Disappointment Aversion in Asset Allocation

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JEL Classification: G11; G12

Keywords: Disappointment Aversion; Risk Aversion; Individualism; Portfolio Choice

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Abstract

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1. Introduction

Since the introduction of disappointment aversion (DA) of Gul (1991), the DA utility together with loss aversion has been widely used for the explanation of investors' behaviour in financial markets. These utility functions, i.e., treating gains and losses rather than the total wealth and imposing heavier weights on disappointment (losses) than elation (gains), have attracted a lot of attentions in the literature (e.g., see Lien and Wang, 2002, Lien and Wang, 2003, Ang et al., 2005, Fielding and Stracca, 2007, Abdellaoui and Bleichrodt, 2007, Routledge and Zin, 2010, Gill and Prowse, 2012). However, the detailed specification of the DA utility function is not clear due to their unknown parameters, e.g., how investors respond to disappointment. Other characteristics of DA utility such as the relationship between DA and risk aversion or changes in DA to wealth levels have yet to be investigated. The purpose of this study is to scrutinise investors' disappointment aversion and its impacts on asset allocation in order to answer these questions.

We propose a utility function that consists of wealth utility as well as DA utility, as in Koszegi and Rabin (2007) and Barberis (2013). The wealth utility reflects the absolute utility from wealth levels which has been used in economics and finance, whereas the DA utility depends on gains and losses calculated with respect to the (endogenous) expected wealth. Our overall utility would help avoid misleading results by ignoring either gains and losses or wealth levels (Barberis, 2013). By interpreting the DA utility as a risk measure (Jia and Dyer, 1996) and assuming that utility is additively separable as in Koszegi and Rabin (2007), we analytically obtain several interesting relationships between the optimal investment proportions, levels of DA and risk aversion, expected excess returns, elation, and disappointment. The analytical relationships are then tested using asset allocations in pension funds of 35 OECD countries.

Our analytical results can be summarized as follows. As expected, the effects of risk and disappointment on asset allocation are not the same. *Ceteris paribus*, optimal investment proportions in risky assets decrease when investors become more risk-averse or more disappointment-averse. These results are consistent with our intuition. However, disappointment aversion increases when risk aversion decreases. Therefore, if decreasing absolute risk aversion holds and thus risk aversion decreases with wealth, wealthier investors may feel more disappointment for losses. We also find that disappointment aversion increases as expected excess return increases. The results are consistent with the experimental findings of Abdellaoui and Bleichrodt (2007) that investors are particularly frustrated for suffering losses when they have a very good chance to win. Therefore, in bear markets when expected excess returns are high, both investment proportions in risky assets and disappointment aversion increase.

These analytical results are supported by empirical results with asset allocations in pension funds of 35 OECD countries. The estimated DA levels (standard errors) of stock, bond, and other investments (a portfolio of real estate, infrastructure, private equities, and hedge funds) are 2.33 (0.31), 1.85 (0.20) and 1.59 (0.14), respectively. As predicted by the analytical results, DA is larger for equities whose expected returns are larger than those of the other risky assets. The large DA in equities could be a potential source of the equity premium puzzle which is not well explained by risk.

We also find empirical evidence that the levels of DA are affected by wealth as well as individualism defined by Hofstede (2001). As predicted by the analytical results, countries with larger wealth (measured by GDP) show higher levels of disappointment aversion for equities. Moreover, individualistic countries appear more disappointment averse than collectivistic countries. According to Van Den Steen (2004) and Chui et al. (2010), individualistic investors tend to show more risk-taking activities in financial markets. Our results indicate that individualistic investors are overconfident of their expectations in risky assets, making themselves more disappointed for losses.

This study expands our understanding of disappointment aversion and its relationship with risk aversion and expected returns. In contrast to other disappointment aversion utility functions defined solely over gains and losses, our utility includes the absolute pleasure of consumption purchased with wealth. Moreover, the assumption of additively separable utility allows us to apply this utility for asset allocation problem with multiple asset classes.[4] In our

[4] Because of tractability, most previous studies focus on asset allocation problems with two assets, i.e., Benartzi and Thaler (1995); Ang et al. (2005); Fielding and Stracca (2007); Hwang and Satchell (2010).

framework, the overall utility is a linear combination of disappointment aversion utilities for different asset classes, and thus analysis becomes simple.

From the empirical side, our results show that cultural differences can play an important role in decision-making under risk, which is consistent with the view that investors from different backgrounds frame their risk-attitude in different ways and are subject to psychological biases (e.g., Chui et al., 2010, Beugelsdijk and Frijns, 2010, Frijns et al., 2013, Breuer et al., 2014). In this study we show that disappointment aversion is also affected by cultural differences. The variation in disappointment aversion due to cultural difference challenges the traditional risk-based theories and contributes a new dimension to current behavioural literature.

The remainder of this paper is organised as follows: in section 2 we propose our utility function and show how optimal asset allocations in risky assets are affected by risk and disappointment aversion. In section 3 we empirically test various analytical results developed in section 2. Section 4 focuses on discussions of the obtained results and concludes the paper.

2. Disappointment Aversion in Asset Allocation

In this section, we propose a DA utility and investigate how assets are allocated with respect to disappointment aversion. As in Koszegi and Rabin (2007), investors' utility is assumed to depend on their multi-dimensional wealth portfolios as well as reference portfolios under the assumption that utility is additively separable across different asset classes. We propose some analytical results between investment patterns, risk aversion, disappointment aversion, and expected excess returns of risky assets.

2.1 The Disappointment Aversion Utility

The DA utility is embedded in the asymmetric preference towards outcomes that do not meet a person's prior expectation (disappointment) and those that exceed the expectation (elation): it predicts that the person reacts more sensitively to disappointments than to elation. Unlike loss aversion where the reference point is predetermined exogenously, the reference point in DA is endogenously decided depending on future return paths. Therefore, it is possible that the person still suffers disappointment even for a positive outcome if the outcome is lower than his expectation (reference point).

While the asymmetric preference with respect to disappointment and elation is a core of the DA utility, consumption levels are also what people care about. For example, Koszegi and Rabin (2007) propose a utility function in which consumption utility is considered in addition to the utility from gains and losses. As argued by Barberis (2013), neglecting the absolute pleasure of consumption surely leads to biased conclusions. Therefore, our DA utility ($u(W, \mu_W)$)) consists of the typical wealth utility and the disappointment-elation utility[5]. Formally, we have:

$$u(W, \mu_w) \equiv \mu_w - \varphi[A|W - \mu_w|^v I^- - |W - \mu_w|^v (1 - I^-)] \qquad (1)$$

where μ_W is the expected wealth, W represents the end-of-period wealth, and I^- is an indicator variable that equals one when $\mathrm{W} - \mu_w < 0$ and zero otherwise. For DA, $A > 1$ is required to give extra weights on disappointments.

The first component of the DA utility is the expected end-of-period wealth μ_w which represents utility from consumption via wealth. Our DA utility increases linearly with the expected wealth, satisfying the non-satiation condition and allowing our model to be tractable (Barberis (2013). Similar to the models of Koszegi and Rabin (2007), the wealth utility (expected wealth) is differentiable and strictly increasing. The second component inside the square brackets in eq. (1), which we refer to as the disappointment-elation utility, represents utility derived from gains and losses. The disappointment-elation utility is also interpreted as a 'standard measure of risk' (Jia and Dyer, 1996). The parameter, $\varphi > 0$, thus, shows the relative importance of risk in the utility and represents the *trade-off* relationship between the wealth utility and risk: it is equivalent to a measure of risk aversion, which should decrease as wealth increases if decreasing absolute risk aversion holds. The curvature parameter, v, decides convexity or concavity of elation and disappointment with respect to gains and losses, respectively. As in many previous studies, the two curvature parameters for gains and losses

[5] For an application of DA utility in the asset allocation problem, we use the wealth level to represent future consumption which is readily observable (Ingersoll, 2012).

are set equivalent to each other (e.g., see Tversky and Kahneman (1992); Abdellaoui (2000); Barberis et al. (2001); Ang et al. (2005); Abdellaoui and Bleichrodt (2007)). Finally, expected wealth is used as the reference point in this study. As pointed out by Koszegi and Rabin (2007), expected wealth is what people use to calculate gains and losses and is determined by rational expectations held in the recent past about outcomes.

2.2 An Application to Asset Allocation Problem

We consider an asset allocation problem for multiple asset classes, which is a generalisation of the typical asset allocation problem where only two types of assets (e.g., equity and risk-free) are considered, e.g., Ang et al. (2005), Fielding and Stracca (2007) and Hwang and Satchell (2010). Suppose that the end-of-period wealth W is an outcome of a portfolio q where $\alpha_1, \alpha_2, \ldots, \alpha_n$ of wealth are invested in n risky assets, and the remaining $(1 - \sum_{i=1}^{n} \alpha_i)$ is invested in the risk-free asset. Short positions are not allowed in a typical pension fund, suggesting $0 \leq \alpha_i \leq 1$ for all *i*. Without loss of generality and for tractability, the initial wealth is assumed to be 1. Let r_i and r_f be the return of asset *i* and risk-free asset, respectively. Then, the end-of-period wealth is given by:

$$W = 1 + r_q = 1 + r_f + \sum_{i=1}^{n} \alpha_i (r_i - r_f),$$

and the expected wealth is:

$$E(W) = \mu_w = 1 + \mu_q = 1 + r_f + \sum_{i=1}^{n} \alpha_i (\mu_i - r_f),$$

where $\mu_i \equiv E(r_i)$ and gains and losses with respect to the expected wealth can be calculated by:

$$W - \mu_w = \sum_{i=1}^{n} \alpha_i (r_i - \mu_i). \tag{2}$$

For simplicity and tractability, let us assume the disappointment-elation utility (the second component of eq. (1)) to be additively separable across different asset types as in Koszegi and Rabin (2007). Then, each of the disappointment-elation utility can be specified with its own curvature and DA parameters. Previous studies show that asset allocations are not sensitive to changes in the curvature parameters (Ang et al., 2005, Abdellaoui and Bleichrodt, 2007), and thus we assume that curvature parameters are the same for different asset types. However, DA may be different for different asset types. For example, investors may be more disappointment aversive for an asset class with a high premium (Abdellaoui and Bleichrodt, 2007), which is more intuitive than assuming a DA parameter regardless of asset types.

When the disappointment-elation utility is additively separable and disappointment aversion differs for different asset types, the expected DA utility in eq. (1) appears as follows:

$$U_{DA} = \mu_w - \varphi[\sum_{i=1}^{n} A_i \alpha_i^v p_i u_i^- - \sum_{i=1}^{n} \alpha_i^v (1-p_i) u_i^+], \quad (3)$$

where A_i and α_i are the level of DA of asset i and its investment proportion, respectively, and p_i is the cumulative probability at the reference point for risky asset i. For $x_i = r_i - \mu_i$ (gains or losses), we have

$$(1-p_i)u_i^+ = \int_0^{\infty} x_i{}^v pdf(x_i)\, dx_i \text{ and } p_i u_i^- = \int_{-\infty}^{0} (-x_i)^v pdf(x_i) dx_i, \quad (4)$$

where $pdf(x_i)$ is the probability density function (pdf) of x_i.

Proposition 1 *Under the above utility setting in Eq. (3), when $v > 1$, the optimal investment proportion with respect to risky asset i is as follows:*

$$\alpha_i^* = \left(\frac{\mu_i - r_f}{\varphi v (A_i p_i u_i^- - (1-p_i) u_i^+)}\right)^{\frac{1}{v-1}}. \quad (5)$$

Proof. When investors maximise their expected DA utility, the first order condition is

$$\frac{\partial U_{DA}}{\partial \alpha_i} = (\mu_i - r_f) - \varphi v \alpha_i^{v-1} (A_i p_i u_i^- - (1-p_i) u_i^+) = 0. \quad (6)$$

From the first order condition, we have the results in eq. (5). The second partials of U_{DA} are arranged into the Hessian matrix $H(\alpha)$:

$$H(\alpha) = \begin{pmatrix} \frac{\partial^2 U_{DA}}{\partial \alpha_1^2} & \frac{\partial^2 U_{DA}}{\partial \alpha_1 \partial \alpha_2} & \cdots & \frac{\partial^2 U_{DA}}{\partial \alpha_1 \partial \alpha_n} \\ \frac{\partial^2 U_{DA}}{\partial \alpha_2 \partial \alpha_1} & \frac{\partial^2 U_{DA}}{\partial \alpha_2^2} & \cdots & \frac{\partial^2 U_{DA}}{\partial \alpha_2 \partial \alpha_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial^2 U_{DA}}{\partial \alpha_n \partial \alpha_1} & \frac{\partial^2 U_{DA}}{\partial \alpha_n \partial \alpha_2} & \cdots & \frac{\partial^2 U_{DA}}{\partial \alpha_n^2} \end{pmatrix}.$$

Note that from eq. (5), it is easy to find that the off-diagonal elements in the Hessian matrix are zero, i.e., for $i \neq j$,

$$\frac{\partial^2 U_{DA}}{\partial \alpha_i \partial \alpha_j} = \frac{\partial^2 U_{DA}}{\partial \alpha_j \partial \alpha_i} = 0. \quad (7)$$

Thus, $H(\alpha)$ becomes a diagonal matrix whose elements are:

$$\frac{\partial^2 U_{DA}}{\partial \alpha_i^2} = -\alpha_i^{v-2} \varphi v(v-1)(A_i p_i u_i^- - (1-p_i)u_i^+),$$

which becomes

$$\left.\frac{\partial^2 U_{DA}}{\partial \alpha_i^2}\right|_{\alpha_i=\alpha_i^*} = -(\mu_i - r_f)(v-1)\alpha_i^{*-1} < 0,$$

under the assumption that $v > 1$ as expected returns of risky assets are higher than riskfree asset returns and $0 < \alpha_i^* \leq 1$. Therefore the optimal investment proportion in eq. (5) satisfies the necessary and sufficient condition when $v > 1$. *QED*

The results are interesting because $v > 1$ implies that investors are risk-seeking in gains and risk averse in losses. Although simple models without the expected wealth or with the assumption of $v = 1$ are popular in the literature for their tractability, they often produce corner solutions in asset allocation problems (e.g., Ang et al. (2005) and Hwang and Satchell (2010)). As in Barberis et al. (2001), this problem can be avoided by including the expected wealth and allowing $v > 1$.

Proposition 2 *For the optimal investment proportion in Eq. (5), the semi-elasticities of* α_i^* *with respect to the optimal* A_i, *the premium* $(\mu_i - r_f)$, *and* φ *are given by*

$$\frac{\partial ln\alpha_i^*}{\partial A_i} = -\frac{p_i u_i^-}{(A_i p_i u_i^- - (1-p_i)u_i^+)\varphi v(v-1)} < 0,$$

$$\frac{\partial ln\alpha_i^*}{\partial(\mu_i - r_f)} = \frac{1}{v-1} > 0,$$

$$\frac{\partial ln\alpha_i^*}{\partial \varphi} = \frac{1}{(1-v)\varphi} < 0.$$

Proof. By taking the natural logarithm of Eq. (5) and differentiating with respect to corresponding variables, we have the results. *QED*

The proof of Proposition 1 indicates that $A_i p_i u_i^- - (1-p_i)u_i^+ > 0$, which is also shown in the proof of Proposition 3 (below) because the risk premium should be positive. Therefore, when $v > 1$, Proposition 2 shows that the semi-elasticity of the optimal investment in the risky asset decreases as DA increases. It also decreases when investors become more risk averse. On the other hand, the semi-elasticity of the optimal investment proportion in the risky asset increases with the expected excess return. The results are consistent with our intuition.

The following two propositions are for the investigation of the properties of DA.

Proposition 3 *For the expected DA utility defined in Eq. (3), when* α_i *is restricted with* $\alpha_i \epsilon [0,1]$ and ***Proposition 1*** *holds, then the lower bound of* A_i *exists at*

$$\mathrm{A}_i \geq \frac{\mu_i - r_f}{\varphi v p_i u_i^-} + \frac{(1-p_i)\mu_i^+}{p_i u_i^-}. \tag{8}$$

Proof. As we know $v > 1$ and $0 \leq \alpha_i \leq 1$, eq. (5) gives

$$0 \leq \left(\frac{(\mu_{r,i} - r_f)}{\varphi v (A_i p_i u_i^- - (1-p_i)u_i^+)}\right)^{\frac{1}{v-1}} \leq 1.$$

Since $\frac{1}{v-1} > 0$,

$$(\mu_i - r_f) < \varphi v (A_i p_i u_i^- - (1-p_i)u_i^+),$$

and the result follows. *QED*

Proposition 4 *The elasticity of* A_i *with respect to* u_i^-*:*

$$\frac{\partial ln A_i}{\partial ln u_i^-} = -1 < 0,$$

the semi-elasticity of A_i *with respect to* φ*:*

$$\frac{\partial ln A_i}{\partial \varphi} = -\frac{(\mu_i - r_f)}{\varphi(\mu_i - r_f) + (1-p_i) v \varphi^2 \alpha^{v-1} u_i^+} < 0,$$

and the semi-elasticity of A_i *with respect to the expected excess return* $(\mu_i - r_f)$*:*

$$\frac{\partial lnA_i}{\partial(\mu_i - r_f)} = \frac{1}{(\mu_i - r_f) + \varphi v \alpha^{v-1}(1 - p_i)u_i^+} > 0.$$

Proof. For a given optimal investment proportion (α_i^*), eq. (5) can be written as

$$A_i = \frac{(\mu_i - r_f)}{\varphi v p_i u_i^-}(\alpha_i^*)^{1-v} + \frac{(1-p_i)u_i^+}{p_i u_i^-}. \tag{9}$$

By differentiating the eq. (9) with respect to lnu_i^- , φ *and* $(\mu_i - r_f)$ we have the results.

QED

The propositions suggest several important implications of the effects of market conditions on the level of DA. When the DA parameter A_i changes in proportion to its lower bound, it increases when the expected excess return $\mu_i - r_f$ increases; when the ratio of elation to disappointment increases (the ratio of $(1 - p_i)u_i^+$ with respect to $p_i u_i^-$ increases) or when φ decreases. The results indicate that investors become more disappointment averse as the expected return in excess of risk-free rate increases in bear markets when current prices are low and marginal utility is high.

It is interesting to find in Proposition 4 that investors become more disappointment averse as losses are expected to decrease. The results are comparable with the well-known house money effects whereby investors tend to be more risk aversive after losses than after gains. However, our results differ from the house money effects because they depict the relationship between DA and *ex-ante* disappointment.

We also find a negative relationship between risk aversion and disappointment aversion although both risk aversion and disappointment aversion reduce investment in risky assets (Proposition 2). When the disappointment-elation utility is interpreted as risk (Jia and Dyer, 1996), investors would become less risk averse, i.e., a smaller value of φ, as their wealth increases, if risk aversion is expected to decrease with wealth (decreasing absolute risk aversion). This means that wealthy investors suffer higher disutility from disappointing outcomes despite their tendency of less risk aversion. These results are consistent with the experimental findings of Abdellaoui and Bleichrodt (2007): people are particularly frustrated for suffering losses when they have a very good chance to win. If risk aversion decreases with wealth, i.e., decreasing absolute risk aversion hold, wealthier investors may feel more disappointment for losses.

2.3. Disappointment Aversion and Individualism

Since the cross-cultural empirical work by Hofstede (2001), a growing number of studies have found how cultural character affects asset pricing and financial risk-taking behaviours. For example, by conducting a cross-country investigation on foreign asset allocations of 26 countries, Beugelsdijk and Frijns (2010) demonstrate that more individualistic countries are more aggressive in foreign investment; Breuer et al. (2014) examine the risk-taking willingness from a total of 449 economic students via a specifically designed survey, and find that individualism increases financial risk-taking. Another set of papers, including Markus and Kitayama (1991), Van Den Steen (2004) and Chui et al. (2010), suggests that individualism can lead to overconfidence, resulting in excessive over-optimism towards future returns. These empirical studies again support a positive relationship between individualism and risk-taking activities.

The risk-taking activities by individualistic investors may be associated with DA. According to Barone-Adesi, Mancini, and Shefrin (2014), risk-return relationship perceived by investors is negatively driven by overconfidence. Our results in Propositions 3 and 4 show that DA increases when risk becomes less important. Therefore, if the risk-taking tendency increases with overconfidence as in the previous literature, our results indicate that overconfidence represented by individualism may lead to more disappointment when losses occur. Disappointment increases with individualism.

2.4 Disappointment Aversion and Subjective Weighting in Probability

It is well-documented that people distort probabilities by disproportionately directing their attention to outcomes (Savage, 1954). According to Tversky and Kahneman (1992), unlikely extreme outcomes are overweighed while highly possible events are underweighted. Quiggin

(1995) introduces a rank-dependent utility model where weights depend on the true probability of an outcome as well as its ranking relative to other outcomes. The combination of rank and reference point dependent utility gives the birth to cumulative prospect theory (CPT), which utilizes a transformed probability weighting function to account for the redistribution of decision weights (Tversky and Kahneman, 1992).

In order to simulate investors' subjective weights, suppose that we use Prelec (1998) single parameter version of the weighting function in the DA utility in eq. (1):

$$w(p) = exp\left[-(-\,ln(p))^{\delta}\right], \tag{11}$$

where p is the *cumulative* probability of any possible outcome. With δ $(0 < \delta < 1)$, the weighting function allocates more (fewer) weights to unlikely (likely) outcomes[6].

Although the rationale behind the subjective weighting is different from risk attitude toward gains and losses, they are closely connected. To see this, assume a transformed density function for gains and losses, $\pi^{+}(x)$ and $\pi^{-}(x)$, respectively, as follows:

$$\pi^{+}(x) = w'(1-p)pdf(x), \text{ and } \pi^{-}(x) = w'(p)pdf(x),$$

where $x = W - \mu_w$ represents gains or losses, and $w'(1-p)$ and $w'(p)$ are the derivatives of Prelec's (1998) weighting functions at the cumulative probabilities of $1-p$ and p, respectively. When the subjective weighting is applied to the disappointment-elation utility, the expected DA utility can be presented as:

$$U_{DA} = E[u(W, \mu_w)] = \mu_w - \varphi[Apu^{-} - (1-p)u^{+}],$$

where

$$(1-p)u^{+} = \int_0^{\infty} x^{v}\pi^{+}(x)\,dx \text{ and } pu^{-} = \int_{-\infty}^{0}(-x)^{v}\pi^{-}(x)dx.$$

The subjective weighting function is designed to replicate the probability distortion of outcomes, but alters the degree of risk attitude towards gains and losses with respect to the objective probability: i.e., $x^{v}[w'(p)pdf(x)] = [x^{v}w'(p)]pdf(x)$. In other words, for given

[6] A number of other weighting functions (e.g., Prelec, 1998, Abdellaoui, 2000, Luce et al., 2000, Bruhin et al., 2010) have been proposed, but they are quite similar to the weighting function of Prelec (1998). See Gonzalez and Wu (1999) and Davies and Satchell (2004) for example.

objective probability, when combined with outcomes, the subjective weighting function creates concavity (risk-aversion) for losses while it creates convexity (risk-seeking) for gains. Even though risk-aversion for gains and risk-loving for losses are assumed for a given subjective weighting function, the net effects of the risk attitude and the subjective weighting function become unclear for a given objective probability.

Because of this lack of clarity between risk attitude and subjective weighting, it is difficult to estimate these two parameters simultaneously, i.e., the parameter of the weighting function (δ) and the curvature parameter (v). Moreover, as explained later, the DA parameter, A, is also closely associated with these two parameters. In order to minimize the difficulties in the estimation but keep the original rationale behind the DA utility and subjective weighting, we estimate DA parameter for given subjective weighting and curvature. More specifically, we use $\delta = 0.74$ for the subjective weighting as in Gonzalez and Wu (1999), and Hofstede's (2001) Uncertainty Avoidance index for risk attitude, the details of which will be discussed later.

3. Empirical Tests

We estimate disappointment aversion and test various analytical results in the previous section using asset allocations in pension funds of 35 OECD countries. Asset allocation in pension funds of a country is not free from its cultural traits, allowing us to investigate the relationship between disappointment aversion and individualism.

3.1 Asset Allocations and Returns across Countries

We have collected asset allocations of pension funds across 35 OECD countries for the period from 2003 to 2012. The number of countries is restricted by the data availability of pension funds, individualism, and returns of the asset classes we consider in this study. Four types of asset classes, i.e., *risk-free asset*, *stocks*, *bonds*, and *others*, are investigated with their 120 monthly returns for the sample period.

Returns of the four asset classes are obtained from the DataStream. Equity returns are calculated from the composite index of the major stock exchange in each country. The summary statistics of annualised log-returns of four asset classes are reported in Table I. The average annual equity return (standard deviation, SD) of the 35 countries is 9.38% (21.04%).

Bond returns are calculated with equal weight on the total returns of government and corporate bonds. *Ten-year benchmark government bonds* are used as government bonds[7]. The quality of corporate bond data is not as good as that of the government bond data, in particular, among emerging markets. To mitigate this defect, we consider three international indexes: FTSE *Euro Corporate Bond Index*[8] for those developed markets outside the Eurozone (Denmark, Hong Kong, Iceland, Japan and Norway); *IBoxx Euro Corp. Bond Index*[9] for countries within the Eurozone (Finland, France, Germany, Greece, Italy, Luxembourg, the Netherland, Portugal, Slovenia and Spain); and finally, *BofA-Merrill Lynch Emerging Markets Corporate Plus Index*[10] for emerging markets (Mexico, Poland, Pakistan, South Africa, Thailand and Turkey). For the remaining countries (Australia, Canada, Chile, Israel, Korea, the United Kingdom and the United States), country-specific indices can be found. The average annual bond return (SD) for all countries is 6.29% (4.75%).

In addition to stocks and bonds, significant proportions of pension funds are invested in other investment vehicles which include, but are not limited to, loans, land and buildings, unallocated insurance contracts, hedge funds, private equity funds, structured products and other mutual funds. Such a wide variety poses enormous difficulties in tracking the performance of each asset class in each country. Moreover, details of investment proportions in these other investment vehicles are not known. Therefore, we construct an index using *MSCI*

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[7] The data of five-year government bonds is non-applicable in Turkey, hence, a similar bond price index with a 5-year maturity is applied.

[8] The FTSE Euro Corporate Bond Index includes Euro-denominated issues from global corporate entities with all maturities from one-three years to more than 15 years. Each bond is classified under the Industry Classification Benchmark (ICB). The index constituents are investment grade debt with a minimum rating of BBB-.

[9] IBoxx Euro Corp. Bond Index is prepared and published by Market, which is an ideal performance benchmark for fixed income research, asset allocation and performance evaluation. This index includes overall, rating and maturity indexes, with a split into financial and non-financial bonds, and rating and maturity sub0indenex for each.

[10] The BofA-Merrill Lynch Emerging Markets Corporate Plus Index tracks the performance of US dollar- (USD) and Euro-denominated emerging markets' non-sovereign debt publicly issued within the major domestic and Eurobond markets. The index includes corporate and quasi-government debt of qualifying countries, but excludes sovereign and supranational debt. Other types of securities acceptable for inclusion in this index are: original-issue zero coupon bonds.

World Real Estate[11], *Dow Johns Brookfield GLB INFRA*[12], *S&P Listed Private Equity*[13] and *HFRI Fund of Funds Composite*[14], in US dollars, for real estates, infrastructure, hedge funds, and private equities, respectively. These four return series are equally weighted to create the ‘others’ asset class, which is then converted to returns for each country using its exchange rate with respect to US dollar. The average annualised return (SD) for other investments is 8.44% (24.58%).

Finally, for the risk-free rates, we use 30-day T-bill rates. If T-bill returns are not available, 30-day interbank rates or repo-rates are used. Countries within the Eurozone share an identical interbank rate. Notably, extremely high short-term interest rates are observed in a few countries due to their particular financial policies or rapid capital growth. For example, the average risk-free rates in Brazil, Iceland, Mexico, South Africa and Turkey are all over 8%. In some cases, high risk-free rates produce negative excess returns for some countries, rendering abnormal DA that will be discussed later.

The investment weights (α_i^*) in each asset type are collected from OECD Global Pension Statistics (GPS)[15], where national asset allocations of pension funds are maintained and updated annually. Table II reports the average weights on asset classes for each country during our sampling period. On average, 45.8% of pension funds is invested in bonds, followed by others

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[11] The MSCI World Real Estate Price Index is a free-float-adjusted market capitalization index that consists of large and mid-cap equity REITs across 23 developed markets, which generate a majority of their revenue and income from real estate rental and leasing operations. With 101 constituents, it represents about 85% of the REIT universe in each country and all securities are classified in the REIT sector according to the Global Industry Classification Standard.

[12] Dow Johns Brookfield GLB INFRA is maintained collaboratively by S&P Dow Jones Indices and Brookfield Asset Management. It aims to measure the stock performance of companies worldwide whose primary business is the ownership and operation of (rather than service of) infrastructure assets. To be included in the indices, a company must have more than 70% of estimated cash flows (based on publicly available information) derived from eight infrastructure sectors: airports, toll roads, ports, communications, electricity transmission & distribution, oil & gas storage & transportation, water and diversified.

[13] The S&P Listed Private Equity Index comprises the leading listed private equity companies that meet specific size, liquidity, exposure, and activity requirements. The index is designed to provide tradable exposure to the leading publicly listed companies that are active in the private equity space.

[14] The HFRI Fund of Funds Composite is a series of benchmarks designed to reflect hedge fund industry performance by constructing equally weighted composites of constituent funds, as reported by the hedge fund managers listed within the HFR Database. The HFRI range in breadth from the industry-level view of the HFRI Fund Weighted Composite Index, which encompasses over 2000 funds, to the increasingly specific level of the sub-strategy classifications.

[15] This dataset includes pension funds statistics with OECD classifications by type of pension plans and by type of pension funds. All types of plans are included (occupational and personal, mandatory and voluntary). We refer to 2005 as the starting year for our study, since the data availability before this year rapidly worsens.

(25.1%), and equities (20.6%). Before the financial crisis of 2008, the proportion of other investments decreased from 32.09% (2005) to 21.24% (2008) while the equity weight increased from 16.10% (2005) to 21.59% (2008). However, the weight in other investments rebounded to 28.61% whereas the equity exposure is still below the crisis-level at 21.52%. Proportions with respect to bonds and risk-free assets are relatively less sensitive to the crisis.

3.2. Individualism and Risk Aversion

In addition to the asset allocation and return data, we use risk-aversion and individualism of each country. As reported in Ang et al. (2005) and Xie et al. (2014) and also discussed in the previous section, optimal asset allocations are jointly influenced by risk aversion and DA, and thus estimating the DA parameter (A_i) and the two risk related parameters (φ and v) at the same time is not a feasible option. In this study, we estimate the DA parameter for given (exogenous) risk aversion.

We refer to Hofstede's *Uncertainty Avoidance (unav)*[16] as a measure of risk aversion in each country. Although Hofstede (2001) does not directly link the uncertainty avoidance to the risk perception, several studies have accumulated evidence about how it affects risk preferences. For example, Kwok and Tadesse (2006) show that countries with stronger uncertainty avoidance are characterized by a bank-based financial system (relatively risk-averse). In contrast, countries with milder uncertainty avoidance are characterized by a market-based financial system (relatively risk-seeking). Chui and Kwok (2008) suggest that uncertainty-avoiding nations tend to spend more money on life insurance. Frijns et al. (2013), empirically, show that firms located in countries with lower risk-tolerance (measured by uncertainty avoidance scores), require higher premiums on takeovers. Taking together the above findings suggests a positive relationship between uncertainty-avoiding and risk-averse.

The two risk-aversion related parameters (φ, v) are calculated using the following conversion:

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[16] The uncertainty avoidance reflects the extent to which people feel either uncomfortable or comfortable in unstructured situations. Unstructured situations may be novel, unknown, surprising, and different from usual.

$$\varphi = \frac{unav}{C_\varphi},$$

$$v = 1 + \frac{C_v}{unav},$$

where the two parameters are initially set to $C_\varphi = 50$ and $C_v = 10$. As *unav* (φ) increases, risk becomes important in the DA utility, indicating a risk-averse attitude. Similarly, countries with higher *unav'*s show fewer risk-seeking patterns, i.e., lower v's, than those with lower values of *unav*. Table III reports all countries' uncertainty avoidance scores along with the values of of (φ, v) with $C_\varphi = 50$ and $C_v = 10$, which range as follows: $0.46 < \varphi < 2.24$ and $1.09 < v < 1.43$. Other sets of C_φ and C_v are tested later to ensure the robustness of our results.

We use Hofstede's Individualism Index (*Indv*) to investigate if individualism has a relationship with DA.[17] The 35 countries are further divided into three groups: the *Collectivism* group includes countries with individualism indexes less than 40; individualism scores between 40 and 65 are arranged into *Median*; the remaining countries with individualism indexes over 65 are labelled to *Individualism*. All countries along with their individualism indices are reported in Table IV. As discussed in previous studies, the *Indv-index* is regionally orientated: most of the developed countries in Western Europe and North America fall into the *Individualism* group while the *Collectivism* group consists of many emerging markets from Asia, Eastern Europe, and South America. The *Median* group, on the other hand, stands in the middle of a mixture, including both developed and emerging countries from Asia, Europe and Africa.

[17] The index is based on a psychological survey of 88,000 IBM worldwide employees, and widely used in the literature as a measure of the degree to which individuals are integrated into groups. A higher side of Indv indicates a more individualistic society, where individuals are expected to take care of only themselves and their immediate families. Its opposite, lower Indv scores represent a collective society in which individuals can expect their relatives or members of a particular in-group to look after them in exchange for unquestioning loyalty. A society's position on this dimension is reflected in whether people's self-image is defined in terms of "I" or "we." Hofstede's Indv are calculated from six work-goal questions out of the total 14 questions about candidates' work and private life.

3.3. Cross-Country Disappointment Aversion

We estimate the level of disappointment aversion for each country using bootstrapping method for given asset allocations in Table II and the subjective probability weighting parameter of $\delta = 0.74$. For each country, 120 monthly returns are randomly sampled with replacement from the historical 120 monthly returns from 2003 to 2012. Under the assumption that asset returns follow the normal distribution, a value of DA is calculated for the average investment weight during the sample period. We repeat this process 1,000 times to obtain 1,000 estimates of DA for each asset class and country. Panels A, B and C in Table V report the average values of the 1,000 DA estimates for stocks, bonds and other investments, respectively. In addition, using the same bootstrapping method, we also calculate and report the minimal level of DA (A^{-}) defined in eq. (8).

Having a glance at these figures quickly reveals some striking results. First, it is evident that higher DA is observed for equities than for bonds and other investments: global average values of DA are $\bar{A}_s = 2.33\ (0.31)$, $\bar{A}_{oi} = 1.85\ (0.20)$, and $\bar{A}_b = 1.59$(0.14), where the subscript s, oi, and b represents stocks, bonds, and other investment respectively, and the numbers in the brackets represent standard errors. This is consistent with the results in Proposition 2 where DA is shown to increase with the expected excess return. The large difference between the average DAs on stocks and bonds (2.33 vs. 1.59) helps to understand the potential sources of the equity premiums puzzle (Mehra and Prescott, 1985). That is, the fear of being disappointed makes investors require higher returns for stocks than for bonds, and thus the equity premium can be explained by higher disappointment aversion.

By dividing 35 countries into three sub-groups depending on Hofstede's Individualism Index, Table V also provides a preliminary view of how individualism is associated with DA. It appears that countries in the Individualism group tend to exhibit higher DAs than those in the Median and Collectivism groups regardless of any asset type. In the following sections, we formally investigate the relationship between DA and individualism.

The levels of disappointment aversion in the US, i.e., 2.24 for equities, 2.54 for bonds, and 2.48 for others, appear slightly larger than the one suggested by Ang et al. (2005), where A is supposed to be smaller than 1.67. Although a direct comparison is not possible due to the difference in the models, one of the main reasons for the higher levels of disappointment aversion in our study comes from the inclusion of the wealth utility: by including positive expected excess returns (μ_w), disappointment aversion levels increase because investors can now sacrifice a part of consumptions in hoping to gain returns from risky assets. In other words, the trade-off relationship between consumption levels and elation-disappointment utility should be acknowledged (Koszegi and Rabin, 2007, Barberis, 2013).

Abnormal levels of DA that contradict the theoretical instinct appear in all asset classes. For example, extremely low levels of DA are more frequent in emerging markets as a result of high risk-free rates due to rapid growth or monetary policies. In some countries associated with negative premiums ($\mu_i - r_f < 0$), investors appear to be "disappointment seeking". On the other hand, some of the developed markets exhibit very high levels of DA, such as Denmark, Sweden and Hong Kong. These countries are somehow much less risk-averse according to the *unav* index, suggesting a negative relationship between risk aversion and disappointment aversion in Proposition 4 (see also the results in the robustness test).

3.4. Individualism vs. Disappointment Aversion

To further investigate the relationship between individualism and DA, we cross-sectionally regress disappointment aversion on the *level of individualism* (Individualism Index, INDV) in the presence of various control variables. If not controlled appropriately, our results are likely to be affected by the development of financial markets or economy because most individualistic countries are developed western countries.

As in the studies of cross-country analysis, e.g., Chui et al. (2010), the variables are the *scale of financial resources* (credit to private sector, as the % of GDP, CGDP); *government's debt solvency* or *how aggressive the government's financial policy* (based on the debt to GDP ratio, DGDP); the *economic openness* (overall economic freedom index published by the heritage foundation, EFE); the *aggregate wealthy level* (GDP in trillions, scaled down by dividing 1000, GDP)*; the individual wealth level* (GDP per Capita, also scaled down by dividing 1000, GDPER); the *relative size of stock capitalization* (ratio of market capitalization to GDP, MGDP); the *political stability* (issued by the World Bank to reflect perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, PSI) and *stability of the aggregate economy* (volatility of foreign exchange rate over the sample period, VEX). The variables such as CGDP, DGDP, and MGDP represent the development of financial markets, whereas EFE and VEX proxy that of economy. We use GDPER as a proxy for wealth level for the country.

We conduct the following cross-sectional regression for each year and then report time series average coefficients:

$$Ln(A_k) = \beta_0 + \beta_1 CGDP_{k.t} + \beta_2 DGDP_{k,t} + \beta_3 EFE_{k,t} + \beta_4 GDP_{k,t} + \beta_5 GDPER_{k,t} + \beta_6 INDV_k + +\beta_7 MGDP_{k,t} + \beta_8 PSI_{k,t} + \beta_9 VEX_{k,t} + \varepsilon_k.$$

The log values of A_k (country *k*'s disappointment aversion) are used to minimise the effects of outliers in DA. In the presence of these variables, a positive coefficient on INDV or GDPER indicates that disappointment aversion increase with individualism or wealth.

Table VI reports the results. First of all, we find strong evidence to support our hypothesis that DA increases with individualism for all asset classes. The coefficients of INDV are all positive and are significant for equities and bonds at the 5% level. Second, DA of equities appears to increase for wealthier countries (higher GDP per capita): the coefficient on GDPER (as a proxy for wealth) is positive for all three asset classes, and are significant for equities and others. Since the rich are less risk averse, this result indicates that risk aversion has negative relationship with DA, confirming our earlier result in Proposition 4.

As expected, DA increases in countries with more developed financial markets, i.e., greater credit scale (CGDP) or higher market openness (EFE). Some other variables show mixed results. For example, political risk (lower PSI) increases DA in equities. Conversely, this relationship is reversed in other investments. In addition, we find that DGDP is not relevant in explaining DA in bonds and other investments as well.

3.5. Robustness Tests

Our results may be affected by the risk related parameters (φ, v) or the subjective weighting parameter, which we use from previous studies such as Hofstede (2001) and Gonzalez and Wu (1999). We test if our results are robust to different risk related parameters and various subjective weighting parameters.

Three different levels of φ are tested by setting C_φ=25, 50 and 100. When C_φ=25, the risk-return relationship parameter φ ranges from 0.92 to 4.48 for the 35 sampled countries while it drops down to the range from 0.2 to 1.1 when C_φ=100. Therefore, a smaller C_φ indicates that risk is more highly priced than a large C_φ suggests. Similarly, by setting C_v=1, 10, and 20 we can test the impact of different curvature parameters on the estimates of DA. A small value of C_v suggests that investors are nearly risk-neutral, i.e., v is close to one, whereas a large value of C_v increases the level of curvature for gains and losses. In addition to the above risk parameters, we also investigate the effects of subjective weighting parameter δ on the estimates of DA by changing the value of δ from 0.5 to 1. When δ=1, there is no subjective distortion in probability whereas a small value of δ indicates a significant bias in the probability density function.

A total number of nine cases by combining C_φ and C_v are reported in Table VII for equities, bonds and others. As expected by Propositions 3 and 4, disappointment aversion for equities increases as φ decreases (C_φ increases). When investors are less risk averse, they become more disappointment averse. The results are in line with what we have found in this study: as wealth increases, investors become less risk averse (because of the decreasing absolute risk aversion), but their disappointment aversion increases.

Our analytical results, however, do not clearly dictate the relationship between the curvature parameter v and disappointment aversion because of their nonlinear relationship. The empirical results in Panel A.1, B.1 and C.1 of Table VII show that when curvature increases, disappointment aversion also increases. Therefore, when investors are less risk averse (i.e., both C_φ and C_v are large), they become disappointment averse.

We conduct a series of regressions for different values of C_φ and C_v to review whether the positive relationship between DA and individualism holds. Selected results are reported in Panels A.2, B.2 and C.2 of Table VII for equities, bonds, and others, respectively. In most cases the coefficient of individualism is significantly greater than zero at the 5% level.

The estimates of disappointment aversion with respect to the different values of subjective probability weighting parameter are reported in Table VIII. In general when subjective weighting becomes severe, i.e., δ decreases, disappointment aversion increases. When extremes events are over-weighted, the fear from disaster-like outcomes increases, and so does disappointment aversion. The variation of statistical significance between DA and individualism is, in fact, similar to the variation from different (C_φ, C_v). In general, a positive relationship between DA and individualism is supported quite well for all values of δ from 0.5 to 1.

However, the robustness of such relationships is sensitive to asset types. For example, in the case of equities, we observe that the effect of individualism becomes more pronounced with the increase in probability distortion. On the contrary, in the case of bonds, individualism tends to be more influential on DA for less probability weighting (δ closes to 1). Finally, the situation for other investments sits in the middle, where the most effective area to enhance the connection between DA and individualism is concentrated around δ=0.7. Overall DA and its relationship with wealth and individualism are more noticeable in riskier assets such as equities whose expected returns are higher than the other asset classes.

4. Discussions and Conclusion

As suggested by Koszegi and Rabin (2007) and Barberis (2013), utility in this study is a combination of wealth (consumption) utility that has been widely used in the conventional economics and finance and DA utility that depends on gains and losses calculated with respect to the expected wealth. Under the assumption that DA utility is additively separable, we demonstrate how the optimal investment proportions in risky assets are affected by disappointment aversion, risk aversion, and expected excess returns.

Building upon an asset allocation problem, we show that DA has a negative relationship with risk aversion. It is well known that risk aversion decreases as wealth increases. Therefore, what we find in this study is that, when wealth increases, risk aversion decreases but DA increases.

We also show that DA increases with individualism, suggesting that overconfident investors would suffer more disutility when outcome falls below the expectation. As investors become less risk averse and more confident as wealth increases, they tend to avoid disappointments more. This means that they require a higher premium for an asset to compensate disappointment if losses from the asset occur.

The fact that highly individualistic cultures showing stronger DA is also interesting to the behavioural perspective. As it indicates that DA might help reduce overconfidence; if investors feel overconfident and suddenly become disappointed, such cognitive dissonance may force investors to cool down and re-evaluate their situation.

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Table I
Summary Statistics of Asset Returns

Equity returns are measured by the composite index of the major stock exchange in each country. Monthly price levels are obtained via DataStream and then converted into log-return. Bond returns are calculated with equal weight on the total returns of government and corporate bonds. Performance of other investments consists of four major assets on equal weights: real estates, infrastructure, hedge funds, and private equities. Four global indexes are utilized as the return proxies, which includes MSCI World Real Estate, Dow Johns Brookfield GLB INFRA, S&P Listed Private Equity and HFRI Fund of Funds Composite. Finally, risk-free rates equal to 30-day T-bill rates. If T-bill returns are not available, 30-day interbank rates or repo-rates are applied instead.

Country	Equity	Equity S.D	Bond	Bond S.D	Others	Others S.D	Risk-Free Rate
Australia	8.58%	14.99%	4.90%	6.77%	3.71%	11.78%	5.13%
Austria	8.09%	23.23%	4.69%	6.24%	6.54%	14.19%	2.34%
Belgium	8.53%	19.30%	5.55%	3.85%	6.54%	14.19%	2.34%
Brazil	18.16%	21.17%	5.40%	2.08%	9.95%	23.26%	13.76%
Canada	9.05%	16.04%	10.71%	13.01%	4.70%	12.58%	2.14%
Chile	15.21%	14.73%	6.52%	1.98%	4.78%	14.94%	0.30%
Czech Republic	15.61%	20.16%	11.31%	11.72%	3.85%	15.12%	2.18%
Denmark	10.68%	19.01%	4.95%	8.91%	6.57%	14.19%	2.64%
Finland	3.45%	23.49%	5.56%	6.02%	6.54%	14.19%	2.34%
France	6.67%	17.70%	5.27%	3.55%	6.54%	14.19%	2.34%
Germany	9.22%	18.98%	5.36%	3.54%	6.54%	14.19%	2.34%
Greece	-4.02%	30.28%	0.75%	15.26%	6.54%	14.19%	2.34%
Hong Kong	12.75%	22.55%	3.79%	2.04%	7.67%	16.76%	1.69%
Hungary	7.30%	24.72%	6.71%	6.76%	7.58%	14.25%	7.68%
Iceland	-7.21%	47.70%	5.95%	8.85%	13.61%	17.85%	8.92%
Israel	9.50%	17.79%	11.26%	7.51%	5.73%	14.43%	4.16%
Italy	2.25%	19.32%	5.88%	5.00%	6.54%	14.19%	2.34%
Japan	2.01%	18.49%	3.30%	2.74%	5.05%	20.24%	0.16%
Korea	13.20%	21.67%	3.17%	4.55%	6.41%	11.92%	3.59%
Luxembourg	12.61%	14.00%	6.28%	2.73%	6.54%	14.19%	2.34%
Mexico	21.12%	17.07%	6.17%	2.02%	9.19%	11.28%	6.39%
Netherlands	4.51%	20.75%	8.46%	7.65%	6.54%	14.19%	2.34%
Norway	13.53%	24.07%	5.83%	3.52%	5.43%	13.07%	3.55%
Pakistan	17.42%	28.92%	7.65%	5.49%	13.56%	16.15%	7.89%
Poland	10.22%	22.96%	10.08%	5.54%	5.06%	13.03%	5.04%
Portugal	4.08%	18.09%	5.14%	10.88%	6.54%	14.19%	2.34%
Slovenia	-0.10%	19.72%	4.68%	2.00%	6.54%	14.19%	2.34%
South Africa	16.77%	17.17%	7.58%	4.41%	10.76%	14.74%	8.21%
Spain	6.82%	19.42%	6.07%	9.95%	6.54%	14.19%	2.34%
Sweden	11.93%	18.76%	5.34%	3.62%	6.02%	12.04%	2.28%
Switzerland	6.87%	14.14%	4.03%	6.55%	3.82%	16.63%	0.79%

Table I-Continued

Country	Equity	Equity S.D	Bond	Bond S.D	Others	Others S.D	Risk-Free Rate
Thailand	17.55%	25.65%	2.67%	5.17%	4.77%	15.74%	2.62%
Turkey	20.20%	31.28%	8.79%	5.95%	9.91%	12.89%	8.23%
UK	8.36%	15.47%	7.71%	8.87%	8.34%	14.28%	3.37%
US	7.36%	17.54%	6.21%	4.91%	7.69%	16.81%	1.91%
Global Average	9.38%	21.04%	6.11%	5.99%	6.93%	14.69%	3.74%

Table II

Asset Allocations of Pension Funds

The asset allocations of pension funds in 35 markets are obtained from OECD database. To save the space, only *Arithmetic means* are reported from a sampling period 2005-2012. The "Other Investments" category includes loans, land and buildings, unallocated insurance contracts, hedge funds, private equity funds, structured products and other mutual funds.

	Equities	*Bonds*	*Cash & Deposits*	*Other Investments*
Australia	25.1695	9.4744	10.7135	54.6426
Austria	30.5283	50.8330	9.0629	9.5758
Belgium	21.6824	25.6172	4.8760	47.8244
Brazil (1)	16.4963	22.3657	0.0537	61.0843
Canada	29.8501	30.9014	3.4008	35.8477
Chile	26.0658	48.2332	0.3491	25.3519
Czech Republic	3.6608	80.9515	8.3485	7.0392
Denmark	19.6888	60.6073	0.5545	19.1494
Finland	41.0950	39.5365	1.5008	17.8677
France (2)	34.6792	47.3857	7.6334	10.3017
Germany	11.2405	35.7408	2.8552	50.1635
Greece (3)	4.3775	50.3979	39.7240	5.5006
Hong Kong	51.2767	26.8288	13.7690	8.1254
Hungary	9.3221	64.0913	2.5127	24.0740
Iceland	24.5674	51.3586	6.0185	18.0555
Israel	5.0994	81.4505	4.7359	8.7142
Italy	11.2408	43.0687	5.9309	39.7595
Japan (4)	12.6493	40.0604	5.8457	41.4446
Korea	0.8013	39.2257	34.7810	25.1920
Luxembourg	0.6408	33.2713	9.9825	56.1058
Mexico	14.7915	82.4656	0.2885	2.4544
Netherlands	34.5430	39.8697	3.1639	22.4234
Norway	28.5919	57.2814	3.5984	10.5283
Pakistan (5)	27.5542	43.7729	26.2138	2.4591
Poland	31.7549	63.1811	4.0786	0.9854
Portugal	21.4362	44.9692	9.4376	24.1570
Slovenia	3.3607	62.8745	19.9857	13.7791
South Africa (6)	21.2638	6.7850	5.7969	66.1543
Spain	13.8413	58.8207	13.5239	13.8141
Sweden	22.3225	59.1517	2.6540	15.8718
Switzerland	15.5877	25.7057	7.8037	50.9028
Thailand	11.4160	72.1295	12.9544	3.5000
Turkey (7)	14.1895	58.2168	12.2605	15.3333
UK	35.3215	24.4189	2.7794	37.4803
US	45.9907	21.3737	1.3019	31.3337
Average	20.6314	45.7833	8.5283	25.0571

Note: (1) Asset allocations of the year 2005 and 2012 in Brazil are not available, the sampling period for Brazil is reduced to 2006-2011.

(2) Since OECD does not have any records for France, mean asset allocations for France are replaced by another similar indicator: “Asset Allocations of Institutional Investors assets," the sampling period covers from 2008 to 2012.

(3) Asset allocations are not available in Greece for the year 2005 and 2006, data for these two years refer to “Asset Allocations of Institutional Investors assets."

(4) Asset allocations are not available in Japan for the year 2005 and 2006, data for these two years refer to “Asset Allocations of Institutional Investors assets."

(5) Asset allocations of the year 2005 and 2006 are not available. Therefore the sampling period for Pakistan is reduced to 2007-2012.

(6) Asset allocations of the year 2012 are not available. Therefore the sampling period for South Africa is reduced to 2005-2011.

(7) Asset allocations are not available in Turkey for the year 2007, another GPS indicator "Personal Pension Fund Assets" is applied as a replacement.

Table III

Hofstede's Uncertainty Avoidance Index around the World

Table III lists the Hofstede's un*certainty avoidance index* (*unav*) for 35 countries around the world. Columns on the right refer to the applying risk aversion parameter φ and *v.*

	UNA	Φ	V
Australia	51	1.0200	1.1961
Austria	70	1.4000	1.1429
Belgium	94	1.8800	1.1064
Brazil	76	1.5200	1.1316
Canada	48	0.9600	1.2083
Chile	86	1.7200	1.1163
Czech Republic	74	1.4800	1.1351
Denmark	23	0.4600	1.4348
Finland	59	1.1800	1.1695
France	86	1.7200	1.1163
Germany	65	1.3000	1.1538
Greece	112	2.2400	1.0893
Hong Kong	29	0.5800	1.3448
Hungary	82	1.6400	1.1220
Iceland	50	1.0000	1.2000
Israel	81	1.6200	1.1235
Italy	75	1.5000	1.1333
Japan	92	1.8400	1.1087
Korea	85	1.7000	1.1176
Luxembourg	70	1.4000	1.1429
Mexico	82	1.6400	1.1220
Netherlands	53	1.0600	1.1887
Norway	50	1.0000	1.2000
Pakistan	70	1.4000	1.1429
Poland	93	1.8600	1.1075
Portugal	104	2.0800	1.0962
Slovenia	88	1.7600	1.1136
South Africa	49	0.9800	1.2041
Spain	86	1.7200	1.1163
Sweden	29	0.5800	1.3448
Switzerland	58	1.1600	1.1724
Thailand	64	1.2800	1.1563
Turkey	85	1.7000	1.1176
UK	35	0.7000	1.2857
US	46	0.9200	1.2174

Table IV

Hofstede's Individualism Index around the World

Table IV lists the Hofstede's individualism for 35 countries around the world. The individualism index is the degree to which individuals are integrated into groups. On the individualist side (higher scores), people are supposed to fit a society where individual opinion are empathized; on the collectivist side (lower scores), everyone is expected to act as a team and look after each other.

Collectivism		**Median**		**Individualism**	
Country	***Indv***	***Country***	***Indv***	***Country***	***Indv***
Pakistan	14	Japan	46	Germany	67
Korea	18	Spain	51	Switzerland	68
Thailand	20	Israel	54	Norway	69
Chile	23	Austria	55	France	71
Hong Kong	25	Hungary	55	Sweden	71
Portugal	27	Czech Republic	58	Denmark	74
Slovenia	27	Iceland	60	Belgium	75
Mexico	30	Luxembourg	60	Italy	76
Greece	35	Poland	60	Canada	80
Turkey	37	Finland	63	Netherlands	80
Brazil	38	South Africa	65	UK	89
				Australia	90
				US	91

Table V

Disappointment Aversion with respect to Equities, Panel A

Table V contains the average DA for each country with respect to equities, bonds and other investment, respectively. DA listed below is calculated via bootstrapping the asset returns (sampling 120 monthly returns randomly out of the actual observations from 2003 to 2012 and then repeat 1000 times). To ease the comparison, in each single figure, we divide DA into the three different groups of *Individualism*, *Median* and *Collectivism*.

Collectivism Group	***A***	*Std.Error*	A^{-}	*Std.Error*
Panel A.1				
Brazil	1.5709	0.0291	1.4504	0.0230
Chile	2.6806	0.0161	2.4374	0.0137
Greece	0.4420	0.0262	0.5780	0.0198
Hong Kong	5.5438	0.0954	4.6090	0.0758
Korea	2.5646	0.0357	1.8867	0.0202
Mexico	2.8834	0.0214	2.4918	0.0169
Pakistan	2.2502	0.0390	2.0399	0.0324
Portugal	1.1655	0.0159	1.1427	0.0137
Slovenia	0.6902	0.0261	0.7893	0.0177
Thailand	3.5647	0.0464	2.8271	0.0330
Turkey	2.4119	0.0359	2.1221	0.0285
Group Average	2.3425	0.0352	2.0340	0.0268
Panel A.2				
Austria	1.8046	0.0318	1.6791	0.0268
Czech Republic	3.2180	0.0351	2.4185	0.0224
Finland	1.2030	0.0378	1.1746	0.0325
Hungary	0.9493	0.0317	0.9620	0.0237
Iceland	-2.1887	0.0877	-1.4082	0.0662
Israel	1.7670	0.0259	1.5311	0.0180
Japan	1.1964	0.0202	1.1569	0.0162
Luxembourg	3.6109	0.0365	2.2690	0.0177
Poland	1.5157	0.0217	1.4559	0.0192
South Africa	3.1251	0.0440	2.5494	0.0321
Spain	1.5223	0.0234	1.4150	0.0186
Group Average	1.6112	0.0360	1.3821	0.0267
Panel A.3				
Australia	1.8237	0.0352	1.6285	0.0268
Belgium	1.5950	0.0195	1.5057	0.0166
Canada	2.7280	0.0388	2.3432	0.0301
Denmark	8.5917	0.1818	4.7452	0.0897
France	1.4491	0.0190	1.3971	0.0168
Germany	2.1897	0.0337	1.8500	0.0241
Italy	0.9930	0.0291	0.9947	0.0217
Netherlands	1.4224	0.0394	1.3457	0.0323
Norway	3.1468	0.0529	2.6713	0.0412
Sweden	6.6386	0.1066	4.3620	0.0636
Switzerland	2.3717	0.0305	1.9956	0.0222
UK	3.0032	0.0597	2.4880	0.0443
US	2.2422	0.0396	2.0492	0.0334
Group Average	2.9381	0.0528	2.2597	0.0356

Table V

Disappointment Aversion with respect to Bonds, Panel B

Collectivism Group	***A***	*Std.Error*	A^{-}	*Std.Error*
Panel B.1				
Brazil	-0.4608	0.0033	-0.1995	0.0027
Chile	1.8258	0.0027	1.7587	0.0024
Greece	0.8952	0.0111	0.9015	0.0105
Hong Kong	3.4623	0.0243	2.5643	0.0154
Korea	0.9521	0.0055	0.9571	0.0049
Mexico	0.9709	0.0027	0.9716	0.0026
Pakistan	0.9582	0.0087	0.9628	0.0077
Portugal	1.2380	0.0093	1.2204	0.0086
Slovenia	1.2902	0.0025	1.2753	0.0024
Thailand	1.0040	0.0087	1.0038	0.0083
Turkey	1.0711	0.0070	1.0667	0.0066
Group Average	1.2007	0.0078	1.1348	0.0066
Panel B.2				
Austria	1.3831	0.0102	1.3478	0.0093
Czech Republic	2.1434	0.0144	2.1112	0.0140
Finland	1.6874	0.0124	1.5873	0.0106
Hungary	0.8715	0.0079	0.8783	0.0075
Iceland	0.3243	0.0200	0.4086	0.0175
Israel	1.8090	0.0083	1.7888	0.0081
Japan	1.3682	0.0032	1.3333	0.0029
Luxembourg	1.7188	0.0050	1.6143	0.0043
Poland	1.5131	0.0057	1.4884	0.0055
South Africa	0.7284	0.0184	0.8431	0.0106
Spain	1.3969	0.0104	1.3732	0.0098
Group Average	1.3585	0.0105	1.3431	0.0091
Panel B.3				
Australia	0.9511	0.0223	0.9692	0.0140
Belgium	1.3648	0.0057	1.3151	0.0052
Canada	3.1853	0.0314	2.7111	0.0246
Denmark	2.8062	0.0712	2.4528	0.0573
France	1.3647	0.0043	1.3343	0.0039
Germany	1.5805	0.0071	1.4955	0.0060
Italy	1.5127	0.0072	1.4582	0.0065
Netherlands	2.3802	0.0175	2.1604	0.0147
Norway	1.6212	0.0093	1.5557	0.0083
Sweden	3.2491	0.0264	2.8766	0.0220
Switzerland	1.7232	0.0140	1.5722	0.0111
UK	3.1098	0.0418	2.4103	0.0280
US	2.5369	0.0176	2.0989	0.0126
Group Average	2.1066	0.0212	1.8777	0.0165

Table V

Disappointment Aversion with respect to Other Investments, Panel C

Collectivism Group	*A*	*Std.Error*	A^{-}	*Std.Error*
Panel C.1				
Brazil	0.5928	0.0270	0.6184	0.0253
Chile	1.5018	0.0178	1.4278	0.0152
Greece	1.4038	0.0135	1.3116	0.0104
Hong Kong	6.4085	0.1548	3.2753	0.0651
Korea	1.3659	0.0151	1.3112	0.0129
Mexico	1.4638	0.0198	1.2951	0.0126
Pakistan	2.1700	0.0348	1.6891	0.0205
Portugal	1.3685	0.0132	1.3215	0.0115
Slovenia	1.5256	0.0172	1.4196	0.0138
Thailand	1.4837	0.0371	1.2865	0.0220
Turkey	1.2146	0.0167	1.1721	0.0134
Group Average	1.8636	0.0334	1.4662	0.0202
Panel C.2				
Austria	1.7309	0.0256	1.5228	0.0183
Czech Republic	1.2623	0.0255	1.1827	0.0179
Finland	1.8614	0.0291	1.6433	0.0217
Hungary	1.0093	0.0180	1.0078	0.0151
Iceland	2.1321	0.0466	1.8039	0.0331
Israel	1.2352	0.0201	1.1738	0.0149
Japan	1.4454	0.0198	1.4047	0.0180
Luxembourg	1.6025	0.0194	1.5547	0.0179
Poland	0.9856	0.0205	0.9912	0.0124
South Africa	1.5026	0.0321	1.4620	0.0295
Spain	1.5061	0.0172	1.4018	0.0137
Group Average	1.4794	0.0249	1.3772	0.0193
Panel C.3				
Australia	0.6758	0.0262	0.7120	0.0232
Belgium	1.4015	0.0147	1.3712	0.0136
Canada	1.6111	0.0328	1.4935	0.0265
Denmark	5.4429	0.1702	3.1655	0.0830
France	1.5401	0.0187	1.4147	0.0143
Germany	1.6252	0.0214	1.5623	0.0193
Italy	1.5263	0.0196	1.4654	0.0173
Netherlands	1.9628	0.0334	1.7261	0.0252
Norway	1.5485	0.0395	1.3497	0.0252
Sweden	3.7386	0.0995	2.4517	0.0527
Switzerland	1.5180	0.0291	1.4610	0.0259
UK	2.9050	0.0580	2.4392	0.0438
US	2.4776	0.0456	2.1482	0.0355
Group Average	2.1518	0.0468	1.7508	0.0312

Table VI

Panel Regression Results between Disappointment Aversion and Explanatory Variables

The next a few tables report mean coefficients of ten simple regression results corresponding to equities, bonds and other investments, using independent variables in each year from 2002 to 2015. We have to exclude countries that exhibit negative DA, which will cause problems when taking the natural logarithm. The dependent variables DA are average values of 1000 DA computed from the bootstrapping method. Namely, DA is not time-varying and identical for each year. Finally, risk parameters are set as $C_{\varphi} = 50, C_{\nu} = 10$ while the probability weighting parameter δ=0.74.

VARIABLE	MEAN OF THE COEF	STD. ERROR
EQUITY		
CGDP	0.0008	0.0002
DGDP	-0.0063***	0.0002
EFE	0.0333***	0.0016
GDP	-0.0369**	0.0096
GDPER	0.0095***	0.0014
INDV	0.0028**	0.0005
MGDP	0.0749***	0.0156
PSI	-0.2754***	0.0317
VEX	0.2892	0.3844
INTERCEPT	-1.6866***	0.1531
BONDS		
CGDP	-0.0014	0.0007
DGDP	-0.0003	0.0006
EFE	0.0100***	0.0024
GDP	0.0207*	0.0033
GDPER	0.0017	0.0009
INDV	0.0070***	0.0005
MGDP	0.1338***	0.0206
PSI	0.0499	0.0146
VEX	-1.4695***	0.5316
INTERCEPT	-0.5012**	0.1902
OTHER INVESTMENTS		
CGDP	0.0015***	0.0002
DGDP	0.0002	0.0003
EFE	0.0179***	0.0013
GDP	-0.0143	0.0026
GDPER	0.0032**	0.0011
INDV	0.0003	0.0008
MGDP	0.0825**	0.0171
PSI	-0.0123*	0.0129
VEX	-2.1803***	0.3366
INTERCEPT	-0.7734***	0.0948

* Indicate significance at the 10% level.

** Indicate significance at the 5% level.

*** Indicate significance at the 1% level.

Table VII

Disappointment Aversion under Different Risk-Related Parameters

A wide range of risk-related parameters is used to examine the robustness between DA and individualism. Panel A.1, B.1 and C.1 list the global average DA for equities, bonds and other investments, respectively. In order to avoid inconsistencies, the mean and SD of asset returns are assumed to be constant over the sampling period of 2003-2012. Panel A.2, B.2 and C.2 report the results of the panel regression.

Panel A.1

C_φ	$C_v = 1$	$C_v = 10$	$C_v = 20$
$C_\varphi = 25$	1.3666	1.6745	2.5764
$C_\varphi = 50$	1.7332	2.3491	4.1527
$C_\varphi = 100$	2.4664	3.6981	7.3054

Panel A.2

(C_φ, C_v)	*Coef*	*t-stat*	*p-value*
(25,1)	0.0011	1.7144	0.0877
(25,10)	0.0021	1.9401	0.0534
(25,20)	0.0037	2.0121	0.0453
(50,1)	0.0024	2.3683	0.0186
(50,10)	0.0043	2.7237	0.0069
(50,20)	0.0078	3.1042	0.0021
(100,1)	0.0063	3.3689	0.0009
(100,10)	0.0069	3.0552	0.0025
(100,20)	0.0060	0.2095	0.8342

Panel B.1

C_φ	$C_v = 1$	$C_v = 10$	$C_v = 20$
$C_\varphi = 25$	1.1516	1.3177	1.8706
$C_\varphi = 50$	1.3032	1.6354	2.7412
$C_\varphi = 100$	1.6064	2.2707	4.4823

Panel B.2

(C_φ, C_v)	*Coef*	*t-stat*	*p-value*
(25,1)	0.0016	2.9603	0.0034
(25,10)	0.0036	3.1459	0.0018
(25,20)	0.0055	3.6129	0.0004
(50,1)	0.0032	2.6677	0.0081
(50,10)	0.0060	2.7987	0.0055
(50,20)	0.0060	3.3407	0.0010
(100,1)	0.0023	2.2644	0.0244
(100,10)	0.0045	2.9470	0.0035
(100,20)	0.0078	3.1746	0.0017

(*continued*)

Table VII-continued

Panel C.1

C_φ	$C_v = 1$	$C_v = 10$	$C_v = 20$
$C_\varphi = 25$	1.2844	1.4849	2.0519
$C_\varphi = 50$	1.5688	1.9798	3.1039
$C_\varphi = 100$	2.1376	2.9596	5.2077

Panel C.2

(C_φ, C_v)	*Coef*	*t-stat*	*p-value*
(25,1)	0.0020	2.4128	0.0165
(25,10)	0.0033	1.8350	0.0676
(25,20)	0.0020	1.3565	0.1762
(50,1)	0.0025	2.3445	0.0198
(50,10)	0.0033	2.2320	0.0265
(50,20)	0.0030	1.6114	0.1085
(100,1)	0.0035	3.8023	0.0002
(100,10)	0.0044	3.1716	0.0017
(100,20)	0.0057	2.7424	0.0066

Table VIII

Robustness Tests under Different degree of Probability Weighting

Table VIII compares the results of panel regression with respect to equities, bonds and other investments for δ from 0.5 to 1. The first column also report the associated a global average DA that are calculated using annual asset allocation of pension funds from 2005 to 2012. In order to avoid inconsistencies, the mean and SD of asset returns are assumed to be constant over the sampling period of 2003-2012. Risk-related parameters are default values: $\mathbf{C}_{\varphi} = 50, \mathbf{C}_{v} = 10$.

Equities

δ	$\bar{A}_s$	*Coef*	*t-stat*
0.5	2.7423	0.0060	3.1686
0.6	2.5282	0.0050	2.9270
0.7	2.3900	0.0044	2.7697
0.8	2.2992	0.0041	2.6681
0.9	2.2395	0.0039	2.6030
1.0	2.2009	0.0038	2.5625

Bonds

δ	$\bar{A}_b$	*Coef*	*t-stat*
0.5	1.8193	0.0037	3.0503
0.6	1.7191	0.0035	3.0883
0.7	1.6545	0.0065	2.5245
0.8	1.6122	0.0053	3.0461
0.9	1.5845	0.0048	3.2103
1.0	1.5667	0.0046	3.2926

Others

δ	$\bar{A}_{or}$	*Coef*	*t-stat*
0.5	2.2647	0.0020	1.3606
0.6	2.1095	0.0059	2.1711
0.7	2.0094	0.0036	2.2525
0.8	1.9437	0.0032	2.0144
0.9	1.9007	0.0030	1.8716
1.0	1.8729	0.0035	1.9400