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The Risk Tolerance Measure in the 2016 Survey of Consumer Finances: New, but is it Improved?

Accepted for publication in the Journal of Financial Counseling and Planning

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Abstract

The Survey of Consumer Finances (SCF) has included a 4-level risk tolerance measure since 1983. In 2016, the SCF also included an 11-level risk tolerance measure. We compare the two measures, and develop suggestions for using the new measure. While the new measure is seemingly simpler than the old measure, we demonstrate that it does not have a monotonic relationship with owning stock assets, with a pattern similar to the relationship of the old measure to stock ownership. We also identify complex patterns of factors related to different levels of the new measure, for instance education has a negative relationship at one level but positive at another level. Those using the new measure should consider the complex patterns we demonstrate.
Keywords: Equity ownership; Measure evaluation; Risk tolerance; Survey of Consumer Finances

Introduction

Grable (2000) defined financial risk tolerance as the amount of uncertainty one will accept when making a financial decision. Hanna et al. (2013) noted that a crucial aspect of portfolio selection is risk tolerance, along with other factors such as risk capacity. They reviewed approaches to measurement of risk tolerance, including one used in a national survey in the U.S. The Survey of Consumer Finances (SCF) introduced a risk tolerance measure in the 1983 SCF. Yao et al. (2004) discussed the origin of measure and investigated changes in risk tolerance levels over time and various factors associated with the change. This SCF risk tolerance measure has been used in many empirical studies, both as a dependent variable and as an independent variable. A few other surveys have used risk tolerance questions similar to the SCF risk tolerance measure, for example, the 2011 Chinese Household Finance Survey (Hanna, Kim & Zhang, 2018). In

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2016, the SCF included both the 4-level old measure and, for the first time, a new 11-level type measure. This inclusion of two risk tolerance measures allows for a rare opportunity to compare risk tolerance measures in a large national survey. The new measure seemingly has more precision, with 11 levels rather than the 4 levels in the old measure. However, the old measure has been included in a national survey representing all U.S. households over a 36-year period (1983 to 2019), so there is value in terms of analyses over time. For instance, Yao et al. (2004) noted that responses to the SCF risk tolerance question varied in response to recent changes in the stock market. We created Figure 1 to illustrate how the percent of respondents in the SCF who stated they were unwilling to take any risk in investments, varied from the 1983 survey to the 2016 survey. The pattern is consistent with the pattern identified by Yao et al. (2004), in that the percent unwilling to take any risk tended to decrease after extended periods of stock market increases. This graph also suggests the benefit of continuing with the same survey question of a key variable such as risk tolerance.

[Insert Figure 1]

In this study, we compare distributions of new and old risk tolerance measure, and discuss advantages and disadvantages of the two risk tolerance variables following some validity tests suggested by Grable and Lytton (2001). We present regression analyses on both risk tolerance measures. For the old measure, we use cumulative logistic regressions, following the example of Yao et al. (2004). For the new measure, we use an ordinary least squares (OLS) regression on the measure as a linear term. Many effects of household characteristics on risk tolerance are consistent between the regressions, but some characteristics have inconsistent patterns, for instance, racial/ethnic status effects. We also create categories of the new risk tolerance measure matching the distribution of the old measure, and use cumulative logistic regressions on the new measure. We find some complex patterns of effects. For instance, there is a positive effect of education on the new measure categorized as some risk, but a negative effect of education on substantial risk.

Does the new risk tolerance measure in the SCF have a more consistent relationship with risky behavior than the old risk tolerance measure? For descriptive patterns of stock ownership by categories of the old and of the new risk tolerance measures, those willing to take substantial risk have lower rates of stock ownership than those willing to take average or above average risk, with a similar pattern based on logistic regressions on stock ownership. This pattern cannot be seen if the new measure is used as a linear term. The new measure is simpler than the old, but based on our empirical analyses, we conclude that use of it as a linear measure may hide some complex patterns. Our analyses show no obvious advantage of the new measure over the old risk tolerance measure. We also conclude that researchers using the new risk tolerance measure should not use it as a linear term, but instead specify it as categorical variable, similar to the categories of the old measure, or consider a quadratic specification.

Review of Literature

Measurements of Risk Tolerance

Hanna et al. (2008) and Hanna et al. (2013) discussed how the concept of risk tolerance derives from the economic model of expected utility. Pratt (1964) introduced the coefficient of relative risk aversion as a measure of how averse a consumer is to risk of a change in wealth and/or fluctuation of consumption over time. Pratt (1964) also defined relative risk aversion as the ratio between the second and first derivative of the utility function, and a risk neutral individual will have a relative risk aversion level of 0. Normative recommendations for portfolio allocation (e.g., Viceira, 1999) are based on the concept of risk aversion. Barsky et al. (1997) analyzed responses to hypothetical income gamble questions in the Health and Retirement Study to estimate risk aversion, and proposed that risk tolerance is the inverse of risk aversion.

A variety of risk tolerance measures have been developed. Hanna et al. (2013) reviewed a number of risk tolerance measures, including one developed by Grable and Lytton (2003). Hanna et al. (2008; 2013) suggested that some of these measures reflect not only risk aversion, but also risk capacity, expectations, and feelings about volatility. Only a few risk tolerance measures have been administered in large, nationally representative surveys in the United States. No other risk tolerance measure has been included in national surveys in the United States longer than the SCF risk tolerance measure. The question for a single respondent is "Which of the statements on this page comes closest to the amount of financial risk that you are willing to take when you save or make investments? (1) Take substantial financial risks expecting to earn substantial returns (2) Take above average financial risks expecting to earn above average returns (3) Take average financial risks expecting to earn average returns (4) Not willing to take any financial risks." The survey question is presumably based on actual or potential investment choices. There have been many researchers using the original SCF risk tolerance measure as a dependent variable or as an independent variable.

Studies Using the SCF Risk Tolerance Question as a Dependent Variable

Table 1 lists selected studies that have used the old SCF risk tolerance variable as a dependent or an independent variable. Hawley and Fujii (1993) was one of the earliest empirical articles using the SCF risk tolerance question as a dependent variable, using ordered probit on a 4-level dependent variable. This article explicitly addressed preferences for financial risk. Sung and Hanna (1996) created a binary variable: 0 for no risk and 1 for all the other three answers, while Grable and Lytton (1998) used three categories of risk tolerance, which combined the substantial and above average risk categories. Yao et al. (2004) analyzed a pooled dataset from the 1983 to 2001 SCF. They reported using ordered logistic regression, but found that ordered logit was not appropriate, and instead used a cumulative logit analysis. They created three new binary variables for risk tolerance in their analysis; some risk to represent substantial, above average and average; high risk to represent substantial and above average; and substantial risk. Yao et al. (2005) also analyzed a combination of the 1983 to 2001 SCF datasets, on a sample of households

excluding households with a respondent who reported the "other" racial/ethnic identity. They found that Blacks and Hispanics were less likely to be willing to take some financial risk but more likely to be willing to take substantial financial risk than Whites, controlling for the effects of other household characteristics. Chiang and Xiao (2017) analyzed the 2007-2009 SCF panel data, using the Financial Crisis as an event to investigate respondents' risk tolerance before and after the crisis. They found individuals were less risk tolerant after the crisis in general, and the degree of decrease differed among different demographic groups.

Studies Using the SCF Risk Tolerance Question as an Independent Variable

Selected studies using the old SCF risk tolerance variable as an independent variable are shown in Table 1. Chang (1994) conducted a multivariate analysis on saving behavior using the 1983-1986 SCF panel dataset. Chang found households willing to take above average or substantial risk in 1983, all other things equal, had an increase in non-housing wealth about $30,000 higher than those only willing to take average risk or no risk. Chen and Finke (1996) investigated factors related to households having negative net worth and found no significant association between risk tolerance and the likelihood of having negative net worth. Sung and Hanna (1998) analyzed spouse effects on investment and participation decisions in retirement plans, and found risk tolerance had a positive effect on the husband's investment decision to hold stocks, but this effect did not hold for the wife's stock holdings.

Yuh et al. (1998) analyzed the effect of risk tolerance on the ratio of projected retirement wealth to needs at expected retirement age. They operationalized risk tolerance as a dichotomous variable coded as 0 representing no risk or average risk and as 1 representing above average or substantial risk. They found that risk tolerance had a positive and significant effect on the retirement adequacy ratio with a pessimistic projection. Hanna and Lindamood (2008) analyzed factors related to the ownership of stock assets separately for White, Black, Hispanic, and Other/Asian households. For White households, controlling for other household characteristics, the likelihood of owning stock assets was highest for those with above average risk tolerance, followed by substantial, average, and no risk. For the three other racial/ethnic groups, the patterns were mixed, with those willing to take substantial risk having slightly lower likelihoods of stock asset ownership than those willing to take average risk.

Xiao et al. (2001) discussed the consistency between risk attitude and risk behavior for business-owning families and non-business-owning families. They found that the families owning businesses were willing to take more risk, and the share of risky assets increased when the respondent were more risk tolerant. For the non-business-owning families, higher risk tolerance was less correlated with the ratio of risky assets. Gutter and Fontes (2006) estimated a two-stage model for the ownership of risky assets and for the riskiness of the portfolio allocation, and found that risk tolerance was related to both risky asset ownership and portfolio allocation risk. Hanna et al. (2010) analyzed factors related to the difference in high return investment ownership between racial/ethnic groups. Results from the Blinder-Oaxaca decomposition analyses indicated that Blacks might have the same level of high return investment ownership as

Whites, if they were similar in household characteristics and preferences, including risk tolerance. Similarly, the ownership difference between Hispanic and White households was much smaller than would be concluded from the standard logistic regression. Shin and Hanna (2015) concluded that 20% of the Black-White ownership difference of higher return investments and 27% of the Hispanic-White ownership difference could be explained by differences in risk tolerance, based on a Fairlie decomposition model.

Fisher and Anong (2012) analyzed factors related to saving habits. They divided the saving habits into three types: saving regularly, saving irregularly and not saving. They found that low risk tolerance (not willing to take any risk) significantly decreased the likelihood of saving, both regularly or irregularly, compared to having average risk tolerance. Fisher (2016) examined the difference in credit card use between White and Hispanic households, and found that lower risk tolerance was significantly related to less credit card use for White households, but for not for Hispanic households. Schooley and Worden (2016) examined the relationship between perceived and realized risk tolerance before and after the Great Recession. They considered the SCF measure as "perceived risk tolerance", and created a variable for equity as a percent of financial assets, referring to it as "realized risk tolerance." They found that the decrease of perceived risk tolerance after the recession led to a reduction of realized risk tolerance.

Summary of Literature Review

Table 1 includes research studies that used the old SCF risk tolerance variable, and represents only a small fraction of all studies that have used this variable. Researchers have used a variety of specifications of the variable in empirical analyses, including combining categories and using it as a linear (1, 2, 3, 4) variable. A number of important respondent characteristics have been found to affect risk tolerance, including gender, racial/ethnic status, and education. The old risk tolerance variable has been found to affect investment choices, portfolio allocation, savings habits, having negative net worth, and credit card use. Clearly, it has been an important risk tolerance measure, despite criticisms of its validity and reliability (e.g., Grable & Schumm, 2010).

The SCF included both the old and the new risk tolerance measures in the 2016 and the 2019 surveys (NORC, 2019). Should the Survey of Consumer Finances continue to include the old risk tolerance question after the 2019 survey, or should it replace it with the new risk tolerance measure? How should researchers use the new SCF risk tolerance measure? In the current study, we compared the two measures, both in terms of factors related to each measure, and the effects of each measure on ownership of stock assets. We also created categories of the new risk tolerance measure, based on the distribution of responses comparable to the old risk tolerance measure, and tested use of the categorical version of the new measure, both as dependent variables and as independent variables.

[Insert Table 1]

Methods

Dataset and Sample Selection

We used the most recent release of the Survey of Consumer Finances (SCF) dataset, which has been administered every three years by Federal Reserve Board since 1983. The SCF contains rich information of U.S. households such as income, assets, liabilities, and other financial characteristics (Bricker et al., 2017). For our analyses, we included all households from the 2016 SCF, excluding imputed cases of risk tolerance variables (Hanna et al., 2018). The total sample size of the 2016 SCF is 6,248 and our analytic sample included 6,227 households.

Dependent Variables

The main dependent variables are two different measures of financial risk tolerance collected in the 2016 SCF. The first dependent variable is a new measure of risk tolerance (X7557) with 11 levels from 0 to 10, newly added to the 2016 SCF. The respondent was asked "On a scale from zero to ten, where zero is not at all willing to take risks and ten is very willing to take risks, what number would you (and your {husband/wife/partner}) be on the scale?"

The second dependent variable, the "old" measure of risk tolerance (X3014) has been included in the SCF since 1983. It is a 4-level risk tolerance measure, which indicates the respondent's willingness to take substantial, above-average, average, or no financial risk for saving or investment decisions. Following previous studies on risk tolerance, e.g., Yao et al. (2004), for logistic regressions on risk tolerance, we created three composite variables of risk tolerance; substantial risk tolerance (i.e., the respondent is willing to take substantial financial risk), high risk tolerance (i.e., the respondent is willing to take substantial or above-average financial risk) and some risk tolerance (i.e., the respondent is willing to take substantial or above-average or average financial risk tolerance). For our analyses, we excluded cases with values of the shadow variables for each risk tolerance variable (J7557 and J3014) greater than 99 (Hanna, Kim, & Lindamood, 2018).

For additional analyses, we also created a categorical version of the new risk tolerance measure, based on matching the distribution of the 11-level scale with the distribution of the old risk tolerance measure. Lastly, we also defined a dummy variable for equity (stock asset) ownership, and included logistic regressions on that dummy variable, controlling for different specifications of the risk tolerance variables, as well as household characteristics. A logistic regression on equity ownership using a quadratic specification of the new risk tolerance variable, available from authors, has results that also support a non-linear relationship with equity ownership.

Independent Variables

We included a set of independent variables based on the existing literature on risk tolerance. Independent variables include age of respondent, education years of respondent, household type (couple, single), gender (male, female), racial/ethnic status of respondent (White, Black,

Hispanic, Asian/others), employment status of respondent, homeownership (yes/no), log of household income, log of positive and negative net worth, health status of respondent (excellent, good, fair, poor), expectation for a substantial inheritance (yes/no), current income relative to normal income (higher, same, lower), and expectation about future income (sure grow, sure same, sure less, not sure). Details of the variable coding are available from the authors.

Empirical Model Specification

Because the old SCF risk tolerance has only 4 levels, it is a limited dependent variable, so use of Ordinary Least Squares (OLS) regression would be inappropriate. Therefore, the use of a technique such as ordered logistic regression might seem an appropriate statistical technique. However, the underlying assumption about the proportional odds across four response categories is rejected by the Score test ($p<.0001$). Instead, we used cumulative logistic regressions following previous SCF studies analyzing the old SCF risk tolerance measure (e.g., Yao et al., 2004; Yao & Hanna, 2005). Our method is similar to the approach by Yao et al. (2004) in defining three binary dependent variables. For the new risk tolerance measure (11-level measure), we used an OLS regression model to analyze factors associated with the level of risk tolerance. In addition, we used cumulative logistic regression for the created 4-level risk variable based on the new measure.

Validity of two risk tolerance measures in the SCF

In order to assess and evaluate validity of the old and the new risk tolerance measures in the SCF, we adopted the frameworks used by Grable and Lytton (2001, 2003). Grable and Lytton (2001) discussed four validity issues related to the SCF question: (a) face validity, (b) content validity, (c) construct validity, and (d) criterion validity, and Grable and Lytton (2003) further discussed the differences among the four types of validity as follows. Face validity is a measure showing whether the content seems to fit the aim as the name suggested, decided by the nonexperts. Content validity also shows whether the content is consistent with the aim, but the analyses are more formally reviewed by the experts in the area. Construct validity is the measure indicating the consistency of the concept among multiple situations. Criterion validity measures the accuracy of the concept when comparing this question in the survey to other existed questions which have been proofed to be valid. Regarding the reliability of the SCF measure, Grable and Schumm (2010) used their created 13-item combined risk tolerance measure to estimate the reliability of the old risk tolerance measure in the SCF. Because the SCF is designed as a cross-sectional survey (i.e., it does not have multiple responses over a period of time), it is impossible to directly test reliability (Litwin, 1995). Only two risk tolerance measures are available in the 2016 SCF and both of them are based on single-item scales, so we cannot adopt Grable and Schumm (2010)'s method to estimate the reliability of the new measure. However, we discuss four validity issues for the old and new risk tolerance measures.

Because the SCF risk tolerance measure has been used in many empirical studies, as Grable and Lytton (2001) discussed, it is plausible that financial planning researchers and

practitioners would generally agree that the SCF question is valid for use in measuring subjective risk tolerance, so there is face validity. With respect to the content validity, we discuss advantages and disadvantages of the two risk tolerance variables in various aspects. Given the limitation of the dataset, we could not directly test the third issue. Instead, similar to Grable and Lytton (2001), we tested the convergent validity of the new risk tolerance measure by estimating the correlation between the two risk tolerance measures. Lastly, similar to Grable and Lytton (2003), we tested the issue of criterion validity by utilizing logistic regressions on equity ownership.

Results

Descriptive Results

Table 2 presents distributions of the two risk tolerance measures. The mean and median of the new risk tolerance question (11-level measure) were 4.3 and 5.0, respectively. About 15% gave a response of not willing to take any financial risk. 39.4% gave a response of 3 or below while 12.1% gave a response of 8 or above. With respect to the old question (4-level measure), 40.8% said they were not willing to take any investment risk, 38.6% said average risk, 16.4% said above average risk, and 4.2% gave a response of being willing to take substantial risk. We also created categories of the new risk tolerance measure that approximately matched categories of the old measure, with the results shown in Table 3. For instance, 4.15% of respondents gave a response of substantial to the old risk tolerance question, and 3.52% gave a response of 10 to the new risk tolerance question. We refer to the categories created for the new risk tolerance measure with the same descriptions as used with the old risk tolerance measure, so, for example, we refer to a response of 10 to the new question as substantial risk tolerance. For the new measure, 18.38% gave responses of 9, 8, or 7, and 16.44% gave a response of above average to the old question, so we refer to the responses of 9, 8, or 7 to the new question as above average risk tolerance. We refer to responses of 6, 5, or 4 to the new question as average risk tolerance, and 3, 2, 1, or -1 as no risk, since the distributions closely match these categories for the old risk tolerance question.

[Insert Table 2 & Table 3]

To test the convergent validity of old and new risk tolerance measures, we used OLS regression with the 11-level financial risk tolerance variable as a function of the 4-level financial risk tolerance as shown in Table 4. As the level of old risk tolerance measure increases, the new risk tolerance measure increases. Specifically, respondents willing to take substantial risk, above average risk and average risk had 4.2, 3.6, and 2.2 points higher financial risk tolerance than those not willing to take any financial risk.

[Insert Table 4]

The graph in Figure 2 provides some insights into the criterion validity of the old and new risk tolerance measures, showing equity (stock asset) ownership percentages by categories of the old and the new risk tolerance measures. For both the old and the new measures, the equity

ownership rates were very low for those in the "no risk" categories, with 30% for the old "no risk" category and 38% for those in the new "no risk" category. For the old average risk category, 67% owned stock assets, while in the new average risk category, 61% owned stock assets. For the old "above average" risk category, 71% owned stock assets, while in the new "above average" risk category, 66% owned stock assets. Therefore, for the three lowest old and new risk tolerance categories, a plausible case can be made for criterion validity, as the patterns are consistent with normative models from economic theory, with higher risk tolerance being related to a higher rate of owning a risky asset (Viceira, 1999; Hanna & Chen, 1997). However, for both the old and the new measures, the rate of equity ownership was significantly lower for those in the highest risk tolerance category, substantial risk. We explore this issue further, with logistic regressions on equity ownership.

[Insert Figure 2]

Multivariate Analyses

OLS and Logistic Regressions on Financial Risk Tolerance

Table 5 shows the results for OLS and three logistic regressions, with the following dependent variables, (A) the new financial risk tolerance 11-level scale and three cumulative variables based on the old risk tolerance measure, i.e., (B) some risk, (C) high risk and (D) substantial risk. Many effects of household characteristics were consistent with the logistic regressions on the composite measures based on the old risk tolerance measure (Table 5), counting effects that were not significant in both or significant with same sign in both as consistent.

Age was negatively related to risk tolerance in regressions (A), (B), (C), and (D). We tried regressions with both age and age squared, but for most of the regressions, only one of the age terms was significant, and in one, neither term was significant. Education was positively related to the risk tolerance measure in regressions (A), (B), (C), and (D). Female respondents had lower financial risk tolerance than male respondents. Racial/ethnic status variables had a somewhat mixed pattern. Black and Hispanic respondents had higher levels of risk tolerance than White respondents (new measure and substantial risk of old measure), but Hispanic respondents had a lower likelihood of some risk than White respondents. The inconsistent effects of Hispanic status on different levels of the old risk tolerance were similar to the inconsistent effects first reported by Yao et al. (2004). Self-employed respondents had higher risk tolerance than employee respondents in all of the regressions. The level of new financial risk tolerance and the likelihood of having some, high, and substantial risk tolerance based on the old measure increased strongly with net worth as net worth increased from zero, but it also increased strongly as net worth decreases from zero. Lastly, respondents who were sure that income will grow had a higher level of financial risk tolerance than other categories in all of the regressions in Table 5.

[Insert Table 5]

Table 6 shows logistic regressions on risk tolerance based on cumulative categories of the new risk tolerance measure. Regression (A) is on having some risk tolerance, having a risk tolerance score above 3. Regression (B) is on having high risk tolerance, having a score above 6. Regression (C) is on having substantial risk tolerance, having a score of 10. Effects that were

inconsistent between the logistic regressions in Table 6 and those in Table 5 included racial/ethnic status effects. In particular, the effect of having a Black respondent on the "some risk" category based on the new measure was positive, but the effect on the "some risk" category based on the old measure was negative and not significant. The effect of Hispanic status on "some risk" based on the new measure was positive but the effect on "some risk" based on the old measure was negative.

[Insert Table 6]

Logistic Regressions on Equity Ownership

In order to provide an approach to evaluating the criterion validity of the risk tolerance measures, we conducted multivariate analyses of the effect of risk tolerance and other household characteristics on the likelihood of owning stock assets, also referred to as equity ownership. Table 7 shows results from three logistic regressions on equity ownership with the new measure as a linear term, with the new measure in categories roughly matching the old measure, and with the old measure of risk tolerance, controlling for other household characteristics. All three regressions had the same independent variables, except for the risk tolerance variables. Regression (A) controlled for the linear version of the new risk tolerance measure, with levels ranging from 0 to 10. Regression (B) controlled for dummy variables representing the new categories we created (Table 3), for no risk, average risk, and substantial risk, with the reference category being above average risk. Regression (C) controlled for dummy variables for the levels of the old risk tolerance measure, for no risk, average risk, and substantial risk, with the reference category being above average risk. In Regression (A), the coefficient of the new risk tolerance variable with the 0 to 10 scale reflects the implicit assumption of a linear relationship with the log odds of equity ownership. The effect of risk tolerance was positive and significant, with an implicit assumption of a monotonic relationship, with the likelihood of equity ownership increasing with risk tolerance.

In both Regression (B) and Regression (C), there was not a monotonic relationship between risk tolerance and the likelihood of equity ownership, but instead an increase in likelihood going from no risk to average risk, and the likelihood of equity ownership for above average risk was not significantly different from the likelihood for average risk for either Regression (B) or Regression (C). The likelihood of equity ownership for substantial risk was significantly lower than the likelihood for above average risk for both Regression (B) and Regression (C). Figure 3 shows the calculated likelihood of owning stock assets based on Regressions B and C, for each level of the categories of risk tolerance, assuming mean values of the other independent variables. The patterns are somewhat similar to the unconditional patterns shown in Figure 2. For the new risk tolerance measure, the likelihood of equity ownership increased from no risk to average risk, did not increase between average risk tolerance and above average, significantly decreased between above average and substantial risk tolerance, and the likelihood for substantial risk tolerance was not significantly different from the likelihood for no risk. Significance tests for comparing coefficient of substantial to no risk are not shown in Table

6, but based on separate calculations. In contrast, for the old measure, the equity ownership likelihood increased from no risk to average risk, and did not significantly change from average risk to above average (two-tail p = 0.13), and the likelihood decreased from above average to substantial. For the old measure, the equity ownership likelihood was higher for substantial risk than for no risk.

[Insert Figure 3]

The effects of the other independent variables in Regressions (A), (B), and (C) in Table 7 were generally similar. For instance, the combined effects of age and age squared imply that the likelihood of equity ownership increased with age up to 46, then decreased with age, for Regression (A), and increased with age up to 47 for Regression (B), and increased with age up to 53 for Regression (C). For other independent variables, there was consistency in which variables had significant differences, with a partial exception for excellent health, which had a positive effect on equity ownership in all three regressions, but for Regression (C), the p value was slightly above the conventional 0.05 level. In all three regressions, the effects of the racial/ethnic status of the respondent (compared to White respondents) were negative and significant, with similar magnitudes.

Model fits from the three logistic regressions indicate that the new measure had a slightly lower explanatory power on equity ownership than with the old measure, with a pseudo-R squared of 0.450 for the logit with the new risk tolerance measure as a linear term, 0.454 for the logit with categorical variables based on the new measure, and 0.464 for the logit with categorical variables based on the old measure. A similar pattern is found with another commonly used indicator of fit for logistic regressions, the concordance ratio, with a value of 89.9% for the regression with the new risk tolerance measure as a linear term (A), 90.0% for the regression with categorical variables based on the new measure (B), and 90.3% for the regression with categorical variables based on the old measure (C).

[Insert Table 7]

Conclusions

While the new 11-level risk tolerance measure is seemingly more precise than the old measure, in terms of having 11 levels rather than 4 levels, it is not clear that it is a more meaningful measure to many respondents. For the new measure, we discussed the face and content validity and tested convergent validity using a regression on the new measure as a function of levels of the old measure (Table 4). We also tested criterion validity with logistic regressions of the new measure (both as a linear term and as categorical variables) on equity ownership and of the old measure on equity ownership (Table 7). The complex patterns of effects of key household characteristics, especially education, and racial/ethnic status, on the cumulative levels of the old and the new measure, especially in terms of the substantial level, suggest that using the simple 11-level measure may be masking some complex differences in perception.

None of our analyses provide evidence for superior criterion validity of the new measure compared to the old measure. Use of either risk tolerance variable as a linear term in a logistic regression on equity ownership is a specification error, because Table 7 shows that there is a non-linear effect of risk tolerance on equity ownership, with those with substantial risk tolerance having a significantly lower likelihood of equity ownership than those with lower levels of risk tolerance. Examination of Figure 3 is suggestive of lower criterion validity of the new risk tolerance measure even with our new created categories, as the likelihood of equity ownership does not increase between average risk tolerance and above average, significantly decreases between above average and substantial risk tolerance, and likelihood for substantial is not significantly different than for no risk. In contrast, for the old measure, the equity ownership likelihood increases from no risk to average risk, and from average risk to above average, though the likelihood does decrease significantly from above average to substantial. For the old measure, the equity ownership likelihood is significantly higher for substantial risk tolerance than for no risk. Obviously, the drop in calculated equity ownership from above average to substantial risk tolerance for both measures indicates limited criterion validity for both the old and new risk tolerance measures.

In this study, we did not explicitly consider a potential endogeneity issue when analyzing the relationship between risk tolerance and equity ownership. For instance, the experience of investment success/failure may modify individuals' risk preference (Fossen, 2011). Instead, we focused on investigating the difference between the two risk tolerance measures. Future research on the effect of risk tolerance on financial decisions should consider the possibility of endogenous relationships between risk tolerance and behaviors.

Our analyses provide no evidence that the new SCF risk tolerance measure is better than the old SCF risk tolerance measure. The old measure is less abstract than the new measure because of the more meaningful descriptions. Researchers using the new risk tolerance measure as an independent variable should not use it as a linear term, but should create categorical variables based on ranges of the risk tolerance score, for instance, perhaps matching the distribution of the old measure as we did in our research. We conclude that it may be better to retain the old SCF risk tolerance measure in the Survey of Consumer Finances, as doing so will allow for comparisons over decades of household survey datasets.

Financial advisors should be cautious in drawing conclusions from risk tolerance scores, because, as our results illustrate, it might not be true that a higher risk tolerance score means riskier behavior. Future research is needed to provide more insights into some of the puzzling patterns we found. Analyses of the 2019 Survey of Consumer Finances dataset can provide additional insights into the reliability of the new 11-level risk tolerance measure. Analyses of risky behavior other than equity ownership might also provide additional insights.

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Table 1. Selected Empirical Studies Using the Old SCF Risk Tolerance Measure as a Dependent or an Independent Variable

Authors (year)	**Risk tolerance used as**	**Dependent Variable**	**Dataset**
Hawley & Fujii (1993)	Dependent variable	risk tolerance	1983 SCF
Chang (1994)	Independent variable	saving behavior	1983-1986 SCF
Chen & Finke (1996)	Independent variable	net worth	1992 SCF
Sung & Hanna (1996)	Dependent variable	risk tolerance	1992 SCF
Grable & Lytton (1998)	Dependent variable	risk tolerance	1992 SCF
Sung & Hanna (1998)	Independent variable	retirement funds	1992 SCF
Yuh et al. (1998)	Independent variable	retirement wealth	1995 SCF
Yao et al. (2004)	Dependent variable	risk tolerance	1983, 89, 92, 95, 98, 2001 SCF
Yao et al. (2005)	Dependent variable	risk tolerance	1983, 89, 92, 95, 98, 2001 SCF
Yao & Hanna. (2005)	Dependent variable	risk tolerance	1983, 89, 92, 95, 98, 2001 SCF
Gutter & Fontes (2006)	Independent variable	risky asset ownership	2004 SCF
Hanna et al. (2010)	Independent variable	risky asset ownership	2004 and 2007 SCF
Fisher & Anong (2012)	Independent variable	saving habit	2007 SCF
Shin & Hanna (2015)	Independent variable	risky asset ownership	2010 SCF
Fisher (2016)	Independent variable	credit card use	2013 SCF
Schooley & Worden (2016)	Independent variable	realized portfolio risk	2007-2009 SCF Panel

Table 2. Distribution of Two Risk Tolerance Variables, 2016 SCF

Category	**11-level risk tolerance measure (X7557)**	**Category**	**4-level risk tolerance measure (X3014)**
Mean (median)	4.25 (5.00)		
10, Very willing to take risks	3.52%	Take substantial financial risks	4.15%
9	2.01%	Take above average financial risks	16.44%
8	6.55%	Take average financial risks	38.57%
7	9.82%	Not willing to take any financial risks	40.84%
6	9.87%		
5	20.06%	**Cumulative category**	
4	8.74%	Take substantial financial risk	4.15%
3	11.83%	Take above average financial risk or above (high risk)	20.59%
2	7.90%	Take average financial risk or above average or substantial (some risk)	59.16%
1	4.73%		
(-1)* Not at all willing to take financial risks	14.97%		

Weighted results, N=6,227. *Authors recoded the lowest value to zero. Imputed cases of two risk tolerance variables (J values>99) were excluded (Hanna, Kim, & Lindamood, 2018).

Table 3. Categorization of New Risk Tolerance Measure into Categories Matching Old Risk Tolerance Variable, 2016 SCF

Category	**Distribution of new risk tolerance measure categories for X7557**	**Category**	**4-level risk tolerance measure (X3014)**
10 = substantial	3.52%	Take substantial financial risks	4.15
9, 8 or 7 = above average	18.38%	Take above average financial risks	16.44
6, 5 or 4 = average	38.67%	Take average financial risks	38.57
3, 2 or 1 or -1 = no risk	39.43%	Not willing to take any financial risks	40.84

Weighted results, N=6,227. * Imputed cases of two risk tolerance variables (J values>99) were excluded (Hanna, Kim, & Lindamood, 2018).

Table 4. OLS Regression on 11-level Risk Tolerance, 2016 SCF

Variables	**Coefficient**	**Standard error**	**p-value**
4-level risk tolerance (reference: no risk)			
Substantial risk	4.2061	0.1523	<.0001
Above average risk	3.5501	0.0714	<.0001
Average risk	2.1759	0.0579	<.0001
Intercept	2.6513	0.0414	<.0001
Adjusted R-squared	0.2776		
F-value	798.56 (p-value <.0001)		

Repeated Imputation Inference (RII) analysis with population and bootstrap weights. Imputed cases of two risk tolerance variables were excluded.

Table 5. OLS and Logistic Regressions on Financial Risk Tolerance, 2016 SCF

	(A) OLS regression on risk tolerance (new)		(B) Logistic regression on some risk (old)		(C) Logistic regression on high risk (old)		(D) Logistic regression on substantial risk (old)	
Variables	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
Respondent age	-0.0199	<.0001	-0.0358	<.0001	-0.0293	<.0001	-0.0303	<.0001
Respondent education years	0.0902	<.0001	0.1575	<.0001	0.0660	<.0001	0.0138	0.5458
Couple (ref.: sing.)	-0.1947	0.0601	0.0892	0.3917	-0.2195	0.0242	-0.2825	0.1016
Respondent female	-1.0736	<.0001	-0.4275	<.0001	-0.7162	<.0001	-0.7722	0.0002
Couple*Female	0.4283	0.0017	-0.1099	0.4090	0.2625	0.0600	0.1964	0.4728
Racial/ethnic status of respondent (ref.: White)								
Black	0.5138	<.0001	-0.0880	0.3521	0.1083	0.3113	0.5761	0.0022
Hispanic	0.2819	0.0140	-0.3898	0.0003	0.1052	0.3746	0.7373	0.0002
Asian/others	0.2093	0.1499	-0.2895	0.0555	0.0172	0.8990	-0.0168	0.9491
Presence of a child under 18 (ref.: No)	0.0416	0.6062	-0.0952	0.2483	-0.1751	0.0234	-0.1284	0.3683
Employment status of respondent (ref.: Salaried worker)								
Self-employed	0.6428	<.0001	0.0961	0.3760	0.1999	0.0253	0.6178	0.0001
Not working	0.0514	0.6182	-0.1755	0.0693	0.0623	0.5711	0.4252	0.0320
Retired	-0.1549	0.1570	-0.0906	0.3956	-0.1813	0.1165	0.0639	0.7955
Homeownership (ref.: No)	-0.1011	0.2771	-0.1587	0.0816	-0.2703	0.0039	-0.2901	0.1030
Log of income	0.0279	0.1227	0.0563	0.0030	-0.0003	0.9837	-0.0050	0.8393
Log of positive net worth	0.2265	<.0001	0.2530	<.0001	0.2085	<.0001	0.1913	<.0001
Log of negative net worth	0.2028	<.0001	0.2305	<.0001	0.1786	<.0001	0.1858	<.0001
Health status of respondent (ref.: Fair health)								
Excellent health	0.5711	<.0001	0.3859	0.0001	0.2507	0.0167	0.0738	0.6987
Good health	0.3012	0.0009	0.2273	0.0070	0.1071	0.2706	-0.0840	0.6405
Poor health	-0.1009	0.5421	-0.2140	0.1751	-0.2022	0.3343	-0.1204	0.7517

	(A) OLS regression on risk tolerance (new)		(B) Logistic regression on some risk (old)		(C) Logistic regression on high risk (old)		(D) Logistic regression on substantial risk (old)	
Variables	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
Expect a substantial inheritance (ref.: No)	0.1164	0.2205	0.4160	0.0001	0.0953	0.2677	0.0529	0.7409
Current income relative to normal (ref.: Same)								
Higher	-0.0163	0.8807	0.2270	0.0511	0.1307	0.1980	-0.0465	0.8104
Lower	0.3932	<.0001	0.0156	0.8641	0.2264	0.0122	0.3039	0.0505
Future income (ref.: Sure grow)								
Sure same	-0.4760	<.0001	-0.4431	<.0001	-0.3433	0.0001	-0.6193	0.0003
Sure less	-0.6249	<.0001	-0.4944	0.0001	-0.2019	0.0643	-0.2191	0.2861
Not sure	-0.1625	0.0993	-0.4572	<.0001	-0.0891	0.3272	-0.0239	0.8769
Intercept	2.6543	<.0001	-1.6556	<.0001	-1.7261	<.0001	-2.6406	<.0001
Model fit								
Adjusted R-squared or Concordance rate	0.2146		81.2%		72.8%		72.7%	

Unweighted results with RII technique. Imputed cases of two risk tolerance variables were excluded. Coefficients are unstandardized.

Table 6. Logistic Regressions on Financial Risk Tolerance (New Measure with Categories Matching Old Measure), 2016 SCF

	(A) Logistic regression on some risk (new)		(B) Logistic regression on high risk (new)		(C) Logistic regression on substantial risk (new)	
Variables	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
Respondent age	-0.0150	<.0001	-0.0108	0.0004	0.0052	0.3709
Respondent education years	0.0957	<.0001	0.0275	0.0300	-0.0521	0.0247
Couple (ref.: sing.)	-0.0491	0.6158	-0.2119	0.0262	-0.2028	0.2477
Respondent female	-0.6474	<.0001	-0.8090	<.0001	-0.6617	0.0014
Couple*Female	0.2217	0.0748	0.2925	0.0317	0.1362	0.6187
Racial/ethnic status of respondent (ref.: White)						
Black	0.3916	<.0001	0.3984	<.0001	0.8006	<.0001
Hispanic	0.2725	0.0085	0.1837	0.1094	0.3787	0.0882
Asian/others	0.1456	0.3082	0.2680	0.0424	0.3713	0.1341
Presence of a child under 18 (ref.: No)	-0.0017	0.9825	0.1015	0.1855	0.0472	0.7531
Employment status of respondent (ref.: Salaried worker)						
Self-employed	0.4337	<.0001	0.4572	<.0001	0.7602	<.0001
Not working	0.0028	0.9753	0.1683	0.1102	0.5916	0.0031
Retired	-0.1264	0.2026	-0.1987	0.0698	0.0452	0.8374
Homeownership (ref.: No)	0.0227	0.7867	-0.1722	0.0607	-0.6332	0.0004
Log of income	0.0574	0.0010	0.0079	0.6233	-0.0187	0.3804
Log of positive net worth	0.1461	<.0001	0.2012	<.0001	0.2076	<.0001
Log of negative net worth	0.1324	<.0001	0.1787	<.0001	0.2015	<.0001
Health status of respondent (ref.: Fair health)						
Excellent health	0.2925	0.0017	0.4349	<.0001	0.2774	0.1440
Good health	0.1819	0.0223	0.1885	0.0464	-0.0398	0.8255
Poor health	-0.1440	0.3189	0.1674	0.3575	0.1653	0.6069

	(A) Logistic regression on some risk (new)		(B) Logistic regression on high risk (new)		(C) Logistic regression on substantial risk (new)	
Variables	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
Expect a substantial inheritance (ref.: No)	0.0820	0.3801	0.0500	0.5651	-0.1981	0.2811
Current income relative to normal (ref.: Same)						
Higher	0.0483	0.6465	-0.0509	0.6214	-0.6907	0.0056
Lower	0.1813	0.0362	0.3687	<.0001	0.4192	0.0047
Future income (ref.: Sure grow)						
Sure same	-0.2259	0.0172	-0.3718	<.0001	-0.6485	<.0001
Sure less	-0.4108	0.0002	-0.4029	0.0002	-0.9508	<.0001
Not sure	-0.0410	0.6766	-0.0705	0.4329	-0.2969	0.0535
Intercept	-1.5053	<.0001	-2.2775	<.0001	-3.2874	<.0001
Model fit						
Concordance rate	73.5%		73.2%		74.5%	

Unweighted results with RII technique. Imputed cases of two risk tolerance variables were excluded. Coefficients are unstandardized.

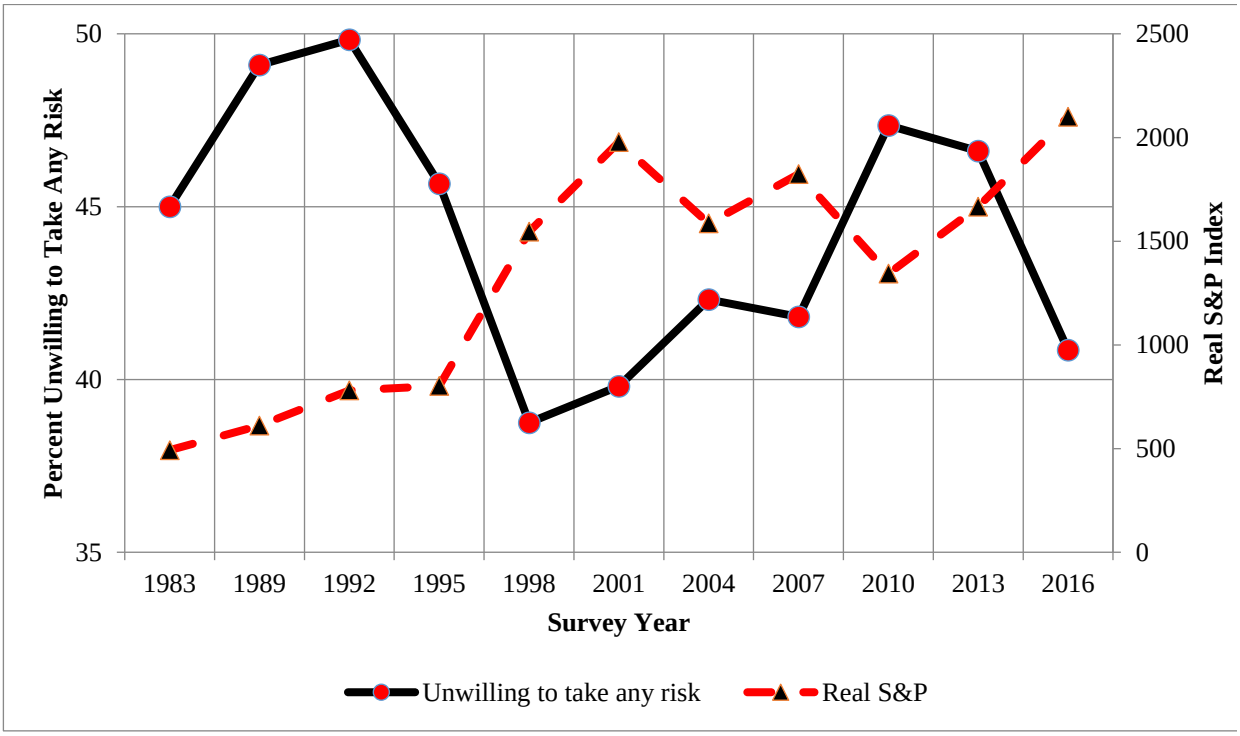
Table 7. Logistic Regressions on Equity Ownership, 2016 SCF

	(A) 11-level risk tolerance measure (new)		(B) 4 point risk tolerance (new)		(C) 4 point risk tolerance (old)	
Variables	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
11-level risk tolerance measure	0.0843	<.0001	-	-	-	-
4-level risk tolerance (reference: above average risk)						
Substantial risk	-	-	-0.5173	0.0093	-0.4855	0.0153
Average risk	-	-	0.0280	0.7909	-0.1739	0.1297
No risk	-	-	-0.5744	<.0001	-1.1088	<.0001
Respondent age	0.0350	0.0160	0.0362	0.0132	0.0379	0.0098
Respondent age squared/10000	-3.7777	0.0059	-3.8564	0.0051	-3.5585	0.0100
Respondent education years	0.1686	<.0001	0.1659	<.0001	0.1508	<.0001
Couple (ref.: sing.)	0.3032	0.0092	0.2894	0.0131	0.2885	0.0149
Respondent female	0.1363	0.2567	0.1126	0.3502	0.1372	0.2633
Couple*Female	-0.1324	0.3843	-0.1134	0.4575	-0.0755	0.6244
Racial/ethnic status of respondent (ref.: White)						
Black	-0.5346	<.0001	-0.5281	<.0001	-0.4726	<.0001
Hispanic	-0.6980	<.0001	-0.7051	<.0001	-0.5798	<.0001
Asian/others	-0.6669	0.0001	-0.6759	0.0001	-0.6023	0.0004
Presence of a child under 18 (ref.: No)	0.0435	0.6482	0.0513	0.5919	0.0567	0.5582
Employment status of respondent (ref.: Salaried worker)						
Self-employed	-1.2638	<.0001	-1.2316	<.0001	-1.2249	<.0001
Not working	-1.1239	<.0001	-1.1261	<.0001	-1.1018	<.0001
Retired	-0.8633	<.0001	-0.8653	<.0001	-0.8773	<.0001
Homeownership (ref.: No)	-0.1621	0.1244	-0.1914	0.0708	-0.1300	0.2223
Log of income	0.1710	<.0001	0.1635	<.0001	0.1643	<.0001
Log of positive net worth	0.5419	<.0001	0.5513	<.0001	0.5185	<.0001
Log of negative net worth	0.4954	<.0001	0.5032	<.0001	0.4731	<.0001
Health status of respondent (ref.: Fair health)						
Excellent health	0.2415	0.0472	0.2591	0.0340	0.2262	0.0650
Good health	0.2239	0.0246	0.2232	0.0255	0.2050	0.0426
Poor health	-0.0337	0.8637	-0.0121	0.9509	0.0214	0.9152
Expect a substantial inheritance (ref.: No)	0.2155	0.0688	0.2117	0.0750	0.1517	0.2048
Current income relative to normal (ref.: Same)						

	(A) 11-level risk tolerance measure (new)		(B) 4 point risk tolerance (new)		(C) 4 point risk tolerance (old)	
Variables	**Coeff.**	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
Higher	0.3003	0.0251	0.2922	0.0302	0.2722	0.0456
Lower	-0.2986	0.0047	-0.2727	0.0102	-0.2798	0.0091
Future income (ref.: Sure grow)						
Sure same	-0.0934	0.4366	-0.1298	0.2816	-0.0809	0.5055
Sure less	-0.1267	0.3647	-0.1544	0.2709	-0.0996	0.4822
Not sure	-0.3775	0.0019	-0.4054	0.0009	-0.3368	0.0062
Intercept	-8.3827	<.0001	-7.7232	<.0001	-7.2782	<.0001
Model fit						
pseudo R-squared	0.4502		0.4536		0.4637	
Concordance rate	89.9%		90.0%		90.3%	

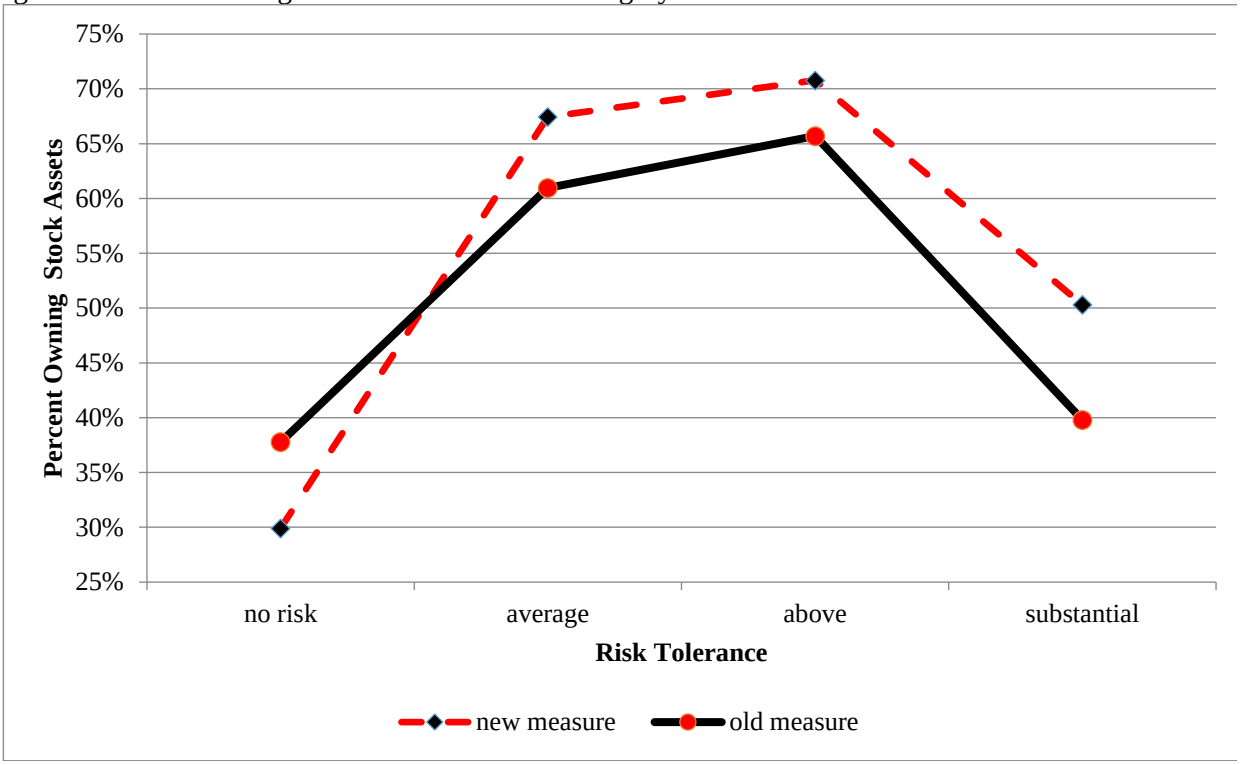
Unweighted results with RII technique. Imputed cases of two risk tolerance variables were excluded. Coefficients are unstandardized.

Figure 1. Percent Unwilling to Take Any Risk With Investments and real S&P 500, 1983-2016 SCF Datasets



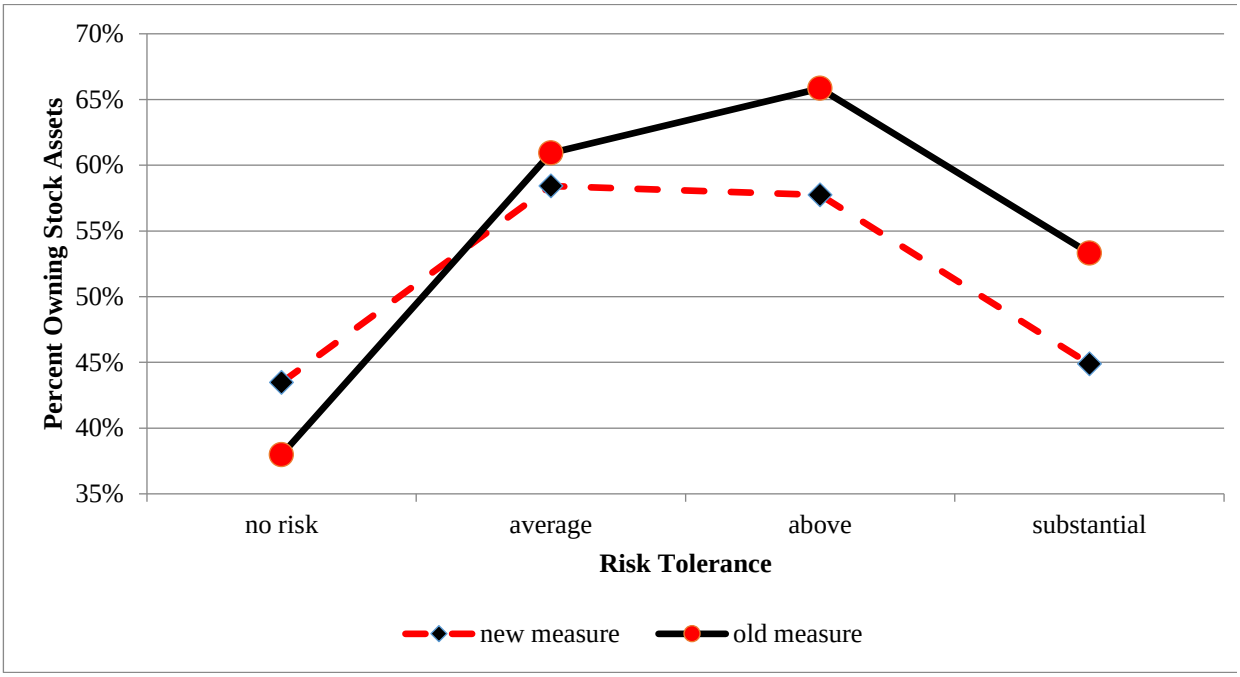
Note: Created by authors. Estimates for 1983 to 1989 from Yao et al. (2004). Estimates for 1992, 1995, 1998, 2001, 2004, 2007, 2010, 2013, and 2016 SCF datasets by authors. All estimates weighted. Shiller's real S&P 500 index for January of each survey year was used (Full data is available at http://www.econ.yale.edu/~shiller/data/ie_data.xls).

Figure 2. Percent Owning Stock Assets for Each Category of Old and New Risk Tolerance Measures



Note: New risk tolerance measure categorized as shown in Table 3.

Figure 3. Calculated Likelihood of Owning Stock Assets for Each Category of Old and New Risk Tolerance Measures



Note: Calculated based on logistic regression (B) (new measure with 4 categories) and logistic regression (C) (old measure) in Table 6, at mean values of all other independent variables.