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The asset holdings of Danish pension funds: Insights from a novel ISIN-level dataset

Based on a new dataset developed by the authors, this paper studies the domestic listed equity investments of Danish pension funds. Compared to other financial investors, tentative evidence is found that pension funds (a) tend to focus more on large companies; (b) have a longer holding period and (c) obtain higher portfolio returns with less volatility. The new dataset, covering about three quarters of Danish pension fund holdings, will form the basis of future research on wider economic effects, including economic growth and productivity, of Danish pension funds' investment activities.

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Note: We thank an anonymous referee for helpful comments. The dataset presented in this paper has been constructed through data collection directly from Danish pension funds. We gratefully acknowledge the participating pension funds for supplying the data to us. Importantly, it will not be possible to associate any data (in text, tables or figures) presented in this paper with the name of a particular pension fund. Crystal Wang has provided valuable research assistance. Remaining errors and shortcomings are our own responsibility. This research was supported by PeRCent, which receives base funding from the Danish pension funds and Copenhagen Business School.

Pension funds play an important role in the Danish economy. At the end of 2019, domestic pension funds managed assets equivalent to 220% of Danish GDP, the largest such ratio among all countries included in comparable OECD statistics (OECD, 2020).

Most research focusing on wider economic effects of accumulated pension savings uses national aggregates on the amount of pension savings and does not, or only to a limited extent, consider the importance of asset allocation (Bijlsma et

al., 2018; Zandberg and Spierdijk, 2013). Yet, how these savings are invested is likely to matter for their effects on, for example, economic growth and productivity (Barr, 2000).

Against that background, the aim of this paper is to look more closely into the allocation of assets possessed by Danish pension funds. However, any such analysis is complicated by the fact that asset allocation data is typically private and thus not widely available to researchers, as is the case in most countries.¹

Thanks to collaboration with six pension funds, covering about 70% of total assets under management by this sector at the end of 2019, this paper presents a novel dataset on monthly, domestic investments of Danish pension funds at the ISIN-level.² The data, directly collected from the involved funds, cover the period 2005-2019. We refer to this as the "Collected Data". We combine this dataset with time series data on the financial instruments of other investors from Refinitiv EIKON and Datastream, two well-known databases for financial market information.

Establishing this Collected Data can be seen as the first step towards achieving our ultimate goal, which is to analyze effects on the wider economy of Danish pension fund investment policies more thoroughly than what has been feasible so far with existing data.³

Our preliminary results suggest that Danish pension funds potentially achieve higher average returns on their Danish listed equity investments than other domestic investors, and that these returns exhibit lower volatility. We also find that pension funds focus their listed investments on larger companies. Lastly, we detect evidence to suggest that pension funds have a longer in-

1. *Notable exceptions include Chile and the Netherlands. The Chilean pension fund supervisor publishes the sector's holdings information on its website. Furthermore, an ISIN-level dataset on the holdings of Dutch pension funds has been used in Artiga González et al. (2020).*
2. *The ISIN (International Securities Identification Numbering) system defines an international standard, which codes securities including stocks, bonds, options, and futures with unique identification numbers.*
3. *We already have research output using this dataset in the pipeline. For example, Beetsma et al. (2021) investigate the importance of pension fund investment in promoting productivity growth at the firm level.*

vestment horizon than other types of investors, in line with previous research (Cella et al., 2013; Cremers and Pareek, 2016).

The remainder of this paper is structured as follows. First, the data is described. The next sections presents some portfolio characteristics and looks at investor horizons. The final section concludes and offers some suggestions for further research.

The dataset

At the end of 2019, the Danish pension funds owned app. 18.5% of all VP-registered securities emitted by Danish issuers (Danmarks Nationalbank, 2021b).⁴ This is a material part of the domestic financial landscape, thus promising a large impact on the Danish economy.

The dataset described below has been constructed through data collection directly from Danish pension funds. We contacted all Danish pension funds with an inquiry to provide information on their domestic asset holdings. Six large pension funds agreed to participate. Data collection took place over the first half of 2020. We performed quality checks by inspecting the data for extreme movements in positions, short breaks in holdings and possible typos, and confirmed the correctness of the data with the participating fund.

The participating funds managed around 70% of assets under management in the Danish pension industry at the end of 2019.⁵ In total, funds submitted information on over 2,500 different financial instruments across listed and unlisted equity and fixed income, private equity, infrastructure and other asset classes.

Given the significant efforts needed to make the data ready for analysis, we decided to focus on the listed equity instruments. This choice is also motivated by the fact that for these instruments it was possible to collect historical information on prices, market capitalization, shares outstanding and shareholder history from Refinitiv EIKON and Datastream. Among other things, this allows us to identify the fraction of equity held by pension funds, as well as to compare pension funds to other investors and compute performance measures.

The result is a unique ISIN-level dataset with extensive information on both the stock itself and pension fund investment in the stock. Since Danish pension funds do not invest in all domestic listed equity instruments, we also searched Refinitiv EIKON for all equity instruments ever listed on the Copenhagen Stock Exchange and added these instruments to our dataset.

Subsample for analysis

This subsection briefly describes how we constructed and cleaned the dataset.⁶ We set out by downloading information on all shareholders at a quarterly frequency over 1997Q1-2019Q4 for all ISINs that were at some point listed on the Copenhagen Stock Exchange according to the Refinitiv EIKON database. This resulted in 412,124 observations from the EIKON database, to which we added 10,070 observations from our data

collected directly from Danish pension funds.⁷ In this dataset, a datapoint is an investor-ISIN-period combination and represents the holding of a particular investor in a particular stock at a specific time. In total, we have 379 different listed equity instruments in the dataset.

We then cleaned the dataset, notably by only selecting instruments defined as preference shares or ordinary shares in Refinitiv EIKON, and by excluding holding companies and investors that only invest in less than five different companies over the sample period. We took this step to ensure a certain degree of comparability among investors in our sample. For example, holding companies might represent the historical owners of the firm and thus have different goals holding a specific stock compared to external institutional investors.

The sample period is 2005-2019 (the directly Collected Data starts in 2005). The joint sample including the Collected Data and the EIKON data consists of 284,148 observations representing the holdings of 2,043 investors in 219 ISINs covering 211 companies over that period.

Coverage

We next report the coverage of the domestic listed equity holdings in the Collected Data.⁸ First, we compare the Collected Data to data on Danish pension fund investments using the shareholder history records from Refinitiv EIKON. The Collected Data gives a much more comprehensive picture of Danish pension fund investments in Danish listed equities than Refinitiv EIKON, both in terms of the number of instruments and the total value of the investments.

On average, the Danish pension funds that participate in the data collection exercise in total invest in approximately 63 different Danish listed stocks per quarter according to the Collected Data, while this number stands at only close to 23 instruments in the EIKON dataset. The total value of these investments is also much larger in the Collected Data, with on average close to DKK 35 bn per quarter in the Collected Data, against DKK 8.5 bn in the EIKON dataset.

Since the number of funds covered by the Collected Data increases over the time span, differences by year show that the coverage of the Collected Data is more complete in later years. The number of observations of pension fund investments, that is the number of unique recordings of a particular pension fund investing in a particular instrument in a given period, is much larger at 9,543 in the Collected Data compared to 1,412 in the EIKON data.

The fact that (a) a large fraction of the observations in our Collected Data is not included in the EIKON dataset and (b) we are reasonably confident to cover all listed equity holdings of our sample pension funds, prompts us to exclude in the sequel the information on Danish pension fund investments from the

4. *VP Securities is the information provider of Danmarks Nationalbank for the Copenhagen Stock Exchange. Danmarks Nationalbank's statistics are based on securities registered with VP.*

5. *Our calculations based on annual report data and sector aggregates provided by Danmarks Nationalbank (2021).*

6. *For a more detailed description of the sample construction procedure, see Pinkus (2021).*

7. *The dataset includes some overlap since the EIKON data includes Danish pension funds. This overlap is eliminated before any analysis.*

8. *These numbers refer to the complete sample, including non-Danish investors, that we use to explore the coverage of the data. The analysis in later sections focuses on only the subsample of Danish investors.*

EIKON dataset and use only the Collected Data for analysis of pension fund investments.

Since “only” six funds participated in the data collection exercise, it is useful to explore how much of the pension sector our dataset covers. At the end of 2019, pension funds participating in the data collection exercise held Danish listed equity worth DKK 60.5 bn. This represents 74.8% of all Danish listed equity assets held directly by the sector based on statistics published by Danmarks Nationalbank (2021).⁹ The Collected Data, therefore, covers a compelling part of the listed equity investments by the Danish pension fund and insurance sector. Furthermore, DKK 60.5 bn represent 2% of the total value of quoted shares issued by Danish entities on the Copenhagen Stock Exchange at the end of 2019 and 4.4% of Danish investors’ holdings.¹⁰

Finally, we explore the coverage of the ownership information on Danish listed equity instruments in the sample, combining the Collected Data and EIKON data. Ideally, we would have information on the ownership of all listed shares, and therefore on 100% of the market capitalization of each instrument. To measure coverage, we constructed, for each period, the ratio of market capitalisation for which we have ownership information to the total market capitalisation of each instrument in our data. The median value of this ratio amounts to 47.7% before the exclusion of strategic investors and 29% afterward.¹¹ This difference can be explained by the fact that investors defined as “strategic” are often among the largest shareholders in an instrument.

To summarise, the Collected Data provides significantly better coverage of Danish pension funds’ domestic listed equity investments than that provided by a widely used financial database. Furthermore, even though not all Danish pension funds participated in the data collection exercise, the Collected Data covers a significant part of the sector’s activity in this asset class. These factors will allow a more comprehensive analysis of Danish pension fund investment activity than studies using any other existing data source, to the best of our knowledge. Moreover, they open new avenues for important research.

Investor portfolio characteristics

Holding size and diversification

This subsection compares the different investor types in the da-

9. *These calculations are based on aggregate investment by Danish pension funds according to Danmarks Nationalbank without performing fund look-through of investment funds domiciled in Denmark. After fund look-through, the amount of investment covered in the Collected Data would represent 50.1% of Danish pension funds’ total investment in Danish listed equity. Since it is not possible to evaluate to what extent the funds participating in the Data Collection exercise performed fund look-through before submitting the data, the true coverage of the Collected Data lies in between 50.1% and 74.8%. However, since most funds did not provide a complete fund look-through, we argue that it is more natural to consider non-fund look-through values as the reference for our exercise. Furthermore, the figures published by Danmarks Nationalbank include pension funds as well as life insurance companies that were not all targeted by our data collection exercise.*
10. *Our calculations based on Danmarks Nationalbank (2021b).*
11. *We exclude investors so the ratio of market capitalization for which we have ownership information becomes smaller.*

taset on several dimensions of their portfolios. Since our goal is to compare Danish pension funds specifically to other investors, the rest of this paper focuses on institutional investors headquartered in Denmark. Foreign investors might pursue different goals when investing in Danish equities, for example because of currency risk. Furthermore, given the significantly better coverage of pension fund investments in the Collected Data, we use the Collected Data for information on pension funds and Refinitiv EIKON for information on all other investor types. The resulting analysis sample covers 2005-2019 and contains 37,768 observations, representing investment by 75 Danish investors in 211 stocks emitted by 203 firms. Table 1 summarises the sources of the variables used.

We first look at the holding size and diversification. Table 2 reports summary statistics on the percentage of shares held by a single investor in the dataset, classified by investor type and conditional on a positive number of shares held.

On average, each Danish pension fund holds 2.14% of shares outstanding at any point in time. Mean and median of the holding size of Danish pension funds are larger than those of other investor types. Moreover, the number of observations for this investor class is relatively large. This suggests that pension funds are important shareholders compared to other (diversified) investor types.

Table 3 explores the degree of diversification by looking at the number of different instruments held by a single investor

TABLE 1: Data items and sources

Item			
Number of stocks		211	
Number of companies emitting stocks		203	
Number of investors – pension funds		6	
Number of investors – non-pension funds		69	
Investor Portfolios	Period	Frequency	Source
Pension funds	2005-2019	Quarterly	Own data collection
Non-pension funds	2005-2019	Quarterly	Refinitiv EIKON
ISIN information			
Total return	2005-2019	Quarterly	Refinitiv EIKON
Price	2005-2019	Quarterly	Refinitiv EIKON
Market capitalization	2005-2019	Quarterly	Refinitiv Datastream

TABLE 2: Holding size of a single investor in a firm, only Danish investors % of shares outstanding, by investor type

Investor Type	Number of investors	N	Mean	SD	Median
Bank and Trust	10	4024	0.53	2.06	0.11
Corporation	10	889	15.75	13.07	12.08
Government Agency	2	185	29.83	22.04	26.35
Individual Investor	2	165	16.93	9.52	17.00
Investment Advisor	35	18150	2.01	6.75	0.13
Investment Advisor/Hedge Fund	4	4616	1.09	2.63	0.16
Pension Fund	6	9543	2.14	3.76	0.42
Private Equity	4	25	33.26	14.82	42.85
Venture Capital	2	171	22.15	11.50	25.50

Notes: The first column gives the number of distinct investors in the sample headquartered in Denmark. Since our focus is on domestic investment, we only include investors headquartered in Denmark. N represents the number of unique investor-instrument-period combinations of a given investor type. All numbers are conditional on a positive number of shares held. The Collected Data is the source for pension funds, while Refinitiv EIKON is the source for all other investor types. Finally, SD is the standard deviation of holding sizes across all observations for a given investor type.

TABLE 3: Number of different stocks held by a single investor per period (Danish investors, by investor type)

	N	Mean	SD	Median
Bank and Trust	196	20.54	15.70	29.00
Corporation	414	2.14	1.46	2.00
Government Agency	73	2.53	1.54	2.00
Individual Investor	64	2.58	1.21	2.00
Investment Advisor	1121	16.19	20.49	7.00
Investment Advisor/Hedge Fund	163	28.32	20.05	29.00
Pension Fund	258	36.99	13.19	37.00
Private Equity	24	1.04	0.20	1.00
Venture Capital	84	2.04	1.13	2.00

Notes: N reflects the number of unique investor-period combinations. SD is the standard deviation of the number of different stocks held across all observations for a given investor type.

TABLE 4: Size (deciles) of firms invested in by investor type

	N	Mean	SD	Median	p25	p75
Bank and Trust	2406	7.20	2.37	8	6	9
Corporation	873	4.09	2.60	3	2	6
Government Agency	181	4.91	3.24	4	2	9
Individual Investor	165	2.42	1.36	2	1	3
Investment Advisor	5417	6.02	2.77	6	4	8
Investment Advisor/Hedge Fund	3008	6.77	2.75	7	5	9
Pension Fund	3581	7.13	2.42	8	6	9
Private Equity	25	2.48	1.90	2	1	3
Venture Capital	166	6.93	1.81	7	6	8

Notes: This table presents descriptive statistics on the deciles of distribution of market capitalization. All numbers are conditional on a non-zero holding in firms. N reflects the number of unique investor type-company-period combinations.

of each type in the same period. Each pension fund invests on average in close to 37 different instruments in any given quarter. As for the other investor types, only Bank and Trusts, Investment Advisors and Investment Advisors/Hedge Funds invest on average in more than three different instruments per period.

The investment strategies of the investor types investing in only a small number of different instruments could differ from those of the more diversified types, making it difficult to compare the two groups. For example, private equity firms might buy large stakes in a few companies to exert influence over the management of these firms. Individual investors might only invest in a restricted number of companies with whom they have a relationship. By contrast, large institutional investors might strive to diversify their portfolios.

Finally, while Table 3 suggests that the domestic listed equity portfolios of pension funds are significantly more diversified than those of other domestic institutional investors, it is important to keep in mind the caveats of comparing investors across two different data sources. In fact, we claim complete information on the portfolios of pension funds included in the Collected Data. Since we rely on EIKON for the portfolios of the other investors, we might miss some part of their portfolios.

Size of firms in the investment portfolios

We next explore if there are significant differences in the size of the firms in investors' portfolios, where size is defined as market capitalization. Let Z_t be the set of all firms in our sample at time t . We sort all companies $z \in Z_t$ according to their market capitalization at time t into deciles. We call this variable $DMCAP_{z,t}$.

It assigns a value between 1 and 10 to each firm z present in the sample in period t , where 10 indicates that firm z is in the top 10% of the firm size distribution in period t . The results are reported in Table 4.

Table 4 shows the values for \overline{DMCAP}_Q ,¹² which we calculate as follows. Let $I_{Q,t}$ be the set of companies in which at least one investor of investor type Q invests in period t and N_Q the number of unique company-period observations with investment by any investor of type Q .¹³ Then,

$$\overline{DMCAP}_Q = \frac{\sum_{z \in I_{Q,t}} DMCAP_{z,t}}{N_Q}$$

The corresponding standard deviation, also reported in Table 4, is calculated as:

$$SD_Q = \sqrt{\frac{1}{N_Q - 1} \sum_{z \in I_{Q,t}} (DMCAP_{z,t} - \overline{DMCAP}_Q)^2}$$

It appears that more diversified investor types on average invest in larger companies. The high average (median) decile of pension funds of 7.13 (8.00) provides further evidence that Danish pension funds focus on the largest companies of the domestic listed equity universe. Specifically, the number 7.13 means that the average firm size a pension fund invests in belongs to the top 30% of the size distribution. For a specific investor type, the SD column gives the standard deviation (across time and across firms) of the size decile of firms that at least one investor of that type invests in. There is not a substantial difference in this standard deviation across the investor types.

While Table 4 presents some evidence that pension funds tend to focus on larger companies, the simple decile of the firm size distribution does not weigh with the size of the holding. To examine this in further detail, we next construct the weighted average decile of firm size as follows:

$$DMCAP_{WEIGHTED_{Q,t}} = \sum_{z \in I_{Q,t}} w_{z,Q,t} \times DMCAP_{z,t}$$

where $w_{z,Q,t} = \frac{(\text{value of holding in company } z)_{Q,t}}{(\text{total value of holdings})_{Q,t}}$ is the weight of firm z in the total portfolio size of investor type Q in period t . The measure is large if investor type Q 's portfolio is concentrated in companies with high market capitalization relative to other companies at time t . Table 5 presents the average (and other statistics) over all periods for each investor type.

This evidence confirms that (a) Danish pension funds tend to focus investment on the largest companies in the domestic listed equity universe and (b) large stakes are on average concentrated

12. Statistics are computed over all unique investor type-company-period combinations. This means that even if several investors of the same type invest in company i in period t , the company is only considered once in the calculations.
13. For illustrative purposes, if investor type Q invests in 3 firms in 3 periods each, N_Q would be 9.

TABLE 5: Firm size (weighted average decile) Danish investors, by investor type

	N	Mean	SD	Median	p25	p75
Bank and Trust	60	8.26	1.07	8.75	7.50	9.05
Corporation	60	7.80	1.52	7.50	6.38	9.42
Government Agency	46	9.19	0.45	8.91	8.86	9.78
Individual Investor	57	3.22	1.41	2.60	2.40	3.02
Investment Advisor	60	9.05	0.33	8.91	8.80	9.36
Investment Advisor/Hedge Fund	60	8.69	1.16	9.25	8.50	9.36
Pension Fund	60	9.36	0.08	9.36	9.30	9.41
Private Equity	17	2.54	1.58	2.00	1.00	3.19
Venture Capital	49	7.98	2.17	8.73	6.95	9.57

Notes: This table shows statistics computed over all periods of the period-specific weighted average decile. All numbers are conditional on a non-zero holding. N reflects the number of unique investor type-period combinations.

in large companies. In fact, Danish pension funds have the largest average and median values of all investor types.

Return

We now turn to the financial returns that pension funds achieve. The granularity of the Collected Data allows assessing the performance of each fund separately. We first computed the average quarterly portfolio return ($r_{i,q}^{mean}$) and the average 4-quarter cumulative return ($r_{i,4q}^{mean}$) of each investor i .¹⁴ Table 6 presents statistics on this measure across investors of the same type.

The average pension fund achieves an average quarterly portfolio return of 4.43% and a 4-quarter return of 17.28%. This is substantially higher than most other investor categories. However, statistical inference is difficult due to the low number of investors in each category.¹⁵ The standard deviation of the average returns among investors of the same type is lowest for pension funds, suggesting that their investment portfolios are relatively similar. An investigation into the reasons and the consequences of this observation is left for future research.

As for the stability of returns, the quarterly and 4-quarter returns of pension funds seem to fluctuate less than those of other investors. Table 7 reports by investor type the standard deviation of the returns of each investor i . On average, the standard deviation of the quarterly returns of the individual pension funds in the Collected Data is 8.62%. This is lower than for most other investor types. The same is true for the volatility of the 4-quarter returns (18.78%). Unreported means comparison

14. The quarterly total return for each stock is sourced from Refinitiv EIKON. We computed the portfolio return for investor i in quarter t by combining these stock-level returns with the weight of each stock in the portfolio of investor i in quarter t . In doing so, we assume that the portfolio weights we observe at the end of quarter t remain constant throughout the quarter. Such an assumption is necessary, because we only observe portfolio weights at the end of the quarter and only have access to quarterly stock returns.

15. The negative average returns for private equity investors can partially be explained by 1) a very low number of observations for that investor category and 2) very concentrated portfolios. In fact, three of the four private equity investors hold only one ISIN per period in our data. The fourth holds 2 ISINs, and does so only in one period. We therefore abstain from interpreting the findings for this category any further.

tests, however, show that the differences in average returns and volatility between the different investor categories are not statistically significant.

It is important to note, though, that the meaningfulness of these tests is limited due to the low number of investors in each category. To summarise, we interpret these findings as very tentative evidence that pension funds may achieve, on average, higher returns at lower risk than other investors in listed equity. Care is warranted in drawing comparisons with other investor types, as it is not clear how much of the various investors types' (including pension funds) equity risk can be diversified away and thus is unpriced.

To compare the performance of pension funds and the broader stock market, Table 8 displays the average quarterly and 4-quarter return of a return benchmark for the Copenhagen Stock Index (more precisely, the Refinitiv Denmark Total Return Index). Pension funds seem to beat the benchmark on average with a difference in the mean quarterly returns of 1.14 percentage points and in the 4-quarter return of even 4.08 percentage points. Pension fund portfolios also outperform the index in terms of volatility. This could indicate that the sector is successful in selecting stocks that achieve higher returns and exhibit less volatility.

We finally examine the divergence of returns among the pension funds and other investor groups. Specifically, the SD in Table 6 is calculated as:

$$SD_Q = \sqrt{\frac{1}{N_Q - 1} \sum_{i \in Q} (\overline{Ret}_{i,Q} - \overline{Ret}_Q)^2}$$

where i is a single investor of type Q and $\overline{Ret}_{i,Q}$ is the average return of investor i in the group of investor type Q . \overline{Ret}_Q is the mean of $\overline{Ret}_{i,Q}$ across all investors of type Q . The formula gives the standard deviation of a specific investor type's average portfolio return and therefore is a measure of variation of the average returns across investors of a given type. The low value in the SD column for pension funds indicates that average portfolio returns are similar across the six funds included in the Collected Data. Average returns vary significantly more within other investor categories.

The SD column in Table 6 is calculated as:

$$SD_Q = \sqrt{\frac{1}{N_Q - 1} \sum_{i \in Q} (SD_{i,Q} - \overline{SD}_Q)^2}$$

where $SD_{i,Q}$ is the standard deviation of the return of investor i across all periods the investor is in the sample. \overline{SD}_Q is the mean of the $SD_{i,Q}$ across all investors of type Q . The column reports the standard deviation of the standard deviations of the returns across the investors of the same type. The low value in the SD column for pension funds indicates that the return volatility is similar across the six pension funds in our sample. Again, we see this only as tentative evidence due to the low number of investors.

Investor horizon

Recent literature has identified pension funds as long-term investors (Cella et al., 2013; Cremers and Pareek, 2016) in line

TABLE 6: Average portfolio return per investor (%), by investor type

	$r_{i,q}^{\text{mean}}$				$r_{i,4q}^{\text{mean}}$			
	N	Mean	SD	Median	N	Mean	SD	Median
Bank and Trust	10	3.50	4.46	4.65	6	20.52	16.06	22.57
Corporation	10	1.02	4.80	1.76	10	1.62	17.36	5.28
Government Agency	2	2.22	7.57	2.22	2	9.95	27.00	9.95
Individual Investor	2	2.68	2.51	2.68	2	27.17	32.39	27.17
Investment Advisor	35	3.40	3.50	3.98	34	14.01	15.11	15.58
Investment Advisor/Hedge Fund	4	2.31	1.40	2.85	4	8.77	6.38	10.91
Pension Fund	6	4.43	0.54	4.31	6	17.28	2.65	16.86
Private Equity	4	-7.55	17.73	-10.01	2	-31.00	25.92	-31.00
Venture Capital	2	2.22	3.03	2.22	2	10.29	4.93	10.29
Total	75	2.45	5.59	3.82	68	11.58	17.36	13.92

Notes: This table presents statistics on the average portfolio returns for a single investor. First, we constructed the returns of each investor's portfolio. Then we computed the mean of these return figures for each investor separately. The table shows statistics on the resulting measure. SD is the standard deviation of these means across the investors within each class. N represents the number of investors. $r_{i,q}^{\text{mean}}$ is the average quarterly portfolio return of investor i . $r_{i,4q}^{\text{mean}}$ is the average cumulative 4-quarter return of investor i over quarters $t-3$ to t . Note that the time span with available data differs for each individual investor, including pension funds.

TABLE 7: Standard deviation of the portfolio returns per investor, by investor type

	$SD_{i,q}$				$SD_{i,4q}$			
	N	Mean	SD	Median	N	Mean	SD	Median
Bank and Trust	9	13.59	7.11	10.99	6	34.71	27.52	22.79
Corporation	10	15.01	6.20	13.46	10	27.69	7.69	24.90
Government Agency	2	17.98	12.46	17.98	2	30.75	23.27	30.75
Individual Investor	2	17.65	15.28	17.65	2	53.93	54.67	53.93
Investment Advisor	35	11.22	3.80	10.18	34	23.43	10.64	23.09
Investment Advisor/Hedge Fund	4	10.34	3.29	10.28	4	23.41	9.25	23.52
Pension Fund	6	8.62	1.80	8.62	6	18.78	7.00	18.88
Private Equity	3	32.63	28.13	23.86	1	32.60	.	32.60
Venture Capital	2	17.36	1.85	17.36	2	38.72	0.19	38.72
Total	73	13.18	8.20	10.99	67	26.38	15.13	24.02

Notes: This table presents statistics by investor type on the standard deviation of the quarterly and 4-quarter returns computed at the investor level. N represents the number of investors. $SD_{i,q}$ is the standard deviation of the quarterly portfolio return of investor i . $SD_{i,4q}$ is the standard deviation of the cumulative 4-quarter return of investor i over quarters $t-3$ to t .

TABLE 8: Copenhagen Stock Exchange index return, Danish equities (%)

	N	Mean	Median	SD	Min	Max
r_q^{Index}	60	3.29	2.90	10.11	-32.10	30.46
r_{4q}^{Index}	57	13.20	18.81	23.86	-51.06	74.04

Notes: This table presents return statistics on a total return index for Danish equities produced by Refinitiv. N represents the number of periods. r_q^{Index} the quarterly return of the index and r_{4q}^{Index} is the cumulative 4-quarter return over quarters $t-3$ to t .

with commonly held beliefs: pension funds match long-duration liabilities with long-term asset holdings. Using our data, we investigate this hypothesis by computing several measures of investor horizon to compare the horizon of Danish pension funds to that of other domestic investors in domestic listed equity.

Table 9 presents the average number of consecutive periods that an investor of each type has held the instruments present in its portfolio in the 4th quarter of 2019. On average, Danish pension funds have held these instruments for 5.57 years, longer than other investor types in the sample. Focusing on investor types with more than 100 unique investor-stock combinations at the end of 2019, none has an average holding length of more than 5 years.

It is noteworthy that the median length of the “Investment

Advisor/Hedge Fund” type is above the median value of pension funds. Yet, looking at the number of consecutive periods provides some evidence of long-termism among pension funds. Unreported means comparison tests show that the mean holding period for pension funds using the Collected Data is significantly different from the means of the other categories with a large number of observations “Bank and Trust” (significance at the 1% level), “Investment Advisor” (1% level) and “Investment Advisor/Hedge Fund” (10% level).

Table 10 presents the number of periods an investor of each type holds a specific instrument, expressed as a share of the total number of periods that the investor is in the dataset. By taking into account the length of time that an investor is in the sample, we take into consideration that investors might have begun operations at different points in time and therefore by definition will be present in the sample for a different number of periods.

Using the Collected Data, a Danish pension fund holds on average an instrument for 54.22% of all periods the fund is in the dataset. Both mean and median of the pension fund type are significantly larger than for the other investor categories with over 100 data points, again providing some evidence of long-termism in pension funds’ investment strategies. Unreported means comparison tests show that the mean holding period of pension funds is statistically significantly longer than that of all other investor categories except “Private Equity”.

TABLE 9: Length of consecutive holding (in years) by investor type, instruments held at end-2019

	N	Mean	SD	Median
Bank and Trust	115	2.67	2.06	1.50
Corporation	9	4.19	4.34	2.50
Government Agency	3	1.42	2.02	0.25
Individual Investor	5	2.00	3.91	0.25
Investment Advisor	365	3.85	2.44	3.75
Investment Advisor/Hedge Fund	127	4.96	2.97	5.50
Pension Fund	242	5.57	4.68	3.75
Venture Capital	6	1.04	1.94	0.25
Total	872	4.30	3.43	3.75

Notes: N reflects the number of unique investor-stock pairs at the end of the 4th quarter of 2019. All numbers are conditional on a positive number of shares held.

TABLE 10: Number of quarters an instrument is held, Danish investors as percentage of total number of periods investors are in the sample

	N	Mean	SD	Median
Bank and Trust	304	38.64	27.49	34.88
Corporation	60	36.79	27.46	30.44
Government Agency	18	30.50	24.22	27.78
Individual Investor	15	30.57	32.83	16.00
Investment Advisor	1226	35.70	26.35	30.64
Investment Advisor/Hedge Fund	243	40.50	30.20	35.59
Pension Fund	399	54.22	34.36	52.63
Private Equity	7	71.43	31.85	80.00
Venture Capital	10	39.47	29.14	34.69
Total	2282	39.92	29.37	35.00

Notes: N reflects the number of unique investor-stock pairs. All numbers are conditional on a positive number of shares held.

As a last measure of holding period using the number of periods, we compute the non-zero-point holding period in our sample based on Elyasiani and Jia (2010). Let $I_{q,t}$ be the set of instruments in which investor q invests in quarter t . The non-zero-point holding period $NZD_{Q,z,t}$ is the number of quarters in which investor q has a non-zero holding in instrument $z \in I_{q,t}$ over the period $t - 19$ to t , or the last 20 quarters (5 years) including the current quarter. Finally, we compute the non-zero point holding period of a stock z at period t at the investor type level, $NZD_{Q,z,t}$, as the average holding period across all investors of the same type $q \in Q$ that hold stock z in period t . Or formally:

$$NZD_{Q,z,t} = \frac{\sum_{q \in Q} NZD_{q,z,t}}{(\text{number of investors})_{Q,t}}$$

Table 11 presents descriptive statistics for this measure for the period 2010Q4-2019Q4, calculated separately for each investor type.¹⁶

16. We start the analysis in the last quarter of 2010 since we need 20 quarters of data to compute this measure. To address the downward bias stemming from the fact that some investors might have started operations less than five years before we observe the first investment, we condition that an investor must first enter the sample at least 20 quarters before period t .

TABLE 11: Non-zero-point holding period by investor type

	N	Mean	SD	Median	Min	Max
Bank and Trust	1784	9.49	4.92	9.00	1.00	20.00
Corporation	456	14.47	5.80	16.00	1.00	20.00
Government Agency	95	12.34	6.28	12.00	1.00	20.00
Individual Investor	115	13.35	6.70	16.00	1.00	20.00
Investment Advisor	3527	11.65	4.94	12.13	1.00	20.00
Investment Advisor/Hedge Fund	2179	12.82	5.93	14.00	1.00	20.00
Pension Fund	2009	15.66	5.54	18.67	1.00	20.00
Venture Capital	126	12.93	6.57	14.00	1.00	20.00

Notes: All numbers are conditional on a non-0 holding and the investor first entering the dataset at least 20 quarters prior to quarter t . N reflects the number of unique ISIN-period combinations with investment by the specific investor type.

The mean non-zero-point holding period for pension funds using the Collected Data is 15.66 quarters, meaning that on average Danish pension funds have held any instrument in their portfolio in period t for approximately 3.91 years over the previous 5 years, while the median holding period for pension funds is 18.67 quarters, very close to the full 20 quarters over which the measure is computed. Higher mean and median holding period of pension funds compared to other investors supports the notion of a longer investment horizon of pension funds.¹⁷

To summarise, we compute three different measures that estimate investor horizon based on the number of periods an investor keeps an instrument in its portfolio. Overall, these measures suggest that Danish pension funds have a longer investment horizon than other types of Danish investors. Nevertheless, it is important to keep in mind the limitations of comparing data from two different sources.

However, it is likely that the shareholder information in EIKON is concentrated on the larger holdings of investors and that these holdings would probably remain in the investor portfolio for longer than smaller stakes that could be divested and re-invested more frequently. Therefore, we see the estimations based on the number of holding periods of non-pension fund investors as conservative.¹⁸ A likely explanation why pension fund holding periods are longer than those of other investors is that pension fund liabilities are long giving them more freedom to bear temporary losses on their assets. Further research on this issue is warranted, though.

Conclusion and prospects for future research

The new dataset presented in this paper is, to the best of our knowledge, the first to contain ISIN-level information on the domestic portfolios of individual Danish pension funds to such a high degree of completeness and covering multiple funds over a rather long period (15 years). Based on relatively simple, descriptive statistics, a number of insights can be extracted about Danish pension funds' investments in domestic listed equities. First, pension funds' domestic listed equity portfolios appear to

17. It is important to note that this measure underestimates the true holding period, since it can take a maximum value of 20 quarters (equivalent to five years), while true holding period does not necessarily end after 20 quarters.

18. We find mixed evidence for long-termism compared to other investors when using measures that also take into account the size of the holding. See Pinkus (2021).

achieve higher returns than other investors and the stock index itself, yet experiencing less volatility of returns, although due to the low numbers of observations formal statistical tests do not confirm this. Second, Danish pension funds concentrate their investments in large companies, measured by market capitalization. Third, pension funds act as long-term investors compared to other investor types.

While it must be recognized that the work presented here only considers domestic listed equity investments by pension funds and further research into these questions is needed, these insights may already at this stage suggest some potentially important policy implications. For example, the indication of long-termism is not only in line with the fact that pension funds tend to have longer-term liabilities, but it also shows that pension funds may be well-placed to take on their balance long-term, illiquid assets.

Our findings also connect to recent developments in Denmark in relation to promoting domestic, long-term investment. Specifically, in May 2021, Denmark's largest pension fund, ATP, announced that it has created a dedicated unit for long-term domestic direct equity investment (Fixsen, 2021).

The focus on domestic investment may also be relevant in view of the small size of the Danish economy. As a result, Danish firms might attract less interest from large foreign financial institutions. This makes domestic investors, of which pension funds form a significant part, all the more important for the domestic economy.

Given the large impact of pension funds in the Danish financial landscape, policy makers should also be interested in the role of pension funds for the economy at large and how this role can be best promoted. In fact, pension policy not directly linked to investment, such as accumulation rules and withdrawal mechanisms, are likely to impact the asset allocation of pension funds.

The unprecedented degree of detail and accuracy of the new dataset will open new avenues for research on the activities of the Danish pension sector and their effects on the broader economy. Researchers are now better equipped to exploring pension fund investment into individual companies and gaining a better understanding of how, and to what extent, pension funds can stimulate growth and access to financing. Beetsma et al. (2021), for example, link the dataset to high-quality register information on Danish firms and explore the relationship between firm-level productivity growth and pension fund investment. Similarly, Pinkus et al. (2021) use patent data to study the effects of pension fund investment on innovation. It would also be interesting to investigate how Danish pension funds dealt with the Global Financial Crisis, the central bank asset purchasing programs and whether they react to increasing pressures towards greener investing.

Such information will also support the dialogue of the industry with other stakeholders such as the government or trade unions. Lastly, firms looking for long-term capital can also gain insights from new research on this important type of investor and the effects of its investments. In an international context, informative research on the Danish experience with a large pension fund sector will be relevant for policy makers and other stakeholders outside Denmark interested in the macroeconomic effects of funded pensions.

In the future, this dataset would benefit from the inclusion of

more pension funds and better coverage of unlisted investments. Such an expansion would result in an even more accurate reflection of the Danish pension fund market. Results combining this data on Danish pension funds with similar data on pension fund activity in other countries where available, for example Chile and the Netherlands, would provide opportunities for cross-country studies.

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