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Contents

Abstract

This paper takes a close look at the "behavioural finance" explanations of the equity premium puzzle, namely myopic loss aversion (Benartzi and Thaler, 1995) and disappointment aversion (Ang, Bekaert and Liu, 2000). The paper proposes a simple specification of loss and disappointment aversion and brings these theories to the data. The main conclusion of the paper is that a highly short-sighted investment horizon is required for the historical equity premium to be explained by loss aversion, while reasonable values for disappointment aversion are found also for long investment horizons. So, stocks may lose only in the short term, but may disappoint also in the long term.

Keywords: Myopic loss aversion, disappointment aversion, equity premium puzzle, investment horizon, reference dependence.
JEL codes: G11, G12

Non-technical summary

The *equity premium puzzle* introduced by Mehra and Prescott (1985) is still far from having received a fully-fledged and convincing explanation in the literature. Despite the sheer research effort, the profession has still to reach a consensus on the explanation of the large equity premium observed historically in the United States and in other industrialized countries.

This paper takes a close look at the "behavioural finance" explanations of the equity premium puzzle proposed thus far in the literature, namely *myopic loss aversion* (Benartzi and Thaler, 1995) and *disappointment aversion* (Ang, Bekaert and Liu, 2000). Both theories posit that agents' preferences, unlike in the expected utility approach, are defined not in absolute terms but against a *reference point.* Moreover, the maintained assumption under both approaches is that agents *narrow-frame* the problem of how to allocate wealth between safe and risky assets and consider this problem in an independent manner, focusing on the prospects for returns without considering other sources of variability in consumption.

In particular:

- Myopic loss aversion posits that economic agents are averse to losses at an irrationally short horizon, due to institutional reasons or because they are affected by a behavioural bias (in particular, because they are too anxious to evaluate the performance of their portfolio on a short-term basis). Benartzi and Thaler showed that the observed equity premium is consistent with a moderate degree of loss aversion at an investment horizon of approximately one year. Under loss aversion, agents have a fixed reference point against which they evaluate gains and losses.

- Disappointment aversion shares some features with loss aversion but is based on the idea that reference points are determined *endogenously*. In particular, the certainty equivalence of a lottery may become a reference point for agents, and outcomes in excess (short of) the certainty equivalence are a source of elation (disappointment) for the agent. Reflecting the idea that pain is more urgent than pleasure, the disappointment related to outcomes below expectations is assumed (and normally found) to be stronger than the elation related to outcomes exceeding expectations.

This paper focuses especially on the role of the *time horizon* in determining the size of the equity premium. This seems a crucial dimension of the problem because it is quite easy to explain a high equity premium with a short time horizon, at which stocks are very volatile, while it may be more difficult at longer time horizons. The empirical analysis in the paper, based on data for excess returns on stocks in the United States from 1871 onwards, shows that an explanation based on loss aversion is crucially dependent on a *very short* time horizon, and already a horizon of three years or so seems too long for loss aversion to be a satisfactory explanation of the historical equity premium. By contrast, disappointment aversion appears to be a satisfactory explanation of the historical equity premium even at horizons as long as ten years. This reflects the empirical finding that, while it is almost impossible to lose on stocks compared with safe assets if the time horizon is relatively long, stocks may disappoint very strongly even in the long run.

Overall, the results in this paper suggest that the invariance to the time horizon of disappointment aversion makes it an interesting explanation of the equity premium, possibly more robust than loss aversion because it can accommodate different time horizons. Moreover, we offer some speculations which point to the idea that disappointment aversion can be considered as a quite realistic representation of preferences especially in the context of delegated portfolio management with a principal-agent relationship affecting the nature of the portfolio selection problem.

1 Introduction

The equity premium puzzle introduced by Mehra and Prescott (1985) is still far from having received a fully-fledged and convincing explanation in the literature (Kochelarkota, 1996; Siegel and Thaler, 1997; Mehra, 2001). A puzzle arises in the first place because, according to Mehra and Prescott, the magnitude of the covariance between the marginal utility of consumption and equity returns is not large enough to justify the 6% (or so) historical equity premium observed in the United States over the last century. Several possible explanations to this puzzle have been proposed in the literature. These include first order risk aversion (Epstein and Zin, 1990), habit formation (Costantinides, 1990; Otrok, Ravikumar, and Whiteman, 2002), fear of disaster (Reiz, 1988), survivorship bias (Brown, Goetzmann and Ross, 1995), borrowing constraints coupled with consumer heterogeneity (Constantinides, Donaldson and Mehra, 2001), and, notably, myopic loss aversion (Benartzi and Thaler, 1995; Barberis, Huang and Santos, 2000) and disappointment aversion (Ang, Bekart and Liu, 2000). In spite of the sheer research effort, however, the profession has still to reach a consensus on the explanation of the large equity premium observed historically in the United States and in other industrialized countries.

Against this background, this paper takes a closer look at the "behavioural finance" explanations of the equity premium puzzle proposed thus far in the literature, namely *myopic loss aversion* (Benartzi and Thaler, 1995) and *disappointment aversion* (Ang, Bekaert and Liu, 2000). The two "behavioural" explanations have something in common, namely the fact that agents' preferences are defined against a reference point (*reference dependence*), and not in absolute terms as in the standard approach.[1] Moreover, the maintained assumption in both approaches is that agents *narrow-frame* the problem of how to allocate wealth between safe and risky assets and consider this problem in an independent manner, focusing on the prospects for returns without considering the co-variability with consumption. This is in contrast with the expected utility approach used by Mehra and Prescott (1985) and many other subsequent papers.

Myopic loss aversion, proposed by Benartzi and Thaler (1995) –

[1]The recent focus on habit formation as a possible explanation of the equity premium appears to be closing the gap between the "standard" and the "behavioural" approaches (indeed, habit formation can be interpreted as a form of reference dependence). For example, Otrok, Ravikumar and Whiteman (2002) show that habit agents are much more averse to high frequency fluctuations than to low frequency fluctuations, which is a result in some sense very close to the analysis in Benartzi and Thaler (1995).

henceforth BT – posits that economic agents are averse to losses at an irrationally short horizon, due to institutional reasons or because they are affected by a behavioural bias (in particular, because they are too anxious to evaluate the performance of their portfolio on a short-term basis). BT showed that the observed equity premium is consistent with a moderate degree of loss aversion at an investment horizon of approximately one year, which BT regard as intuitively reasonable. Under loss aversion, agents have a *fixed* reference point (which BT assume to be the current level of wealth) against which they evaluate gains and losses.

Disappointment aversion, introduced by Gul (1991) and applied to explain the high premium required on equity by Ang, Bekaert and Liu (2000) – henceforth ABL – is based on the idea that reference points evolve *endogenously.* In particular, the *certainty equivalence* of a lottery may become a reference point for agents, and outcomes in excess (short of) the certainty equivalence are a source of elation (disappointment) for the agent. Reflecting the idea that pain is more urgent than pleasure, the disappointment related to outcomes below expectations is assumed (and normally found) to be stronger than the elation related to outcomes exceeding expectations. Unlike under loss aversion, a lottery with a higher certainty equivalence is not necessarily an improvement compared with a lottery with a smaller certainty equivalence, because higher expectations can result in a stronger disappointment (Jia, Dyer and Butler, 2001).

The main objective of this paper is to take a close look at, and in particular carry out a sensitivity analysis of, the two behavioural finance explanations of the equity premium puzzle. We concentrate especially on the role of the *time horizon* in determining the size of the equity premium. This seems a crucial dimension of the problem because it is quite easy to explain a high equity premium with a short time horizon, at which stocks are very volatile, while it may be more difficult at longer time horizons. The key questions of this paper are, first, how dependent the explanation proposed by BT is on a very short time horizon (how myopic agents have to be, assuming a reasonable degree of loss aversion) and, second, at what horizons reasonable parameters for the degree of disappointment aversion can explain the historical equity premium, which is an issue not directly addressed by ABL.

The analytical approach proposed in this paper is a very simple one, inspired by, but not identical to, the analyses by BT and ABL. We posit that the choice between a safe Treasury bill and a risky equity portfolio represents a *framed prospect* for our representative agent, namely a self-contained decision problem which is analysed independently. The agent has a certain time horizon in mind when editing the decision problem.

The value function is defined in terms of *excess* returns on the risky asset at the relevant time horizon for both loss aversion and disappointment aversion (for the latter, we use the simple risk-value generalized disappointment utility function proposed by Jia, Dyer and Butler, 2001). It is important to emphasize the difference with the analysis in BT and ABL who focus on the *absolute* return on equity and bonds (or Treasury bills). Moreover, the paper derives a model of expected returns and risk based on an equilibrium condition requiring stocks to be held in positive amount. Assuming rational expectations (the agent not making systematic mistakes in expectations), a testable condition linking the degree of loss and disappointment aversion respectively and the time horizon can be derived and tested on the data.

The empirical analysis, based on data for excess returns on stocks in the United States from 1871 onwards, shows that an explanation based on loss aversion is crucially dependent on a *very short* time horizon, and already a horizon of three years or so seems too long for loss aversion to be a satisfactory explanation of the historical equity premium. So, loss aversion requires a high degree of "myopia" and BT's results are crucially dependent on this assumption. By contrast, disappointment aversion appears to be a satisfactory explanation of the historical equity premium no matter the time horizon. In fact, realistic values for the degree of disappointment aversion can be found for long time horizons such as ten years. This reflects the empirical finding that, while it is almost impossible to lose on stocks compared with safe assets if the time horizon is relatively long, stocks may disappoint even at long horizons. Overall, we suggest that this feature of disappointment aversion makes it an interesting explanation of the equity premium, possibly more robust than loss aversion because it can accommodate different time horizons. Moreover, we offer some speculations which point to the idea that disappointment aversion can be considered as a quite realistic representation of preferences especially in the context of delegated portfolio management with a principal-agent relationship affecting the nature of the portfolio selection problem. Still, taking into account that the arguments put forward by BT in favour of myopic loss aversion are very convincing, we prefer to think of the results of this paper as indicating that a *combination* of myopic loss aversion at short horizons and disappointment aversion at longer horizons is an attractive overall explanation of the equity premium puzzle. In fact, the idea that agents may have a *multiple* time horizon and consequently multiple reference points in making portfolio allocation decisions seems interesting and plausible, as is also suggested by BT.

The paper is organised as follows. After briefly describing the related approaches followed by BT and ABL in Section 2, we derive expected returns under loss aversion and disappointment aversion in Section 3, and derive a testable condition. In Section 4, we bring this condition to the data and find results which are then discussed in Section 5. Section 6 concludes.

2 The "behavioural finance" explanations of the equity premium puzzle

2.1 The Benartzi and Thaler (1995) approach

Loss aversion is based on psychological insight as well as experimental evidence (Kahneman and Tversky, 2000). It is a prominent feature of prospect theory, first introduced by Kahneman and Tversky (1979). Key elements of prospect theory are reference dependence (outcomes are evaluated not in absolute terms, but rather compared with a reference point), diminishing sensitivity (marginal departures from the reference point count more if they are close to it), loss aversion (losses compared with the reference point loom larger than gains) and non-linear weighing of probabilities (thus departing from the linear weighing as in expected utility theory). Moreover, the decision problem is analysed in two steps. First, the problem is "edited" in a certain (narrow) frame. Second, the agent takes his decision by maximising his prospective value function defined for the problem.

BT held the view that loss aversion, combined with a myopic behaviour of agents, might explain the equity premium puzzle. At time t, agents are concerned about *returns* (and not wealth *levels*) at time $t+h$, where h is the investment horizon.[2] The value function used by BT is the following:

$$V(x_{t+h}) = \{ \begin{matrix} x_{t+h}^b, \text{ if } x_{t+h} \geq 0 \\ -a(-x_{t+h})^b, \text{ if } x_{t+h} < 0 \end{matrix}, \quad (1)$$

where x is either the nominal or the real return on equity or bonds, the reference point for the agent being the current level of wealth, and $a = 2.25$, $b = 0.88$ (which are estimates drawn from Tversky and Kahneman, 1992). As $2.25 > 1$, the representative agent is loss averse.[3]

BT bootstrap from the historical time series of equity and five-year bond returns over the sample period 1926-1990, and compute the horizon h for which the representative investor with value function as in (1)

[2] BT point out that what matters is the *evaluation period* – which is the *implicit* relevant time horizon – rather than the original time horizon for the agent.

[3] Barberis, Huang and Santos (2000) use the current level of wealth plus the risk-free rate as the reference point.

is indifferent between investing in equity and in bonds. They find that if h is approximately one year, investing in bonds and equity provides the same prospective value. Thus, if the agent's investment horizon is approximately one year, loss aversion can explain the equity premium puzzle. BT also report that considering a non-linear weighing of probabilities and a piecewise linear function (i.e., $b = 1$ in (1)) does not change the substance of the results. Hence, BT interpret this finding as suggesting that agents may forgo superior returns on equity due to their "myopia", i.e. the irrationally short time horizon at which they evaluate gains and losses. So, agents are "willing" to pay a high price for their "excessive vigilance".

In this paper, we consider the simple linear case $b = 1$, which is broadly consistent with the available empirical evidence (Tversky and Kahneman, 1992) and greatly simplifies the notation. So, we shall consider the following piecewise linear loss aversion value function:

$$V_{LA}(x_{t+h}) = \{ \begin{matrix} x_{t+h}, & \text{if } x_{t+h} \geq 0 \\ a_{LA}x_{t+h}, & \text{if } x_{t+h} < 0 \end{matrix}, \tag{2}$$

where x_{t+h} is the variable of interest for the agent, and LA stays for "loss aversion".

2.2 The Ang-Bekaert-Liu (2000) approach

Disappointment aversion, introduced by Gul (1991), is based on the idea that agents are disappointed if the outcome of a lottery falls short of the certainty equivalence, while they are elated if the outcome exceeds the certainty equivalence. In both disappointment aversion and loss aversion, a *reference point* plays a key role, but there is an important difference between the two theories. Under disappointment aversion, the reference point is endogenous to the lottery, i.e. it may change for different lotteries. By contrast, under loss aversion the reference point is generally given, so exogenous to the lottery.

ABL examine the role of disappointment aversion in the determination of the equity premium, by introducing an otherwise standard power utility function $U(w)$, where w is wealth, in which outcomes are weighted differently according to whether they exceed or fall short of the certainty equivalence. They show that a reasonable value for the degree of disappointment aversion is consistent with the historical equity premium if the investment horizon of the agent is one quarter or one year.

To illustrate ABL's explanation in a simple way, a convenient representation of disappointment aversion is the risk-value generalized disappointment aversion utility function proposed by Jia, Dyer and Butler

(2001) written in terms of returns:

$$V_{DA}(x_{t+h}) = x_{t+h} + \{ \begin{matrix} e(x_{t+h} - E_t x_{t+h}), \text{ if } x_{t+h} \geq E_t x_{t+h} \\ d(x_{t+h} - E_t x_{t+h}), \text{ if } x_{t+h} < E_t x_{t+h} \end{matrix}, \quad (3)$$

where DA stays for "disappointment aversion", and $d > e > 0$, reflecting the idea that disappointment is more important than elation (this is closely related to the concept that losses loom larger than gains and that agents are loss averse). So, stocks may disappoint exactly because their rate of return has a high expected value (i.e., $E_t x_{t+h}$ is "high"). If d is large and stock returns are very volatile, the equity premium required to compensate for a high probability of disappointment will have to be high.

3 Loss aversion, disappointment aversion, and the investor time horizon

3.1 A simple specification of preferences for loss and disappointment aversion

In this paper we build on the "behavioural" theories of the equity premium and propose a simple approach to map combinations of, respectively, loss aversion and disappointment aversion with the time horizon, with the objective of assessing their overall plausibility. In particular, the analysis of this paper is built on the following assumptions. First, we posit that the allocation of a representative agent's wealth between a safe and a risky asset constitutes a *framed prospect* in the sense of Tversky and Kahneman (1986), i.e. a self-contained decision problem. As in BT and ABL, we assume that the representative agent considers his portfolio choice problem in isolation, and does not look at the correlation with other sources of variability in consumption. Second, we assume that the agent has only two assets available, namely a risk-free Treasury bill and a risky equity.[4]

There is almost a consensus in the literature that a is a number of the order of magnitude of 2. Tversky and Kahneman (1992) estimated a to be 2.25, and this number has been later broadly confirmed in several experimental studies (Kahneman and Tversky, 2000). A number of this magnitude also makes much sense from an intuitive, everyday life perspective; it indicates that agents are more or less twice more upset

[4]BT consider a five-year bond as a "safe" asset. In this chapter, we prefer a one-year Treasury bill because it does not have practically *any* risk, at least in nominal terms, making it a plausible reference point for our representative agent. By constrast, five-year bonds bear some risk at horizons shorter than five years.

for a loss than they are happy for a gain. However, there seem to be no compelling reasons to assume a certain time horizon for the representative investor. BT put forward some arguments in favour of the one year horizon (e.g., portfolio managers often report to their clients on a yearly basis), but they did not provide definitive answers on this matter. In addition, BT treat myopic behaviour as an essentially "irrational" behaviour, explaining the equity premium as the "cost of impatience". So, it should not be ruled out *a priori* that the representative agent has a time horizon different from one year, especially a longer one which might arguably be interpreted as being more "rational" from a normative standpoint.

Even if we have the same question in mind, our approach is different from that of BT and ABL in two main respects. First, as noted, our value function is defined on the *excess* return on the risky asset, rather than on its absolute return. We believe that this measure makes more sense when analysing the allocation of wealth between a safe and a risky asset, as the agent is likely to be concerned above all by the *relative* performance of the two (Cochrane, 1997).[5] Second, BT's aim was to find out the time horizon h at which the representative investor with value function as in (1), and *given* a_{LA}, is indifferent between investing in equity and bonds. Our approach is different and slightly more general. We seek to look at the combinations $\{a_{LA}, h\}$ for which the degree of loss aversion derived from the data is a realistic number (i.e., a small number possibly not too far from 2). BT found that for a_{LA} to be approximately equal to 2, h must be approximately one year; they could not say anything about what happens to a_{LA} if h is assumed to be longer, say ten years or so. This sensitivity analysis is the main objective of this study.

Turning to disappointment aversion, the analysis in ABL does not really deal with the problem of the time horizon. ABL only find that at a one-quarter or one-year horizon disappointment aversion seems to be a good explanation of the historical equity premium. This does not seem surprising given the close similarity between disappointment aversion and loss aversion and BT's results on myopic loss aversion and the equity premium. In this paper, we seek to look at the parameters of a simple disappointment aversion model if the investment horizon is progressively increased beyond one year.

To pin down our simple model of preferences under loss aversion (henceforth LA) and disappointment aversion (henceforth DA), we shall consider the following measure of *departure* of the outcome from the reference point relevant for each specification of preferences. We call

[5] A value function defined on the excess return on the risky asset is also used in Barberis, Huang and Santos (2000).

this *ex post* measure ρ_j, where $j = LA, DA$. If evaluated *ex ante* in expectation and in absolute value, this measure can be interpreted as a measure of *risk*. The variable ρ_j can be defined in a compact way for both LA and DA as follows:

$$\rho_{j,t+h} = (x_{t+h} - z^j_{t+h})(1 - I^-_j) + a_j I^-_j (x_{t+h} - z^j_{t+h}), \tag{4}$$

where z^j_{t+h} is the reference point, $z^{LA}_{t+h} = 0$, $z^{DA}_{t+h} = E_t x_{t+h}$, $I^-_j = 1$ if $x_{t+h} < z^j_{t+h}$ and zero otherwise, and $a_{LA} > 1$, $a_{DA} = \frac{d}{e} > 1$. Under loss aversion, the ex post value function is simply given by $V_{LA,t+h} = \rho_{LA,t+h}$, while under generalized disappointment aversion as in Jia, Dyer and Butler (2001) – which is a risk-value utility function – it is given by:

$$V_{DA,t+h} = x_{t+h} + e\rho_{DA,t+h} \tag{5}$$

Ex ante, the expected value function under loss aversion is:

$$E_t V_{LA,t+h} = E_t \rho_{LA,t+h}, \tag{6}$$

while for disappointment aversion it is obtained:

$$E_t V_{DA,t+h} = E_t x_{t+h} + eE_t \rho_{DA,t+h} \tag{7}$$

It should be noted that under this specification the coefficient e can be interpreted as a measure of the overall risk aversion (measuring the importance of the expected value vis-a-vis deviations from it), while a_{DA} measures the relative importance of disappointment (negative feeling) compared with elation (positive feeling) in this preference specification. Reflecting previous results in the literature, one should expect e to be quite a small number, perhaps not too different from 1, and a_{DA} (by analogy with loss aversion) not too distant from 2. In the continuation, we shall assume for simplicity (and quite realistically) $e = 1$ and concentrate the estimation effort on a_{DA}. Given that $E_t(x_{t+h} - E_t x_{t+h})(1 - I^-_{DA}) = E_t(x_{t+h} - E_t x_{t+h}) I^-_{DA}$, the disappointment aversion specification in (7) can be rewritten in a simplified format as:

$$E_t V_{DA,t+h} = E_t x_{t+h} + (a_{DA} - 1) E_t (x_{t+h} - E_t x_{t+h}) I^-_{DA} \tag{8}$$

Under both specifications of preferences, as argued above, we consider the excess return on equity between t and $t + h$ to be the variable of interest, x_{t+h}. In the next section, we derive an equilibrium condition between investing in the safe and the risky asset for our either loss or disappointment averse agent, which will serve as a basis for the empirical estimation carried out thereafter.

3.2 A model of expected returns under loss aversion and disappointment aversion

We assume that in every period t the investor evaluates the investment prospects based on the expected value functions as in (6) for loss aversion and (7) for disappointment aversion. As far as the mechanism for expectation formation is concerned, we allow expectations to be formed under a non-linear weighing of probabilities, which is in line with most experimental evidence on decision-making under risk (Kahneman and Tversky, 2000).

The expected (or "prospective") value function for investing in the (risky) equity portfolio is the following:

$$EV_{j,t} = E_t^w V_{j,t+h} = \int_{-\infty}^{\infty} V_{j,t+h} w(p(x_{t+h}))dx_{t+h}, \tag{9}$$

where $w(\cdot)$ is a function used to weigh the probabilities p (Tversky and Kahneman, 1992), $E_t^w V_{j,t+h}$ is the *subjective* expected value of $V_{j,t+h}$ at time t (where "subjective" signals that it is computed with the probabilities weighted with the function w), and $j = LA, DA$.

Having normalized the expected value function for investing in the safe asset at zero, letting α be the share of wealth invested in the risky asset, the expected value function for the portfolio will be equal to αEV_j (where EV_j is defined as in (9)). In equilibrium, for any $\alpha \neq 0$ this implies that $EV_j = 0$ (otherwise, if $EV_j > 0$ it would be convenient for our investor to be infinitely short in the safe asset and long in the risky asset, and the opposite would be true if $EV_j < 0$).[6] So:

$$E_t^w V_{j,t+h} = 0 \tag{10}$$

Recalling the results of the previous section, in the case of loss aversion this implies that:

$$E_t^w x_{t+h}(1 - I_{LA}^-) + a_{LA} E_t^w x_{t+h} I_{LA}^- \tag{11}$$

For disappointment aversion, assuming that also for the subjective expectation $E_t^w(x_{t+h} - E_t^w x_{t+h})(1 - I_{DA}^-) = E_t^w(x_{t+h} - E_t^w x_{t+h})I_{DA}^-$, equation (10) implies:

$$E_t^w x_{t+h} + (a_{DA} - 1)E_t^w(x_{t+h} - E_t^w x_{t+h})I_{DA}^- = 0 \tag{12}$$

[6] This implies that our method does not allow to identify α, as it may be the case with the approach followed by BT and ABL. So, the optimal portfolio allocation remains *indeterminate*, exactly because we assume that agents are indifferent between investing in equity and Treasury bills.

Further, we assume that agents have rational expectations and do not make systematic mistakes in their subjective expectations. Hence:

$$E_t^w V_{j,t+h} = V_{j,t+h} + \varepsilon_{t+h}, \tag{13}$$

with $\varepsilon_{t+h} \sim MA(h-1)$ with all roots outside the unit circle, i.e. a stationary process. Let us consider a sample period $t = 1, ..., T$, with T large (in particular, $T >> h$). Asymptotically, we have:

$$\sum_{t=1}^{T} (E_t^w \frac{V_{j,t+h}}{T} - \frac{V_{j,t+h}}{T}) = \sum_{t=1}^{T} \frac{\varepsilon_{t+h}}{T} \simeq 0, \tag{14}$$

owing to our assumption on the stochastic properties of ε_{t+h}. Because ε_{t+h} is a stationary process, the unconditional mean of $V_{j,t+h}$ is an unbiased estimate of $E_t^w V_{j,t+h}$. Therefore, the equilibrium condition (10) requires that the value function is ex post approximately zero on average:

$$\sum_{t=1}^{T} E_t^w \frac{V_{j,t+h}}{T} = \sum_{t=1}^{T} \frac{V_{j,t+h}}{T} = 0 \tag{15}$$

This equation is the basis for our empirical analysis. For loss aversion, this implies:

$$\frac{1}{T} \sum_{t=1}^{T} (x_{t+h}(1 - I_{LA}^-) + a_{LA} x_{t+h} I_{LA}^-) = 0, \tag{16}$$

or:

$$a_{LA} = \frac{\sum_{t=1}^{T} x_{t+h}(1 - I_{LA}^-)}{\sum_{t=1}^{T} x_{t+h} I_{LA}^-} \tag{17}$$

For disappointment aversion, expression (15) leads to:

$$\frac{1}{T} (\sum_{t=1}^{T} x_{t+h} + (a_{DA} - 1) + (x_{t+h} - \frac{1}{T} \sum_{t=1}^{T} x_{t+h}) I_{DA}^-) = 0, \tag{18}$$

whereby:

$$a_{DA} - 1 = \frac{\sum_{t=1}^{T} x_{t+h}}{\sum_{t=1}^{T} (x_{t+h} - \frac{1}{T} \sum_{t=1}^{T} x_{t+h}) I_{DA}^-} \tag{19}$$

From equations (17) and (19), for given values of the time horizon h, a_{LA} and a_{DA} can be estimated from the data. The key objective of our analysis is to see which combinations $\{a_j, h\}$ deliver plausible values for both variables under loss and disappointment aversion.

4 The empirical analysis

4.1 The data

In the empirical analysis of this paper we use annual observations for the returns on the US stock market as proxied by the Standard and Poor composite index from 1871 to 2001, which gives us 130 annual observations. The data are drawn from Global Financial Data. Stock returns include both dividends and capital gains. For the return on the safe asset, we consider the return on the one-year Treasury bill, also available from 1871 onwards in the database.

It should be noted that our sample period is different from that of BT (1926-1990). In particular, the last part of the sample period, after 1990, seems particularly interesting given the large swings in equity prices and the boom-bust of the dot.com bubble (Shiller, 2000). In this respect, an interesting question on its own is whether the results of BT carry through to our sample period. As we show later, we broadly find this to be the case.

We make the assumption that our representative investor has one US dollar at the end of 1871, and may invest it either in the U.S. stock market (i.e., in the Standard and Poor composite index) or in one-year Treasury bills. Then, we compute the value outstanding in each year t in dollars for the investment in equity (which we call $RISKY$) and for the 1-year Treasury bill (which we call $SAFE$). Chart 1 reports the value of the investments $RISKY$ and $SAFE$ over the whole sample period. Consistent with many other contributions in the literature (see, e.g., Siegel and Thaler, 1997), we find that over our sample period, which covers more than a century, stocks outperformed Treasury bills by a very wide margin. Indeed, the same dollar invested in 1871 in the stock market would have been worth more than 100,000 dollars, against only slightly more than 250 dollars if invested in Treasury bills (Chart 1). It is interesting to observe that the difference in performance is particularly striking in the postwar period, and much more contained beforehand (Chart 2).

However, it is highly doubtful that there is any investor having such a long investment horizon. Therefore, we look at shorter, more realistic time horizons, in particular between *one year* and *ten years*. The upper panel of Chart 3 reports the one-year *excess* return on the Standard and Poor composite compared with the one-year Treasury bill, and – for a comparison – the lower panel of the chart reports the ten-year excess return. It stands out in these charts that excess returns often turn out to be negative at the one-year horizon, but hardly so at the ten-year horizon (in the postwar period, ten-year excess returns have been negative only in the seventies). Nonetheless, at both the one-year and ten-year horizons equity excess returns are very volatile, ranging between losses of around 40% for both horizons and gains of more than 40% for the one-year and almost 500% for the ten-year horizon. So, already a first look at this evidence suggests that if the relevant horizon h is short, loss aversion and disappointment aversion are both plausible explanations of the historical equity premium. In fact, excess returns on stocks at a short horizon imply both the possibility of losses (relevant for LA) and large volatility around the mean (relevant for DA). By contrast, at longer horizons such as ten years excess returns remain very volatile, but the probability and size of the losses declines dramatically. This is reflected in the key statistics for the returns at one-year and ten-year horizons reported in Table I. At the short horizon and over the full sample period from 1881 onwards, excess returns on equity have a mean of 6.6% and a standard deviation of 19.5%, which implies that positive returns are 2.27 times greater than negative returns on average.[7] At the long horizon, excess returns on equity are positive by 115.5% on average and have a high standard deviation, 132.0%, but the positive excess returns are as much as 24.67 times greater on average than negative excess returns.

In the empirical analysis, we consider ten investment horizons, from one to ten years. Ex post *excess* returns at time $t+h$ are computed as follows:

$$x_{t+h} = \frac{RISKY_{t+h} - RISKY_t}{RISKY_t} - \frac{SAFE_{t+h} - SAFE_t}{SAFE_t}, \qquad (20)$$

for $h = 1, ..., 10$ years. For each h, we then compute a_{LA} and a_{DA} as implied by equations (17) and (19).

4.2 Results

Starting with loss aversion, we run the analysis on the full sample period 1881-2001 first, and then on the restricted sample period 1926-2001, which partly overlaps that used by BT. The upper panel of Chart 4 reports the combinations of the estimated degree of loss aversion, a_{LA}, and the time horizon h which satisfy equation (17).

One first striking result of this analysis is that, despite the use of a different methodology and sample period compared with BT, the combination $\{a_{LA}, h\}$ identified in BT is broadly supported. In fact, if $h = 1$, a_{LA} is very close to 2.25 found by BT. In this respect, our analysis is in keeping with the results of BT, even if we only look at a different

[7] These are values close to those analysed in Mehra and Prescott (1985) and subsequent studies.

sample period and include the dot.com boom-bust in the second part of the nineties and early 2000s, which might have significantly affected the results.

The novel element of our analysis, which could have been easily anticipated by just looking at the excess returns at the different horizons in the previous section, is what happens with longer time horizons. The upper panel of Chart 4 shows that the estimated a_{LA} increases quite dramatically with h, and only at horizons of less than three years is this parameter of acceptable size. At the longer time horizon, ten years, the loss aversion parameter is close to 25, which seems to be a exaggerately high value. Such a large value for a_{LA} would imply, for instance, that the representative agent would possibly turn down a lottery paying, say, 24 dollars with probability $\frac{1}{2}$ and losing 1 dollar with probability $\frac{1}{2}$. This is clearly unrealistic and at odds with the experimental evidence suggesting that a_{LA} is a small number (Kahneman and Tversky, 2000).

The conclusion of this analysis does not change if we look at the sample period starting from 1926, reported in the lower part of Chart 4. Indeed, the increase in the estimated loss aversion if the time horizon gets longer is even more pronounced, reflecting the larger weight of the postwar period in the sample when stock market developments have been particularly favourable. The conclusion of this analysis is that loss aversion is a good explanation of the equity premium puzzle only if the representative agent's time horizon is very short – agents must have a high degree of myopia, so to speak.

In Chart 5, we repeat the same analysis on disappointment aversion, making use of equation (19). In the upper part of the chart, we refer to the full sample period, while results for the restricted sample period starting from 1926 are in the lower panel. It can be observed that the degree of disappointment aversion, $a_{DA} - 1$, rises only very mildly with the time horizon. In the full sample period, it is close to 1 at short horizons, and rises to close to 2 at the longer horizons. In the shorter sample period, it is again close to 1 at very short horizons, and rises to somewhat above 2 at longer horizons – again, reflecting a greater weight of the good stock market performance in the postwar period. These values for disappointment aversion seem very reasonable and in keeping with the experimental evidence on loss aversion. So, this analysis suggests that an explanation of the historical equity premium based on disappointment aversion is valid no matter the length of the investment horizon (within reasonable limits). In particular, an explanation built on disappointment aversion does not necessarily hinge on the assumption that agents are highly myopic. Stocks may lose compared with Treasury bills (or similarly safe assets) only at short horizons, but may disappoint at *both* short and long time horizons.

One *caveat* surrounding these results is the size of our sample period compared with the longest time horizon we look at. In fact, the assumption that $\sum_{t=1}^{T} \frac{\varepsilon_{t+h}}{T} \simeq 0$ is warranted only if $T >> h$. Although our sample period covers more than a century, for the longest horizon that we consider, $h = 10$, the sample has only 12 independent observations, and even fewer when we look at the sample period starting from 1926. This might raise the concern that the results that we obtain might be spurious and distorted by small sample bias.

To take into account this possibility, we check the robustness of the results by doing a simulation exercise as follows. A very simple model is estimated for the *one-year* excess return on equity, $x_{t+1} = \frac{RISKY_{t+1}-RISKY_t}{RISKY_t} - \frac{SAFE_{t+1}-SAFE_t}{SAFE_t}$, for which 129 non-overlapping observations are available. The model estimated is very simple:

$$x_{t+1} = \beta + \eta_{t+1}, \tag{21}$$

where β is a real scalar and η_t is a white noise disturbance term. The coefficient β is the average annual premium on equity, while the variance of the shock η indicates the degree of uncertainty surrounding one-year excess returns on equity. The purpose of estimating the model in (21) is to identify a very simple stochastic process driving *excess* returns on equity, in order to find out what configuration of the parameters of the representative agent's value function (namely a_j and h) makes the agent indifferent between investing in a hypothetical asset with annual excess returns given by (21) and holding financial wealth in safe assets. The simplicity of the model makes it plausible that it may have been perceived as the "approximate" model driving annual excess returns by a relatively unsophisticated representative investor.

The estimate for the simple model in (21) over the whole sample period 1871-2001 is reported in Table II. It is found, in particular, that $\beta = 6.4\%$ and $\sigma_\eta^2 = 19.4\%$. The diagnostic statistics for the model are good and tend to indicate that the model is well specified and stable, despite its simplicity. For instance, recursive residuals and the recursive estimate of β (see the charts reported for illustrative purposes underneath Table II) do not signal any significant instability in the model over the considered sample period. Interestingly, there is no sign of serial correlation in the residuals (for example as measured with the Q-test). Overall, these results indicate that we cannot reject the hypothesis that excess returns on equity are constant and i.i.d. in our sample period.

With this simple model at hand, we simulate 10,000 annual observations of x_{t+1}, and compute excess returns at various horizons, i.e for $h = 1, ..., 10$, by cumulating one-year excess returns. Subsequently, we estimate equations (17) and (19) on the simulated data. The results of this analysis (not reported here for brevity) confirm those based on the historical data and lead to the same conclusions as regards the relationship between loss and disappointment aversion and the investment time horizon.

Summing up, the results of the empirical analysis in this study (i) confirm that loss aversion and myopic behaviour, if combined, represent a good explanation of the historical equity premium, as argued by BT, but also that (ii) disappointment aversion, at *both* short and long horizons, is also a valid explanation of the equity premium, as suggested by ABL. In the next section we provide some speculations on which one of the two explanations of the equity premium considered in this paper is more plausible and interesting.

5 Discussion

Both "behavioural finance" explanations put forward to solve the equity premium puzzle involve some departure from rationality, at least as defined in the expected utility sense. Under myopic loss aversion, agents are irrationally short-sighted and forgo superior returns for being too anxious about short-term outcomes, as pointed out by BT. However, they are "rational" in the sense that they treat safe and risky returns in the same way, by having the same reference point for both types of investment. Under disappointment aversion, there is an element of "irrationality" (again, defined in terms of departure from standard preferences) which is related to the fact that agents' preferences depend on, and vary with, the lottery they are confronted with. So, there can be a lottery A displaying weak stochastic dominance vis-a-vis a lottery B, but agents might still prefer lottery B if this is less likely to disappoint their expectations. Therefore, agents may be more disappointed by stocks even if they are better than bonds in absolute terms *in every state of nature*.

The key question here is what form of departure from standard preferences is more plausible to describe financial investment behaviour and thereby to be a good explanation of the historical equity premium.

BT forward some strong arguments in favour of myopia in financial markets, mostly related to institutional features of the financial market and in particular to agency costs. While households should care about long-term outcomes, there is usually a principal-agent relationship between their money and investment decisions, and this relationship might work in favour of short-sightness. Noting that delegated portfolio management and institutional investment are now largely prevalent in financial markets, the arguments proposed by BT are *prima facie* convincing.

It should be emphasised, however, that the same trend towards institutional trading and delegated portfolio management might also underpin a disappointment aversion specification of prefences. In a principal-agent relationship, the agent is often assessed in terms of performance against a certain benchmark, due to information asymmetries (Bray and Goodhart, 2002). The agent proposing an investment in stocks to the principal is likely to set a higher benchmark for returns compared with a safe investment strategy based on fixed income securities. From the perspective of the agent (who actually decides and implements the investment strategy) an outcome which falls short of the expectation is likely to lead to disappointment by the principal and to a reputation loss for himself. Conversely, an outcome exceeding expectations might lead to elation by the principal and to a reputation gain for the agent. This mechanism, which seems intuitively reasonable and realistic, would suggest that disappointment aversion is a good characterisation of preferences in financial markets, at least approximately.

In addition, the finding that disappointment aversion works well to explain the equity premium at an horizon of approximately ten years seems to be quite interesting. Arguably, the single most important reason to invest in the US financial markets is saving for retirement. If this is true, the most relevant and "rational" investment horizon for each investor should be the time span before retirment, as this would maximize the agent's utility in terms of living standards after retirement.[8] Noting that peak saving years occur in mid and late career, ten years or so do not seem unreasonable as a time span before retirement for the "median" investor in the financial market (where the median is calculated taking into account each agent's stock of wealth).

All in all, we argue that disappointment aversion is a very interesting "behavioural" candidate for the explanation of the equity premium puzzle, which becomes particularly relevant at long time horizons. It should be stressed that myopic loss aversion and disappointment aversion might well be considered *in conjuction* for the overall explanation of the historical equity premium. Myopic loss aversion would imply that stocks can be quite painful in the short term but are a very good choice (too good to be true) if the investment horizon is long. Disappointment aversion would work to reduce the net benefit of investing in stocks if seen from the perspective of long-horizon returns. As pointed out by BT, agents may actually have *many* relevant investment horizons, which makes a multi-faceted explation of the equity premium quite reasonable. Overall, we surmise that *both* loss and disappointment aversion might contribute

[8]This can be rationalised in an overlapping generations economy, where major investors in the market are middle-aged households (Constantinides, 2002).

to raise the equity premium to the high levels observed historically in the United States (and other industrialized economies).

6 Conclusions

This paper takes a close look at the "behavioural finance" explanations of the equity premium puzzle, namely myopic loss aversion (Benartzi and Thaler, 1995) and disappointment aversion (Ang, Bekaert and Liu, 2000). Building on these ideas, this paper proposes a simple specification of preferences, which is able to capture the main idea behind loss and disappointment aversion and highlight the differences between the two approaches, the most important being the way the reference point is determined. Moreover, this paper brings these theories to the data with a special focus on the relationship between the degree of loss and disappointment aversion and the investment time horizon.

The main conclusion of the paper is that a highly short-sighted investment horizon is required for the historical equity premium to be explained by loss aversion, while reasonable values for disappointment aversion are found also for long investment horizons. So, stocks may lose only in the short term, but may disappoint also in the long term.

Which of the two "behavioural" explanations of the equity premium has to be preferred? Benartzi and Thaler (1995) put forward the idea that institutional factors and principal-agent relationships might lead to myopic loss aversion, but there are also arguments in favour of disappointment aversion based on similar grounds, as argued in this paper. One intriguing possibility is that the two approaches are not alternative, and that a high equity premium can be explained by *both* myopic loss aversion at short horizons and disappointment aversion at longer horizons. This would imply that the reference point evolves according to the time horizon. This is an interesting possibility which we leave to further research.

Finally, extending this analysis to data from other countries and periods would be an interesting topic for future research. Due to the observed "home bias" in equity investment, it is possible that participants in individual stock markets display country-specific cultural and psychological traits, which might lead to different degrees of loss and disappointment aversion as well as time horizons for investment.

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Chart 1 – Value of one dollar invested in equity and Treasury bills in 1871

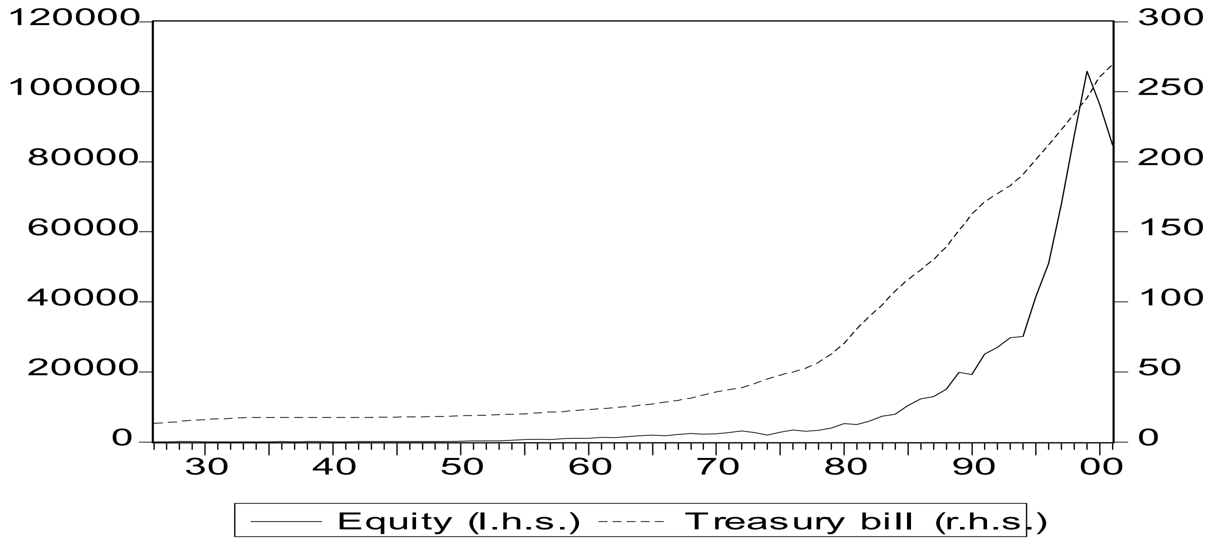


Chart 2 – Value share of equity and Treasury bill investment, in USD

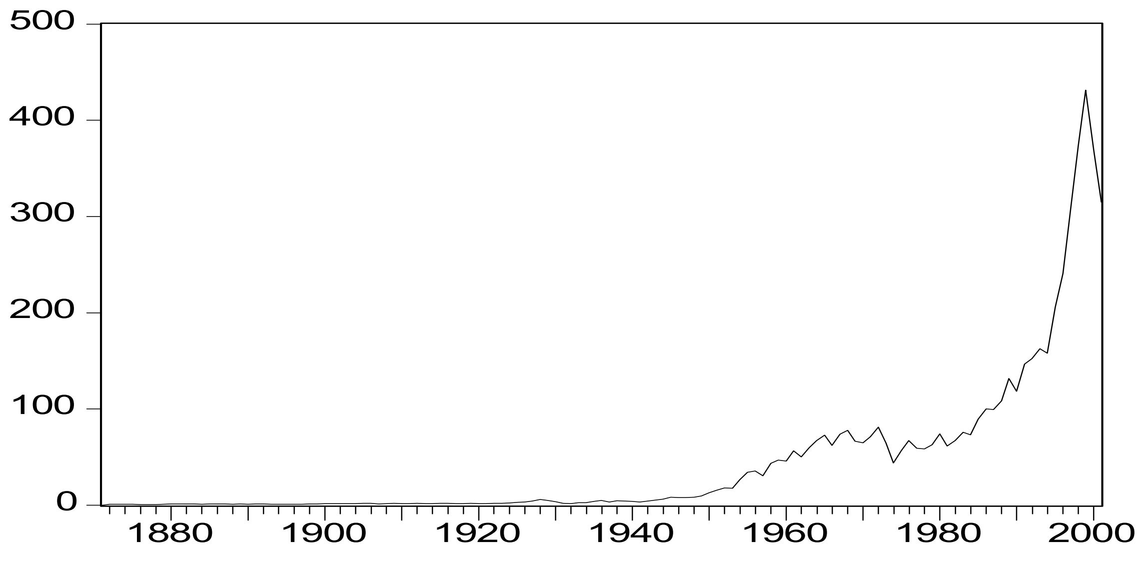
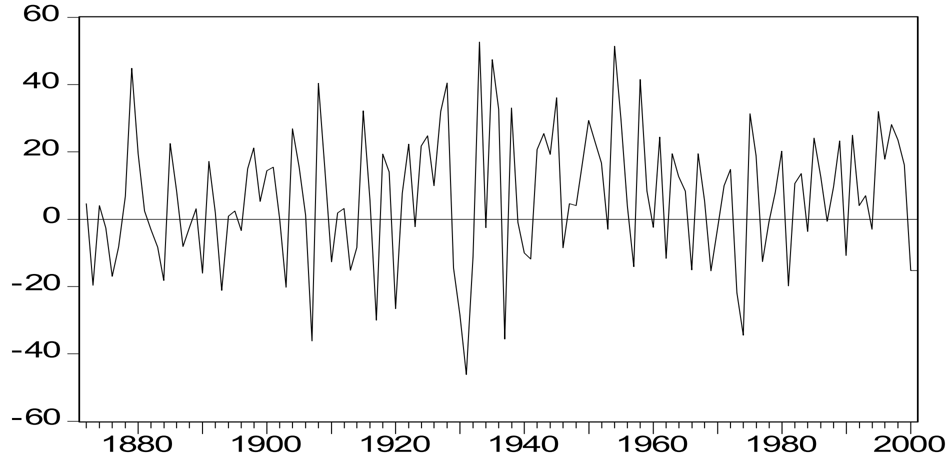


Chart 3 – Excess returns on equity, 1871-2001

1-year horizon



10-year horizon

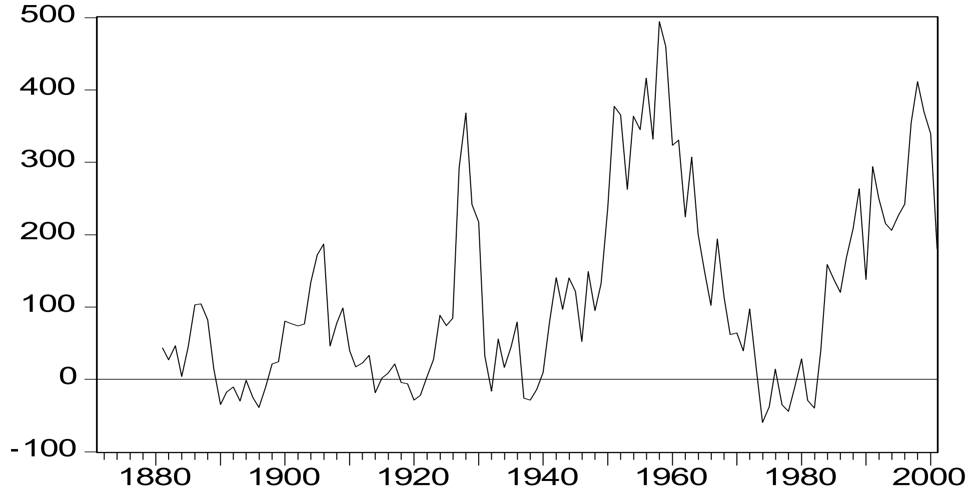


Table I – Excess returns on equity at a 1-year and 10-year horizon

Sample period: 1881-2001

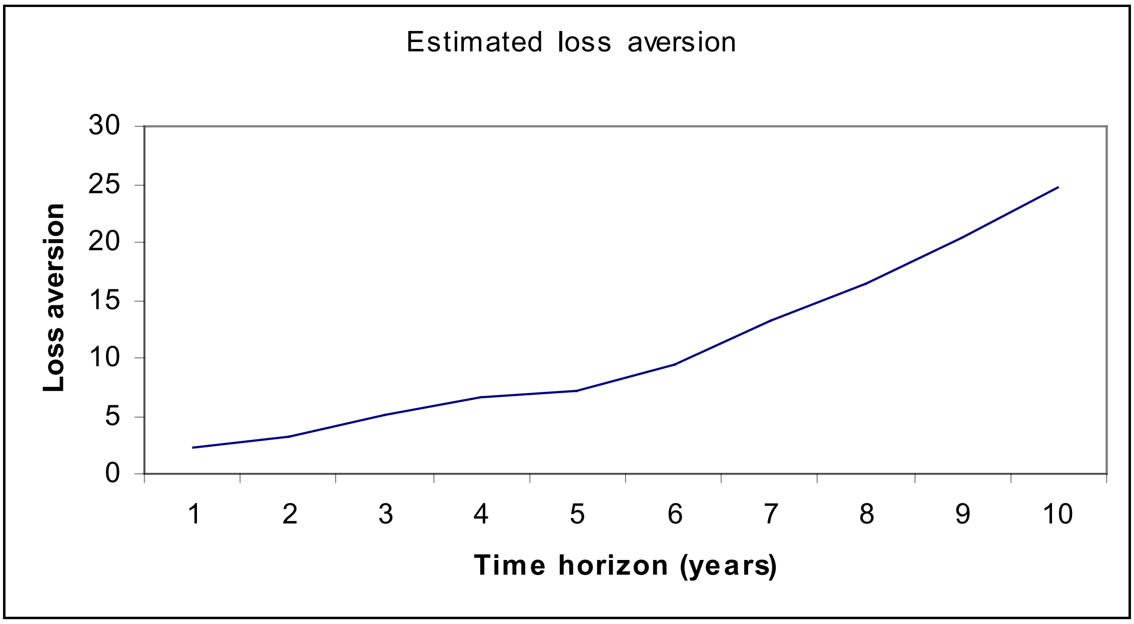
	ER1	ER10
Mean	6.590311	115.5088
Median	7.015681	78.71211
Maximum	52.65015	494.6028
Minimum	-46.19185	-59.84369
Std. Dev.	19.46995	132.0429
Skewness	-0.129030	0.896184
Kurtosis	2.815639	2.872475
Jarque-Bera	0.507110	16.27876
Probability	0.776037	0.000292
Pos./Neg.	**2.27**	**24.67**
Observations	121	121

Sample period: 1926-2001

	ER1	ER10
Mean	8.519619	162.4898
Median	9.777976	140.4511
Maximum	52.65015	494.6028
Minimum	-46.19185	-59.84369
Std. Dev.	20.68226	142.1342
Skewness	-0.195230	0.336087
Kurtosis	2.768986	2.120308
Jarque-Bera	0.651786	3.881302
Probability	0.721883	0.143610
Pos./Neg.	**2.74**	**37.2**
Observations	76	76

Chart 4 – Loss aversion and the time horizon

Sample period: 1881–2001



Sample period: 1926–2001

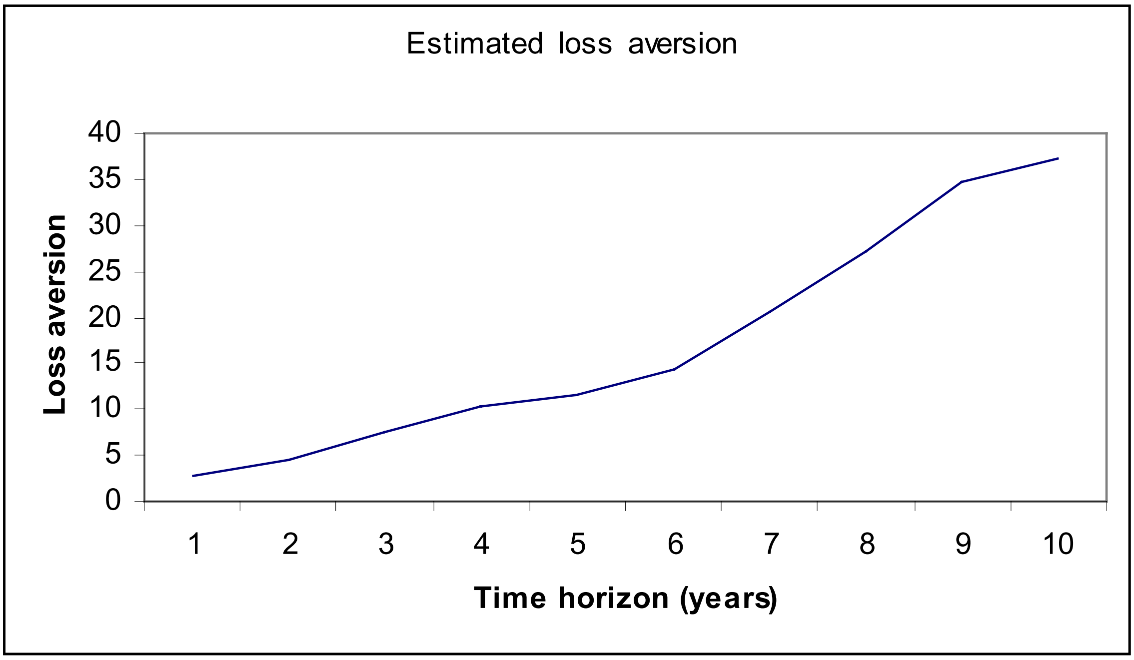
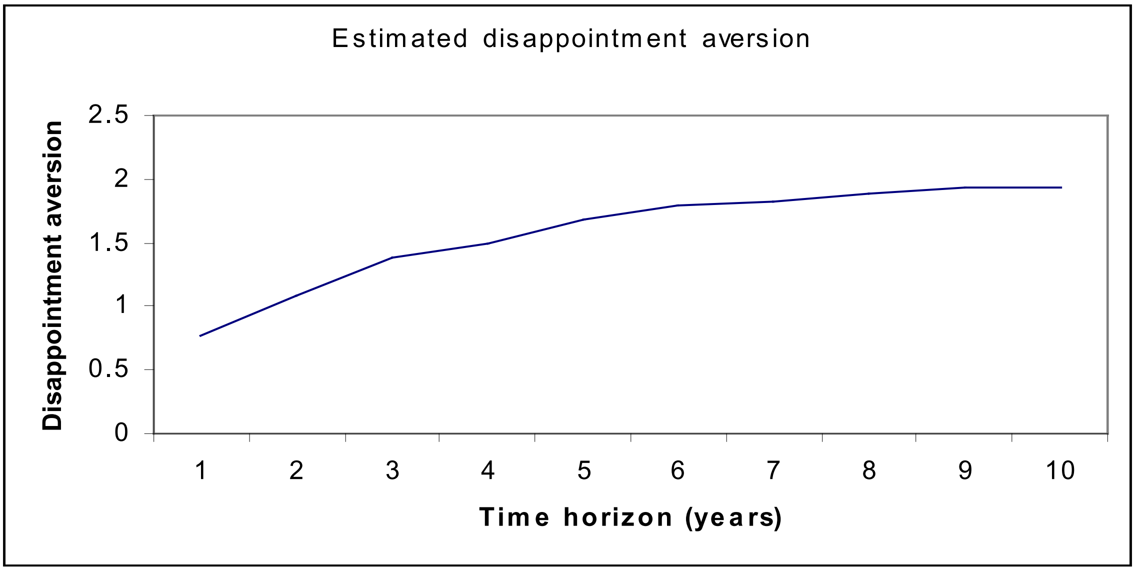


Chart 5 – Disappointment aversion and the time horizon

Sample period: 1881-2001



Sample period: 1926-2001

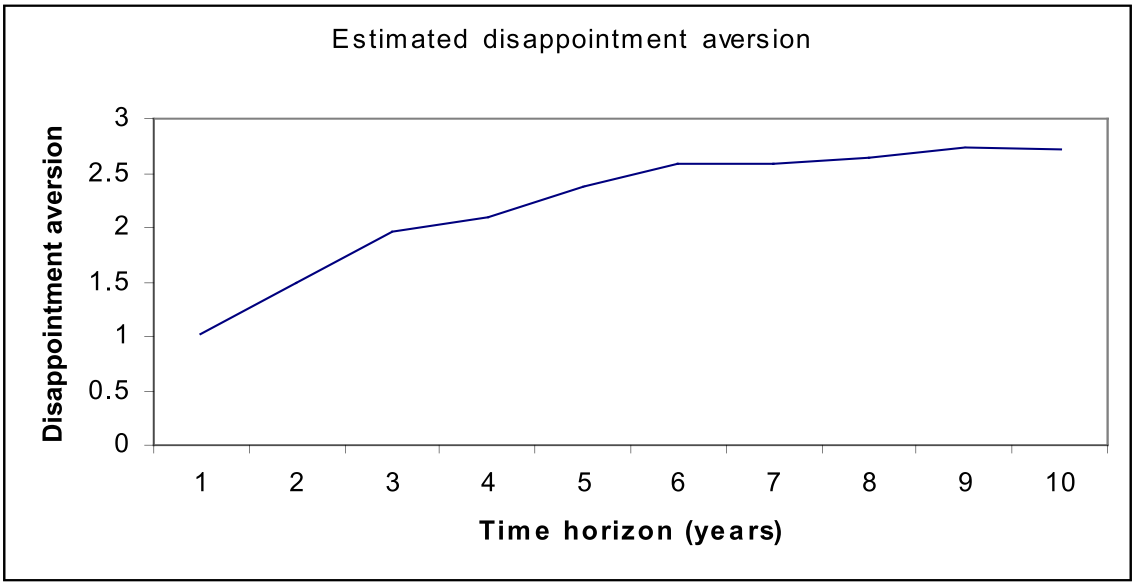
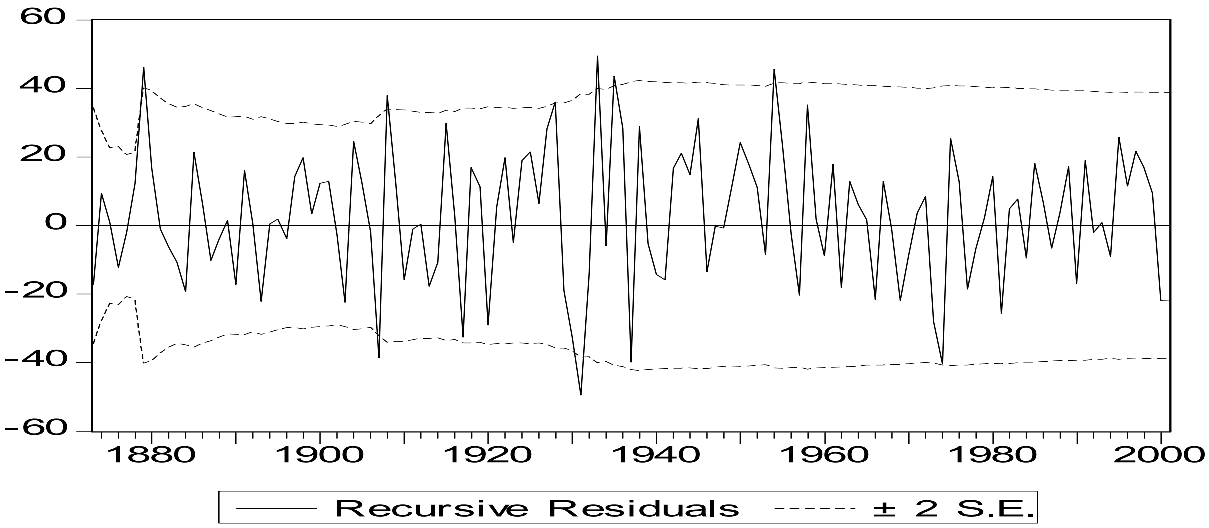
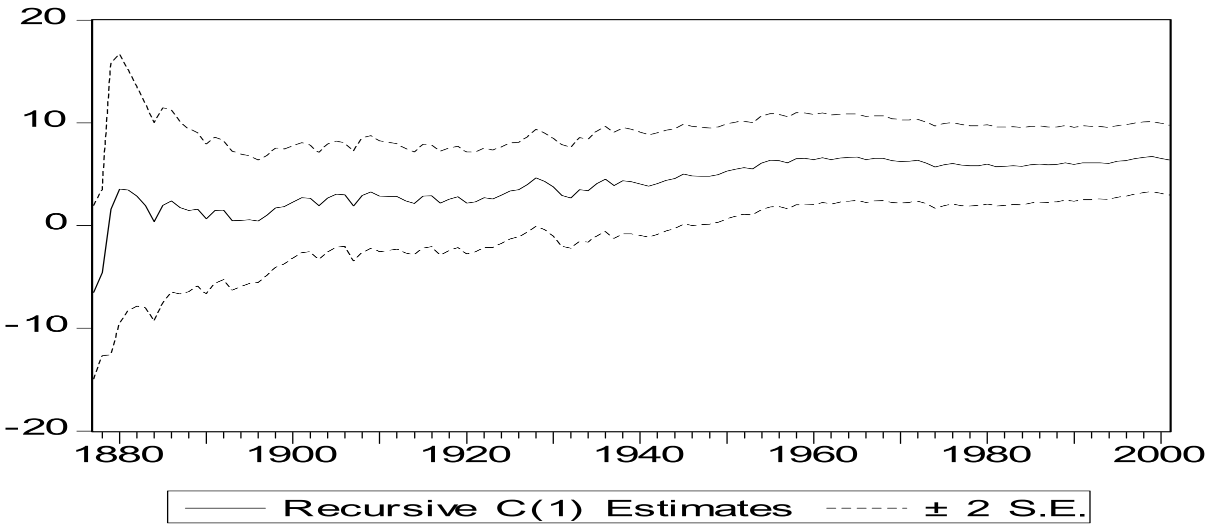


Table II – Excess returns on equity, 1872-2001

Dependent Variable: ER1				
Method: Least Squares				
Sample(adjusted): 1872 2001				
Included observations: 130 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.381532	1.703692	3.745708	0.0003
R-squared	0.000000	Mean dependent var		6.381532
Adjusted R-squared	0.000000	S.D. dependent var		19.42507
S.E. of regression	19.42507	Akaike info criterion		8.778669
Sum squared resid	48676.02	Schwarz criterion		8.800727
Log likelihood	-569.6135	Durbin-Watson stat		1.944997





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