The Bare Bones of the Swedish Premium Pension offering

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Abstract

In June 2017, The Swedish Premium Pension system offered 867 funds from which participants are allowed to choose up to five funds to construct a portion of their pension portfolio. If no choice is made, the allotted money (premiums) are invested in the default alternative, SÅFA, a fund managed by AP7 (an agency under the parliament).

The purpose of this analysis is to investigate to what extent it is possible to reduce the number of funds in the Premium Pension system without reducing the participants' ability to diversify their portfolios. We therefore pose the following two questions: Can we reduce the current fund universe into a limited set of building blocks? To what extent are these building blocks used by participants in their investment portfolios?

Our preliminary results support the following findings:

1. Between 90-93% of all variation found within the 867 available funds can be explained by seven identifiable building blocks or "fund factors".
2. 94-99% of all invested premiums have been allocated to these seven factors.

From a participant perspective, dividing the available funds into seven relatively independent factors may help participants design more diversified portfolios. At the time of this research there were 867 funds of which more than 50% belonging to the same factor.

From a diversification perspective, in the extreme, it would be possible to reduce the number of funds by offering one or two funds in seven independent fund categories.

[1] The author would like to thank the Swedish Pension Authority for access to, help in retrieving as well as structuring a vast amount of data. Special thanks to Birgitta Bergman, Ole Settergren for the access and Per Wikman and Marcus Andersson for their "boots on the ground" and Stefan Lundbergh at Cardano for valuable discussions and feedback. Without their help this analysis had not been possible.

Important notice: all finding are preliminary. This analysis serves as a basis for further academic research.

1. Can we reduce the current fund universe into a limited set of building blocks?

In the Swedish Premium Pension system, a total of 1762 funds have been offered. In June 2017, the system offers 867 funds out of which 188 have been available from the beginning in the year 2000. The current offering is found in Table 1 in the appendix.

The main purpose of this analysis it to investigate to what extent it is possible to reduce the current fund universe into a limited set of building blocks. This is done by first identifying independent building blocks that can explain the total variation of the fund offering and then interpret these blocks or "factors" in terms of available fund categories.

To identify these factors, we perform a Principal Component Analysis followed by a factor analysis.

To control for different sample periods, we perform the analysis on four data sets[2]:

- Funds that have been offered since inception, 188 funds within 46 categories
- Funds that were offered the first 5 years, 353 funds within 56 categories
- Funds that were offered the last 10 years, 389 funds within 52 categories
- Funds that were offered the last 5 years, 570 funds within 55 categories

Principal Component Analysis

The first step of the principal component analysis is to identify 'principal components' that are uncorrelated with each other and explain the variability observed in the data. A drawback with this method is that these 'principal components' are purely determined by data and cannot be mapped directly to specific observable funds or fund categories.

By definition, there are as many 'principal components' as there are input variables. To estimate the importance of each 'principal component', their eigenvalues are calculated. 'Principal components' with eigenvalues >1 explain the variation in the data set more than any one of the input variables (i.e. fund categories) do by themselves. This gives an indication of how many of the 'principal components' that are relevant. 'Principal

[2] For a Principal Component Analysis to compute, we need more return observations than funds. An analysis over the past 10 years on monthly data has 120 return observations and 389 funds. By creating equally weighted portfolios based on the categories instead it was possible to also analyze 5 and 10 year periods.

components' with eigenvalues <1 are less interesting as they explain less than any one of the existing fund categories.

Table 2a shows that 5-7 'principal components' have eigenvalues >1, for each of the data sets.

Table 2a. Eigenvalues for the Principal Components				
	Since inception	First five years	Last five years	Last ten years
Component 1	5,39	6,18	5,85	5,66
Component 2	2,35	2,56	2,36	2,66
Component 3	1,53	1,59	1,77	1,58
Component 4	1,37	1,40	1,56	1,40
Component 5	**1,17**	**1,16**	1,32	1,26
Component 6	0,94	0,90	1,20	**1,11**
Component 7	0,86	0,83	**1,05**	0,98
Component 8	0,80	0,81	0,94	0,80

The results show that 5-7 Principal Components have Eigenvalues >1 for the different data sets
The different data sets are:
From the beginning = Funds offered since the beginning in Sep 2000, 188 funds in 46 categories
First five years = Funds that were offered the first five years, 353 funds in 56 categories
Last five years = Funds that have been offered over the past five years, 389 funds in 52 categories
Last ten years = Funds that have been offered over the past ten years, 570 funds in 55 categories

Table 2b shows that 7 principal components explain between 90-93% of all variation of the funds that are available in the Premium Pension system. This implies that it is possible to construct 7 investment funds (or categories) based on these principle components that will could cover >90% of all variation produced by 867 funds.

Table 2b. Cumulative proportion of all variation in the fund offering				
	Since inception	First five years	Last five years	Last ten years
Component 1	0,63	0,68	0,62	0,62
Component 2	0,75	0,80	0,72	0,75
Component 3	0,80	0,84	0,78	0,80
Component 4	0,84	0,88	0,82	0,84
Component 5	0,87	0,90	0,86	0,87
Component 6	0,89	0,92	0,88	0,89
Component 7	**0,91**	**0,93**	**0,90**	**0,91**
Component 8	0,92	0,94	0,92	0,92

The results show that 7 Principal Components explain between 90-93% of all variation in the fund offerings in the different data sets. The data sets are the same as in table 2a

The following step is to investigate to what extent these seven 'principal components' can be interpreted into actual funds or fund categories.

Factor Analysis

To interpret the Principal components into observable fund categories we perform a factor rotation[3] which enhances the variances of the components. By doing so their interpretation becomes clearer and they can be interpreted in terms of available fund categories. This technique is known as "factor analysis".

The factor analysis shows how much of each fund category can be explained by one factor, which is called factor loading.

> *e.g. over the past ten years, the category 'Aktiefonder Sverige' has had a loading of 0.97 on Factor 1 which is the dominating factor for this category. In 37 out of 63 categories (59%) Factor 1 is the dominating factor with loadings between 0.66-0.97*

Table 3 summarizes the factor analyses performed using the four different data sets. The first two factors 'Developed Markets Equitiy' and 'Developed Markets Fixed income' cover between 72% and 82% of all variation observed in the data. The other five factors, two fixed income and three equity factors, cover between 11.5% and 22% of all variation. We conclude that the fund categories offered within the Premium Pension can be captured by these seven building blocks.

[3] We perform a Varimax rotation. For details see Sharma (1996)

Table 3. Interpretation of the first seven factors from the four data sets

Developed Markets Equity	covers 62-68% of all fund variation (Sweden, Nordics, Europe, Northamerica, Global) also IT & communication, small cap and medicine also mixed funds and generation funds
Developed Market Fixed Income	covers 10-14% of all fund variation covers European, Global and Forreign Fixed Income funds
China, Asia and Far East	covers 4-6% of all fund variation
Russia and Eastern Europe	covers 2-5% of all fund variation
Swedish long-term fixed income and real interest rate	covers 2-4% of all fund variation
Swedish short-term fixed income	covers 2-3% of all fund variation
Japan	covers 1,5-4% of all fund variation

Table 3 is a conclusion of the factor analyses performed on the same data as tables 2a and 2b. The seven factors presented in the table cover >90% of all fund variation in the data.

Possible applications of the factor analysis

If seven fund categories can explain > 90% of all variation in the current funds available on the platform, then this can be used in streamlining the fund offering without the individual losing more than 10% of the ability to diversify his/her portfolio.

Data shows that 58-75% of all categories are dominated by Factor 1 (Developed Markets Equities). Based on how individuals typically make choices under uncertainty[4], there is a high probability that an individual's portfolio is less diversified than she thinks it is when she chooses one fund.

> *e.g. an individual who chooses four funds can let herself be guided by there being four different fund types (Equity funds, Mixed funds, Generation funds and Fixed Income funds) and chose 25% in each type, hoping to get a diversified portfolio. Such a choice has a high probability of rendering a 75% exposure towards Factor 1, (Developed Markets Equity).*

[4] For example naive diversification or, 1/n rule.

One way for the Pension Authority to better assist those who are making choices on the fund platform is to categorize all funds into categories whose correlated is as low as possible, for example the seven factors presented in table 3. By presenting these seven categories to the investor, it is easier for the individual to build a better diversified portfolio by selecting funds from categories with a low correlation. This would decrease the risk for individuals to unintendedly hold under-diversified portfolios.

2. To what extent are the building blocks used by the participants?

From its inception in Sep 2000, the Swedish Premium Pension system has hosted 1731 funds (excluding the default alternatives offered by AP7).

Table 4 below shows that of all funds ever offered, 71% have been dominated by Factor 1, Developed Markets Equities.

Table 4. Number of funds in each factor

Factor	# funds from inception	proportion
Developed Markets Equity	1240	71%
Developed Markets Fixed Income	214	12%
China, Asia adn Far East	108	6%
Russia and Eastern Europe	65	4%
Swedish short-term Fixed Income	31	2%
Swedish long-term Fixed Income	42	2%
Japan	56	3%

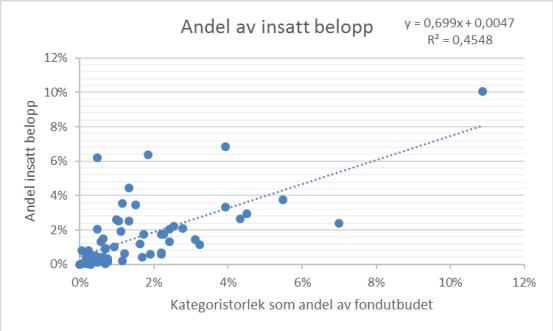
From the analysis in section 1, Table 2b states that seven factors explain >90% of all variation from these funds.

Figure 1a and 1b in the appendix show that of the <1,600 billion SEK invested into the system from inception, 94-99% has been allocated to these seven factors.

Figure 2 shows that the number of funds in a category correlates strongly with how much of the capital has been allocated to that category. A category with more funds also receives a large portion of the total capital in the system.

> *E.g. Fund category "Aktiefonder Europa" with its 121 funds received more premiums that "Aktiefonder Asien" with 38 funds.*

Figure 2. Correlation between allotted premiums and size of a fund category[5]



x-axis: is the proportional size of a fund category
y-axis: is the proportional amount of money that has been allocated to a category from the beginning

A question is whether the supply of funds cause the demand[6] or the demand drives the supply.

A study from 2006[7] examines this relationship and finds that an increase in the number of funds in a fund category by 1%, increases the demand for funds in that category by 0.38% based on choices and changes made in two six-month periods early in the Swedish Premium Pension system.

To investigate this question we perform a Granger-causality test where we test the proportion of funds in a category (size)[8] against the proportion of premiums a category receives in a given month (money)[9]. In essence, we run a regression where the money invested into a certain category is explained by the size of that category in the previous month and vice versa[10].

Tables 6a and b show that "Size" (proportion of funds in a category) appears to Granger-cause "Money" (proportion of premiums a category receives). A full length table is found in the appendix as Table 6c.

[5] The data for Figure 2 is found in table 5 in the appendix.

[6] Also known as The Relationship between Shelf Space and Unit Demand; R.C. Curhan (1972)

[7] A.Karlsson, M.Massa and A. Simonov, Portfolio Choice and Menu Exposure

[8] Number of funds in a category / Total number of funds available = proportion of funds in a category

[9] Amount of new money invested into a category / Total amount of new money = proportion of premiums a category receives

[10] The Granger causality test first regresses "proportion of premiums" against "proportion of premiums last month" to get a reference point. Then ads "proportion of funds in a category last month" and tests if the equations explanatory power increases as a whole. If it does, and the "proportion of funds in a category last month" is significant, then that variable is said to "Granger-cause" the "proportion of premiums".

Statistics show that in 35 out of 65 fund categories “Size” Granger-causes “Money” at the 10% significance level.

Table 6a, Size causes money and table 6b, Money causes size

Size causes money		
	positive	negative
***	27	2
**	33	2
*	35	3

Money causes size		
	positive	negative
***	1	2
**	4	3
*	10	3

There are 65 categories. In 35 of them (54%) size causes money at the 10% significance level
Size = proportion of funds in a category
Money = proportion of premiums a category receives
*** = significant on the 1% level
** = significant on the 5% level
* = significant on the 10% level
Positive = the independent variable has a positive effect on the dependent variable
Negative = the independent variable has a negative effect on the dependent variable

Notice: There are a number of control variables that are known to affect fund choice, which need to be introduced, e.g. fund performance, risk, fees, years of existence, domicile of the fund manager etc. These will be included in a later version of this evaluation. What we see here is a cause to investigate further.

3. Conclusion

The purpose of this analysis is to investigate to what extent the fund offering in the Premium Pension system can be reduced while still being able to offer its participants the same level of diversification and variability.

The data shows that the offering of 867 funds can be reduced to seven fund factors while still maintaining >90% of all diversification possibilities. Also, >90% of all invested premiums are allocated to these seven fund factors.

While analyzing the data, it appears that attention gravitates towards fund categories with many funds in them. Preliminary testing suggests that an increased number of funds in a category leads to more money being allocated to that category. This is an interesting subject to investigate further.

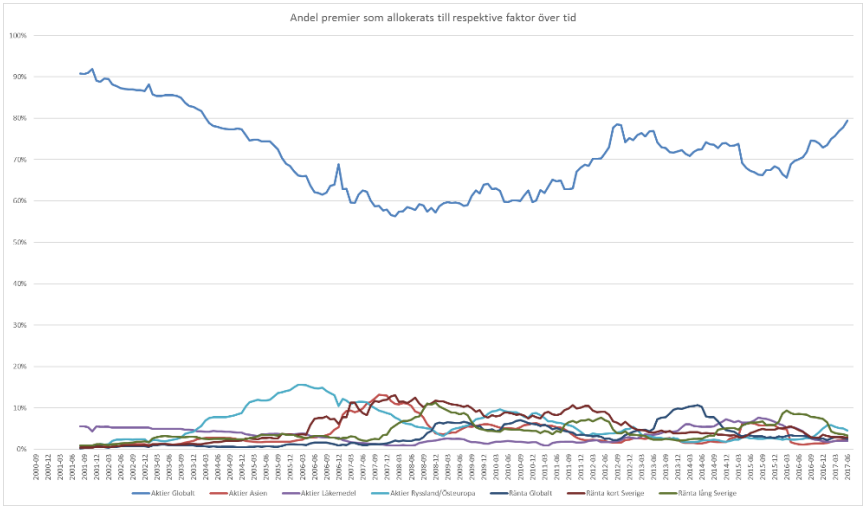
Appendix

Table 1. Current offering of Fund Type and Fund Category

Fondtyp	Fondkategori
Aktiefonder	Asien
	Asien och Fjärran östern
	Europa
	Europa småbolag
	Europa/Euroland småbolag
	Fastighet
	Global
	Global och Sverige
	Indien
	IT och kommunikation
	Japan
	Kina
	Latinamerika
	Läkemedel
	Läkemedel och bioteknik
	Nordamerika och USA
	Norden
	Nya marknader
	Ryssland
	Råvaror och energi
	Svenska aktier + Utländska aktier
	Svenska aktier och utländska aktier
	Svenska och utländska aktier
	Sverige
	Sverige (normal)
	Sverige index
	Sverige småbolag
	USA och Nordamerika
	Östeuropa
	Övriga branscher
	Övriga länder
Blandfonder	Aggressiv
	Balanserad
	Försiktig
	Svenska aktier + utländska aktier + svenska räntor
	Svenska aktier och räntor
	Svenska aktier, utländska aktier och svenska räntor
	Svenska och utländska aktier samt svenska räntor
	Utländska aktier och räntor
	Varierande
Generationsfonder	Pension om mer än 10 år
	Pension om mer än 20 år
	Pension om mindre än 10 år
	Pension om mindre än 20 år
Räntefonder	Europa ränta
	Global ränta
	Norden ränta
	Sverige kort
	Sverige kortränta
	Sverige lång
	Sverige lång och realränta
	Sverige Övriga
	Tillväxtmarknad ränta
	Övriga
	Övriga räntefonder
	Övriga utländska

Today's fund offering of 867 funds are divided into 4 fund types and 56 categories. The categories have varied over time (Source: Swedish Pension Authority)

Picture 1a. Proportion of premiums allocated to the seven factors over time



Picture 1a shows the proportional allocation to the seven most important factors: Developed Markets Equity, Developed Markets Fixed Income, China, Asia and Far East, Russia and Eastern Europe, Swedish Short-term Fixed Income, Swedish Long-term Fixed Income, and Japan.

Developed Markets Equity has received the majority of all premiums, the other six have varied in importance over time. In all these seven factors have received 94-99% of all allotted premiums.

Picture 1b. The proportion of all premiums allocated to the seven factors

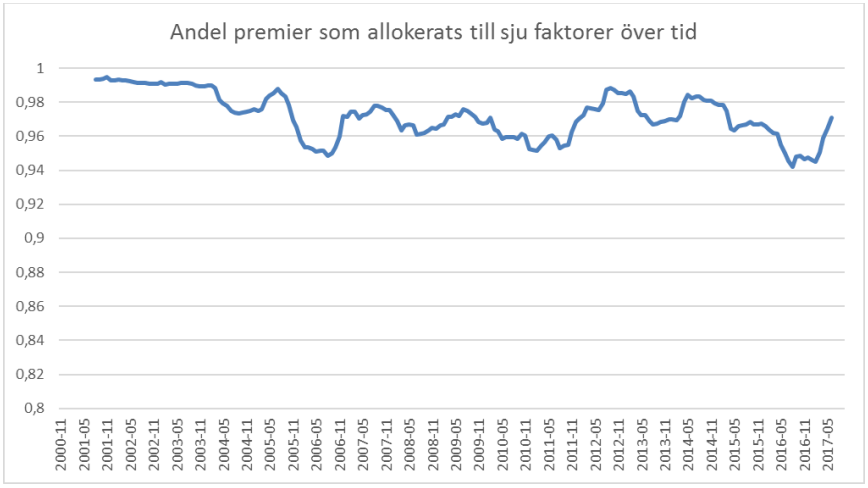


Bild 1b is a summary of the proportion of premiums to all seven factors over time.

Table 5. Fund categories and allocation of premiums

Fondkategrier	Fonder	Andel av fondutbu	Allokering av premier från år 2000-2017	Andel av insatt belopp
AktiefonderAsien	38	2%	10 922 852 278	1%
AktiefonderAsien.och.Fjärrar	38	2%	28 048 084 803	2%
AktiefonderBioteknik	3	0%	368 986 658	0%
AktiefonderEuroland	5	0%	102 740 985	0%
AktiefonderEuropa	121	7%	38 944 620 064	2%
AktiefonderEuropa.småbola	21	1%	10 572 401 325	1%
AktiefonderEuropa/Eurolar	8	0%	2 178 801 591	0%
AktiefonderEuropa/Eurolar	13	1%	2 432 275 435	0%
AktiefonderFastighet	13	1%	4 123 731 055	0%
AktiefonderGlobal	188	11%	162 803 941 506	10%
AktiefonderGlobal.och.Sveri	10	1%	21 315 254 605	1%
AktiefonderIndien	4	0%	8 450 856 266	1%
AktiefonderIT.och.kommun	44	3%	35 664 652 967	2%
AktiefonderJapan	56	3%	18 477 107 647	1%
AktiefonderKina	30	2%	28 507 378 611	2%
AktiefonderLatinamerika	12	1%	14 918 603 396	1%
AktiefonderLäkemedel	11	1%	6 761 215 404	0%
AktiefonderLäkemedel.och.l	17	1%	41 968 544 991	3%
AktiefonderNordamerika.oc	42	2%	21 678 973 841	1%
AktiefonderNordamerika.oc	4	0%	313 099 457	0%
AktiefonderNorden	39	2%	28 581 745 805	2%
AktiefonderNya.marknader	95	5%	60 920 054 615	4%
AktiefonderRyssland	20	1%	57 236 904 507	4%
AktiefonderRåvaror.och.ener	11	1%	24 005 814 494	1%
AktiefonderSvenska.aktier.+.	1	0%	13 353 897 882	1%
AktiefonderSvenska.aktier.oc	3	0%	7 678 003 274	0%
AktiefonderSvenska.och.utlär	4	0%	12 944 945 893	1%
AktiefonderSverige	68	4%	111 019 726 050	7%
AktiefonderSverige.(normal)	19	1%	30 738 659 600	2%
AktiefonderSverige.index	7	0%	8 146 320 952	1%
AktiefonderSverige.småbolag	23	1%	40 643 876 950	3%
AktiefonderUSA.och.Norda	54	3%	23 354 931 453	1%
AktiefonderÖsteuropa	42	2%	32 852 855 492	2%
AktiefonderÖvriga.branscher	78	5%	47 890 149 631	3%
AktiefonderÖvriga.länder	68	4%	53 584 542 532	3%
BlandfonderAggressiv	13	1%	5 153 690 934	0%
BlandfonderBalanserad	16	1%	16 230 728 939	1%
BlandfonderFörsiktig	12	1%	3 828 201 270	0%
BlandfonderSvenska.aktier,.u	8	0%	3 730 656 723	0%
BlandfonderSvenska.aktier.+	2	0%	993 354 536	0%
BlandfonderSvenska.aktier.o	8	0%	100 285 834 547	6%
BlandfonderSvenska.och.utlä	5	0%	1 255 478 260	0%
BlandfonderUtländska.aktier.	48	3%	34 097 669 917	2%
BlandfonderVarierande	75	4%	43 101 053 554	3%
GenerationsfonderPension.o	32	2%	102 942 272 541	6%
GenerationsfonderPension.o	10	1%	2 421 196 881	0%
GenerationsfonderPension.o	18	1%	40 640 621 892	3%
GenerationsfonderPension.o	5	0%	4 736 115 695	0%
RäntefonderEuropa.och.eur	20	1%	3 437 820 836	0%
RäntefonderEuropa.och.Eur	12	1%	269 881 613	0%
RäntefonderEuropa.ränta	33	2%	9 772 954 363	1%
RäntefonderGlobal.ränta	12	1%	5 416 863 694	0%
RäntefonderNorden.ränta	10	1%	7 071 911 722	0%
RäntefonderSverige.kort	8	0%	32 789 752 371	2%
RäntefonderSverige.kortränta	23	1%	72 167 893 513	4%
RäntefonderSverige.lång	12	1%	14 447 786 881	1%
RäntefonderSverige.lång.och.	26	2%	56 251 669 789	3%
RäntefonderSverige.Realränta	1	0%	420 202 622	0%
RäntefonderSverige.Övriga	3	0%	6 677 304 815	0%
RäntefonderTillväxtmarknad	13	1%	2 694 628 713	0%
RäntefonderÖvriga	29	2%	6 836 289 032	0%
RäntefonderÖvriga.räntefon	28	2%	19 416 323 642	1%
RäntefonderÖvriga.utländska	38	2%	9 464 346 240	1%

Table 6c. Granger causality and significance

Fund Category	Size causes money Estimate	P-value		Money causes size Estimate	P-value	
AktiefonderAsien	0,43	0,01	***	0,00	0,80	
AktiefonderAsien och Fjärran östern	0,99	0,00	***	0,00	0,47	
AktiefonderBioteknik	0,25	0,01	***	0,01	0,42	
AktiefonderEuroland	0,04	0,16		0,01	0,87	
AktiefonderEuropa	0,26	0,01	**	0,03	0,21	
AktiefonderEuropa småbolag	1,45	0,00	***	0,02	0,03	**
AktiefonderEuropa/Euroland Index	-0,03	0,83		-0,01	0,69	
AktiefonderEuropa/Euroland småbolag	-0,06	0,46		0,01	0,36	
AktiefonderFastighet	-0,22	0,07	*	-0,01	0,22	
AktiefonderGlobal	1,98	0,00	***	0,00	0,62	
AktiefonderGlobal och Sverige	0,36	0,33		0,00	0,73	
AktiefonderIndien	1,08	0,00	***	0,00	0,18	
AktiefonderIT och kommunikation	0,37	0,00	***	-0,02	0,01	***
AktiefonderJapan	0,30	0,30		0,00	0,82	
AktiefonderKina	0,06	0,83		0,00	0,91	
AktiefonderLatinamerika	0,41	0,05	**	0,00	0,22	
AktiefonderLäkemedel	0,32	0,28		0,00	0,45	
AktiefonderLäkemedel och bioteknik	-3,58	0,00	***	0,00	0,24	
AktiefonderNordamerika och USA	0,00	0,98		0,01	0,06	*
AktiefonderNordamerika och USA småbolag	-0,01	0,85		0,02	0,57	
AktiefonderNorden	-0,02	0,91		0,00	0,61	
AktiefonderNya marknader	0,19	0,30		0,00	0,44	
AktiefonderRyssland	-2,50	0,00	***	0,00	0,96	
AktiefonderRåvaror och energi	1,15	0,01	***	0,00	0,92	
AktiefonderSvenska aktier + Utländska aktier	14,47	0,00	***	0,00	0,62	
AktiefonderSvenska aktier och utländska aktier	1,32	0,38		0,00	0,57	
AktiefonderSvenska och utländska aktier	-0,51	0,86		0,00	0,96	
AktiefonderSverige	3,03	0,00	***	0,00	0,69	
AktiefonderSverige (normal)	2,45	0,00	***	0,00	0,93	
AktiefonderSverige index	0,80	0,00	***	0,00	0,79	
AktiefonderSverige småbolag	1,10	0,07	*	0,01	0,15	
AktiefonderUSA och Nordamerika	-0,22	0,28		-0,02	0,05	**
AktiefonderÖsteuropa	-0,26	0,41		0,00	0,25	
AktiefonderÖvriga branscher	-0,33	0,26		0,00	0,78	
AktiefonderÖvriga länder	1,01	0,11		0,00	0,50	
BlandfonderAggressiv	0,54	0,00	***	0,05	0,00	***
BlandfonderBalanserad	1,14	0,00	***	0,01	0,15	
BlandfonderFörsiktig	0,61	0,01	***	0,01	0,38	
BlandfonderSvenska aktier, utländska aktier och svenska rä	0,32	0,00	***	-0,03	0,15	
BlandfonderSvenska aktier + utländska aktier + svenska rä	0,31	0,00	***	0,04	0,01	**
BlandfonderSvenska aktier och räntor	24,12	0,00	***	0,00	0,00	***
BlandfonderSvenska och utländska aktier samt svenska rän	0,27	0,00	***	0,05	0,09	*
BlandfonderUtländska aktier och räntor	0,95	0,01	***	0,01	0,17	
BlandfonderVarierande	1,05	0,01	**	0,01	0,09	*
GenerationsfonderPension om mer än 10 år	-0,48	0,47		0,00	0,13	
GenerationsfonderPension om mer än 20 år	0,15	0,00	***	0,06	0,05	*
GenerationsfonderPension om mindre än 10 år	0,88	0,00	***	0,00	0,90	
GenerationsfonderPension om mindre än 20 år	1,01	0,00	***	0,01	0,10	*
RäntefonderEuropa och euro	0,12	0,14		-0,02	0,26	
RäntefonderEuropa och Euroland	0,12	0,00	***	0,04	0,13	
RäntefonderEuropa ränta	0,23	0,54		0,00	1,00	
RäntefonderGlobal ränta	0,45	0,00	***	0,01	0,25	
RäntefonderNorden ränta	0,08	0,52		0,00	0,43	
RäntefonderSverige kort	3,58	0,00	***	0,00	0,05	*
RäntefonderSverige kortränta	2,59	0,03	**	0,00	0,04	**
RäntefonderSverige lång	0,49	0,48		0,00	0,30	
RäntefonderSverige lång och realränta	0,68	0,67		0,00	0,95	
RäntefonderSverige Realränta	0,38	0,01	***	0,00	0,64	
RäntefonderSverige Övriga	0,80	0,03	**	0,00	0,68	
RäntefonderTillväxtmarknad ränta	0,08	0,02	**	0,00	0,99	
RäntefonderÖvriga	0,58	0,06	*	0,00	0,62	
RäntefonderÖvriga räntefonder	0,89	0,22		0,01	0,12	
RäntefonderÖvriga utländska	0,04	0,75		0,00	0,81	