Can Security Design Foster Household Risk-Taking?

Laurent Calvet — EDHEC
Claire Célérier — UofT
Paolo Sodini — SSE
Boris Vallée — HBS

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Motivation

- In every country, a sizable group of households with significant financial assets only invest a **small share of financial wealth in stocks and mutual funds.**
  - These households forfeit substantial income over their lives.
  - A challenge to canonical models of portfolio allocation.
- The market for retail **capital guarantee products (CGPs)** represents more than **$4.5tn globally.**
  - $1.7tn of guaranteed annuities in U.S,$400bn of retail structured products globally.
  - Financial theory does not provide a clear rationale for the success of these products.
- **Can security design entice households to increase their risk-taking?**

Risk-Taking Data

This paper

- **We focus on the introduction of CGPs in Sweden between 2002 and 2007.**
  - CGPs were adopted by 14% of households within 5 years.
  - Administrative data on Swedish households (3 million households), merged with data on CGPs (1,510 products) and equity mutual funds.
- Capital guarantee products offer a **positive expected excess return.**
- **We show that CGPs do foster risk-taking,** especially among participants with very low equity shares ex ante.

Theoretical explanations

- In a life-cycle context, these facts are consistent with:
  - **loss aversion and narrow framing** (Barberis and Huang 2009),
  - **pessimistic beliefs** (Prelec 1998), possibly combined with ambiguity aversion.
- We construct a life-cycle model with a riskless asset, an equity fund, and CGPs.
- The model generates higher risk taking for households initially less willing to take risk, in line with our empirical facts.
- The introduction of CGPs produces sizable welfare gains, even when assessed by **experienced utility.**

Related literature

- **Behavioral explanations of financial risk-taking**
  Prelec 1998, Barberis, Huang and Thaler 2006
- **Possible solutions to sub-optimal financial decision-making**
  - **Financial literacy**: Duflo and Saez 2003, Lusardi 2012.
  - **Financial advisors**: Genaioli et al. 2015.
  - **Default options**: Madrian and Shea 2001.
  - **Security design** ⇐ **This paper**
- **Contract design and behavioral biases**
  Thaler and Benartzi 2004, DellaVigna and Malmendier 2004, Célérier and Vallée 2017.

Outline

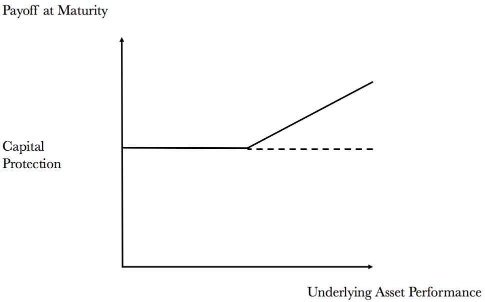
1. **Risk premia and markups of CGPs**
2. **Empirical link between CGPs and household risk-taking**
   - Empirical facts
   - Instrumental variable analysis
3. **Theoretical explanations in a life-cycle context**
   - Underlying mechanisms
   - Welfare implications

Risk Premia and Markups of CGPs

Design of most popular CGPs sold in Sweden

CGPs are defined by an underlying and:

- a face value, F,
- an issue price, P_0,
- a fixed maturity, T,
- a nonlinear pay-off formula that includes:
  - a guaranteed rate of return, g,
  - the average performance of the underlying over a time period, R^*_T,
  - a participation rate, p,
  - a payoff ratio $\xi_T \in [0, 1]$ (credit risk).



$$1 + R_{g,T} = \frac{F}{P_0}[1 + \max(p\, R^*_T; g)]\, \xi_T$$

◂ Example

Computation of CGP risk premia and markups

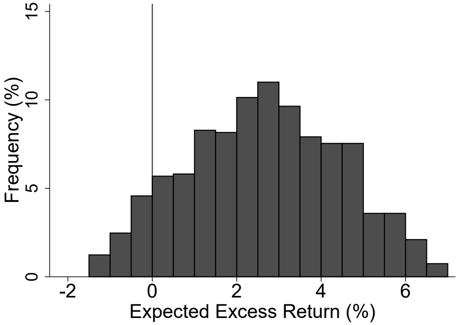
- We take into account all the features of the contract:
  - face value & issue price,
  - capital guarantee,
  - participation rate,
  - definition of underlying's average performance,
  - dividend yield of underlying,
  - credit risk.

- We assume that the underlying asset follows a geometric Brownian motion $dS_t/S_t = (\mu - q)\,dt + \sigma\,dZ_t$
- We obtain μ from world CAPM and set q and σ to their historical averages
- We compute expected CGP returns by Monte Carlo

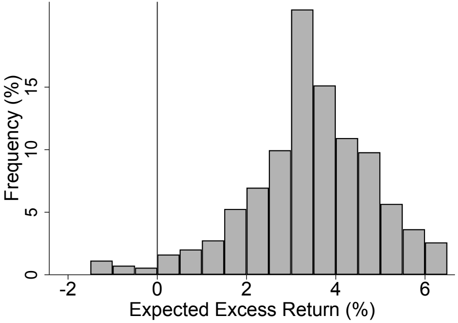
Pricing formula

Expected excess return (net of fees/markups)

CGPs (2.6% on average)



Equity Funds (3.3% on average)

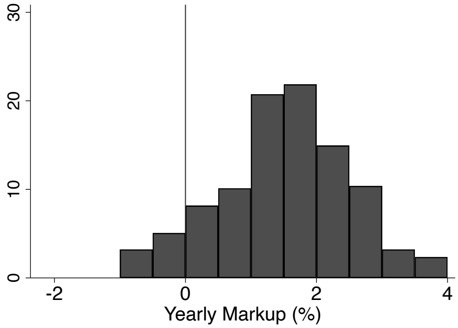


Yearly markup

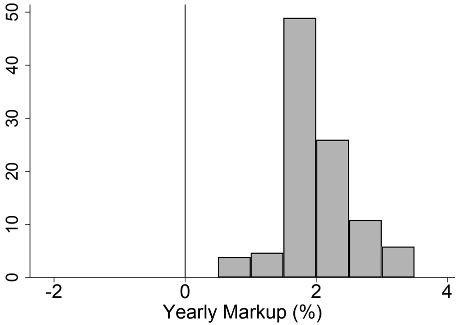
The **yearly markup** is a **complete measure of the profit** earned by the issuer

It is the difference between the **issue price** and the **fair value** of the product, divided by the issue price

CGPs (1.6% on average)



Equity Funds (2.1% on average)



Risk-Taking and CGPs: Empirical Evidence

Measuring household risk-taking

- We define the risk-taking index of a product or portfolio i as the fraction of the equity premium it provides investors:

$$\eta_i = \frac{\text{Expected Excess Return}_i}{\text{Equity Premium}}.$$

  Driven by the product's design, systematic exposure, and fees.

- η_i is on average:
  - **44% for capital guarantee products,**
  - **55% for equity funds.**

Data: Sweden 2000 - 2007

Swedish Household Data (2002-2007)
3 million Households

- *Demographics*
  - **Financial Wealth**
  - **Age**
  - **Willingness to take financial risk**
  - Number of children, family size, gender, location, income...
- *Portfolio Composition*
  - ISIN
  - Amounts

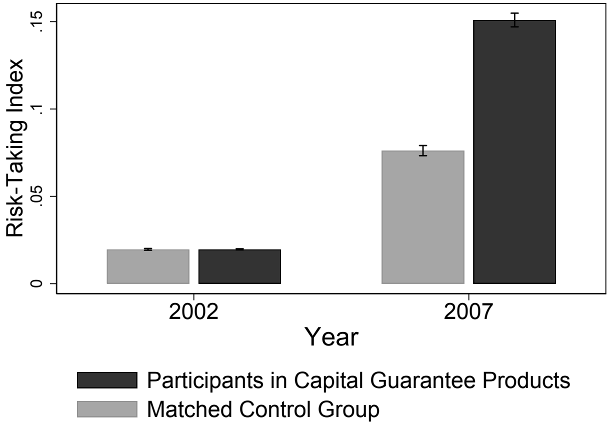
CGPs
1,510 Products – 430,000 Households

- *Raw Data*
  - ISIN
  - Underlying Asset
  - Maturity
  - 4 Parameters of the formula
- *Asset Pricing Exercise*
  - Risk taking index η
  - Yearly markup
  - Expected excess return

Standard Equity Products
2 million Households

- *Raw Data*
  - Fees
  - ISIN
- *World CAPM*
  - Risk taking index η
  - Expected excess return

Bottom quartile of risk-taking

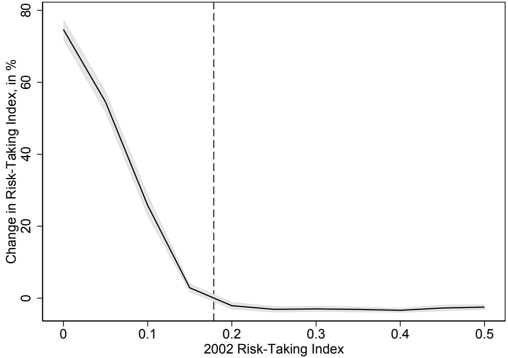


Heterogeneity across household willingness to take risk

Conditional on initial risk-taking, we compute:

- the 2002-2007 change in risk-taking index of CGP adopters,
- the 2002-2007 change in risk-taking index of non-adopters.

We then compute the difference in differences, scaled by the level of the risk-taking index



Panel specification

$$\eta_{h,t} = \alpha + \beta_2 \, CGP\ Share_{h,t} + \lambda' x_{h,t} + \gamma_h + \mu_t + \varepsilon_{h,t}, \tag{1}$$

where

- $CGP\ Share_{h,t}$ is the share of CGP in financial wealth,
- $x_{h,t}$ a vector of household characteristics:

  Financial wealth deciles, income deciles, risk-taking index quartiles, years of education, age deciles, number of children, gender of household head, province.

The OLS estimate of β_2 is:

- 0.21 in the population of risky asset participants (to compare to an average η_i of 0.44 for CGPs),
- 0.40 in the bottom quartile of risk-taking.

Instrumental variable analysis: Empirical strategy

- We instrument $CGP\ Share_{h,t}$ with bank-year idiosyncratic shocks to CGP supply, based on **household-bank relationships at beginning of sample period.**
- We include **household, bank, and year fixed effects.**
- Similar to Borusyak Hull and Jaravel (2019), our strategy does not require that the matching between households and banks be exogenous.

Measurement of bank-year CGP supply shocks

- We use two complementary measures of supply shocks for bank b in year t.
  - **Measure 1:** the **fraction of CGPs in the bank's supply of risky products**.
  - **Measure 2:** the **average participation rate** of the CGPs issued by bank b in year t.
- These supply shocks might result from:
  - marketing campaigns specific to CGPs,
  - bank-specific time-varying structuring costs, for instance when the bank develops structuring expertise, starts a partnership with an investment bank having such an expertise, or experiences a change in funding costs.

Definition of instruments

We construct two measures of idiosyncratic household-year CGP supply shocks.

- **Instrument 1**
  - We measure the fraction of CGPs in a bank's risky product mix in a given year in a random half of the household population.
  - We use this measure to instrument $CGP\ Share_{h,t}$ in the other half of the population.
  - This approach mitigates concerns that our measure of supply might be driven by time-varying risk appetite among the bank's client base.
- **Instrument 2**
  - The second instrument captures variation in the most salient dimension of design, the participation rate, which is conceptually close to a variation in price.

IV estimation #1: Fraction of CGPs in bank risky products

	OLS	First Stage	Second Stage				
				Quartiles of 2002 Risk-Taking Index			
			All	Q1	Q2	Q3	Q4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CGP $Share_{h,t}$	0.21***		0.43*	0.55***	0.35*	0.33	0.30
	(0.01)		(0.21)	(0.15)	(0.20)	(0.29)	(0.22)
Relative Supply Main Bank		0.75***					
		(0.02)					
Relative Supply Second Bank		0.48***					
		(0.02)					
Observations	954,908	954,908	954,908	238,008	239,280	238,092	239,532

IV estimation #2: Average participation rate of bank CGPs

	OLS	First Stage	Second Stage Quartiles of 2002 Risk-Taking Index				
			All	Q1	Q2	Q3	Q4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CGP $\text{Share}_{h,t}$	0.18***		0.64*	0.85***	0.78**	0.46	0.05
	(0.02)		(0.34)	(0.30)	(0.33)	(0.37)	(0.39)
Participation Rate Main Bank		0.01***					
		(0.00)					
Participation Rate Second Bank		0.01***					
		(0.00)					
Observations	411,120	411,116	411,116	107,423	99,330	100,571	103,781

Understanding the mechanism:

Life-cycle model of portfolio allocation

Life-cycle model of portfolio allocation

- We develop life-cycle models consistent with the following empirical facts:
  1. a sizeable demand for CGPs,
  2. an increase in risk-taking triggered by the introduction of CGPs,
  3. a larger proportional increase for households less willing to take risk ex ante.
- We introduce CGPs in a life-cycle model of consumption-portfolio choice of Cocco, Gomes and Maenhout 2005 and Gomes and Michaelides 2005.

Setting (1/2)

- Agent faces a mortality risk and labor income risk (both transitory and permanent shocks) before retirement.
- Agent can invest in a riskless and a risky asset (e.g. equity mutual fund).
- The agent has recursive utility over consumption streams:

$$V_t = \left[(1-\delta)\, C_t^{1-1/\psi} + \delta p_t \left(\mu_{t+1}\right)^{1-1/\psi} \right]^{\frac{1}{1-1/\psi}}$$

where

- p_t : probability that the agent is alive at $t+1$ conditional on being alive at date t,
- μ_{t+1} : certainty equivalent of future consumption

Setting (2/2)

We augment the model as follows:

- We introduce CGPs by modeling their payoff design, illiquidity (maturity=4 years), and credit risk.
- We span a set of:
  - **utility functions** → specifications of certainty equivalent μ_{t+1},
  - **beliefs** → subjective distributions of equity index.

Solution Method

Model 0: Epstein-Zin Utility

- Specification: $\mu_{t+1} = \left[\mathbb{E}_t^{\mathbb{P}}(V_{t+1}^{1-\gamma})\right]^{\frac{1}{1-\gamma}}$. Expected utility if $\gamma = 1/\psi$.
- We solve the model numerically for the baseline CGP and the median household.
- The introduction of CGPs does not increase risk-taking.
- **We reject the combination of Epstein-Zin utility and rational expectations.**

Model 1: Loss aversion and narrow framing

- Specification of Barberis and Huang 2009:

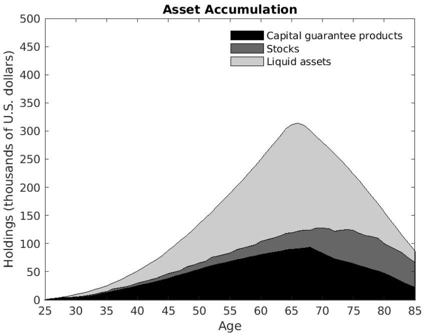
$$\mu_{i,t+1} = \left[\mathbb{E}_t^{\mathbb{P}}(V_{i,t+1}^{1-\gamma})\right]^{\frac{1}{1-\gamma}} + b_0 \mathbb{E}_t v(W_{i,t+1} - W_{i,t}),$$

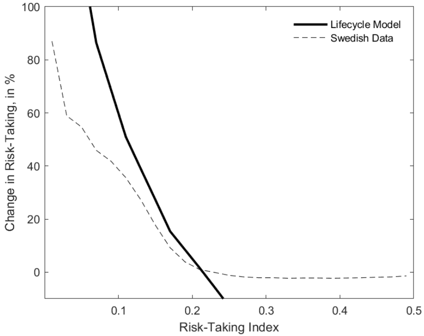
where v is the kinked function:

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

- **This specification generates the increase in risk-taking observed in the data, more strongly so households least willing to take risk.**

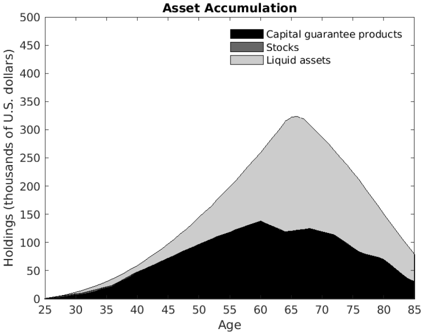
Model 1: Loss aversion and narrow framing (cont.)

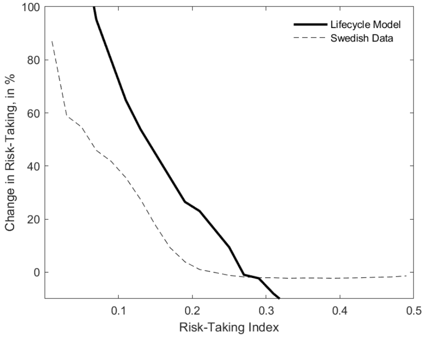




Model 2: Pessimistic beliefs

- The agent has pessimistic beliefs over the payoff of the underlying.
- Pessimistic beliefs also explain the increase in risk-taking, and its heterogeneity. E.g.: Prelec (1998) probability weighting, crash risk, volatility misperception.

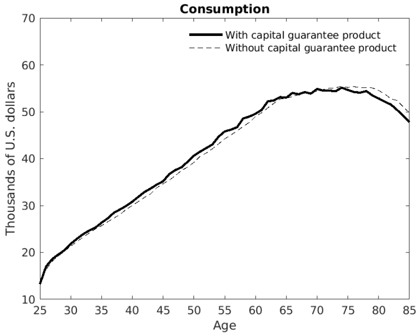


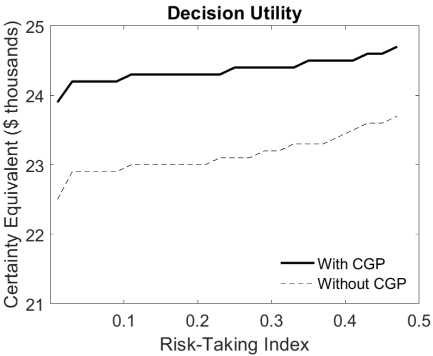


Household welfare

The introduction of CGPs generates higher average consumption and utility.

Loss aversion and narrow framing:





Welfare analysis

- **Household welfare gains:** wealth transfer at date $t = 1$ in the economy with two assets (the bond and the stock) that gives the same lifetime utility as the one achieved in the economy with three assets (bond, stock and CGP).

- **Bank benefit from financial innovation:** present value at date $t = 1$ of the change in profit triggered by financial innovation.

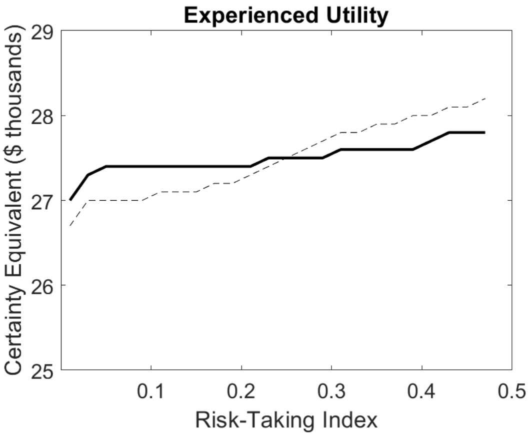
Welfare gains predicted by the models

Households with 8% risk-taking index ex ante
(25^{th} percentile in Swedish population)

Model	**% Change in Risky Share**	**Gain in Utility Amount in $**	**% Share of Surplus to the Household**
Barberis and Huang	86.4%	12,875	52.2%
Prelec	95.2%	12,751	42.0%

Experienced Utility

- Households have CRRA experienced utility ($\gamma = 2$).



Conclusion

Conclusion

- **Households with low initial willingness to take risk** are the **prime beneficiaries of the introduction of CGPs**
- This paper provides both empirical and theoretical evidence that **innovative security design can foster household risk-taking** by addressing behavioral biases
- These results have direct policy implications and illustrate a **bright side to the interaction of behavioral biases and financial security design**

Thank you!

Appendix

Pay-off Formula

- In Sweden, the pay-off of the standard product is specified by **4 parameters**:
  1. **a guarantee** g: *"At maturity, the product offers a minimum capital return of 100% (...)"*
  2. **a participation rate** p: *"(...) Plus 110% of the positive -* **not dividend adjusted** *- performance of the OMX 30 index over the investment period"*
  3. **an asian option of length** n: *"(...) The performance of the index is calculated as the average over the last 13 monthly readings"*
  4. **an issuance price** $1 + init$: *"The product is issued at 111%"*

- Our sample includes all the capital-protected investments issued from 2002 to 2007 (1,510 products)

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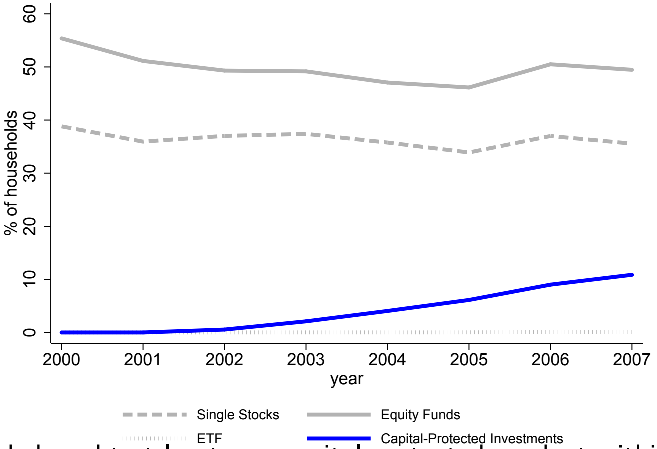
Capital Guarantee Products in Sweden



13% of households bought at least one capital-protected product within 5 years.

Household Risk-Taking Around the World, 2015

Country	% of Aggregate Household Financial Wealth Invested in Stocks	Stock Market Participation	Median % of Household Wealth Invested in Stocks
Austria	27.48%	13.29%	24.76%
Belgium	38.28%	28.59%	35.73%
Croatia	n/a	4.28%	64.36%
Czech Republic	22.93%	9.25%	30.00%
Denmark	34.05%	37.52%	44.71%
Estonia	56.45%	4.41%	42.31 %
France	22.35%	17.52%	21.74%
Germany	11.09%	21.24%	27.54%
Greece	20.87%	2.10%	20.00%
Israel	22.44%	13.24%	41.30%
Italy	32.14%	8.03%	30.00%
Luxembourg	32.06%	22.68%	20.00%
Poland	27.78%	1.89%	35.42%
Portugal	20.75%	6.46%	40.91%
Slovenia	25.93%	8.47%	37.65%
Spain	32.38%	4.82%	39.15%
Sweden	41.20%	57.72%	44.74%
Switzerland	n/a	36.56%	35.71%
United Kingdom	10.96%	31.0%	21.8%
United States	35.21%	51.88%	40.00%

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OMX 30: 2000 - 2007

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Return on Capital Guarantee Products

- The **benchmark return** is the average performance of the underlying asset over the length of the Asian option:

$$1 + R_T^* = \frac{S_{t_1} + S_{t_2} + \dots + S_{t_n}}{nS_0}.$$

- The **return** on the guaranteed product is

$$1 + R_{g,T} = \frac{1 + \max(p\,R_T^*; g)}{1 + init}$$

◂ Payoff Function

Fair Initial Fee - Formula

- Under the **risk-adjusted measure** $\mathbb{Q}$,

$$\mathbb{E}_0^{\mathbb{Q}}(1 + R_{g,T}) = \mathbb{E}_0^{\mathbb{Q}}\left[\frac{1 + \max(p\,R_T^*; g)}{1 + init}\right] = (1 + R_{swap})^T$$

- The **fair initial fee** is given by a Black-Scholes type formula

$$init_{fair} = (1 + R_{swap})^{-T}\left[1 + g + p\,M_1^{\mathbb{Q}}\,N(d_1) - (p + g)\,N(d_2)\right] - 1,$$

where $M_1^{\mathbb{Q}}$, $M_2^{\mathbb{Q}}$, d_1, and d_2 are provided in the paper.

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IV: Instrumenting with time-varying bank product mix

	First Stage $CGPShare_{h,t}$	Second Stage Risk-Taking $\text{Index}_{h,t}$	
	All	All	First Quartile
	(1)	(2)	(3)
$\widehat{\text{CGP Share}}_{h,t}$		0.48*	0.68***
		(0.22)	(0.30)
Product Mix Changes	0.003***		
	(0.0001)		
Household FE	Yes	Yes	Yes
Household Time Varying Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Fixed effects × year FE	Yes	Yes	Yes
Observations	8,131,784	8,131,784	8,131,784
F-statistic		211	

Solution Method

- The state variables (input to decision) at t are:
  (i) liquid wealth (cash on hand),
  (ii) illiquid wealth (investment in capital-protected product) **[when available]**,
  (iii) time to maturity for the capital-protected product,
  (iv) cumulative return of the underlying index.
- The control variables (output of decision) are:
  (i) consumption, $C_{i,t}$,
  (ii) investment in the illiquid product issued at t, $I_{i,t}$, **[when available]**
  (iii) the share of liquid wealth invested in the stock, $\alpha_{i,t}$.
- We derive the optimization problems that define the **policy functions** and solve the model numerically
- We then simulate 10,000 income profiles and calculate the associated consumption and investment profiles from the policy functions with and without capital protected products

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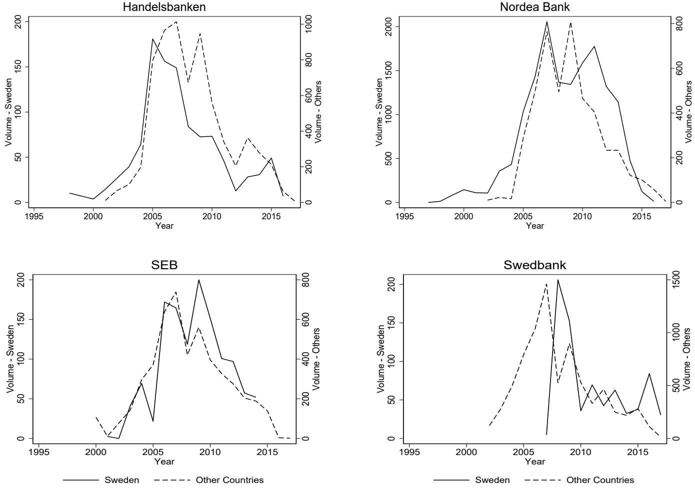
Bank supply of CGPs: Domestic versus foreign markets



Bank Idiosyncractic Supply Shocks