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Growth and Decline of Assets: On Biased Judgments of Asset Accumulation and Investment Decisions

Abstract*: Previous research showed that accumulations of capital following stationary interest rates are underestimated by human judges. Hyperbolic discounting was suggested as a descriptive and explanatory model for this phenomenon. First, we investigated judged accumulated capital after a period of annual growth and decline. The degree of underestimation increased with accumulated growth and the results supported hyperbolic discounting as a descriptive model on the group level. However, the hyperbolic model did not apply to the data for one third of the participants. Second, we investigated how investment decisions were related to capital accumulation before the investments and to judgments of the possible outcomes of the future investments. To our surprise, the participants' judgments of expected future accumulated capital did not add predictive power to predictions based on whether there was growth or decline before the investment decision. Unfortunately this strategy leads to suboptimal investment decisions.*

Key words: *investment decisions, discounting, uncertainty, growth, decline*

Imagine that you have €10 000 invested in a fund with a constant annual growth factor of 5%. What will it be worth after 10 years? With a calculator you will find that it has grown to €16 289, a total gain of 63%. If there was a constant annual decline of 5% the capital would decrease to €5987, a total loss of 40%. The asymmetry between accumulated percentages of change of the capital gained and lost increases with the annual discount factor. Intuitive judgment of proportionally accumulating capital is important because they correlate with borrowing and saving behavior, portfolio choice, and estimated net worth (Stango & Zinman, 2009). Hence, if people are not fully aware of the magnitude of these effects it may have consequences for their own private economy and be an opening for biased financial advice.

Several studies have found that judgments of functions with exponential changes, such as capital accumulation, are difficult to make and they are often biased (Benzion, Shachmurove &Yagil, 2004; Timmers & Wagenaar, 1977; Wagenaar & Sagaria, 1975). This holds independently of what kind of capital or asset that was judged (e.g. monetary capital or natural resources). However, Benzion et al. (2004) found that judgments for products that increased in value over time, at a given constant proportional growth rate each year, were fairly accurate for products as far back as 5 years ago and up to 2 years into the future. The judgments were more biased for longer time periods into the future and with increasing proportional change per year. Timmers and Wagenaar (1977) reported that judgments of exponential decline where more accurate than judgments of exponential growth which were severely underestimated. Exponential growths have been presented in various formats such as, exponential expressions in the mathematical form of a^n (Mullet & Cheminat, 1995) and numerical series or graphs (Timmers and Wagenaar, 1977), unfortunately the underestimations persist independent of the presentation form.

The mathematical formula for describing capital change of funds with annual proportional growth is described by

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$$V_t = V_0 (1 + g)^t \quad (1)$$

V_t denotes the accumulated capital after the period t of proportional growth, V_0 denotes the capital before any capital growth, and g denotes the proportion of change for each time unit t, and we assume that $V_0 > 0$, $g > 0$ and $t > 0$. Using the same denotations, the capital change depending on annual proportional decline is described by

$$V_t = V_0 (1 - g)^t \quad (2)$$

Decline gives a decelerating exponential change while growth gives an accelerating change. Hence, growth yields a bigger difference and proportional change between starting and accumulated capital than decline when g is the same and $t > 1$, as illustrated by the previous examples.

Proportional changes in the real world are seldom constant over time, as exemplified by the monetary sector and the stock market. For this reason, first the studies in this paper will investigate judgments of accumulated fund capital with different annual proportional changes. The study will include growth, decline, and combinations of growth and decline over different periods of time and proportional changes.

An intuitive judge may ask if 5 years of decline preceding 5 years of growth gives a different finally accumulated capital compared to 5 years of growth preceded by 5 years of decline. The answer is no, because the annual proportional changes are multiplied with each other to get the final capital, the temporal order of the changes does not affect the final capital V_t.

Judgments of capital value after a period of proportional change over time tend to be hyperbolic (Loewenstein & Prelec, 1992) implying that people tend to discount less early in a discount period than later. This implies a primacy effect and therefore, we wanted to test if there is a primacy effect (Anderson, 1965; Forgas, 2011; Pinsker, 2011) when final capital accumulations are judged.

In our first condition, we first wanted to verify that the judgments in our study will follow the trend of prior studies. Because of earlier results (Benzion et al., 2004; Timmers & Wagenaar, 1977; Wagenaar & Sagaria, 1975), our first hypothesis predicts that underestimation of objective capital accumulation should increase with increasing objective accumulated growth. Second, we wanted to test the hypothesis that there is a primacy effect when participants judge a series of proportional changes. Assuming that the participants read the information from left to right, this means that the first annual change will be given greater weight than later changes. A primacy effect may explain why these kinds of judgments tend to be hyperbolic.

It is well known, since a long time, that decisions cannot always be predicted by judgments (Slovic, 1975; Slovic, Griffin & Tversky, 1990; Slovic & Lichtenstein, 1983). Therefore, in the second condition we wanted to test to what extent judgments of capital accumulations following a series of proportional annual changes can predict investment decisions. We will return to this when we present the hypotheses in condition 2 of the study.

General Method

A questionnaire with two sections was used with one section for each condition. The instructions informed about the basic concept of annual percentage of change and capital accumulation. The participants were not allowed to use a calculator, paper and pencil, or other external aids. When a page of problems was completed it was not allowed to look back at that page again. No time limit was set but the participants were encouraged not to spend too much time on each individual problem.

Problems

The problems in both conditions consisted of 10 year periods of annual proportional changes presented in two 5 year periods. In the second condition participants were also asked to make investment decisions for the second period.

Participants

In all, 46 students from the Department of Psychology of Stockholm University participated and completed the questionnaire. There were 12 male and 34 female participants. The mean age was 24.6 years (SD = 4.6) with ages ranging from 19 to 38 years. One participant did not report age. The participants received either 1 hour course credit for participation or a cinema ticket-voucher worth approximately €10.

Procedure

The participants were informed that all instructions were included in the questionnaire but if they felt uncertain about anything they should ask the experimenter. They also signed an informed consent for participation. The participants filled out the questionnaire in a quiet classroom at their own pace and convenience.

Condition 1 was always presented in the first section of the questionnaire preceding condition 2. The problems within each condition were randomized and counterbalanced by having half of the participants completing the problems in reversed randomized order.

Data analysis

Capital judgments above or below 4 SD from the mean were excluded (2 judgments in condition 1 and 3 judgments in condition 2). Judgments indicating no change at all or growth judgments for funds that declined during an entire 10 year period were also excluded because we considered them as mistakes (2 judgments in condition 1 and 2 judgments in condition 2). The data from one participant was excluded from all analyses because more than four judgments were greater than SEK 1 000 000.

Condition 1: Judgments of accumulated capital following growth and decline

Previous findings suggest that subjective discount rates decline over time for both gains and losses also described as hyperbolic discounting (Loewenstein & Prelec, 1992). The present study investigates weather this applies to judgments of accumulated capital after a period of repeated percentage changes. If the proportions of change, or the capital accumulating during the period, follow hyperbolic discount function the changes in the beginning of the period will affect the judged accumulation of capital relatively more than changes towards the end of the period.

In this study we used 10 years of annual proportional change divided into two consecutive 5 year periods in the problems. Within each 5 year period the annual proportional change was stationary (the same proportional change each year). In this way the funds could be compared pairwise, by having the same changes over two periods but in alternating order (e.g. years 1 – 5: +5%, years 6 – 10: -10%, compared to years 1 – 5: -10%, years 6 – 10: +5%). As explained earlier, the order of the two 5 year periods does not matter for the size of the objective capital accumulated. A hyperbolic discount function predicts that the accumulated capital of the fund with the greater annual positive change percentage during the first 5 years should be influencing the judged final capital more than if the same positive change was presented during the last 5 years.

Method

The participants were asked to make unaided judgments of the capital in bank funds after 10 years of annual percentage changes. The 10 years were presented as two consecutive 5 year periods with different stationary annual percentages of growth or decline during each period. The annual percentages used were -15%, -10%, -5%, 5%, 10% and 15%. All combinations of these proportional changes were used except for the same change during two consecutive periods (see table 1 for the full range of problems). Each fund started at a capital value of SEK 10 000 and changed with a given percentage each year. The following is an example of a problem.

Annual change	Year 1-5	Year 6-10	
Value: SEK 10 000	-5%	+10%	Value after 10 years:
			_ _ _ _ _ _ _ _ _ _ _ _
(Invested at the beginning of year 1)			

Results and discussion

First, the mean judgments of each fund capital after 10 years of cumulative annual change were compared with the objective capital in one sample T-tests. For funds with a final cumulated growth above 50% of the initial capital after the 10 years there were significant underestimations for 7 of the 8 problems, and greater average differences between judgments and correct values for these problems compared to the other problems (Table.1). Mean judgments of funds with objectively cumulated capital below 50% growth did not reach more than spurious significances (3 of 16 tests, Table 1). This supports our first hypothesis predicting underestimation of objective capital accumulation should increase with increasing objective accumulated growth. In general, these results correspond to the previous findings of Benzion et al., (2004) and Timmers and Wagenaar (1977), indicating that growth judgments are less accurate for greater growth rates.

Table 1. Condition 1: Judged and correct fund capital after 10 years.

Year 1-5	Year 6-10	Judged capital	Correct capital	t-value and significance
15%	10%	25 268.51 (10 031.72)	32 393.11	-4.76***
10%	15%	23 502.02 (9 261.78)	32 393.11	-6.44***
15%	5%	21 129.55 (7 803.94)	25 670.58	-3.86***
5%	15%	19 637.53 (7 218.08)	25 670.58	-5.61***
10%	5%	19 280.00 (7 590.08)	20 554.64	-1.13$^{n.s.}$
5%	10%	18 425.27 (6 427.35)	20 554.64	-2.22*
15%	-5%	13 504.56 (2 708.21)	15 563.50	-5.10***
-5%	15%	13 161.51 (3 116.67)	15 563.50	-5.17***
10%	-5%	12 215.18 (1 627.00)	12 461.50	-1.00$^{n.s.}$
-5%	10%	11 493.13 (3 412.27)	12 461.50	-1.90$^{n.s.}$
15%	-10%	11 117.78 (2 627.46)	11 876.86	-1.94$^{n.s.}$
-10%	15%	11 292.84 (3 122.53)	11 876.86	-1.26$^{n.s.}$
5%	-10%	7 851.78 (2 544.45)	7 536.31	.83$^{n.s.}$
-10%	5%	8 365.73 (2 771.62)	7 536.31	2.16*
10%	-15%	8 630.00 (2 771.62)	7 145.92	3.55**
-15%	10%	7 698.33 (2 531.87)	7 145.92	1.46$^{n.s.}$
5%	-15%	6 596.13 (2 272.55)	5 662.93	2.76**
-15%	5%	6 444.11 (2 755.87)	5 662.93	1.90$^{n.s.}$
-5%	-10%	4 669.13 (2 427.27)	4 569.10	.28$^{n.s.}$
-10%	-5%	4 092.07 (2 360.38)	4 569.10	-1.26$^{n.s.}$
-5%	-15%	3 632.29 (2 654.32)	3 433.31	.50$^{n.s.}$
-15%	-5%	3 598.93 (2 782.27)	3 433.31	.40$^{n.s.}$
-10%	-15%	2 995.11 (2 847.87)	2 620.04	.88$^{n.s.}$
-15%	-10%	2 659.71 (2 554.67)	2 620.04	.10$^{n.s.}$

Note. One sample T-tests between the participants' mean judgments of capital in the funds after 10 years and the formally correct calculated capital, n.s. = non-significant, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$. Standard deviations in parentheses. The table includes all problems from condition 1.

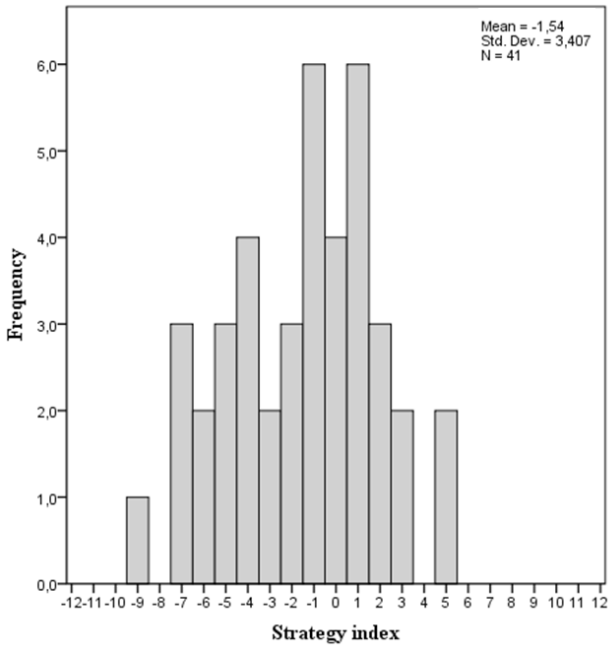
Second, we wanted to know if judged accumulated capital depended on the order of the two periods of annual change. A repeated-measures ANOVA (fund pair x order of periods) showed a significant main effect of fund pair, $F(11, 440) = 117.19$, $p < .001$, partial $\eta^2 = .906$, as well as a significant main effect of order of periods, $F(1, 40) = 5.82$, $p = 0.21$, partial $\eta^2 = .127$ but no significant interaction effect.

The order in time of the annual percentages does not affect the final objective accumulated capital. However, from a subjective point of view this may not be true and

different judgment strategies may occur. If in a pair of funds with the same annual percentages during the two 5 year periods, but with the order of the periods switched, the fund with the greater percentage first was judged to increase more than the fund with the smaller percentage first this was coded as a primacy effect. A primacy strategy was coded *-1*. Correspondingly, when a greater percentage was presented last and that fund was judged to grow faster than its paired fund, this was interpreted as a recency effect and coded *+1*. If there was no difference the strategy was coded 0. A strategy index was defined as the sum of strategy codes across the 12 fund pairs. A hyperbolic discounting rule predicts that the strategy index should be smaller than zero.

Figure 1 illustrates individual differences in judgment strategy across all problem pairs in condition 1 and shows that 16 of 41 (39%) of the participants (3 particpants with missing values for some problem where excluded) did not confirm a hyperbolic discounting rule.

Figure 1. Frequency distribution of primacy/recency strategy index.



Condition 2: Judgments and investment decisions

The main focus of this condition was to investigate investment decisions and if they could be predicted by judgments of future possible investment outcomes and prior investment history. Investment problems were presented to the participants with two outcomes, equally probable. Accumulated capital was judged after two consecutive 5 year periods of annual proportional change. In this condition, the participants were asked to judge the final accumulated capital after a complete 10 year period consisting of two 5 year periods. After the first 5 year period it was possible to reinvest 0 to 100 percent of the accumulated capital in a 50/50 chance of winning or losing capital during the last 5 years.

Figure 2. Example of problem from condition 2.

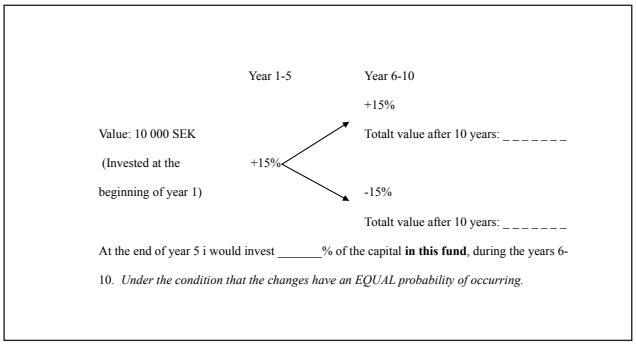


Figure 2 shows an example of a problem. For the first 5 years for half of the cases there was an annual growth of capital and for the other half there was an annual decline. During the second 5 year period, there were two possible outcomes with the same annual numerical percentage but with different signs (growth and decline). The probabilities for each of the outcomes were the same ($p = 0.5$). The capital accumulated after the first 5 year period differs depending on sign and magnitude of the proportional change during that period. Therefore, we analyzed the investment decisions concerning the next 5 years in terms of how much (in percent) of that capital a person reinvested. Assume a constant change during the first 5 years. Then, the expected positive difference in money between a positive and a negative outcome increases with the size of annual change during the last 5 years. The expected capital value for investments in funds either growing or declining with the same proportion during each of *t* years follows equation (3).

$$EV = V_0 (1 + g)^t p_g + V_0 (1 - g)^t p_d \qquad (3)$$

In the equation *EV* denotes the expected value of the investment. V_0 denotes the capital invested at the beginning of the period. The expression $V_0 (1 + g)^t$ is the accumulated fund value after growth, where g is the annual proportional change and t is the number of years for which the change occurs. The parameter p_g denotes the probability of growth. The expression $V_0 (1 - g)^t$ is the accumulated fund value after proportional decline, and p_d denotes the probability of decline, and $p_g + p_d = 1$.

Barberis, Huang and Santos (2001) argued that an investor's loss aversion is dependent on prior performance of investments. Growing investments tend to be sold to a greater extent than declining investments, called the 'disposition effect' (Weber & Camerer, 1998). Therefore, our first hypothesis in this condition predicts that reinvestment size will be greater for a declining fund compared to a fund that grows during the first 5 years before the reinvestment decision.

Assuming that people are not risk aversive and sensitive to expected value, the second hypothesis predicts that fund reinvestment will increase with increasing absolute annual change during the second 5 year period.

Assuming that an investor should invest according to her or his judgments of the investment outcomes, the third hypothesis predicts that judgments of accumulated capital outcomes should predict investment decisions. However, we know that judgments do not always predict decisions (Slovic, 1975: Slovic, Griffin & Tversky, 1990; Slovic & Lichtenstein, 1983).

Method

In the investment decision task of the present condition, the proportional change percentages were presented for two consecutive 5 year periods as in condition 1, but with the difference that two alternative growth changes were presented for the second period (years 6-10), one growing and one declining.

There were six problems (3 x 2) during the first period (years 1-5) and each numerical percentage (5%, 10% and 15%) was presented once as a growth with a plus sign, and once as a decline with a minus sign. Absolute numerical percentage refers to the proportional change independent of growth or decline and it was always the same during the entire 10 year period (i.e. year 1-5: +15%, year 6-10: +15% and -15%, illustrated in Figure 2).

The participants were asked to give judgments of accumulated fund capital after the complete 10 year period including the constant growth/decline during the first 5 years and with the following growth and decline outcomes. After having judged the accumulated capital for each outcome, the participants were asked to state, in percent, how much of the capital of the fund that had been accumulated at the end of the first period (years 1-5) they would like to invest in the fund for the remaining period (years 6-10). There was an equal chance of growth and decline ($p = 0.5$). To avoid differences due to the participants' private economy, the participants were also instructed to assume that they had enough money to handle an eventual loss without any serious impact on their own private economy.

Results and discussion

First, of the total of 6 funds 3 funds increased during the first 5 year period and the other 3 funds decreased during this period. We used the funds change direction (growth or decline) during the first 5 year period to predict the proportions of the (after the first 5 years) accumulated capital invested during the second 5 year period. To growth we assigned +1 and to decline -1 and found that a linear regression explained 0.050 of the variance of the investment judgments, corresponding to a correlation of 0.22, $F(1,259) = 13.52$, $p < .001$. The reinvested capital was greater following a period of growth (56%) than for decline (39%). When the full numerical information from -15 to +15 was added to the regression as an independent variable, this did not increase the explained variance and the contribution was statistically non-significant. This shows that increase or decrease of a fund during the 5 first years was a significant but weak predictor of future investments and that the size of the increase or decrease was of no importance. Participants tended to invest more following a 5 year growth period compared to a corresponding decline period.

Second, the risk of an investment increases with the difference between win and loss outcomes. In the present context the win and loss alternatives were equally probable and the annual growth and decline was always of the same absolute size, but with different signs. A greater difference in absolute size of the growth parameter leads to greater expected difference of accumulated capital between the outcomes during the last period. Therefore, the difference between the annual percentages of the win and loss outcomes during the last period was used as a predictor of the investment decisions. A linear regression with invested percentage as dependent variable explained less than 0.001 of the variance and was non-significant.

Third, when making an investment decision, a coherent investor should use her or his judgments of the

Table 2. Condition 2: Judged and correct fund capital after 10 years, and mean investments for the second period (years 6-10).

Fund	Year 1-5	Year 6-10	Judged capital	Correct capital	t-value and significance	Investment for years 6-10
1.	15%	15%	26 931 (9 704)	40 455.58	-9.24***	58.79 (36.42)
		-15%	8 996 (3 004)	8 924.50	.158$^{n.s.}$	
2.	10%	10%	21 327 (5 555)	25 937.42	-5.51***	53.07 (34.15)
		-10%	10 120 (2 495)	9 509.90	1.62$^{n.s.}$	
3.	5%	5%	16 021 (3 970)	16 288.95	-.45$^{n.s.}$	55.23 (37.75)
		-5%	9 726 (1 208)	9 875.62	-.83$^{n.s.}$	
4.	-5%	5%	9 961 (1 292)	9 875.62	.44$^{n.s.}$	39.59 (39.46)
		-5%	6 197 (1 989)	5 987.37	.69$^{n.s.}$	
5.	-10%	10%	9 024 (1 204)	9 509.90	-2.70*	41.52 (38.84)
		-10%	3 962 (2 487)	3 486.78	1.28$^{n.s.}$	
6.	-15%	15%	8 816 (2 781)	8 924.50	-.26$^{n.s.}$	36.24 (38.43)
		-15%	2 609 (2 763)	1 968.74	1.50$^{n.s.}$	

Note. One sample T-tests between the mean judgments of fund capital after 10 years and the formally correctly calculated capital, n.s. = non-significant, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$. Standard deviations in parentheses. The table includes all judgments from condition 2. Mean investments for years 6-10 are given in percent of the accumulated capital at the end of year 5.

different outcomes of an investment to guide the following investment decision. Therefore, we first investigated, in a regression analysis, if the annual percentage of change during the first and the second 5 year periods (independent variables) could predict subjective judgments of accumulated capital after 10 years (dependent variable). The independent variables where given close to equal weights and together they explained 0.68 of the variance, $F(2,528) = 557.81$, $p < 0.001$. This shows that the the judged accumulated outcomes were quite sensitive to the annual percentages during the accumulation periods. As in condition 1, the greatest objectively accumulated capital were significantly underestimated (table 2 - page 33).

Further, we investigated if the participants' judgments of finally accumulated capital after 10 years, following the growth and the decline outcomes during the last 5 years, could predict how much they would invest. We intended to find out if the growth or decline outcome was most important for the investment decisions. Therefore, we analyzed judged capital after growth and decline outcomes separately as predictors for investment decisions. A linear regression with judged capital after growth during the first and last 5 years as the independent variable and percentage invested as the dependent variable explained 0.048 of the investment variance. This minor proportion of explained variance was significant, $F(1,259) = 13.06$, $p < 0.001$. The corresponding analysis was conducted for decline outcomes during the last 5 years. The linear regression with judgments of accumulated capital following decline during the last 5 years as independent variable and proportion invested as the dependent variable explained 0.022 of the investment variance, $F(1,254) = 5.77$, $p < 0.05$. This seems to indicate that the judgments of the growth outcome were somewhat more important for the participants' investment decisions. We also wanted to know if the judgments following growth and decline outcomes together could predict investment decisions better than the judgments separately. We added judgments of decline outcome as a second independent variable after judgments of growth outcome to the regression equation with investment decisions as the dependent variable, the explained variance increased with only 0.001, a change that was not significant. Thus, even though the correlations were small but significant, the win alternative seemed to play a somewhat greater role than the loss alternative for an investor.

However, we do not know if the subjective judgments of accumulated capital add predictive power over what change direction during the first period (growth or decline) already predicted for the investment decisions for the second period. To investigate this, we used the regression equation with the independent variable change direction (coded +1 for growth and -1 for decline during the first period) as a predictor of proportion invested for the second period (independent variable). To this equation we added the independent variable judgments of accumulated capital following growth outcomes as a predictor of investment decisions. The explained variance from change direction 0.050 increased to 0.057 when judgments following growth was added as an independent variable, but the increase was not significant, $F(1,258) = 2.02$, $p = 0.16$. Hence, the subjective judgments of accumulated capital did not improve the weak predictive power of the trend of a fund during the first 5 years.

To summarize, the best predictor we found of investment decisions for the second period was the direction of change during the first period explaining 5% of the variance and an increase during that period was associated with greater willingness to invest. Adding the size of the growth/decline to the equation did not explain more variance of the investment decisions. Judgments of objectively accumulated capital after 10 years follow a similar pattern in conditions 1 and 2 (large total growth is underestimated while small growths and decline is fairly accurate). Interestingly, these judgments did not add predictive power of the investment decisions over the growth decline information during the first period.

If there was annual growth instead of annual decline during the first period the participants were willing to reinvest around 17% more of the accumulated capital during the first period for the second period which is the opposite of what the disposition effect predicts. Investing the same proportion of the accumulated capital for a fund growing during the first period compared to a declining fund results in the risk of losing a greater amount of the accumulated capital if there is decline during the second period. However, the amount that can be gained from the investment if there is growth during the second period is even greater as described by inequality (3). Therefore, in terms of expected value this is suboptimal because for all fund problems the expected value was always maximized by reinvesting 100% for the second period. Hence, from a normative point of view the capital accumulated during the first period was irrelevant if one wants to maximize expected value from a reinvestment.

Concluding Remarks

The results in condition 1 showed increasing underestimations of finally accumulated capital with objective accumulation increase, similar to previous studies investigating judgments of cumulative growth (Benzion et al., 2004; Timmers & Wagenaar, 1977; Wagenaar & Sagaria; 1975). We also investigated if judgments of accumulated fund value after 10 years of growth and decline could be described by a hyperbolic discounting function. The results showed a small but significant effect of the annual change percentage during first 5 years having greater weight on mean judgments than the second 5 years, indicating that a hyperbolic discount function may describe the results on a group level. However, a substantial minority of the participants (39%) did not follow a hyperbolic discounting rule.

In condition 2 we investigated fund reinvestments decisions following a first period of 5 years of growth or decline. The investments were made for a second period of 5 years with equal probabilities of either a growth or a numerically equal decline.

First, the results showed that the direction of change (growth or decline) during the first 5 years predicted reinvestment decisions to a small but significant extent. Information about the numerical size of the growth or decline did not add any predictive power to the regression equation. In contrast to the disposition effect (Weber & Camerer, 1998), the proportion of reinvested capital for the second period was greater following a period of growth, 56% than a period of decline, 39%.

Second, in the present context we used the same annual numerical percentages for the growth and decline outcomes during the second period and the probability for growth and decline was equal ($p = 0.5$). If the participants were sensitive to expected value, they should make greater investments for greater changes during the last 5 years compared to smaller changes. However, the results showed that investments were independent of annual percentages of growth and decline outcomes during the second period.

Third, judgments of accumulated capital following growth outcomes predicted 5% of the variance in the investment decisions. Adding the decline outcome to the equation did not increase the explained variance. This was also the case for the former successful variable of direction of change, which did not add any explained variance to the regression equation.

Our results indicated a suboptimal heuristic if a person wants to maximize future expected value from the investments. An explanation of this may be that the probabilities for growth and decline during the second 5 years were perceived as unreliable and therefore disregarded. Because, the size of the annual percentage of change was disregarded as a decision attribute, another explanation of the results would be that the complexity of the decision task led the participants to use less complex information (positive or negative sign during the first 5 years). Interestingly, underestimations of accumulated growth indicate biased intuitive understanding of the wealth that may accumulate from, e.g. long term pension funds.

A puzzling result was that a person's judgments of accumulated capital did not add to the predictions of the investments based on growth/decline during the first period. According to Prospect Theory losses are judged to have greater subjective impact than gains of the same size. Previous results suggest that the utility of avoiding a loss may be about twice as great as the utility of gaining the same amount (Tversky & Kahneman, 1992). Because, the investment decisions did not indicate any sensitivity to the judged differences or the objective differences in gains and losses they seem not to support Prospect Theory.

There is a limitation to investigations using hypothetical investment cases because there is no real capital at stake that can induce feelings of e.g. real loss aversion in the participants. But, many financial decisions are made without crucial personal feedback to the decision maker. To conclude, in a series of annual proportionally accumulating capital there seems to be a primacy effect for a majority of judges supporting hyperbolic discounting on the group level. When making investment decision the judges seemed to rely on both growth/decline before the investment and on their own judgments. But, to our surprise the judgments did not add any predictive power over the growth/decline before the investment decision. The results of the study invite future studies with other samples of participants in other contexts including investors and financial markets.

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