ACCOUNTING & FINANCE

afaanz

Accounting and Finance 55 (2015) 165–185

Individual financial risk tolerance and the global financial crisis

Paul Gerrans[a], Robert Faff[b], Neil Hartnett[c]

[a]*UWA Business School, The University of Western Australia, Crawley, WA, Australia*
[b]*UQ Business School, University of Queensland, St Lucia, QLD, Australia*
[c]*Newcastle Business School, University of Newcastle, Callaghan, NSW, Australia*

Abstract

We investigate individual investors' tolerance towards financial risk by focusing on changes associated with the global financial crisis (GFC) of 2007–2009. Financial risk tolerance (FRT) is analysed longitudinally controlling for demographic, socio-economic and regional variations. In absolute terms, the change in FRT is small and contrasts with a popular view that risk tolerance is an elastic psychological state overly influenced by the pervading market conditions. Even in the presence of significant financial events, FRT tends to be a reasonably stable attribute in the shorter term but possibly influenced and reshaped by events more gradually over time.

Key words: Financial risk tolerance; Risk attitude; Global financial crisis; FinaMetrica

JEL classification: D14, G11

doi: 10.1111/acfi.12053

1. Introduction

Financial risk tolerance (FRT) represents the extent to which an investor '… is willing to risk experiencing a less favourable financial outcome in the pursuit of a more favourable financial outcome' (International Organization for Standardization, 2006).[1] Enhancing our knowledge of FRT is important

[1] While a unique definition of FRT does not exist, other definitions of FRT have been proposed with similar intent. For example, Grable *et al*. (2004) utilise the broader literature on risk-taking behaviour (Irwin, 1993, p. 11) to derive their definition of FRT as '… the willingness to engage in behaviours in which the outcomes remain uncertain with the possibility of an identifiable negative outcome' (p. 142).

Received 14 February 2013; accepted 16 September 2013 by Henk Berkman (Editor).

because FRT provides one approach to operationalising a key input into an individual investor's choice of a preferred investment strategy. Moreover, the financial planning industry is particularly interested in finding a reliable risk tolerance metric as it provides one obvious way for advisors to explicitly address an important aspect of their duty of care to their clients.[2]

While the FRT literature identifies a range of factors and characteristics that are able to explain cross-sectional variation in FRT, less well understood are the factors that explain changes in FRT over time. Indeed, there is a fundamental disagreement between those who believe FRT to be an inherently stable given its trait basis (Roberts and Del Vecchio, 2000) and empirical evidence (Sahm, 2012) versus those who see it as susceptible to influence from significant market events (Pan and Statman, 2010; Benartzi, 2011). Such tension helps to motivate our study. Specifically, in this paper, we address the question of whether and to what extent FRT fluctuates in response to major financial events, exemplified by the recent global financial crisis (GFC).

The GFC of 2007–2009 was associated with significant financial market turmoil. It is plausible that many individual investors experienced a considerably lower appetite for financial risk as the seriousness of the GFC unfolded and so reduced their exposure to risky asset classes such as equities. For example, McCarthy (2009, p. 19) discusses the GFC and possible shifts in investor FRT and asks '… are current market conditions – up or down – the primary determinant of contemporaneous risk tolerance?' However, it is not clear to what extent risk tolerance actually declined, if at all, given the possible role played by other factors as catalysts for the investment behaviour observed during the GFC.

Our study offers three key contributions to the risk tolerance literature. First, we provide empirical evidence of FRT change based on test–retest[3] FRT assessments, which we contrast with the predominant focus in the literature of cross-sectional variation in the level of FRT. Second, we exploit a sample period which includes the GFC thereby allowing us to investigate the competing views of FRT stability during a period of substantial market variability. Third, given the nature of our sample, we investigate not only the level of variables previously shown to explain FRT but also changes in these variables. A strength of our paper is that we utilise risk tolerance data derived from a psychometrically validated psychological trait scale, along with

[2] In the US the Investment Advisers Act specifically requires a risk tolerance assessment. The Australian Securities and Investments Commission make clear that to comply with the Best Interests Obligations (section 961B of the Corporations Act), advisers need to demonstrate consideration of a client's risk tolerance (ASIC, 2012). In the UK, the Financial Services Authority has a similar requirement for advisers to determine the client's appetite for risk as well as capacity for loss. Cavezzali and Rigoni (2012) recently calibrate the role that an individual's assessed risk tolerance plays in an adviser's recommended asset allocations.

[3] We use 'test–retest' to refer to a repeated risk tolerance measure over time for the same individual, following Roszkowski *et al.* (2009).

demographic/socio-economic data from a total sample of 4,741 individual investors drawn from the United States, Australia and the UK. A subsample of 3,368 investors is used to explore the possible effect of temporal changes in control variables.[4]

Our main findings can be summarised as follows. Statistically, post-GFC risk tolerance scores are significantly lower than their pre-GFC counterparts. However, the magnitude of this difference is economically small. When we model changes in FRT, we find evidence of stability across the overall sample, with the mean individual change in tolerance quite small and not statistically significant. Thus, we confirm in this changes analysis that the impact of the GFC on risk tolerance is small. However, there is some evidence that the drop in risk tolerance scores in absolute terms is larger in both tails of the FRT distribution.

The remainder of this paper evolves as follows. Section 2 gives a brief review of the related literature. Section 3 outlines the research method, while our results are presented and discussed in Section 4. Section 5 concludes.

2. Related literature

Research into the cross-sectional variation of FRT has identified a number of key demographic and socio-economic background variables as key discriminators of FRT among individuals. Typically a positive association between FRT and males, wealth, income, education, investment knowledge/experience, professional/self-employed occupations and race/ethnicity/culture (white vis-à-vis Black/Hispanic/other) has been reported (for example Powell and Ansic, 1997; Yao *et al.*, 2005; Statman, 2010). A negative relationship has generally been observed between FRT and age, being married/partnered and number of financial dependents (Palsson, 1996; Yao and Curl, 2011). Cavezzali and Rigoni (2012) investigate the separate contribution of these demographic variables, grouped as indicative of investors' risk capacity, in explaining recommended asset allocations. They highlight that an individual's risk attitude, self-reported in their case, was not reliably proxied by risk capacity.[5]

The nature of temporal, or intraperson, variation in FRT appears less well researched or understood. More broadly, the consistency of personality traits has attracted considerable interest. In a meta-analysis of personality trait consistency, Roberts and Del Vecchio (2000) find high levels of consistency across the life course, attributed to several factors including environment, genes

[4] Several prior papers have drawn samples from the same basic source – see, for example, Faff *et al.* (2008, 2011).

[5] Less conspicuous factors have also been explored including whether adviser-assisted individuals were less risk tolerant than those who made their own decisions (Baker and Haslem, 1974); the external/internal locus of control, where externals were observed to be more risk tolerant (McInish, 1982); and personal health (Yao *et al.*, 2005).

and psychosocial factors. However, whereas McCrae and Costa (1994, p. 173) suggest personality trait differences ‘are also essentially fixed by age 30’, Roberts and Del Vecchio (2000, p. 20) find a positive linear trend in consistency, using rank-order estimates of personality traits and suggest ‘consistency peaks after age 50 at a level not high enough to infer a complete lack of change in personality traits’. Thus, while consistency in risk tolerance might be expected, it is not completely fixed and appears to be linked to age.

Some view risk tolerance as a variable that readily changes in response to various day-to-day stimuli such as financial market activity. For example, Shefrin (2002, pp. 27–28) suggests ‘… people are not uniform in their tolerance to risk. It depends on the situation… (and)… on several factors, one being recent experience facing risk’. Pan and Statman (2010) consider the potential influence of financial market movements upon investor emotions and claim that, notwithstanding reports to the contrary, ‘… investors’ risk tolerance varies as financial markets go up and down’ (p. 2). Benartzi (2011, p. 9) quotes Thaler as suggesting that due to the financial losses suffered during the GFC, risk aversion increased as ‘…people are even more averse to the prospect of future losses when they have experienced loss in the recent past’.

A number of studies have reported associations between their proxies for FRT and market activity or mood/sentiment and, thereby, cast doubt upon the notion of FRT stability. For example, Grable *et al.* (2004) studied the cross-sectional variation of a FRT proxy across time and concluded that FRT ‘… appears to be an elastic and changeable attitude… (and)… stock market price data does influence risk tolerance attitudes’ (pp. 142, 145). Similar conclusions have been reported in other cross-sectional analyses of individuals’ risk tolerance variation across various study periods ranging from 17 weeks to 18 years (Grable, 2000; Yao and Curl, 2011). In a study of long-term market returns and investor risk-taking behaviour in the USA, Malmendier and Nagel (2011) proxy a measure of ‘elicited risk tolerance’ and conclude ‘… that risky asset market returns experienced over the course of an individual’s life have a significant effect on the willingness to take financial risks’ (p. 410).[6]

In contrast, several studies report FRT to be a reasonably stable measure across time and not materially associated with market activity or sentiment. Some of these studies perform cross-sectional analyses of their FRT proxies across time. For example, Santacruz (2009) uses cross-sectional data to consider the relationship between FRT, measures of investor sentiment and share market returns but observes no significant relationship. Others have adopted a longitudinal ‘test–retest’ of individuals’ FRT stability. Roszkowski

[6] Malmendier and Nagel (2011) suggest caution in the use of Survey of Consumer Finances (SCF) risk measure, which is one of a suite they employ, for reasons similar to Hanna and Lindamood (2009, p. 3) who cast doubt on its strict validity and suggest it captures an ‘attitude reflecting expectations’. This and other issues associated with test instrument suitability are considered later in this section.

and Cordell (2009) examine the test–retest stability of FRT over time intervals ranging from 269 to 814 days, using a small sample of university students. The relative temporal stability was substantial, although absolute stability was less so. Roszkowski *et al.* (2009) find temporal stability in both overall and the intraperson (test–retest) variability of their FRT proxy when applied to various small samples of married couples.

Weber *et al.* (2012) investigate investors' attitude to risk and their risk and return perceptions using a panel of surveys conducted at three monthly intervals between September 2008 and June 2009 for UK online-brokerage customers. While they find return and risk expectations change with market conditions, there was no significant change in risk attitude. Changes in risk and return expectations explained risk-taking, whereas changes in risk attitude did not. Bateman *et al.* (2011) use experimental risky retirement investment choices to explore whether the GFC was associated with risk tolerance changes. They find a 'mild moderating of risk tolerance' (2011, p. 214) evident between different 2007 and 2008 samples with only income and age able to explain different classes of risk tolerance.

In contrast to Weber *et al.* (2012) and Hoffmann *et al.* (2013) who observe risk tolerance change over relatively short periods (maximum 10- and 12-month periods, respectively), our sample allows comparisons over an average 2.5 years. Additionally, Weber *et al.* (2012) and Hoffmann *et al.* (2013) sample begins in 2008, as the GFC is unfolding, whereas our sample includes observations clearly before the GFC begins.

In summary, the literature exposes a wide array of research studies associated with the modelling of FRT, yet much remains unresolved particularly with regard to temporal variation. The literature has to date provided differing viewpoints and conflicting evidence concerning the resilience of a person's FRT across time, and it is likely that contextual and methodological issues limit the strength or generality of conclusions. For example, the instruments used to measure 'risk tolerance' vary from single item measures (for example, the Survey of Consumer Finances), to more comprehensive surveys or scales that comprise a battery of items (for example the 25-item FinaMetrica survey or the 40-item American College's Survey of FRT). This leaves aside the range of measures developed by financial institutions for in-house use by their clients and sometimes reported in the literature. Further, the actual trait or attribute being surveyed or measured may not be consistent across studies and so questions of external validity and comparability arise. A more detailed review of the particular strengths or weaknesses of these competing measures is beyond the scope of this paper, but we note these differences have been considered in the literature.[7] Our rationale for choosing the particular risk

[7] For example, Yook and Everett (2003) investigate the consistency of responses to six different questionnaires that all purport to measure a person's FRT, yet the average correlation of responses is only 0.56 (p. 50).

tolerance instrument used in our study is discussed in the Method section that follows.

3. Method

3.1. Financial risk tolerance proxy

Our study utilises a psychological trait scale to proxy FRT. Specifically, we analyse the responses to the FinaMetrica FRT Scale, derived from a 25-item instrument developed by FinaMetrica in the 1990s and since utilised globally by investors, advisers, financial institutions and researchers.[8] The veracity of the scale has been psychometrically tested, with reported measures of reliability considerably in excess of the accepted psychometric standards (notably Cronbach's alpha 0.90; Spearman–Brown test of scale reliability coefficient 0.87 and confirmatory factor analysis that indicates only one underlying factor being measured: termed risk tolerance).[9] Faff *et al.* (2008) demonstrate that the FRT proxy provided by the test instrument used in our study is closely aligned with conventional risk aversion attributes typically derived from the revealed preferences for probabilities/pay-offs in simulation exercises involving investor choices between various hypothetical situations of differing risk/reward.

The 25 questions solicit responses to a range of issues pertinent to financial risk and draw from actual, future and hypothetical behaviour, emotional elements and self-assessment. The responses are used to estimate a standardised FRT score over the range from 0 to 100 (termed the risk tolerance score (RTS) by FinaMetrica). In addition to this FRT score, we use responses to the survey's final question which asks respondents for their own perception of their FRT on the same 0–100 scale. This question includes a statement that the average FRT score is 50, two-thirds of people are typically within 10 of the average and only 1 in 1,000 people score <20 or more than 80. This self-assessed or perceived financial risk tolerance is labelled 'PFRT' in our analyses and tables. In addition to the 25 questions, a rich set of demographic/socio-economic background information is captured – including gender, age, marital status, dependants, education, income and wealth.

In précis, our study contributes to the FRT literature, and our method overcomes prior study weaknesses in several ways. First, the temporal stability of FRT is analysed using a 'pure' longitudinal, intraperson 'test–retest' approach in addition to temporal, cross-sectional analysis of FRT levels. Second, the GFC provides a unique opportunity to consider the temporal

---

[8] See Faff *et al.* (2009); Santacruz (2009); and Roszkowski and Cordell (2009), among others.

[9] For more details of these tests, usability evaluation, norming tests and other information concerning the instrument, see the technical manual by Bright and Adams (2000).

stability of FRT across a period of extreme 'life event' financial turmoil and, thus, provides scope for stronger conclusions concerning the association of market/investor sentiment with individual FRT. Third, the level, and changes in, pertinent demographic/socio-economic background variables are controlled in turn, including possible cross-border effects. Fourth, the study has strong external validity in that our samples are large and subjects are actual individual investors dealing with real-world events (as distinct from investor surrogates and simulations). Finally, the study has strong internal validity in that FRT is measured using an independently validated, psychometric instrument.

3.2. Data and sampling

Our target population is (i) individuals who are (ii) invested into risky assets or in a position to contemplate such investment (iii) at a time prior to, and continuing through, the GFC and (iv) whose FRT and background features are documented across time. The sample provides a sufficiently diverse and unbiased set of individuals of contrasting demographic and socio-economic background variables amenable to analysis.

Our sample consists of 4,741 individual investor clients of financial advisory firms using the FinaMetrica scale for FRT who completed at least two FRT surveys between January 2001 and July 2009. After excluding those with incomplete background information across both surveys and after applying validity checks on date of birth, education and gender,[10] the total number of individuals with two complete sets of background information in the test and retest procedure was 3,368. This subsample formed the basis for our further analysis of the change in FRT across test–retest after controlling for possible changes in background variables for each respondent.

3.3. Basic modelling approach

Two methods of analysis are conducted to examine the temporal variability of FRT across the GFC. The first method utilises the whole sample of 4,741 respondents, focuses on the tolerance (FRT) and perceived tolerance (PFRT) levels recorded from the most recent survey and seeks to examine the time variation in these levels, as the GFC unfolded. This method is similar to that employed by earlier cross-sectional studies of interperson variation in risk tolerance level over time. The method is more robust than earlier studies in view of our large sample size, reliability of the FRT measurement instrument and the controls employed. The second method of analysis examines longitudinally the test–retest time variation in FRT and PFRT, thereby focusing upon the temporal change in risk tolerance scores of each individual (i.e. an intraperson

[10] That is, clients were excluded where they became younger, lowered their education level or changed gender between test and retest.

rather than interperson analysis). The variables utilised in our analysis, both in level form and as changes in those variables, are summarised in Tables 1 and 2.

To assess any association between the GFC and risk tolerance scores, a series of dummy variables denoting time period were created to represent the date when the most recent survey was completed by each respondent (with the base period being prior to 2007). Therefore, the dummies created and coded were for January 2007–June 2007, July 2007–December 2007, January 2008–June 2008, July 2008–December 2008 and January 2009–July 2009. In this way, we proxy exposure or 'doses' to the buoyant earlier period of 2007 as a prelude to the GFC phenomenon and also incremental exposure to the unfolding GFC with each successive time period category. For example, respondents who had completed their test and retest of risk tolerance prior to 2007 became the base period group and were considered to have no exposure to (or 'dose' of) GFC-related events, regardless of the precise timing between their two tests. All other categories are considered to have zero GFC experiences as at their first test that occurred prior to 2007, but then with varying exposures to events pertinent to the GFC, depending upon the period in which their retest occurred.

Dummy variables were also created to model the country/region of each respondent, noting the existing literature on race/culture association with risk tolerance (referenced earlier) and also the potential for differential GFC experiences across countries. Therefore with Australia/New Zealand (NZ) treated as the base region, three other region dummies were coded: North America (USA and Canada), UK and other.

For the test–retest analyses where a person had undertaken more than two tests, the two most recent tests were used. To control for cross-sectional differences in using the second or third test score, a dummy variable is included if the retest was the third survey administered. Tables 1 and 2 provide summary statistics of the risk tolerance variables used in the whole sample and subsample analyses, respectively, in addition to information about the key subcategories of each control variable and the proportion of respondents therein.

Table 1 shows the mean FRT is 53.3 with a standard deviation of 11.9. The distribution of FRT scores is marginally positively skewed. The mean self-assessed financial risk tolerance (PFRT) is lower (48.6) than the calculated FRT, with a slightly higher standard deviation (13.3) and with a slight negative skewness. Table 2 shows that the mean change in FRT between test–retest is close to zero with a standard deviation of 8.1 and slightly positive skewness. This change in FRT is not significantly different from zero. A categorical breakdown of change in FRT by the period the latest test was completed identifies an increasing trend in the proportion of FRT scores declining as the GFC unfolds. For example, the proportion of retests completed in the second half of 2009 which had a FRT the same or lower was 65 per cent. In contrast, for retests completed prior to January 2007, the proportion was only 48 per cent, and 45 per cent for those retests completed in 2007. The change in PFRT is also small (0.19) with a similar variation (11.5 standard deviation) and a

Table 1
Summary sample statistics: level of financial risk tolerance (FRT)

	Mean	SD	Proportion of respondents (%)
FRT	53.35	11.86	
PFRT	48.61	13.33	
Female			41.8
Partnered			83.4
Dependants (number of)	1.26	1.34	
Age (years)	55.90	12.37	
Education level	3.28	0.95	
1. Did not complete high school			7.0
2. Completed high school			14.3
3. Trade or diploma qualification			22.5
4. University degree or higher			56.2
Personal income	2.14	1.05	
1. Under \$50,000			34.7
2. \$50,000–99,999			30.9
3. \$100,000–199,999			20.0
4. \$200,000 or over			14.4
Combined income	2.23	1.34	
1. Under \$50,000			28.4
2. \$50,000–99,999			22.5
3. \$100,000–199,999			29.3
4. \$200,000 or over			19.8
Net worth	6.00	1.08	
1. Under \$10,000			0.9
2. \$10,000–24,999			0.8
3. \$25,000–49,999			0.7
4. \$50,000–99,999			2.1
5. \$100,000–499,999			26.1
6. \$500,000–999,999			29.0
7. \$1,000,000 or over			40.4
Region			
Australia/New Zealand			50.2
North America			33.2
United Kingdom			15.8
Other			0.8
Number of tests completed by individuals			
Two			90.5
Three			9.5
Period when most recent test completed			
Before 2007			28.3
January 2007–June 2007			9.5
July 2007–December 2007			8.8
January 2008–June 2008			12.9
July 2008–December 2008			14.0
January 2009–July 2009			26.5

This table provides summary mean, standard deviation and proportions statistics for the regression sample comprising the most recent survey, used to estimate equation 1 and 2 when modelling the level of risk tolerance (n = 4,741).

Table 2
Summary sample statistics: change in financial risk tolerance (FRT)

	Mean	SD	Proportion of respondents (%)
Δ FRT	−0.04	8.12	
Δ PFRT	0.19	11.54	
Female			39.4
Partnered			91.0
Δ Dependants	−0.01	1.07	
Δ Age	2.52	1.52	
Δ Education level	0.08	0.32	
1. Did not complete high school			6.1
2. Completed high school			13.8
3. Trade or diploma qualification			22.7
4. University degree or higher			57.4
Δ Personal Income	0.10	0.72	
1. Under $50,000			34.6
2. $50,000–99,999			30.3
3. $100,000–199,999			20.3
4. $200,000 or over			14.8
Δ Combined Income	0.09	0.66	
1. Under $50,000			21.6
2. $50,000–99,999			24.8
3. $100,000–199,999			32.4
4. $200,000 or over			21.2
Δ Net Worth	0.11	0.80	
1. Under $10,000			0.7
2. $10,000–24,999			0.7
3. $25,000–49,999			0.5
4. $50,000–99,999			1.9
5. $100,000–499,999			27.1
6. $500,000–999,999			28.4
7. $1,000,000 or over			40.7
Region			
Australia/New Zealand			50.4
North America			34.5
United Kingdom			14.5
Other			0.6
Number of tests completed by individuals			
Two			89.4
Three			10.6
Period when most recent test completed			
Before 2007			29.8
January 2007–June 2007			8.5
July 2007–December 2007			8.4
January 2008–June 2008			12.2
July 2008–December 2008			14.0
January 2009–July 2009			27.1

This table provides summary mean, standard deviation and proportions statistics for variables used in estimations of equations 3, 3a, 4 and 4a when modelling the change in FRT and PFRT between test and retest, as a function of the latest survey's demographics, region and global financial crisis time period (in the case of equations 3 and 4) or as a function of the changes thereof across the surveys (in the case of equations 3a and 4a). The mean change and standard deviation in the relevant demographics between the test and retest are presented (n = 3,368).

small positive skewness. The average period between survey completions is approximately 2.5 years (903 days, with a standard deviation of 536 days).

Our regression specifications follow those of Faff *et al.* (2009), including the potential for nonlinear linkages between risk tolerance and age, income and number of dependants. The first two regressions estimate the level of the FRT (Eqn 1) and PFRT (Eqn 2) from the respondent's most recent test, as a function of the level of demographics, GFC time dummies and region dummies. The specifications are characterised as follows:

$$FRT_2 = f(\text{demographics, GFC time period dummies, region dummies}) \tag{1}$$

$$PFRT_2 = f(\text{demographics, GFC time period dummies, region dummies}) \tag{2}$$

A counterpart pair of regressions examine the change in risk tolerance test scores rather than the levels:

$$FRT_2 - FRT_1 = f(\text{demographics, GFC time period dummies, region dummies}) \tag{3}$$

$$PFRT_2 - PFRT_1 = f(\text{demographics, GFC time period dummies, region dummies}) \tag{4}$$

3.4. Change in demographic/socio-economic variables

We also assess the impact of changes in demographics/socio-economic characteristics on the test–retest changes in FRT and PFRT. By modelling these changes that might naturally occur between tests, we seek to further filter any 'extraneous' explanations for an observed change in the test–retest scores. Equations 3a and 4a respecify 3 and 4 by using changes in each of the following independent variables: client's partnered status, number of dependants, age, education level, personal income and net worth. Change in combined income also enters the estimation for those clients who were partnered when test one or two was completed.

$$FRT_2 - FRT_1 = f(\Delta\text{Demographics, GFC time period dummies, region dummies}) \tag{3a}$$

$$PFRT_2 - PFRT_1 = f(\Delta\text{Demographics, GFC time period dummies, region dummies}) \tag{4a}$$

3.5. Robustness checks

We begin with OLS estimations which focus on the relationship between client characteristics and the level of FRT. The FRT range is potentially from 0 to 100, and thus, FRT represents a censored variable. In view of this, equations 1 and 2 are also estimated via a double-sided Tobit but given that the results are almost identical to OLS, we report only the OLS results to be consistent with other reported regressions, as well as the previous relevant literature. Additionally, to investigate whether the relationship between FRT and individual characteristics is consistent across the FRT distribution, a quantile regression is estimated. Specifically, the 10th, 25th, median, 75th and 90th percentiles are investigated and compared with each other and OLS.

4. Results and discussion

4.1. Modelling financial risk tolerance levels: cross-sectional analyses

Table 3 presents the results of regressions 1 and 2 which seek to explain the level of FRT and PFRT. Regarding analysis of the association between FRT and the GFC time period within which the risk tolerance survey was completed, recall that the reported GFC time period dummy regression coefficients in Table 3 reflect comparisons between the relevant 'GFC time period' test scores and FRT surveys undertaken in the base period prior to January 2007. Surveys undertaken in the first half of 2007 reported a marginally significant and higher FRT than earlier pre-2007 surveys, and this is not inconsistent with the proposition that quite buoyant, heightened investment market activity might have positively impacted upon actual and self-perceived tolerances. However, the increases in tolerance scores were only modest (approximately one measurement point), and thus, the materiality of the change might conceivably be negligible. From the second half of 2007, the GFC dummies become negative and increase in size, however, while the 2008 and 2009 dummies are negative and significant the magnitudes are not large, and so unlikely to be economically important (with the largest being-1.67 for the first half of 2009). The estimated PFRT time dummy coefficients are not significant.

The associations observed between the level of FRT and gender, partnered status, number of dependants, education, income, partnered income and net worth are comparable to those of earlier studies that use similar cross-sectional modelling. The results in our study suggest risk tolerance decreases with age, but at a decreasing rate (indicated by the positive coefficient of the age-squared term), whereas Faff *et al.* (2009) report an increasing rate of decline (via their negative coefficient of their age-squared term). However, while the quadratic age coefficient is positive here, when considered

Table 3
Regression estimation results: level of financial risk tolerance (FRT)

	FRT (Eqn 1)	PFRT (Eqn 2)
Female	−4.6611 (0.3407)***	−5.1626 (0.4024)***
Partnered	−4.7341 (1.3844)***	−3.4252 (1.6339)**
Dependants	−0.2235 (0.2779)	−0.3180 (0.3652)
Dependants^2	0.0611 (0.0515)	0.0804 (0.0748)
Age	−0.4693 (0.0950)***	−0.4993 (0.1063)***
Age^2	0.0016 (0.0008)*	0.0020 (0.0009)**
Education level	1.1167 (0.1789)***	0.9246 (0.2070)***
Personal income	2.0965 (0.8974)**	0.6092 (1.0751)
Personal income^2	−0.1038 (0.1890)	0.2148 (0.2260)
Partnered combined income	3.0490 (1.0878)***	2.9437 (1.2705)**
Partnered combined income^2	−0.5288 (0.2135)**	−0.5950 (0.2503)**
Net worth	0.5380 (0.1795)***	0.6637 (0.2086)***
Third test comparison	0.9965 (0.5462)*	1.3581 (0.5960)**
Region (Base: Australia/NZ)		
North America	−2.7282 (0.3818)***	−2.5357 (0.4564)***
UK	−3.9741 (0.4811)***	−4.3491 (0.5145)***
Other	0.4648 (1.7091)	−3.4694 (2.4412)
GFC-2007 January–June	1.0295 (0.5817)*	1.1907 (0.7127)*
GFC-2007 July–December	−0.0750 (0.5709)	−0.3464 (0.6790)
GFC-2008 January–June	−0.9866 (0.5348)*	−0.5410 (0.6074)
GFC-2008 July–December	−1.0578 (0.5107)**	−0.4671 (0.6043)
GFC-2009 January–July	−1.8019 (0.4454)***	−0.5864 (0.5174)
Constant	73.0736 (2.7418)***	69.9021 (4.0386)***
Observations	4,741	4,741
Adjusted R-squared	0.24	0.17

*Significant at 10%, **5%, ***1% confidence level. This table reports estimation results for equations 1 and 2 which examine, cross-sectionally, the level of FRT and PFRT indicated in the latest survey taken, as a function of the level of respondent demographics, regions and global financial crisis (GFC) time period. Robust standard errors are reported in parentheses.

collectively with the linear age coefficient, the implied minimum point for age lies well beyond any plausible human age. That is, in effect, the age-FRT relationship is persistently negative and consistent with previous literature. The results for the perceived financial risk tolerance (PFRT) estimations are all of the same sign as the FRT estimation, although personal income is no longer significant.

The results in Table 3 also reveal that the region/country of respondents is a significant discriminator of FRT. The North American and United Kingdom dummy variables are significant and negative, suggesting that Australian respondents had a higher average risk tolerance level. The difference is largest for the UK coefficient with a four point difference. The sign and size of the region dummies are the same for the PFRT estimation.

4.2. Modelling changes in financial risk tolerance: longitudinal 'test–retest' analyses

Table 4 presents the results of regression estimates for equations 3 and 4 which focus on the change in FRT and PFRT across time for each individual investor and as a function of the level of demographic and other control variables. That is, the analysis here considers the temporal stability of investor FRT and to what extent the difference in individual test–retest scores for FRT is associated with a particular respondent category.

In contrast to the cross-sectional regression analyses reported in Table 3, almost all of the demographic/socio-economic background variables in Table 4 show insignificant regression coefficients in their association with FRT change or PFRT change, consistent with the sample-wide stability of FRT and PFRT shown earlier in Table 2. Age retains a significant and negative relationship. The regression

Table 4
Regression estimation results: change in financial risk tolerance (FRT)

	Change in FRT (eq. 3)	Change in PFRT (eq. 4)
Female	0.3305 (0.276)	0.1862 (0.396)
Partnered	−0.7689 (1.115)	−1.0737 (1.672)
Dependants	0.0545 (0.217)	−0.2792 (0.379)
Dependants^2	−0.0279 (0.040)	0.0157 (0.080)
Age	−0.1239 (0.072)*	−0.2190 (0.105)**
Age^2	0.0007 (0.001)	0.0015 (0.001)
Education level	−0.0172 (0.142)	0.0396 (0.208)
Personal income	0.4685 (0.688)	−0.5960 (1.024)
Personal income^2	−0.0584 (0.144)	0.1797 (0.213)
Partnered comb income	−0.1918 (0.859)	0.7109 (1.272)
Partnered combined income^2	0.0914 (0.165)	−0.1400 (0.244)
Net Worth	−0.0279 (0.139)	0.3215 (0.206)
Third test comparison	−0.7241 (0.388)*	−0.2314 (0.528)
Region (Base: Australia/NZ)		
North America	−0.8249 (0.292)***	−0.8157 (0.438)*
UK	0.1797 (0.334)	0.5974 (0.486)
Other	3.3673 (1.143)***	−0.5838 (3.034)
GFC-2007 January–June	0.4942 (0.455)	−0.0800 (0.686)
GFC-2007 July–December	0.1556 (0.453)	0.4245 (0.663)
GFC-2008 January–June	−1.1239 (0.413)***	−0.2999 (0.604)
GFC-2008 July–December	−2.4749 (0.392)***	−2.0714 (0.587)***
GFC-2009 January–July	−3.7578 (0.349)***	−3.0015 (0.498)***
Constant	5.9024 (2.095)***	7.3739 (3.004)**
Observations	4,741	4,741
Adjusted R-squared	0.06	0.02

*Significant at 10%, **5%, ***1% confidence level. This table reports estimation results for equations 3 and 4 which examine, longitudinally, the change in FRT and PFRT between each respondent's test and retest, as a function of the level of respondent demographics, regions and global financial crisis (GFC) time period in the latest test survey taken. Robust standard errors are reported in parentheses.

output pertaining to the regional dummy variables suggest that the change in FRT and PFRT for North American respondents was negative and significant relative to Australian respondents, although again the variation was <1 point in both cases. The 'other' category indicates a significant positive association, yet it remains unclear what might be driving this result. The GFC time period dummy variables remain conspicuous in their general association with risk tolerance, this time the change in tolerance between test and retests. The GFC time period dummy variable coefficients are negative and statistically significant from the first half of 2008, whereas for the PFRT it is from the second half of 2008. Thus for example, after controlling for all other variables, a FRT resulting from a retest conducted in the first half of 2009 is approximately four points lower than the initial test score (and three points lower for the retest of PFRT).[11]

The final two regression estimations seek to explain changes in FRT and PFRT given changes in the demographic/socio-economic variables that might naturally occur between the test–retest procedure for each investor (i.e. equations 3a and 4a). The results are reported in Table 5.

Some of the background variables' changes from test to retest are associated with risk tolerance changes, but the explanatory power is not as high as for the explanation of the level of FRT and PFRT scores. The coefficients for change in personal income and change in net worth are positive and significant, the former for FRT and the latter for PFRT. There is a significant and positive relationship of becoming partnered with self-assessed financial risk tolerance (PFRT). The role of age is no longer significant, but a breakdown of the changes in FRT score identifies variation across age groups. For the two youngest age quintiles, a positive change in FRT is observed. The absolute size of the change for the youngest quintiles is twice as large as the remaining quintiles. Also, and as revealed by Table 2, the average change in age between test–retest was only 2.52 years. Subtle 'true' changes in risk tolerance may not be clearly discernible in such cases, and it would seem that the finer associations between age and risk tolerance are yet to be definitively resolved.

Those completing a third test also had marginally but significantly, lower retest scores. The UK region dummy variable is positive and significant for PFRT changes. Importantly, the GFC time period dummies' coefficients retain their sign, significance and magnitude with the largest negative change recorded for the first half of 2009. That is, after controlling for other likely influences upon changes in risk tolerance over time, the GFC effects remain discernible.

The explanatory power of the whole model investigating change in FRT is low as evidenced by the low adjusted *R*-squared values and can be contrasted

[11] Notably, this result is not driven by the number of days between test and retest. Specifically, the correlation between the number of days between tests and change in FRT is not significant either overall or when the data are partitioned into subsamples before and after 1st Jan 2007. We thank an anonymous referee for prompting us to explore these possibilities.

Table 5
Regression estimation results: change in financial risk tolerance (FRT) and demographic change

	Change in FRT (Eqn 3a)	Change in PFRT (Eqn 4a)
Female	0.2019 (0.282)	0.3277 (0.407)
Δ Partnered to unpartnered	0.8710 (0.972)	1.2873 (1.374)
Δ Unpartnered to partnered	−1.6844 (1.345)	3.6593 (2.174)*
Δ Dependants	0.2072 (0.191)	0.0982 (0.198)
Δ Age	0.3591 (0.281)	0.3349 (0.396)
Δ Age^2	−0.0302 (0.044)	−0.0114 (0.060)
Δ Education level	0.4575 (0.476)	−0.8838 (0.725)
Δ Personal income	0.7294 (0.234)***	0.3669 (0.335)
Δ Partnered combined income	−0.0403 (0.268)	−0.5697 (0.376)
Δ Net worth	0.2963 (0.186)	0.4839 (0.250)*
Third test comparison	−0.8285 (0.445)*	−0.4273 (0.604)
Region (Base: Australia/NZ)		
North America	−0.5194 (0.312)*	−0.3967 (0.454)
UK	0.3089 (0.407)	1.5557 (0.599)***
Other	3.7886 (1.069)***	−1.1577 (4.532)
GFC-2007 January–June	1.2858 (0.564)**	0.6039 (0.844)
GFC-2007 July–December	0.5414 (0.523)	0.7950 (0.717)
GFC-2008 January–June	−1.1111 (0.474)**	−1.0675 (0.721)
GFC-2008 July–December	−2.4098 (0.455)***	−2.2409 (0.683)***
GFC-2009 January–July	−3.5513 (0.417)***	−2.8655 (0.605)***
Constant	0.3740 (0.586)	0.0141 (0.798)
Observations	3,368	3,368
Adjusted R-squared	0.06	0.02

*Significant at 10%, **5%, ***1% confidence level. This table reports estimation results for equations 3a and 4a which examine, longitudinally, the change in FRT and PFRT between each respondent's test and retest, as a function of their demographic changes, regions and global financial crisis (GFC) time period. Robust standard errors are reported in parentheses.

with the estimations explaining the level of FRT and reported in Table 3. This is in line with the view of Roberts and Del Vecchio (2000) that consistency of risk tolerance scores is to be expected, given a personality trait based explanation linked with age. Nevertheless, the continued significance of the GFC time period dummy variables suggests the importance of time-specific events, independent of the whole model and the modelled demographics. It is also possible that change in FRT may be better explained by anticipated changes in variables such as income and dependants rather than those changes already experienced as included in the regressions.

4.3. Regional differences in risk tolerance

In the previous estimations, regional differences were accounted for through fixed effects via dummy variables for each region (United States, UK, Other) with Australia/NZ the reference or 'base' category. To more closely investigate possible regional differences in the relationships between respondent background characteristics and FRT, separate regressions (not reported here) are estimated for each region. The results suggest only limited support for significant differences in the role of demographic/socio-economic characteristics between regions. Briefly, we note that in terms of the level of FRT, there are no significant differences in coefficient estimates between Australia/NZ and the United States with the exception of partnered status, which is not significant in the US sample. A significant difference does exist for the relationship between gender and FRT and education level and FRT level between Australia/NZ and the UK. The gender gap is wider in the UK with females having an FRT 6.3 points lower than their male counterparts, compared with Australia/NZ (4.0). For the United States, the gender effect of 4.5 points is also significantly different to the UK, but at the 90 per cent confidence level. The positive effect of education on FRT is significantly larger for Australia/NZ and USA respondents than for their UK counterparts.

4.4. Quantile estimation of FRT change

In our final analysis, using quantile regressions (untabulated), we investigate the sensitivity of the reported demographics, region and GFC time period relationships across the distribution of FRT and PFRT. Five points of the distribution are examined (10th, 25th, 50th, 75th and 90th percentiles), and an *F*-test of the equality of coefficients across the five points of the distribution is estimated in addition to paired tests of distribution points. This allows examination of the role of characteristics for different levels of risk tolerance.[12]

There is no rejection of the hypothesis of equal coefficients across the distribution of the level of FRT or for differences in individual pairings of the main distribution percentiles for all of the demographics. The only demographic that approached 90 per cent significance was age between the 10th and 90th percentile. In this case, the 90th percentile coefficient suggests each year of age decreased FRT by 0.83, whereas at the 10th percentile the decrease was 0.47.[13] Differences across the FRT distribution are also investigated through separate regressions for each region, and the results are qualitatively similar to the combined regression. Collectively the results suggest pervasive character-

[12] The regressions employ bootstrapped standard errors with 200 replications to account for underestimation of standard errors in the presence of heteroscedastic errors (Rogers, 1993).

[13] An alternative explanation for possible age effects across the distribution is heteroscedasticity. Cameron and Trivedi (2010) show the susceptibility of quantile regressions to provide evidence of scale differences across the distribution when in fact the cause is over dispersion linked with an explanatory variable. While there is very little difference between OLS standard errors with and without robust error specification, suggesting little heteroscedasticity (Cameron and Trivedi, 2010, p.213), the Breusch-Pagan/Cook-Weisberg test was estimated and rejects homoscedastic variance.

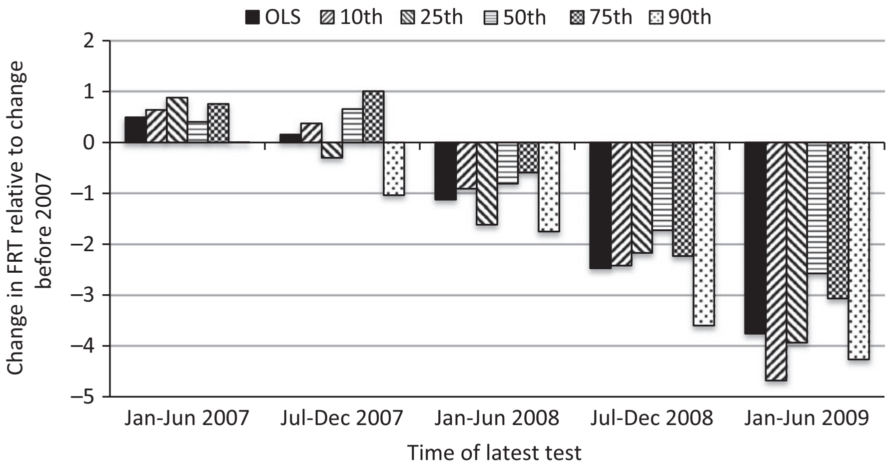

Figure 1 Change in financial risk tolerance across distribution (percentiles) for the most recent test relative to changes prior to 2007.

istic effects across the distribution, with the possible exception of age. With regard to the impact of the GFC on FRT level, the results suggest that the observed small negative impact (in the order of <2 points) was the same for low and high FRT levels.

The same quantile regressions are estimated for the change in FRT. The results are again largely similar, in that none of the demographic characteristic coefficients were significantly different across the main distribution points. However, the GFC time variables do suggest a difference across the distribution. From the first half of 2008, the second test score is lower than the earlier test. An interesting feature of the estimated coefficients is revealed for the second half of 2008 and the first half of 2009 (which in hindsight was the worst of the GFC) whereby the negative change in FRT is larger at both ends of the distribution, relative to changes observed prior to 2007 (see Figure 1). That is, while there is still a negative change at the median of the distribution during the GFC low-points, relative to 2007 they are smaller than at the distribution tails. This suggests that the change in risk tolerance observed in test–retest surveys is relatively larger for those with lower risk tolerance levels conducted during the GFC.

5. Conclusions and future work

This paper investigates whether and to what extent FRT fluctuates in response to major financial events, exemplified by the recent GFC. In terms of the cross-sectional variation in the level of FRT scores observed over time, the test scores observed during the GFC were significantly lower in the statistical sense than those recorded prior to the GFC. However, the magnitude of this difference is small with the decrease being <2 points for FRT.[14] A significant GFC variation is not observed for investors' own assessment of their risk tolerance score (the perceived tolerance, PFRT). When examining the change observed in individual FRT and PFRT across time, we find the measures to be quite stable across the overall sample, with the mean individual change in tolerance not statistically significant. Overall, these results challenge the view that the shift in risk-taking behaviour observed during the GFC is attributable to material changes in risk tolerance and they support the proposition that FRT can be viewed as a reasonably stable trait.

While our work is instructive with regard to the stability of an individual's risk tolerance, a number of important issues remain unresolved. The persistence of the observed changes to risk tolerance is worthy of further investigation, for the GFC-associated change to tolerance might only be a temporary phenomenon rather than a permanent revision. Also, future work could address possible issues relating to the intraitem variation in the responses to each of the 25 questions that comprise the overall risk tolerance scale used in this study.

References

Australian Securities and Investments Commission, 2012, *Regulatory Guide 175: Licensing: Financial Product Advisers—Conduct and Disclosure* (Australian Securities and Investments Commission, Sydney).

Baker, H., and J. Haslem, 1974, The impact of investor socioeconomic characteristics on risk and return preferences, *Journal of Business Research* 2, 469–476.

Bateman, H., J. Louviere, S. Thorp, T. Islam, and S. Satchell, 2011, Retirement investor risk tolerance in tranquil and crisis periods: experimental survey evidence, *Journal of Behavioral Finance* 12, 201–218.

Benartzi, S., 2011, Behavioral finance in action, White paper (Center for Behavioral Finance, Allianz). Available at: http://www.befi.allianzgi.com/en/Publications/Documents/behavioral-finance-in-action-white-paper.pdf.

Bright, J., and A. Adams, 2000, *Technical Manual: The FinaMetrica Risk Profiling System* (FinaMetrica, Sydney).

[14] The associate editor raised that an implicit bias may be present in the research design, depending on the extent to which a portion of the survey respondents were 'potential' investors rather than actual investors. Specifically, the concern is that if/as the former respondent type did not really experience the true effect of the GFC, their presence in the sample will bias downward the magnitude of any detected GFC impact on FRT. To address this concern, in a robustness check (untabulated), we examined that part of our sample where it is more likely that the respondents are 'actual' rather than 'potential' investors. We selected high 'Net worth' individuals as a reasonable instrument for this purpose. Specifically, we rerun our models for that portion of our sample whose net worth exceeded \$500,000 (approximately 70 per cent of the sample) and find a strong robustness of our showcased results. For example, in risk level (Table 3), the difference in the GFC-2009 Jan–Jul coefficient is −1.80 (original) versus −1.75. In Table 4, the original is −3.75 versus −3.78. Accordingly, while it cannot be totally ruled out, we dismiss as a major concern the 'potential investor' bias effect on our analysis.

Cameron, C., and P. Trivedi, 2010, *Microeconometrics Using Stata*, Revised Edition (Stata Press Books, College Station, TX).
Cavezzali, E., and U. Rigoni, 2012, Know your client! Investor profile and tailor-made asset allocation recommendations, *Journal of Financial Research* 35, 137–158.
Faff, R., D. Mulino, and D. Chai, 2008, On the linkage between financial risk tolerance and risk aversion, *Journal of Financial Research* 31, 1–23.
Faff, R., T. Hallahan, and M. McKenzie, 2009, Nonlinear linkages between financial risk tolerance and demographic characteristics, *Applied Economic Letters* 16, 1329–1332.
Faff, R., T. Hallahan, and M. McKenzie, 2011, Women and risk tolerance in an aging world, *International Journal of Accounting and Information Management* 19, 100–117.
Grable, J., 2000, Financial risk tolerance and additional factors that affect risk taking in everyday money matters, *Journal of Business and Psychology* 14, 625–630.
Grable, J., R. Lytton, and B. O'Neill, 2004, Projection bias and financial risk tolerance, *Journal of Behavioral Finance* 5, 142–147.
Hanna, S., and S. Lindamood, 2009, Risk tolerance: Cause or effect? Proceedings of the Academy of Financial Services. Available at: www.academyfinancial.org/09Conference/ 09Proceedings/(1C)%20Hanna,%20Lindamood.pdf.
Hoffmann, A., T. Post, and J. Pennings, 2013, Individual investor perceptions and behavior during the financial crisis, *Journal of Banking and Finance* 37, 60–74.
International Organization for Standardization (ISO), 2006, Personal Financial Planning 22222:2005 (ISO, Geneva).
Irwin, C., 1993, Adolescence and risk taking: how are they related?, in: N. J. Bell, R. W. Bell, eds., *Adolescent Risk Taking* (Sage Publications, Newbury Park, CA), 7–28.
Malmendier, U., and S. Nagel, 2011, Depression babies: do macroeconomic experiences affect risk-taking?, *Quarterly Journal of Economics* 126, 373–416.
McCarthy, E., 2009, Time for another look at client risk tolerance?, *Journal of Financial Planning (February)*, 1, 8–24.
McCrae, R., and P. Costa, 1994, The stability of personality: observations and evaluations, *Current Directions in Psychological Science* 3, 173–175.
McInish, T., 1982, Individual investors and risk-taking, *Journal of Economic Psychology* 2, 125–136.
Palsson, A., 1996, Does the degree of risk aversion vary with household characteristics, *Journal of Economic Psychology* 17, 771–787.
Pan, C., and M. Statman, 2010, Beyond risk tolerance: regret, overconfidence, and other investor propensities, Research paper 10-05 (Leavey School of Business, University of Southern California).
Powell, M., and D. Ansic, 1997, Gender differences in risk behaviour in financial decision-making: an experimental analysis, *Journal of Economic Psychology* 18, 605–628.
Roberts, B., and W. Del Vecchio, 2000, The rank-order consistency of personality traits from childhood to old-age: a quantitative review of longitudinal studies, *Psychological Bulletin* 126, 3–25.
Rogers, W., 1993, Regression standard errors in clustered samples, *Stata Technical Bulletin STB* 13, 19–23.
Roszkowski, M., and D. Cordell, 2009, A longitudinal perspective on financial risk tolerance: rank-order and mean level stability, *International Journal of Behavioural Accounting and Finance* 1, 111–134.

Roszkowski, M., M. Delaney, and D. Cordell, 2009, Intraperson consistency in financial risk tolerance assessment: temporal stability, relationship to total score, and effect on criterion-related validity, *Journal of Business and Psychology* 24, 455–467.

Sahm, C. R., 2012, How much does risk tolerance change?, *Quarterly Journal of Finance* 2, 1250020.

Santacruz, L., 2009, Effect of general economic mood on investor risk tolerance – implications for financial planning, *Journal of Applied Science in Southern Africa* 1, 35–42.

Shefrin, H., 2002, *Beyond Greed and Fear: Understanding Behavioural Finance and the Psychology of Investing* (Oxford University Press, New York, NY).

Statman, M., 2010, The cultures of risk tolerance, Working paper (Santa Clara University).

Weber, M., E. Weber, and A. Nosic, 2012, Who takes risks when and why: determinants of changes in investor risk taking, *Review of Finance* 17, 847–883.

Yao, R., and A. Curl, 2011, Do market returns influence risk tolerance? Evidence from panel data, *Journal of Family and Economic Issues* 32, 532–544.

Yao, R., M. Gutter, and S. Hanna, 2005, The financial risk tolerance of Blacks, Hispanics and Whites, *Financial Counselling and Planning* 16, 51–62.

Yook, K., and R. Everett, 2003, Assessing risk tolerance: questioning the questionnaire method, *Journal of Financial Planning* 4, 8–55.