FINANCIAL SERVICES REVIEW

Financial Services Review 27 (2018) 279-302

Factors related to the risk tolerance of households in China and the United States: Implications for the future of financial markets in China

Sherman D. Hanna[a,*], Kyoung Tae Kim[b], Lishu Zhang[c]

[a]*Human Sciences Department, Ohio State University, 1787 Neil Avenue, Columbus, OH 43210, USA*
[b]*Department of Consumer Sciences, 312 Adams Hall, Box 870158, University of Alabama, Tuscaloosa, AL 35487, USA*
[c]*Department of Economics, ShenZhen University, 3688 Nanhai Avenue, Nanshan, Shenzhen, GuangDong, China*

Abstract

We analyzed factors related to the financial risk tolerance of Chinese households, using the 2011 China Household Finance Survey (CHFS). The risk tolerance question was similar to one in the U.S. Survey of Consumer Finances (SCF), and we found that CHFS respondents had slightly higher risk tolerance than SCF respondents, but the percentage of households with stock assets was 9%, compared with 49% in the United States. Our multivariate analyses found many household characteristics in the CHFS had effects on risk tolerance similar to those found in the 2013 SCF. We discuss implications for the future of Chinese investment markets.

JEL classifications: D14; G11

Keywords: Risk tolerance; Individual investing; China Household Finance Survey; Survey of Consumer Finances

1. Introduction

Risk tolerance is an important topic for household financial choices because it affects many types of household decisions, including portfolio selection, insurance choices, and saving decisions. There have been many normative analyses on the relationship between risk tolerance and

* Corresponding author. Tel.: +1-614-292-4584; fax: +1-614-292-4339.
E-mail address: hanna.1@osu.edu (S.D. Hanna)

1057-0810/18/$ – see front matter

optimal financial decisions, for example, Campbell and Viceira (2002). Standard advice for households, based on normative analyses by economists, is that they should consider their risk tolerance in making investment decisions. There are extensive studies on the relationships between the risk tolerance and decision-making. Grable and Joo (2004) suggested that one's subjective financial risk tolerance is largely determined by social factors such as demographic, socioeconomic, and attitudinal characteristics. Households willing to take some risk have been found to be more likely to own high return investment (Shin and Hanna, 2015) and stocks (Wang and Hanna, 2007). Kim and Hanna (2015) found that those willing to take average or above average risk had higher likelihoods of having an adequate retirement than those unwilling to take any risk. Kim, Wilmarth, and Choi (2016) found that as a household's level of risk tolerance increased, outstanding credit card balance and installment loan balances increased. Lastly, households not willing to take any investment risk have been found to be more likely to own life insurance (Gutter and Hatcher, 2008).

There are many studies on the factors related to the financial risk tolerance of U.S. households. However, the risk tolerance of Chinese households has been understudied. In one of the few studies that attempted to compare the risk tolerance of U.S. respondents (Fan and Xiao, 2006), the authors noted that their study was exploratory and their Chinese respondents were not representative of all of China. They concluded that there was a need for future research using more comparable data. The only other studies we found that attempted to directly compare the risk tolerance of U.S. and Chinese respondents used small student samples, for instance, in Terpstra-Tong and Terpstra (2013), the U.S. sample included only 70 students at one university, and 452 students at universities in Hong Kong and Macao. Those authors noted that despite that fact that China had a rapidly growing capital market, little was known about investors in China, and the increasing middle class represented a great opportunity for financial services companies. The primary research objective of our study is to ascertain the factors that affect respondent financial risk tolerance, in a large sample representative of all households in China. A secondary objective is to compare the effects of household characteristics on risk tolerance in China to the results of a similar analysis of U.S. data.

Lv (2007) stated that risk tolerance is not commonly considered by the wealth management industry in China in making recommendations for clients. In the United States, low proportions of households own stocks directly, but many own through mutual funds, especially inside retirement accounts controlled by workers, the proportion of households with direct or indirect ownership of stocks increased from 32% in 1989 to over 50% by 2001, and has remained at about that level since, with a decrease after the financial crisis of 2008 (Fig. 1). As we will demonstrate (Table 5), only about 9% of households in China in 2011 had direct or indirect ownership of stocks, which is not surprising given much lower income levels in China compared with the United States, but the high level of economic growth in China makes it likely that China will approach U.S. levels of household income in the coming decades. Will future investment patterns of households in China be similar to the patterns in the United States? Comparison of factors related to risk tolerance in China and the United States may provide insights into future investment patterns in China. In the United States, government and employer policies related to household financial decisions, including optimal settings for "nudge" policies to encourage households to make better decisions, take

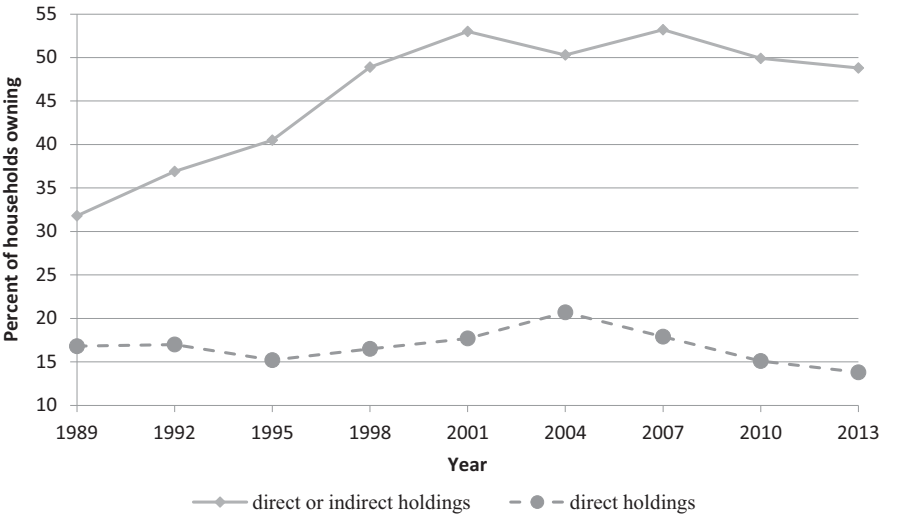

Fig. 1. Percent of U.S. households owning stocks directly and/or indirectly, 1989–2013. Created by authors, based on data from Federal Reserve Board, https://www.federalreserve.gov/econres/files/scf2013_tables_internal_real.xls.

household risk tolerance levels into account, and it may be appropriate to consider risk tolerance levels of households in China for such policies.

2. Literature review

2.1. Why measure risk tolerance?

Recommendations for investment portfolios often are based on the expected utility model, which despite criticisms that it represents actual household behavior poorly, is the best normative model available (Hanna and Chen, 1997; Schoemaker, 1982). Economists have used expected utility analysis to evaluate whether individuals have made optimal financial decisions (e.g., Calvet, Campbell, and Sodini, 2007; Cocco, Gomes, and Maenhout, 2005). A crucial part of normative household finance is a plausible estimation of utility function parameters, as discussed by Brown and Poterba (2000).

The expected utility model, as a normative model for decision making involving risky choices (Hanna and Chen, 1997), includes risk aversion as an important parameter of individual utility functions. Pratt (1964) had one of the earliest presentations of mathematical forms of utility under risk, and Arrow (1971) and Deaton and Muellbauer (1980) are among those with expositions of the model. In particular, Arrow (1971, p. 94) presented the mathematical forms for absolute risk aversion and relative risk aversion. Hanna and Chen (1997) noted that it is reasonable to assume that most households are risk averse, as risk seeking utility functions imply the willingness to accept a chance of zero consumption, and even for households with plausible levels of risk aversion, optimal portfolios include some risky investments. Bailey, Olson, and Wonnacott (1980) concluded that the phenomenon of people engaging in gambling is better explained by direct utility from the experience, rather than from a risk-seeking level of risk aversion.

A relative risk aversion level of zero is consistent with risk neutrality, so the optimal choice is based on maximizing expected value. For household investment decisions, both relative risk aversion and the share of total household wealth that is human wealth are important factors in determining optimal allocations of the financial investment portfolio. Campbell and Viceira (2002, p. 188) presented analyses showing that for retired households, the optimal allocation to stocks ranges from 80% for relative risk aversion of 2, to 13% for a relative risk aversion of 12. Cocco (2005), Gomes and Michaelides (2005), and Horneff, Maurer, and Stamos (2008) also presented analyses showing how optimal investment choices depend on the household's level of risk aversion. Some normative articles such as Hubbard, Skinner, and Zeldes (1994), Scholz, Seshardi, and Khitatrakun (2006), and Gomes and Michaelides, (2003) derived optimal savings levels under risk with several different levels of relative risk aversion. Hubbard et al. (1994) derived optimal savings levels and examined predictions of a life-cycle simulation model subject to uninsured idiosyncratic risk (risky earnings, medical expense, and life span). Campbell and Cocco (2003) showed how the optimal choice between a fixed rate and a variable rate mortgage loan depended on the level of the household's risk aversion.

Clearly, the prescriptions of normative household finance (Campbell, 2006) depend on the level of risk aversion assumed, and analysis of public policies related to household financial decisions also depend on the level of risk aversion assumed. Risk tolerance is the inverse of risk aversion (Barsky et al., 1997). Is there heterogeneity in levels of household risk tolerance among Chinese households? While there is considerable research about that question for U.S. households, the evidence is limited for Chinese households. As Terpstra-Tong and Terpstra (2013) noted, little is known about investors in China, but comparisons of risk tolerance levels and factors related to risk tolerance between China and the United States may provide insights into future financial markets in China. Ownership of stock assets in the United States was somewhat limited before the 1990s (Haliassos and Bertaut, 1995), which seemed puzzling to economists given the equity premium (Siegel and Thaler, 1997). Siegel and Thaler discussed whether the equity premium was a puzzle in countries other than the United States, for instance, in Japan and Germany. They concluded that even in countries with wartime destruction of the value of stocks, there still was an advantage of investment in stock assets over the long run, compared with bonds and cash equivalents. Therefore, the advantage of investments in stocks over alternative financial investments (e.g., Hanna and Chen, 1997) may apply to China despite the difference in the economic history of the two countries.

2.2. Measuring risk tolerance

According to Hanna, Gutter, and Fan (2001), there are at least four different methods of measuring risk tolerance: (1) asking about investment choices, (2) asking a combination of investment and subjective questions, (3) assessing actual behavior, and (4) asking hypothetical questions with carefully specified scenarios. Below, we briefly review selected articles using each method.

An example of the first method is in the Survey of Consumer Finances (SCF), a nationally representative survey conducted every three years in the United States (Bricker et al., 2014), which has since 1983 included a risk tolerance measure. Yao, Hanna, and Lindamood (2004)

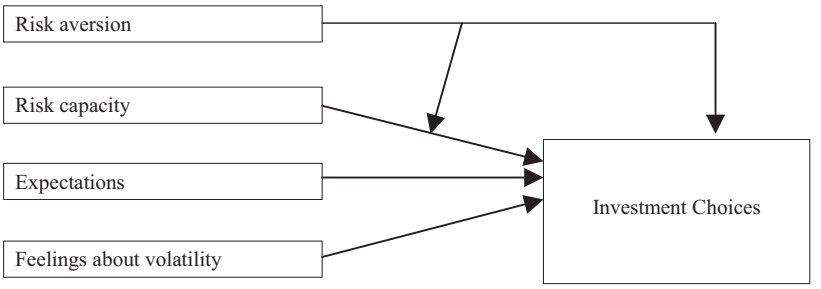

Fig. 2. Conceptual model of investment choices involving risk modified version of model in Hanna et al. (2008).

was the first study published in a journal that provided the history of the SCF risk tolerance measure. The question in the SCF simply asks respondents whether they were willing to take substantial risk to make a substantial return, above average return, average risk to make an average return, or no risk when making investments. Yao et al. (2004) presented a conceptual model that suggested that the answer to the SCF risk tolerance question might be affected not only by the level of respondent risk aversion, but also perceptions influenced by recent stock market changes, and by one's life cycle stage. The SCF risk tolerance measure has been used in many studies both as a dependent variable and an independent variable. Grable and Lytton (2001) listed six previous studies using it as a dependent variable and 11 studies using it as an independent variable. We estimate that at least 50 additional publications have used the SCF risk tolerance measure. We do not discuss all studies that have used the SCF risk tolerance measure, focusing instead on studies that used approaches consistent with the approach used in this article.

An example of the second method is in Grable and Lytton (1999), who presented a measure based on 13 questions, based both on investment choices and financial beliefs, feelings, needs, and aspirations. The Grable-Lytton measure has been used in dozens of studies, but it has not been tested in a nationally representative survey in the United States. Some of the components are situational, for instance, would you cancel a "once-in-a-lifetime" vacation if you lost your job three weeks before the vacation? Obviously, a person's answer would depend on other resources and other household income, the person's age, and other factors. Grable and Lytton (2001) reported that their risk tolerance measure has good validity.

An example of the third method, assessing actual behavior to measure risk tolerance, is Wang and Hanna (1997), who used the theoretical framework proposed by Friend and Blume (1975) to infer risk aversion from the proportion of total wealth invested in risky assets. Attanasio, Banks, and Tanner (2002)'s equity premium estimates were also based on actual investment choices. However, this method could be problematic. As Hanna, Waller, and Finke (2008) noted, investment choices may be based on risk tolerance, but also expectations and risk capacity. They presented a model of factors affecting investment choices, and stated "The SCF measure, which asks respondents whether they are willing to take greater risk to achieve greater returns, may be an imperfect measure of risk tolerance, as people may be thinking of all four elements on the left side of their model in stating how much investment risk they would be willing to take." Based on this observation, we have modified the model presented in Hanna et al. (2008) in our Fig. 2, suggesting that answers to the SCF risk

tolerance question might be affected by all of the factors on the left side, risk aversion, risk capacity, expectations, and feelings about volatility. For instance, for two individuals with identical risk aversion, if one expects the stock market to keep increasing and the other expects a 10 year slump, they might choose different portfolios, or, for those with no current risky investments, different potential portfolios as reflected in the choices in the SCF risk tolerance question.

The fourth method, using hypothetical questions to infer risk tolerance, may control for other factors that determine actual investment choices and, therefore, may reveal each respondent's true risk aversion. For example, Kimball (1988) presented hypothetical income gambles to infer relative risk aversion. Barsky et al. (1997) used the framework proposed by Kimball (1988) to include hypothetical income gamble questions in the Health and Retirement Study survey. The hypothetical scenarios presented to respondents attempted to control for other factors such as household resources, and if a constant relative risk aversion utility function is assumed, relative risk aversion levels can be inferred from respondent choices. Considerable individual variation is present, for instance, Hanna and Lindamood (2004) found an interquartile range from 2 to 6, and in a sample of older adults (Fang, Hanna, and Chatterjee, 2013), 39% had levels of relative risk aversion over 7.5 and over 40% had levels under 3.8. Hanna and Lindamood (2004) and Hanna et al. (2001) noted some flaws in the hypothetical income gambles used in the U.S. Health and Retirement Study dataset reported in Fang et al. (2013), which might have led to downward bias in estimates of relative risk aversion.

Even though there are a variety of ways to measure risk tolerance, only one, the SCF measure, has been used in nationally representative samples in the United States over a period of more than 30 years. Furthermore, the SCF measure is based on one simple question, rather than a complex question based on hypothetical income gambles (Barsky et al., 1997) or a combination of many questions that include investment experiences and risk capacity (Grable and Lytton, 1999). Most national household surveys have a very limited capacity for additional questions, so it is unlikely that the Grable-Lytton measure will be used in such surveys. Therefore, we focus on the SCF question, since a nationally representative survey in China has used a very similar question.

2.3. Empirical research on factors that affect respondent risk tolerance

There have been many empirical studies with risk tolerance as a dependent variable, with a large variety of measures of risk tolerance. In this section we focus on selected empirical studies using the SCF risk tolerance variable as a dependent variable. There have been dozens of publications reporting analyses of risk tolerance in the United States, but we focus on three studies using SCF datasets from 1983 to 2004 (Table 1). Sung and Hanna (1996) used the 1992 SCF to test the effect of financial variables and demographic variables on risk tolerance for a subsample of households with employed heads. They used a logistic regression with a dependent variable of whether the respondent was willing to take some risk (average, above average, or substantial) versus no risk. Yao et al. (2004) analyzed a combination of the 1983 to 2001 SCF datasets, and noted that even though the SCF risk tolerance measure had four levels, a statistical test indicated that an ordered logit was not

Table 1 Selected studies on factors related to risk tolerance: U.S. studies using nationally representative samples; Chinese studies using various samples

Study	Sample	Dependent variable (analysis)	Selected effects in multivariate analysis of respondent characteristics	Selected effects in multivariate analysis of household characteristics
Sung and Hanna (1996)	U. S. SCF, 1992, households with an employed respondent, $N = 2{,}659$	SCF risk tolerance (logistic regression)	Years to retirement: Positive Education: Positive Racial/ethnic: White>Hispanic, White > Asian/other	Non-investment income: Positive Liquid assets >3 months income: Positive Self-employed: Positive Household size: NS Homeownership: NS Single female: Negative
Yao, Hanna, and Lindamood (2004)	U. S. SCF, 1983–2001, all households, $N = 24{,}132$	SCF risk tolerance (logistic regression)	Age: Negative Education: Positive Racial/ethnic White: Positive Male: Positive Married: Positive	Children < 18: Negative Income: Positive Self-employed: Positive Homeowner: NS Poor health: Negative
Wang and Hanna (2007)	U. S. SCF, 1992–2004, all households, $N = 21{,}471$	SCF risk tolerance (logistic regression)	Age: Negative Education: Positive Racial/ethnic White: Positive Male: Positive Married: NS	Children < 18: Negative Income: Positive Have business: Positive Homeowner: Positive
Fan and Xiao (2006)	Workers in Guangzhou, China, 1998, $N = 470$; U.S. SCF, 1998, non-farm full-time worker households, $N = 2{,}671$	SCF risk tolerance (multi-nominal logistic regression)	Age: Negative in both Education: Positive in both Racial/ethnic White: Positive Male: Positive in United States, NS in Chinese Married: positive in United States, NS in Chinese (both = significant effect in both Chinese and U.S. analyses)	Income: Positive in both Self-employed: Positive in Chinese Household size: NS Homeownership: positive in both Single female: Negative
Terperstra-Tong and Terperstra (2013)	Students in United States, Hong Kong, Macao, $N = 522$	Grable measure (OLS regression)	Chinese respondents not significantly different from U.S. respondents (Model 3) Age: Negative Male: Positive	NA
Pyles, Li, Wu, and Dolvin (2016)	Survey of students at a United States university ($N = 215$) and 2 Chinese universities (N-620)	SCF measure (Logit) and Grable measure (OLS regression)	Chinese respondents more risk tolerant than U.S. respondents Female: Negative for both measures	NA except for parent education and income Low parent education: Positive for SCF measure, NS for Grable measure High parent income: Negative for SCF measure, NS for Grable measure Low parent income: NS for SCF measure, negative for Grable measure

For studies analyzing SCF risk tolerance variable, effects for some risk vs. no risk reported unless otherwise noted. U. S. SCF = U.S. Survey of Consumer Finances; NS = not significantly different from 0 at 5% level.

appropriate, so they used a cumulative logit model, with three separate logistic regressions on some risk, high risk, and substantial risk.

Wang and Hanna (2007) analyzed a combination of the 1992–2004 SCF datasets, using the same cumulative logit approach used by Yao et al. (2004). Wang and Hanna obtained results generally similar to those found by Yao et al., including a significant negative effect of age squared, with the combined effect of age and age squared implying that at mean values of other variables, the likelihood of being willing to take some risk was about 42 percentage points lower for a respondent aged 80 than for one aged 25. They estimated that a household with a head with a bachelor's degree would be almost 38 percentage points more likely to be willing to take some risk than an otherwise similar household with less than a high school degree. Households with a female respondent had a predicted likelihood of being willing to take some risk 14 percentage points lower than an otherwise similar household with a male respondent. Income was positively related to risk tolerance.

2.4. Empirical research on risk tolerance in China

Very few studies have directly addressed financial risk tolerance in China, and even fewer studies have attempted to directly compare risk tolerance in China to risk tolerance in the United States. Fan and Xiao (2006) compared the risk tolerance of Chinese workers and comparable U.S. respondents in 1998 (Table 1). This research used a self-collected data of 407 workers from four categories of enterprises in GuangZhou, a major city in China. They reported that a higher proportion of U.S. workers were willing to take some risk (72%) than were Chinese workers (65%). The multivariate analyses showed cross-sectional patterns of age being negatively related to risk tolerance, and education and income being positively related to risk tolerance, with self-employed workers being more risk tolerant than employees. Homeowners had a higher likelihood of being willing to take average risk but a lower likelihood of being willing to take substantial risk than renters. They also found that more risk-tolerant individuals were more likely to own stocks. Fan and Xiao (2006) noted that their Chinese sample had limited generalizability to all of China.

Terpstra-Tong and Terpstra (2013) compared the financial risk tolerance of three samples of students at universities in Hong Kong and Macao and at a university in the United States based on a self-collected data, with a total of 522 responses (Table 1). In a multivariate model controlling for various respondent characteristics, there were no significant differences in the responses of Chinese respondents and U.S. respondents. However, the sample from the United States consisted of only 70 students from one university. The authors attempted to compare residents of China attending a university in Macao to students from Hong Kong and Macao. Men had higher risk tolerance than women in Hong Kong but not in the other samples, and age was negatively related to risk tolerance.

Pyles et al. (2016) surveyed 215 students at a U.S. university and 620 students at universities in Hong Kong and Macao (Table 1). Their questions included both the SCF measure and the Grable-Lytton measure. The Chinese students were more risk tolerant than otherwise similar students in the United States. Women were less risk tolerant than otherwise similar male students. We found one other journal article (Lv, 2007) reporting analyses of

risk tolerance in China, but it was based on a survey with 88 bank customers in China, so we did not include it in Table 1.

2.5. Summary of consistent empirical effects

Most research, including research based on U.S. household surveys, has found men have higher risk tolerance than women. Research using household surveys has generally found that risk tolerance is positively related to education and income. White respondents in the U.S. have been found to be more likely to be willing to take some risk than otherwise similar respondents with other racial/ethnic identifications. Households with a self-employed head or with a business have been found to be more willing to take risk. The effect of being a single head versus being a couple has been found to have inconsistent effects in the United States and in China. Homeowners have been found to be more likely to be willing to take some risk. It is difficult to compare the results of household surveys to the results of student surveys, as the age and education levels of student respondents do not vary much, and the most recent analysis of household survey data from China was for a 1998 survey of workers in one city, so analyses of more recent household survey data from both countries should provide valuable insights into factors affecting risk tolerance.

In the next section, we present a conceptual model for factors related to risk tolerance. It is plausible that the respondent and household characteristics are related to risk preferences and to risk capacity. Selection of the variables for our empirical analyses was based on our conceptual model, but also by variables used in previous empirical research. Thus, in our study, we control for respondent and household characteristics, including gender, education level, age, and household income to identify the factors that could have significant effect on Chinese respondents' risk tolerance. The main contribution of this research is to use the China Household Finance Survey (CHFS), a nationwide dataset to test the risk tolerance of Chinese households. In addition, we included ethnicity in our regression model, Han versus one of the other 56 ethnicities recognized in China, because of the consistent result in U.S. research that White respondents are more likely to be willing to take some risk than otherwise similar respondents with other racial/ethnic identities. Moreover, we present a comparison of the U.S. respondents and Chinese respondents in terms of the distribution of risk tolerance and present multivariate analyses of U.S. risk tolerance parallel to our multivariate analyses of risk tolerance of Chinese households.

3. Conceptual model and research hypotheses

Risk tolerance is sometimes assumed to be a preference, and economic theory provides limited insights into the determinants of preferences (Yao et al., 2004). Previous authors examining factors related to levels of risk tolerance have used psychological and sociological models for conceptual models. For instance, Yao et al. (2004) used a psychological theory that people are affected more strongly by recent events to explore patterns of risk tolerance over time. Yao et al. also presented a conceptual model proposing that willingness to take investment risk (i. e., the SCF risk tolerance measure)

is influenced by risk aversion, recent stock market changes, and risk capacity as related to life cycle stage, and so forth.

A risk tolerance measure that is based on a respondent's willingness to invest in risky assets may reflect many factors, not just risk tolerance as the inverse of the economist's concept of the inverse of risk aversion. Fig. 2 shows a modified version of the model presented by Hanna et al. (2008), who suggested that a household's actual investment choices may depend on risk tolerance, and other factors. Some households do not have funds to make any investments, but the SCF and CHFS risk tolerance questions could reflect potential investment choices. Statistical analyses with controls for many household characteristics may provide some insights into variations of risk tolerance responses. Based on the model in Fig. 2, and also on discussion in Shin and Hanna (2015), we created the hypotheses shown in Table 2.

Campbell and Viceira (2002) and Hanna and Chen (1997) presented normative analyses based on historic returns on financial assets, and demonstrated that the optimal proportion of stock assets in the financial investment portfolio depended on risk capacity, which is related to human wealth. Somebody with a particular level of risk aversion (as defined by economists) should decrease the proportion of the portfolio in stocks as retirement approaches, even if there is no change in risk aversion. Therefore, the willingness to take financial risk may decrease with age, even if risk aversion does not change, because of the decreasing proportion of household wealth in human wealth. The negative relationship between age and risk tolerance has been found by almost all researchers in studies of households with a wide age range, so we expected to find the same pattern.

In most empirical studies of households of risk tolerance, men have been found to be more risk tolerant than women. Yao and Hanna (2005) found this pattern in a combined sample of the 1983–2001 SCF datasets, with unmarried men being most willing to take some risk, followed by married men, unmarried women, and married women. They suggested that the differences could be because of genetic factors, socialization, and culture. Controlling for other factors, women should be willing to invest somewhat more aggressively than men because of the longer life expectancies of women (Ho, Milevsky, and Robinson, 1994), but most research has found that men have higher risk tolerance than women, and we expect to find a similar pattern in both the CHFS and the SCF. Marital status has been found to have mixed effects in previous research, and as Yao and Hanna (2005) discuss the contradictory results they obtained for marital status and respondent gender. A couple would have a longer life expectancy than a single person of the same age, so objectively should be more willing to take investment risk, but there may be a selection effect, with more risk tolerant people being more likely to be single. We do not have a specific expectation for the effect of marital status on risk tolerance, so it is listed as a null hypothesis in Table 2.

Education has been found to be related to risk tolerance in most empirical studies, though if income is controlled, the cause of this relationship is not immediately apparent. In terms of the SCF and CHFS risk tolerance measures, in Fig. 2, willingness to take financial risks might be reflected in actual investment choices for some households, but for households without any investments, the answer to the risk tolerance questions might reflect potential investment choices. Haliassos and Bertaut (1995) posed the question "Why do so few hold

Table 2 Hypotheses and theoretical justifications

Variables	Category	Expected effect	Theoretical justification
Age		−	As age increases, the investment horizon shortens, and human wealth decreases.
Gender	**Male**		No rigorous theoretical justification, though virtually all empirical studies have shown that women have lower risk tolerance scores than men.
	Female	−	
Education	**Less than high school**		Education level is related to financial knowledge, and cognitive burdens and information costs are required in investing. Even after controlling for income, there might be a positive relationship between education and risk tolerance.
	High school	+	
	Some college without degree	+	
	Bachelor degree	+	
Employment status	**Employee**		Without the stability of a salary, respondent would be less willing to invest in a high return asset. However, self-selection might result in different preferences for self-employed.
	Self-employed other than farmer	+	
	Farmer	−	
	Retired	−	
	Other job status	−	
Health status	**Poor health**		If household expects poor health in the future, it might have a greater need for more stable funds to cover medical expenses.
	Fair health	+	
	Good health	+	
	Excellent health	+	
Race/ethnicity	**Han**		Controlling for other factors including income and age, there should not be any differences.
	Non-Han	0	
Home ownership	Yes	+	Renters are less likely to be willing to invest in high return assets because they would choose to invest in assets with low volatility to buy a house in the future.
	No		
Household type	**Couple**		Couple household might have higher expected lifetime income than single households, and this leads to higher likelihood to be willing to hold high return investments.
	Single	−	
Income		+	Higher income households have more resources to invest in high return investments.
Financial assets		+	Those with more financial assets are more able to cover short term expenses, so will be more willing to invest in high return assets

(+) is positive effect, (−) is negative effect, 0 is no effect. The reference category is indicated in bold.

stocks?" One of their answers they discussed is the information costs of investing in stocks, and education could be related to the cost of understanding information about investing. More educated respondents may also be more future-oriented, having been willing to defer earning to obtain more education. Therefore, we expect a positive relationship between education and risk tolerance.

Employment status could have an effect on risk tolerance, both in terms of risk capacity and also exposure to information about investments, for instance, with employer-based retirement plans in the United States. There might also be a selection effect for self-employment, as those choosing self-employment over being an employee may tend to be

more risk tolerant. Empirical studies in the United States have consistently found that self-employed respondents are more risk tolerant than respondents who are employees (e.g., Yao et al., 2004), and we expect to find a similar pattern. It is plausible that health would be related to risk tolerance because poor health may shorten the investment horizon, given the possibility of medical expenses.

In U.S. research, White respondents have been found to be more willing to take some risk (vs. no risk) than those identifying as Black or Hispanic. Yao et al. (2005) discussed both cultural differences and differing levels of exposure to information about financial markets as possible reasons for the lower risk tolerance of Black and Hispanic respondents compared with White respondents. In Yao et al. (2004) the respondents who identified as "Other," which Hanna and Lindamood (2008) noted were mostly of Asian identification, were less likely than otherwise similar White respondents to be willing to take some risk. Yao et al. (2004) found that Blacks and Hispanics were less willing than White respondents to be willing to take some risk, but more willing to take substantial risk. This apparent inconsistency might be because of the lack of financial sophistication and lower exposure to financial information in these groups. Controlling for other characteristics, we do not expect Han Chinese to have different level of risk tolerance compared with other ethnic groups.

Household resources, including financial assets, homeownership, and income, have been found to be positively related to risk tolerance, and the part of the reason might be because of the information costs of making investment decisions, as discussed by Haliassos and Bertaut (1995). A household with low resources might have very limited funds and the information costs of making an investment choice would be higher than the expected gains of choosing a higher return investment. Therefore, we expect a positive relationship between resources (financial assets, homeownership, and income) and risk tolerance.

4. Method

4.1. Dataset and sample selection

We used the 2011 China Household Finance Survey (CHFS). The survey is sponsored by the Southwest University of Finance and Economics in cooperation with the Finance Research Branch of People's Bank of China, and according to Gan et al. (2012), when it was released, it was the first nationally representative survey on household finances in China. This dataset is highly focused on detailed level of economic status as well as various demographic characteristics of households. Among the existing datasets in China, the CHFS can be considered as the dataset with the highest response rate (Gan et al., 2013). The overall response rate of the CHFS is around 88%. In the 2011 CHFS, the survey respondent was selected as the person who was most financially knowledgeable in the household. The total sample size of survey respondents was 8,438. We selected respondents with a valid response regarding to his or her risk attitude. There were 169 cases where the risk tolerance question was missing or unlisted, and those cases were excluded from our analyses. Our analytical sample size was 8,269. We also analyzed the 2013

SCF (Bricker et al., 2014), which had 6,015 households, but after excluding 13 cases with values of the risk tolerance variable imputed because of respondent nonresponse (Hanna et al., 2018), our analytic sample was 6,002.

4.2. Weighting

Gan et al. (2012) described the sampling method and creation of the CHFS survey weight. As with the U.S. SCF (Bricker et al., 2014), wealthy households were oversampled, and the survey weight also reflects variations in geographic sampling rates, so the data need to be weighted by the survey weight variable for results to be better representative of Chinese households. Thus, we reported weighted results for descriptive and multivariate analysis. For comparison with the logistic regressions for the CHFS, we ran logistic regressions based on the 2013 SCF dataset for cumulative risk tolerance variables, following the methods reported in Yao et al. (2004). We followed the recommendations discussed in Shin and Hanna (2017) for applying population and replicate weights in multivariate analyses of SCF data.

4.3. Measurement of variables

4.3.1. Dependent variable

The CHFS has a variable for a household's financial risk tolerance with five different levels, indicating the household's willingness to take high, above-average, average, below-average, or no financial risk. The English translation of the codebook has the following:

> [A4003] Assume you have some assets to invest, which type of project would you invest in?

1. High risk, high return
2. Slightly above-average risk, slightly above-average return
3. Average risk, average return projects
4. Slightly below-average risk, slightly below-average return
5. Unwilling to take any risk

This variable is similar to the risk tolerance question in the U.S. survey of consumer finances (SCF):

> [X3014] Which of the statements 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

Based on the empirical specification (see Section 4.4.), we created three dichotomous composite variable of one's financial risk tolerance; substantial risk, high risk, and some risk as follows:

x1=1 if high risk, and 0 otherwise;
x2=1 if high, above-average, and average, and 0 otherwise,
x3=1 if high, above-average, average, or below average, and 0 otherwise

4.3.2. Independent variables

Based on previous research on risk tolerance and our research questions, the independent variables for the logistic regressions (Table 6) included age of respondent, gender of the respondent (male vs. female), marital status (couple vs. single), education of the respondent (less than high school, high school degree, some college, and bachelor degree), employment status (salary worker, self-employed other than farming, farming, retired, and others), health status (excellent, good, fair, and poor), race/ethnicity of the respondent (Han or not), homeowner (homeowner vs. renter), and total family income and the level of financial assets. Family income included income from all sources. For comparison, our logistic regressions for the 2013 SCF (Appendix) included comparable variables: age of respondent, gender of the respondent, marital status (couple vs. single), education of the respondent (less than high school, high school degree, some college, bachelor degree), employment status (salary worker, self-employment other than farming, farming, retired and unemployed), health status (excellent, good, fair and poor), race/ethnicity of the respondent (White or not), homeownership, and total family income and the level of financial assets.

4.4. Empirical specification

Given the characteristics of the SCF risk tolerance variable, it would seem reasonable to use an ordered logit to analyze it. The assumption in the ordered logistic regression model is proportional odds (i.e., parallel), with constant effects across response categories. A Score test indicated that the proportional odds assumption was not valid, and therefore, ordered logit was not appropriate. Clogg and Shihadeh (1994) proposed using K-1 separate cumulative logistic regression models. We followed previous SCF studies analyzing risk tolerance (e.g., Yao et al., 2004; Yao & Hanna, 2005) in using cumulative logistic regressions.

Therefore, three separate cumulative logit models were used in this study:

$$logit[P(Y \leq 1)] = \log\left(\frac{Y \leq 1}{Y > 1}\right)\alpha_1 + \beta_1 X \tag{1}$$

$$logit[P(Y \leq 2)] = \log\left(\frac{Y \leq 2}{Y > 2}\right)\alpha_2 + \beta_2 X \tag{2}$$

$$logit[P(Y \leq 3)] = \log\left(\frac{Y \leq 3}{Y > 3}\right)\alpha_3 + \beta_3 X \tag{3}$$

The cumulative logit models examine the effect of explanatory variables on the probability for households willing to take substantial risk, high risk and some financial risk tolerance. Yao et al. (2004) discussed issues related to analysis of the SCF risk tolerance

Table 3 Distribution of selected characteristics, 2011 Chinese Household Financial Survey and 2013 SCF

Variable	Percentage or mean	
	2011 CHFS	2013 SCF
Age of respondent (mean)	48.8	50.5
Gender of respondent		
Male	53.6	47.4
Female	46.4	52.6
Education of respondent		
Less than high school degree	68.1	9.9
High school degree	12.1	28.6
Some college	11.9	27.2
Bachelor degree or higher	7.9	34.3
Marital status (married or partners)	85.6	56.7
Employment status of respondent		
Employee	25.2	54.7
Farming	31.6	0.3
Self-employed other than farming	9.1	8.4
Retired	12.8	10.0
Other	21.3	26.5
Health status of respondent		
Excellent	12.3	23.9
Good	31.8	48.8
Fair	40.1	21.0
Poor	15.8	6.3
Ethnicity (Han or White)	95.7	70.1
Homeowner	81.8	65.2
Mean household income, Renminbi. (in U.S. dollars at 6.4 to 1)	55,226 ($8,629)	$86,707
Mean financial assets, Renminbi (in U.S. dollars at 6.4 to 1)	63,968 ($9,995)	$251,156
N	8,269	6,002

SCF = Survey of Consumer Finances; CHFS = China Household Finance Survey. CHFS and SCF results are weighted.

variable, and concluded that it is not appropriate to analyze the variable as one continuous variable. Our method is similar to the approach by Yao et al. (2004) in defining three binary dependent variables.

5. Results

5.1. Descriptive results

In the 2011 CHFS, there were 8,269 valid responses to the risk tolerance question. Table 3 shows the mean age of respondents, and the distribution of selected other characteristics. The mean age was about 49, and 54% of the respondents were male. Most (68%) respondents did not have a high school degree, and only 8% had a college degree. In the SCF, 34% of respondents had a college degree. In the CHFS, almost 86% were married or partners, compared with only 57% in the SCF. In the CHFS, over 40% were in farming or otherwise self-employed, compared with less than 9% in the SCF. In the CHFS, 56% reported being

Table 4 Risk tolerance responses, 2011 CHFS and 2013 SCF

2011 CHFS		Relative risk aversion estimate[b]	2013 U.S. SCF	
Response	Distribution		Response	Distribution
1. Unwilling to take any risk	44.7%[c]	> 6.7	1. No risk	46.6%
2. Slightly below average or average risk[a]	42.5%[c]	5.4	2. Average risk	36.3%
3. Slightly above average risk	7.2%[c]	4.0	3. Above average risk	14.1%
4. Substantial risk	5.6%[c]	<2.7	4. Substantial risk	3.0%
Sample size	8,269			6,002

SCF = Survey of Consumer Finances; CHFS = China Household Finance Survey. CHFS and SCF results are weighted.

[a]Slightly below average, 15.91%; average, 25.55%

[b]Estimates of relative risk aversion based on regression in Hanna and Lindamood (2004).

[c]Rate significantly different from corresponding SCF rate at $p < 0.05$.

in poor or fair health, compared with 27% in the SCF. Almost 96% were of the Han ethnicity, with the others distributed among the 55 other ethnic groups/nationalities listed in the codebook, whereas in the SCF, 70% of respondents were White. Almost 82% in the CHFS were homeowners, compared with 65% in the SCF. The mean household income in the CHFS was only about 10% of the level of the United States, with an even greater relative difference for financial assets.

Table 4 presents descriptive results of distribution of the 2011 CHFS risk tolerance, and the distribution of the comparable 2013 SCF risk tolerance question (two categories in the CHFS are combined for comparability). In the 2011 CHFS, about 45% said they were not willing to take any investment risk, 42.5% said below average or average risk, 7.2% said above average risk, and 5.6% gave a response of being willing to take substantial risk. The distributions are somewhat similar between CHFS and SCF, though the proportion of no risk responses in the SCF, 46.6%, is significantly higher than the rate in the CHFS, using a simple z test for comparing proportions in two independent samples.

The risk tolerance questions in the SCF and in the CHFS measure willingness to take risks, though there is not a direct connection of these questions to the economic concept of risk aversion. Hanna and Lindamood (2004) presented respondents with both the SCF risk tolerance question, and a series of hypothetical income gamble questions with a graphical extension of the questions presented in Barsky et al. (1997). Hanna and Lindamood (2004) estimated a regression of relative risk aversion on the responses to the SCF risk tolerance question, to be able to project the distribution of risk aversion levels for households of all ages in the U.S. population. The middle section of Table 4 relative risk aversion estimate, are based on the regression in Hanna and Lindamood (2004). Based on our discussion in Section 2.2., one should be skeptical of these estimates, but while very crude, the estimates allow for comparison with normative analyses of optimal portfolios by a number of economists, for example, Campbell and Vicerea (2002) and Hanna and Chen (1997). Based on the Hanna and Chen analysis, even households with the no risk response should be willing to have 50% or more of their investment portfolio

Table 5 Ownership of stocks and stock assets, 2011 CHFS and 2013 SCF

	Percent of households	
Type of investment	2011 CHFS	2013 SCF
Direct ownership of stocks	8.63	13.75
Direct and/or indirect ownership of stocks	9.03	48.85

SCF = Survey of Consumer Finances; CHFS = China Household Finance Survey. Weighted analyses of all households in each dataset.

Estimate for CHFS for direct and/or indirect ownership of stocks is an upper estimate, based on the assumption that all mutual funds, financial derivatives, and wealth management products contain stock assets.

in stocks until they approach retirement. Assuming that a no risk response corresponds to a relative risk aversion level of 8, and a substantial risk response corresponds to a relative risk aversion level of 2, the mean relative risk aversion level would be about 6.3 in both surveys, which according to Hanna and Chen (1997) would imply fairly aggressive retirement portfolios until about 20 years before retirement, and some stock assets even at retirement.

Table 5 shows direct and indirect ownership of stocks. The SCF has very detailed questions that are used to estimate whether stocks are in mutual funds, including retirement accounts under the control of respondents, as well as to estimate the dollar value of stock holdings for each household. The CHFS does not have comparable questions about indirect stock holdings. As Table 5 shows, almost 9% of households in the CHFS owned stocks directly, compared with about 14% of households in the CHFS. The CHFS has questions about ownership of mutual funds, financial derivatives, and wealth management products, but very few households reported owning these products who did not also own stocks directly. If we assume that all such products contained stock assets, then 9% of households in the CHFS directly and/or indirectly owned stock assets, compared with almost 49% of households in the SCF. Although analysis of factors related to stock ownership in the CHFS would be interesting (cf. Wang and Hanna, 2007), the proportion is small and the definitions in the survey are unclear, so we will not attempt that in this article.

5.2. Multivariate results

An ordered logistic regression model was tested with the CHFS data, but the result of the Score test (cf., Yao et al., 2004) indicated that ordered logistic regression was not appropriate. A cumulative logistic regression model was utilized for testing the impact of each independent variable on each level of risk tolerance for Chinese respondents (Table 6), and for comparison, we also present the same logistic regressions estimated with the 2013 SCF (Appendix). We divided risk tolerance into three levels: substantial risk tolerance, high risk tolerance (willing to take above average or substantial risk vs. no risk or average risk) and some risk tolerance (the three levels vs. unwilling to take any risk).

Table 6 Logistic regressions for some, high, and substantial risk tolerance, 2011 CHFS

Variable	Some risk			High risk			Substantial risk		
	Coefficient	*p* value	Odds ratio	Coefficient	*p* value	Odds ratio	Coefficient	*p* value	Odds ratio
Age of respondent	−0.056	<.001	0.945	−0.050	<.001	0.951	−0.030	<.001	0.970
Male (ref: Female)	0.582	<.001	1.789	0.476	<.001	1.609	0.474	<.001	1.606
Single (ref: Couple)	−0.037	0.653	0.964	−0.034	0.671	0.967	0.279	0.041	1.321
Education of respondent (ref: Less than a high school degree)									
High school degree	0.483	<.001	1.621	0.385	<.001	1.469	0.100	0.506	1.106
Some college	0.710	<.001	2.035	0.535	<.001	1.708	0.088	0.577	1.092
College degree	1.228	<.001	3.414	0.873	<.001	2.393	0.012	0.948	1.012
Employment status of respondent (ref: Employee)									
Self-employed (other than farmer)	0.421	<.001	1.523	0.366	<.001	1.442	0.390	0.015	1.477
Farmer	0.117	0.133	1.125	0.144	0.061	1.155	0.102	0.500	1.108
Retired	0.066	0.505	1.069	0.000	0.997	1.000	−0.117	0.623	0.890
Other job status	0.060	0.524	1.062	0.170	0.063	1.186	−0.300	0.101	0.741
Health status of respondent (ref: Poor health)									
Excellent	−0.174	0.085	0.841	0.218	0.028	1.244	0.299	0.083	1.348
Good	−0.041	0.605	0.960	0.159	0.050	1.172	−0.488	0.003	0.614
Fair	−0.168	0.024	0.846	−0.005	0.948	0.995	−0.267	0.079	0.766
Han (other ethnic)	−0.111	0.366	0.895	−0.227	0.058	0.797	−0.277	0.195	0.758
Homeowner (ref: Renter)	0.141	0.050	1.152	0.206	0.003	1.229	0.038	0.769	1.038
Log (income)	0.028	0.002	1.029	0.031	0.001	1.031	0.019	0.274	1.020
Log (financial assets)	0.049	<.001	1.050	0.031	<.001	1.032	−0.015	0.354	0.985
Intercept	−1.736	<.001		0.816	<.001		−1.438	<.001	
Mean concordance rate	74.6%			72.7%			66.0%		

CHFS = China Household Finance Survey. Weighted analyses of 2011 CHFS. Total sample size is 8,269.
For dummy variables or sets of dummy variables, reference category is in parentheses.
The *p* values are based on two-tail tests.

5.2.1. Some risk tolerance

The first three columns of Table 6 contain the logistic regression results on willingness to take some risk in the CHFS. If the respondent was willing to take average, above average, or substantial risk then "some risk" was set to 1, otherwise, "some risk" was set to 0. The likelihood of being willing to take some risk decreased with age in both the CHFS and in the SCF (Appendix). The odds ratios for both survey results indicate that men have odds 1.8 times those of women in being willing to take some risk. For both the CHFS logit and the SCF logit (Appendix), the likelihood of being willing to take some risk increased strongly with education. In both surveys, being self-employed (other than farming) was associated with the likelihood of being willing to take some risk, though farmers in the CHFS were not significantly different from others, while those in farming related jobs in the SCF were more likely to be willing to take some risk than others. Those with fair health status in the CHFS were less likely to be willing to take some risk than those with poor health, while in the SCF, those with excellent health were more

likely to be willing to take some risk than those with poor health. In the SCF, White respondents were much more likely to be willing to take some risk than those with other racial/ethnic identifications (Black, Hispanic, and Asian/other) but Han respondents in the CHFS were not significantly different from non-Han respondents. Homeowners were more likely than renters in the CHFS to be willing to take some risk, but there was no difference in the SCF. In both surveys, the likelihood of being willing to take some risk increased strongly with income and with financial assets.

5.2.2. High risk tolerance

The middle three columns of Table 6 present logistic regression results on willingness to take high risk in the CHFS. If the respondent was willing to take above average risk or substantial risk then "high risk" was set to 1, otherwise, high risk was set to 0. The likelihood of being willing to take high risk decreased with age in both the CHFS and in the SCF. Men had odds of being willing to take high risk 1.61 times as high as women in the CHFS, and the SCF had a similar pattern. Single respondents were not significantly different from couple respondents in the CHFS, but respondents in single households in the SCF were more likely to be willing to take high risk than those in married or partner households. Education was positively related to having high risk in the CHFS, while in the SCF, college educated respondents were more likely to willing to take high risk than those without a high school degree. Self-employed respondents in both the CHFS and the SCF were more willing than others to take high risk. Ethnic status was not significant in either the CHFS or the SCF. Those with excellent or good health status in the CHFS were more likely to be willing to take high risk than those with poor health, while in the SCF, health status was not significantly related to being willing to take high risk. In the CHFS, homeowners were more willing to take high risk than renters, but the effect was not significant in the SCF. In both surveys, income and financial assets were positively associated with the likelihood of being willing to take high risk.

5.2.3. Substantial risk tolerance

The last three columns of Table 6 contain logistic regression results on willingness to take substantial risk. If the respondent was willing to take substantial risk then "substantial risk" was set to 1, otherwise, substantial risk was set to 0. Age was negatively related to willingness to take substantial risk, with the odds ratio indicating almost a 3% decrease in the odds of being willing to take substantial risk with every one year increase in age. In the Appendix table, the effect of age was similar for the U.S. respondents, with a 2% decrease in the odds for every one year increase in age. Male respondents were more likely to be willing to take substantial risk than female respondents, with odds 1.6 times as high in the Chinese survey and 1.4 times as high in the U.S. survey. Being single was related to substantial risk tolerance in the CHFS but not in the SCF. Education did not have a significant effect in the CHFS on substantial risk tolerance, and had a mixed effect in the SCF, with those with some college being more likely than those without a high school degree to be willing to take substantial risk. Self-employed respondents (other than farmers) had odds of being willing to take substantial risk 1.5 times that of other respondents in the Chinese survey and 1.9 times as high in the U.S. survey. One large difference between the

two surveys was the effect of being a farmer or in a related occupation, while in China, farmers were not significantly different from others in being willing to take substantial risk, while in the United States, those who were farmers or in a related occupation had odds of being willing to take substantial risk over six times as high as those in other occupations. Han respondents were not significantly different from non-Han respondents in being willing to take substantial risk in the CHFS. In the SCF (Appendix), White respondents were less likely than others to be willing to take substantial risk, opposite to the effect for some risk tolerance, similar to a result reported by Yao et al. (2004). These results provide additional support beyond the results of the Score test for using a cumulative logit model rather than an ordered logit model.

6. Discussion and implications

Our descriptive results show that despite the much higher income and education levels of U.S. respondents, the risk tolerance levels of Chinese respondents were very similar to those of U.S. respondents, with estimated levels of relative risk aversion almost identical in the two surveys. However, about 49% of households in the United States had stock assets, compared with only 9% of households in China. This suggests that as household incomes continue to increase in China, there may be a rapid increase in the ownership of stocks, perhaps through mutual funds. Education and appropriate regulation will be important in the future for households in China. Some studies have found relationships between education, financial literacy, and the ownership of risky investments. Most research has found that respondents with higher education levels and/or more financial knowledge are more risk tolerant (Gibson, et. al, 2013; Grable, 2000; Nobre and Grable, 2015). Better understanding of risk will enhance the involvement and utilization of appropriate investments by Chinese households to better achieve their financial planning goals, which could have a substantial impact on retirement adequacy (Kim and Hanna, 2015).

Based on cumulative logistic regressions, many household characteristics affected respondent risk tolerance for Chinese respondents and also for U.S. respondents, and for seven types of variables, generally in ways consistent with our research expectations. There was a cross-sectional negative relationship between age and the willingness to take risk, and while this does not necessarily imply that people will become less risk tolerant as they get older, in terms of financial education and policies, age should be considered as an important correlate to risk tolerance. Men were more willing to take risk than women in both surveys. The willingness to take some risk and to take high risk increased with education in the CHFS and generally in the SCF. In both surveys, self-employed respondents were more willing to take investment risk than others. Those with excellent health in the SCF were more likely to be willing to take some risk than those with poor health, but otherwise health was not related to risk tolerance. Health status had a few significant effects in the CHFS, but with no consistent pattern. Risk tolerance increased with income and financial assets in both the SCF and in the CHFS. Being a homeowner was related to being more willing to take some risk and to take high risk in the CHFS but not in the SCF. In the SCF, White respondents were more willing to take some risk

but less willing to take substantial risk than respondents identifying as Black, Hispanic, or Asian, a result previously found by Yao et al. (2004). In the CHFS, Han respondents were not different in risk tolerance from respondents of other ethnic identities, which may reflect the shrinking income gap (Gustafsson and Shi, 2003).

Despite some differences between the CHFS and the SCF in the effects of household characteristics on risk tolerance, the similarity of the distribution of risk tolerance levels and the general similarity of effects in the logistic regressions suggest that risk tolerance is perceived in a somewhat similar way in China and the United States. Therefore, future research with Chinese household surveys could benefit from careful consideration of research with United States datasets. For instance, analysis of factors related to ownership of stocks (e.g., Wang and Hanna, 2007) could provide valuable insights for China.

Campbell and Viceira (2002) derived optimal stock percentages for households, based on age, risk aversion, and the correlation of human wealth with financial returns. Given their assumptions about patterns of human wealth and age, the optimal percentage of the total portfolio in stocks was very sensitive to the assumed level of risk aversion, For instance, for a worker 35 years away from retirement, with zero correlation between human wealth and investment returns, the optimal stock percentage ranged from 148% for a relative risk aversion level of 3, to 27% for a relative risk aversion level of 12. For any given level of risk aversion, the optimal stock allocation decreased with age, for instance, for a risk aversion level of 5, decreasing from 76% at 35 years from retirement to 42% at 5 years from retirement. However, even at very low risk tolerance levels (relative risk aversion level of 12), households should have some stock assets. The general optimal patterns obtained by Campbell and Viceira (2002) and others (e.g., Hanna and Chen, 1997) should be considered in terms of the risk tolerance findings reported in this article. Individual advice to households should consider their risk tolerance and also their risk capacity (Cordell, 2002; Hanna and Chen, 1997). Thaler and Sunstein (2008) argued that trying to educate households to make good decisions about complex issues such as retirement investments is likely to fail, and present choice architecture, or "nudges" as a way to improve household decision-making. However, the key issue for many of the "nudge" suggestions is starting with the appropriate default levels, for instance, the default portfolio composition of worker retirement portfolios.

The normative analyses of Campbell and Viceira (2002) and of Poterba, Rauh, and Venti (2005) show that optimal investment allocations depend crucially on the level of risk aversion of households. Therefore, measurement of risk tolerance is important in devising policies that will help households make better decisions. Our research on the risk tolerance of households in China represents a first step in that task for China. Future household surveys in China should use several measures of risk tolerance and risk aversion, for instance, including an income gamble question to try to isolate preferences from situational factors (Hanna et al., 2001). As financial investment choices expand in China, it should be better to obtain improved estimates of the relationship between risk tolerance and investment choices.

Appendix Logistic Regressions for Some, High, and Substantial Risk Tolerance, 2013 SCF

Variable	Some risk			High risk			Substantial risk		
	Coefficient	*p* value	Odds ratio	Coefficient	*p* value	Odds ratio	Coefficient	*p* value	Odds ratio
Age of respondent	−0.022	<.001	0.978	−0.026	<.001	0.974	−0.020	0.002	0.980
Male (ref: Female)	0.545	<.001	1.725	0.455	<.001	1.575	0.337	0.001	1.401
Single (ref: Couple)	0.153	0.006	1.165	0.151	0.011	1.163	0.162	0.386	1.175
Education of respondent (ref: Less than a high school degree)									
High school degree	0.422	<.001	1.523	0.092	0.583	1.096	0.242	0.469	1.273
Some college	0.763	<.001	2.145	0.442	0.012	1.555	0.715	0.048	2.045
College degree	1.419	<.001	4.131	0.789	<.001	2.202	0.417	0.225	1.517
Respondent's employment status (ref: Employee)									
Self-employed (other than farmer)	0.427	<.001	1.532	0.313	0.005	1.368	0.620	0.005	1.858
Farmer	1.413	<.001	4.107	0.703	0.084	2.019	1.936	0.001	6.928
Retired	0.174	0.058	1.190	−0.114	0.222	0.892	−0.196	0.396	0.822
Not working	−0.198	0.047	0.820	−0.204	0.061	0.815	0.020	0.926	1.020
Health status (ref: Poor health)									
Excellent	0.425	0.001	1.530	0.282	0.160	1.325	0.654	0.156	1.924
Good	0.220	0.060	1.246	0.250	0.217	1.283	0.617	0.195	1.852
Fair	0.173	0.170	1.188	0.165	0.421	1.179	0.842	0.054	2.321
White (ref: Black, Hispanic, or other)	0.272	<.001	1.313	0.099	0.191	1.105	−0.410	0.006	0.664
Homeowner (ref: Renter)	0.061	0.419	1.063	0.090	0.338	1.095	−0.053	0.780	0.948
Log (income)	0.158	<.001	1.172	0.101	0.030	1.106	0.037	0.650	1.038
Log (financial assets)	0.139	<.001	1.149	0.060	<.001	1.062	−0.004	0.826	0.996
Intercept	−3.277	<.001		−3.111	<.001		−3.968	<.001	
Mean concordance rate	81.9%			71.2%			64.5%		

SCF = Survey of Consumer Finances RII procedure with population and replicate weights applied. Total sample size is 6,002.

For dummy variables or sets of dummy variables, reference category is in parentheses.

The *p* value are based on two-tail tests.

References

Arrow, K. J. (1971). *Essays in the Theory of Risk-Bearing*. Chicago, IL: Markham Publishing Co.

Attanasio, O. P., Banks, J., & Tanner, S. (2002). Asset holding and consumption volatility. *Journal of Political Economy, 110,* 771–792.

Bailey, M. J., Olson, M., & Wonnacott, P. (1980). The marginal utility of income does not increase: Vorrowing, lending, and Friedman-Savage gambles. *American Economic Review, 70,* 372–379.

Barsky, R. B., Juster, F. T., Kimball, M. S., & Shapiro, M. D. (1997). Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement survey. *Quarterly Journal of Economics, 112,* 537–579.

Bricker, J., Dettling, L. J., Henriques, A., Hsu, J. W., Moore, K. B., Sabelhaus, J., Thompson, J., & Windle, R. A. (2014). Changes in U.S family finances from 2010 to 2013: Evidence from the Survey of Consumer Finances. *Federal Reserve Bulletin, 100,* 1–41.

Brown, J. R., & Poterba, J. M. (2000). Joint life annuities and annuity demand by married couples. *The Journal of Risk and Insurance, 67,* 527–554.

Calvet, L., Campbell, J. Y., & Sodini, P. (2007). Down or out: Assessing the welfare costs of household investment mistakes. *Journal of Political Economy, 115,* 707–747.

Campbell, J. Y. (2006). Household finance. *Journal of Finance, 61,* 1553–1604.

Campbell, J. Y., & Cocco, J. F. (2003). Household risk management and optimal mortgage choice. *The Quarterly Journal of Economics, 118,* 1449–1494.

Campbell, J. Y., & Viceira, L. M. (2002). *Strategic Asset Allocation: Portfolio Choice for Longterm Investors*. New York, NY: Oxford University Press.

Clogg, C. C., & Shihadeh, E. S. (1994). *Statistical Models for Ordinal Data*. Thousand Oaks, CA: Sage Publications.

Cordell, D. M. (2002). Risk tolerance in two dimensions. *Journal of Financial Planning, 15,* 30–35.

Cocco, J. F., Gomes, F. J., & Maenhout, P. J. (2005). Consumption and portfolio choice over the life cycle. *Review of Financial Studies, 18,* 491–533.

Cocco, J. F. (2005). Portfolio choice in the presence of housing. *The Review of Financial Studies, 18,* 535–567.

Deaton, A., & Muellbauer, J. (1980). Economics and consumer behavior. New York, NY: Cambridge University Press.

Fan, J. X., & Xiao, J. J. (2006). Cross-cultural differences in risk tolerance: A comparison between Chinese and Americans. *Journal of Personal Finance, 5,* 54–75.

Fang, M. C., Hanna, S. D., & Chatterjee, S. (2013). The impact of immigrant status and racial/ethnic group on differences in responses to a risk aversion measure. *Journal of Financial Counseling and Planning, 23,* 64–77.

Friend, I., & Blume, M. E. (1975). The demand for risky assets. *American Economic Review, 65,* 900–922.

Gan, L., Yin, Z., Jia, N., Xu, S., & Ma, S. (2013). Asset allocation of Chinese households and housing demand analysis. *Journal of Finance Research, 4,* 1–14.

Gan, L., Yin, Z., Jia, N., Xu, S., Ma, S., & Zheng, L. (2012). *Data You Need to Know About China: Research Report of China Household Finance Survey.* Berlin: Springer Science & Business Media.

Gibson, R., Michayluk, D., Venter, G. V. (2013). Financial risk tolerance: An analysis of unexplored factors. *Financial Services Review, 22,* 23–50.

Gomes, F. J., & Michaelides, A. (2005). Optimal life-cycle asset allocation: Understanding the empirical evidence. *Journal of Finance, 60,* 869–904.

Gomes, F. J., & Michaelides, A. (2003). Portfolio choice with internal habit formation: a life-cycle model with uninsurable labor income risk. *Review of Economic Dynamics, 6,* 729–766.

Grable, J. E. (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. E., & Joo, S. H. (2004). Environmental and biopsychosocial factors associated with financial risk tolerance. *Financial Counseling and Planning, 27,* 73–82.

Grable, J. E., & Lytton, R. H. (1999). Financial risk tolerance revisited: The development of a risk assessment instrument. *Financial Services Review, 8,* 163–181.

Grable, J. E., & Lytton, R. H. (2001). Assessing the concurrent validity of the SCF risk tolerance question. *Financial Counseling and Planning, 12,* 43–52.

Gutter, M. S., & Hatcher, C. B. (2008). Racial differences in the demand for life insurance. *Journal of Risk and Insurance, 75,* 677–689.

Gustafsson, B., & Shi, L. (2003). The ethnic minority-majority income gap in rural China during transition. *Economic Development and Cultural Change, 51,* 805–822.

Haliassos, M., & Bertaut, C. C. (1995). Why do so few hold stocks? *The Economic Journal, 105,* 1110–1129.

Hanna, S. D., & Chen, P. (1997). Subjective and objective risk tolerance: Implications for optimal portfolios. *Financial Counseling and Planning, 8,* 17–26.

Hanna, S. D., Gutter, M. S., & Fan, J. X. (2001). A measure of risk tolerance based on economic theory. *Financial Counseling and Planning, 12,* 53–60.

Hanna, S. D., Kim, K. T., & Lindamood, S. (2018). Behind the numbers: Understanding the Survey of Consumer Finances. *Journal of Financial Counseling and Planning, 29,* 410–418.

Hanna, S. D., & Lindamood, S. (2008). The decrease in stock ownership by minority households. *Journal of Financial Counseling and Planning, 19,* 46–58.

Hanna, S. D., Waller, W., & Finke, M. (2008). The concept of risk tolerance in personal financial planning. *Journal of Personal Finance, 7,* 96–108.

Ho, K., Milevsky, M. A., & Robinson, C. (1994). Asset allocation, life expectancy and shortfall. *Financial Services Review, 3,* 109–126.

Horneff, W. J., Maurer, R. H., & Stamos, M. Z. (2008). Optimal gradual annuitization: Quantifying the costs of switching to annuities. *The Journal of Risk and Insurance, 75,* 1019–1038.

Hubbard, R. G., Skinner, J., & Zeldes, S. P. (1994). The importance of precautionary motives in explaining individual and aggregate saving. *Carnegie-Rochester Conference Series on Public Policy, 40,* 59–125.

Kim, K., & Hanna, S. D. (2015). Does financial sophistication matter in retirement preparedness? *Journal of Personal Finance, 14,* 9–20.

Kim, K., Wilmarth, M., & Choi, S. (2016). Credit use of U.S. households after the Great Recession: The role of credit constraints. *Family & Consumer Sciences Research Journal, 44,* 280–294.

Kimball, M. S. (1988). Farmers' cooperatives as behavior toward risk. *The American Economic Review, 78,* 224–232.

Lv, X. L. (2007). Analysis of bank customer's risk tolerance. *Mathematical Statistics and Management, 26,* 1062–1065.

Nobre, L. H. N., & Grable, J. E. (2015). The role of risk profiles and risk tolerance in shaping client investment decisions. *Journal of Financial Service Professionals, 69,* 18–21.

Pyles M. K., Li, Y., Wu, S., & Dolvin, S. D. (2016). Cultural influences on risk tolerance and portfolio creation. *Journal of Behavioral and Experimental Finance, 9,* 43–55.

Poterba, J., Rauh, J., & Venti, S. F. (2005). Utility evaluation of risk in retirement saving accounts. In D. A. Wise (Ed.), *Analyses in the Economics of Aging* (pp. 13–58). Chicago, IL: University of Chicago Press.

Pratt, J. W. (1964). Risk aversion in the small and in the large. *Econometrica, 32,* 122–136.

Schoemaker, P. J. H. (1982). The expected utility model: Its variants, purposes, evidence and limitations. *Journal of Economic Literature, 20,* 529–563.

Scholz, J. K., Seshadri, A., & Khitatrakun, S. (2006). Are Americans saving "optimally" for retirement? *Journal of Political Economy, 114,* 607–643.

Shin, S. H., & Hanna, S. D. (2015). Decomposition analyses of racial/ethnic differences in high return investment ownership after the Great Recession. *Journal of Financial Counseling and Planning, 26,* 43–62.

Shin, S. H., & Hanna, S. D. (2017). Accounting for complex sample design in analyses of the Survey of Consumer Finances. *Journal of Consumer Affairs, 51,* 433–447.

Siegel, J., & Thaler, R. H. (1997). Anomalies: The equity premium puzzle. *Journal of Economic Perspectives, 11,* 191–200.

Sung, J., & Hanna, S. D. (1996). Factors related to risk tolerance. *Journal of Financial Counseling and Planning, 7,* 11–19.

Terpstra-Tong, J. L., & Terpstra, R. H. (2013). Differences in financial risk tolerance: A study of the U.S., China, Hong Kong and Macao. *Euro Asia Journal of Management, 23,* 43–65.

Thaler, R. H., & Sunstein, C. R. (2008) *Nudge: Improving decisions about health, wealth, and happiness.* New Haven, CT: Yale University Press.

Wang, C., & Hanna, S. D. (2007). The risk tolerance and stock ownership of business owning households. *Journal of Financial Counseling and Planning, 18,* 3–18.

Wang, H., & Hanna, S. (1997). Does risk tolerance decrease with age? *Financial Counseling and Planning, 8,* 27–31.

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

Yao, R., & Hanna, S. D. (2005). The effect of gender and marital status on financial risk tolerance. *Journal of Personal Finance, 4,* 66–85.

Yao, R., Hanna, S. D., & Lindamood, S. (2004). Changes in financial risk tolerance, 1983–2001. *Financial Services Review, 13,* 249–266.