Time Diversification in Pension Savings

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Abstract

We take a closer look at how investment horizon affects risk taking, often referred to as the time-diversification controversy. We use data on individuals' choices in the Swedish pension system. Theoretically, if returns are serially uncorrelated, investors do not have human capital, and investors have constant relative risk aversion then investment horizon should not influence asset allocation. This theory causes some academics to explain the positive correlation between investment horizon and risk exposure by generational differences in human capital, not the investment horizon per se. Our empirical analysis shows that portfolio risk significantly declines with age in a statistical context. This behavior is still evident after controlling for alternative explanations related to human capital and difficult to reject in an economic context.

I. Introduction

A major asset allocation decision is the amount of risk one is willing to tolerate. Different investors will naturally be more or less risk averse depending on their economic and demographic situation. A commonly observed practice, encouraged by financial planers, is that ones risk should be related to ones investment horizon.

Expected utility theory states that if returns are serially uncorrelated and investors have both constant relative risk aversion and no human capital, then time is not a factor in portfolio allocation. Economists as P. Samuelson (1963, 1989, 1994), Bodie, Merton and W. Samuelson (1992), and Kritzman (1994) offer intuitive examples and convincing formal arguments showing that time-diversification is in fact not diversification at all. They show that an investor who prefers a certain level of risk with, say, a three-month horizon will prefer that same level of risk with, say, a 10-year investment horizon. In fact, Bodie (1995) even labels the belief in time diversification a fallacy. These researchers suggest that the reason risk exposure decreases with horizon in some studies has to do with the investors' demographic or economic situation and is not an attempt to diversify.

On the other hand, if returns are serially correlated or if investors do not have constant relative risk aversion, a decrease in investment horizon can very well lead to decreased risk. Lee (1990), Siegel (1994), Thorley (1995) and Campbell and Viceira (2002) explore this. Thorley (1995) shows that the academic view does not necessarily contradict the practitioner view if Samuleson's proof is correctly understood. In essence, Thorley rephrased Samuleson's statement; if investors are expected utility maximizers who do *not* have constant relative risk aversion, then the optimal proportion of their portfolio allocated to risky stocks is influenced by the investment horizon. In particular, if investors have decreasing relative risk aversion, then investors will optimally decrease their exposure to risky stocks as their investment horizon decreases. Campbell and Viceira show empirical evidence of asset prices being mean reverting over the past 100 years and argue therefore that risks can appear different to long-term investors than to short term investors. Because of mean reversion in prices, stocks may hold a lower risk for long term investors than for short term investors. This is regardless of the investors relative risk aversion. In other words, academics can prove or disprove time diversification depending on whether they assume decreasing or constant relevant risk aversion or if prices are mean reverting or not. Thus, the time-diversification controversy is an empirical issue.

In this study we investigate how a great number of investors have chosen to allocate a portion of their pension. The first round of choices made in the Swedish pension system had many characteristics of a laboratory experiment. By fiat, the entire work force, those with short and long investment horizons, in the Swedish population constructed portfolios using an equal proportion of their wage. The portfolios were for retirement purposes so the investment horizon is known. All investors were provided with the same information at the same time. We couple this individual portfolio choice data with an extensive database of individual demographic and economic variables in an attempt to explain the time-diversification phenomenon.

Our results show that younger investors have higher risk than older investors, or investors with long horizons have higher risk than investors with short horizons. Our attempts in controlling for differences in human capital do not change this. We also find it difficult to reject this finding in an economic context.

In the following sections we will first review theory concerning time-diversification. In section III we present our data and describe the Swedish pension system focusing on the defined contribution portion and discuss our methodology. Section IV presents our results and we will offer our concluding remarks in Section V.

II. Theory

The basic idea of time-diversification is that above-average returns tend to offset below-average returns over long horizons. Formally, if returns are lognormal and independent over time then the average return will increase linearly with time while the standard deviation will increase by the square root of time. Consequently, the risk of getting a lower return than the risk free rate, alternatively, the risk of loosing money, approaches zero as time moves towards infinity. The other side of this argument is that although the risk of losing money may decrease with time, the amount that can be lost increases proportionally thus canceling out any increase in utility that a longer horizon can offer.

In table 1 we review five possible explanations why horizon could affect risk, three against time diversification and two in favor of time diversification.

Arguments against Time Diversification

While critics agree that the ratio of expected return to standard deviation (reward-to-risk ratio) increases with time, they also point out that the size of an investor's potential loss increases in the same proportion as the expected returns, thus reducing the attractiveness of the higher reward-to-risk ratio. Although one is less likely to lose money over a long horizon than over a short horizon, the magnitude of the potential loss increases with the duration of the investment horizon. Kritzman makes a comparison with cross-sectional diversification. If an investor is unwilling to invest $10,000 in a risky project based on his level of risk aversion, then that same investor would not agree to invest in ten independent but equally risky projects which require $10,000 each. Although the investors' risk of losing money is reduced when investing in the ten independent projects, the exposure and, therefore, the amount the investor risks losing is ten times as great. The only way to reduce risk while keeping the exposure constant is if the investor instead is able to invest $1,000 in each of the independent projects. Kritzman further explains that whether an investor has a utility function equal to the logarithm of wealth, or if an individual is even more risk averse and has a utility function equal to negative one divided by wealth, the utility of the risky venture will remain unchanged over time, meaning that an increase in time horizon will not affect an investors tolerance towards risk (see Kritzman 1994 for details). The critics of time diversification are well aware of the studies that show that as investors grow older or as the investment horizon decreases, investors tend to carry lower risk in their portfolios. However, the critics claim that the observed relationship between risk and horizon is not driven by time diversification. We will briefly review three of these alternative explanations.

Non tradable assets (i.e. human capital) may have an impact on the risk of an investor's portfolio. The prediction of utility theory assuming constant relative risk aversion is that the fraction of equities in proportion to true total wealth is unchanged over time. True total wealth is defined as human capital plus liquid capital. Samuelson (1994) illustrates the confounding effect of human capital with a young professional with future non-security earnings. Since the human capital prospects can not be capitalized or borrowed on, to keep the portion of equities at a proper fraction of true total wealth, the young professional should keep a relatively large fraction of his liquid wealth in equities. Later in life, as human capital is converged into liquid capital, the fractional holding of equities appears to decrease when compared to liquid capital, whereas, in fact, the fraction has remained unchanged when compared to true total wealth. Developing this argument further, Bodie, Merton and W. Samuelson (1992) propose that an investor with the ability to work a little harder or postpone consumption is more likely to take a higher risk whereas an older professional does not have the same option.

Another aspect of human capital expressed by Strangeland and Turtle (1999) concerns ones ability to work in times of poor risky-asset returns. We call this the covariance between ones earnings and market performance. If two investors with the same investment horizon differ in covariance, then the investor with a higher covariance is expected to have a lower portfolio risk. The reason being that, if covariance is high, earning power is reduced in times of poor market performance resulting in a major shortfall. A longer investment horizon allows for more of these extreme shortfalls. A "high covariance" investor is more cautious of taking risky investments. If this is true, then investment horizons effect on risk is related to the covariance of ones earning power with market performance.

The third factor in table 1 concerns the frequency of required withdrawals from ones portfolio. Samuelson (1989) suggests that this can explain why risk may decrease as horizon decreases. If an investor requires a minimum amount at a future date i.e. for future pension payments, the investor makes a series of low risk investments to meet this requirement. As the future date approaches, the low risk fund increases in size compared to high risk investments. Such an investment strategy creates the illusion that the investor believes in time diversification. The opposite is true if periodic withdrawals are needed for everyday consumption i.e. if the investor is a pensioner and the investment horizon goes from 65 years of age to death. Then the low risk fund will shrink in size gradually compared to the risky investments as time goes by which may give the appearance of an investment strategy which is opposite to time diversification.

Arguments in support of Time Diversification

Researchers who criticize the notion of time-diversification all assume that returns are Independent and Identically Distributed (IID) and that investors have constant relative risk aversion (CRRA), meaning that they will allocate the same proportion of their wealth towards risky assets regardless of their absolute level of wealth.

Thorley (1995) shows mathematically that given an expected utility setting and that investors have a decreasing relative risk aversion towards what they perceive to be serially uncorrelated returns, time is in fact a factor in investment decisions and that the allocation towards risk should increase with an increase in investment horizon. Several techniques are used in estimating the nature of investors' relative risk aversion. The various techniques lead to conflicting conclusions. J. Pratt (1964) and K. Arrow (1965) formalize measures of risk aversion and suggest that investors generally have an increasing relative risk aversion (IRRA). K. Arrow referred to IRRA's ability to explain observed economic behavior with respect to holding cash (see Selden 1956, Friedman 1959, Latane 1963 and Meltzer 1963). The measurement of relative risk aversion has shown to be sensitive to what measure of wealth is used. Research since the mid 1960's have shown evidence of increasing- (Siegel and Hoban 1982, Eisenhauer and Halek 1999), constant- (Szpiro 1986) and decreasing-relative risk aversion (Levy 1994).

There is a great deal of research on exploring how mean reverting prices affect risk with respect to investment horizon. Campbell and Viceira (2002) find that prices over the past 100 years are mean reverting and therefore time diversifies risk. According to Campbell and Viceira, because of mean reversion, there is a degree of predictability in stock prices. Measured over long horizons the risk in stock returns is lower than when measured over shorter horizons. Bull markets tend to follow bear markets. Short term investors will seek assets with higher mean reversion, namely bonds, while investors with longer investment horizons accept assets that are less mean reverting since over time the long term risk is lower than the short term risk. This is suggested to be true regardless of an investors relative risk aversion. Hansson and Persson (2000) also conclude that optimal weights using US data from

1990-1997 suggest that time diversification exists and that allocation decision seems to be independent of the utility function of the investor.

The idea of mean reverting prices is not uncontested. Brown, William and Ross (1995) argue that if an equity market survives, average returns in the beginning of a time period is higher than average return near the end of that time period. For this reason, statistical measures of long-term dependence are typically biased towards rejection of a random walk. On another note, ex post evidence of mean reversion does not guarantee mean reverting prices in the future.

III. Data and Methodology

Data

The data used in this study represent a cross section of the Swedish work force. The first pension investments in the new pension system, in autumn 2000, involved 4.4 million individuals. Their investment choices are linked with individual demographic data collected by Statistics Sweden for the year 2000.[2] Statistics Sweden surveys 15,000 households which represent a cross section of the whole population in Sweden. This compiled data set makes it possible to study investment behaviour in great detail. For each individual there is information on the amount invested, which funds and how many funds the individual has invested in. Also, the age, gender, education, occupation, income and net wealth for the same individual is included in the data set. From the 15,651 individuals with complete individual information in the data set, 10,375 individuals (66.4%) made an active investment decision. For these individuals it is possible to investigate the exact allocation of assets in their portfolios. The remaining 5,276 individuals (33.7%) did not make an active investment decision. Instead, they are assigned to the default alternative; the Seventh Swedish Pension Fund, which is an equity fund run by the government. We treat the default alternative as an entirely passive choice. Even if an individual considered the default fund to be the optimal

[2] Data sources from Statistics Sweden are, HEK 2000; a report on household economy, IoF 2000; income report and SUN 2000; educational status. These three reports are for the total population in Sweden. They are linked to a survey on 15,000 households reporting in-depth wealth statistics.

choice, and acted accordingly, he/she still shows up as making a passive choice in the data set[3].

Our data set has five advantages. First, our data is a representative sample of an entire country's population. Second, all investment decisions were made during the same brief time period. Third, all investors choose from the same investment universe and were given the same information on that investment universe. The information includes a risk measure on most funds which provides us with reasonable proxies for perceived risk.[4] Table 1 is an illustration of what information is provided for all funds in the Swedish pension system. Fourth, we know the approximate investment horizon for each investor since the investment can be used for retirement purposes only and can not be passed on to a third party.[5] Fifth, we have a number of variables stating the demographic and economic situation of the individual investor. These data have been gathered for the same time period that the initial investment choices were made. The Swedish pension system offers a unique opportunity to study how an entire population handles choice under uncertainty.

Dependent variable, Portfolio risk

Four risk measures with varying degrees of sophistication are associated with each investor. In table 1 we can see how these risk measures are presented to the investors.

First, we use proportion of equity in ones portfolio. The available funds are divided into four groups: equity-, mixed-, generation- and bond funds. For mixed- and generation funds, information concerning equity proportion is generally available. If no information is available for one particular fund we assign it the equity proportion of its peer funds in the same subgroup[6] in the brochure.

Second, all funds with three years of history or more are assigned a risk category from 1-5 represented by a colored graph. An illustration where a green flat line represents the lowest risk category (1) and a jagged red line represents the highest risk category (5). For this

[3] For a detailed analysis over default investors see Engström and Westerberg 2003
[4] We use five different risk measures.
[5] Under certain circumstances the retirement account could be passed on to a spouse, but not to any other third party.
[6] The brochure assigns each fund to a subgroup consisting of funds with similar allocation objectives (i.e., Swedish growth stocks or European value stocks)

risk measure we take the weighted average risk category of the funds in each portfolio. Funds with less history than three years are assigned the average risk category of its peers in the same subgroup in the brochure.

Third and fourth, next to the risk category illustration there is a number representing the annual standard deviation calculated using returns for the past 36 months. We use this number to construct two risk measures: the weighted average standard deviation of the funds in a portfolio with and without considering the covariance between these funds. Although the covariance between funds is not included in the general information given to all investors there is no stopping them in gathering this information on their own. Also, we can not rule out the possibility that investors have a certain feeling for correlation between sectors. We therefore use both measures in our tests. All funds do not have 36 months of history, wherefore we extrapolate a risk measure for these funds by assigning it the average 36 month standard deviation of the funds in its subgroup.

Independent variables

Our primary focus is to investigate to what extent investment horizon affects asset allocation with regards to risk. The investment horizon in this particular investment is 65 minus the investors age since this investment is for retirement purposes only and can not be passed on to any third party. In our model we will use the logarithm of investment horizon, since the difference between 5 and 4 years left to retirement represents a 20 percent reduction in time; whereas, the difference between 35 and 34 years is only a 2.5 percent reduction in time left to retirement. We mentioned 5 main theories as to why investment horizon affects or appears to affect risk. In the following paragraphs we explain how we attempt to control for these theories.

First, Samuelson states that one must control for total wealth, meaning liquid wealth + human capital. We use the logarithm of net-wealth assuming a concave utility function. Net wealth is made up of four components: market value of low risk assets plus market value of risky assets plus market value of real estate less debt. The survey used to calculate this particular data (HEK 2000) includes foreign as well as domestic assets and debt. The market value of real estate is estimated using tax and comparable sales data. The market value of a house is estimated as the tax assessment value times the ratio of market price to assessed value using data from recent sales prices of houses in the same area. In Sweden, condominiums are not assessed for taxation purposes. The market value of condominiums is estimated as the average value of the recently sold condominiums in the immediate area. According to Samuelson, net wealth or, liquid capital as he calls it, is only one part of total wealth. The other part is human capital. Human Capital can be defined as a discounted present value of expected income[7] (see Halek and Eisenhauer 1999, Poterba et al 2003 and Cocco and Gomes 2005).

$$E(income_i) = \alpha(age_i) + \gamma \; Z_i + \varepsilon_i \qquad (1)$$

Expected income can be seen as a function of age and a vector of other individual characteristics (Z_i). For each investor we derive expected income for each year until retirement. We do this by allowing age to increase one year at a time while holding all other variables constant at average values for the sample multiplying them with the parameter estimates from equation (1). The discounted value of expected income represents an individuals non-tradable asset; human capital.

$$Human \;\; Capital_i = \sum_{t=1}^{65-age} \frac{E(income_i)_t}{(1+r_i)^t} \qquad (2)$$

When estimating the present value of future income the discount factor used (r_i) should correspond to occupational risk. Our main assumption is that individuals within the same occupational cohort have approximately the same occupational risk. Following this argument, the discount factor will also be similar for these individuals. For example, we estimate expected income for all employees in the public sector. Once we have these estimates we calculate human capital using the same discount factor for all employees within the public sector. We use the same discount factor as Halek and Eisenhauer 1999, namely 2% corresponding to the inflation adjusted risk free rate.

[7] We have also calculated human capital as the present value of disposable income but due to the tax system in Sweden, demographic variables such as education and occupation are better at predicting income than disposable income.

Our primary interest lies in controlling for differences in human capital between individuals. We argue that using the same discount factor for individuals with similar occupational risk is sufficient in revealing these differences. We therefore estimate expected income and its present value separately for our four occupational cohorts. Because of this, our results from the different cohorts are not comparable, but they serve as robustness checks to verify whether the coefficient signs and levels of significance tell the same story. We also estimate human capital using the same discount factor for the whole population regardless of occupation. Consequently we have five series of estimates of human capital, one for each occupational cohort and one for the entire sample. Albeit a noisy measure, we still argue that it captures the essential portion of human capital.

Bodie's argument is that one can work more if investments go bad. A risky investment gone poorly can be compensated by working harder or consuming less over the remaining investment horizon. A longer investment horizon will then allow higher risk. Since human capital is related to age we expect a high level of multicollinearity in our model. We therefore orthogonalize the horizon variable with human capital and use the error term from the regression:

$$\ln(65 - age_i) = \alpha + \beta_1 human\ capital_i + \varepsilon_i \qquad (3)$$

thus using the portion of investment horizon which is not explained by our human capital related variable. In table 4 we see that human capital explains investment horizon ($\ln(65 - age_i)$) to a very large extent.

Second, we consider the covariance between expected income and market performance. It is argued that horizons influence on risk will differ depending on the covariance between an investors earning power and market performance. We use our four occupational cohorts mentioned earlier as dummies. We need not make any assumptions on the differences in market covariance between the different cohorts, only that market covariance is similar for all individuals within the same cohort. In the four equations where the occupational cohorts are estimated separately, the aspect of covariance between market performance and earning power is taken into account.

Third, Samuelson raises the issue of how frequent withdrawals need to be made from the investor's portfolio. The basis for his argument is that the present value of a minimum level of required wealth at retirement is invested in a risk less fund and that this investment will become an increasing portion in ones portfolio. Consequently, the risk less portion of pension savings resembles a time diversification strategy. Therefore, we need to focus on pension savings in excess of the portion required for minimum wealth at retirement to see if horizon affects risk. The investments observed in our dataset are in excess of the portion required for minimum wealth at retirement and is therefore suitable to use in this context. So, by default this aspect is taken into consideration by the nature of this data.

Fourth and fifth, we are faced with two other factors in explaining horizons effect on risk: the investors' relative risk aversion and whether returns are IID or not. Based on classic economics we assume that investors believe returns are random walk and have constant relative risk aversion.

The Menu

Investors' choices are affected by how the alternatives are presented (Benartzi and Thaler 2001). Each investor is given a brochure including information on all investment alternatives. Table 1 is a representation of how the funds are presented to the investor. In total 464 funds are available[8]. The funds are divided into four major categories; Equity, mixed, generation and bond funds. We add all aspects of how the investment alternatives are presented in an attempt to control for the effect they may have on risk.

Portfolio optimization primarily concerns risk and return. We therefore control for historical return reported in the brochure with regards to the well documented momentum effect. We also control for the number of years of historical return reported in the brochure and whether the fund is new. We include two normalized variables from 0 – 1 to control for the order in which the funds are presented. The funds are divided into subgroups representing region or industry and then placed in an alphabetical order in each subgroup. A fund in the first subgroup in the brochure and starting with the letter "A" will consequently receive values close to 0. In the fund information in the brochure the investor gets information concerning the portion of domestic/foreign assets in the fund. Since home bias is a known issue in asset allocation we control for this aspect. Market cap and fee are also presumed to impact

[8] 455 funds were included in the original brochure. Before the first choice was completed some were added and some were taken away resulting in a total of 464 funds.

investors' choice and are therefore included in the regression. Since our intention is to measure the time-diversification phenomenon, we need to control for a category of funds called "generation funds". Generation funds are similar to the suggested "pre-set mix" fund in the U.S. The investors that have chosen generation funds could be seen as time-diversifiers by default if they choose the "correct" fund for their investment horizon. Since we are provided with the details of all investment choices we can control for those who have chosen generation funds, whether they have chosen a "correct" mix with regards to their investment horizon or not.

Method

The purpose of this paper is to test whether we can empirically discard the practice of time diversification. The data we have provides information on the risk level of a specific investment bearing economic consequence and the corresponding horizon of this investment, namely time to retirement. Because our sample suffers from selection bias, in the sense that one third of our sample ended up investing in the default fund with unknown risk, we estimate our parameters with the two step Heckman procedure (Heckman 1979) where first the likelihood of investing is estimated from a probit model. The method may be described by the following two equations:

$$risk_i = x_{1i}\beta_1 + \varepsilon_{1i} \ , \qquad (4)$$

$$e_i^* = x_{2i}\beta_2 + \varepsilon_{2i} \ . \qquad (5)$$

Equation (4) determines the individual's risk, whereas (5) is a "participation equation" describing the individual's propensity to work. Thus, $risk_i$ is the observed risk for individual i if she participates in the pension system and e_i^* is a latent variable that captures the propensity to participate in the pension system; x_{1i} and x_{2i} are vectors of observed explanatory variables, such as age and education; ε_{1i} and ε_{2i} are mean-zero stochastic errors representing the influence of unobserved variables affecting $risk_i$. The vectors of interest are β_1 and β_2.

Although the latent variable e_i^* is unobserved, we can define a dummy variable e_i =1 if $e_i^* \geq 0$ and e_i = 0 otherwise; we thus observe individual risk only if e_i =1, i.e. only if the individual makes an observable choice in the pension system. It is possible that the unobserved terms ε_{1i} and ε_{2i} are positively correlated; individuals with higher risk, given x_{1i} and x_{2i}, might also be more likely to participate in the pension system. If so, the sample of individuals that participate in the pension system will not accurately represent the underlying population.

Heckman suggests the following method to deal with this selection problem. Note that the conditional mean of ε_{1i} can be written as:

$$E(\varepsilon_{1i} | \ e_i^* \geq 0) = E(\varepsilon_{1i} | \ \varepsilon_{2i} \geq -x_{2i}\beta_2), \qquad (6)$$

and hence

$$E(risk_i | \ x_{1i}, e_i = 1) = x_{1i}\beta_1 + E(\varepsilon_{1i} | \ \varepsilon_{2i} \geq -x_{2i}\beta_2). \qquad (7)$$

Thus, the regression equation on the selected sample depends on both x_{1i} and x_{2i}. Omitting the conditional mean of ε_{1i} will cause the estimates of β_1 to be biased (unless ε_{1i} and ε_{2i} are uncorrelated, in which case the conditional mean of ε_{1i} is zero).

Under the assumption that ε_{1i} and ε_{2i} are drawn from a bivariate normal distribution, we can derive the regression equation:

$$E(risk_i | \ x_{1i}, e_i = 1) = x_{1i}\beta_1 + \rho\sigma_1\lambda_i \ , \qquad (8)$$

In (8) ρ is the correlation coefficient between ε_{1i} and ε_{2i}, σ_1 is the standard deviation of ε_{1i}, and λ_i, which is the inverse mills ratio, is given by

$$\lambda_i = \frac{\phi(x_{2i}\beta_2 / \sigma_2)}{\Phi(x_{2i}\beta_2 / \sigma_2)} \ , \qquad (9)$$

where ϕ and Φ are the density and distribution functions of the standard normal distribution and σ_2 is the standard deviation of ε_{2i}.

Heckman shows how to estimate (8) in a two step procedure. The first step involves estimating the parameters in (5) by the probit method, using the entire sample. These estimates can then be used to compute λ_i for each individual in the sample. Once λ_i is computed, we can estimate (8) over the sample of working individuals with an OLS regression, treating $\rho\sigma_1$ as the regression coefficient for λ_i. When modelling the likelihood of making an active investment choice we use experience with risky assets and the amount invested in this specific investment[9] as explanatory variables. The inverse mills ratio from the probit estimation is used in the second step estimation with risk as the dependent variable and investment horizon being the key explanatory variable and proxies for the factors which are known to affect risk, mentioned in the previous section. The database we use provides suitable proxies for three of these factors: human capital, the covariance between earning power and market performance and the frequency of required withdrawals from ones portfolio.

We run heckman estimations for each occupational cohort and one for the entire sample where we include dummies for occupation. We do this for four different risk measures which in total provide us with 25 estimates for the horizon coefficient.

IV. Empirical Results

Estimating expected income

We estimate the present value of expected income in accordance with equation (1). Ln(income) is explained by age, age^2, education level and major, occupation, whether you live in a city, town or village, gender, marital status and number of children. In table 2 we report the coefficients and t-statistics used in estimating expected income. In the general equation where all individuals' income is estimated, the R-square is 68% which is relatively large. On the other hand, when estimating income for the self employed the R-square is just

[9] We also estimate the Heckman model with a maximum likelihood procedure and retrieve the same results.

above 2% and for the self employed, hardly any of the coefficients are significantly separate from zero. R-square for the other three occupational cohorts are around 10%. Examining the coefficients in our five regressions we first see that age has a positive effect on income which seems to turn negative as age reaches a certain level (since age^2 is negative). Secondly, in most cases, education level seems to have a reasonable effect on income. Post high school education yields a higher income and less than high school yields a lower income. The level of education seems to matter more than education major. For those employed in the private sector (occ2), an education major within social science (edm1) tends to result in a higher income than an education within medicine (edm3)[10]. We find the opposite effect among the unemployed or those with an unknown employment (occ4). Third, in the overall equation (all) we find that those employed in the private sector have a higher income than those employed in the public sector and the self employed and the unemployed have significantly lower income levels. Fourth, those living in an urban setting[11] have a higher income than those living in smaller towns or on the country side (rural). Finally, Men tend to have higher income than women and finally, married individuals tend to have higher income while those with children on average have lover income. A possible explanation for the coefficient on children could be that if one parent stays home or works part time, he or she will have a relatively low income thus decreasing the average income for individuals with children.

All parameters are used when calculating expected ln(income). When so doing, all variables are held constant except age. A string of expected ln(income) from current age to retirement is converted to expected income and then discounted to a present value in accordance with equation (2). Figure 1 displays the estimated values for ln(income) for ages between 21 and 62 compared to income averages for the corresponding age group. The hump-shaped estimated curve corresponds well with the actual income averages in our samples.

As we discussed earlier, when calculating the present value, the discount factor should vary in accordance with the risk of ones occupation. We address this issue by estimating the present value of expected income separately for each occupational cohort. By doing this, we

[10] Edm4 = unknown education major which makes this coefficient difficult to interpret.

[11] Here, urban is a dummy for living in one of the three major cities in Sweden: Stockholm, Göteborg or Malmö. Rural is if you live on the country side.

assume the same occupational risk for all individuals within the same cohort. We therefore let the occupational cohorts in themselves act as proxies for covariance between market performance and earning power.

Descriptive statistics of all variables that will be used in our main regressions are reported in table 3. As for our risk measures, we note that the demand for equity is fairly high, 90.3% equity on average. The high proportion of equity is reflected in the average portfolio standard deviation of ca: 18%. Overall, the average risk level is fairly high for a pension plan.

According to our variables on individual characteristics the average age is 43. Investment horizons in the dataset span from ln(3 years) to ln(46 years) with an average of ln(21.97 years). These numbers reflect time to retirement and capture a representative sample of the working force in Sweden. and human capital is lower for individuals in the public sector than for individuals in the private sector. Also, the standard deviation for the human capital estimates is larger for individuals in the private sector than those in the public sector. We find these results to be reasonable. There is a large variation in ln(net wealth) with a minimum of 0 and a maximum MSEK 354 (ln(19.686)).

From the information from the brochure we find that the average compounded three year return is 143%, which is exceptionally high in comparison with historical figures. This high figure reflects an unusually positive development for equity markets. This among other factors may explain the comparatively high rate of participation in the pension system (only one third default investors) and the demand for equity as noted earlier. Funds investing in domestic markets represent 34.2% of all investment alternatives, which is relatively high since the proportion of Swedish assets on global markets is closer to 3%. Correct, shorter and longer corresponds to the generation funds available. The numbers of observations display how many have chosen generation funds with a correct, shorter or longer investment horizon. The average market cap is MSEK 3,419 and the fee is on average 0.734. In the brochure each fund reports at most 5 years of history where the average fund has ca: 2 years of history. A fund is considered new if there is less than two years of history since there then isn’t enough data to calculate the funds standard deviation based on 36 months annualized return. Subgroup and alphabet simply refers to the order in which the funds are presented. A mean above 0.5 indicates that funds in the latter half of the individual subgroups were on average more popular than the rest.

Finally, we have our two variables related to the fist step selection equation in the Heckman procedure. Approximately 61% of the population or 9507 individuals have previous experience with risky assets, meaning equity or equity funds. This variable and the amount invested in the pension system have proven to be of importance in explaining pension system participation (see Karlsson & Nordén 2004 and Engström & Westerberg 2003).

Human capital is per definition correlated with age wherefore we orthogonalize the horizon variable so it reflects the portion of horizon not explained by human capital. From the regressions in table 4 we observe large values for adjusted r-squares as expected. There is however still a portion of horizon which is not explained by our proxies related to human capital. The error term in equation 3 is used as our horizon variable when estimating horizons affect on risk. For robustness we use four different risk measures as the dependent variable and redo our estimations five times, one for each occupational cohort and one for the entire population. Since we are primarily interested in the horizon coefficient we report only them in table 5 while the full results can be found in the appendix.

In table 5 we see that out of the four occupational cohorts, occ4 (employment sector unknown) have the weakest results where the horizon coefficient is not significantly separate from zero in three cases out of four. This corresponds to the fact that the R-square in table 4 for occ4 is 0.83 which indicates that most of the investment horizon for those in occ4 is inseparable from their human capital. In most other cases, the horizon coefficient is significantly positive on the 1% level.

Although the t-values are large, the relevance of the horizon coefficient is not altogether clear. The difference in risk caused by a 1 standard deviation difference in investment horizon ranges between 4% – 2%. 1 standard deviation change in investment horizon corresponds to ca: 2 years. We also measure the difference in estimated risk between a 5 year and 45 year investment horizon, all other variables held equal. In this case the differences in risk range between 13% - 5% which in our view is too large to ignore.

In summary, our results can not discard the practice of time diversification in pension savings among non professional investors, at least not in a pure statistical context. Also, we find that changes in risk caused by changing the horizon coefficient are too large to dismiss.

V. Conclusion

Previous research offers compelling arguments for and against time diversification. Arguments against time diversification are that if returns are IID, investors have no human capital and have constant relative risk aversion then, investment horizon should not affect risk. Arguments related to human capital in some way or another are used to explain why many studies show a positive relationship between risk and investment horizon. These arguments stress that it may be rational to increase risk as investment horizon increases but time in and of itself does not decrease risk. Arguments for time diversification attack the assumptions of IID returns and constant relative risk aversion. If investors have a decreasing relative risk aversion or if asset prices are mean reverting, then investment horizon will affect risk.

The purpose of this analysis is to study whether investment horizon affects risk. In so doing, we attempt to control for three of the explanations offered by economists which would explain such behavior; Investors' human capital, the covariance between their earning power and the market and the frequency of required withdrawals. In accordance with classic finance literature we assume that returns are IID and our investors' utility display constant relative risk aversion.

We use investment data from the first round of the Swedish pension system. Our data represents the entire population in Sweden, all investments are made during the same brief time period, and investors chose from the same investment universe and are given the same information on that investment universe. Also, we know the approximate investment horizon for all investors and have four reasonable measures for risk, proportion of equity, average risk category of the portfolio and two measures of portfolio standard deviation, one measure considering the covariance and one without the covariance.

Having linked all investment data to detailed demographic data we calculate estimates for human capital by regressing income on age, education, gender, marital status and number of children. The present value of expected income is our human capital measure. We use the investors' occupation in an attempt to control for effects on risk caused by the covariance between earning power and market fluctuations. The effects on risk caused by the frequency of required withdrawals are controlled for by the construction of the pension system since no funds can be withdrawn before retirement. Net wealth and historical returns are also included in the model since they also are known to affect risk. Finally, we add control variables to control for confounding effects that may be caused by how the investment alternatives are presented.

One third of the population did not make an observable investment choice. Their money was invested in the government run equity fund which is the default alternative. Since we can not tell which of these investors actively chose not to make a choice or simply didn't care, we treat all default investors as non-active investors. We use the method introduced by Heckman in 1979 to address the selection bias.

We regress risk on three major variables, investment horizon human capital and net wealth. Since human capital and investment horizon are correlated we use the portion of investment horizon which can not explain human capital in our Heckman procedure. Our results indicate that investment horizon matters. Whether this is due to mean reverting prices, investors having decreasing relative risk aversion or the mere fact that much of the advice in media propagates strategies resembling time diversification, we can not say.

Our proxies for human capital receive coefficient signs in accordance with theory whereas the covariance of ones earning power with market fluctuations, i.e. our occupation dummies, have either coefficients that are indistinguishable from zero or coefficients so small, they have very little economic significance. A full account of all coefficients is found in the appendix.

We conclude that while focusing on risk measures which are available to the average investor, we can not reject the impact of investment horizon on risk, even when including our measure for human capital.

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Table 1: Extract from the information folder, fund example

Fund number	Fund name, Management company	Information regarding the funds	Market cap MSEK 99-12-31	Fund fee (%)	Percentage return 99-12-31 (after fees)						Total risk
					In the year					Last 5	(last 3
					95	96	97	98	99	years	years)
191080	Baring Global Emerging Markets Baring International Fund Managers (Ireland) Ltd	Emerging markets' equity and equity related assets	3 896	1.59	-32	10	25	-25	77	25.3	32 (Red)

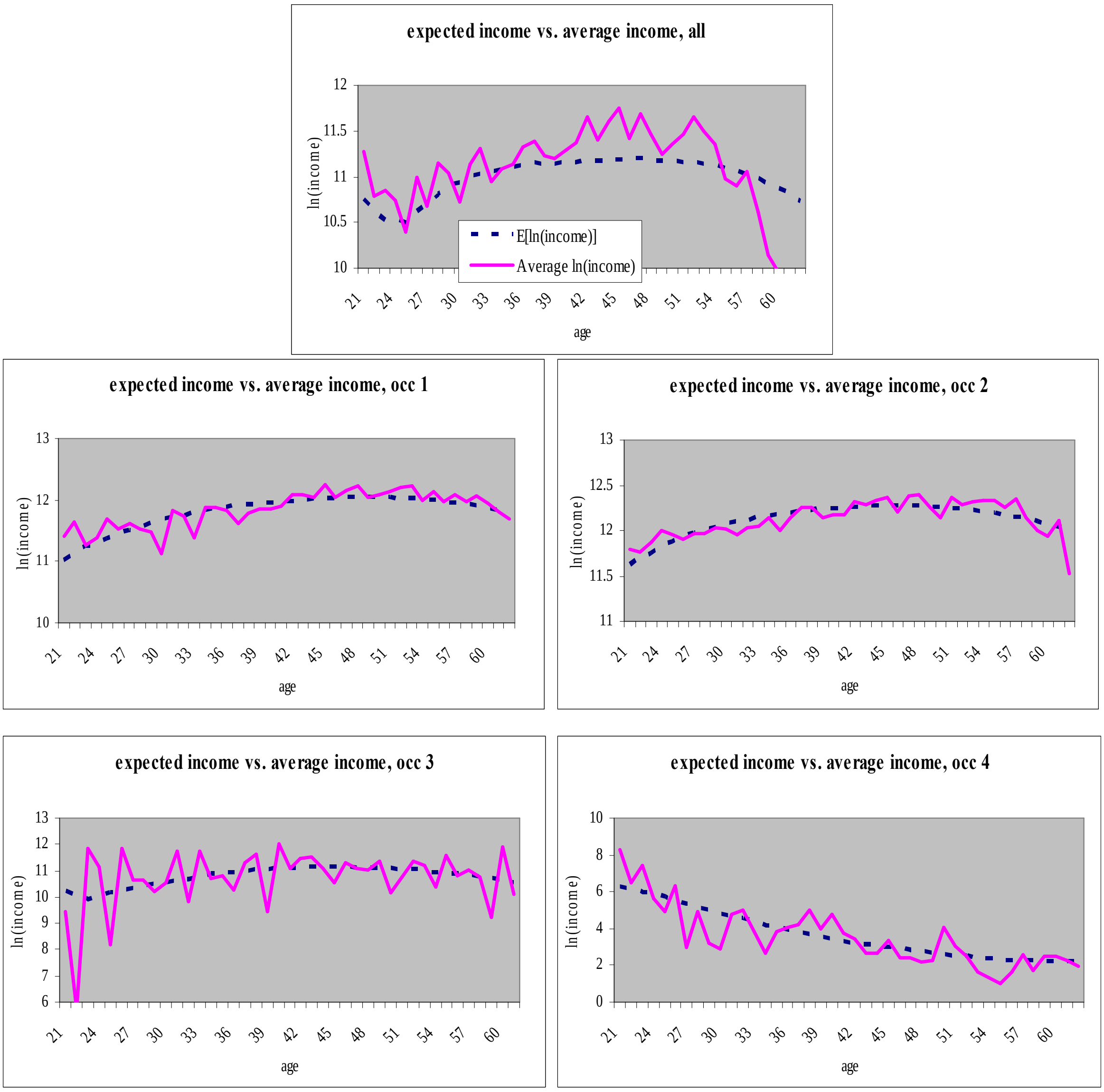
The percentage return for the last five years equals the compounded annual growth rate of return for the years 1995 through 1999. The total risk corresponds to an annualised percentage standard deviation of three-year monthly historical fund returns. The total risk is also categorised into five different classes, and colours, with respect to standard deviation; Class 1: very low risk, dark green, percentage standard deviation in the range 0-2; Class 2: low risk, light green, 3-7; Class 3: average risk, yellow, 8-17; Class 4: high risk, orange, 18-24; Class 5: very high risk, red, 25-.

Table 2, results from OLS regressions on ln(income)

	All	OCC 1	OCC 2	OCC 3	OCC 4
age	0.059	0.130	0.089	0.193	-0.272
	4.35	*9.31*	*9.46*	*1.49*	*-3.79*
age2	-0.001	-0.001	-0.001	-0.002	0.002
	-4.89	*-8.40*	*-8.35*	*-1.45*	*2.56*
edl1	-0.229	-0.142	-0.081	-0.170	-1.101
	-4.03	*-1.72*	*-1.97*	*-0.61*	*-3.42*
edl3	0.458	0.322	0.281	-0.003	1.517
	12.82	*9.23*	*10.49*	*-0.01*	*5.13*
adm2	-0.068	-0.077	-0.032	-0.148	0.024
	-1.51	*-1.08*	*-1.06*	*-0.38*	*0.07*
edm3	0.020	0.038	-0.180	-0.337	0.641
	0.40	*1.03*	*-3.04*	*-0.58*	*1.66*
edm4	-0.011	-0.080	-0.120	-0.126	0.822
	-0.21	*-1.43*	*-3.19*	*-0.35*	*2.32*
occ2	0.160				
	5.54				
occ3	-1.034				
	-9.61				
occ4	-8.451				
	-75.69				
urban	0.104	0.082	0.141	0.259	0.145
	2.87	*2.25*	*5.27*	*0.98*	*0.58*
rural	-0.073	-0.048	-0.032	-0.051	-0.148
	-1.95	*-1.16*	*-1.12*	*-0.20*	*-0.57*
gender	0.475	0.472	0.480	0.281	0.448
	13.28	*13.55*	*17.69*	*1.23*	*1.89*
married	0.129	0.031	0.084	0.681	0.380
	2.97	*0.71*	*3.33*	*1.88*	*1.56*
children	-0.100	-0.101	-0.072	0.023	-0.169
	-5.45	*-4.62*	*-4.51*	*0.17*	*-1.35*
constant	10.634	8.847	9.932	6.055	9.943
	39.79	*31.38*	*56.71*	*2.22*	*6.96*
n obs	15651	4486	8736	745	1648
mean ln(inc)	11.38	11.94	10.93	10.93	3.38
prob > F	0.000	0.000	0.000	0.202	0.000
adj. R-sq	0.679	0.109	0.095	0.021	0.116

Age and age^2 relate to the individuals age 31 Dec 2000. Edl1 = less than high school education, edl2 (default) = high school education, edl3 = more than high school education. Edm1 (default) = social science major, edm2 = technical engineer major, edm3 = major in medicine and edm4 = unknown major. Occ1 (default) = employed in public sector, occ2 = employed in private sector, occ3 = self employed and occ4 = sector unknown. Gender 1 = man, 0 = woman. Married or cohabitant = 1, single = 0. Children, refers to number of children. N.obs is the number of observation in the entire sample and in each occupational cohort. Mean ln(inc) = the average ln(income) for the entire sample and each occupational cohort. Prob>F = the probability that all coefficients are collectively indistinguishable from zero. Adj. R-sq = the adjusted R-square of the regressions. The t-statistics are reported under each coefficient in italics.

Figure1. Expected income vs. average income



Expected income is the predicted value of ln(income) which is calculated for each individual separately using the coefficients in table 2, the dotted line is the average of the separate outcomes. Average income is the average ln(income) for ages 21 to 62 in our sample. The top figure includes all individuals. In the other four figures we divide the individuals on basis of their occupation. Occ 1= employed in the public sector, occ 2 = employed in the private sector, occ 3 = self employed and occ 4 = unknown employment or unemployed.

Table 3. Summary statistics, average values

Risk measures from the brochure					
Variable	Obs	Mean	Std. Dev.	Min	Max
equity	10375	0.903	0.169	0	1
riskcat	10375	3.811	0.574	1	5
stdev (no cov)	10375	0.188	0.050	0	0.53
sedev	10375	0.179	0.043	0.002	0.766
Individual characteristics					
Variable	Obs	Mean	Std. Dev.	Min	Max
age	15651	43.028	11.111	19	62
horizon	15651	2.922	0.634	1.099	3.829
human capital (all)	15651	2 495 358	1 983 527	36	11 600 000
human capital (occ1)	4486	2 489 360	1 362 728	225 995	8 207 950
human capital (occ2)	8736	3 528 756	1 872 326	247 734	10 000 000
human capital (occ3)	745	838 310	508 538	45 794	2 426 976
human capital (occ4)	1684	134 384	90 682	12 106	358 252
Ln(net wealth)	15651	8.290	6.041	0	19.686
Information from the brochure					
Variable	Obs	Mean	Std. Dev.	Min	Max
compounded return	10375	1.429	0.519	-0.241	6.705
domestic	10375	0.342	0.246	0	1
correct	2729	n.a.	n.a.	0	1
shorter	499	n.a.	n.a.	0	1
longer	283	n.a.	n.a.	0	1
market cap	10375	3418.6	11178.0	0	208666.3
fee	10375	0.734	0.300	0	1.98
years of history	10375	1.971	1.495	0	5
new	10375	0.602	0.360	0	1
subgroup	10375	0.557	0.242	0.053	1
alphabet	10375	0.536	0.219	0.036	1
Selection variables for probit estimation in heckman model					
Variable	Obs	Mean	Std. Dev.	Min	Max
experience with risky assets	9507	n.a.	n.a.	0	1
amount invested	15 651	12 858	6 647	210	26 202

Full sample = 15 651 observations, sub-sample including only those who made an active portfolio choice = 10 375 observations. When estimating human capital for the four occupational cohorts we only use individuals in that cohort.

Risk measures include four variables; amount invested in equity / total invested amount (equity), the average risk category according to the information in the brochure (risk category), weighted average standard deviation without considering covariance (stdev (no cov)) and portfolio standard deviation including the covariance (stdev).
Individual Characteristic consists of four main variables: age is the investors age, horizon is ln(65-age). In the heckman regression, we use horizon orthogonalized with regards to human capital in accordance with equation (3). Human capital is the present value of estimated ln(income) estimated for all investors and for each occupational cohort separately reported in SEK. Occ1=employed in public sector, occ2=employed in private sector, occ3=self employed and occ4=unknown employment or unemployed. Net wealth is financial wealth + real estate – debt.
Information from the brochure include 11 variables which are found in the brochure given to each investor. Compounded return is the total return from Jan 1997 to Dec 1999, domestic is the proportion of investment alternatives with investments in the Swedish market, correct, shorter and longer corresponds to the number of individuals who have chosen generation funds with a correct, shorter or longer investment horizon than is prescribed by that particular fund. Market cap is the average fund market capitalization measured in MSEK. Fee is the average fund fee. Years of history is the average number of years of recorded fund performance listed in the brochure where the maximum number of years is 5. A fund is labeled as new if it has less than three years of performance data listed in the brochure. Subgroup and alphabet are related to the order the fund is presented in the brochure.
Selection variables for probit estimation in heckman model include compounded three year return, our estimates for and
a dummy variable for previous experience with risky assets, meaning equity or equity funds. 61 % of the population was exposed to risky assets prior to this investment decision. Amount invested represents the SEK amount invested in this particular investment.
Menu variables 10 variables from the brochure are included in all regressions. Full results reported in appendix tables A1-A5.

Table 4. Results from regression explaining horizon with human capital

	all	occ1	occ2	occ3	occ4
Human Capital	1.9E-07	3.2E-07	2.5E-07	9.2E-07	8.2E-06
constant	2.439	2.042	2.117	2.023	1.704
n.obs	15651	4486	8736	745	1684
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000
adj. R-sq	0.37	0.54	0.59	0.63	0.83

Human capital is the present value of expected income. N.obs is the number of observation in the entire sample and in each occupational cohort. Prob>F = the probability that all coefficients are collectively indistinguishable from zero. Adj. R-sq = the adjusted R-square. Occ 1 represents employees in the public sector, occ2 represent employees in the private sector, occ3 represent self employed and occ4 are of unknown employment.

Table 5. Horizon coefficients

	all	occ1	occ2	occ3	occ4
equity	0.078	0.089	0.077	0.059	0.060
t-value	*27.3*	*15.2*	*18.29*	*3.13*	*3.48*
change 1 stdev	*4%*	*4%*	*4%*	*3%*	*4%*
change 5 - 45 yr horizon	*11%*	*13%*	*11%*	*10%*	*9%*
riskcat	0.175	0.180	0.161	0.171	(0.116)
t-value	*22.7*	*11.63*	*14*	*2.94*	*2.41*
change	*2%*	*2%*	*2%*	*2%*	*2%*
change 5 - 45 yr horizon	*6%*	*7%*	*6%*	*6%*	*5%*
stdev (no cov)	0.016	0.017	0.015	0.016	(0.010)
t-value	*23.14*	*12.15*	*14.29*	*2.84*	*2.34*
change	*4%*	*4%*	*4%*	*4%*	*4%*
change 5 - 45 yr horizon	*11%*	*12%*	*10%*	*11%*	*7%*
stdev	0.007	0.006	0.006	(0.007)	(0.006)
t-value	*10.13*	*5.3*	*5.31*	*0.83*	*1.36*
change	*2%*	*2%*	*2%*	*2%*	*2%*
change 5 - 45 yr horizon	*6%*	*5%*	*5%*	*5%*	*4%*

Coefficients in parenthesis are not significantly separate from zero on a 1% level.

The results in table 5 we report the coefficients for portion of investment horizon not explained by human capital. As a robustness check we run the regressions using four separate risk measures; amount invested in equity / total invested amount (equity), the average risk category according to the information in the brochure (risk cat), weighted average standard deviation without considering covariance (stdev (no cov)) and portfolio standard deviation including the covariance (stdev). The Heckman regression is estimated separately for each occupational cohort and once for the entire population. Occ 1 represents employees in the public sector, occ2 represent employees in the private sector, occ3 represent self employed and occ4 are of unknown employment. The t-values are reported under each coefficient in italics. *Change 1 stdev* represents the change in the risk measure if the horizon variable changes 1 standard deviation and *change 5 – 45 yr horizon* represents the change in the risk measure if the investment horizon changes from 5 to 45 years. When the risk measure is estimated, all other variables are held at average values.

Appendix, variable explanation for tables A1-A4 found after table A4

EQUITY	all	occ1	occ2	occ3	occ4
Horizon	0.0775	0.0886	0.0773	0.0588	0.0604
	27.3	*15.2*	*18.29*	*3.13*	*3.48*
Compounded return	0.1406	0.1781	0.1332	0.0920	0.1148
	51.34	*31.31*	*38.12*	*8.07*	*13.42*
Human capital	1.1E-08	2.3E-08	1.5E-08	5.2E-08	5.7E-07
	14.39	*12.72*	*16.29*	*3.63*	*9.49*
Ln(net wealth)	3.2E-04	-1.4E-04	3.4E-04	1.6E-03	2.2E-03
	1.4	*-0.34*	*1.17*	*1.4*	*2.57*
Employed private sector	0.0066				
	2.34				
Self employed	-0.0082				
	-1.23				
Employment sector unknown	-0.0091				
	-1.71				
Proportion domestic funds	-0.0897	-0.1166	-0.0814	0.0383	-0.0899
	-13.72	*-9.78*	*-9.51*	*1.29*	*-3.91*
correct	-0.0227	-0.0344	-0.0158	-0.1014	-0.0041
	-6.7	*-5.73*	*-3.64*	*-5.49*	*-0.3*
shorter	-0.1078	-0.1017	-0.0905	-0.2336	-0.1547
	-17.78	*-10.05*	*-11.29*	*-9.31*	*-5.12*
longer	-0.0331	-0.0095	-0.0440	-0.0692	-0.0225
	-4.22	*-0.64*	*-4.51*	*-1.77*	*-0.7*
Market cap	3.8E-07	5.6E-07	2.9E-07	-1.2E-08	6.6E-07
	3.29	*2.48*	*2.15*	*-0.01*	*1.41*
fee	0.1072	0.1166	0.0885	0.1225	0.1697
	18.17	*10.29*	*11.92*	*4.68*	*7.67*
Years of history	-0.0340	-0.0373	-0.0288	-0.0440	-0.0425
	-14.74	*-8.47*	*-9.91*	*-4.38*	*-4.88*
new	-0.1190	-0.1358	-0.0972	-0.1614	-0.1290
	-13.51	*-7.93*	*-8.83*	*-4.34*	*-3.79*
subgroup	-0.1399	-0.1618	-0.1219	-0.0366	-0.2042
	-20.51	*-12.95*	*-13.74*	*-1.12*	*-8.41*
alphabet	-0.0676	-0.0407	-0.0739	-0.0714	-0.0908
	-10.91	*-3.46*	*-9.48*	*-2.28*	*-3.98*
_cons	0.9158	0.8560	0.8921	0.8136	0.8755
	64.62	*28.42*	*51.62*	*8.88*	*14.03*
choice					
experience	0.3693	0.3961	0.3871	0.3691	0.0840
	17.29	*13.69*	*15.63*	*7.07*	*2.04*
amount	0.0000	0.0000	0.0000	0.0000	-0.0001
	18.04	*10.87*	*25.09*	*-4.29*	*-14.27*
_cons	-0.1608	-0.8669	-0.7425	-1.4887	-0.6464
	-6.46	*-24.96*	*-25.32*	*-26.59*	*-15.16*
mills					
lambda	-0.0615	-0.0372	-0.0489	0.0347	-0.0088
	-6.18	*-2.55*	*-6.26*	*0.87*	*-0.33*
rho	-0.4691	-0.2970	-0.3912	0.2802	-0.0625
sigma	0.1311	0.1252	0.1249	0.1239	0.1401

RISKCAT	all	occ1	occ2	occ3	occ4
Horizon	0.1750	0.1799	0.1606	0.1711	0.1165
	22.7	*11.63*	*14*	*2.94*	*2.41*
Compounded return	0.5826	0.7017	0.5652	0.4368	0.4889
	78.34	*46.46*	*59.66*	*12.34*	*20.55*
Human capital	2.5E-08	5.5E-08	3.3E-08	1.2E-07	1.6E-06
	12.18	*11.39*	*13.36*	*2.62*	*9.77*
Ln(net wealth)	1.4E-03	2.4E-04	1.5E-03	4.7E-03	6.8E-03
	2.27	*0.21*	*1.86*	*1.3*	*2.85*
Employed private sector	0.0159				
	2.07				
Self employed	0.0001				
	0				
Employment sector unknown	-0.0306				
	-2.11				
Proportion domestic funds	0.0217	-0.0325	0.0370	0.2684	0.0773
	1.22	*-1.03*	*1.6*	*2.91*	*1.21*
correct	-0.2003	-0.1868	-0.1879	-0.4195	-0.2473
	-21.75	*-11.75*	*-15.97*	*-7.32*	*-6.48*
shorter	-0.4173	-0.3753	-0.3940	-0.7629	-0.3879
	-25.33	*-13.97*	*-18.11*	*-9.8*	*-4.61*
longer	-0.1134	-0.1088	-0.1141	-0.4133	-0.0389
	-5.32	*-2.77*	*-4.3*	*-3.41*	*-0.44*
Market cap	8.9E-07	1.2E-06	8.8E-07	-2.0E-06	7.7E-07
	2.85	*2.04*	*2.36*	*-0.78*	*0.59*
fee	0.5889	0.6211	0.5446	0.6154	0.6862
	36.76	*20.64*	*27.02*	*7.57*	*11.14*
Years of history	-0.1510	-0.1632	-0.1368	-0.1402	-0.1809
	-24.1	*-13.96*	*-17.35*	*-4.5*	*-7.47*
new	-0.4844	-0.4874	-0.4317	-0.4961	-0.6317
	-20.25	*-10.73*	*-14.46*	*-4.29*	*-6.67*
subgroup	-0.0561	-0.1169	-0.0334	0.4359	-0.1455
	-3.03	*-3.53*	*-1.39*	*4.29*	*-2.15*
alphabet	-0.0754	0.0153	-0.0756	-0.1687	-0.2521
	-4.48	*0.49*	*-3.58*	*-1.73*	*-3.97*
_cons	3.2848	3.0584	3.2363	3.1070	3.2444
	85.28	*38.23*	*69.02*	*10.96*	*18.69*
choice					
experience	0.3693	0.3961	0.3871	0.3691	0.0840
	17.29	*13.69*	*15.63*	*7.07*	*2.04*
amount	0.0000	0.0000	0.0000	0.0000	-0.0001
	18.04	*10.87*	*25.09*	*-4.29*	*-14.27*
_cons	-0.1608	-0.8669	-0.7425	-1.4887	-0.6464
	-6.46	*-24.96*	*-25.32*	*-26.59*	*-15.16*
mills					
lambda	-0.1834	-0.1118	-0.1445	-0.0186	0.0248
	-6.75	*-2.88*	*-6.8*	*-0.15*	*0.34*
rho	-0.5090	-0.3334	-0.4230	-0.0500	0.0637
sigma	0.3602	0.3353	0.3416	0.3723	0.3899

STDEV_NC	all	occ1	occ2	occ3	occ4
Horizon	0.0161	0.0166	0.0149	0.0163	0.0100
	23.14	*12.15*	*14.29*	*2.84*	*2.34*
Compounded return	0.0417	0.0517	0.0408	0.0206	0.0356
	62.04	*38.62*	*47.43*	*5.91*	*16.91*
Human capital	3.2E-09	5.8E-09	4.0E-09	1.5E-08	1.4E-07
	16.81	*13.74*	*17.6*	*3.34*	*9.52*
Ln(net wealth)	9.4E-05	-5.4E-06	6.8E-05	2.9E-04	6.4E-04
	1.65	*-0.05*	*0.95*	*0.83*	*3.04*
Employed private sector	0.0016				
	2.34				
Self employed	0.0035				
	2.17				
Employment sector unknown	0.0004				
	0.33				
Proportion domestic funds	-0.0028	-0.0037	-0.0016	0.0106	-0.0028
	-1.72	*-1.32*	*-0.76*	*1.17*	*-0.5*
correct	-0.0209	-0.0199	-0.0193	-0.0489	-0.0235
	-25.08	*-14.14*	*-18.09*	*-8.65*	*-6.95*
shorter	-0.0483	-0.0450	-0.0447	-0.0835	-0.0589
	-32.47	*-18.93*	*-22.67*	*-10.87*	*-7.91*
longer	-0.0175	-0.0133	-0.0178	-0.0457	-0.0191
	-9.08	*-3.82*	*-7.4*	*-3.81*	*-2.43*
Market cap	1.5E-07	2.0E-07	1.5E-07	-3.6E-08	4.2E-08
	5.24	*3.78*	*4.4*	*-0.14*	*0.36*
fee	0.0572	0.0551	0.0541	0.0691	0.0656
	39.51	*20.69*	*29.6*	*8.62*	*12.02*
Years of history	-0.0165	-0.0165	-0.0156	-0.0187	-0.0186
	-29.15	*-15.95*	*-21.84*	*-6.08*	*-8.69*
new	-0.0551	-0.0561	-0.0498	-0.0636	-0.0679
	-25.47	*-13.95*	*-18.38*	*-5.58*	*-8.1*
subgroup	-0.0038	-0.0079	-0.0027	0.0392	-0.0109
	-2.29	*-2.68*	*-1.25*	*3.91*	*-1.81*
alphabet	-0.0182	-0.0102	-0.0170	-0.0223	-0.0380
	-11.95	*-3.68*	*-8.87*	*-2.32*	*-6.76*
_cons	0.1698	0.1475	0.1646	0.1748	0.1759
	48.83	*20.86*	*38.71*	*6.25*	*11.44*
choice					
experience	0.3693	0.3961	0.3871	0.3691	0.0840
	17.29	*13.69*	*15.63*	*7.07*	*2.04*
amount	0.0000	0.0000	0.0000	0.0000	-0.0001
	18.04	*10.87*	*25.09*	*-4.29*	*-14.27*
_cons	-0.1608	-0.8669	-0.7425	-1.4887	-0.6464
	-6.46	*-24.96*	*-25.32*	*-26.59*	*-15.16*
mills					
lambda	-0.0130	-0.0057	-0.0115	-0.0011	-0.0006
	-5.37	*-1.67*	*-6*	*-0.09*	*-0.1*
rho	-0.4111	-0.1966	-0.3759	-0.0306	-0.0183
sigma	0.0317	0.0289	0.0306	0.0367	0.0345

STDEV_36M	all	occ1	occ2	occ3	occ4
Horizon	0.0074	0.0062	0.0057	0.0070	0.0062
	10.13	*5.3*	*5.31*	*0.83*	*1.36*
Compounded return	0.0370	0.0498	0.0368	-0.0064	0.0358
	52.76	*43.61*	*41.55*	*-1.25*	*15.95*
Human capital	1.9E-09	3.3E-09	2.1E-09	8.2E-09	7.5E-08
	9.44	*9.24*	*9.14*	*1.27*	*4.77*
Ln(net wealth)	1.0E-04	4.2E-05	4.0E-05	4.8E-04	4.0E-04
	1.74	*0.49*	*0.54*	*0.93*	*1.76*
Employed private sector	0.0023				
	3.13				
Self employed	0.0120				
	7.07				
Employment sector unknown	0.0038				
	2.76				
Proportion domestic funds	-0.0158	-0.0148	-0.0123	-0.0137	-0.0161
	-9.44	*-6.19*	*-5.66*	*-1.03*	*-2.67*
correct	-0.0046	-0.0038	-0.0032	-0.0327	-0.0036
	-5.35	*-3.17*	*-2.89*	*-3.93*	*-1.01*
shorter	-0.0127	-0.0100	-0.0114	-0.0418	-0.0099
	-8.21	*-4.94*	*-5.6*	*-3.7*	*-1.24*
longer	-0.0055	0.0002	-0.0061	-0.0440	-0.0042
	-2.76	*0.06*	*-2.44*	*-2.5*	*-0.5*
Market cap	-4.4E-08	-9.8E-09	-4.0E-08	1.9E-08	-1.2E-07
	-1.51	*-0.22*	*-1.15*	*0.05*	*-1*
fee	0.0385	0.0231	0.0345	0.1022	0.0512
	25.54	*10.18*	*18.33*	*8.66*	*8.8*
Years of history	-0.0046	-0.0049	-0.0040	-0.0028	-0.0064
	-7.81	*-5.6*	*-5.4*	*-0.61*	*-2.8*
new	-0.0060	-0.0093	-0.0035	0.0189	-0.0152
	-2.67	*-2.7*	*-1.27*	*1.13*	*-1.7*
subgroup	-0.0157	-0.0212	-0.0129	0.0309	-0.0265
	-8.97	*-8.45*	*-5.73*	*2.09*	*-4.16*
alphabet	-0.0277	-0.0143	-0.0264	-0.0660	-0.0467
	-17.5	*-6.05*	*-13.37*	*-4.67*	*-7.79*
_cons	0.1343	0.1179	0.1342	0.1470	0.1725
	37.2	*19.55*	*30.7*	*3.57*	*10.45*
choice					
experience	0.3693	0.3961	0.3871	0.3691	0.0840
	17.29	*13.69*	*15.63*	*7.07*	*2.04*
amount	0.0000	0.0000	0.0000	0.0000	-0.0001
	18.04	*10.87*	*25.09*	*-4.29*	*-14.27*
_cons	-0.1608	-0.8669	-0.7425	-1.4887	-0.6464
	-6.46	*-24.96*	*-25.32*	*-26.59*	*-15.16*
mills					
lambda	-0.0002	0.0035	-0.0038	-0.0055	-0.0177
	-0.08	*1.2*	*-1.96*	*-0.31*	*-2.5*
rho	-0.0060	0.1415	-0.1256	-0.1018	-0.4418
sigma	0.0315	0.0245	0.0303	0.0542	0.0400

Tables A1-A4 report all coefficients from the Heckman estimations. We run five sets of regressions for four different risk measures: proportion of equity (A1), average risk category (A2), average standard deviation without considering covariance (A3) and portfolio standard deviation (A4). The five columns in each table report coefficients when the Heckman estimations are done for the entire sample (all), individuals employed in the public sector (occ1), private sector (occ2), self employed (occ3) and unknown sector (occ4). The horizon variable is the portion of horizon which is not explained by human capital (hc): $horizon_i = LN(65 - age) - (\alpha + \beta_1 (hc)_i)$. Compounded return is the historical average three year return of the portfolio. Human capital is the present value of expected income. Log of net wealth is the logarithm of net wealth (market value of financial assets + market value of real estate – debt). Employed in public sector is the default whereas employed in private sector, self employed and employment sector unknown are the other occupational dummies. Proportion of domestic funds is the % amount of the portfolio which is invested in domestic assets. Correct, shorter and longer are dummies which refer to generation funds. For example, if an investor with ten years to retirement invests in a generation fund labeled "ten years to retirement", correct = 1. Market cap is a chosen fund's market capitalization in SEK * the portfolio weight of that fund. Fee is the weighted average of the fees of the funds in the portfolio. Years of history represents the weighted average amount of years of the funds in the chosen portfolio. New = 1 if the fund has no history. Subgroup and alphabet deal with the order in which the funds are presented. In each asset class (equity-, mixed-, generation- and bond funds) there are subgroups (e.g. medical funds, European funds etc). The order of the subgroups and the alphabetical order within the subgroups are quantified into a number between 0 and 1. The two variables in the first step probit equation, listed under *choice* are; previous experience with risky assets and amount invested in this particular investment. Under *mills* we report the three parameters lambda, rho and sigma which are associated with the correction of the selection bias.