CAUSES, CONSEQUENCES, AND CURES OF MYOPIC LOSS AVERSION – AN EXPERIMENTAL INVESTIGATION*

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We use an experiment to examine the causes, consequences and possible cures of myopic loss aversion (MLA) for investment behaviour under risk. We find that both investment horizons and feedback frequency contribute almost equally to the effects of MLA. Longer investment horizons and less frequent feedback lead to higher investments. However, when given the choice, subjects prefer on average shorter investment horizons and more frequent feedback. Exploiting the *status quo* bias by setting a long investment horizon or low feedback frequency as a default turns out to be a successful behavioural intervention to increase investment levels.

The concept of myopic loss aversion (MLA) has been introduced by Benartzi and Thaler (1995) to explain the puzzling evidence that stock markets offer an abnormally high equity premium, which is known as the equity premium puzzle (Mehra and Prescott, 1985). MLA basically constitutes a behavioural combination of loss aversion (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) and mental accounting (see Kahneman and Tversky, 1984; Thaler, 1985). In the context of financial decision making, loss aversion means that individuals' disutility from suffering a loss is in absolute terms higher than the utility from receiving an equally high gain, and mental accounting implies that long-term investments are evaluated according to their short-term returns. Assuming that investors suffer from MLA, an abnormally high equity premium can be rationalised in that stocks are relatively unattractive for investors because stock prices fluctuate and generate not only frequent gains but also losses. Based on simulations of real financial market data, Benartzi and Thaler (1995) have argued that the size of the equity premium is consistent with investors who weigh losses twice as large as gains and evaluate their portfolios on an annual basis.

In this article, we focus on two research questions related to MLA. First, we examine whether the influence of MLA on investment decisions is driven by the frequency of feedback on performance or by the time horizon of an investment. If information feedback is the driving force, subjects should be backward-looking and more likely base their investments on previous returns. If the time horizon of an investment – i.e. the flexibility in changing one's investment levels – is the important source of MLA, subjects will rather be forward-looking and, therefore, probably less affected by past returns. We show in an experiment that both the length of the investment horizon and the feedback frequency have a significant effect on investment levels. Given this finding, we address, second, how MLA can be contained or attenuated. This issue has not

been addressed in the literature on MLA so far but it seems highly relevant for the design and regulation of real-world investments in risky assets. Hence, we look for behavioural interventions that make subjects opt for longer investment horizons or lower feedback frequency in order to avoid the negative effects of MLA on investment levels. It turns out that setting a long investment horizon or longer feedback intervals as a default is a successful intervention that increases investment levels significantly. Hence, exploiting the *status quo* bias can attenuate, if not fully cure, the effects of MLA.

The analysis of MLA by the use of controlled experiments has been initiated by two independent papers – Thaler *et al.* (1997) and Gneezy and Potters (1997). Thaler *et al.* (1997) conducted an experiment where subjects could invest in two funds with positive expected returns, a low risk and return fund corresponding to a real five-year bond, and a high risk and return fund mimicking a stock-index fund. Subjects had to learn about risk and return distributions with experience. When providing feedback, investment returns were aggregated to reflect either a monthly, yearly or five-yearly horizon, depending on the treatment. Results showed that investments in the more risky fund were highest in the five-yearly condition followed by the yearly condition. The aggregation of short-term outcomes apparently was sufficient to reduce the frequency of experiencing losses and thus to increase investment levels.

Gneezy and Potters (1997) demonstrated the same effect in an experiment where participants could invest in a risky lottery where, with probability two thirds, the invested amount was lost but, with probability one third, a subject won 2.5 times the amount invested. In the 'high' treatment, subjects could decide on the invested amount in each single round (out of 12 rounds in total) and received feedback about the return after each round. In the 'low' treatment, subjects could only change their investment amount every third round and also received a cumulative feedback for three rounds, so that gains or losses could not be attributed to a particular round. In the 'low' treatment, subjects invested significantly more in the risky lottery than in the 'high' treatment, demonstrating that a longer evaluation period renders a risky option with positive expected return more attractive. This finding has been replicated in several other experiments, like in the context of an asset market (Gneezy *et al.* 2003), in a repeated choice task with minimal information (Barron and Erev, 2003), with groups and individuals as decision makers (Sutter, 2007) and it has been confirmed to exist to an even greater extent in professional traders (Haigh and List, 2005).

In most of the previous experiments it was argued that less frequent feedback makes risky investments more attractive, when in fact yet another variable was varied simultaneously: the investment horizon or, in other words, the flexibility of changing one's investment. Individuals learned about joint returns over a specific period of time and also had to commit their investment for that particular time span. Thus, myopic loss aversion might not only crucially depend on feedback frequency but also on the investment horizon. To assess whether both factors, or only a single one, trigger the effects of MLA is the first purpose of our article. After having run the first experiment presented below we found out that there are two studies that have also addressed this question. Whereas Bellemare *et al.* (2005) argue that the frequency of feedback determines the effects of MLA, Langer and Weber (2008) identify investment flexibility as the relevant factor. Our results will suggest that both factors are more or less equally important and that MLA has a robust impact on investment behaviour.

The second – and main – purpose of this article is then to examine behavioural interventions that might curtail, if not cure, the effects of MLA. Such an endeavour has not been undertaken so far in the context of MLA and its effects on investments. To design a behavioural intervention that restrains the effects of MLA, it is, first of all, necessary to investigate individuals' preferences for high or low investment flexibility and more or less frequent feedback. In aggregate, we find a slight preference for more investment flexibility rather than less; subjects also strongly prefer more frequent feedback to less. In order to possibly influence the endogenous choice of investment flexibility and feedback frequency we set up another experimental condition where subjects were informed about the average payoff previously achieved by subjects with either high or low flexibility or high or low feedback frequency. Yet, this additional information does not induce subjects to switch to the more rewarding regime (i.e. low flexibility or low feedback frequency). Finally, exposing subjects to a default setting seems to resolve the problem: although free to switch between high and low flexibility or feedback frequency at small costs, most individuals stick to the *status quo* that they experience initially. This result implies that decision inertia can be used to guide behaviour to achieve more desirable outcomes. Remarkably though, individuals rather switch from low to high flexibility than *vice versa*, indicating a slight discomfort with less investment flexibility.

The rest of the article is organised as follows. Section 1 gives an overview of the basic experimental design. Section 2 is devoted to our first research question on the relative importance of investment flexibility and feedback frequency for the effects of MLA. Sections 3 and 4 present the treatments addressing our second research question, namely how to design behavioural interventions that make subjects choose a longer investment horizon or less frequent feedback. Section 5 reports a comprehensive econometric estimation of the determinants of investment levels in all treatments. Besides considering the influence of investment flexibility and horizon, the econometric model captures the influence of past behaviour and past realisations of investments. The latter aspects have not been taken into account in previous papers on MLA, and therefore add further insights into the determinants of investment behaviour. Section 6 concludes the article with a brief summary and discussion.

1. Basic Experimental Setup

All experimental treatments are variations of the basic investment task of Gneezy and Potters (1997). Subjects are endowed with 100 ECU (experimental currency units, with 100 ECU = 50 Euro-Cents) in each of a total of 18 rounds. They can decide to keep the endowment with zero interest or invest any amount $X \in [0,100]$ in a risky lottery. If the lottery wins (with probability $1/3$), subjects win 2.5 times the amount invested (in addition to keeping their initial endowment). If the lottery loses (with probability $2/3$), the amount invested is lost. Therefore, the profit $\pi_{i,t}$ of an individual i that invests the amount $X_{i,t}$ in round t is given by:

$$\pi_{i,t} = \begin{cases} 100 + 2.5X_{i,t} & \text{with probability } 1/3 \\ 100 - X_{i,t} & \text{with probability } 2/3 \end{cases} \tag{1}$$

In total, 444 subjects from Jena University were recruited to participate in a series of three experimental studies which are presented below. Subjects were invited to participate by using the recruitment system ORSEE (Greiner, 2004), and the computerised sessions were run using the software z-Tree (Fischbacher, 2007). Each of the treatments was conducted in a separate session and no subject could participate in more than one session. The average session length was 40 minutes. Participants earned 12.4€, on average including a show up fee of 2.5€ (SD = 2.7€). The instructions for all treatments are available from the authors upon request.

2. The Influence of Investment Flexibility and Feedback Frequency (Experiment 1)

2.1. *Experimental Design*

To analyse the impact of investment flexibility and information feedback on risky investments, we employ a 2-by-2 design where both investment horizon and feedback frequency are varied in two distinct levels.

The investment horizon to which participants have to commit is either one (H1) or three periods (H3). In condition H1, subjects can decide on the risky investment ($X_{i,t}$) in each single round and therefore have high flexibility in changing their investments. With a three-period horizon (H3), subjects must decide every third round about the level of investment in the next three rounds, subject to the restriction that the particular investment level has to be identical in all three rounds. In this case, flexibility is low.

The feedback on the investment is either given after each single period (F1) or provided in aggregated form for a respective sequence of three periods (F3). In the former case feedback frequency is high (F1), in the latter case it is low (F3).

The combination of both factors allows full identification of the relative importance of investment flexibility and feedback frequency for the level of investments in risky lotteries. The two treatments H1F1 (high flexibility and high feedback frequency) and H3F3 (low flexibility and low feedback frequency) correspond to the classical design by Gneezy and Potters (1997), where feedback frequency and investment horizon were varied simultaneously. The additional treatments H1F3 (high flexibility and low feedback frequency) and H3F1 (low flexibility and high feedback frequency) enable us to disentangle the effects of feedback frequency and investment flexibility when comparing either of them to H1F1. If it is solely frequent feedback that causes MLA, more or less investment flexibility should not matter and therefore no difference in risky investments is expected between conditions H1F1 and H3F1 or between H1F3 and H3F3. Yet, if high investment flexibility leads to myopic loss aversion, we expect no difference in investment levels between H1F1 and H1F3 or between H3F1 and H3F3.

In total, 118 subjects participated in the four treatments of this experiment. We call the treatments *Exogenous*, because both the investment horizon and the feedback frequency were exogenously imposed on subjects by the experimenter. In each of the three treatments H1F1, H3F1 and H3F3 we had 30 subjects, and in treatment H1F3 we had 28 subjects.
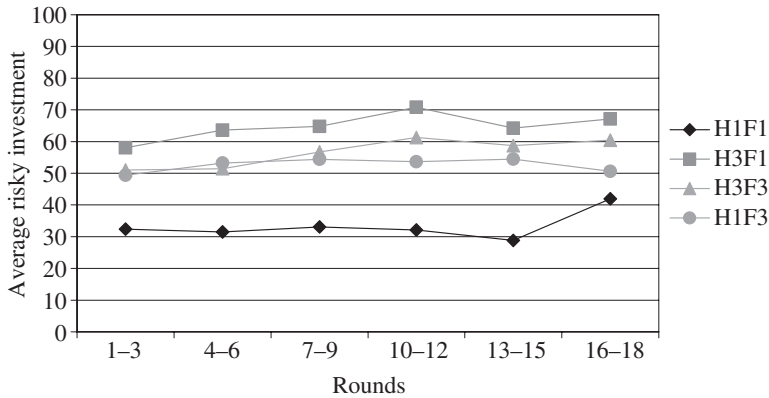
Fig. 1. *Exogenous Treatments*

2.2. *Results in the Exogenous Treatments*

Figure 1 displays the average investments in the risky lottery across rounds. The overall averages are 33.3 in H1F1, 52.6 in H1F3, 64.8 in H3F1 and 56.6 in H3F3. Investment levels in H1F1 are significantly lower than in any of the three other treatments (p < 0.01; two-sided Mann-Whitney U-test).[1] This is an indication that both feedback frequency and investment horizon have an influence on myopic loss aversion.[2] Investments increase if either the investment horizon is long (H3) or the feedback frequency is low (F3). It is interesting to note, though, that there is no cumulative effect of investment horizon and feedback frequency: the average investment in H3F3 is 56.6, which is significantly higher than in H1F1, as already established by Gneezy and Potters (1997). However, investments in H3F3 are not higher than in H1F3 or in H3F1 (p > 0.2 in any comparison; Mann-Whitney U-tests).

3. Behavioural Intervention I: Endogenous Choice (Experiment 2)

Experiment 1 has found that both feedback frequency and investment flexibility cause the effects of MLA. In Experiment 2 we want to find out subjects' preferences for (high or low) investment flexibility and (high or low) feedback frequency on their invest-ments. Given that all previous experimental studies on MLA have determined both feedback frequency and investment horizon exogenously, no evidence is available yet on subjects' preferences with respect to both aspects. If subjects were found to prefer low investment flexibility or low feedback frequency, MLA could be regarded as a minor issue in practice, since subjects would then invest under conditions which run counter to the effects of MLA. In such a situation no policy intervention would be necessary. If subjects preferred high flexibility and frequent feedback, policy inter-ventions to ameliorate the effects of MLA might be important, though. Experiment 2 is designed to shed light on subjects' preferences by a series of what we call *Endo*

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[1] All tests reported below are two-sided.
[2] We discuss this finding and its relation to the papers of Bellemare *et al.* (2005) and Langer and Weber (2008) in more detail in the final Section of this article.

treatments. To keep control as tight as possible we let subjects in the different treatments choose only *one* aspect of the investment conditions, *either* investment flexibility (Section 3.1) *or* feedback frequency (Section 3.2), holding the other aspect constant.

3.1. *Preferences for Investment Flexibility (Endo-horizon Treatments)*

3.1.1. *Experimental design*
Subjects can choose their preferred investment horizon (H1 or H3) before the first round. No switching is possible between the long and short horizon throughout the 18 rounds. Feedback frequency is high (F1) and fixed, meaning that subjects are informed on their investment return after every round.

There are two conditions in this treatment. In the *No-Profit* condition, the game is explained to subjects and afterwards the investment horizon can be chosen. In the *Profit* condition, subjects are additionally informed about the average profits for the two different horizons achieved by subjects in the *Exogenous* treatment (with 9.3€ in H1F1, and 10.1€ in H3F1, excluding the show-up fee). The *Profit* condition is chosen in order to check whether linking the choice of the investment horizon with information on average profits with each horizon has an effect on subjects' choices. In total, 53 subjects participated in the *No-Profit* condition and 28 subjects in the *Profit* condition.

3.1.2. *Results in the endo-horizon treatments*
In the *No-Profit* condition, 32 subjects (60.4%) chose the short horizon (H1) and 21 subjects (39.6%) the long one (H3). The distribution of choices is not significantly different from a random choice (Binomial test), indicating that no clear cut preference for either horizon exists on an aggregate level. Figure 2 shows the average investments across rounds. Subjects with a long horizon invest more than subjects with a short horizon, however not significantly so (53.8 in H3 vs. 46.2 H1; $p > 0.2$; Mann-Whitney U-Test).

In the *Profit* condition, each investment horizon was chosen by exactly 14 subjects, confirming that there is no clear-cut preference for either horizon in the aggregate.
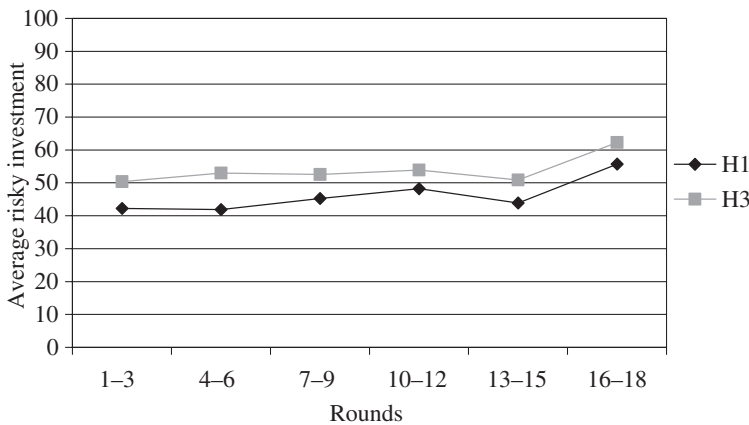

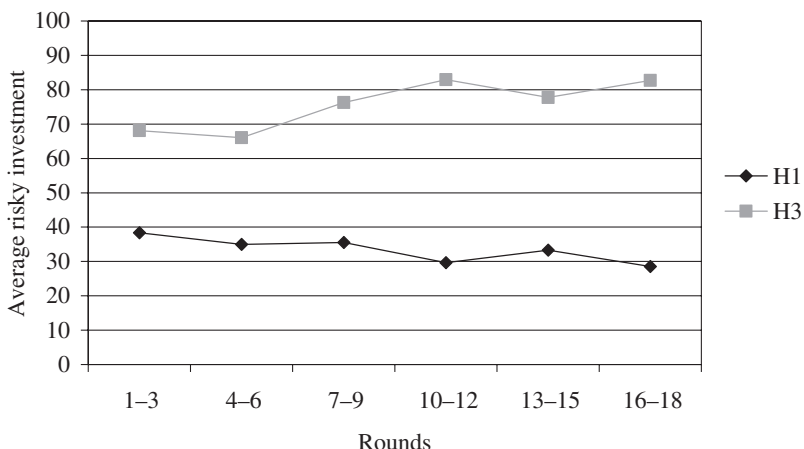Fig. 2. *Treatment Endo-horizon − No-Profit Condition*

Fig. 3. *Treatment Endo-horizon – Profit Condition*

Figure 3 indicates that the longer horizon (H3) triggers significantly higher investments (75.6 vs. 33.4; $p < 0.01$; Mann-Whitney U-Test).

Though the frequency of choosing the long horizon is somewhat higher in the *Profit* condition (50%) than in the *No-Profit* condition (39.6%), the difference is insignificant (χ^2-test). This means that adding information about higher profits with a longer horizon is an inadequate intervention to make subjects choose the longer investment horizon significantly more often.

3.2. *Preferences for Feedback Frequency (Endo-frequency Treatments)*

3.2.1. *Experimental design*
Here, subjects can choose before the first round whether they would like to receive feedback on their investments every round (F1) or every third round in aggregate form (F3). No further switching is possible throughout the 18 rounds. Subjects can decide on the invested amount in every round, meaning that the investment horizon is short (H1) and thus investment flexibility high.

Again, there are two conditions: in the *No-Profit* condition, only the game is explained before subjects choose the feedback frequency. In the *Profit* condition subjects are additionally informed about the average profits for the different feedback frequencies achieved by subjects in the analogous *Exogenous* treatment (with 9.4€ in H1F1, and 9.6€ in H1F3, excluding the show-up fee). In total, 32 subjects participated in the *No-Profit* condition and 31 subjects in the *Profit* condition.

3.2.2. *Results in the endo-frequency treatment*
Twenty-eight out of 32 subjects chose high frequency (F1) in the *No-Profit* condition, and only four the low frequency (F3). This is significantly different from a random choice ($p < 0.01$, Binomial test), demonstrating a clear preference for frequent feedback. However, Figure 4 shows that subjects with the lower feedback frequency choose significantly higher investments (65.0 *vs.* 39.8; $p < 0.05$; Mann-Whitney U-test).
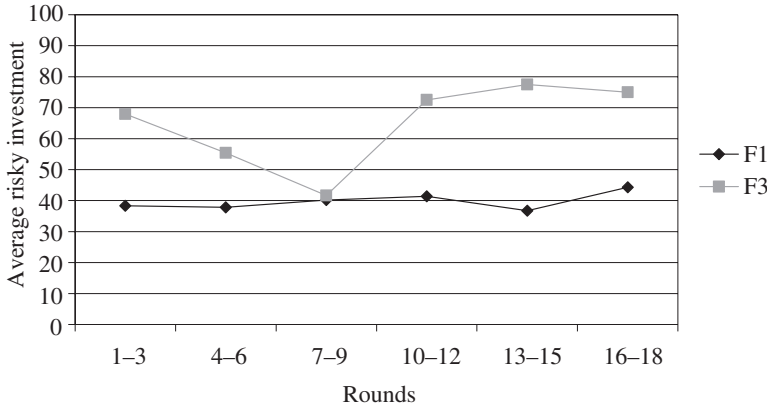
Fig. 4. *Treatment Endo-frequency – No Profit Condition*

In the *Profit* condition, 20 out of 31 subjects chose F1 and eleven F3. The choice distribution is significantly different from a random one (p < 0.05; Binomial test), confirming an aggregate preference for frequent feedback. Subjects with a lower feedback frequency invest more on average (see Figure 5), but the difference is not significant (50.0 *vs.* 34.0; p = 0.15; Mann-Whitney U-test). Comparing the choice distribution across conditions, we find that in the *Profit* condition subjects choose significantly more often the low feedback frequency than in the *No-Profit* condition (35.5% of subjects vs. 12.5%; p < 0.05; χ^2-test).

The bottom line of our Experiment 2 is the finding that, on average, individuals slightly prefer more investment flexibility (H1) over less (H3) and clearly more frequent feedback (F1) over less (F3). Hence, the preferred conditions are those in which subjects make less (profitable) investments and less profit, as has been documented in Experiment 1. Informing subjects about the prospect of higher profits in the more favourable condition (less flexibility or less frequent feedback) led to mixed evidence:
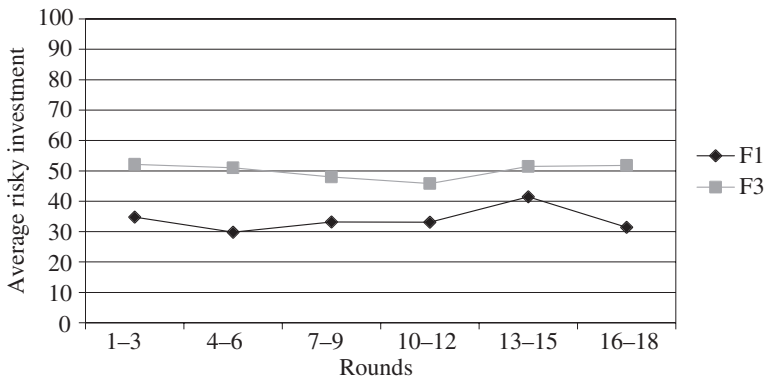

Fig. 5. *Treatment Endo-frequency – Profit Condition*

giving information about profits did not induce subjects to commit to a longer investment horizon, but it did induce them to choose less frequent feedback, although the relative frequency of subjects preferring less frequent feedback was still only around one third. So what can be done to induce subjects to make investments with a long horizon (H3) or a low frequency of feedback (F3)? Experiment 3 intends to answer this question.

4. Behavioural Intervention II: Providing a Default (Experiment 3)

4.1. *Setting a Default Investment Horizon (Default-horizon Treatments)*

4.1.1. *Experimental design*
At the beginning of the experiment, subjects are assigned by default to either a short or a long investment horizon, i.e. to condition H1 or H3. Feedback is always given after every round (F1). After having played the first three rounds in the default condition, subjects are offered the chance to switch from the short to the long horizon or *vice versa*. Switching is possible every third round[3] at a small cost of 40 ECU.[4] The *Default-horizon* treatments thus offer subjects complete autarky over their horizon (every third round), but simply exposes them to a default condition at the beginning. In total, we had 118 participants in *Default-horizon*, of which 60 were initially assigned to the short horizon (H1) and 58 to the long horizon (H3).

4.1.2. *Results in the default-horizon treatments*
Figure 6 displays the cumulative number of subjects switching to the alternative condition (from H1 to H3 and vice versa) for every block of three rounds. At most four out of the 60 subjects (6.7%) switch from a short (H1) to a long investment horizon (H3). Switching is more frequent with the long default horizon, though. By round 7, a total of 12 subjects have switched from H3 to H1 and by round 16 this number increases to 15 out of 58 participants (26%). The difference in switching frequencies between the two default conditions is significant ($p < 0.01$; χ^2-test). This finding indicates that individuals are more eager to switch to higher investment flexibility (in H1) than to lower (in H3).

However, even though subjects switch more often from the long horizon to the short horizon, Figure 6 also shows that at least 74% (43 out of 58) of subjects stick to the long horizon H3 when exposed to it by default. This frequency of voluntarily restricting one's own flexibility is significantly larger than in treatment *Endo-horizon*, compared both to the *No-Profit* condition and to the *Profit* condition ($p < 0.05$ in any case; χ^2-tests). Hence, the behavioural intervention of setting a default is successful in keeping many more subjects with the long investment horizon, i.e. low flexibility.

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[3] The restriction to switch only every third round was chosen in order to keep investment decisions in H1 and H3 comparable.

[4] If someone switches after the third round, the switching costs amount to about 2.6% of his total sum of endowments in rounds 4–18. Of course, switching becomes relatively more expensive in later rounds (in relation to one's endowment in the remaining rounds), but if a subject has a clear preference for the alternative horizon – instead of the default horizon – she should anyhow switch immediately right after round 3.
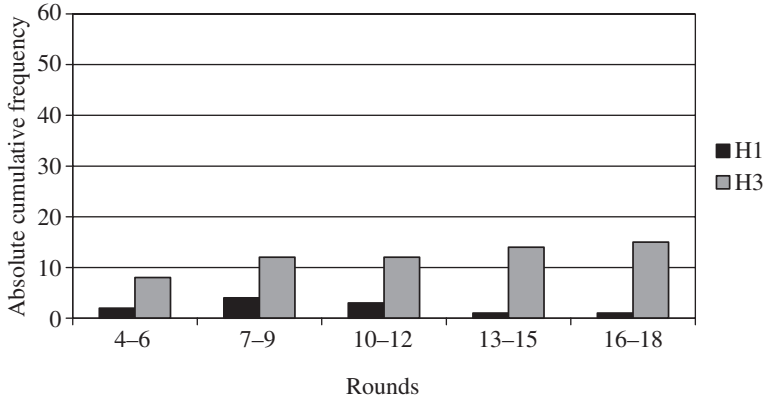
Fig. 6. *Treatment Default-horizon – Cumulative Number of Subjects Opting for Alternative Horizon*
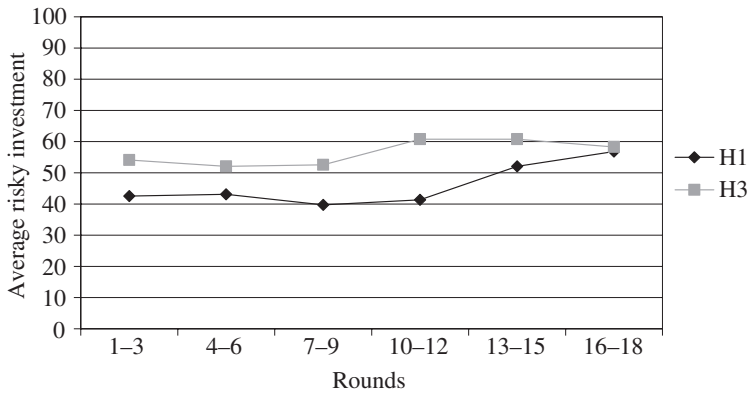

Fig. 7. *Treatment Default-horizon*

Figure 7 shows investment patterns in the *Default-horizon* treatments. Subjects with the short horizon (H1) invest less than subjects with the long horizon (H3) (56.4 vs. 45.9; p < 0.05; Mann-Whitney U-test).

The opportunity of switching investment horizons allows for a within-subjects test of how the horizon affects investments. Since only four subjects out of 60 switched from the short default horizon (H1) to the long horizon (H3), we cannot reasonably test for within-subjects differences. Yet, in the H3-default we have a total of 17 subjects who experienced both H1 and H3 by at least switching once from H3 to H1.[5] We find no differences in investment levels for these 17 subjects between H1 and H3 (with average investments of 51.5 in H1 versus 53.4 in H3; p > 0.2; Wilcoxon signed ranks test). Hence, it seems that the initially experienced long horizon induces rather high investment levels that are not significantly reduced when subjects switch to a short

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[5] A probit regression of the determinants of switching from the default horizon to the alternative one shows that the likelihood of switching is about 4.5% higher when the default is the long horizon (H3) rather than the short one (H1). Furthermore, we find that the more often a subject won in previous rounds, the less likely becomes switching (by about 0.8% per win). Detailed results are available upon request.

horizon. We have also investigated whether subjects who switched from the H3-default to H1 show different investment levels than those who did not switch. This is not the case, though.

4.2. *Setting a Default Feedback Frequency (Default-frequency Treatments)*

4.2.1. *Experimental design*
Subjects are assigned by default to either a high (F1) or a low feedback frequency (F3) at the beginning. The investment horizon is always short (H1). After every third round subjects are given the possibility to switch from high to low feedback frequency or vice versa at fixed costs of 40 ECU. The *Default-frequency* treatments assign subjects full discretionary power over the feedback frequency on their investments but expose them initially to a default condition. 64 subjects participated in *Default-frequency*; half of them were initially assigned to a high frequency (F1) and the other half to a low frequency (F3) as default.

4.2.2. *Results in the default-frequency treatments*
Figure 8 shows the cumulative number of subjects who decided to abandon the default feedback frequency in favour of the alternative one. The dark bars represent the number of subjects switching from F1 to F3 and the light bars represent subjects switching from F3 to F1. Nearly everyone (96.8%) stays with high feedback frequency F1. Yet, the remarkable finding is that also more than two thirds (68.75%) of subjects remain in the low feedback frequency (F3) when this is their default. This proportion is significantly larger than the fraction of subjects choosing F3 in the *Endo-frequency* treatments ($p < 0.01$; χ^2-tests). Figure 9 shows that subjects with the low default frequency invest on average more than those with the high default frequency, though the difference is weakly significant ($p = 0.09$, Mann-Whitney U-Test).

As some of the subjects experience both feedback frequencies, we can explore the within-subjects sensitivity to different feedback conditions. Only one subject out of 32 switched from the F1-default to F3, thus no reasonable test can be employed. However, in the F3-default, 11 of the 32 subjects experienced both F1 and F3 by switching at least
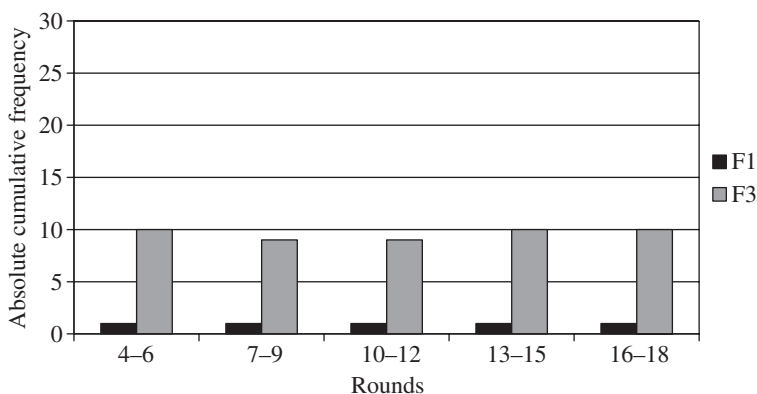

Fig. 8. *Treatment Default-frequency – Cumulative Number of Subjects Opting for Alternative Frequency*
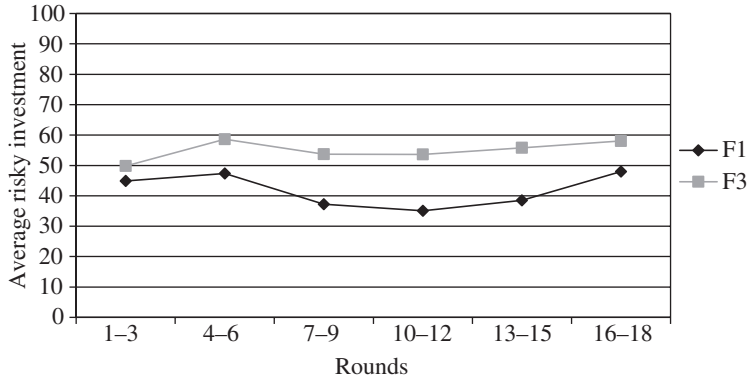
Fig. 9. *Treatment Default-frequency*

once from F3 to F1.[6] Their average investments do not differ across feedback conditions (42.6 in F1 vs. 40.8 in F3; $p > 0.2$; Wilcoxon signed ranks test), which is a similar result as the one found for subjects switching in the *Default-horizon* treatments.

5. The Determinants of Behaviour Over Time and Across Treatments

Somewhat surprisingly, all previous experimental studies on MLA did not take the time pattern of investment behaviour into account, most probably because their main focus was to examine the aggregate effects of MLA. Yet, an analysis of investment behaviour over time may yield further insights into the determinants of investments. Hence, we estimate a Tobit panel regression model where the dependent variable is the invested amount, aggregated over three rounds.[7] The main independent variables are *Investment horizon* (0 = H1, 1 = H3) and *Feedback frequency* (0 = F1, 1 = F3). Several additional variables (see Table 1) reflect the experience throughout the course of the experiment and allow us to examine how subjects react to past investment returns. *Accumulated wealth* measures the sum of earnings up to the recent sequence of three rounds. *Number of all previous wins* ranges from 0 to a maximum of 9 in the data; *Number of wins in previous three rounds* indicates the most recent experiences of winning and ranges from 0 to 3. Finally, several dummy variables for the different treatments and conditions are included. *Choice* (0 = exogenous conditions, 1 = endogenous conditions including default treatments) allows examination of whether freely choosing the basic investment setting has an influence on investment levels (controlling for the investment horizon and feedback intervals). Additional dummies are *Profit condition* (equals 1 in the *Endo*-treatments if average profits were revealed before the experiment) and *Default condition* (equals 1 whenever subjects were provided with a default horizon or feedback interval that could be changed subsequently).

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[6] A probit regression reveals that switching is more likely (by about 3.3%) in the F3-default and that switching becomes less likely with more wins in previous rounds (by about 0.6% per win).

[7] The aggregation is necessary since investment levels do not change for three rounds whenever the investment horizon is long (i.e. in condition H3).

Table 1

Tobit Panel Regression on Lottery Investment

Dependent Variable:	Full Model		Exogenous		Endogenous	
Investment $X_i^t \in [0, 100]$	coef.	Se	coef.	se	coef.	se
Constant	31.278**	3.320	31.414**	2.905	45.276**	1.965
Investment horizon (0 = $H1$, 1 = $H3$)	35.333**	3.350	35.112**	3.058	14.119**	1.751
Feedback frequency (0 = $F1$, 1 = $F3$)	21.800**	3.359	21.556**	3.045	12.512**	2.360
Horizon × Frequency	−30.826**	4.749	−30.638**	4.423	—	
Accumulated wealth	0.003	0.005	0.002	0.004	−0.005	0.003
Number of all previous wins	1.412	1.398	1.440	1.168	4.170**	1.058
Number of wins in previous three rounds	−4.992**	1.432	−4.984**	1.361	−8.532**	0.964
Choice	13.996**	3.850	—		—	
Profit conditions	−1.805	2.211	—		−1.841	2.252
Default conditions	0.645	1.755	—		0.670	1.782
Choice × Horizon	−21.282**	3.770	—		—	
Choice × Frequency	−9.291*	4.077	—		—	
Choice × Accumulated Wealth	−0.008	0.006	—		—	
Choice × Number of all previous wins	2.770	1.748	—		—	
Choice × Number of wins in previous three rounds	−3.524*	1.717	—		—	
σ_y^2	34.127**	1.044	33.971**	1.813	34.328**	1.259
σ_i	20.763**	0.384	19.793**	0.689	21.109**	0.460
ρ	0.730		0.747		0.726	
Log likelihood	−8424.228		−2230.710		−6192.531	
No. of subjects	444		118		326	
No. of observations	2,220		590		1630	
No. uncensored	1,619		437		1182	
No. left censored	159		27		132	
No. right censored	442		126		316	

Significance levels: * p ≤ 0.05 ** p ≤ 0.01

Table 1 reports three different model specifications,[8] starting on the left-hand side with a full model, including interaction effects of *Choice* and the different parameters capturing experience. The positive regression coefficients for both investment horizon and the feedback frequency confirm that the effect of MLA is caused by both. However, the effects are not cumulative as indicated by the significantly negative interaction effect (*Horizon × Frequency*). On the contrary, investments are most positively affected if either the investment horizon is long (at short feedback intervals) or the feedback intervals are long (at short horizons).

Findings with respect to experience over the course of the experiment reveal that individuals invest less after repeated gains in the past three rounds or, *vice versa*, invest more after repeated losses in the past three rounds, which is in accordance with the hypothesis of loss recovery (Staw, 1976). This finding is also an indication for myopia, as subjects react strongest to very recent gains and losses but do not react significantly to the accumulated number of gains throughout the whole experiment or the accumulated wealth.

[8] The significant mean value of random errors due to unobserved individual heterogeneity (σ_u) and the relatively high proportion of the error term in total residuals due to individual heterogeneity (ρ) both confirm the need of using a random effects model.

The variable *Choice* reveals some remarkable implications. First, investments are higher with endogenous choice. Hence, subjects invest generally more with a higher degree of freedom in the investment setting. Second, several interaction effects of *Choice* and other variables show fundamental differences between the exogenous and endogenous treatments. As a consequence, Table 1 also includes separate Tobit regressions for the exogenous and the endogenous treatments, thereby illustrating the nature of the interaction effects in the full model.

The first fact to catch one's eye from comparing the *Exogenous* with the *Endogenous* model is that both the coefficients of the investment horizon and the feedback frequency are considerably smaller in the endogenous treatments. Endogenous choice seems to reduce the negative impact of MLA on investments but still does not eliminate it.

The second noteworthy finding is that in the *Endogenous* treatments subjects react differently to gains within the past three rounds and gains throughout all previous rounds. Subjects invest less the higher the number of very recent wins. Yet, they invest more the more often they experienced wins throughout all previous rounds, which is reminiscent of the house money effect (Thaler and Johnson, 1990). Moreover, it seems that in the presence of endogenous choice subjects are more sensitive to experiences, and by reacting not only to recent gains and losses exhibit less myopia.

Finally, in the *Exogenous* treatment, as well as in the full model, the coefficient for horizon is significantly larger than for feedback frequency (Wald-test, $p < 0.01$), suggesting that the investment horizon has a relatively stronger impact on investments than the feedback frequency. In the *Endogenous* treatments, the significant difference between the coefficients of investment horizon and feedback frequency vanishes (Wald-test, $p > 0.2$), albeit both factors still affect investments significantly.

6. Summary and Discussion

In the seminal paper by Benartzi and Thaler (1995), myopic loss aversion has been identified as one explanation why investors might invest less in risky assets when returns are frequently evaluated and the length of the investment horizon is rather short. In this article, we have tried to disentangle the causes of myopic loss aversion and to put forward possible cures for it.

Whereas most previous papers have stressed the role of feedback frequency for MLA, attempts to disentangle the relative importance of feedback frequency and investment horizon have only been undertaken recently – and independently from each other. In addition to feedback frequency, we have identified the length of commitment to a given investment as a crucial factor for the level of risky investments. With lower investment flexibility – and, thus, longer investment horizons – subjects invest more in a risky lottery, even if they receive frequent feedback on gains and losses. The latter result has also been found by Langer and Weber (2008). Bellemare *et al.* (2005), however, have claimed that feedback frequency, but not the investment horizon, is responsible for MLA. Yet, it has to be noted that Bellemare *et al.* (2005) have only investigated the three conditions that have been denoted in our Experiment 1 as H1F1, H3F3 and H1F3. They lack the fourth treatment, H3F1, though and, therefore, have not been able to examine whether a longer investment horizon by itself may yield

higher investments (in spite of frequent feedback). In fact, our Experiment 1 has shown that it does. The common denominator of Langer and Weber (2008), Bellemare *et al.* (2005) and our study is therefore the finding that a manipulation of feedback frequency *and/or* investment flexibility leads to different investment levels. Given the consensus on this fact, it seems a natural next step to search for behavioural interventions to attenuate the effects of MLA. This is the second focus – and main novelty – of our article.

Giving subjects the option to choose investment horizon or feedback frequency (in Experiment 2), we have found that the majority of subjects prefer high feedback frequency and short investment horizons. Even adding the information that lower feedback frequency and longer investment horizons lead on average to higher profits does not cause a strong shift of preferences towards longer horizons and less feedback.[9] Hence, subjects still prefer on aggregate those investment conditions (with respect to investment horizon and feedback frequency) that cause the effects of MLA. These findings indicate that fighting myopia is not a trivial task.

Experiment 3 has therefore further examined how to avoid subjects opting into investment conditions that support MLA. Setting a default – be it a long investment horizon or low feedback frequency – with a switching option has been found to be a successful behavioural intervention: It makes about 75% of subjects stay with the long horizon and at least 66% of subjects stay with low feedback frequency. Exploiting the *status quo* bias thus seems to be a promising avenue to fight myopic loss aversion as subjects who face a long investment horizon or low feedback frequency invest more in the risky lottery. This result is important for two reasons. First, it demonstrates that the effects of MLA also prevail when subjects have discretionary power over the investment setting. Thus, the influence of MLA is not restricted to settings where the horizon or the feedback frequency is exogenously determined by the experimenter, as has been the case in all previous studies. Second, the behavioural trait of MLA can actually be exploited by setting the long horizon or low feedback frequency as a default, thereby inducing higher investments (with higher expected returns). The latter result is remarkably similar to the effects of setting a default in 401(k) plan enrolment in US companies (Benartzi and Thaler, 2004; Mitchell and Utkus, 2006). As Choi *et al.* (2003, 2004), for instance, have shown, enrolment in retirement savings plans is much higher (sometimes by a factor of four) when new employees are enrolled by default in the savings plan and have to opt out (by making a phone call to the personnel office) than when they have to opt in (also by simply making a call). In our experiment, we have found that at most one third of subjects opt out from the long investment horizon or the low feedback frequency, which is close to the opting-out rate reported in Choi *et al.* (2003, 2004). Gneezy *et al.* (2003) report an interesting case where an Israeli commercial bank has tried to make use of investors' *status quo* bias. The Israeli bank has reduced the frequency with which it informs its customers about their stocks' returns in order to avoid that they experience losses in short intervals. Obviously, the bank has

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[9] An implication of this finding is that subjects are willing to forego possibly higher profits in order to keep high flexibility in changing their investments (i.e. having a short investment horizon) or to receive frequent feedback on the performance of their investments. Whereas we have only indirect evidence for this implication, a paper by Charness and Gneezy (2003) finds that subjects are, indeed, willing to pay money to receive frequent feedback on their investments' performance.

tried to set a low feedback frequency-default in order to avoid the effects of MLA. Presumably, the main motivation for this institutional change of investment conditions was to induce an increase in investment levels. Unfortunately, in contrast to Choi *et al.* (2003, 2004), there are no data on how the bank's behavioural intervention has actually worked out. However, our data suggest it should have had an impact on the customers' investment levels.

Contrary to all previous experimental studies on MLA, we have also examined the development of investment patterns over time. The panel data analysis has confirmed that both feedback frequency and investment horizon have an influence on investment levels. On top of this, the analysis has provided further insights into how the exogenous or endogenous determination of investment conditions (concerning horizon and feedback) affects investment behaviour. Though MLA prevails both with endogenous choice and exogenous determination of investment conditions, a closer examination of the time pattern of investments has revealed different reactions to experienced gains and losses between the exogenous and endogenous treatments. Subjects in the endogenous treatments react positively to the total number of previous wins but negatively to wins in the most recent three rounds. This suggests a belief in some kind of (short-term) trend reversal, also known as gambler's fallacy (Clotfelter and Cook, 1993). If the number of wins in the past three rounds was high, one may expect it to be lower in the next three rounds and therefore reduce the investments. If, however, in the longer term the number of previous wins was high (and therefore potentially also accumulated earnings) one may decide to risk more money, which is in line with the house money effect (Thaler and Johnson, 1990). In sum, it seems that subjects who are given degrees of freedom in choosing the basic investment conditions are more actively managing their investments, as they react more intensively to past experience concerning gains and losses, whereas subjects with an exogenous assignment of the investment horizon or feedback frequency seem more passive and unaffected by past experience.

An additional difference between the endogenous and exogenous determination of investment conditions has been found with respect to the magnitude of myopic loss aversion. When subjects have autonomy over investment horizon or feedback frequency (in Experiments 2 and 3), the effect of MLA is, on average, less pronounced than when subjects have no autonomy (in Experiment 1). This implies that all previous experiments with exogenous assignments may have measured an upper limit of the effects of MLA, since in the real world investors can be considered to have a high degree of autonomy in determining their investment flexibility and the frequency of monitoring their investments. It is important to stress, though, that even with full autonomy our results suggest that MLA prevails. As a consequence, behavioural interventions, like setting a longer investment horizon or a low feedback frequency by default are an appropriate tool to contain, if not fully cure, the effects of MLA. Investment companies or commercial banks – like the Israeli bank referred to in Gneezy *et al.* (2003) – seem obvious candidates to apply such behavioural interventions with their customers in order to keep investments high. But (stock) market designers might also want to consider the effects of *status quo* biases – such as those shown in this article – on investment behaviour. Small changes in transactions costs that make, e.g., short-term investments more costly and thus longer-term investment horizons more attractive might have strong effects on investment levels. Thus it seems an interesting

avenue for future research, to examine how institutional changes on real-world markets that affect the frequency of feedback on investment returns or the length of commitment to a specific investment influence the aggregate level of investments.

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