WHAT DETERMINES RISK TOLERANCE?

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Abstract

Possible explanations for the historical size of the equity premium include habit formation, loss aversion and investor sentiment. We hypothesize that these three factors account for significant variation in risk tolerance. We analyze average monthly scores from a widely used risk tolerance questionnaire that spans the global financial crisis (January 2007 - December 2010). We find that the habit formation, loss aversion, and sentiment proxies account for 27.01%, 36.49% and 24.93% of the variation in average monthly risk tolerance, respectively. Sentiment did not account for additional variation in average monthly risk tolerance when controlling for loss aversion and habit formation.

Introduction

There is strong evidence that habit formation, loss aversion, investor sentiment, or some combination of these factors drives time-varying risk aversion and accounts for variation in the equity premium. The purpose of this paper is to describe the research that supports time-varying risk aversion and explore the extent to which external habit formation, loss aversion and sentiment account for variation in risk tolerance. The first section of this paper provides an overview of the literature on habit formation, loss aversion and investor sentiment. Figure 1 displays the conceptual framework and can be found in the appendix. The second section describes the methodology used to construct measures for external habit formation, loss aversion, and investor sentiment. The third section reports the results and the forth section discusses implications for risk tolerance assessment.

Literature Review

According to Modern Portfolio Theory assets with a higher variance should have a higher expected return (Markowitz, 1952). This corresponds to the curvature of a personal utility function. The greater the curvature of someone's utility function, the less willing they are to accept variation in consumption over time. These risk averse individuals must be compensated with a higher expected return, compared to those who are less risk averse, in order to accept greater consumption variation. Consumption-based asset pricing models are based on the covariance between asset returns and consumption growth. Individuals prefer a smooth consumption path over their lifecycle in order to maximize expected lifetime utility, which results in a low covariance between asset returns and consumption growth (Campbell, 2003). In this case it is difficult to explain the equity premium without an unrealistically high coefficient of

relative risk aversion (RRA) (Campbell, 2003). The equity premium has been attempted to be explained in the literature through models that incorporate habit formation.

Models that incorporate habit formation have been introduced to provide a possible explanation for the historical size of the equity premium. The relative income hypothesis states that individuals evaluate their consumption levels in relation to those of other people, rather than on an absolute basis (Duesenberry, 1949). Individuals assess their current consumption levels based on a weighted average of their relative recent past consumption under a theory known as habit formation. Habit preferences can either be internal or external. Abel (1990) proposes an external habit formation model which is similar to Duesenberry's "Catching up with Joneses'" hypothesis. Habit formation helps explain why the disutility experienced during recessions is so severe, even though the consumption shock is relatively small given the time horizon of the lifecycle (Campbell and Cochrane, 1999). Habit formation implies that risk aversion is time-varying, which means the optimal portfolio allocation invested in the risky asset also varies (Heaton and Lucas, 2000). Models of habit formation imply that risk aversion varies with short term changes in consumption (Campbell and Cochrane, 1999). Merton (1971) derives Equation 1, which calculates the percentage of wealth that should be invested in the risky asset, :

$$= \frac{\quad}{\quad} \tag{1}$$

where is the average return on the risky asset, is the risk-free rate of return, is the standard deviation of the risky asset, and is a constant coefficient of relative risk aversion (RRA). The Merton Model holds when is replaced with a coefficient of RRA that is time-varying (Constantinides, 1990).

Constantinides (1990) claims that the equity premium can be explained in a rational expectations model using habit preferences. Mehra and Prescott (2003) state that habit

preferences cannot resolve the equity premium because it results in extreme aversion to consumption risk. They also question whether individuals actually have significant time-varying counter-cyclical changes in RRA that is implied by habit formation models, such as the one developed by Campbell and Cochrane (1999). Habit preferences can explain the difference between the historical low real returns of government bonds compared to stocks since increased risk aversion increases the quantity demanded for fixed income assets, which drives down the risk free rate (Weil, 1989).

Studies in behavioral finance attempt to explain variation in the equity premium using prospect theory. Prospect theory states that individuals evaluate gains and losses from a reference point and describes the utility function as being steeper in the loss domain compared to the gain domain (Kahneman and Tversky, 1979). Benartzi and Thaler (1995) find that the historical equity premium can be explained if investors are loss averse and myopic. Thaler and Johnson (1990) find that individuals experience less disutility from losses after a prior gain and greater disutility after a prior loss. Therefore models that incorporate loss aversion should decrease an individual's coefficient of loss aversion, , after prior losses and increase it after prior gains. It is important to note that the more negative is, the more someone overweighs losses compared to equivalent gains.

The empirical finding of Thaler and Johnson (1990) implies that risk aversion is time-varying. After experiencing prior financial gains, individuals should become less risk averse because prior gains will protect them from subsequent losses. After experiencing prior losses, current losses should make individuals more risk averse. Barberis, Huang and Santos (2001) study asset prices by incorporating the findings of Kahneman and Tversky (1979) and Thaler and Johnson (1990). They find that individuals are loss averse from fluctuations in consumption and

that is dependent on previous investment returns. Their framework helps explain the high historical equity premium, the low correlation between stock returns and consumption growth and the excess volatility and predictability of equity returns.

The closed-end fund discount is one proxy for investor sentiment (Lee, Shleifer and Thaler, 1991; Baker and Wurgler, 2006; Baker and Wurgler, 2007). When closed-end funds are less discounted or are priced above net asset value (NAV) investors may be optimistic about future returns (Lee, Shleifer and Thaler, 1991). During periods of high sentiment equity prices mean revert, resulting in lower future returns. Poterba and Summers (1988) find evidence of mean reversion in stock returns and state that one of the possible explanations is "price fads" that cause equity prices to deviate from fundamental values. The findings of Thaler and Johnson (1990) imply that when closed-end funds trade at a significant premium to NAV investors have become less risk averse. Investor sentiment helps explain why the equity premium decreases during high sentiment periods.

Other proxies for investor sentiment include average stock turnover, trading volume, number of IPOs, first-day IPO closing prices, the demand for dividend paying stocks and the equity- to-debt-issue ratio. When noise traders are optimistic, there is greater stock turnover, which increases liquidity. Trading volume is a signal that investors have heterogeneous beliefs and differ in their evaluations of equity prices (Hong, Scheinkman and Xiong, 2006)[1]. Lowry and Schwert (2002) state that IPOs tend to be held when investors are optimistic and are therefore willing to pay an inflated price. Cornelli, Goldreich and Ljungqvist (2006) find that high grey market prices (a signal that investors are optimistic) are a good predictor of first-day IPO closing prices. The demand for dividend-paying stocks should rise when investors'

[1] It should also be noted that when an index changes its constituents; then, index funds need to conduct trades simply to continue to replicate their index.

marginal propensity to consume is high and they are pessimistic about future returns. Baker and Wurgler (2002) find that companies issue more equity relative to debt prior to periods of low stock market returns.

Methods

Risk tolerance is measured using a questionnaire that has been psychometrically tested for validity and reliability. The survey is widely used within the financial planning industry. The questionnaire includes 25 risk tolerance questions that can be found at http://www.lgcdwealth.com/FinaMetrica.pdf. Scores range from 0-100 with zero being most risk averse and 100 being most risk tolerant. The mean score was provided each month from individuals surveyed in the U.S. and Canada. The repeated cross sectional data were collected between January 2007 and December 2010. A total of 227,895 different individuals were surveyed. The mean and standard deviation of the number of people surveyed per month was 4,748 and 1,074, respectively. No demographic or socioeconomic data were provided.

We use a model developed by Illmanen (1995) in this analysis as a proxy for external habit-based preferences. A proxy for external habit formation is derived by taking the exponentially weighted ratio of past real consumption to current real consumption, . The Ilmanen (1995) model is similar to the habit formation model developed by Constantinides (1990), as the subsistence level of consumption is the exponentially weighted mean of past consumption. As the gap between the exponentially weighted ratio of past real consumption to current real consumption rises, RRA increases.

Indexed and seasonally adjusted real monthly personal consumption expenditures are obtained from the Bureau of Labor Statistics. Ilmanen (1995) assigns smaller weights to

consumption levels that are further out in time. A smoothing coefficient of 0.90 is used to capture business cycle effects (Ilmanen, 1995). The weights for the cumulative last 12 months and cumulative last 36 months are 70 percent and 95 percent, respectively. Ilmanen (1995) states that the appropriate span for lagged consumption is somewhat arbitrary. Equation 2 displays the derivation for the habit formation proxy.

(2)

The proxy for loss averse preferences is developed by Kahneman and Tversky (1992) and Barberis, Huang and Santos (2001). Kahneman and Tversky (1992) find that individuals weigh losses 2.25 times more than equivalent gains when they are offered isolated gambles. They estimate that the marginally decreasing aspect of the value function, α, is 0.88. In the Barberis et al. (2001) model losses are not evenly weighted as there is evidence that sensitivity differs depending on whether a prior gain or loss preceded the current loss. increases after a prior gain and decreases after a prior loss due to the house money effect (Thaler and Johnson, 1990). Barberis, Huang and Santos (2001) create a parameter, *k*, to determine how much more painful losses are after a prior loss, and conversely, how much less painful losses are after a prior gain. They find that $k = 3$ results in a mean that is approximately -2.25. For example, if the stock market falls 10 percent in a given month *k* is multiplied by -0.10 and then added to -2.25, which results in a loss aversion weight, *w*, of -2.55. If the stock market rises five percent in a given month *k* is multiplied by 0.05 and then added to -2.25 which results in $w = -2.10$. The return on Fama and French's value-weighted portfolio of U.S. stocks is used to proxy for the market return, *Mkt*. The one-month Treasury bill rate, *Rf*, is subtracted from *Mkt* to account for the opportunity cost of investing in the equity market. The derivation of the loss aversion proxy is

displayed in Equation 3. Equation 3 is similar to the one proposed in Tversky and Kahneman (1992), except that the weight, w, is replaced with -2.25.

if 0, else (3)

Shumway (2007) develops an asset pricing model based on loss averse investors. The model explains annual returns better than competing models, but it does not explain monthly, quarterly or half-year returns. This is consistent with the finding that a one-year evaluation period is utility maximizing assuming that investors are myopic and loss averse (Benartzi and Thaler, 1995). A one-year moving average is used for the loss aversion proxy.

Baker and Wurgler (2007) develop an index to measure investor sentiment that includes the monthly change in the closed-end fund discount, , detrended log turnover, , the number of IPOs, , the first day return on IPOs, , the dividend premium, , and the equity share in new issues, , as factors. The index is standardized to have a mean of zero and a variance of one (Baker and Wurgler, 2007). Equation 4 displays the Baker and Wurgler (2007) sentiment index formula.

Δ $= -0.17\Delta$ $+ 0.32\Delta$ $+ 0.17\Delta$ $+ 0.41\Delta$ $- 0.49$ $- 0.28\Delta$ (4)

Results

Descriptive statistics on all of the regression variables are displayed in Table 1. A Shapiro-Wilk normality test was run on . The p-value for the Shapiro-Wilk test was 0.1708 so the null hypothesis of a normal distribution was not rejected at conventional confidence levels.

Table 1: Descriptive Statistics

		Loss Aversion	Habit Formation	Sentiment
Mean	53.1406	-2.2233	0.7118	-0.0383
σ	1.0474	3.1219	0.0065	0.3665
75^{th} percentile	54.0358	0.0836	0.7162	0.2796
Median	53.0729	-1.0796	0.7140	0.0498
25^{th} percentile	52.1889	-4.1446	0.7072	-0.4252
Minimum	51.1398	-8.6434	0.6991	-0.6166
Maximum	55.0690	2.5282	0.7231	0.5375

Table 2 displays the results from ordinary least squares (OLS) regressions of on the hypothesized factors that account for variation in risk tolerance. The signs of the parameter estimates are consistent with theory. As would be expected under habit formation, as the gap between the exponentially weighted ratio of past real consumption to current real consumption rises, declines. For a prospect theory utility function that incorporates the house money effect, as increases, increases. The sentiment index is positively associated with .

When each of the three hypothesized determinants of are examined in separate univariate regressions (columns 1 – 3), the loss aversion proxy explains the greatest amount of the variation in . This is evidenced by the largest adjusted r-squared value (0.3649) among the three univariate regressions. Overall, loss aversion and contribute meaningfully to explaining variation in . This is evidenced by the adjusted r-squared value of our regression model improving from .2701 (column 1) to .4306 (column 4) when the loss aversion and variables are added to the plain vanilla model with only the habit formation proxy.

The values of our dependent variable fall within a finite range. Therefore, we also examine the results from a beta regression model with a logit link specification. A beta regression model is a generalized linear model for dependent variables that are marginally distributed following a beta distribution. The model was originally designed for percentage data that range from 0-100%. The MRTS variable is scaled by a factor of 1/100 in order to conform to the parameters of a beta distribution. The beta regression model results, which are displayed in Table 3, are consistent with the OLS results in terms of the incremental explanatory power of the multivariate models.

Table 2: Variation in MRTS – OLS Model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	-86.4016**			-50.7158*	-54.8142	-38.9246	
	(-4.29)			(-2.51)	(-1.69)	(-1.33)	
Loss Aversion		0.2064**		0.1566**		0.1511**	0.1601**
		(5.29)		(3.74)		(3.48)	(3.71)
Sentiment			1.4718**		0.7109	0.2936	0.7962*
			(4.08)		(1.24)	(0.56)	(2.16)
Constant	114.6428**	53.5995**	53.1970**	89.5893**	92.1856**	81.1951**	53.5270**
	(7.99)	(361.09)	(403.87)	(6.25)	(4.00)	(3.89)	(364.86)
Adjusted R-Squared	0.2701	0.3649	0.2493	0.4306	0.2786	0.4218	0.4120
Observations	48	48	48	48	48	48	48

* denotes significance at $p < 0.05$. ** denotes significance at $p < 0.01$

Table 3: Variation in MRTS – Beta Regression Model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	-3.4717**			1.5006	1.5390	2.2575*	
	(-4.38)			(1.59)	(1.31)	(2.16)	
Loss Aversion		-0.0000**		-0.0001**		-0.0000**	-0.0000**
		(-8.59)		(-6.61)		(-3.81)	(-3.32)
Sentiment			0.0092**		0.0118**	0.0043	0.0015
			(7.20)		(5.09)	(1.54)	(0.57)
Constant	2.5970**	0.1732**	0.1603**	-0.8838	-0.9257	-1.4192	0.1724**
	(4.60)	(25.94)	(25.25)	(-1.33)	(-1.12)	(-1.93)	(25.39)
ln *L*	159	174	169	175	170	176	174
AIC	-313	-341	-332	-342	-331	-342	-340
Observations	48	48	48	48	48	48	48

* denotes significance at $p < 0.05$. ** denotes significance at $p < 0.01$

Conclusions

Habit formation, loss aversion and sentiment all accounted for significant variation in from 2007-2010. Loss aversion and habit formation accounted for 43.06% of the variation in . When the sentiment proxy was added to the model with loss aversion and habit formation it did not account for additional variation in . This time period, while relatively small, is important because it encompassed the greatest financial panic since the Great Depression. It is in time periods such as these where the assessment of how a client will react to a severe market downturn will be critical in determining whether they continue to follow their financial planner's investment recommendations. This paper provides evidence that more of the variation in is explained by loss aversion than by habit formation. It is essential for risk tolerance surveys to include questions that measure a client's level of loss aversion. The marginal effect of the habit formation proxy observed in the OLS models also supports the inclusion of questions that measure an individual's willingness to accept consumption variation. We find no evidence that measuring investor sentiment improves risk tolerance assessment when loss aversion and habit formation are already being measured.

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Appendix

Figure 1. Conceptual Framework