are and the more the cost of risk management and market analyses involved. Further, TA/P represents investments per participant, as investment strategies and costs may relate to the average pension wealth. Other explanatory variables are type of pension fund organisation (industry, company or professional group pension funds), pension scheme (defined premiums versus defined benefits) and age and working position of participants (working, inactive or retired). They are included in the estimated model, but appear not to be significant.

Note that both the sum of all investments products and the sum of all ratings amount to 1, so that we (twice) delete one category to avoid singularity in the explanatory variables. We delete fixed income, so that all other coefficients of investments products reflect cost differences with fixed income. And, similarly, we delete the AAA rating class, so that all other rating coefficients show cost differences with the AAA rating.

We use the model of Broeders *et al* as a robustness check. This model deviates from our Equation (4) in two respects. First, the dependent variable is not the logarithm of investments costs ($ln\ IC_{it}$) but the cost margin IC_{it}/TA_{it}, and second, the non-linear terms of total investments are absent (so that scale economy does not vary with pension fund size, expressed as total investments):

$$IC_{it}/TA_{it} = \alpha\ ln\ TA_{it} + \sum_k \varepsilon_k\ IP_{ikt}/TA_{it} + \sum_j \varphi_j\ R_{ijt} + v\ TA_{it}/P_{it} + u_{it} \qquad (5)$$

Broeders *et al*. (2016) have two other explanatory variables related to duration, not available to us or considered as less relevant. The main disadvantage of this model, in our view, is that the relationship between economies of scale and pension fund size is imposed, as in the TCF model, explained above. An advantage is that the simple relationship between scale economies and pension fund size more easily results in significant effects. A minor disadvantage is that scale economies cannot directly be derived from the estimation results as in Equation (5), where they follow directly from (4), see Equation (3).

6. Estimation results

6.1. Models of total costs and their components

Table 2 provides the estimates of Equation (4), using pooled OLS and Newey-West estimates of heteroscedasticity and autocorrelation consistent (HAC) standard errors. In this presentation, we drop the constant and the insignificant other explanatory variables discussed below that equation: organizational types of pension funds, pension schemes, as well as age and working position of participants. The negative coefficients of the quadratic total assets term reveal that the unit cost function is concave, that is, costs decrease less than proportionally with size, reflecting large economies of scale for small pension funds and smaller economies of scale for larger pension funds. Positive coefficients of the inverse terms of total assets would indicate that fixed costs exist which may be allocated to ever-increasing investments. This can reflect a component to economies of scale that exist for any pension fund size. This is indeed the case for total costs, management costs and transaction costs, as the positive effect of the first inverse term outweighs the effect of the second (quadratic) inverse term. The opposite is true for performance fees, where the classical scale economy theory does not (fully) apply.

Note that multicollinearity may exist between the four total assets terms, which may prevent statistical significance of the separate terms, see the correlation matric of the explanatory variables in Table A.4 in the appendix. A Variance Inflation Factor (VIF) test confirms the multicollinearity among the four size terms, but reveals that multicollinearity among all other explanatory variables, and between the size variables and the other explanatory variables, are very low, with VIF values below 2.5, see last column of Table A.4 in the appendix. In Section 6.8, we test whether one or more of the non-linear total assets variables may be excluded. This is not the case: these tests reveal that all exclusion restrictions are rejected. Hence, we need to keep the model specification as it is.

The four coefficients of the size terms together determine the cost elasticity (*CE*), as explained by Equation (3). For total costs this *CE* is 0.94 for the average pension fund, defined as the geometric mean of the pension fund's investments, which corresponds to € 751 million. This implies average economies of scale of 6%. For managements costs these economies of scale are larger at 9%, while for performance costs and transaction costs, diseconomies of scale exist, at least for the average pension fund. For performance costs, the traditional scale economy theory may not be applicable, as performance fees are expected to be compensated by higher returns from investments. However, Broeders, Van Oord and Rijsbergen (2019) do not find such 'compensation' effect in their empirical investigation. Also for transaction costs, one likely expects that the additional (transaction) costs of active management are compensated by higher returns. Here too, traditional scale economy theory may not be applicable.

Table 2. Estimates of the investment costs of pension funds Equation (4) over 2012-2019

	Total costs		Management costs		Performance costs		Transaction costs	
Column	*1*		*2*		*3*		*4*	
ln(total assets)	3.17	0.78*	1.78	0.94°	1.90	1.62	2.61	2.46
(ln(total assets)-ln(gem.))^2	-0.08	0.03*	-0.04	-0.04	-0.08	0.05	-0.09	0.04°
1/ln(total assets)	774.21	271.73*	309.23	334.91	-233.13	736.20	368.80	369.83
1/(ln(total assets))^2	-2474.8	874.17*	-1010.04	1099.23	2748.52	2936.8	-598.86	1181.91
ln (assets/participants)	-0.04	0.02°	-0.04	0.02°	0.09	0.07	-0.08	0.03*
Stocks#	0.37	0.12*	0.34	0.12*	2.02	0.69*	0.24	0.30
Real estate#	1.82	0.26*	2.00	0.26*	-2.62	1.59	1.02	0.59
Hedge funds#	6.09	0.45*	5.89	0.47*	15.01	1.78*	-1.19	2.50
Commodities#	4.61	1.71*	6.18	1.77*	0.97	9.47	-8.60	3.87°
Private equity#	7.67	0.52*	7.14	0.57*	23.30	2.85*	2.37	1.26
AA#	-0.58	0.10*	-0.54	0.09*	-0.70	0.58	-0.53	0.20*
A#	-0.19	0.13	-0.07	0.15	-1.28	0.85	0.15	0.26
BBB#	0.78	0.14*	0.70	0.14*	2.62	0.90*	-0.30	0.35
lower than BBB#	1.35	0.17*	1.52	0.17*	-1.05	1.00	1.28	0.52°
no rating#	0.55	0.13*	0.72	0.13*	-1.21	0.55°	-0.25	0.33
Cost elasticity (average p.f.)	0.941		0.911		1.173		1.104	
R^2 adjusted for d.o.f.	96.2		96.0		74.0		82.5	
Number of observations	1486		1486		667		1387	

Notes: Newey-West estimates of heteroscedasticity and autocorrelation consistent (HAC) standard errors are shown in red. # indicates that the shares are expressed as per units. * and ° indicate statistical significance at the respectively 99% and 95% confidence level.

We start with the first two columns referring to estimates of the total costs and management cost models. As the category management costs is the main component of total costs, these estimates are rather similar. The model variables reflecting the composition of the investment portfolio show that all investment products have attached to them considerably more, and statistically significantly more total and management costs than fixed income (which are chiefly bonds). That is plausible because market analysis and risk management of these products are, on average, more complex. If investments in stocks, real estate, hedge funds, commodities or private equity were doubled at the cost of fixed income investments, total investment costs would increase by, respectively, 10%, 20%, 16%, 1% or 29%.[8] Cost difference across asset types are better reflected, if we considered marginal cost, and increase investment for each asset category by, say, 10 percentage points. Total costs would then increase by, respectively, 3%, 20%, 66%, 45% or 52%.[9] For management costs the outcomes are roughly the same.

In addition to the decomposition of the entire investment portfolio, we have the decomposition of the rating distribution for fixed income. Total and management costs increase significantly with the rating: investment in relatively save AA and A bonds bring much less costs along, while those in the more risky BBB and below BBB bonds go with more costs. If investments in BB and BBB bonds

[8] The formula reads: exp(coeff. x change) – 1. ‘Coeff.’ of the shares in investment by asset type are from Table 2, while ‘change’ here means doubling the current shares of the investment categories which are presented in Table A.2 in the Appendix.
[9] Here ‘change’ is 0.1.

would be doubled at the cost of AAA bonds, total investment costs would increase with 6%,[10] or for an increase in investment for each of these categories by, say, 1 percentage point: respectively, 0.85% and 1.47%. The rating class costs are compared to those of AAA bonds. It is remarkable that they are higher than those of AA and A rating classes. We observe this also for all individual years. This may be because the risk of the safest counterparties is more difficult to assess, as the probability on default or credit quality downgrading in this class is extremely rare or absent. Wealth per participant (investments per participant) is accompanied by lower costs. The total cost and management cost models explain around 96% of all variation in costs (R^2, adjusted for degrees in freedom).

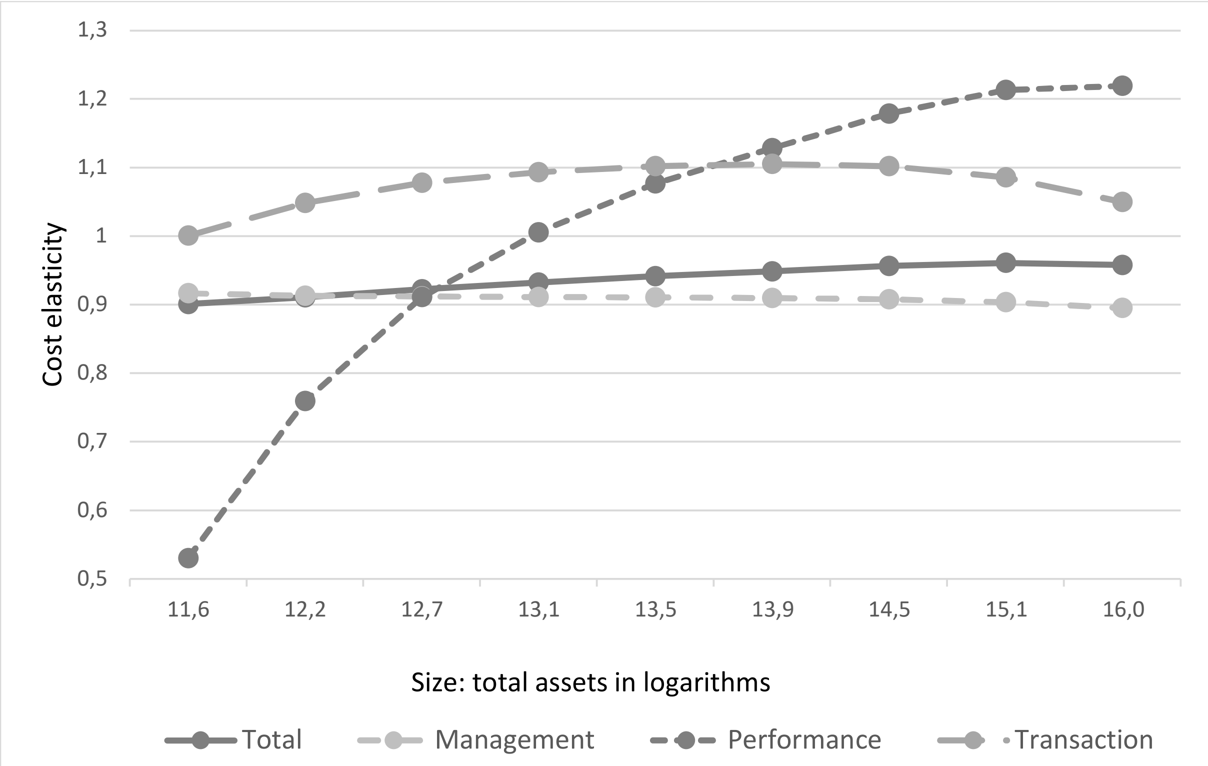
Performance costs are only paid by a minority of pension funds (those who invest more in complex assets), see the relative low number of observations (663, see 3rd column of Table 2). They increase strongly with investments in hedge funds and private equity, while they increase slightly, but significantly with investments in stocks, all compared to fixed income. The coefficients of hedge funds and private equity of above 15 imply that total performance costs would increase by, respectively, 44% and 65%, if these asset categories were to double their investment, at the cost of fixed income investments,[11] or increase in both cases by 17%, when the respective investments would increase with 1 percentage point.[12] Significant effects are not found for real estate and commodities nor for the rating classes, except for rating BBB. Relatively wealthy pension funds have higher performance costs, as they invest more in hedge funds and alternative assets. The performance cost model explains around 73% of all variation in costs, a much lower percentage than for *e.g.* managements cost. Transaction costs are high for commodities but do not vary much for the other categories (last column in Table 2).

6.2. Scale economies by size classes and cost type

Figure 2 shows how the cost elasticity of our Equation (4) varies with pension fund size. The nine points on each graph represent the cost elasticity for the 10th to the 90th percentile of the size distribution. Note that pension funds which matter from an economic perspective are all in the highest size class. Clearly, the cost elasticity of the total costs (straight line) increases – and economies of scale decrease – with size, so that substantial economies of scale occur mainly in the smaller pension funds. For the 50th percentile (the median) of the pension funds, the *CE* is close to 0.94, equal to the *CE* of the geometric average of pension funds, which is € 751 million. For total costs, economies of scale for the smallest institutions are 10%, declining for larger funds to 6% and becoming 5% for the largest organisations.

[10] See footnote 7.
[11] See footnote 7.
[12] Here 'change' is 0.01.

Figure 2. Cost elasticities of total investments of pension funds by their size (2012-2019)



Note: This figure shows the nine percentile borders of 10% to 90%. The total investments of the 10%-percentile amounts € 110 million and that of the 90%-percentile € 8.6 billion.

Disaggregation to cost types reveals that cost elasticities for management costs (light grey dotted line) are fairly constant at around 0.91 for smaller and medium-sized pension funds, so that scale economies are around 9%. Scale economies increase to 10% for the largest pension funds. That is remarkable as the classic economy of scale mechanism – constant costs can be allocated across a large group of participants – is expected to have the greatest impact for small pension funds. Performance fees have large economies of scale for the small pension funds (47%), declining to zero for larger funds (where *CE* is equal to 1, for pension funds with investments of almost a half billion euro), and thereafter diseconomies of scale up to 22% for the largest pension funds. For transaction costs, we observe diseconomies of scale ranging from 0% via 10% to 5%.

We have calculated how much investment costs the smaller and medium-sized pension funds together may save, when they would become equal to, say, the five but largest funds by growth, mergers or takeovers. The scale economy savings would be € 36 million, that is only 1,4% of the costs of the respective smaller and medium-sized pension funds, or less than 0.5% of the investment costs of all funds together. The savings percentage increases (but the savings amount decreases) when we consider smaller pension funds only. For instance, the smallest ten pension funds would save 6%, or

€ 0.3 million. On the other hand, when two large pension funds merge, they can, *mutatis mutandis*, save 2.5-3% of their investment costs.[13]

6.3. Analyses by asset class

In order to better explain the outcomes presented in Figure 2, we disaggregate our analyses by estimating *CEs (*and, hence, economies of scale) separately for the six asset classes and for the three cost types. Table 3 presents these *CEs* of investment costs of the – in terms of size – average pension fund over 2012-2019 based on Equation (4). The first row refers to the total investment costs estimates from Table 2: for the total costs-total investments case the economies of scale for the average pension fund are 6%, and for the management costs-total investments case the economies of scale are 9%. The *CE* coefficients below 1 reflect the existence of (unused) economies of scale. For both total costs and management costs, we observe economies of scale for all investment categories, except real estate and private equity. Total costs of economies of scale of the key investment categories fixed income and stocks are around 5%, while they are somewhat lower for hedge funds and commodities. All these economies of scale are much larger for management costs, particularly for commodities. For real estate and private equity, the cost margins *increase* with size instead of *decrease*. This unexpected result for real estate may be explained by the fact that larger pension funds have more complex real estate categories, such as shopping centres and office buildings, to which higher management and analyses costs are attached, but where expected returns may also be higher. A similar argument may apply to private equity: large pension funds may hold more laborious private equity types, which require more management and analyses costs. Table 3 also shows that the number of observations falls sharply for the more complex and more sophisticated investment categories, confirming that these categories are held only by a limited number of pension funds, particularly the larger ones. This has also been observed in Table 1.

Performance fees also show substantial scale economies for fixed income, stocks, and commodities, but *dis*economies of scale for real estate, hedge funds, private equity and, remarkably, total investments. These – implausible –diseconomies of scale in the total costs-performance fees case are likely caused by the complex investments products real estate, hedge funds and private equity. We will investigate that in Section 6.6. In any case, we conclude that disaggregation in asset classes appears to increase our insight here.

Equations (2) and (4) include four size-related variables, which allow all non-linear relationships to be incorporated, as follows from the economic theory. A consequence is that the model does not provide significant results for economies of scale, due to multicollinearity. If we drop

[13] A large pension fund can save 5-6% of the investment costs (the scale economies) when its size doubles, hence a saving of 50% of the costs of the two initial pension funds.

the three non-linear terms and use a linear model, we do obtain statistically significant results of economies of scale (that is: $CE < 1$), indicated with asterisks in Table 3.

Table 3. Cost elasticities of investments costs of the average pension fund (2012-2019)

	Total costs	Management costs	Performance costs	Transaction costs	Total costs	Management costs	Performance costs	Transaction costs
	Cost elasticity				*Number of observations*			
Total investment	0.941**	0.911**	1.173	1.104	1486	1486	667	1387
Fixed income	0.954**	0.910**	0.910	1.064	1461	1453	178	1308
Stocks	0.953**	0.931**	0.799**	0.998	1475	1471	326	1276
Real estate	1.107**	1.085**	1.168	0.835**	1213	1208	273	736
Hedge funds	0.980	0.915	1.243	0.905	272	270	179	107
Commodities	0.967	0.772	0.860	0.449**	283	189	39	96
Private equity	1.095**	1.042**	1.024	0.854	522	521	286	225

Note: Cost elasticities below 1 imply that economies of scale exist. Two asterisks point to significance of economies of scale on the 95% confidence level, based on the linear model, see text.

6.5. Broeders's model estimates

We estimate Broeder's model of Equation (5) as a robustness test. The disadvantage of this model is that it only distinguishes a very simple relationship between costs and size, but the advantage is that it provides statistically significant results much more easily. Table 4 presents the coefficient α in Equation (5), which is the effect of pension fund size (i.e. total investments) on investment costs over 2012-2019. For total investments, fixed income and stocks, for all three cost components, the negative size effects in this table correspond to the economy of scale effects in Table 3. All these effects are now significant on the 1% level, except the stocks-performance fees case, where the significance level is 5%. Hence, these results are robust. For the other investment categories the results differ in various places compared to those in Table 3. Statistically significant results at the 5% level are found only for the real estate-performance fee case (diseconomies of scale) and the commodities-management cost case (economies of scale). Here, the lower number of observation is likely the cause of lower

Table 4. Effect of pension fund size on investments costs (α) of Equation (5) over 2012-2019

	Total costs	Management costs	Performance costs	Transaction costs
Total investment	-3.98***	-4.45***	0.29***	-0.28
Fixed income	-3.00***	-2.98***	-0.88***	-0.43**
Stocks	-2.73***	-2.43***	-1.09**	-1.03***
Real estate	1.10	-0.47	1.54**	-2.01*
Hedge funds	-2.54	-8.30*	-8.31	-0.87
Commodities	4603.32*	-625.36**	-6.20	15,546*
Private equity	-752.60	-660.14	5.62*+	-3.25

Note: Two and three asterisks refer to significance on the, respectively, 5%- and 1% level, using a one-sided test. Negative coefficients reflect the existence of economies of scale. Numbers of observations are equal to those in Table 3.

significance. For 2013, Broeders *et al*. (2016) did find similar effects, with a few exceptions, both for our 2013 results (not shown here)[14] and our full period results.

6.6. Performance fees and investment categories

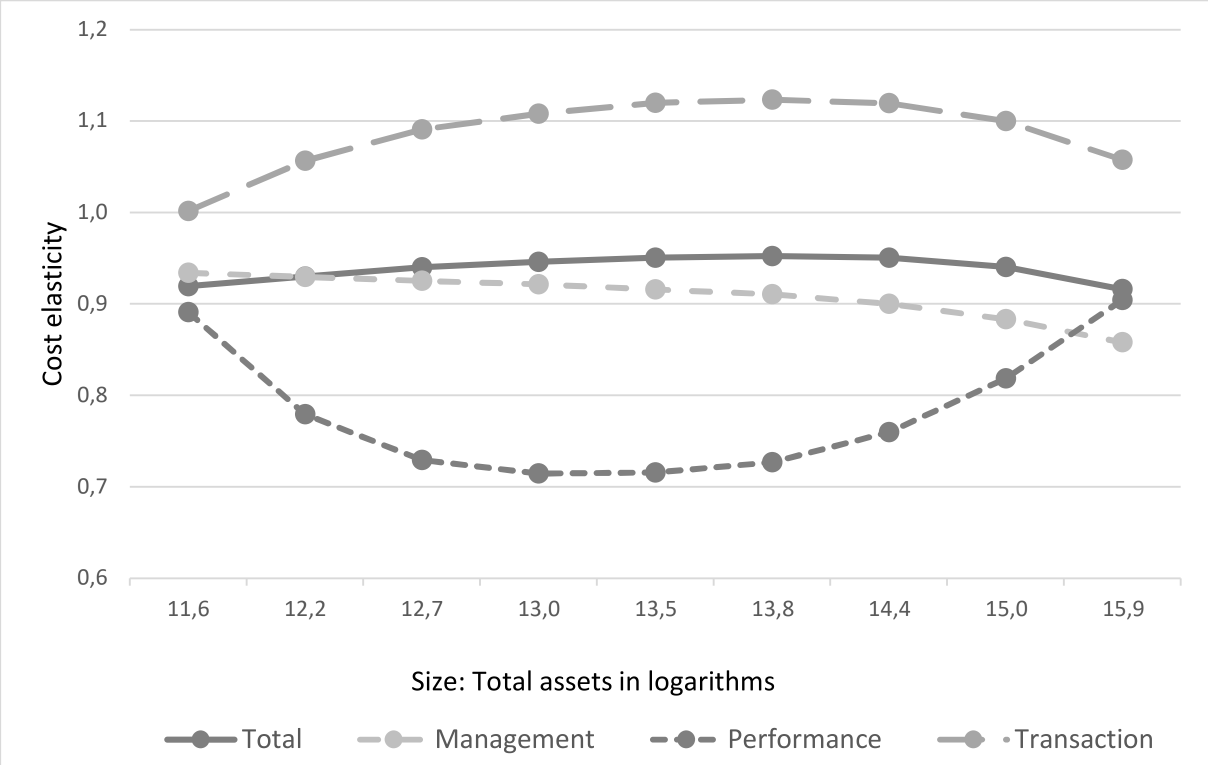
Using the results of Tables 3 and 4, we now investigate the outcomes when we drop either real estate, hedge funds or private equity, or all three categories together, to see whether the less plausible results of the total investments-performance fee case is attributable to these categories. Dropping each of these asset categories moves its CE curve down, compared to the initial situation in Figure 2. In Figure 3 we present the outcome when all three complex asset categories are excluded. Hence, this graph represents the fixed income, stocks and commodity investments portfolio, which is 85% of the total portfolio (see Table A.2 in the appendix).

The total costs of economies of scale of this classic investment portfolio range from 8% for the smallest pension funds to 5% of the medium-sized funds and to 7% for the largest institutions. The management cost economies of scale now range from 7% for the smallest pension funds to 14% for the largest ones. For performance fees and transactions costs, economic theory has less predictive power with respect to economies of scale. We observe economies of scale for performance fees ranging from 11% (for small pension funds) to 29% (medium-sized) back to 10% (large) and diseconomies of scale for transaction costs, with values similar to those in Figure 2 (0%, 11% and 5%).

The total cost economies of scale of this classic investment portfolio range from 8% for the smallest pension funds via 5% of the medium-sized funds to 7% for the largest institutions. The management cost economies of scale now range from 7% for the smallest pension funds to 14% for the largest ones. For performance fees and transactions costs, economic theory has less predictive power with respect to economies of scale. We observe economies of scale for performance fees ranging from 11% (for small pension funds) to 29% (medium-sized) back to 10% (large) and diseconomies of scale for transaction costs, with values similar to those in Figure 2 (0%, 11% and 5%).

[14] Differences in estimates for 2013 may come from later data revisions, small model differences and selection applied to the data.

Figure 3. Cost elasticities of fixed income, stocks and commodity investments of pension funds by their size (2012-2019)



6.7. Developments over time

We repeat the estimates of Table 2 for each single year and present the cost elasticities in the upper panel of Table 5. Remarkably, the economies of scale in total investment costs were close to zero over 2012-2016 and did disappear fully in the year 2014, but returned in later years, increasing to 8% in 2019. This is in part due to the management costs which had smaller economies of scale over 2012-2014. For performance fees elasticities, we observe a substantial rise over the years, as well as fluctuations. Transaction cost diseconomies of scale peaked in the years 2014 and 2015.

Table 5. Cost elasticities of investments costs of average pension fund by year

	2012	2013	2014	2015	2016	2017	2018	2019	2012-2019
Total costs	0.97	0.99	1.00	0.98	0.96	0.94	0.94	0.92	0.94
Management costs	0.95	0.96	0.94	0.91	0.92	0.92	0.93	0.91	0.91
Performance fees	1.01	0.98	1.17	1.33	1.06	1.27	1.44	1.44	1.17
Transaction costs	1.11	1.20	1.23	1.27	1.16	1.10	1.05	0.99	1.10
	Exclusive of complex investments in real estate, hedge funds and private equity								
Total costs	0.98	1.01	1.02	1.00	0.98	0.95	0.96	0.93	0.95
Management costs	0.95	0.97	0.96	0.93	0.93	0.93	0.94	0.91	0.92
Performance fees	0.89	0.55	0.42	0.71	0.81	0.96	1.12	1.03	0.75
Transaction costs	1.12	1.20	1.30	1.32	1.21	1.11	1.06	1.03	1.12

Note: Values below 1 indicate that scale economies are present.

When the costs of the complex investments in real estate, hedge funds and private equity are excluded (lower panel), we observe that performance fees show economies of scale in most years (except 2018 and 2019), particularly in the first part of the sample period. This is in line with what we have seen in Figure 3. For the other cost components the picture in the lower panel hardly differ from that in the upper panel. These results confirm that economies of scale in pension fund investment costs indeed disappeared almost or fully around 2012-2015, but did return somewhat in later years.

6.8. Robustness tests

This section presents a number of variants on the model and an alternative estimation approach, in order to observe how robust our estimation outcomes are, in addition to the variants of Sections 6.6 and 6.7. Column 1 of Table 6 shows the original model also presented in Table 2. In the next three models one or two inverse 'total assets' terms have been excluded, whereas Column 5 displays the linear model. We use F-tests for the exclusion restrictions. The key outcome is that the F-tests reject the restrictions with high levels of confidence: the test statistics range from 19 to 54 while the 99% critical values range from 3.9 to 6.4. Hence, the four total assets terms are all needed to describe the cost-size relationship precisely. Secondly, cost elasticities range from 0.93 to 0.95, that is, scale economies are rather similar with values between 5% and 7%. Some non-linear 'total assets' coefficients shift heavily when restrictions are applied, but – and this is the third result – the other coefficients are fairly stable across the variants. This also holds for Column 6 where we presents the

Figure 4. Cost elasticities of total investments of pension funds by their size for various specifications(2012-2019)

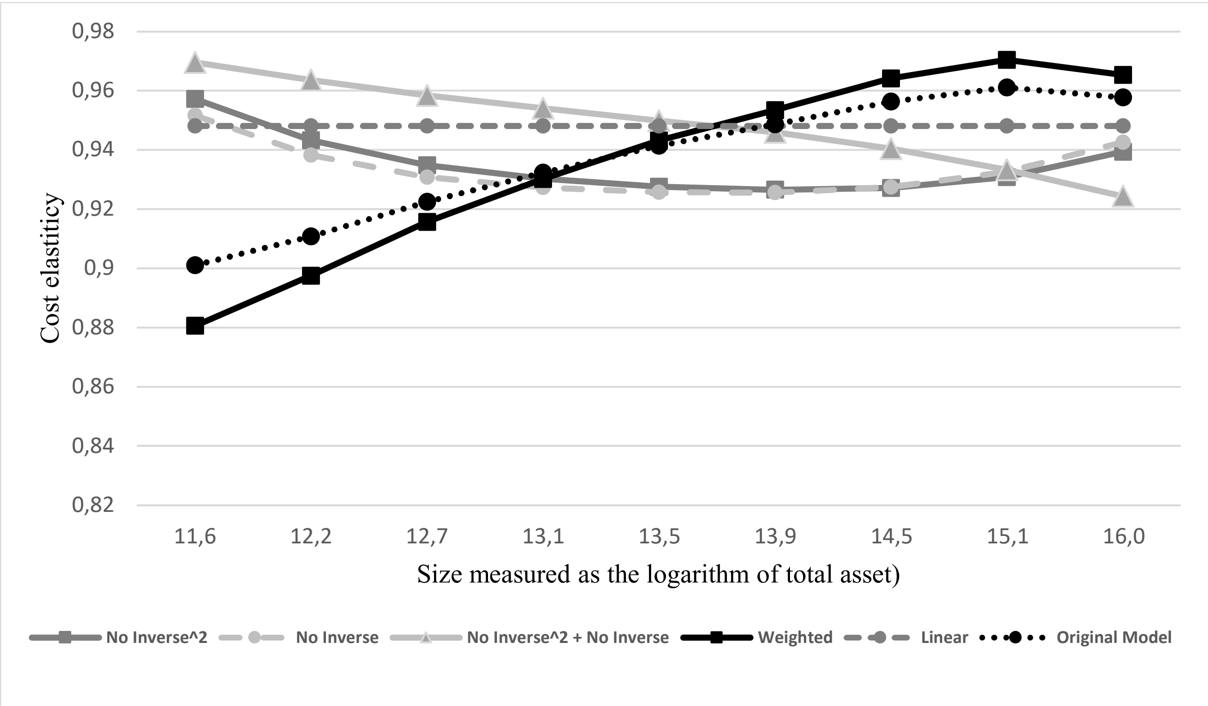


Table 6. Estimates of the total investment costs of pension funds Equation (4) for various specifications of 'size' over 2012-2019

	Original model		Without squared inverse term		Without simple inverse term		Without the two inverse terms		Linear		Weighted regression	
Column	*1*		*2*		*3*		*4*		*5*		*6*	
ln(total assets)	3.17	0.78*	0.64	0.20	0.78	0.10	0.95	0.01	0.95	0.01	3.92	1.65
(ln(total assets)-ln(gem.))^2	-0.08	0.03*	-0.02	0.01	0.01	0.01	-0.01	0.00	—	—	-0.11	0.03
1/ln(total assets)	774.21	271.73*	-52.02	33.88	—	—	—	—	—	—	1021.73	183.36
1/(ln(total assets))^2	-2474.8	874.17*	—	—	-176.13	105.81	—	—	—	—	-3225.62	674.75
ln (assets/participants)	-0.04	0.02°	-0.03	0.02	-0.04	0.02	-0.03	0.02	-0.02	0.03	-0.04	0.02
Stocks#	0.37	0.12*	0.36	0.12	0.35	0.12	0.42	0.13	0.41	0.13	0.42	0.13
Real estate#	1.82	0.26*	1.74	0.25	1.76	0.26	1.64	0.26	1.67	0.25	1.74	0.27
Hedge funds#	6.09	0.45*	5.89	0.44	5.90	0.44	5.94	0.44	5.86	0.43	6.10	0.46
Commodities#	4.61	1.71*	4.50	1.70	4.48	1.71	4.68	1.73	4.71	1.73	6.17	2.31
Private equity#	7.67	0.52*	7.80	0.51	7.78	0.51	7.85	0.49	7.31	0.66	7.69	0.54
AA#	-0.58	0.10*	-0.59	0.10	-0.59	0.10	-0.59	0.10	-0.58	0.10	-0.56	0.10
A#	-0.19	0.13	-0.34	0.19	-0.32	0.18	-0.41	0.27	-0.40	0.28	-0.28	0.17
BBB#	0.78	0.14*	0.83	0.15	0.82	0.14	0.87	0.16	0.88	0.17	0.85	0.14
lower than BBB#	1.35	0.17*	1.42	0.17	1.42	0.17	1.38	0.17	1.39	0.16	1.37	0.18
no rating#	0.55	0.13*	0.55	0.14	0.55	0.14	0.52	0.13	0.52	0.13	0.60	0.15
Cost elasticity (average p.f.)	0.941		0.928		0.926		0.950		0.948		0.948	
R^2 adjusted for d.o.f.	96.2		96.1		96.1		96.1		96.0		92.3	
F-test on restriction(s)	—		54.9		33.2		19.2		39.8		—	
Number of observations	1486		1486		1486		1486		1486		1486	

Notes: See Table 2.

results of a size-weighted regression, where each invested euro counts equally, instead of each pension fund. A final test is pictured in Figure 4, where the cost elasticities (and, hence, scale economies) are presented for various pension fund sizes. Weighted and unweighted cost elasticities are fairly similar, which points to robust CE estimates. Furthermore, we see the effect of the exclusion restrictions, but we have to hold in mind that they are rejected. With the dropping of inverse terms, the higher scale economies for smaller pension funds are not present anymore. The linear model excludes variation with the pension fund size, hence we see a constant line, not reflecting the U-formed unit cost qualities.

7. Conclusions

Over the years, the investment costs of pension funds, expressed in percentages, have declined substantially from 0.54% in 2012 to 0.49% in 2019. This holds for almost all investment categories for total costs as well as management costs. Economies of scale in total investment costs of pension funds are nowadays smaller than in the past, but not yet disappeared completely: during 2012-2019 ranging from 10% for the smaller pension funds to 5% for the largest ones. Disaggregation to cost types and pension fund size reveals that economies of scale in management costs are around 9% for all pension fund sizes. Remarkably, performance fees have huge economies of scale for small institutions but substantial diseconomies of scale for the large funds. Large pension funds invest more in the complex asset categories where high performance fees are paid. Disaggregation into asset categories reveals that performance fee diseconomies of scale do not exist for the key investment categories fixed income and stocks (as well as for commodities) and are mainly due to complex asset classes.

In the hypothetical case that all smaller and medium-sized pension funds would be equally large as the fifth but largest pension fund through growth, mergers or take-overs, than their investment costs in 2019 would decline by only 1.4% (or € 36 million). That is less than 0.5% of total investment costs of all funds together. On the other hand, when two large pension funds merge, they can, *mutatis mutandis*, save 2.5-3% of their investment costs.

Finally, to answer the question posed by the title of this paper: have scale effects on cost margins of pension fund investment portfolios disappeared? Not according to the benchmark model of Broeders: there is statistical evidence that the size of investment portfolios affects costs. But the limited economies of scale we find with our sophisticated economies of scale model are from an economic viewpoint rather mediocre. In a breakdown of the analysis in individual years, we find absence of economies of scale for a number of years. Our conclusion is that some economies of scale do exist (in most years) but that they are of moderate magnitude only. The argument for consolidation still exists but is limited.

References

Alserda, G.A.G., J.A. Bikker. S.G. van der Lecq, 2018, X-efficiency and economies of scale in pension fund administration and investment, *Applied Economics* 50 (48), 5164-5188.

Andonov, A., R.M.M.J. Bauer and K.J.M. Cremers, 2011, Can large pension funds beat the market? Asset allocation, market timing, security selection and the limits of liquidity, Maastricht University Working paper.

Bauer, R.M.M.J., K.J.M. Cremers and R.G.P. Frehen, 2010, Pension fund performance and costs: small is beautiful, Maastricht University Working paper.

Bikker, J.A., L. Spierdijk, P.J. van der Sluis, 2007, Market impact costs of institutional equity trades, *Journal of International Money and Finance* 26, 974-1000.

Bikker, J.A., L. Spierdijk, R.P.M.M. Hoevenaars, P.J. van der Sluis, 2008, Forecasting market impact costs and identifying expensive trades, *Journal of Forecasting* 27, 21–39.

Bikker, J.A., J. de Dreu, 2009, Operating costs of pension funds: the impact of scale, governance, and plan design, *Journal of Pension Economics and Finance* 8, 63-89.

Bikker, J.A., L. Spierdijk, P.J. van der Sluis, 2010, What factors increase the risk of incurring high market impact costs?, *Applied Economics* 42, 369–387.

Bikker, J. A., 2013, *Is there an optimal pension fund size? A scale-economy analysis of administrative and investment costs*, DNB Working Paper, De Nederlandsche Bank, Amsterdam.

Bikker, J.A., 2017, Is there an optimal pension fund size? A scale-economy analysis of administrative costs, *Journal of Risk and Insurance* 84 (2), 739-770.

Broeders, D.W.G.A., A. van Oord, and D.R. Rijsbergen, 2016, Scale economies in pension fund investments: A dissection of investment costs across asset classes, *Journal of International Money and Finance* 67, 147-171.

Broeders, D.W.G.A., A. van Oord and D.R. Rijsbergen, 2019, Does it pay to pay performance fees? Empirical evidence from Dutch pension funds, *Journal of International Money and Finance* 93, 299-312.

Canback, S., P. Samouel, D. Price, 2006, Do diseconomies of scale impact firm size and performance?, *Journal of Managerial Economics* 4, 27-70.

Chatterton, M., E. Smyth, K Darby, 2013, *Pension scheme administrative costs*, Department for Work and Pensions, Working Paper No 91, London.

Christensen, L.R., W.H. Greene, 1976, Economies of scale in US electric power generation, *Journal of Political Economy* 84, 655-676.

Collins, S., and Ph. Mack, 1997, The optimal amount of assets under management in the mutual fund industry, *Financial Analyst Journal* 53, 67-73.

Dietsch, M., 1993, Economies of scale and scope in French commercial banking industry, *The Journal of Productivity Analysis* 4, 35-50.

Dyck, A. and L. Pomorski, 2011, *Is bigger better? Size and performance in pension plan management*, Working paper, Rotman School of Management, University of Toronto, Canada.

Edirisuriya, P., G. O'Brien, 2001, Financial deregulation and economies of scale and scope: evidence from the major Australian banks, *Asia-Pacific Financial Markets* 8, 197–214.

Griffin, D., A. Tversky, 1992, The weighing of evidence and the determinants of confidence, *Cognitive Psychology* 24, 411–435.

Indro, D.C., C.X. Jiang, M.Y. Hu, and W.Y. Lee, 1999, Mutual fund performance: Does fund size matter?, *Financial Analysts Journal* 55, 74-87.

Ippolito, R.A., 1989, Efficiency with costly information: A study of mutual fund performance, 1965-1984, Quarterly Journal of Economics 54, 1-23.

Jensen, M.C., 1968, The performance of mutual funds in the period 1945-1964, *The Journal of Finance* 23, 389-416.

Lakonishok, J., A. Schleifer, and R.W. Vishny, 1992, The structure and performance of the money management industry, *Brookings Papers on on Economic Activity: Microeconomics*, 339- 391.

Malhotra, D.K., R.W. Mcleod, 1997, An empirical analysis of mutual fund expenses, *The Journal of Financial Research* 20, 175-190.

Malhotra, D. K., V. B. Marisetty, and M. Ariff, 2001, *Economies of Scale in Retail Superannuation Funds in Australia*, Working Paper, Monash University.

Malkiel, B.G., 1995, Returns from investing in equity mutual funds 1971 to 1991, *The Journal of Finance* 50, 549-572.

McKenna, F.W., Y.H. Kim, 1986, Managerial risk preferences, real pension costs, and long-run corporate pension fund investment policy, *The Journal of Risk and Insurance* 53, 29-48.

Nauriyal, B.B., 1995, Measures of cost economies in Chilean banking: 1984-1991, *Revista de analisis economico* 10, 71-99.

Shaffer, S., 1998, Functional forms and declining average costs, *Journal of Financial Services Research* 14, 91-115.

Appendix. Pension fund investment cost data

Table A.1 presents the investment costs in basis points of all asset classes by year. The figures of 2012 and 2019 can be found back in Table 1. We see fluctuations and a downward trend for all asset classes, except private equity. Costs of other investment also includes general cost, such as liquidity costs, CEM benchmarking, as well as currency and interest rate derivatives, as far as not directly related to investment categories.

Table A.1. Investment costs in basis points of asset classes by year

	2012	2013	2014	2015	2016	2017	2018	2019	*Avgs*
Total	*54*	*53*	*51*	*50*	*48*	*54*	*50*	*50*	*51*
Fixed income	19	19	18	17	17	19	18	16	*18*
Stocks	28	33	29	28	27	29	23	23	*28*
Real estate	92	86	93	84	75	76	72	72	*81*
Hedge funds	338	349	314	252	263	310	274	268	*296*
Commodities	245	1085	578	545	274	290	257	224	*437*
Private equity	308	385	423	398	344	381	395	370	*376*
Other investments	182	-98	-121	-79	-55	-388	159	-47	*-56*

Table A.2 shows the investments by asset category as % of total investments by year, with a subdivision of fixed income by rating class. The allocation of asset categories over time is rather stable. We observe a slight increase over time of investments in fixed income and private equity and a slight decrease of hedge fund investments. This suggests a decrease of risky assets. Within fixed assets, the share of risk-free triple A bonds falls substantially, at the benefit of, particularly, double A investments as well as lower rated or unrated rating bonds. This points to an increase is risky bonds.

Table A.2. Investments by asset category as % of total investments by year

		2012	2013	2014	2015	2016	2017	2018	2019	*Avgs*
Total portfolio	*(in bill. €)*	*838*	*914*	*1,030*	*1,168*	*1,235*	*1,296*	*1,352*	*1,484*	*1,165*
Fixed income		47.0	49.3	49.1	49.5	50.4	48.8	49.4	50.3	*49.2*
Of which:	AAA	25.4	21.2	19.2	18.5	18.3	17.4	17.4	17.0	*19.3*
	AA	5.6	10.5	11.8	12.0	11.8	11.4	12.1	12.6	*11.0*
	A	5.4	4.7	4.5	4.6	4.8	4.5	4.9	5.4	*4.9*
	BBB	5.0	7.1	7.9	7.5	7.2	7.3	6.7	6.7	*6.9*
	Lower	3.3	3.6	3.5	3.9	4.1	4.4	4.5	4.5	*4.0*
	No rating	2.3	2.2	2.1	3.0	4.2	3.9	3.9	4.2	*3.2*
Stocks		30.0	31.0	32.1	30.8	29.5	31.8	30.9	29.8	*30.7*
Real estate		9.5	8.9	8.4	8.9	8.9	8.9	9.1	9.2	*9.0*
Hedge funds		3.1	3.0	2.6	2.4	2.1	1.9	1.8	1.8	*2.3*
Commodities		0.2	0.1	0.0	0.1	0.3	0.2	0.3	0.3	*0.2*
Private equity		5.2	5.2	5.0	4.9	5.0	5.2	5.3	5.5	*5.2*

Table A.3 presents the costs per asset category as share in the total investment portfolio's costs by year and by cost type. We observe quite stable cost shares over the years for most asset classes. An exception is the decline in the total costs share of hedge funds, in line with a decline in hedge fund investments share (see Table A.2). We see this decline also for management costs and performance fees, but for transaction costs we find the opposite. The total cost share and performance fees share of private equity increases over the years, while its investment share remains stable. In 2018 and 2019, almost all performance fees are related to private equity.

Table A.3. Costs per asset category as share in the total investment portfolio's costs by year

	2012	2013	2014	2015	2016	2017	2018	2019
	Total costs							
Total portfolio (in billion €)	*5.01*	*5.82*	*6.26*	*6.52*	*6.62*	*7.56*	*7.42*	*7.88*
Fixed income	0.17	0.16	0.16	0.17	0.18	0.17	0.17	0.17
Stocks	0.14	0.16	0.16	0.15	0.15	0.16	0.13	0.13
Real estate	0.15	0.12	0.13	0.13	0.12	0.12	0.12	0.12
Hedge funds	0.18	0.16	0.14	0.11	0.10	0.10	0.09	0.09
Commodities	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Private equity	0.25	0.29	0.32	0.31	0.32	0.34	0.38	0.38
Other investments	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.02
	Management costs							
Total portfolio (in billion €)	*3.36*	*3.45*	*3.66*	*4.02*	*4.07*	*4.17*	*4.22*	*4.45*
Fixed income	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.18
Stocks	0.16	0.17	0.18	0.17	0.16	0.16	0.16	0.14
Real estate	0.19	0.17	0.17	0.17	0.16	0.16	0.16	0.16
Hedge funds	0.14	0.14	0.13	0.12	0.10	0.09	0.08	0.08
Commodities	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Private equity	0.23	0.22	0.23	0.24	0.26	0.27	0.27	0.29
Other investments	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01
	Performance fees							
Total portfolio (in billion €)	*1.11*	*1.58*	*1.75*	*1.47*	*1.51*	*2.03*	*1.97*	*2.10*
Fixed income	0.06	0.04	0.02	0.03	0.03	0.01	0.01	0.00
Stocks	0.07	0.09	0.08	0.08	0.09	0.10	0.02	0.06
Real estate	0.05	0.04	0.04	0.07	0.06	0.06	0.06	0.08
Hedge funds	0.36	0.29	0.22	0.15	0.17	0.14	0.10	0.10
Commodities	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Private equity	0.43	0.54	0.63	0.67	0.65	0.68	0.80	0.76
Other investments	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00
	Transaction costs							
Total portfolio (in billion €)	*0.54*	*0.79*	*0.85*	*1.04*	*1.05*	*1.36*	*1.24*	*1.32*
Fixed income	0.59	0.41	0.42	0.37	0.43	0.39	0.39	0.39
Stocks	0.16	0.25	0.20	0.19	0.19	0.21	0.21	0.18
Real estate	0.05	0.07	0.11	0.08	0.07	0.06	0.07	0.07
Hedge funds	0.01	0.01	0.01	0.00	0.01	0.08	0.09	0.08
Commodities	0.02	0.02	0.01	0.03	0.02	0.02	0.03	0.03
Private equity	0.00	0.06	0.06	0.06	0.07	0.07	0.06	0.08
Other investments	0.03	0.02	0.02	0.07	0.06	0.03	0.03	0.04

Note: Five cost types are included in total portfolio costs but are not split into separate asset class costs: Costs of investment management by the pension fund and management office, Costs of fiduciary management, Safe-custody charges, Consultancy fees and Other costs of investment management; detailed definitions are available from the authors upon request. This mainly regards management and transaction costs.

Table A.4. Correlation matrix of the dependent variables of the total costs of investment model (2012-2019)

	ln(assets)	(ln(assets)-ln(geo mean))^2	1/ln(assets)	1/ln(assets)^2	ln(assets/participant)	Stocks	Real estate	Hedge funds	Commod-ities	Private equity	AA	A	BBB	Lower than BBB	No rating	Vif test results
ln(assets)	1.00															5936.9
(ln(assets)-ln(geo mean))^2	0.19	1.00														97.7
1/ln(assets)	-0.97	0.06	1.00													21107.4
1/ln(assets)^2	-0.92	0.19	0.99	1.00												5143.2
ln(assets/participant)	0.24	-0.23	-0.32	-0.36	1.00											2.4
Stocks	-0.03	-0.05	0.01	-0.01	0.11	1.00										1.1
Real estate	0.39	0.10	-0.37	-0.34	0.02	0.08	1.00									1.3
Hedge funds	0.18	0.08	-0.17	-0.15	0.14	-0.05	0.11	1.00								1.2
Commodities	-0.02	-0.02	0.01	0.02	0.00	-0.09	0.02	0.03	1.00							1.1
Private equity	0.51	0.32	-0.44	-0.39	0.17	-0.05	0.30	0.19	-0.04	1.00						1.6
AA	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.12	1.00					1.2
A	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.10	0.18	1.00				1.2
BBB	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	-0.23	0.00	0.23	1.00			1.2
Lower than BBB	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	-0.17	-0.15	-0.06	0.07	1.00		1.3
No rating	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	1.00	-0.12	-0.10	-0.23	-0.17	1.00	1.1