Can Security Design Foster Household Risk-Taking?

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ABSTRACT

This paper shows that securities with non-linear payoff designs can foster household risk-taking. We demonstrate this effect by exploiting the introduction of capital guarantee products in Sweden between 2002 and 2007. The fast and broad adoption of these products is associated with an increase in expected financial portfolio returns. The effect is especially strong for households with low risk appetite ex ante. In a life-cycle model, the introduction of capital guarantee products substantially increases risk-taking by households with pessimistic beliefs or preferences combining loss aversion and narrow framing. Our results illustrate how security design can mitigate behavioral biases and enhance well-being.

JEL Codes: I22, G1, D18, D12.

Keywords: Security design, household finance, capital guarantee product, behavioral biases, stock market participation, risk-taking.

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I. Introduction

The low share of stocks and mutual funds in the financial wealth of a sizable group of households poses a significant challenge to neo-classical finance theory (Campbell, 2006). Households with low equity holdings forfeit an important source of income over their lives (Haliassos and Bertaut, 1995; Mankiw and Zeldes, 1991), which reinforces wealth inequality (Bach, Calvet, and Sodini, 2019).

Another, and potentially related, challenge to established finance theory is the impressive growth over the past two decades of the market for retail *capital guarantee products* (thereafter CGPs), a class of equity-linked contracts offering a capital protection. In 2015, CGPs total more than $4.5 trillion in global outstanding volumes and represent a significant share of household savings in major economies, such as the U.S., China, and the European Union.[1] In Sweden, where precise data on household portfolio composition is available, CGPs were adopted quickly and broadly, reaching 14% of the population within 5 years of their introduction. However, rational-choice portfolio theory does not provide a clear economic rationale for the success of these products. By contrast, several innovative financial assets with strong economic motivations, such as low-cost exchange-traded funds or inflation-indexed bonds, have experienced much slower speeds of adoption (Shiller, 2004).

Taken together, these major stylized facts raise a number of questions. Does the capital protection embedded in CGPs foster household financial risk-taking? If so, through which economic mechanism? Are households better off as a result? More generally, can security design mitigate behavioral biases preventing sizable groups of households from making efficient decisions?

In this paper, we take a first step in answering these questions by empirically studying the effects of the introduction of CGPs on household risk-taking in Sweden in the 2000s. Our analysis exploits a unique administrative data set containing granular information on the demographics and exact portfolio composition of every Swedish resident (see Calvet,

[1] See Table 1.

Campbell, and Sodini (2007)), which we merge with detailed information on all CGPs sold in Sweden (see Célérier and Vallée (2017)). The resulting panel offers a comprehensive coverage of the 2002-2007 period, the first five years of the development of the retail market for CGPs. In a second step, we investigate the theoretical mechanisms that can rationalize our empirical findings by augmenting the life-cycle model of portfolio allocation of Cocco, Gomes, and Maenhout (2005). We include capital guarantee products in the set of financial assets available to households and span a series of preference and belief specifications for these agents. We calibrate each version of the model to the data. This theoretical exercise allows us to identify two possible economic explanations for our empirical findings and also to assess the implications of financial innovation for household well-being.

We begin our empirical analysis by showing that the CGPs sold in Sweden allow retail investors to earn a significant fraction of the equity premium. We conduct an asset pricing assessment of these products that accounts for all aspects of their design, including their exact payoff formula, disclosed fees, credit risk, and the ex-dividend nature of the final payoff. CGPs offer on average a risk premium amounting to 44% of the equity premium to investors. This result holds despite the fact that these products embed relatively high total markups amounting to 1.6% per year on average. These expected excess returns and markups are comparable to the values obtained for equity mutual funds sold in Sweden over the same period.[2]

Among equity participants, households that adopt CGPs are found to increase their risk-taking significantly more than households that do not. We define a household's *risk-taking index* as the expected fraction of the yearly equity premium earned on their financial portfolio, net of fees.[3] Over the 2002-2007 period, the risk-taking index increases by 3

[2]Gennaioli, Shleifer, and Vishny (2015) report similar magnitudes for mutual funds in the U.S. once taking into account all types of fees.

[3]The literature usually measures risk-taking with the risky share, which is the weight of risky assets in the financial wealth, without adjusting for the heterogeneity in the risk premium that each risky asset might offer based on the payoff design, beta and fees (see for example Calvet et al. (2007)). Another technique would be to use the delta coefficient used in derivatives pricing, but this continuous-time measure is ill-suited to analyze the portfolios of retail investors trading at lower frequencies.

percentage points (pp) for adopters and 1 pp for non-adopters, to compare with a median risk-taking index in 2002 of 17 pp for equity markets participants.

The relationship between CGP investing and a risk-taking increase is significantly more pronounced for households that are initially less willing to take risk. While the initial risk-taking index is only 2 pp for households in the bottom quartile of the willingness to take risk in 2002, the index increases by 13 pp for adopters versus only 6 pp for non-adopters at the end of the sample period. This heterogeneity results from a higher demand for CGPs for household initially less willing to take risk, and from low substitution with traditional equity products.

To gain causal identification, we instrument household investments in CGPs by quasi-random shocks to the bank idiosyncratic supply of these products in a panel model with household and year fixed effects. We provide evidence that bank supply shocks drive an important share of the volumes of CGPs. Similar to Borusyak, Hull, and Jaravel (2018), our identification strategy relies on the exogeneity of the shock in the time series and does not require the exogenous matching of households and banks. We estimate the idiosyncratic supply shocks by regressing the quantity of CGPs a household holds in a given year on bank-year fixed effects, controlling for household characteristics, in a random half of the household population. We then use the other half to analyze the causal effects of the supply of CGPs on the household risk-taking index. We find that a 1 pp increase in the share of financial wealth invested in CGPs leads to a 0.69 pp increase in the risk-taking index.

We next examine the theoretical determinants of investments in CGPs. We develop a life-cycle model with stochastic labor income that extends standard models (e.g., Cocco et al. (2005)) along several dimensions. The investment set includes a bond, a stock, and a CGP with the exact same design, embedded markup, and illiquidity as the median product in our sample. We solve the life-cycle model across a set of utility functions and beliefs and relate the results to our empirical findings. This exercise provides a set of novel theoretical insights.

We show that preferences incorporating narrow framing on investment income with loss aversion (Barberis and Huang, 2009) explain why the introduction of CGPs fosters financial risk-taking, especially among households that are initially less willing to take risk. By contrast, Epstein and Zin (1989) preferences, general disappointment aversion (Gul, 1991; Routledge and Zin, 2010), and smooth forms of narrow framing cannot explain the data. The intuition is the following. When risk aversion is second-order, as is the case under Epstein-Zin preferences or smooth forms of narrow framing, the stock offers an attractive trade-off between risk and return, while the welfare benefits from CGPs and the demand for these products are weak. First-order risk aversion is therefore a natural avenue. However, as Barberis, Huang, and Thaler (2006) explain, the presence of other preexisting risks, such as labor income risk, makes a purely loss averse agent act in a second-order risk-averse manner toward independent, delayed gambles. The combination of narrow framing and loss aversion is therefore necessary to explain the empirical results in our life-cycle framework under rational expectations.

We demonstrate that pessimistic beliefs alone, for instance those captured by probability weighting (Prelec, 1998), can also explain the positive and heterogeneous response of risk-taking to financial innovation. Pessimistic households have a strong demand for CGPs because these contracts combine the upside potential of equity markets with a protection against adverse outcomes, which pessimistic households view as particularly likely. The increase in risk-taking is therefore the strongest for the most pessimistic households.

Building on these results, we assess the welfare gains associated with the introduction of CGPs. By revealed preference, a household should be strictly better off under the lens of its *decision* utility if it adopts the innovation, and we indeed observe large gains under this metric.[4] We estimate how the surplus created by the introduction of capital guarantee products is shared between financial institutions and households. We observe that, despite the comfortable markup that banks charge, households obtain a substantial share of the

[4]We make the simplifying assumption that the riskfree rate and the dynamics of equity are not impacted by financial innovation, which seems to be a reasonable approximation in our sample period.

surplus. These results suggest that banks do not necessarily capture the entire surplus that they create when addressing a bias.

Last, we take a conservative approach by assessing household welfare through the lens of *experienced* utility (Kahneman, Wakker, and Sarin, 1997). Assuming that experienced utility exhibit less pronounced behavioral traits than the decision utility, we still find sizable welfare gains, except for households with high initial willingness to take risk. Financial institutions seeking to improve the well-being of their customers should target the sale of capital guarantee products to households with low levels of risk-taking.

This paper contributes to the strand of the household finance literature investigating low risk-taking by a sizable group of households. While the literature provides a long list of possible explanations for such behavior (e.g. Haliassos and Bertaut (1995); Attanasio and Vissing-Jørgensen (2003); Hong, Kubik, and Stein (2004); Barberis et al. (2006); Guiso and Jappelli (2005); Calvet et al. (2007); Guiso, Sapienza, and Zingales (2008); Kuhnen and Miu (2017)), our work identifies specific preferences or beliefs as first-order mechanisms underlying such behavior by assessing the effectiveness of a targeted remedy.

In this respect, our study opens a new direction in the active debate on whether financial education (Bernheim, Garrett, and Maki, 2001), financial advisors (Gennaioli et al., 2015) or default options (Madrian and Shea, 2001) should be prioritized to address the frictions households face when making financial decisions. While the evidence on the effectiveness of financial education is mixed (e.g. Duflo and Saez (2003), Lusardi (2008)), Chalmers and Reuter (2020) show that in the context of U.S retirement plans, introducing default options in target funds is more valuable to households than providing them with access to financial advisors. Due to offsetting household behaviors at longer horizons however, extrapolating the short-run gains from default option introductions can significantly overstate their benefits at longer horizons, as Choukhmane (2019) documents. Our findings suggests that security design might be both more effective and more targeted than each of these alternatives by specifically addressing the bias distorting household financial decision-making.[5] In this sense, the security design solution we identify has the ability to provide customized efficiency, analogous to the decision process designs advocated by Thaler and Benartzi (2004) and others to encourage higher saving rates.

Our work also contributes to the literature on the cost and benefits of financial innovation. Several studies have underlined potential adverse effects of financial innovation, such as speculation (Simsek, 2013) or rent extraction (Biais, Rochet, and Woolley, 2015; Biais and Landier, 2018), particularly from unsophisticated agents (Carlin, 2009). The present paper illustrates how innovative financial products may also benefit unsophisticated market players by mitigating investor behavioral biases. This mechanism differs from and complements the more traditional role of financial innovation to improve risk-sharing and complete markets (Ross, 1976; Calvet, Gonzalez-Eiras, and Sodini, 2004).

This study adds to the literature examining how to tailor security design to investor preferences or beliefs. Célérier and Vallée (2017) document how banks design financial products to cater to yield-seeking investors, which allows them to charge larger markups.[6] The present paper further establishes that security design is a powerful tool for affecting economic decisions. In contrast to earlier work, however, we focus on the bright side and show that security design can foster actions beneficial to investors. Our paper therefore brings nuance to the prevailing negative view of tailored security design. In this respect, our findings expand the literature advocating contract design as a possible solution to behavioral biases (DellaVigna and Malmendier, 2004).

The paper is organized as follows. Section II provides background on retail capital guarantee products and presents the data for our empirical analysis. Section III describes the product design, and develops an asset pricing model to measure their expected returns and markups. In Section IV, we test whether investing in capital guarantee products induces

[5]The security design we study does not mitigate a bias by exploiting another one, such as inertia for default options or gambling propensity for lottery-saving accounts (Cole, Iverson, and Tufano, 2018).

[6]Henderson and Pearson (2011), Li, Subrahmanyam, and Yang (2018), and Vokata (2019) also focus on the dark side of non-linear products.

a causal increase in household risk-taking. Section V develops a theoretical life-cycle model of portfolio allocation to study the mechanisms that can explain the empirical effects we document. In Section VI, we measure the welfare gains from financial innovation and how they are divided between product providers and households. Section VII concludes. An Online Appendix provides derivations and additional empirical results.

II. Background and Data

A. Background on Capital Guarantee Products and their Introduction in Sweden

Capital guarantee products are retail investments that offer exposure to the upside potential of risky assets and protect a substantial part of the invested capital, typically close to 100%.

Retail CGPs are widespread around the world. As of 2015, their total outstanding volumes exceed $4.5 trillion. Table I provides country-level outstanding volumes for the largest classes of CGPs. In the United States, guaranteed variable annuities represent a $1.7 trillion market (Ellul, Jotikasthira, Kartasheva, Lundblad, and Wagner, 2020). In France, Euro-life insurance contracts amount to $1.5 trillion, or 60% of GDP (Hombert and Lyonnet, 2020). In China, guaranteed wealth management products account for $854 billion. Finally, global outstanding volumes of retail structured products with a capital protection exceed $400 billion.[7] The pervasiveness and large volume outstanding of CGPs suggest that their design strongly appeals to retail investors.

Financial institutions use three main approaches to structure a capital guarantee product. They can choose to design a synthetic product, implement a portfolio insurance strategy, or build reserves. Synthetic CGPs, also referred to as retail structured products with a capital protection, are passive, limited-horizon products with a non-linear payoff that depends on

[7] The risky assets covered by this list of products include public equities, bonds, and loans.

the performance of their underlying asset (Célérier and Vallée, 2017).[8]

The first synthetic CGPs were created in the United Kingdom in the early 1990s. These products initially targeted institutional investors. However, financial institutions quickly rolled-out the products to their retail client bases, as they discovered the popularity of the CGPs among retail investors. Then, the technology spread to other European countries over the decade and reached Sweden in the early 2000s.

We exploit the introduction of CGPs in Sweden over the 2002-2007 period as a laboratory to study the impact of security design on household risk-taking for the following reasons. First, CGPs were adopted quickly and broadly in this country, reaching 14% of the population within 5 years of their introduction. Figure IA.1 in the Online Appendix illustrates the speed and depth of the adoption of CGPs in Sweden over the period. This choice is further supported by the unmatched quality and scope of Swedish data on household financial holdings and demographics, as described in the following section. Finally, the structure of the retail market for financial products in Sweden, where banks play a dominant role, allows us to develop an identification strategy aimed at establishing a causal claim.

In Table II, we document the low level of financial risk-taking by a substantial share of households across countries. We consider a selected set of countries for which data are available and provide summary statistics on household participation in equity markets. In Sweden, as of 2015, 17% of household total financial wealth is invested in equity (column 1), 68% of households that are 50 years or older participate in equity markets (column 2), and the median participating household invests 37% of its financial wealth in equity (column 3). While modest compared to predictions from standard portfolio allocation models, these levels are relatively high by international standards. For instance, in the European Union, only 8.7% of total household wealth is invested in equity and 25% of households with a head aged 50 or above participate in equity markets.[9] Sweden's relatively high level of stock

[8]Portfolio insurance is a dynamic trading strategy aimed at managing downside risk. Reserves are built by the product provider to offset fluctuations in asset returns, as is the case for Euro life insurance contracts in France (Hombert and Lyonnet, 2020).

[9]Section 2 in the Online Appendix provides details on the methodology used to obtain these statistics.

market participation may somewhat attenuate the potential effect of CGPs on household risk-taking. Therefore, the relationships established in the present paper are likely to be stronger in other countries.

B. Data

Our empirical analysis relies on a data set on all the synthetic CGPs and mutual funds sold to Swedish retail investors over the 2002-2007 period, merged with a data set on the portfolio composition and socio-demographic characteristics of all Swedish households over the same period.

1. Capital Guarantee Products and Equity Mutual Funds. The data set contains detailed information on the synthetic CGPs sold to Swedish retail investors between 2002 and 2007, which we retrieved from the Célérier and Vallée (2017) database of European retail structured products. The data set reports the underlying instrument, maturity, volumes, and disclosed fees of every CGP sold in Sweden, as well as text from which we obtain the payoff formula of each contract.[10] Panel A of Table III reports summary statistics. The sample contains 1,511 equity-linked contracts issued over the 2002 to 2007 period, for a total volume of $8 billion.[11]

For equity mutual funds, we obtain the historical fees, age, family, and geographical scope from each fund's factsheet. The reported fees include transaction costs, operating costs, and management fees. The returns, volatility, and dividend distributions of mutual funds, and the historical returns and volatility of the instruments underlying CGPs are retrieved from Bloomberg, Datastream, and FinBas.[12]

2. Household Demographics, Income, and Wealth. The administrative household panel, described in Calvet et al. (2007), contains the demographics, income, and disaggregated

[10] See Célérier and Vallée (2017) for the description of the textual analysis involved.
[11] In Sweden, the large majority of CGPs offer equity exposure (87% of the products).
[12] FinBas is a financial database maintained by the Swedish House of Finance.

financial holdings of every Swedish household between 2000 and 2007. Demographic and income variables include the age, gender, education level, parish of residence, and income of each member of a household. The panel's distinguishing feature is that it contains the comprehensive disaggregated financial holdings of each household, including the positions in cash, equity mutual funds, stocks, and CGPs at the level of each account or security.[13] The security-level information is identified by the International Security Identification Number (ISIN). The panel also provides a unique identifier for the institution where each bank account is held.

The household panel covers the entire population of Sweden and provides the exact portfolio composition of each household. It is highly reliable because the wealth information is collected by Statistics Sweden for tax purposes and is incorporated in tax forms, which households then have an opportunity to correct in case of a mistake. Statistics Sweden collects this information from a variety of sources, including the Swedish Tax Agency, welfare agencies, and private employers. Financial institutions supply to the tax agency their customers' deposits, interest paid or received, security investments, and dividends.[14]

We construct the merged household panel as follows. We filter out households with a head younger than 25 years or with financial wealth lower than $200 in 2002. We then only keep households that are observable over the whole sample period, consistent with our aim to investigate the effects of capital guarantee products on household risk-taking over the 2002-2007 period.[15] Our final panel contains 3,107,893 households. We merge it with the CGP and equity fund data via the unique ISIN identifier. The high-quality panel covers the launch and subsequent high growth of the market for CGPs in Sweden.

[13]Bonds and bond mutual funds, which we can also observe, are infrequent.

[14]The panel does not report defined contribution pension savings. These pension savings include assets in private pension plans and in public defined contribution accounts that were established in a 1999 pension reform. According to official statistics, defined contribution pension savings had an aggregate value of $25.6 billion in Sweden at the end of 2002, whereas aggregate household financial wealth invested outside pension plans amounted to $131.3 billion.

[15]In our data set, a household exits every time the composition of adults of the household changes, due to either death, divorce, marriage or change in partnership.

C. Summary Statistics

Table IV reports demographic and financial characteristics for the full sample of 3.1 million households, the subsample of 2.1 million households that participate in equity markets in 2002 (68.5% of the total sample), and the subsample of 430,000 households that invest in CGPs at least once over the sample period (13.9% of the full sample).

Panel A of Table IV focuses on 2002. While equity participation is relatively high in Sweden compared to other developed economies, the share of financial wealth invested in risky assets conditional on participation is 32.9% on average. Participants mostly take financial risk by investing in equity funds, which represent 22.9% of financial wealth on average (median = 16.9%), and individual stocks, which represent 9.3% of financial wealth on average (median = 1.4%). Moreover, household characteristics such as financial wealth, age, and income vary substantially across groups, which calls for using precise controls in the empirical analysis.

Panel B of Table IV illustrates that CGPs quickly gained traction within a few years. At the end of 2007, 13.9% of Swedish households had participated at least once in the new asset class, and participants allocated on average 11.9% (median = 7.3%) of financial wealth to these products.

III. Design, Expected Return, and Markup

In this section, we compute the risk premia that capital guarantee products provide to investors, and the gross markups earned by the financial institutions that market them. For this purpose, we develop a no-arbitrage pricing methodology that captures the specificities of these contracts, such as their option features, issue price, the dividend yield of the underlying instrument, and issuer credit risk. We document that CGPs offer a share of the equity premium that is slightly lower than the share offered after fees by equity mutual funds, the most popular form of household risky investments. In addition, the gross markups earned by sellers of CGPs are comparable to the gross markups earned by mutual fund companies.

A. Product Design

The majority of CGPs in our sample have the following design. The contract is sold at time $t = 0$ at the issue price P_0 and face value F, and reaches maturity at time M. The product offers upside potential by allowing the household to earn at maturity a fraction p of a benchmark return, R^*, applied to the face value F. The benchmark R^* is defined by the returns on an underlying asset, index, or basket of indexes. The contract also offers downside protection by offering a guaranteed net rate of return, g, on face value.

Capital guarantee products are typically structured as notes and therefore bear the credit risk of the bank structuring them. Let $\xi \in [0, 1]$ denote the random fraction of pledged cash flows that is paid at maturity, commonly called the payoff ratio (Jarrow, 2019; Jarrow and Turnbull, 1995). The gross return on the CGP is

$$1 + R_g = \frac{F}{P_0} \left[1 + \max(p\, R^*; g)\right] \xi \tag{1}$$

between issuance and maturity.

The benchmark return R^* is the average ex-dividend performance of the underlying measured at prespecified dates $t_1 < \cdots < t_n$:

$$1 + R^* = \frac{S_{t_1} + S_{t_2} + ... + S_{t_n}}{nS_{t_0}}, \tag{2}$$

where S_{t_0} is the initial reference level of an index or asset at t_0, which is typically the day of issuance or shortly thereafter. We call $t_n - t_1$ the length of the Asian option. If $n = 1$, the option is European and the length of the Asian option is equal to 0.

Panel B of Table III provides summary statistics. Contracts with this representative design account for 54% of CGPs issued in Sweden during our sample, and 60% of volumes. The average volume of an issuance is around \$5 million. The median maturity M is 4 years, the median net rate of guarantee g is 0%, the median issue price is 110% of face value, and the median participation rate p is 1.10.[16] We note that to this date, no default has occurred on CGPs sold to Swedish retail investors.

B. *Expected Return and Markup: Methodology*

We develop a no-arbitrage pricing method designed to compute the risk and return of CGPs. The model is based on the following assumptions. Under the physical measure $\mathbb{P}$, the underlying follows a geometric Brownian motion:

$$\frac{dS_t}{S_t} = (\mu - q)dt + \sigma dZ_t, \tag{3}$$

where μ is the drift, q is the dividend yield, and σ denotes volatility. The payoff ratio ξ is independent of the underlying, consistent with the view that credit risk is driven by operational risk. Let r_f denote the continuous-time interest rate. Under the risk-adjusted measure $\mathbb{Q}$, the drift of the underlying is $r_f - q$. We consider for simplicity that the payout ratio's distribution and independence from the underlying are not impacted by the change of measure.

The expected return on the CGP over the life of the contract is given by:

$$\mathbb{E}_0^{\mathbb{P}}(1 + R_g) = (1 - \kappa)\, \frac{F}{P_0}\, \mathbb{E}_0^{\mathbb{P}}[1 + \max(p\, R^*; g)], \tag{4}$$

where $1 - \kappa = \mathbb{E}_0^{\mathbb{P}}(\xi)$ denote the expected payoff on a \$1 promise. This approach provides conservatively low estimates of the expected return if default is more likely when the underlying is low.[17] In practice, we compute the expected return (4) as follows. We obtain

[16] A product can offer both substantial capital protection and a participation rate higher than unity because of the Asian option feature and the ex-dividend nature of the benchmark return, as Section III.B further explains.

[17] The expected return

$$\mathbb{E}_0^{\mathbb{P}}(1 + R_g) = (1 - \kappa)\, \frac{F}{P_0} \left\{1 + \mathbb{E}_0^{\mathbb{P}}[\max(p\, R^*; g)]\right\} + \frac{F}{P_0} Cov[\xi, \max(p\, R^*; g)]$$

$\mathbb{E}_0^{\mathbb{P}}[1+\max(p\,R^*;g)]$ by Monte Carlo simulations of the underlying and the benchmark return, as we explain in the Online Appendix. We set κ equal to the CDS spread of the issuer.[18]

The fair issue price, $P_0^{\text{fair}} = (1-\kappa)\,F\,e^{-r_f\,M}\,\mathbb{E}_0^{\mathbb{Q}}[1+\max(p\,R^*;g)]$, is the price that equates the expected return of the contract under $\mathbb{Q}$ to the return on a riskless bond of same maturity. It is also conveniently computed by Monte Carlo.

The *gross markup* of the contract, $(P_0 - P_0^{\text{fair}})/P_0$, is the difference between the market issue price and the fair issue price divided by the market issue price. To compare it to the stream of fees generated by standard funds, consider a mutual fund company that charges a fraction φ of asset value at the beginning of each year. An initial investment of \$1 generates over M periods a flow of fees equal to $\sum_{t=0}^{M-1}\varphi\,(1-\varphi)^t = 1-(1-\varphi)^M$.[19] The gross markup on the CGP coincides with the fair value of the stream of fund fees if

$$\varphi_{CGP} = 1-(P_0^{\text{fair}}/P_0)^{1/M}. \tag{5}$$

This formula allows us to convert a CGP's markup into its yearly mutual fund fee equivalent.

The baseline products in our sample cover 155 different underlying instruments, which can be a stock index, a basket of stock indices, or a basket of stocks. For each underlying, we estimate the risk premium at the monthly frequency, $\mathbb{E}(R_{i,t})$, by applying the World CAPM over the longest time-series available and a world market risk premium of 6%. We set the model's yearly drift μ_i to $12\,\ln[1+\mathbb{E}(R_{i,t})]$, the volatility parameter σ_i to the historical volatility over the 1990-2007 period, and q_i to the latest dividend yield before the product's issuance. We use the M-year SEK swap rate as the risk-free rate in the option pricing model. The yearly expected excess return earned by an investor on a CGP is the difference between the product's annualized expected return and the annual yield on an M-year Swedish

is higher than (4) entails if the payoff ratio ξ and the benchmark return R^* co-move positively, that is if default is more likely in bad times than in good times.

[18] Since the CDS swap typically includes a risk premium, this choice produces conservatively low values of $\mathbb{E}_0^{\mathbb{P}}(1+R_g)$

[19] This formula holds if the household invests \$1 at $t=0$, keeps its investment in the fund until $t=M$, and makes no intermediate withholdings or contributions. We refer the reader to the Appendix for the derivation.

Treasury bond.

C. Expected Return and Markup: Results

Panel A of Figure 1 displays the distribution of expected excess returns and yearly markups of CGPs sold in Sweden during the sample period. Corresponding key statistics are reported in Panel B of Table III. There are two take-aways. First, the expected excess return on CGPs is significantly positive and amounts to 2.7% per year on average, or close to half the premium on the world index.[20] More than 90% of products earn a positive risk premium. These results confirm that retail CGPs allow households to earn a significant part of the risk premium. Second, the average markups earned by banks on CGPs are equivalent to an annual fee $\varphi = 1.6\%$. In Table IA.1 of the Online Appendix, we verify that these results are robust to alternative parameter choices.

For comparison purposes, Panel B of Figure 1 report the expected return and fees of equity mutual funds available to Swedish retail investors over the 2002-2007 period. We compute expected returns by applying the World CAPM and deducting fees. Beta coefficients are estimated from the historical returns of each fund over the longest period available. Equity funds have an average beta of 0.9 relative to the World Index and therefore a risk premium before fees of $0.9 \times 6\% = 5.4\%$ per year. Fees, which include transaction costs, operating costs, and management fees, amount to 2.1% per year on average during our sample period. The average expected excess return on equity funds is therefore 3.3% in annual units, or a fraction of about 55% of the world equity premium.

Overall, capital guarantee products and mutual funds exhibit comparable expected returns and similar markups on average. This finding suggests that banks have equivalent financial incentives to market equity funds and CGPs to retail investors.[21]

[20] Our share estimate exhibits little sensitivity to the value of the world index equity premium we assume.
[21] Discussions with practitioners also support this hypothesis.

IV. Measuring the Impact of Capital Guarantee Products on Household Risk-Taking

We have shown that the capital guarantee products marketed to Swedish households offer a substantial fraction of the equity premium even when accounting for embedded markups. In this section, we test whether the introduction of these products has an impact on household risk-taking.

A. Measuring Household Risk-Taking

The literature usually measures household risk-taking as the share of financial wealth invested in equity products (e.g. Calvet, Campbell, and Sodini (2009)). One limitation of this approach is that diverse equity products, such as stocks, mutual funds, allocation funds, and CGPs, tend to earn heterogeneous risk premia that vary with design, maturity, and fees. For this reason, we now develop a novel measure of equity market exposure.

We define the *risk-taking index* of an equity product p as the fraction of the equity premium it provides investors:

$$\eta_p = \frac{[\mathbb{E}(1+R_p)]^{\frac{1}{M}} - e^{r_f}}{\mathbb{E}(1+R_m) - e^{r_f}}, \tag{6}$$

where M denotes product maturity, R_p the net arithmetic return on the equity product, R_m the net return on the world index, and r_f the average log yield on Swedish 1-year Treasury bonds.[22] We set $M = 1$ for a liquid product. The measure (6) intentionally focuses on the compensation for risk-taking, which motivates participation in risky assets markets, and not on downside risk.

We obtain η_p for all equity products in our sample as follows. The asset pricing results of Section III.C give the expected returns $[\mathbb{E}(1+R_p)]^{\frac{1}{M}}$ on CGPs and equity mutual funds.

[22] The log yield satisfies $r_f = \ln(1+R_f)$, where R_f is the yearly arithmetic yield on Swedish Treasury bonds. The yield R_f is 3.5% on average over the period.

For the subsample of CGPs that we do not price, we use the average η_p in the sample of baseline CGPs. For stocks and exchange traded funds (ETFs), we assume that management fees amount to 0.2% and 0.5%, respectively, and that the World CAPM β is unity. We also assume that $\eta_p = 0.3$ for allocation funds, which represent around 2% of household financial wealth.[23]

Panels B and C of Table III provide summary statistics on the risk-taking index η_p of CGPs and equity mutual funds. As expected, CGPs offer a relatively lower fraction of the equity premium than equity mutual funds. The average risk-taking index is 0.44 for CGPs and 0.55 for equity funds. The gap is limited in part because the beta coefficient is on average higher for CGPs ($\beta = 1.1$) than for equity mutual funds ($\beta = 0.9$).

We define the *risk-taking index* of household h in period t by:

$$\eta_{h,t} = \sum_{p=1}^{n} Share_{p,h,t} \times \eta_p,$$

where $Share_{p,h,t}$ is the share of product p in the household's financial wealth in period t. The sum is taken over all CGPs, equity mutual funds, stocks, ETFs, and allocation funds.

Panel C of Table IV provides summary statistics on the risk-taking index of households. In 2002, the average index is 0.22 for stock market participants and 0.26 for CGP participants. Between 2002 and 2007, the proportional change in the index is 0.7% for stock market participants versus 17.6% for CGP participants, which suggests a positive correlation between risk-taking and CGP investing.

B. OLS Results: Capital Guarantee Products and Risk-Taking

1. Total Change in Risk Taking. We now investigate whether CGP investing is associated with an increase in household risk-taking. Panel A of Figure 2 plots the *risk-taking index* in 2002 and in 2007 for: (i) households that participate at least once in capital guarantee

[23]Allocation funds are hybrid funds that combine equity funds and money market funds.

products over the sample period, and (ii) a control group of equal size containing stock market participants matched based on their 2002 risk-taking index. The two groups exhibit diverging risk-taking indexes over the sample period. While by construction the gap between the two groups is close to zero in 2002, it increases to 2 pp, or more than 6% of the 2002 risk-taking index, by the end of the sample period.

In Panel B of Figure 2, we apply the same analysis to households in the bottom quartile of risk-taking index in 2002. The divergence in risk-taking index between CGP participants and the matched control group is significantly more pronounced than in Panel A, with a gap in risk-taking index of 8 pp in 2007. This gap is particularly large when compared to the baseline risk-taking index of 2 pp for this subsample in 2002. This finding suggests some heterogeneity across households in the extent of the relationship between CGP participation and change in risk-taking.

In column 1 of Table V, we confirm this result by running a cross-sectional regression of the evolution of the risk-taking index in the sample of 2002 equity market participants:[24]

$$\Delta_{2007,2002}(\eta_h) = \alpha + \beta_1 \mathbb{1}_{CGP,h} + \lambda' x_{h,2002} + \varepsilon_h. \tag{7}$$

In this regression, $\Delta_{2007,2002}(\eta_h)$ denotes the Davis and Haltiwanger (1992) growth rate of the index,[25] $\mathbb{1}_{CGP,h}$ is an indicator variable equal to unity if the household purchases a CGP at least once during the sample period, $x_{h,2002}$ is a vector of household characteristics in 2002, and ε_h is an error term. Characteristics include the percentage change in income and in financial wealth over the period, as well fixed effects for the number of children, household size, gender, locality, years of education, and deciles of financial wealth, income, age and risky share. The coefficient of the variable $\mathbb{1}_{CGP,h}$ confirms that households that participate

[24] We therefore estimate the effect at the intensive margin. Our results are robust to including the whole population. However, effects on the extensive margin are minimal, which could be due to the high level of stock market participation in Sweden, or to the existence of a fixed cost to participation, which would not be alleviated by CGPs.

[25] The Davis and Haltiwanger (1992) growth measure, $\Delta_{2007,2002}(\eta_h) = 2(\eta_{h,2007} - \eta_{h,2002})/(|\eta_{h,2007}| + |\eta_{h,2002}|)$, limits the extreme values created by low denominator values in a standard growth rate.

in CGPs increase their risk-taking index significantly more than households that do not. The percentage change in the index is 24 pp higher for CGP participants, while the average household increases its index by only 0.7 pp over the period. This magnitude is comparable to the increase in risk-taking resulting from having access to a financial advisor, as estimated in Chalmers and Reuter (2020). However, the effect we document applies to a larger base: the household's entire financial wealth instead of a single retirement investment account.

2. Active Change in Risk-Taking. We now show that the heterogeneous response of risk-taking to innovation is driven by active investment decisions and not simply by the mechanical effect of realized asset returns.[26] To do so, we measure the active change in the risk-taking index of household h between t and $t+n$, $\Delta^{A}_{t,t+n}(\eta_h)$, as the Davis and Haltiwanger (1992) growth rate between the initial index, $\eta_{h,t}$, and the *market-neutral risk-taking index* $\eta^{\text{MN}}_{h,t+n}$ in year $t+n$, which we define as follows. The market neutral index is the index that the household would achieve if all asset returns were equal to zero.[27] By construction, $\eta^{\text{MN}}_{h,t+n}$ only differs from $\eta_{h,t}$ as a result of active trading and saving decisions.

Figure IA.2 in the Online Appendix reproduces Figure 2 using the market-neutral risk-taking index. As for the risk taking index, CGP participants and the matched control group exhibit diverging trends.

In column 3 of Table V, we regress the active change $\Delta^{A}_{2002,2007}(\eta_h)$ on CGP participation and household characteristics. The active change associated with CGP participation is comparable to the result obtained with the total change in the index, which rules out that our results are purely mechanical.

[26] As some active allocation decisions might be in reaction to passive performance, we view both exercises as complementary.

[27] The market-neutral risk-taking index is defined by $\eta^{\text{MN}}_{h,t+n} = \sum_{p=1}^{n} \eta_p \, Share^{\text{MN}}_{p,h,t+n}$, where $Share^{\text{MN}}_{h,p,t+n}$ is the share of product p in year $t+n$, adjusted for the mechanical changes due to realized asset returns from year t to $t+n$. Specifically,

$$Share^{\text{MN}}_{p,h,t+n} = \frac{X_{p,h,t} + \sum_{s=t+1}^{t+n}[X_{p,h,s} - (1+R_{p,h,s})\,X_{p,h,s-1}]}{FW_{h,t} + \sum_{s=t+1}^{t+n}[FW_{h,s} - (1+R_{h,s})\,FW_{h,s-1}]},$$

where $X_{p,h,s}$ is the amount invested in product p at date s, $R_{p,h,s}$ is the yearly realized return of product p from year $s-1$ to s, $FW_{h,s}$ is the total financial wealth, and $R_{h,s}$ is the return on financial wealth. Values are winsorized at the 1% level.

3. Panel Model. The following panel specification allows us to measure the sensitivity of the risk-taking index to the purchased quantity of capital guarantee products:

$$\eta_{h,t} = \alpha + \beta_2 \, CGP\ Share_{h,t} + \lambda' x_{h,t} + \gamma_h + \mu_t + \varepsilon_{h,t}, \tag{8}$$

where $CGP\ Share_{h,t}$ is the share of CGPs in household h's financial wealth, $x_{h,t}$ is a vector of characteristics, γ_h is a household fixed effect, μ_t is a time fixed effect, and $\varepsilon_{h,t}$ is a stochastic error.

If a household fully funds CGP purchases from bank deposits, the linear coefficient β_2 is approximately equal to the average risk-taking index of CGPs. By contrast, if a household views CGPs as perfect substitutes for traditional equity products, it funds CGP purchases by selling traditional products and β_2 can be negative. We report the panel regression results in Table VI. The point estimate of β_2 is 0.21, around half of the average risk-taking index of CGPs. We find similar results when the market-neutral risk-taking index $\eta^{MN}_{h,t}$ is used as the dependent variable.[28]

C. Heterogeneity along Household's Willingness to Take Risk

1. Main Result. We now show that the increase in risk-taking associated with CGP investing tends to vary substantially with a household's initial willingness to take risk, as Panel B of Figure 2 suggests. We measure this willingness by filtering out household characteristics from the initial risk-taking index. That is, we write $\eta_{h,2002} = \bar{\eta}_h + b'(x_h - \bar{x}) + e_h$, where $\bar{\eta}_{2002}$ and $\bar{x}$ respectively denote the sample means of $\eta_{h,2002}$ and x_h. Hence $\eta^{\mathrm{F}}_{h,2002} = \eta_{h,2002} - b'(x_h - \bar{x})$ represents the household's initial willingness to take risk that is not captured by observable characteristics.

Figure 3 illustrates the relationship between a household's willingness to take risk and the change in risk-taking for adopters of CGPs. To construct the figure, we regress the

[28]The coefficient β is slightly stronger, consistent with the fact that capital guarantee products are valued at issuance price while traditional equity products are marked to market in our data.

household change in the risk-taking index over the 2002-2007 period, $\eta_{h,2007} - \eta_{h,2002}$, on the indicator variable $\mathbb{1}_{CGP,h}$ interacted with the filtered risk-taking index in 2002:

$$\eta_{h,2007} - \eta_{h,2002} = \alpha + \beta_3 \, \mathbb{1}_{CGP,h} + \beta_4 \, \mathbb{1}_{CGP,h} \times \eta^{\mathrm{F}}_{h,2002} + \lambda' x_{h,2002} + \varepsilon_h, \tag{9}$$

where $x_{h,2002}$ includes fixed effects for deciles of wealth, income, and age, as well as the income change over the period. We then plot the proportional change in risk-taking for CGP participants, e.g. the ratio of the predicted incremental change in the risk-taking index for CGP participants vs. non-participants to their period-average of risk-taking index $\frac{\eta_{h,2002}+\eta_{h,2007}}{2}$, as a function of their filtered risk-taking index in 2002.[29]

The incremental increase in risk-taking for CGP adopters monotonically falls with the initial willingness to take risk.[30] The magnitude is particularly large for households with a low initial willingness to take risk. For households with a filtered 2002 risk-taking index below 0.10, the adoption of CGPs result in an increase in the risk-taking index of more than 60%. By contrast, the effect is close to zero for households that have a filtered 2002 risk-taking index above the median, or 0.17.

In columns 2 to 5 of Table VI, we confirm these results by estimating equation (8) within each quartiles of filtered 2002 risk-taking index. The coefficient β_4 is a decreasing function of their initial willingness to take risk.

2. Mechanism. To better understand the mechanisms at play, we explore whether the demand for CGPs increases with household willingness to take risk, as is the case for stocks and mutual funds, or decreases with it, as is the case for bank deposits. We consider four asset classes: CGPs, bank deposits, stocks, and equity mutual funds. For each asset class j, we run the OLS regression of the share of financial wealth invested in the class at the end

[29] We scale by $\frac{\eta_{h,2002}+\eta_{h,2007}}{2}$ and not by $\eta_{h,2002}$ to reduce distortions when $\eta_{h,2002}$ is close to zero.

[30] We obtain a comparable result when using the ex-ante bank deposit share of the financial wealth as a proxy for household (un-)willingness to take risk.

of 2007, $Share_{j,h}$, on the willingness to take risk:[31]

$$Share_{j,h} = \alpha_j + \beta_5 \, \eta^{\mathrm{F}}_{h,2002} + \lambda_j' x_{h,2002} + \varepsilon_{h,j}. \tag{10}$$

The vector of characteristics, $x_{h,2002}$, includes fixed effects for deciles of financial wealth, income, age, and years of education in 2002.

Figure 4 plots the predicted share of financial wealth invested in each asset class in 2007 as a function of the filtered 2002 risk-taking index. The share of stocks and mutual funds in 2007 is positively correlated with the initial willingness to take risk. This strong correlation is consistent with the persistence of household preferences and portfolio allocations, as the 2002 index is driven by stock and fund holdings. By contrast, the share of CGPs and the share of bank deposits are both negatively correlated with the initial willingness to take risk. The patterns of investment in CGPs are therefore similar to the patterns observed for bank deposits but opposite to the patterns of traditional equity products. These results suggest that households perceive CGPs to be closer to bank deposits than to traditional equity products, most likely because both protect the capital invested.[32]

D. *Instrumental Variable Analysis*

Our baseline result is a within-household positive correlation between risk-taking and CGP investing, controlling for a comprehensive set of time-varying household characteristics. Such correlation should be interpreted causally with caution. The share of capital guarantee products, $CGP\ Share_{h,t}$, and the error term of the structural equation (8), $\varepsilon_{h,t}$, may be driven by the same time-varying latent variables, such as the household's time-varying idiosyncratic willingness to take risk not predicted by characteristics. This endogeneity issue could bias OLS estimates downward or upward. Therefore, we develop an instrumental variable estimation of the structural equation (8), which we implement by two-stage least

[31] For each regression, we restrict the sample to participants in this given class.

[32] Bank deposits and capital guarantee products also have significantly different levels of liquidity.

squares (2SLS).

Design. We instrument the CGP share, $CGP\ Share_{h,t}$, by a measure of supply of capital guarantee products in year t from the banks with which household h has the strongest relationship at the beginning of the sample period. To do so, we exploit information on the identity of all the banks households receive interest income from. About two thirds of the sample of stock market participants declare an interest income.

The instrument is motivated by the evidence suggesting that bank supply largely drives CGP volumes. Figure IA.4 of the Online Appendix illustrates the strong correlation of the CGP volumes issued inside and outside Sweden by Swedish banks. Table IA.2 takes a more systematic approach and documents that bank-year fixed effects have significantly more explanatory power than country-year fixed effects for explaining the volume of CGPs sold by a given bank in a given country in a given year. When we introduce bank-year fixed effects in addition to country-year fixed effects that should absorb local demand to a certain extent, the adjusted R^2 increases from 0.03 to 0.19. Possible explanations for strong supply effects include securing access to a structuring desk and marketing efforts.

Let $\theta_{h,b}$ denote the indicator variable equal to unity if bank $b \in \{1, \ldots, B\}$ is the bank where household h deposits the largest share of cash at the beginning of the sample period, and let $\theta_h = (\theta_{h,1}, \ldots, \theta_{h,B})'$. We instrument the CGP share of household h hold in year t by

$$Z_{h,t} = \hat{\Phi}_t' \theta_h,$$

where $\hat{\Phi}_t$ is a measure of bank supply shocks.

The instrument is valid if the following condition holds.

Identifying Restriction 1. *The exogeneity condition* $\mathbb{E}(\hat{\Phi}_t' \theta_h \, \varepsilon_{h,t}) = 0$ *holds for every* h *and* t, *where* $\varepsilon_{h,t}$ *is the error term of the structural equation* (8).

That is, supply shocks are exogenous to time-varying unobservable characteristics that might drive household portfolio decisions. Similar to Borusyak et al. (2018), our strategy does not require that the matching between households and banks be exogenous.

In the first stage of 2SLS, we regress the share of capital guarantee products on the instrument, household characteristics, and household and time fixed effects:

$$CGP\ Share_{h,t} = \alpha + \beta_6\, \hat{\Phi}_t' \theta_h + \lambda'\, x_{h,t} + \gamma_h + \mu_t + u_{h,t}, \tag{11}$$

where $x_{h,t}$ includes time-varying household characteristics that are driving the demand for CGPs, and $u_{h,t}$ is a stochastic error term. In the second stage, we estimate:

$$\eta_{h,t} = \alpha + \beta\, \widehat{CGP\ Share}_{h,t} + \lambda' x_{h,t} + \gamma_h + \mu_t + v_{h,t}, \tag{12}$$

where $\widehat{CGP\ Share}_{h,t}$ is the predicted share from the first stage.

Measuring the Banks' Time-Varying Supply Shocks. A first approach is to use banks' CGP issuance per depositor as a proxy for supply shocks. This approach is motivated by the previously described evidence that bank supply drives total volumes. While this first approach has the advantage of simplicity, it may not satisfy the identification restriction. Total volumes can also be driven by demand factors that vary heterogeneously across banks along with unobservable household characteristics, which may imply that $\mathbb{E}(Z_{h,t}\, \varepsilon_t) \neq 0$.

In a second approach, we address this issue by filtering out demand effects and trends from the volumes offered by banks, thereby focusing on idiosyncratic supply shocks at the bank level. We obtain $\hat{\Phi}_t$ by estimating the panel regression:

$$CGP\ Share_{h,t} = \alpha + \Phi_t' \theta_h + \lambda'\, x_{h,t} + \gamma_h + \mu_t + w_{h,t}, \tag{13}$$

where $x_{h,t}$ includes the same set of time-varying fixed effects interacted with year fixed effects as in the structural equation (8), and $w_{h,t}$ is a stochastic error term with zero mean. Importantly, (11) is a random coefficients model, because the vector of linear coefficients Φ_t

is allowed to vary randomly through time. We make the following assumption.

Identifying Restriction 2. *The error term* $w_{h,t}$ *of equation* (13) *satisfy* $\mathbb{E}(\theta_h\, w_{h,t}) = 0$ *for every* h *and* t.

This restriction is reasonable to the extent that θ_h is not time-varying.

To further ensure that the estimator $\hat{\Phi}_t$ produces a valid instrument $Z_{h,t} = \hat{\Phi}_t'\theta_h$, we randomly partition the household population into two sub-samples of equal size. We estimate the idiosyncratic supply shock $\hat{\Phi}_t$ on the first sub-sample, and run the second stage of 2SLS on the other sub-sample. By doing so, we reduce the likelihood that unobservable characteristics of households in the first sub-sample are correlated with the error terms $\varepsilon_{h,t}$ of households in the second sub-sample.[33]

In practice, households have multiple banking relationships. We also use as instruments the supply shocks of the second and third banks with which the household has the largest balances.

Results. In columns 1 and 2 of Table VII, we instrument a household's CGP share in year t by the issuance of CGPs per depositor from the household's main banks during the year. Standard errors are clustered at the bank $\times$ year level, the level of granularity of the instrumental variable. The regression coefficients are consistent with a positive causal effect of CGP investing on household risk-taking.

Columns 3 and 4 of Table VII report the regression coefficients for both stages of the instrumental variable analysis, estimated on the second half of the sample, the first half having been used to estimate θ. Column 3 displays the coefficients of the first stage. A higher supply intensity of CGPs from a given bank significantly increases CGP investments by households in a relationship with this bank, even when controlling for detailed time-

[33] The estimator of the idiosyncratic supply shock at date t can be written as $\hat{\Phi}_t = \Phi_t + A\,w$, where w is the vector of yearly errors $w_{h,t}$ of households in the first subsample and the matrix A is a function of the observations $\theta_{h,t}$ and $x_{h,t}$. Since $\mathbb{E}(Z_t\,\varepsilon_{h,t}) = \mathbb{E}(\Phi_t'\,\varepsilon_{h,t}) + \mathbb{E}(w'\,A'\,\varepsilon_{h,t}) = 0$, the instrument is valid if supply shocks are uncorrelated with the error terms of the structural equation and if observations of households in different subsamples are independent.

varying household characteristics in a panel specification. The F-statistic of the first stage, at 569, is significantly above the threshold for strong instruments (Stock and Yogo, 2005).

Column 4 provides the coefficients of the second stage. The positive and significant coefficient on the instrumented quantity of CGPs confirms our central result and strengthens its causal interpretation: offering CGPs is associated with a significant increase in the risk-taking index of households. The larger magnitude of the coefficient in the instrumented specification suggests that sources of endogeneity are biasing our OLS results downwards. In columns 5 to 8, we restrict the sample to quartiles of filtered 2002 risk-taking index. Consistent with the OLS results, we find that the positive change in the risk-taking index is decreasing with household willingness to take risk, which provides for a causal interpretation of the cross-sectional result from the previous section. The sensitivity of the household risk-taking index with respect to the CGP share is on average equal to 0.69. Its confidence interval strongly overlaps with the distribution of the risk-taking index across CGPs (Table III), consistent with the weak substitutability of CGPs and equity mutual funds.

V. Can Economic Theory Explain the Impact of Capital Guarantee Products on Household Risk-Taking?

This section shows that two economic mechanisms can explain the increase in household risk-taking triggered by the introduction of capital guarantee products. In Section V.A, we develop a life-cycle model with stochastic labor income and three types of financial assets: a bond, an equity fund, and a CGP exhibiting the nonlinear payoffs and illiquidity of actual contracts. We use the life-cycle framework to assess how the introduction of CGPs impacts household portfolios under several specifications of preferences and beliefs. In Section V.B, we demonstrate that the causal impact of innovation on risk-taking is consistent with recursive preferences with loss aversion and narrow framing (Barberis and Huang, 2009), while other common preferences do not explain our empirical results. Pessimistic subjective beliefs are a powerful complementary explanation, which we investigate in Section V.C.

A. *A Life-Cycle Model with Capital Guarantee Products*

We develop a life-cycle model with stochastic labor income and CGPs. The model extends Cocco et al. (2005) by expanding the set of assets, alternative preferences, and beliefs.

1. Labor Income. The agent lives at dates $t = 1, \dots, T$, and receives a stochastic labor income Y_t every period. Before retirement, labor income is specified by:

$$Y_t = Y_t^P \; Y_t^H,$$

where Y_t^P, is a persistent component of income and Y_t^H is a transitory component. The permanent component is specified by $Y_t^P = e^{f(t;\chi_t)+\nu_t}$, where $f(t;\chi_t)$ is a fixed effect driven by the vector of deterministic characteristics χ_t and ν_t follows a random walk with Gaussian increments: $\nu_{t+1} - \nu_t \sim \mathcal{N}(0, \sigma_u^2)$. The transitory components have identical lognormal distributions, are mutually independent, and are also independent from the permanent components. We denote by RA the retirement age. After retirement, income is $Y_t = \lambda \, Y_{RA}^P$, where λ is a replacement ratio.

2. Financial Assets. The agent can trade two liquid financial securities every period. The riskless asset has constant yield $1 + R_f = e^{r_f}$ on a 1-period investment. The equity fund has random return $R_{eq,t} = (1 - \varphi)(1 + R_{m,t})$ between $t - 1$ and t, where $R_{m,t}$ is the return on an equity index and φ is a per-period fee.

Before financial innovation, the agent can only trade these two liquid assets. After innovation, the agent can also invest in capital guarantee products of staggered maturities. All CGPs are identical except for the issue date. A CGP issued at date t reaches maturity at date $t+M$, and we denote by $1+R_{g,t+M}$ the return on the guaranteed product over the life of the contract.

We make several conservative assumptions: (i) CGPs are written on the same index as the equity fund, (ii) they are strictly illiquid before maturity, and (iii) the agent can hold at most one type of CGP at given point in time. These assumptions ensure that the demand for CGPs over the life-cycle is not driven by an artificially strong diversification motive, or early redemption or rollover strategies that bypass the illiquidity of CGPs.[34] These choices allow us to provide a disciplined assessment of household demand for capital guarantee products and its impact on risk-taking.

3. Budget Constraint. At the beginning of period t, cash on hand X_t is the sum of the period's labor income, the value of holdings in the riskless asset and equity fund, and the value of holdings in the CGP if the contract reaches maturity at t. Capital previously invested in a structured product and still illiquid at date t is denoted by K_t, and time to maturity by τ_t.

The household selects the following variables at t: (i) consumption, C_t, (ii) investment in the illiquid product issued in the period, I_t, and (iii) the share of liquid wealth invested in the equity fund, α_t. We impose the constraint $I_t = 0$ whenever $\tau_t > 0$, so that the agent only invests in one type of CGP. Therefore, cash on hand at the beginning of period $t+1$ is

$$X_{t+1} \;=\; Y_{t+1} \;+\; (X_t - I_t - C_t)\left[1 + R_f + \alpha_t(R_{eq,t+1} - R_f)\right] \;+\; (1 + R_{g,t+1})K_t \mathbb{1}_{\{\tau_t = 1\}}. \quad (14)$$

The last term in (14) expresses that the capital K_t becomes liquid at $t+1$ if $\tau_t = 1$.

4. Information Structure. The household observes every period the returns on the equity index, the equity fund, and the held CGP if it reaches maturity. The observation of index returns helps the agent produce increasingly accurate forecasts of the CGP's return as time

[34] The investor could diversify by investing directly in the underlying of the capital guarantee product.

goes by. At date t, a sufficient statistic for the information available on the held CGP, issued at date $t-s$, is the cumulative return $CR_t = e^{-qs}(1+R_{m,t-s+1})\ldots(1+R_{m,t})$. The agent's position at the beginning of period t is summarized by the state vector (X_t, K_t, CR_t, τ_t). We now close the model by considering the specification of preferences and beliefs.

B. The Role of Preferences

In this section, we investigate the preference structures that can explain the empirical results of Section IV. We assume that the household has rational expectations and recursive utility:

$$V_t(X_t, K_t, CR_t, \tau_t) = \max_{(C_t, I_t, \alpha_t)} \left[(1-\delta)\, C_t^{1-1/\psi} + \delta p_t\, (\mu_{t+1})^{1-1/\psi}\right]^{\frac{1}{1-1/\psi}}, \tag{15}$$

where $t \in \{1, ..., T-1\}$, p_t is the probability that the agent is alive at $t+1$ conditional on being alive at date t, and μ_{t+1} is the certainty equivalent of future consumption. We let $V_T = (1-\delta)^{1/(1-1/\psi)}\, C_T$ at the terminal date, which does not include a bequest motive.

For each given specification of the certainty equivalent, μ_{t+1}, we solve the model numerically before and after financial innovation. Capital guarantee products have the median representative design: a maturity of 4 years, the full guarantee of the contract's face value ($g = 0$), a participation rate p of 112%, an underlying index with a risk premium of 6%, a volatility of 20%, a dividend yield of 2%, and an issue price equal to 111% of face value. The return on the CGP is based on the values of the index in the last 13 months of the contract. These paremeters imply a markup of 1.5% in annual units. We refer the reader to the Online Appendix for a full description of the model and solution methodology.

Under the Epstein and Zin (1989) utility: $\mu_{t+1} = [\mathbb{E}_t^{\mathbb{P}}(V_{t+1}^{1-\gamma})]^{1/(1-\gamma)}$, financial innovation does not generate an increase in the risk-taking index, as we show in the Online Appendix for the baseline specification and a battery of alternative parameter values. Since Epstein-Zin preferences imply second-order relative risk aversion, the equity fund provides an attractive risk premium to the household, which generates strong demand for the equity fund before financial innovation. CGPs offer the partial protection of invested capital and diversification opportunities. The guarantee offers only weak welfare benefits to an investor with second-order risk aversion. The benefits from diversification are also limited since the CGP and the equity fund are both linked to the same equity index. As a result, the life-cycle model with rational expectations and Epstein-Zin utility does not explain the strong increase in risk-taking triggered by financial innovation observed in large segments of the Swedish population.

The natural next step is to consider preferences with first-order risk aversion. As Barberis et al. (2006) explain, the choice of such preferences requires some care in multi-period environments. The presence of other preexisting risks, such as labor income risk, makes the agent act in a second-order risk-averse manner toward independent, delayed gambles. Therefore, first-order risk aversion alone may be insufficient to explain our empirical results. The Online Appendix confirms this intuition. We report that financial innovation does not substantially increase risk-taking when the household exhibits generalized disappointment aversion, a classic class of loss-averse preferences (Gul, 1991; Routledge and Zin, 2010).[35] The combination of narrow framing and loss aversion might be required to explain the empirical results of Section IV.

Thus, we consider the recursive specification incorporating narrow framing on investment income with first-order risk aversion developed by Barberis and Huang (2009):

$$\mu_{t+1} = \left[\mathbb{E}_t^{\mathbb{P}}(V_{t+1}^{1-\gamma})\right]^{\frac{1}{1-\gamma}} + b_0 \mathbb{E}_t^{\mathbb{P}}\left[v(W_{t+1} - W_{t+1}^R)\right], \tag{16}$$

where $b_0 \geq 0$ is a constant, W_{t+1} is the value of liquid financial wealth at the beginning of

[35]The certainty equivalent μ_{t+1} is implicitly defined by:

$$(\mu_{t+1})^{1-\gamma} = \mathbb{E}_t^{\mathbb{P}}(V_{t+1}^{1-\gamma}) + (\lambda - 1)\mathbb{E}_t^{\mathbb{P}}\left\{\left[V_{t+1}^{1-\gamma} - (\kappa\mu_{t+1})^{1-\gamma}\right]\mathbb{1}_{\{V_{t+1} < \kappa\mu_{t+1}\}}\right\},$$

where $\lambda \geq 1$ is a kink parameter and κ controls the disappointment threshold. This specification coincides with disappointment aversion (Gul, 1991) if $\kappa = 1$.

period $t+1$, $v(\cdot)$ is the piecewise linear function:

$$v(x) = \begin{cases} x & \text{if } x \geq 0, \\ \lambda x & \text{if } x \leq 0, \end{cases}$$

and $\lambda \geq 1$ is a kink parameter. The reference level, W_{t+1}^R, is set equal to the current value of past investments if the agent only invests in the riskless asset: $W_{t+1}^R = (X_t - C_t - I_t)(1+R_f) + K_t\,(1+R_f)^M\,\mathbb{1}_{\{\tau_t=1\}}$. This reference level offers the benefits of not altering the consumption-saving path when the household does not invest in risky assets.[36]

In Figure 5, we plot the life-cycle profile of an agent with loss aversion and narrow framing, as defined in equation (16). We set $\gamma = 4$, $\delta = 0.98$, and $\psi = 0.5$. The agent accumulates substantial amounts of CGPs (Panel A), which induces a considerable increase in the risk-taking index until retirement (Panel B). The higher average returns on savings allow the agent to increase her consumption during most of her working life and retirement (Panel C). The CGP therefore fosters risk-taking and consumption during most of the life-cycle. We examine the implications for household welfare in Section VI.

In Panel A of Figure 6, we plot the proportional change in the risk-taking index triggered by innovation as a function of the household's initial level of the index. The solid line illustrates the predictions from the life-cycle model and the dashed line the empirical values. In the model plot, we capture heterogeneity in initial risk appetite by varying the kink parameter λ controlling first-order risk aversion, while other preference parameters are set to the constants used in Figure 5. In practice, we let λ vary between 2 and 5 to span the empirical range of the index before innovation. The model seems reasonably consistent with the data. The proportional increase in the risk-taking index is high for households with low initial risk-taking, and decreases sharply with the initial risk-taking index. The model with narrow framing and loss aversion explains why the innovation has a higher impact on

[36] This specification of the reference level is consistent with earlier life-cycle applications of Barberis and Huang (2009) preferences available in the literature (Chai and Maurer, 2012).

households that are less willing to take risk.

One may ask if the same results would arise under preferences combining second-order risk aversion and narrow framing toward financial assets. Such preferences can be obtained by letting $\lambda = 1$ in the Barberis and Huang (2009) specification, or more generally by letting $\mu_{t+1} = \left[\mathbb{E}_t^{\mathbb{P}}(V_{t+1}^{1-\gamma})\right]^{\frac{1}{1-\gamma}} + b_0 \left\{[\mathbb{E}_t^{\mathbb{P}}(W_{t+1}^{1-\gamma})]^{\frac{1}{1-\gamma}} - W_{t+1}^R\right\}$, where W_{t+1}^R is the reference level defined earlier in the section. The Online Appendix verifies that such specifications do not explain the data. While these tests are not exhaustive, they strongly suggest that the combination of narrow framing and loss aversion is important to explain our empirical results under rational expectations.

C. The Role of Subjective Beliefs

Another possible explanation for the portfolio impact of financial innovation is that households hold pessimistic subjective beliefs about the equity index. Pessimistic beliefs assign a higher likelihood to negative outcomes than the physical measure $\mathbb{P}$, which discourages investment in the equity fund. By contrast, CGPs provide a protection against negative realizations of equity markets, which pessimistic households view as quite likely, while also providing an upside potential. Financial innovation can then increase risk-taking, an effect that should be especially strong for households with more pessimistic beliefs.

An extensive literature motivates the use of pessimistic beliefs in our model. Prospect theory points to the importance of pessimistic beliefs in decision-making, and one of its components, probability weighting, has emerged as a key building block of behavioral economics (Barberis, 2013). Complementary survey evidence documents that a substantial fraction of households assign a high probability to the occurrence of a large crash (Goetzmann, Kim, and Shiller, 2017). Pessimism is therefore a plausible driver of the demand for CGPs.[37]

We incorporate household pessimism into the life-cycle model by adopting Prelec (1998)'s

[37] Of course other households may be irrationally exuberant about stock market investing. However, optimistic households likely have a high risk-taking index before financial innovation and are less likely to drive the demand for guaranteed products.

probability weighting methodology. Let $F_{\mathbb{P}}(r)$ denote the cumulative distribution function of the yearly log return on the equity index, $r_{m,t}$, under the physical probability measure $\mathbb{P}$. The household's subjective belief about $r_{m,t}$ is specified by the cumulative distribution function:

$$F(r; a, b) = \exp\left\{-b\left[-\ln F_{\mathbb{P}}(r)\right]^{a}\right\},$$

where a and b are strictly positive constants. The parameter a controls the curvature of $F(\,\cdot\,; a, b)$. The Prelec transform $F(r; a, b)$ decreases with b, so a higher value of b implies stronger pessimism.

In Figure 7, we plot the life-cycle profile of an agent with Epstein-Zin utility and Prelec probability weighting. We set $a = 0.5$ and let the pessimism parameter b vary from 0.6 to 1.3. The results are qualitatively similar to the ones obtained in Figure 5 under rational expectations and Barberis-Huang preferences. The household has a strong demand for CGPs, which is hump-shaped over the life-cycle. This strong demand is associated with an increase in the risk-taking index. The higher average returns on savings triggered by innovation encourage households to slightly reduce consumption in their early years, and then enjoy higher average consumption after 40. Panel B of Figure 6 also illustrates that the proportional increase in the risk-taking index is stronger for households with more pessimistic beliefs and a lower initial risk-taking index, consistent with the data.

The Online Appendix shows that the results of Figures 6 and 7 are strongly robust to alternative specifications of pessimism. We define the subjective probability distribution as a mixture of a Gaussian and a crash event. Alternatively, we consider that the household believes that the volatility of the index exceeds its volatility level under $\mathbb{P}$, while the mean return remains unchanged. Variation in the crash probability or in volatility misperception induces variation in the risk-taking index analogous to the results reported in Figure 6.

Overall, the portfolio impact of financial innovation documented in Section IV is consistent with a life-cycle model of consumption and portfolio choice, provided that one departs from the canonical combination of Epstein-Zin preferences and rational expectations. Loss aversion and narrow framing (Barberis and Huang, 2009), or pessimistic subjective beliefs specified by probability weighting, subjective disaster risk, or volatility misperception deliver a model that explains the demand for CGPs and its cross-sectional variation with initial risk-taking.

VI. Implications for Household Welfare

This section measures the implications of financial innovation for household welfare under a set of assumptions on decision and experienced utilities. We show that households with pronounced behavioral biases and low initial levels of risk-taking are prime beneficiaries of capital guarantee products. The welfare gains to these households are large, comparable to six to 12 months of yearly income over the life-cycle, and corresponds to a substantial share of the surplus generated by the innovation. By contrast, households with weaker biases enjoy smaller welfare gains and can even incur welfare losses in some cases.

The results are obtained as follows. Section VI.A measures the total surplus generated by innovation and its allocation to households and institutions. This calculation is conducted under the assumption that the decision utility, which households use to make consumption-portfolio choices, coincides with the experienced utility used to assess economic well-being (Kahneman et al., 1997). Section VI.B breaks this restriction, and documents the sensitivity of household welfare benefits to the strength of behavioral biases.

A. Total Surplus and Its Allocation

The life-cycle model allows us to measure the total surplus per household generated by CGPs. In this subsection, we conduct the analysis under the following assumptions. First, household decision and experienced utilities coincide. Second, we use actual CGP prices. Third, equity returns and the riskless rate have identical properties before and after financial innovation in Sweden, consistent with the global pricing of asset markets. Under these assumptions, a consumption-portfolio strategy that is feasible before the introduction of the new product remains feasible afterward, so that financial innovation cannot reduce household welfare.

We define the *household benefit from financial innovation* as the wealth transfer that allows the household to attain in the pre-innovation economy the same lifetime utility as the one it achieves in the post-innovation economy without the transfer. For simplicity, the transfer takes place at the beginning of the life-cycle, that is at $t = 1$ in the notation of Section V. Our measure takes into account the optimization of financial resources via asset markets.

In Table VIII, we report the innovation benefits to households under several specifications of preferences and beliefs. In all cases, the parameters are chosen so that the risk-taking index before innovation is set to 8%, its 25th percentile in the Swedish population. The introduction of CGPs generates a benefit of about $15,000 for households under loss aversion and narrow framing (Barberis and Huang, 2009) or under Prelec (1998) beliefs. Alternative specifications of pessimism produce even higher estimates. The measured gains represent a substantial fraction of average yearly income during our sample period. Therefore, financial innovation is highly beneficial to households with strong behavioral biases and low initial risk-taking.

The *bank benefit from financial innovation* is defined as the no-arbitrage value at date $t = 1$ of the change in the profit per household:

$$\text{Bank benefit} = \mathbb{E}^{\mathbb{Q}}\left[\sum_{t=1}^{T} \frac{p_1 \dots p_{t-1}\Delta(\text{Profit}_t)}{(1+R_b)^{t-1}}\right], \tag{17}$$

where R_b is the funding cost of the bank and p_t denotes the survival probability defined in Section V. Given the limited information at our disposal, we proxy the change in bank profits by the sum of (i) the change in the fees earned on equity funds sold to the household and (ii) the gross profit margin earned on CGP sales. This approach is conservative because our measures of the bank's benefit and surplus share are upper bounds of actual values. We measure the funding cost R_b by the swap rate, which we take as constant, and we assume that the stochastic variation in profit is not priced, so that we take expectations under $\mathbb{P}$. The analysis therefore incorporates the reduction of profit from mutual funds that can be caused by financial innovation, commonly referred to as crowding out effects.

The *total surplus* is the sum of the household and bank benefits. In Table VIII, we report that the share of the surplus received by the bank is about 50-60% and the share received by the household is correspondingly 40-50% across specifications of preferences and beliefs. Thus, pricing by the bank does not appear to be predatory, consistent with the results of Section III.[38]

B. Sensitivity to Decision and Experienced Utilities

We now assess how behavioral biases impact the measured benefits from financial innovation. In particular, we allow that households may assess well-being by way of an experienced utility that differs from the decision utility used to select consumption and investments. While one can impute the decision utility from observed choices, the experienced utility is considerably more challenging to estimate in the present context. For this reason, we focus on two polar cases. In one scenario, the experienced utility coincides with the decision utility. In a second scenario, households are prone to behavioral biases in decision-making (as explained in previous sections) but not in the assessment of economic well-being.[39] We then assume that the experienced utility exhibits constant relative risk aversion (CRRA) and is evaluated under the physical measure $\mathbb{P}$.

In this expanded framework, we evaluate the welfare implications of financial innovation as follows. For a given decision utility and probability belief, we solve numerically the policy

[38]In the Online Appendix, we show that markups are not strongly tied to IQ, which further confirms that predatory pricing is not a dominant concern for this asset class.

[39]In both cases, the experienced utility exhibits less behavioral traits in preferences or beliefs than the decision utility. If instead the experienced utility has stronger behavioral traits, financial innovation could trigger an increase in risk-taking that would make the household worse off.

function $(C_t^*, I^*, t, \alpha_t^*)$ and then compute by simulation the experienced utility:

$$V^{\text{EXP}} = \mathbb{E}_0^{\mathbb{P}} \left[\sum_{t=1}^{T} \delta^{t-1} \, p_1 \ldots p_{t-1} \, u(C_t^*) \right],$$

where $u(C) = C^{1-1/\psi}/(1-\psi^{-1})$. To map the experienced utility V^{EXP} into yearly units, we define its *constant consumption equivalent* as the time- and state-invariant yearly consumption level C^{EXP} that achieves the same life-cycle experienced utility: $\sum_{t=1}^{T} \delta^{t-1} \, p_1 \ldots p_{t-1} \, u(C^{\text{EXP}}) = V^{\text{EXP}}$. The constant consumption equivalent is given by $C^{\text{EXP}} = \left[(1-\psi^{-1}) \, V^{\text{EXP}} / (\sum_{t=1}^{T} \delta^{t-1} \, p_1 \ldots p_{t-1}) \right]^{1-1/\psi}$

In the left graph of Figure 8, Panel A, we consider households with identical decision and experienced utilities, which are of the Barberis-Huang type. Variation in initial risk-taking is obtained by letting the loss aversion parameter λ vary, while the other preference parameters are set as in Section V.B. The figure plots the constant consumption equivalent before and after innovation as a function of the initial risk-taking index. The innovation increases the constant consumption equivalent by \$1,500 per year for households with low initial risk-taking, and about \$1,000 for households with high initial risk-taking. The welfare gains are substantial for all households and are most pronounced for households that have a higher loss aversion parameter λ and therefore a lower risk-taking index *ex ante*.

In the right graph of Figure 8, Panel A, we consider households with (i) Barberis-Huang decision utilities with heterogeneous loss aversion parameters λ, and (ii) a common CRRA experienced utility with parameters $\psi = 0.5$ and $\delta = 0.98$. The figure plots the constant consumption equivalent before and after innovation as a function of the initial risk-taking index (corresponding to different levels of λ). While financial innovation increases the experienced utility of households with low initial risk-taking, it now *decreases* the experienced utility of households with high initial risk-taking. Under our chosen specification, the difference in utility breaks even when the risk-taking index is about 20% *ex ante*. Households with high initial risky shares cater to their behavioral biases (loss aversion and narrow framing) by purchasing CGPs, which lowers their risk-taking index and reduces average consumption and experienced utility over the life-cycle.

Panel B reports similar findings for households with Prelec subjective utilities. The most pessimistic households strongly benefit from financial innovation, while less biased households incur losses in experienced utility.

Overall, this section documents that households with low initial risk-taking are the prime beneficiaries of the introduction of CGPs across preference and belief specifications. The new products address these households' concerns about very adverse outcomes and allows them to increase their participation in risky asset markets, which produces an increase in average consumption. Since the experienced utility is not particularly sensitive to consumption volatility, household welfare improves. By contrast, for households initially more willing to take risk, the introduction of CGPs crowds out equity fund investments, thereby reducing average consumption and experienced utility. Our results suggests that in order to maximize household welfare, financial advisers and institutions should target the sale of CGPs to households with low risk exposures, while continuing to market diversified equity funds to customers with stronger risk appetites.

VII. Conclusion

This study provides empirical evidence that security design can help to alleviate low financial risk-taking by a sizable segment of the household population. The growing class of capital guarantee products provide investors with a substantial share of the equity premium, along with a guarantee typically representing about 90% of invested capital. Using a large administrative data set, we show that the introduction of retail capital guarantee products significantly increases the expected returns of household financial portfolios, especially if the initial willingness to take risk is low.

The present paper illustrates that financial innovation can be used as a laboratory to test theories of portfolio choice. For instance, we show that pessimistic beliefs or preferences combining loss aversion with narrow framing can explain low levels of household risk-taking and the impact of financial innovation, while the combination of second-order risk aversion and rational expectations cannot explain these facts in a standard life-cycle model.

Our work also contributes to the literature that assesses the welfare implications of financial innovation. When experiential utility coincides with decision utility, the introduction of capital guarantee products generates large welfare gains for households with a low initial willingness to take risk, and more modest gains for other households. If instead behavioral biases impact decision utility but not experiential utility, the innovation is only beneficial for households with the strongest biases and the lowest initial equity shares. This analysis suggests that capital guarantee products should be primarily marketed to low risk-takers, while low-fee traditional equity products are better suited for other households.

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Table I
Capital Guarantee Products Around the World

Country or Region	Product Type	Outstanding Volume (Billion U.S. $)
North America		1,764
USA	Guaranteed Life Annuity*	1,720
	Retail Structured Products	22
Canada	Retail Structured Products	20
Mexico	Retail Structured Products	2
Europe		1,794
France	Euro Contracts*	1,540
	Retail Structured Products	31
Germany	Retail Structured Products	47
Belgium	Retail Structured Products	45
UK	Retail Structured Products	12
Asia		936
China	Guaranteed Wealth Management Products*	854
	Retail Structured Products	13
South Korea	Retail Structured Products	31
Japan	Retail Structured Products	17
Other	Retail Structured Products	18

Notes: This table reports the types and outstanding volumes of capital guarantee products around the world in 2015. The outstanding volume is obtained from Ellul et al. (2020) for guaranteed life annuities in the United States, Hombert and Lyonnet (2020) for Euro contracts in France, the 2015 Annual Report of China Banking Wealth Management Product by "China Central Depository & Clearing Co. Ltd" for wealth management products in China, and from the same data provider as in Célérier and Vallée (2017) for retail structured products. Retail structured products volume only include issuances offering a capital protection of at least 90% of the capital invested. * *For these products the guarantee is obtained using reserves, possibly complemented by hedging.*

Table II
Household Risk-Taking Across Countries in 2015

	National Accounts	Surveys of Households Above 50	
	Share of Equity in Aggregate Financial Wealth in %	Fraction of Equity Participants in %	Median Share of Equity in Financial Wealth in %
	(1)	(2)	(3)
Sweden	17.41	68.16	36.64
United States	31.91	35.48	30.09
China	n/a	10.08	19.88
European Union	8.74	25.26	31.25
Selected European countries			
Austria	7.80	18.69	33.33
Belgium	14.24	40.46	33.11
Croatia	n/a	6.93	33.33
Czech Republic	1.18	37.92	21.98
Denmark	28.27	58.31	32.38
Estonia	5.09	8.40	33.26
Finland	15.71	n/a	n/a
France	9.12	30.57	23.37
Germany	6.29	32.91	26.19
Greece	3.14	2.58	27.36
Hungary	3.86	n/a	n/a
Italy	7.13	8.03	30.00
Latvia	3.48	n/a	n/a
Lithuania	4.20	n/a	n/a
Luxembourg	10.98	26.68	36.80
The Netherlands	26.00	n/a	n/a
Norway	15.80	n/a	n/a
Poland	10.12	2.38	36.36
Portugal	3.21	16.36	28.00
Slovakia	0.38	n/a	n/a
Slovenia	8.19	10.97	30.11
Spain	8.90	7.81	31.09
United Kingdom	9.05	25.70	7.06

Notes: This table reports (1) the percentage of aggregate household financial wealth invested in equity, (2) the fraction of households participating in equity markets, and (3) the median share of equity in the financial wealth of participants. The data in column 1 are retrieved from the OECD National Accounts and the US Federal Reserve's Financial Accounts. The statistics in columns 2 and 3 are based on surveys of households representative of the population of people aged 50 years and older, except for China, where the sample is representative of the total population. The surveys are the following: the 2016 wave of the University of Michigan Health and Retirement Study (HRS) for the US, the 6^{th} wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) for European countries including Sweden, the 7^{th} wave of the English Longitudinal Study of Ageing (ELSA) for the United Kingdom, and the 2015 China Household Finance Survey (CHFS) for China. Section II in the Online Appendix describes the precise methodology.

Table III
Design, Markup, and Expected Return of Retail Equity Products

	Mean	p1	p10	p50	p90	p99
Panel A. Full sample of capital guarantee products (1,511 contracts)						
Issuance year	2006	2002	2004	2006	2007	2007
Volume (2000 $ million)	5.2	0.1	0.5	2.6	13.0	29.1
Design parameters:						
- Maturity (months)	40.1	12.0	17.9	37.6	60.5	72.5
- Guarantee (% of face value)	100.2	100.0	100.0	100.0	100.0	108.0
- Issue price (% of face value)	107.0	100.0	101.0	106.0	112.0	122.0
Panel B. Baseline capital guarantee products (809 contracts)						
Issuance year	2006	2002	2004	2006	2007	2007
Volume (2000 $ million)	4.8	0.1	0.5	2.7	11.9	25.9
Design parameters:						
- Maturity (months)	44.4	12.6	24.5	48.0	60.5	72.5
- Guarantee (% of face value)	100.2	100.0	100.0	100.0	100.0	108.0
- Issue price (% of face value)	108.7	100.0	101.5	111.5	112.0	122.0
- Participation rate (%)	112.9	30.0	60.0	110.0	160.0	210.0
- Asian option length (months)	13.6	0.0	4.0	13.0	24.0	60.0
Asset pricing inputs:						
- Historical volatility	0.1	0.0	0.0	0.1	0.1	0.1
- Dividend yield (%)	2.0	0.0	0.5	2.1	3.0	4.5
- CDS premium (%)	18.8	8.0	11.2	15.4	31.5	47.5
- Beta of underlying to world index	1.1	0.5	0.9	1.1	1.3	1.4
Asset pricing outputs:						
- Yearly markup (%)	1.6	-0.7	0.3	1.6	2.7	3.9
- Risk-taking index η	0.44	-0.17	0.02	0.45	0.83	1.06
Panel C. Equity mutual funds (1,376 funds)						
Volume in 2007 ($ million)	21.7	0.0	0.0	0.4	27.2	448
Beta to world index (%)	0.9	0.0	0.5	0.9	1.2	1.5
Yearly fees (%)	2.1	0.6	1.6	1.9	2.8	4.1
Asset pricing outputs:						
- Risk-taking index η	0.55	0.0	0.0	0.58	0.89	1.16

Notes: Panel A reports the average characteristics of retail CGPs issued in Sweden between 2002 and 2007. The capital guarantee, g, is the minimum fraction of face value the household receives at maturity. The issue price, P_0, is expressed as a percentage of face value. Panel B displays summary statistics on the subsample of baseline CGPs with total returns of the form $1 + R_g = [1 + \max(p\,R^*; g)]\,\xi\,F/P_0$, where p is the participation rate, R^* is the average performance of the underlying, and ξ is the fraction of pledged cash flows paid at maturity. The Asian option length is the length of the period over which the underlying's performance is averaged to define R^*. The risk-taking index η is the ratio of the product's risk premium to the world index's risk premium, as defined in equation (6). The yearly markup is computed as defined in Section III.B. Panel C reports summary statistics on all equity mutual funds available in Sweden between 2002 and 2007. Yearly fees include the management and entry fees paid by retail investors.

Table IV
Household Characteristics and Portfolio Allocation

	Full Sample (1)				Traditional Equity Product Participants (2)				Capital Guarantee Product Participants (3)			
	Number of households: N=3,107,893				Number of households: N=2,128,612 (68.5% of total)				Number of households: N=428,337 (13.9% of total)			
	Mean	Median	p10	p90	Mean	Median	p10	p90	Mean	Median	p10	p90
Panel A: 2002												
Financial wealth (in 2000 $, thousands)												
Total	33.7	11.2	2.5	72.8	44.9	17.7	4.6	92.3	72.9	38.0	8.0	149.6
Traditional equity products	15.3	1.2	0.0	29.6	22.4	4.4	0.2	42.9	36.1	11.8	0.2	79.1
Stocks	7.1	0.0	0.0	6.5	10.4	0.3	0.0	11.3	13.5	0.9	0.0	22.4
Equity mutual funds	8.0	0.5	0.0	19.7	11.7	2.6	0.0	28.5	22.1	7.8	0.0	54.5
Bank deposits	13.1	6.3	2.0	27.4	1.6	7.7	2.6	32.4	22.4	10.5	3.0	48.0
Fixed income securities	4.2	0.0	0.0	11.6	5.5	0.0	0.0	14.9	11.4	2.1	0.0	30.5
Demographics												
Family size	2.1	2.0	1.0	4.0	2.3	2.0	1.0	4.0	2.2	2.0	1.0	4.0
Number of children	0.2	0.0	0.0	1.0	0.2	0.0	0.0	1.0	0.2	0.0	0.0	1.0
Disposable income (in 2000 $)	27.5	22.8	10.5	48.0	31.5	28.0	12.3	52.0	35.3	30.9	14.2	57.0
Years of schooling (head)	11.4	11.0	8.0	15.0	11.8	11.0	8.0	15.0	11.9	12.0	8.0	16.0
Male, in % (head)	60.0	100.0	0.0	100.0	63.5	100.0	0.0	100.0	62.9	100.0	0.0	100.0
Age (head)	53.1	52.0	33.0	76.0	52.0	52.0	32.0	73.0	55.2	56.0	37.0	72.0
Equity participants, in %	68.5	-	-	-	100	-	-	-	92.9	-	-	-
Allocation of financial wealth (%, 2002 participants only)												
Traditional equity products	22.5	11.5	0.0	65.0	32.9	27.5	2.5	72.6	37.9	35.9	1.3	76.5
Stocks	6.4	0.0	0.0	20.9	9.3	1.4	0.0	30.2	9.8	2.5	0.0	30.7
Equity mutual funds	15.7	4.3	0.0	48.8	22.9	16.9	0.0	56.3	27.3	23.5	0.0	61.1
Bank deposits	66.5	74.0	17.1	1	54.4	55.0	12.9	95.1	42.9	37.7	8.6	88.1

Table IV (continued)
Household Characteristics and Portfolio Allocation

Panel B: 2007												
Allocation of financial wealth (%)												
Capital guarantee products	1.6	0.0	0.0	2.5	2.1	0.0	0.0	6.2	11.9	7.3	0.0	30.0
Traditional equity products	24.4	11.8	0.0	70.1	34.5	30.5	0.0	76.5	34.4	31.9	0.7	71.0
Stocks	6.4	0.0	0.0	21.8	9.2	0.3	0.0	31.7	9.1	1.6	0.0	30.1
Equity mutual funds	16.5	1.4	0.0	54.5	23.6	15.9	0.0	61.9	23.2	18.7	0.0	55.0
ETFs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank deposits	63.8	69.0	14.3	100.0	52.1	49.2	11.2	99.2	36.9	31.6	7.7	75.4
Panel C: Household risk-taking index (η_h)												
Year 2002	0.15	0.06	0.0	0.46	0.22	0.17	0.0	0.53	0.26	0.23	0.01	0.56
Year 2007	0.17	0.06	0.0	0.51	0.25	0.20	0.0	0.58	0.28	0.26	0.01	0.56
2002-2007 % Change					0.7	13.5	-195.1	122.2	17.6	13.6	-78.8	123.8

Notes: This table reports summary statistics on the characteristics, portfolio allocation, and risk-taking behavior of Swedish households. In Panel A, we tabulate the financial characteristics, demographics, equity participation, and share of financial wealth allocated to equity in 2002. Panel B displays equity participation and the equity share of households in 2007. Panel C shows the risk-taking index in 2002 and 2007. The statistics are computed on all households in Sweden in the first set of columns ($N = 3,107,893$ households), participants in traditional equity products in the second set of columns ($N = 2,128,612$ households or 68.5% of the total household population), and participants in capital guarantee products ($N = 428,337$ households or 13.8% of the total population).

Table V
Participation in Capital Guarantee Products and Financial Risk-Taking: Cross Section Analysis

	2002 -2007 Percentage Change in Risk-Taking Index ($\Delta\eta_h$)			
	Total Change		Active Change	
	(1)	(2)	(3)	(4)
$\mathbb{1}_{CGP_h}$	0.24***	0.44***	0.27***	0.51***
	(0.01)	(0.01)	(0.01)	(0.01)
$\mathbb{1}_{CGP_h} \times$ 2002 risk-taking index		-0.85***		-0.99***
		(0.02)		(0.02)
Fixed effects (2002 value)				
Risk-taking index quartiles	Yes	Yes	Yes	Yes
Financial wealth deciles	Yes	Yes	Yes	Yes
Income deciles	Yes	Yes	Yes	Yes
Age deciles	Yes	Yes	Yes	Yes
Gender	Yes	Yes	Yes	Yes
Years of education	Yes	Yes	Yes	Yes
Family size	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
Control				
2002-2007 change in income	Yes	Yes	Yes	Yes
Observations	2,128,612	2,128,612	2,128,612	2,128,612
R^2	0.106	0.061	0.05	0.05

Notes: This table displays OLS regression coefficients of the change in the risk-taking on an indicator variable for participation in capital guarantee products and control variables. In Columns 1 and 2, the dependent variable is the Davis and Haltiwanger (1992) measure of growth in the risk-taking index from 2002 to 2007. In Columns 3 and 4, the dependent variable is the *active* change in risk-taking index from 2002 to 2007. We compute the active change in the risk-taking index as the Davis and Haltiwanger (1992)'s growth rate between the risk-taking index in 2002 and the 2007 "market-neutral" risk-taking index, as described in Section IV.B. The indicator variable $\mathbb{1}_{CGP_h}$ is equal to unity if the household invests at least once in capital guarantee products over the 2002 to 2007 period. In Columns 2 and 4, we interact $\mathbb{1}_{CGP_h}$ with the household 2002 risk-taking index, filtered with household observable characteristics as described in Section IV.C. The sample is restricted to households participating in stock markets in 2002. Standard errors are clustered at the district level and displayed below their coefficient of interest. *, **, and *** represent statistical significance at the 10%, 5%, and 1% confidence levels, respectively.

Table VI
Participation in Capital Guarantee Products and Financial Risk-Taking: Panel Analysis

		Quartiles of 2002 Risk-Taking Index			
	All	Q1	Q2	Q3	Q4
	(1)	(2)	(3)	(4)	(5)
Panel A. Dependent variable: Risk-taking index $\eta_{h,t}$					
CGP Share$_{h,t}$	0.21***	0.40***	0.31***	0.15***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Controls and Observations: see Panel C					
R^2	0.832	0.723	0.731	0.680	0.708
Panel B. Dependent variable: Market-neutral risk-taking index $\eta_{h,t}^{MN}$					
CGP Share$_{h,t}$	0.26***	0.40***	0.33***	0.22***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Controls and Observations: see Panel C					
R^2	0.629	0.542	0.515	0.566	0.623
Panel C. Control variables and Number of Observations					
Fixed Effects					
Household	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Fixed effects interacted with year fixed effects					
2002 risk-taking index quartiles	Yes	Yes	Yes	Yes	Yes
Financial wealth deciles	Yes	Yes	Yes	Yes	Yes
Income deciles	Yes	Yes	Yes	Yes	Yes
Age deciles	Yes	Yes	Yes	Yes	Yes
Gender	Yes	Yes	Yes	Yes	Yes
Years of education	Yes	Yes	Yes	Yes	Yes
Family size	Yes	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes
Observations	12,771,671	3,192,917	3,192,908	3,192,912	3,192,916

Notes: This table reports panel regressions of household risk-taking on the share of financial wealth invested in capital guaranteed products, *CGP Share*$_{h,t}$. In Panel A, the dependent variable is the risk-taking index. In Panel B, the dependent variable is the "market-neutral" risk-taking index, as described in Section IV.B. Panel C lists the control variables used in the regressions reported in Panels A and B. The sample is restricted to households participating in stock markets in 2002. Standard errors are clustered at the bank times year level and displayed below their coefficient of interest. *, **, and *** represent statistical significance at the 10%, 5%, and 1% confidence levels, respectively.

Table VII
Instrumental Variable Panel Analysis

Instruments	**Volumes per Depositor**		**Idiosyncratic Supply Shocks**					
	First Stage	Second Stage	First Stage	Second Stage				
	$CGPShare_{h,t}$	Risk-Taking Index	$CGPShare_{h,t}$	Risk-Taking Index				
	Full	Full	Full	Full	Quartiles of Risk-Taking Index			
	Sample (1)	Sample (2)	Sample (3)	Sample (4)	Q1 (5)	Q2 (6)	Q3 (7)	Q4 (8)
$\widehat{\text{CGP Share}}_{h,t}$		0.9***		0.69**	0.79***	0.60***	0.61*	0.33
		(0.9)		(0.30)	(0.20)	(0.31)	(0.36)	(0.43)
Volume issued by main bank	2.84***							
	(0.6)							
Idiosyncratic supply shocks								
Main bank			1.15***					
			(0.03)					
Second main bank			0.56***					
			(0.04)					
Third main bank			0.65***					
			(0.07)					
Fixed effects								
Household	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects interacted with year fixed effects								
Risk-taking index quartiles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Financial wealth deciles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income deciles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age deciles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gender	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Years of education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,131,784	8,131,784	4,164,828	4,164,828	1,013,793	1,013,793	1,013,793	1,013,793
R^2	0.49		0.51					
F-statistic	76.2		568.5					

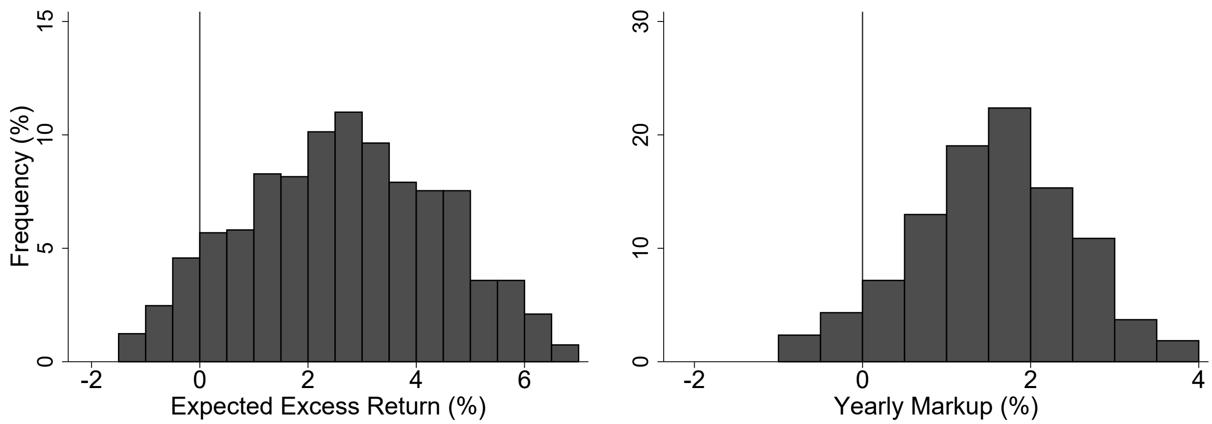
Notes: This table displays the results of the instrumental variable analysis, in which the share of CGPs in the financial wealth of household h in year t, *CGP Share*$_{h,t}$, is instrumented by a measure of *CGP* supply by the main bank(s) with which the household has a relationship in 2002. In columns 1 and 2, we instrument *CGP Share*$_{h,t}$ by the contemporaneous outstanding volume of CGPs per depositor issued by household h's main bank. In Columns 3 to 7, we filter out demand effects from this measure by partitioning the household population into two random sub-samples of equal size. We use the first sub-sample to estimate idiosyncratic bank-level supply shocks, and the second sub-sample to estimate the structural equation. More specifically, in the first sub-sample, we regress *CGP Share*$_{h,t}$ on (i) a vector of indicator variables for every bank b, where the b^{th} indicator is equal to unity if b is one of the household's three main banks at the beginning of the sample period, and (ii) a set of household characteristics. The resulting linear coefficients of bank indicators provide measures of bank-levels idiosyncratic supply shocks. We then use the second random sub-sample to implement two stage least squares (2SLS). In the first stage of 2SLS, we regress *CGP Share*$_{h,t}$ on the supply shocks of the household's three main banks. In the second stage of 2SLS, we regress the household's risk-taking index on the predicted $\widehat{\text{CGP Share}}_{h,t}$ from the first stage. Both stages of 2SLS are panel models with household and year fixed effects. The sample is restricted to household participating in stock markets in 2002. Standard errors are clustered at the bank times year levels and are displayed below their coefficient of interest. *, **, and *** represent statistical significance at the 10%, 5%, and 1% confidence levels, respectively.

Table VIII
Household Welfare Gains Predicted by the Models

Models	**Loss Aversion with Narrow Framing** (1)	**Probability Weighting** (2)
Key parameter value	Utility kink parameter $\lambda = 3.5$	Pessimism parameter b=0.71
Change in risk-taking (%)	95.4	121.6
Household utility gain, in U.S. $	15,737	14,088
Bank revenue gain, in U.S. $	14,741	19,419
Household share of surplus (%)	51.6	42.0

Notes: This table reports the changes in the household risk-taking index, welfare gains, bank revenue gains, and the household share of the surplus generated by the introduction of capital guarantee products under various specifications of preferences and beliefs. Decision and experienced utilities are assumed to be identical. Under all specifications, the starting value is household with an ex-ante risk-taking index of 8%, which corresponds to the 25^{th} percentile in the Swedish population. In column 1, we consider an investor with Barberis and Huang (2009) preferences, which combines loss aversion with narrow framing, and rational expectations. In column 2, we consider an investor with Prelec (1998) probability weighting. The subjective cumulative distribution function of the investor is given by $F(r; a, b) = \exp\{-b[-\ln F_{\mathbb{P}}(r)]\}$, where $F_{\mathbb{P}}(r)$ denotes the cumulative distribution function of the yearly log return on the underlying under the physical measure $\mathbb{P}$.

Panel A. Baseline Capital Guarantee Products (809 Products)



Panel B. Equity Mutual Funds (1,376 Products)

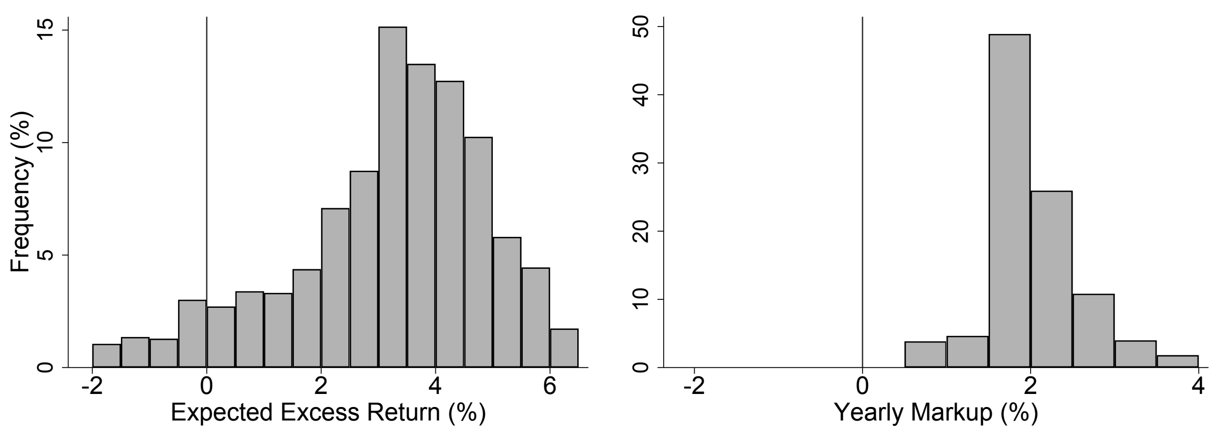


Figure 1. Expected Excess Returns and Yearly Markups of Capital Guarantee Products and Equity Mutual Funds. Panel A shows the histogram of the expected excess return offered by the 809 baseline capital guarantee products issued in Sweden over the 2002-2007 period (left graph) and the histogram of the gross markup of the banks distributing them (right graph). Both measures result are computed by following the asset pricing methodology outlined in Section III. Panel B shows the histograms of the expected excess return (left graph) and gross markup (right graph) of the 1,376 equity mutual funds under management in Sweden over the 2002-2007 period.

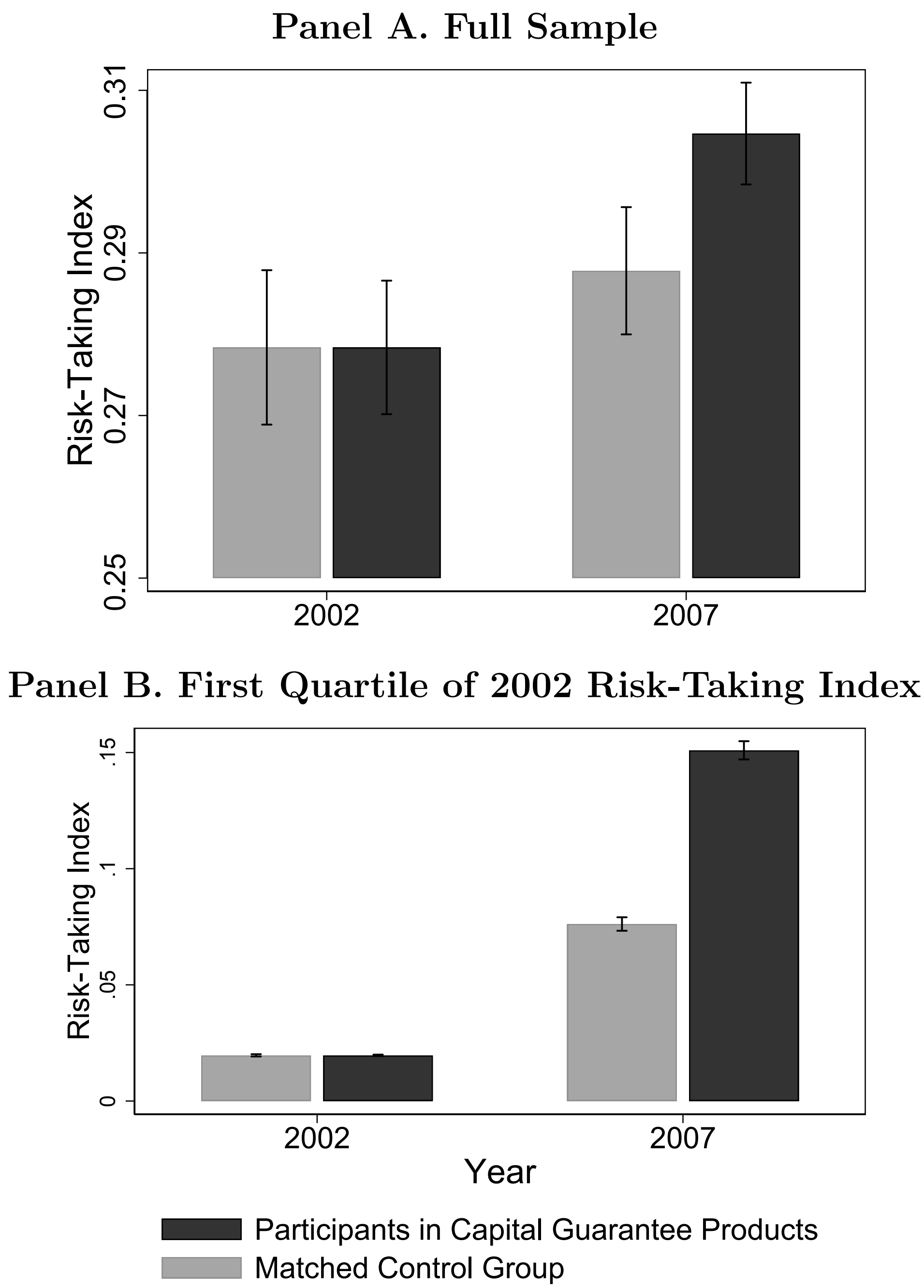


Figure 2. Household Risk-Taking Index in 2002 and 2007. Panel A plots the risk-taking index in 2002 and in 2007 for: (i) capital guarantee product participants, and (ii) a control group of equal size made of stock market participants matched based on their 2002 risk-taking index. Panel B reproduces the same graph when restricting the sample to households in the first quartile of risk-taking index in 2002. The whiskers represent the confidence band at the 95% level.

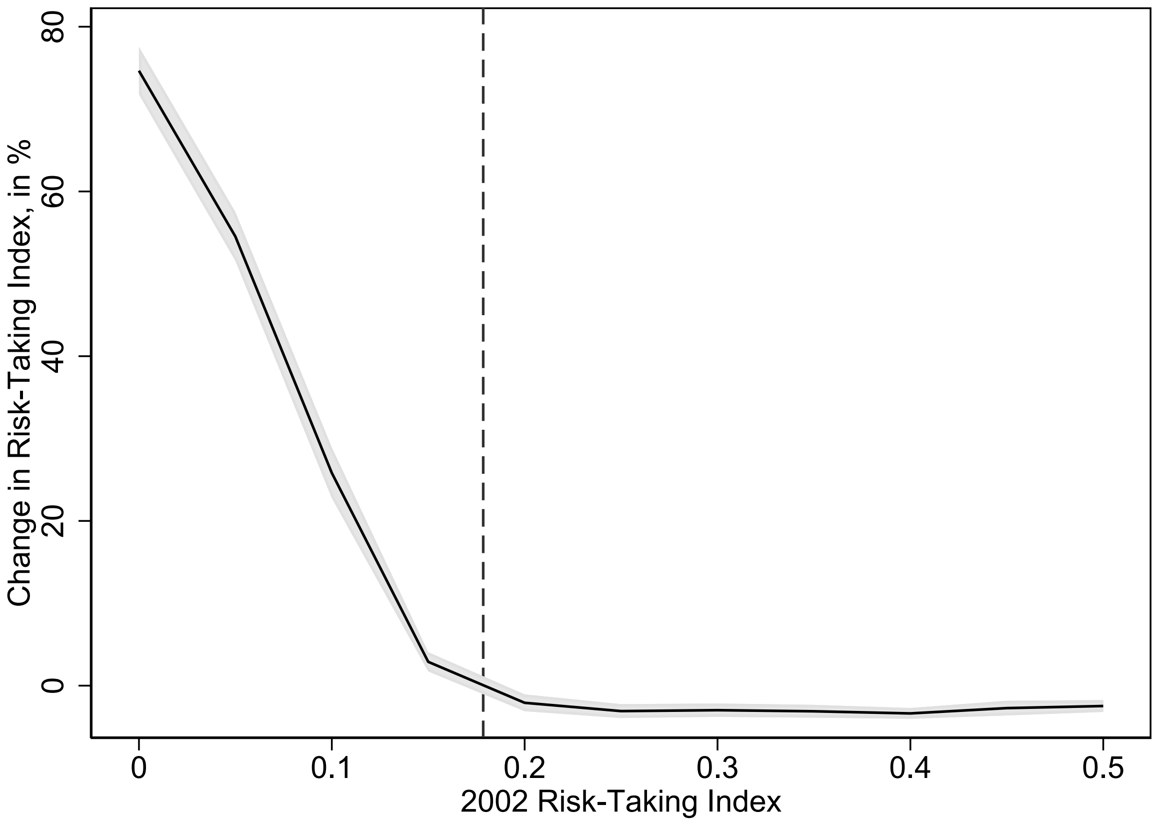


Figure 3. Proportional Change in Risk-Taking Index as a Function of Initial Risk-Taking for Capital Guarantee Product Participants. This figure shows the proportional change in the risk-taking index for CGP participants as a function of their filtered risk-taking index in 2002. The proportional change in risk-taking for CGP participants is the ratio of the predicted incremental change in the risk-taking index for CGP participants (vs. non participants) to their period-average of risk-taking index $\frac{\eta_{h,2002}+\eta_{h,2007}}{2}$. The 2002 risk-taking index is filtered from household observable characteristics, as described in Section IV.C. The vertical dotted line plots the median 2002 risk-taking index. The shaded area represents the confidence band at the 95% level.

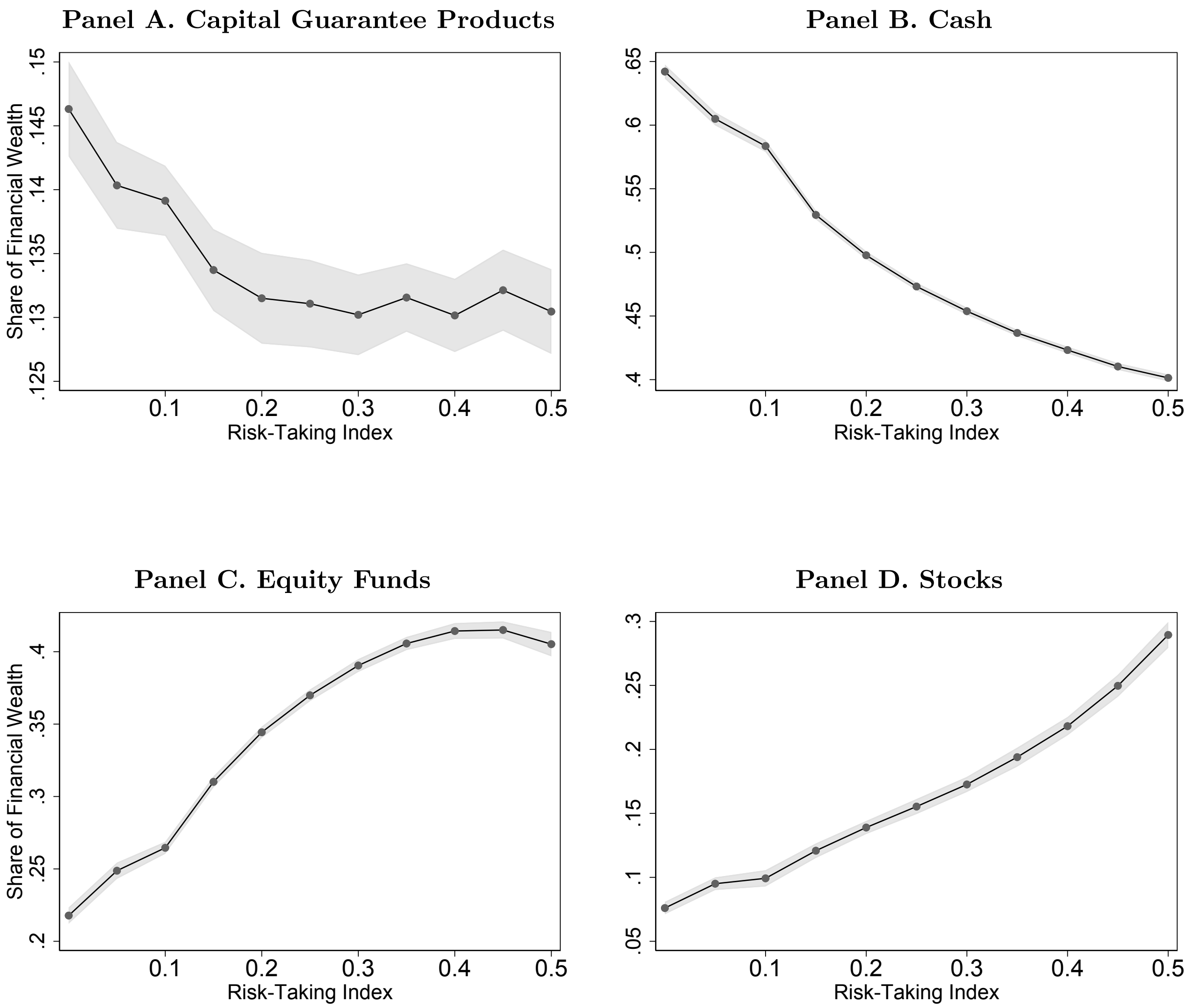


Figure 4. Allocation of 2007 Financial Portfolio as a Function of Initial Risk-Taking. This figure displays the predicted share of household financial wealth invested in capital guarantee products, cash, funds and stocks in 2007 as a function of the 2002 risk-taking index. The 2002 risk-taking index is filtered from household observable characteristics as described in Section IV.C. The sample is restricted to participants in each asset class. The shaded area represents the confidence band at the 95% level.

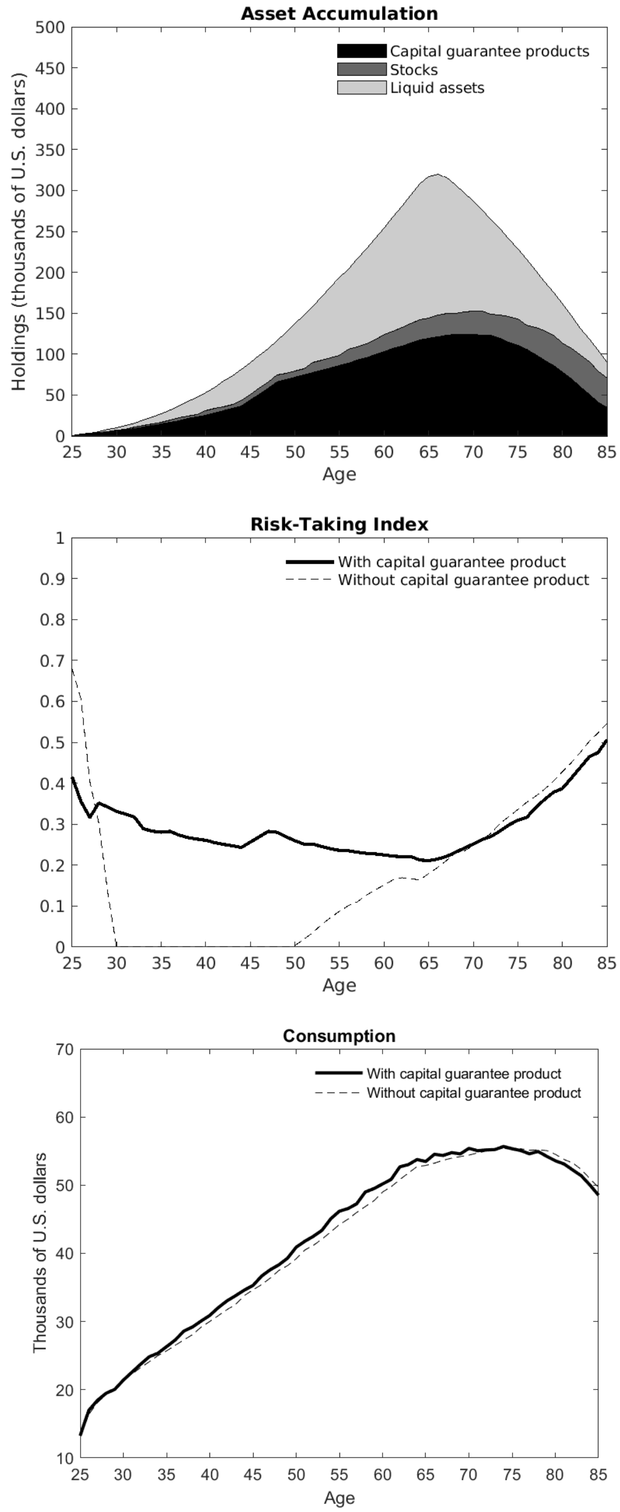
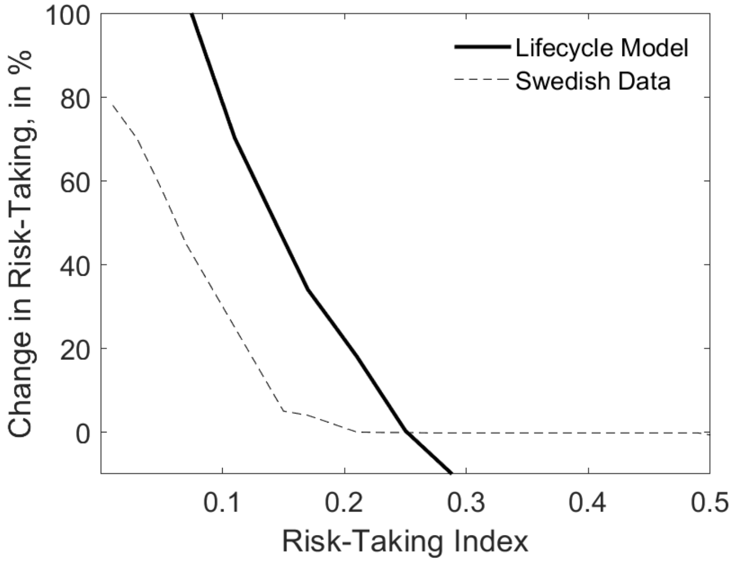


Figure 5. Life-Cycle Model with Loss Aversion and Narrow Framing. This figure displays the average portfolio allocation (Panel A), risk-taking index (Panel B), and consumption (Panel C) in a life-cycle model with equity funds, bonds, and capital guarantee products. The investor has Barberis-Huang utility with parameters $b_0 = 0.05$, $\lambda = 3.3$, $\gamma = 4$, and $\psi = 0.5$.

Panel A. Loss Aversion and Narrow Framing



Panel B. Probability Weighting

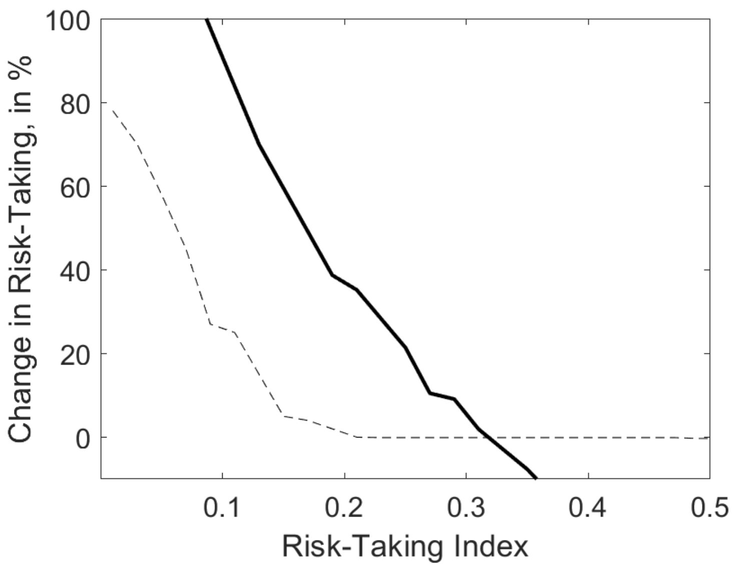


Figure 6. Change in Risk-Taking: Life-Cycle Model versus Data. This figure illustrates the relationship between initial risk-taking and the change in the risk taking index that follows the introduction of capital guarantee products. In each panel, the dashed line corresponds to empirical data, while the solid line plots the value implied by the life-cycle model with Barberis and Huang (2009) utility (Panel A) or Prelec (1998) probability weighting (Panel B). Each point is an average over households with a head between 50 and 60. The solid line is obtained by varying the kink parameter λ (Panel A) or the probability weighting parameter b (Panel B), while all other model parameters are kept constant.

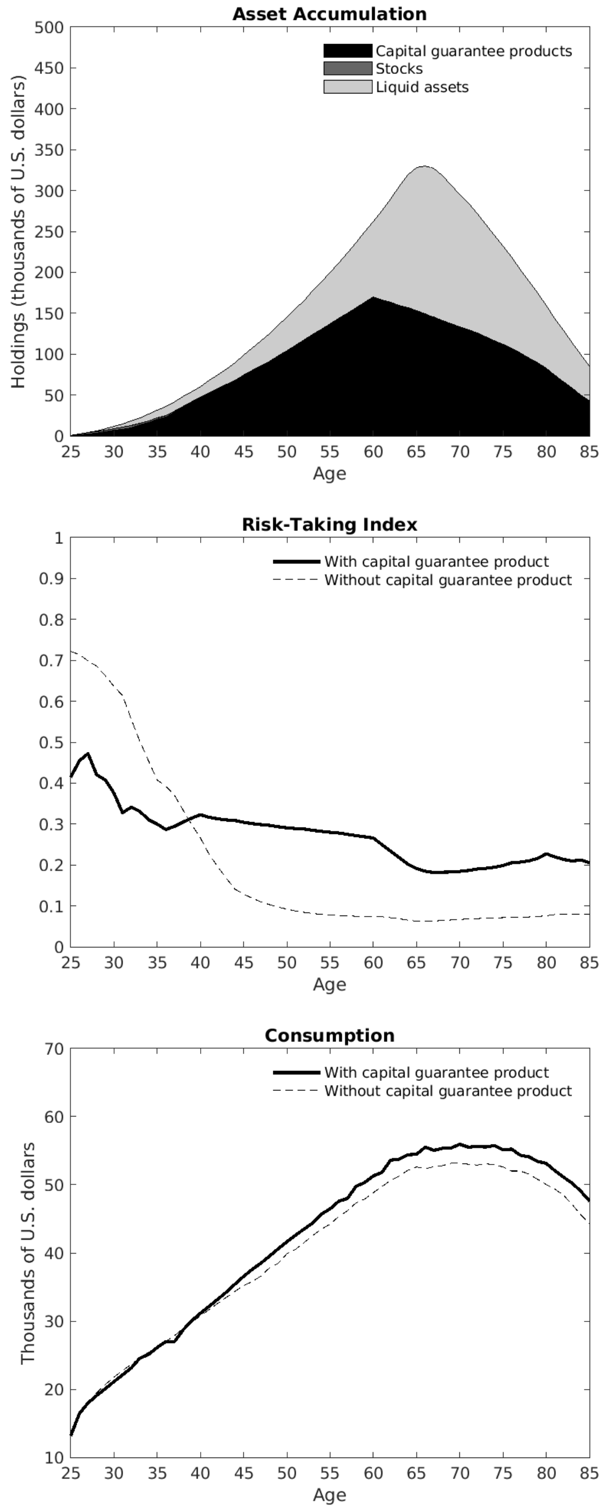


Figure 7. Life Cycle Model with Probability Weighting. This figure displays the average portfolio allocation (Panel A), risk-taking index (Panel B), and consumption (Panel C) in a life-cycle model with equity funds, bonds, and capital guarantee products. The investor has Prelec (1998) utility function with the following parameter: $a = 0.5$, $b = 0.73$, $\gamma = 4$, and $\psi = 0.5$.

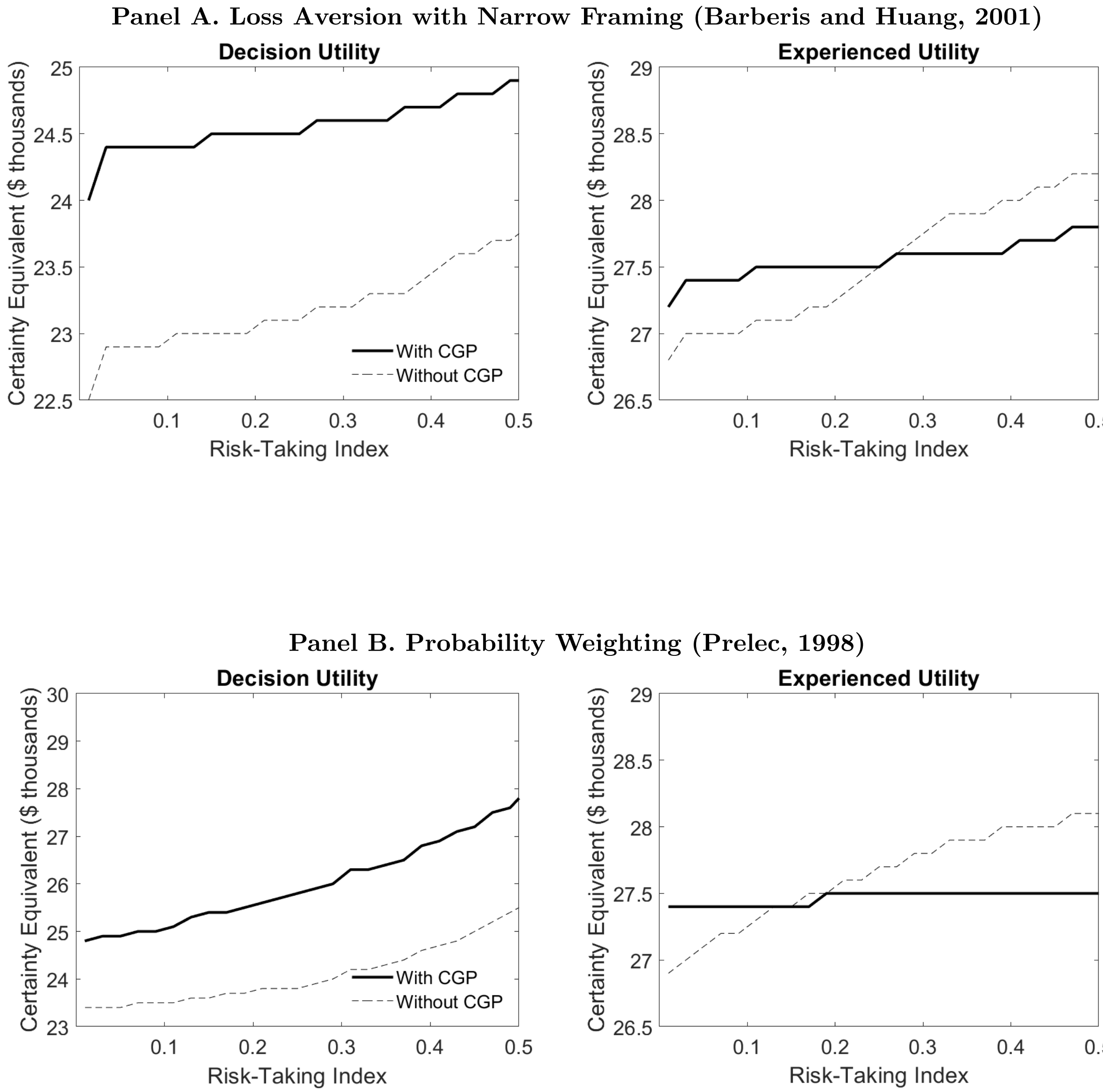


Figure 8. Welfare Implications of Capital Guarantee Products. This figure plots the welfare implications of introducing capital guarantee products under the life-cycle model with Barberis and Huang (2009) utility (Panel A) and Prelec (1998) probability weighting. For each specification, we compute the certainty equivalent before and after the introduction of the product under the decision utility (left subpanel) and the experienced utility (right subpanel). The certainty equivalent is the deterministic level of yearly consumption, assumed for simplicity to be constant over the life-cycle, that provides the same lifetime utility as the lifetime utility predicted by a model.