How Do Households Suppress the Price of Tail Risk?

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The market for tail risk insurance

- Historically, the **variance risk premium**, especially at low strikes, has been large and persistent, challenging standard risk models.
- This suggests a **positive net demand for deep out-of-the-money put options from end users**, with financial intermediaries typically **writing these puts** (Garleanu, Pedersen, and Poteshman, 2009).
- In **periods of market stress**, however, regulatory constraints force intermediaries to **reduce or even reverse the supply of these puts,** precisely when demand for protection is highest (Chen et al., 2019; Almeida and Freire, 2026).

$\Rightarrow$ **Which agents can offer an alternative and more stable supply of insurance?**

Households as insurers against tail risk?

- Households are typically viewed as **highly risk-averse or even loss-averse**, and thus unlikely candidates for providing tail-risk insurance.

- Yet, in the past two decades, retail investors have increasingly allocated their savings to innovative financial products whose designs embed tail risk exposure, such as:
  - retail structured products (Henderson and Pearson, 2015; Celerier and Vallee, 2017; Vokata, 2023),
  - structured funds (Gao, Hu, Kelly, Peng and Zhu, 2024),
  - annuities and life insurance products (Barbu and Sen, 2024).

- This growing retail market may **expand the supply of tail-risk insurance** and **decrease its costs**.

Short Put Products

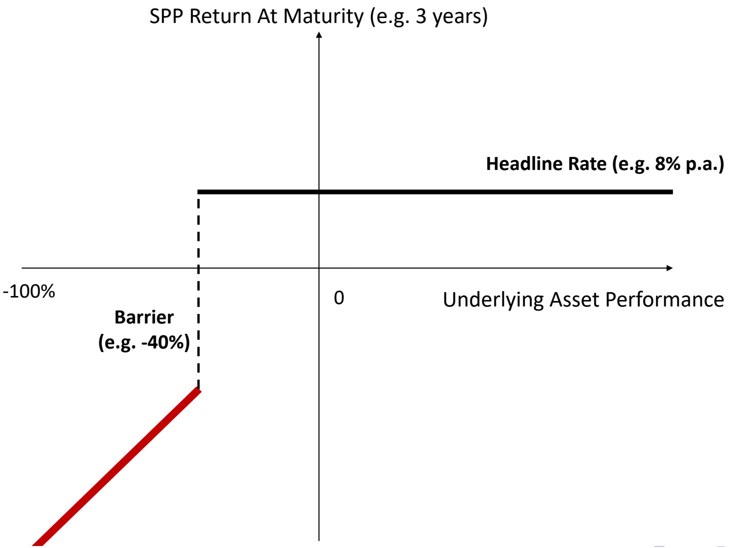
- Among retail structured products, **Short Put Products (SPPs)** are the most widely sold globally.

- They embed the sale of **out-of-the-money put options.**
  - SPPs offer **high headline rates**, or promised returns, as long as the underlying asset stays above a pre-defined barrier.
  - If the barrier is breached, households **absorb the losses**.

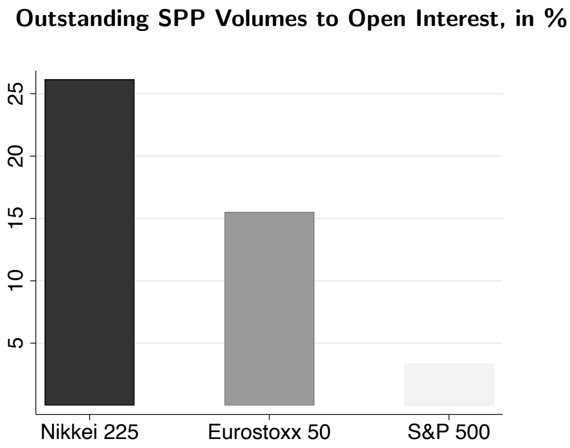
- Outstanding SPP volumes now exceed **1 trillion USD** across the U.S., Europe, and Asia.

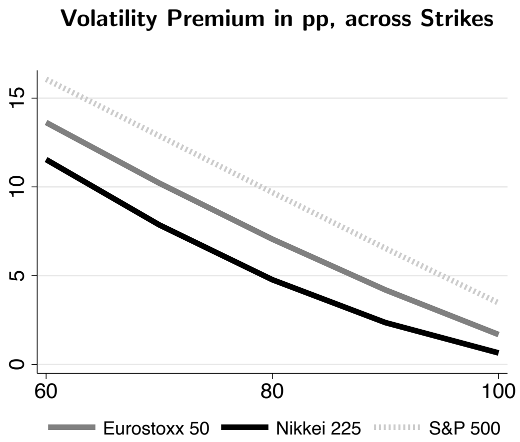
- They account for up to **20% of open interest** in out-of-the-money put options with maturities of 3 months or more, and represent **end user** transactions.

SPP design


SPP Return At Maturity (e.g. 3 years)
Headline Rate (e.g. 8% p.a.)
-100%
0
Underlying Asset Performance
Barrier
(e.g. -40%)

Lower price of tail risk insurance: Suggestive evidence





Research questions

- Do SPP volumes **affect the price of tail-risk insurance**, especially in periods of market stress?
- If so, what are the driving **mechanisms** on the demand and supply sides?
- What are the implications for **financial stability?**

Preview of results

1. Higher volumes of index-linked SPPs are associated with **lower implied volatility** of the corresponding indexes, especially in **relatively narrow option markets** and **in periods of market stress.**

2. A **2015 ban on a subset of SPPs in South Korea** leads to a significant **increase in implied volatility** for the corresponding index, **especially at low strikes.**

3. In a structural model, households' underweighting of left-tail risk explains persistent demand for SPPs. In turn, higher SPP volumes **depress put prices through the pricing kernel.**

$\Rightarrow$ Households **lower the price of tail risk, especially in periods of stress**, as they **underweight left-tail risk**.

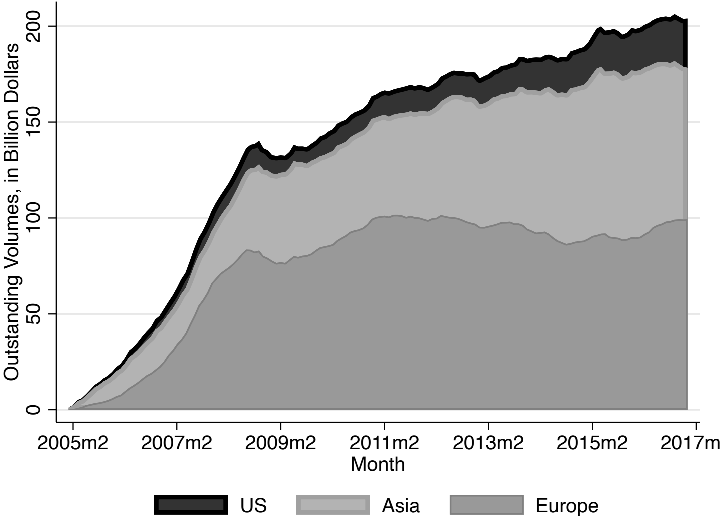
SPP Volumes and Volatility Prices: Reduced-Form Results

Data: Index-linked SPP issuances and implied volatility surface

For the 12 main global indices, representing over **70% of global market cap**, we collect data on:

- **All SPP issuances from 2005 to 2019, accounting for 45% of total volume.**
  - **180,000 products** and over **1.3 trillion dollars** in cumulative issuance volume across **53 countries**.
  - **Detailed product-level data**, including the underlying asset, payoff structure, issuance volume, issuance date, and ex-post performance.
- **Traded options on these indices**
  - Put prices at strikes ranging from 80% to 100%, and 50% to 100% for 3 main indices.
  - Corresponding open interest data.

Outstanding volumes of SPPs across regions



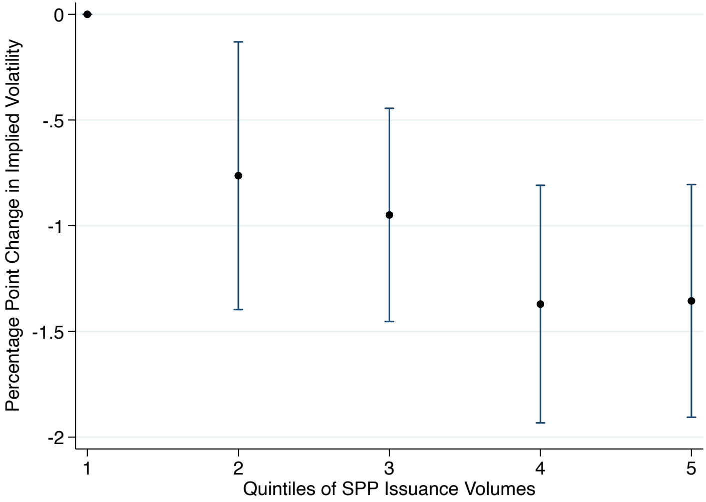
Monthly panel regression across all indices and strikes (2005-2019)

$$IV^u_{K,t} = \alpha + \beta\, SPP\ Volume^u_t + \gamma RealizedVolatility^u_t + \eta SwapRate^u_t + \theta + \varepsilon^u_{K,t},$$

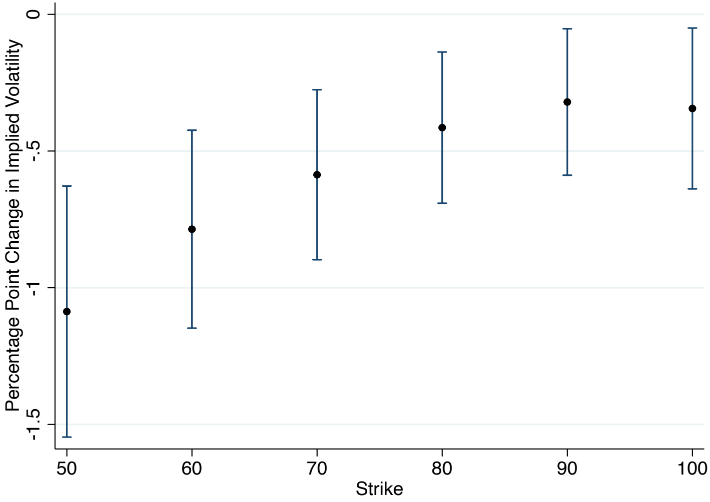
where:

- $IV^u_{K,t}$ is the 1-year implied volatility of underlying asset u and strike K, observed in month t
- $SPP\ Volume^u_t$ is the issuance volume of SPP with underlying asset u issued in month t
- θ is a set of fixed effects: underlying index, strike, and month
- Standard errors are clustered at the year-underlying index and month levels

SPP issuance volumes and implied volatility



Relationship across moneyness



SPP issuance volumes and implied volatility: by option market size

	Dependent Variable : Implied Volatility, in %					
	Strikes				Option Market Size	
	All (1)	80% (2)	90% (3)	100% (4)	All Strikes (5)	80% (6)
Scaled Issuance Volumes, in BP	-0.34***	-0.39***	-0.35***	-0.30***	0.27	0.35
	(0.10)	(0.11)	(0.10)	(0.11)	(0.30)	(0.32)
Volumes × Medium Size					-0.54*	-0.62**
					(0.29)	(0.31)
Volumes× Small Size					-0.65**	-0.80***
					(0.28)	(0.31)
90-Day Realized Volatility, in %	0.41***	0.40***	0.41***	0.25***	0.41***	0.40***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
3-Year Swap Rate	-0.21*	-0.27**	-0.20*	-0.16	-0.21***	-0.27***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.07)	(0.07)
Fixed Effects						
Strike	Yes				Yes	
Month	Yes	Yes	Yes	Yes	Yes	Yes
Index	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,398	2,128	2,135	2,135	6,398	2,128
R^2	0.92	0.91	0.92	0.92	0.92	0.91

In periods of market stress

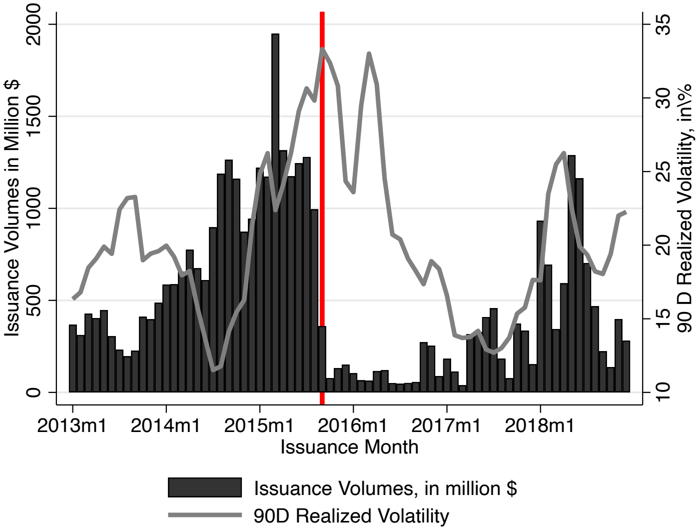
- Using the same panel specification, we show that the suppressing effect of SPP outstanding volumes on volatility prices is **stronger in times of market stress,** i.e. when index annual returns fall sharply.
  - A drop in the index spot price **raises the need for vega-hedging** by banks.
- **On the demand side,** higher realized volatility allows the structuring of SPPs with **higher headline rates**, **stimulating demand for these products.**

Natural Experiment

Identification strategy

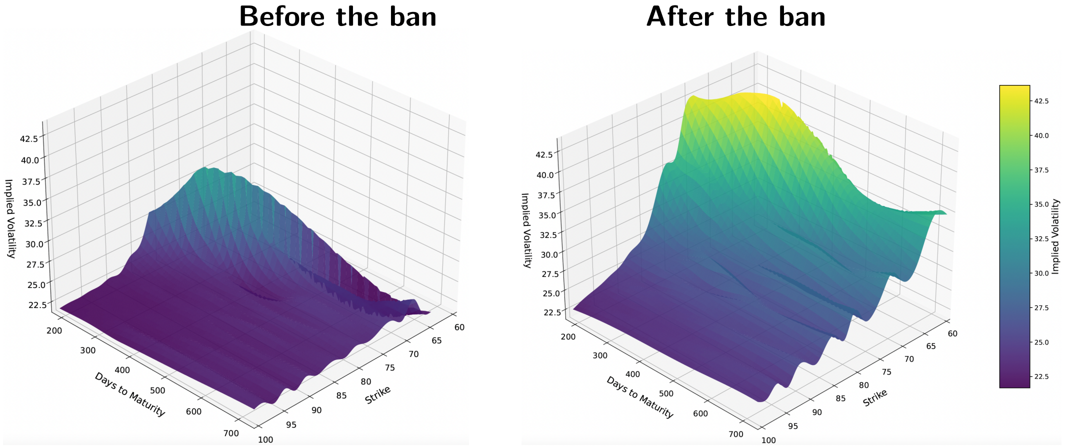
- In September 2015, following a **regulatory warning**, SPP providers in South Korea **stopped issuing HSCEI (China)-linked SPPs**.
  - HSCEI = Hang Seng China Enterprises Index.
- The decision followed a **sharp crash in the index**, leading to losses for retail investors in SPPs.
- In a differences-in-differences analysis, we can compare the implied volatility of the HSCEI index to that of other indices.

Issuance volumes on HSCEI-linked SPPs



Volatility surface of HSCEI options (2014-2016)

Yearly average



HSCEI implied volatility: Difference-in-differences analysis

	Dependent Variable : Implied Volatility, in %							
	All	**80%**	**90%**	**100%**	**All**	**80%**	**90%**	**100%**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
HSCEI Index × Post	1.92***	3.22***	2.05***	0.50	2.20***	3.49***	2.33***	0.80*
	(0.32)	(0.63)	(0.61)	(0.57)	(0.49)	(0.58)	(0.52)	(0.44)
90D Realized Volatility, in %					0.14***	0.14***	0.14***	0.14***
					(0.03)	(0.03)	(0.03)	(0.03)
3Y Swap Rate					0.01	-0.03	-0.01	0.07*
					(0.05)	(0.06)	(0.05)	(0.04)
Fixed Effects								
Strike	Yes				Yes			
Month	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Index	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	863	287	288	288	863	287	288	288
R^2	0.74	0.92	0.94	0.94	0.75	0.93	0.95	0.96

Structural Model

Structural model: Discrete-time financial market

- Financial markets are driven by an **exogenous state vector** $\boldsymbol{z_t = (z_{1,t}, z_{2,t})'}$ consisting of the **prevailing interest rate** $\boldsymbol{z_{1,t}}$ and the **stochastic volatility of the stock index** $\boldsymbol{z_{2,t}}$.
- Every period, the economy is populated by:
  1. **A representative household** with wealth W_t^H who consumes C_t^H, and pays a fraction ϕ of savings to the dealer, so that the cash on hand is
  $$X_t^H = (1-\phi)\,(W_t^H - C_t^H).$$
  2. **A representative dealer** with wealth
  $$X_t^D = \phi(W_t^H - C_t^H) = X_t^H/\lambda^H, \quad \text{where } \lambda^H = (1-\phi)/\phi.$$
  3. **Outside investors** with an exogenous demand for options $d_n^E X_t^D$, where d_n^E is the number of units of put n demanded per unit of wealth (Garleanu et al., 2009).

Four categories of financial assets

- The dealer trades **four categories of financial assets** in each period t:
  1. A **zero-coupon bond** with maturity date $t+T$,
  2. An **equity index M**,
  3. A **short put product**, with arithmetic return

  $$R_{\text{SPP},t:t+T} = y_t \mathbb{1}_{\{R_{\text{M},t:t+T} > B\}} + R_{\text{M},t:t+T} \mathbb{1}_{\{R_{\text{M},t:t+T} \leq B\}},$$

  4. A set of **plain-vanilla European puts** on the equity index with maturity date $t+T$, strikes $K_1, \ldots, K_N$, and endogenous prices $P_1, \ldots, P_N$.
- The household can trade the riskless asset, the equity index, and the SPP. However, it does **NOT have access to put markets**.

The dealer's portfolio

- The dealer's wealth in period $t+T$ is:

$$W^D_{t:t+T} = X^D_t \left(1 + R_{f,t:t+T} + \alpha^D_{\mathrm{M},t}\, R^e_{\mathrm{M},t:t+T} + \alpha^D_{\mathrm{SPP},t}\, R^e_{\mathrm{SPP},t:t+T} + \sum_{n=1}^{N} \alpha^D_{\mathrm{PUT},n,t}\, R^e_{\mathrm{PUT},n,t:t+T}\right),$$

- The dealer has CARA utility, $u_t(W^D_{t+T}) = -e^{-A_t\, W^D_{t+T}}/A_t$, where $A_t = \gamma^D / X^D_t$.
- The dealer optimally chooses the portfolio weights $\alpha^D_{\mathrm{M},t}$, $\alpha^D_{\mathrm{SPP},t}$, and $\alpha^D_{\mathrm{PUT},n,t}$.
- We set $\gamma^D = 1$ for identification.

Stationary equilibrium: Definition

- A **stationary equilibrium** consists of SPP yield $y(z_t)$, put prices $P_{\mathrm{PUT},n}(z_t)$, household portfolio $\alpha^H(z_t, y)$, and dealer portfolio $\alpha^D(z_t)$, s.t. markets clear in every state.

- The dealer's optimal holdings offset the households demand for the SPP:

$$\alpha^D_{\mathrm{SPP},t} = -\lambda^H \, \alpha^H_{\mathrm{SPP},t}.$$

and the exogenous demand for puts: $\alpha^D_{\mathrm{PUT},n,t} = -d^E_n \, P_{\mathrm{PUT},n,t}$ in every state.

- The dealer's marginal utility is a **stochastic discount factor**:

$$SDF_{t:t+T} = e^{-\gamma^D\left[\alpha^D_{\mathrm{M},t} \, R^e_{\mathrm{M},t:t+T} - \boldsymbol{\lambda^H \, \alpha^H_{\mathrm{SPP},t}} \, R^e_{\mathrm{SPP},t:t+T} - \sum_{n=1}^N d^E_n \; (K_n - 1 - R_{\mathrm{M},t:t+T})_+\right]}.$$

$\Rightarrow$ **SPP volume enters the SDF and thereby affects put prices.**

Estimation strategy

- We conduct the likelihood-based estimation of the model based on the system:

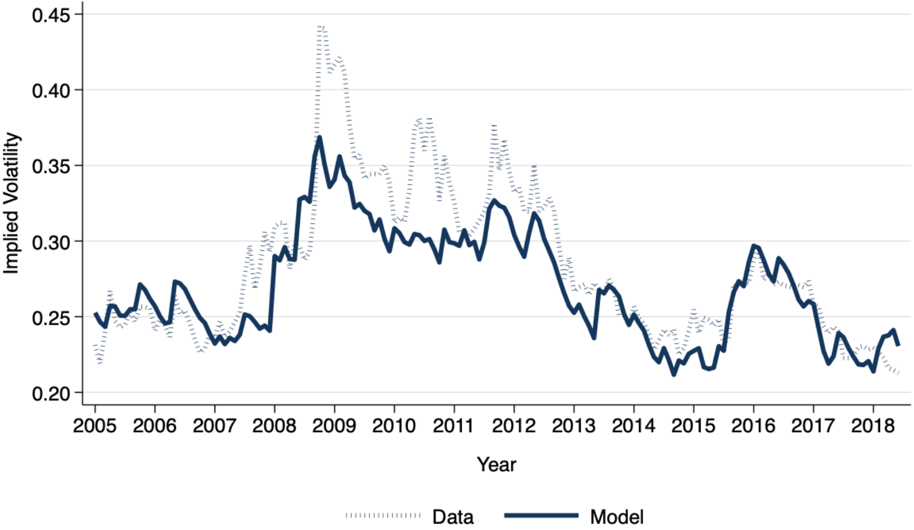
$$
\begin{array}{rll}
\text{Interest rate} & z_{1,t} & = \mu_1 + \phi_1(z_{1,t-1} - \mu_1) + \sigma_1 \varepsilon_{1,t} \\
\text{Stoch vol} & z_{2,t} & = \mu_2 + \phi_2(z_{2,t-1} - \mu_2) + \sigma_2 \varepsilon_{2,t} \\
\text{Equity index} & r^e_{\mathrm{M},t} & = \mu_r + e^{z_{2,t}/2} \varepsilon_{\mathrm{M},t} \\
\text{SPP yield} & y_{\mathrm{SPP},t} & = y^D(Z_t) + \sigma_{\mathrm{SPP}} u_t \\
\text{Puts} & IV_{n,t} & = \mathcal{V}^D_n(Z_t) + \sigma_{\mathrm{IV}} \eta_{n,t} \\
\text{Volume} & SPPVolume_t & = b\, \alpha^H_{\mathrm{SPP}}(z_t, y) + \sigma_{\mathrm{SPPV}} e_t
\end{array}
$$

- We apply the model to the Eurostoxx50 but aim to expand the analysis to other indices in the future.

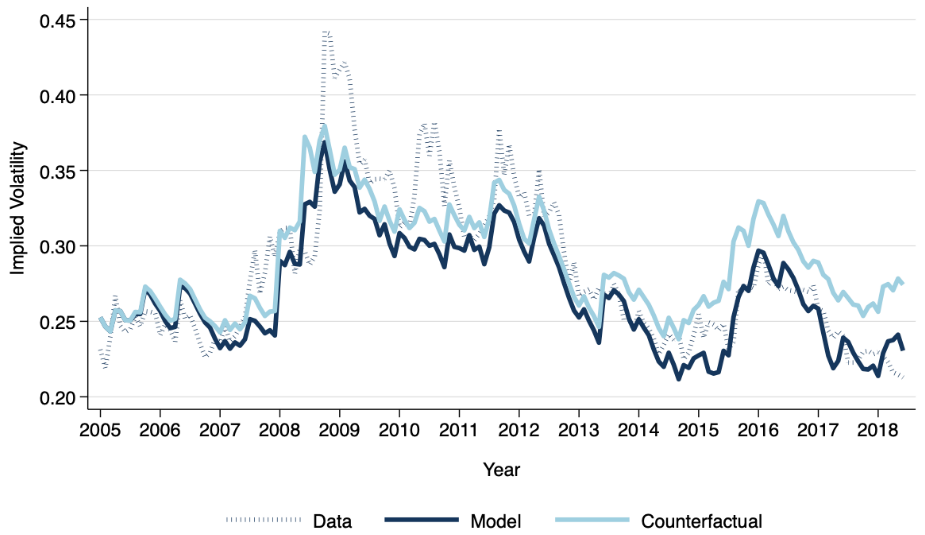
Estimation results

- The coefficient λ_H, which measures the elasticity of the SDF to SPP volumes, is **significantly different from 0** (t-test).
- This result is confirmed by a **likelihood ratio test**, based on a comparison between the likelihood of the full model and that of the restricted model, which sets the sensitivity λ_H equal to zero.
- The household with **Prelec probability weighting**, who **underweights left-tail risk** has a positive demand for the SPP, while the investor with rational expectation does not.

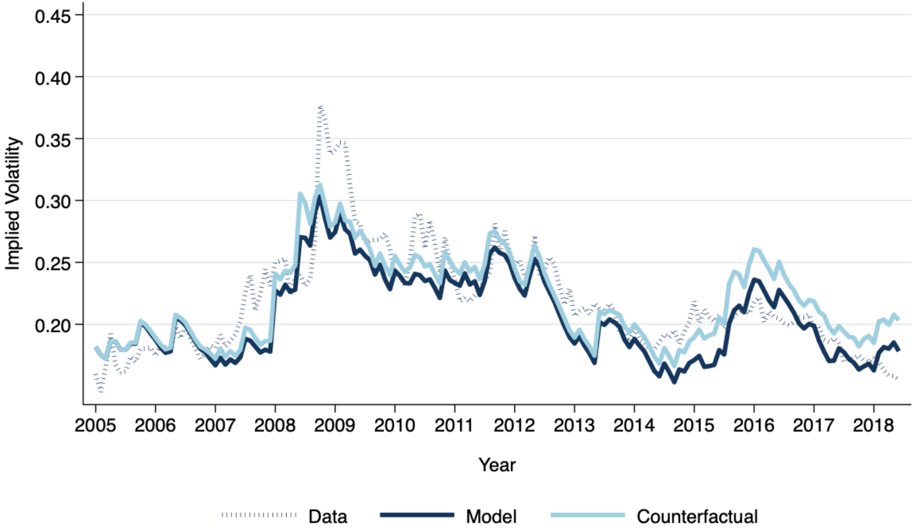
Implied volatility at 60% strike: Model outputs vs. data



Implied volatility at 60% strike: Counterfactual analysis



Implied volatility at 100% strike: Counterfactual analysis



Conclusion

- **Main Result**: Households can increase the supply of tail-risk insurance.
  - Economically significant: SPP volumes **reduce implied volatility by up to 15%**.
  - May help explain a recent decline in the variance risk premium (Dew-Becker and Giglio, 2024).
- **Implications**
  - **Efficient risk sharing?** Intermediaries can offload tail risk to households willing to bear it in exchange for yield.
  - **Consumer protection:** Whether (and why) households should bear left-tail risk raises welfare and regulatory questions.
  - **Financial stability:** Greater awareness and stronger consumer protection could increase the cost of insuring against tail risk.

Thank you!