# Wealth, Portfolio Shares, and Risk Preference

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# Introduction

- Questions:
  1. What is the causal effect of wealth on the share of risky assets held in a household's financial portfolio?
  2. What inferences can we make about risk aversion from these results?
- Many papers in last 10 years study these questions:
  - Brunnermeier Nagel (2008), Calvet Campbell Sodini (2009), Chiappori Paiella (2010), Calvet Sodini (2014), Paravasini Rappaport Ravina (2015), Cai Liu Yang (2016)
- Contributions:
  1. New data
  2. New statistical findings
  3. New interpretation

# Motivation

- Relationship between wealth and financial risk taking has important implications for asset prices:
  - Countercyclicality in risk aversion contributes to countercyclicality in risk premia (Constantinides (1990), Jermann (1998), Campbell Cochrane (1999)).
- Habit models, consumption commitments used to generate decreasing relative risk aversion (e.g. Constantinides (1990); Chetty Szeidl (2005))
- Precise estimates of the effect of wealth on risky asset share inform mechanisms behind behavior

# Empirical Challenge

1. Wealth shocks are rarely exogenous
2. Wealth is hard to measure accurately

"The ideal experiment would be to exogenously dump a large amount of wealth on a random sample of households and examine the effect ... on their risk-taking behavior"

– Chris Carroll (2002)

# Addressing this Challenge

- Sample of Swedish lottery players matched to administrative wealth records
  - $500 million assigned to more than 300,000 individuals, underlying participant pool of $\approx$ 4 million
  - Three distinct lottery subsamples with different selection criteria
  - Institutional features that permit identification of causal effect
  - High quality wealth measures
  - High quality demographic and income measures and no attrition

# Empirical Results

- What is the causal effect of a wealth shock on the share of risky assets in a household's portfolio?
  - 150K USD causes 9 percentage point **decrease** in risky portfolio share among pre-lottery equity market participants
  - Negative effect robust across subpopulations and lotteries
- First paper to find empirical evidence that increases in wealth cause a decrease in risky portfolio share
  - Brunnermeier et.al (2008): wealth causes **no change**
  - Calvet et.al (2009): wealth causes an **increase**
  - Chiappori et.al (2011): wealth causes **no change**
  - Paravisini et.al (2015): wealth causes an **increase**

# Interpreting Results

- Quantitative lifecycle portfolio choice model comparable to Gomes Michaelides (2005)
- Calibrate to match historical Swedish data, simulate lottery winnings, and examine model predictions
  - Model predicts effects of wealth on risky portfolio share qualitative and quantitatively consistent with empirical estimates
  - Non-tradable human capital generates negative effect of wealth on risky portfolio share - households consider all wealth when making portfolio decisions

# Literature

- Portfolio share - Brunnermeir Nagel (2008), Calvet Campbell Sodini (2007,2009), Chiappori Paiella (2011), Calvet Sodini (2014), Paravisini Rappaport Ravina (2015), Cai Liu Yang (2016)
- Structural portfolio choice models - Samuelson (1969), Merton (1971), Viceira (2001), Gomes Michaelides (2005), Cocco (2005), Cocco Gomes Maenhout (2005), Davis Kubler Willen (2006), Khorunzhina (2013), Fagerang Gottlieb Guiso (2013)
- Behavioral Finance - Guiso Japelli (2002, 2005), Vissing-Jørgensen (2003), Campbell (2006), Calvet Campbell Sodini (2007), Guiso Sapienza Zingales (2008), Grinblatt Keloharju Linnainmaa (2011)

1 Data and Identification

2 Selected Statistical Analyses

3 Interpretation/Structural Model

# Lottery Data

Kombi

- Subscription lottery run by Swedish Social Democrats
- Selection by political ideology

PLS

- Prize linked savings accounts
- Selection by bank account ownership

TV-Triss

- Scratch-ticket game/TV show
- Selection by lottery ticket purchase

# Registry data

- Year-end records of financial variables from 1999-2007
  - $\approx$ 86% of all wealth
  - Stocks
  - Mutual Funds
  - Bonds
  - Bank Accounts
  - Debt
  - Real Assets
- Other demographic covariates, $\mathbf{Z}_{i,-1}$
  - Income
  - Age
  - Gender
  - Education
- All-Year and Post-1999 samples

# Definitions

For remainder of talk:

- Risky asset share = (Stocks+Mutual Funds)/Total Financial Wealth
- Household = Winner (+ Spouse if present)

# Sample Description

## Comparing Samples

| | Post-1999 | | Post-1999 by Lottery | | |
|---|---|---|---|---|---|
| | Pooled (1) | Pop (2) | PLS (3) | Kombi (4) | Triss (5) |
| **Demographic** | | | | | |
| Female | .516 | .516 | .575 | .436 | .558 |
| Age (years) | 56.3 | 56.3 | 63.2 | 62.2 | 51.9 |
| Household Members (#) | 1.97 | 1.97 | 1.75 | 1.81 | 2.13 |
| Household Income (K USD) | 38 | 37 | 28 | 31 | 43 |
| Married | .519 | .525 | .518 | .483 | .543 |
| Retired | .311 | .279 | .481 | .425 | .217 |
| Self-Employed | .046 | .059 | .026 | .003 | .040 |
| Student | .026 | .032 | .032 | .078 | .052 |
| College | .193 | .257 | .229 | .153 | .216 |
| **Financial** | | | | | |
| Net Wealth (K USD) | 131 | 161 | 220 | 124 | 127 |
| Gross Debt (K USD) | 54 | 52 | 35 | 37 | 67 |
| Home Owner | .702 | .630 | .666 | .732 | .686 |
| Equity Participant | .591 | .558 | .682 | .625 | .560 |
| Risky Share | .536 | .586 | .525 | .549 | .573 |

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# Sample Description

**Prize Distribution**

| Prize Amount (USD) | A. All-Year | B. Post-1999 |
|---|---|---|
| $L_i \leq 1.5K$ | 293,470 | 71,211 |
| $1.5K < L_i \leq 15K$ | 16,020 | 742 |
| $15K < L_i \leq 75K$ | 3,348 | 1,240 |
| $75K < L_i \leq 150K$ | 232 | 89 |
| $150K < L_i \leq 300K$ | 605 | 298 |
| $300K < L_i$ | 190 | 78 |
| **Total** | 313,865 | 73,658 |

# Identification

Identification

- Use institutional knowledge of lotteries to construct cells $\mathbf{X}_i$ in which wealth is randomly assigned
- Control for for cell-fixed effects in statistical analyses

Estimating equation

$$Y_{i,s} = L_{i,0} \times \beta_s + \mathbf{Z}_{i,-1} \times \gamma_s + \mathbf{X}_i \times M_s + \eta_{i,s}$$

- $L_{i,0}$: assigned wealth normalized by 1M SEK (150K USD)
- $Z_i$: controls observed the year before the lottery
- Causal interpretation of $\beta_s$: Lottery wealth is randomly assigned conditional on $\mathbf{X}_i$

# Identification

## Testing for Random Assignment

| | All-Year | | Post-1999 | |
|---|---|---|---|---|
| | Pooled | | Pooled | |
| | (1) | (2) | (3) | (4) |
| Fixed Effects | Cells | None | Cells | None |
| Demographic Controls | | | | |
| *F*-stat | .69 | 11.54 | .87 | 10.01 |
| *p* | .74 | <.001 | .56 | <.001 |
| Financial Controls | | | | |
| *F*-stat | — | — | 1.81 | 12.80 |
| *p* | — | — | .14 | <.001 |
| Demographic+Financial Controls | | | | |
| *F*-stat | — | — | 1.29 | 15.20 |
| *p* | — | — | .22 | <.001 |

# Identification

## Testing for Random Assignment

| | All-Year | | Post-1999 | |
|---|---|---|---|---|
| | Pooled | | Pooled | |
| | (1) | (3) | (4) | (8) |
| Fixed Effects | Cells | None | Cells | None |
| Demographic Controls | | | | |
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1 Data and Identification

2 Selected Statistical Analyses

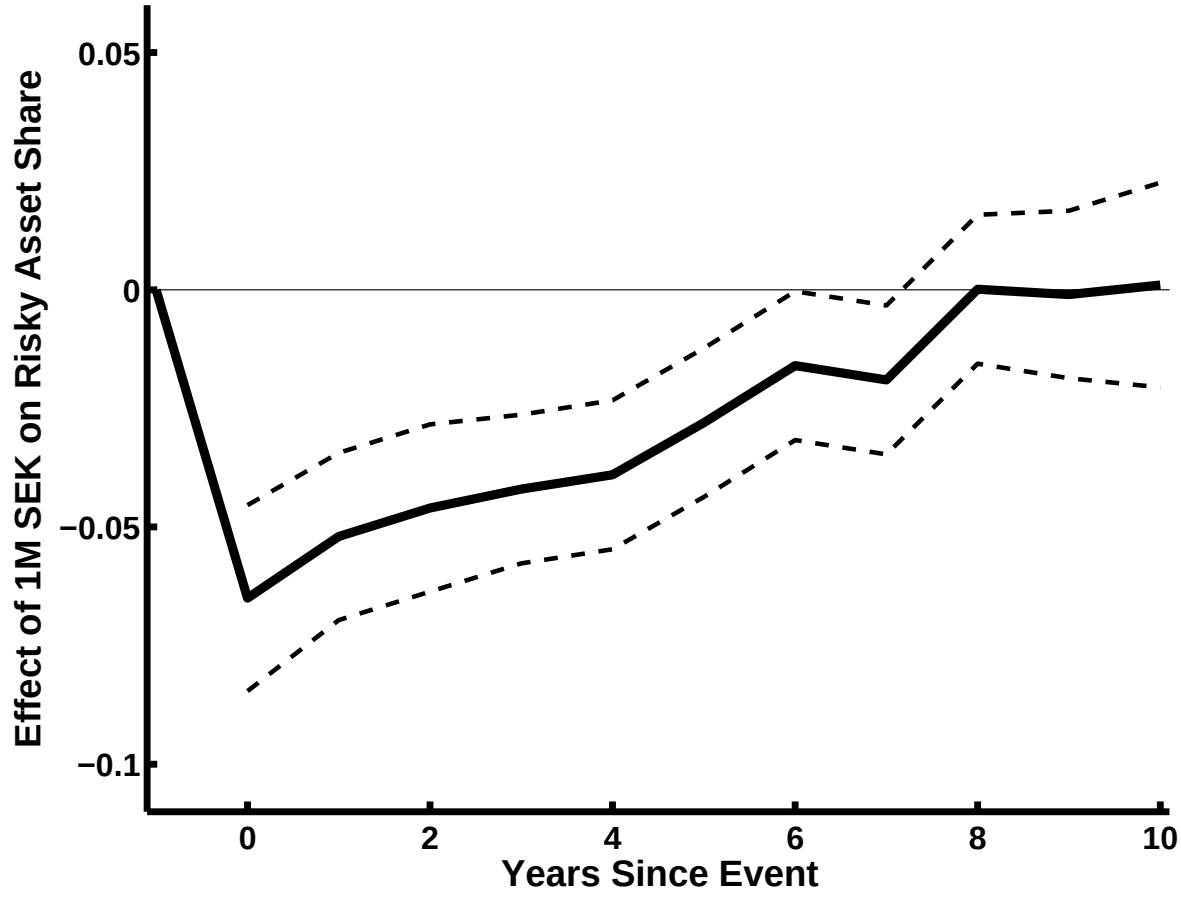
3 Interpretation/Structural Model

# Questions

1. What is the effect of wealth on risky portfolio share?
2. What is the effect of wealth on risky portfolio share among pre-lottery equity owners?
3. Is the effect similar across lottery subamples?
4. Are the effects non-linear in prize size?
5. How does the effect compare to non-experimental estimates?
6. How are lottery winnings allocated across wealth categories?

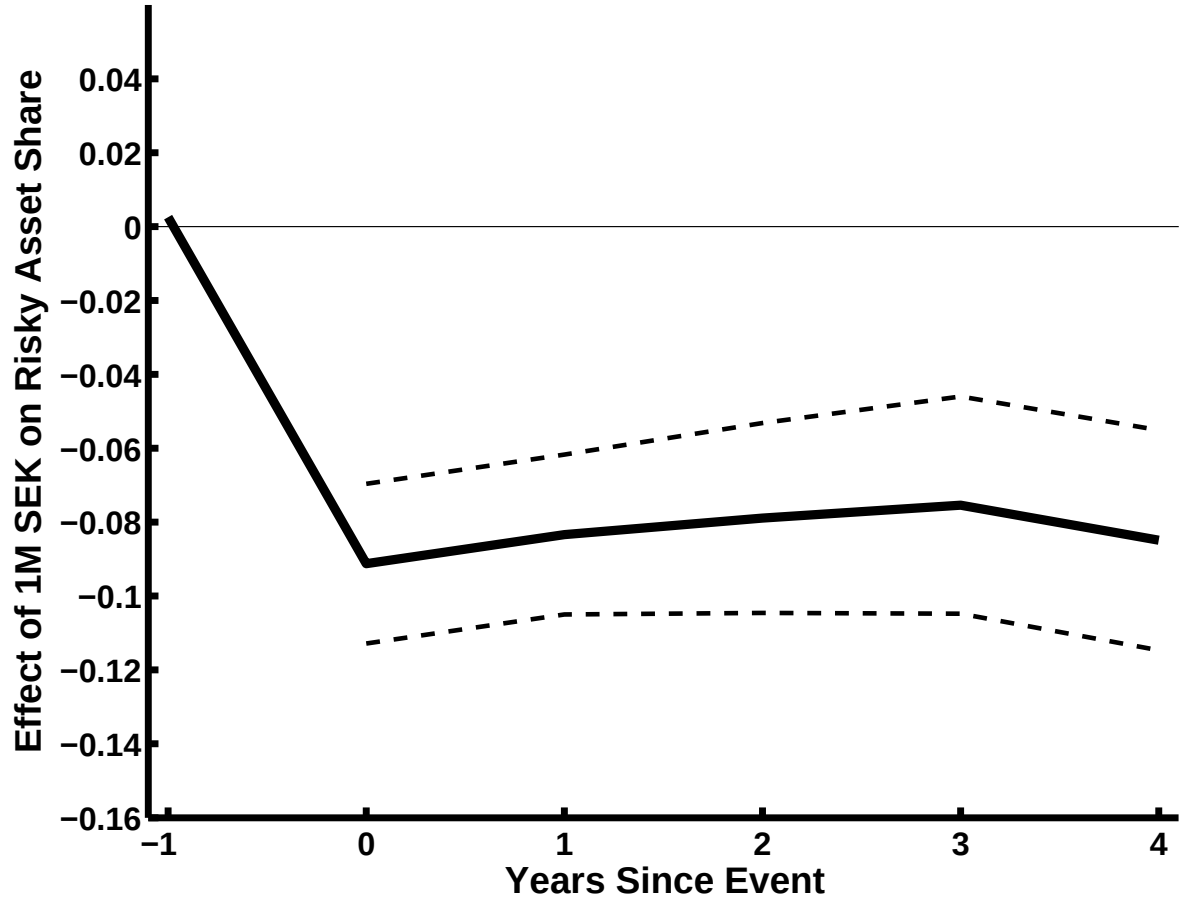
# Results - Question 1

What is the effect of wealth on risky portfolio share?



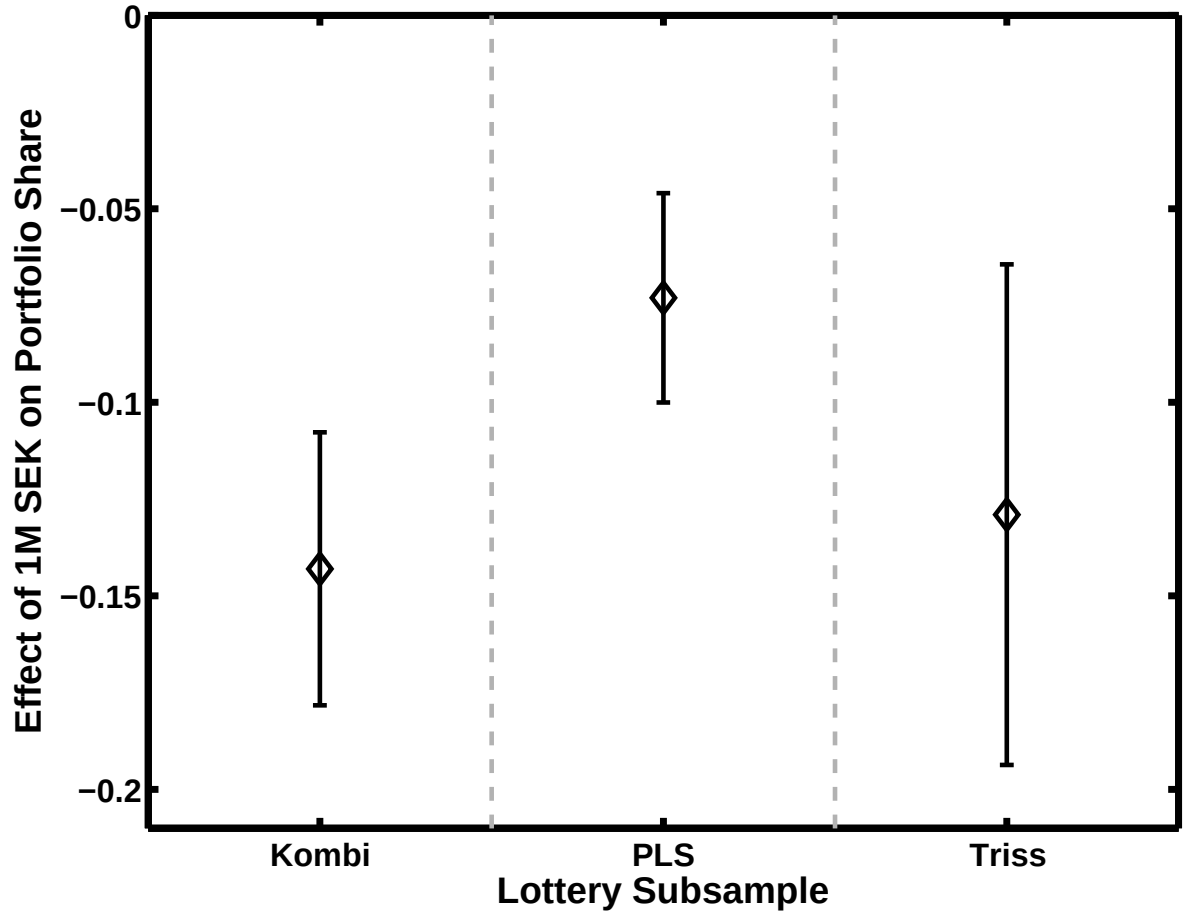
# Results - Question 2

What is the effect of wealth on risky portfolio share among pre-lottery equity owners?



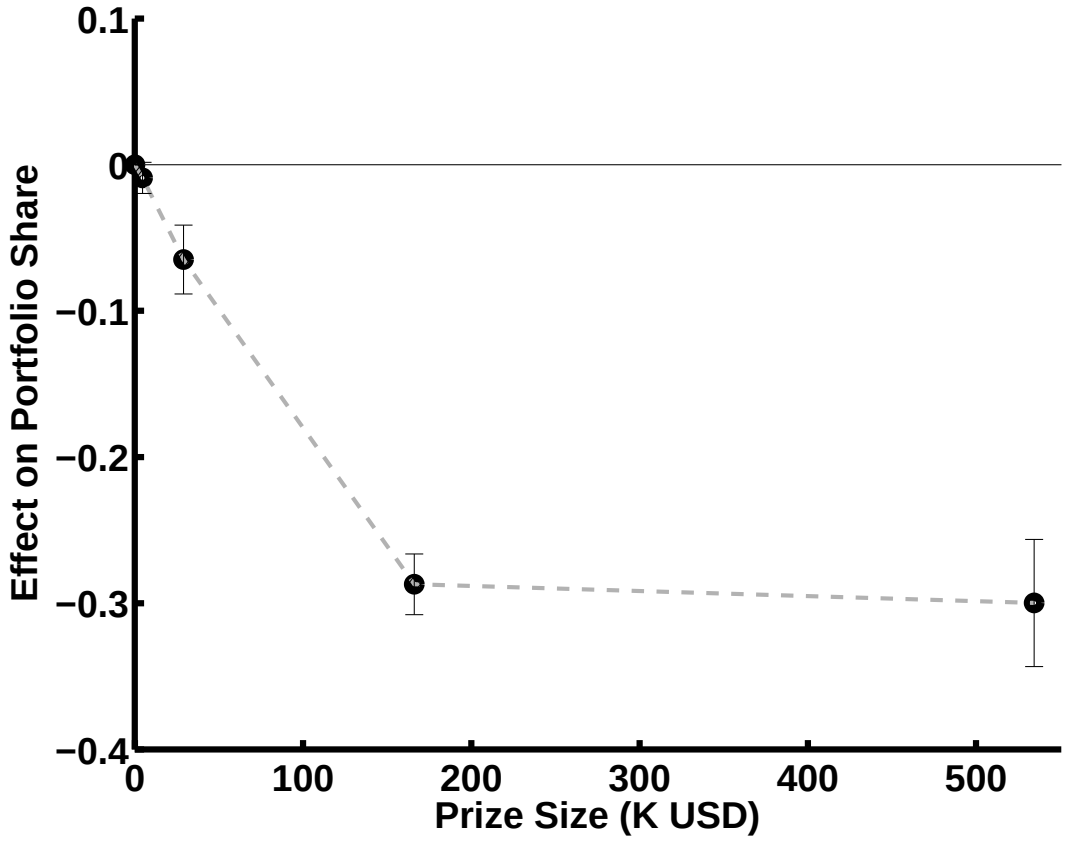
# Results - Question 3

Are the effects similar across subsamples stratified by lottery?



# Results - Question 4

Are the effects nonlinear in prize size?




Categories (in K USD): 0-1.5, 1.5-15, 15-150, 150-300, 300+

# Results - Question 5

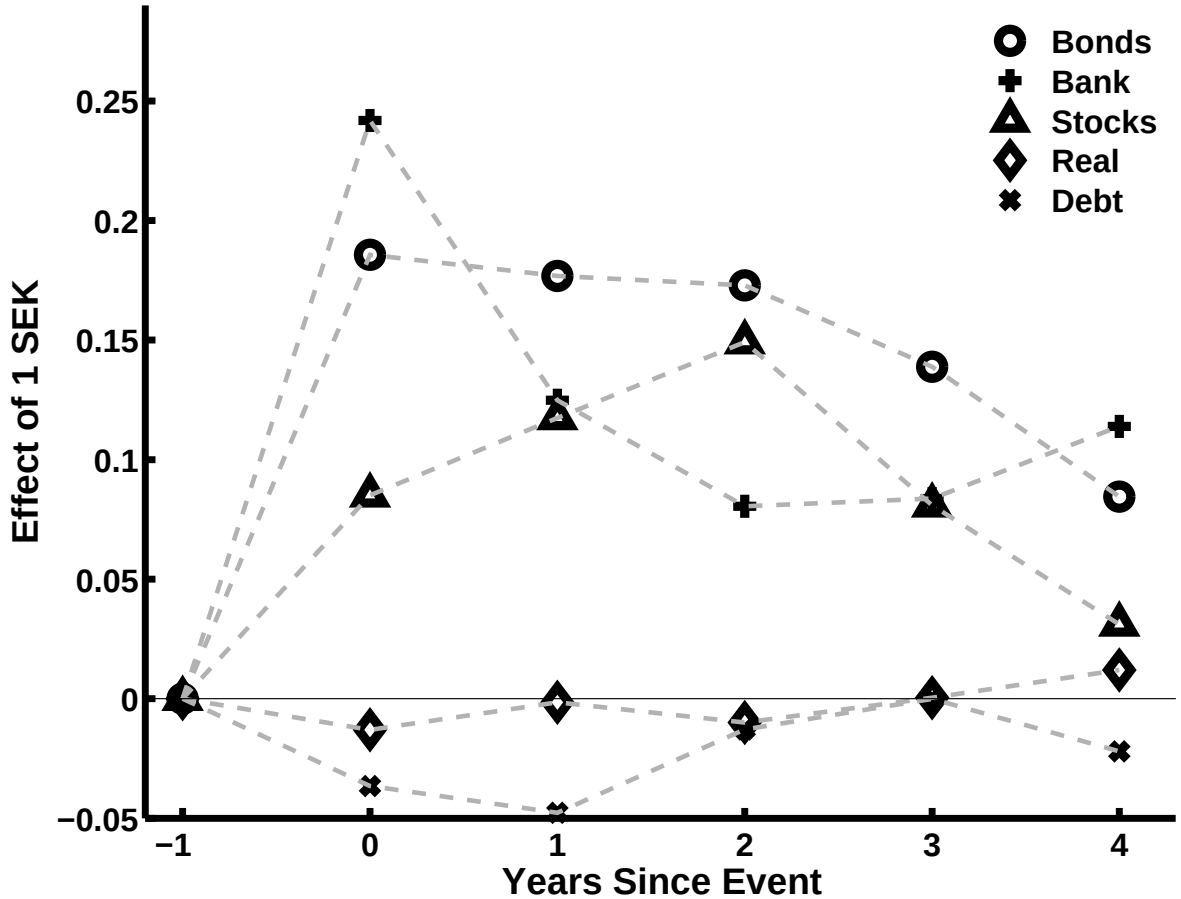
How do the estimates compare to non-experimental estimates?

$$\Delta_s \alpha_t = \beta_s \Delta_s w_t + \rho q_{t-s} + \gamma \Delta_s h_t + \epsilon_t$$

| | $s = 2$ **Year** | | $s = 5$ **Year** | |
|---|---|---|---|---|
| | **OLS** | **TSLS** | **OLS** | **TSLS** |
| | **(1)** | **(2)** | **(3)** | **(4)** |
| **Lottery Sample** | | | | |
| $\Delta w_t$ | -.014 | -.025 | .003 | .045 |
| SE | (.002) | (.069) | (.002) | (.083) |
| | | | | |
| **Brunnermeier Nagel (2008)** | | | | |
| $\Delta w_t$ | .023 | -.136 | -.013 | -.012 |
| SE | (.011) | (.076) | (.009) | (.058) |

# Results - Question 6

How are the lottery winnings allocated across various wealth categories?



1. Data and Identification

2. Selected Statistical Analyses

3. Interpretation/Structural Model

# Interpretation

- Literature:
  - Brunnermeier Nagel (2008) wealth causes no change in portfolio share
  - Calvet et.al. (2009) wealth causes an increase in portfolio share
  - Chiappori Paiella (2011) wealth causes no change in portfolio share
  - Paravisini et.al. (2015) wealth causes an increase in portfolio share
- This study:
  - Change in wealth causes a decrease in portfolio share

# Interpretation

Simplest Problem:

$$V(W) = \max_{\alpha} \mathbb{E}\left[U(C)\right]$$
$$s.t.\ \ C = W\left((r - r_f)\alpha + (1 + r_f)\right)$$

If relative risk aversion is constant, then $\alpha^\star = \bar{\alpha}$ independent of wealth.

# Interpretation

Simpler Problem:

$$V(W) = \max_{\alpha} \mathbb{E}\left[U(C - X)\right]$$
$$s.t.\ \ C = W\left((r - r_f)\alpha + (1 + r_f)\right)$$

If relative risk aversion is constant, then $\alpha^\star = \bar{\alpha}$ independent of wealth.

Allowing for consumption habit $X$, the allocation becomes

$$\alpha^\star = \bar{\alpha}\left(1 - \frac{X}{W(1 + r_f)}\right)$$

- Plausible explanation for findings in prior studies.

# Interpretation

Simple Problem:

$$V(W) = \max_{\alpha} \mathbb{E}\left[U(C - X)\right]$$
$$s.t.\ \ C = W\left((r - r_f)\alpha + (1 + r_f)\right) + H$$

If relative risk aversion is constant, then $\alpha^\star = \bar{\alpha}$ independent of wealth.

Allowing for habit X and risky labor income $H$, the allocation becomes

$$\alpha^\star = \left(1 - \frac{X}{W(1 + r_f)} + \frac{H}{W}\right)\left(\bar{\alpha} - \frac{\sigma_{h,r}}{\sigma_r^2}\right) + \frac{\sigma_{h,r}}{\sigma_r^2}\left(1 - \frac{X}{W(1 + r_f)}\right)$$

- Plausible explanation for findings in this study
- Plausible explanation for sensitivity to choice of instrument

# Structural Model

Can a structural model of lifecycle portfolio choice replicate the effects on stock market participation and portfolio choice?

- Lifecycle portfolio choice model comparable to Gomes Michaelides (2005) (and others)
  - Preferences: Epstein-Zin utility
  - Two assets: risk free and equity
  - Equity returns: lognormal distribution
  - Income: stochastic permanent and transitory component
  - Mortality: age specific survival probability $s_t$
  - State variables: wealth, permanent income, prior participation
  - Choices: consumption, saving, participation, equity share
  - Costs: one-time entry cost, per-period participation cost

# Structural Model

Preferences

- Epstein-Zin utility with coefficient of RRA $\rho$, IES $\psi$, discount factor $\beta$, and age $t$ survival probability $s_t$

$$V_t = \left\{ (1 - \beta s_t) C_t^{1-1/\psi} + \mathbb{E}\left[ s_t V_{t+1}^{1-\rho} \right]^{\frac{1-1/\psi}{1-\rho}} \right\}^{\frac{1}{1-1/\psi}}$$

# Structural Model

Income

- For ages $t = t_0 ... 65$, income has a permanent component $P_t$ and transitory component $U_t$

$$H_t = P_t U_t$$
$$P_t = exp(f(t, Z_t)) P_{t-1} N_t$$

  - $U_t$, $N_t$ lognormal with standard deviations $\sigma_U$, $\sigma_N$ respectively.

- For ages $t = 66 ... T$, income is a constant fraction of age 65 income

$$H_t = \lambda P_{65}$$

- $f(t, Z_t)$ is a function of age and marital status

# Structural Model

Assets

- Risk-free bond
  - Risk-free return $r_f$
- Risky equity
  - Calibrated to historical Swedish equity returns
    - Excess return $\mu_s = .065$
    - Standard deviation $\sigma_s = .21$
    - $cov(N_t, r_t) = \sigma_{n,s}$
- Equity market participation costs
  - $I_t = 1$ if no prior participation.
  - One time entry cost - $\chi \times P_t \times I_t$
  - Per-period participation cost - $\kappa \times P_t$

# Structural Model

Decision Problem:

- Nonparticipant

$$V_t^{NP}(W_t, P_t, I_t) = \max_{C_t} \left\{ (1-\beta s_t) C_t^{1-1/\psi} + \mathbb{E}\left[ s_t V_{t+1}^{1-\rho} \right]^{\frac{1-1/\psi}{1-\rho}} \right\}^{\frac{1}{1-1/\psi}}$$

$$W_{t+1} = r_f (W_t - C_t) + H_{t+1}$$

$$I_{t+1} = I_t$$

- Participant

$$V_t^{P}(W_t, P_t, I_t) = \max_{C_t, \alpha_t} \left\{ (1-\beta s_t) C_t^{1-1/\psi} + \mathbb{E}\left[ s_t V_{t+1}^{1-\rho} \right]^{\frac{1-1/\psi}{1-\rho}} \right\}^{\frac{1}{1-1/\psi}}$$

$$W_{t+1} = r_f (W_t - C_t - \kappa P_t) + \alpha_t (r_{s,t+1} - r_f)(W_t - C_t - \kappa P_t) + H_{t+1}$$

$$0 \leq \alpha_t \leq 1$$

$$I_{t+1} = 0$$

- Final decision problem

$$V_t(W_t, P_t, I_t) = \max\{ V_t^{NP}(W_t, P_t, I_t) \ , \ V_t^{P}(W_t - \chi P_t I_t, P_t, I_t) \}.$$

# Baseline Calibration

| Parameters | | | |
|---|---|---|---|
| **Initial Age** | $t_0 = 18$ | **Death Age** | $T = 108$ |
| **Intertemporal Elast. of Sub.** | $\psi = .2$ | **Relative Risk Aversion** | $\rho = 5$ |
| **Transitory Risk** | $\sigma_U = .23$ | **Permanent Risk** | $\sigma_N = .09$ |
| **Income/Asset Covariance** | $\sigma_{n,s} = -.04$ | **Retirement Rep. Rate** | $\lambda = .60$ |
| **Discount Factor** | $\beta = .96$ | **Risk Free Return** | $r_f = .02$ |
| **Mean Excess Return** | $\mu_s = .065$ | **Return St. Dev.** | $\sigma_s = .21$ |
| **Entry cost** | $\chi = .025$ | **Per-period cost** | $\kappa = 0$ |

- Preference parameters taken from Gomes Michaelides (2005)
- Income process estimated from lottery sample using income observations prior to lottery

# Structural Results

Experiment:

1. Solve model and save policy functions
2. For every member of the lottery data set, simulate windfall gain and subsequent participation and portfolio choices
3. Repeat statistical analysis on simulated data set

# Structural Results

## Comparison of Model-Predicted Effect to Empirical Estimates

| | | | Model Predictions | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | | **Estimate (1)** | **Baseline (2)** | **Habit (3)** | $\sigma_{n,s} = .15$ **(4)** | $\rho = 8$ **(5)** | **Lower Eq. Premium (6)** |
| **Equity Owners** | Baseline | -.091 | -.123 | -.104 | -.081 | -.143 | -.112 |
| **Prize Size** | 10K to 100K | -.009 | -.024 | -.018 | -.016 | -.034 | -.013 |
| | 100K to 1M | -.065 | -.102 | -.087 | -.081 | -.114 | -.088 |
| | 1M to 2M | -.287 | -.244 | -.223 | -.124 | -.253 | -.237 |
| | 2M+ (300K+) | -.300 | -.273 | -.246 | -.253 | -.297 | -.259 |

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- Impose an external consumption habit

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- Higher correlation between income and equity returns

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| **Effect** | | **Estimate (1)** | **Baseline (2)** | **Habit (3)** | $\sigma_{n,s} = .15$ **(4)** | $\rho = 8$ **(5)** | **Lower Eq. Premium (6)** |
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| **Prize Size** | 10K to 100K | -.009 | -.024 | -.018 | -.016 | -.034 | -.013 |
| | 100K to 1M | -.065 | -.102 | -.087 | -.081 | -.114 | -.088 |
| | 1M to 2M | -.287 | -.244 | -.223 | -.124 | -.253 | -.237 |
| | 2M+ (300K+) | -.300 | -.273 | -.246 | -.253 | -.297 | -.259 |

- Higher risk aversion

# Structural Results

## Comparison of Model-Predicted Effect to Empirical Estimates

| | | | Model Predictions | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | | **Estimate (1)** | **Baseline (2)** | **Habit (3)** | $\sigma_{n,s} = .15$ **(4)** | $\rho = 8$ **(5)** | **Lower Eq. Premium (6)** |
| **Equity Owners** | Baseline | -.091 | -.123 | -.104 | -.081 | -.143 | -.112 |
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- Reduce expected equity premium to .027

# Additional Exercise

What if the windfall gain affects both wealth and income?

- Portfolio share increases in permanent income, decreases in financial wealth
- Experiment: Hold present discounted value of windfall gains constant, but assign half to an increase in $P_t$
  - Effect on risky asset share: -.017
- More closely replicates findings in other studies.

# Conclusion

- Contributions/findings:
  1. New data set that permits credible causal estimates
  2. 1M SEK (150K USD) causes s 9 percentage point decrease in risky portfolio share among pre-lottery equity owners
  3. Counterintuitive, but aligns with qualitative and quantitative predictions of standard model under multiple extensions
- Risky asset share can not be interpreted as proxy for risk aversion without carefully controlling for future labor income
- Next steps:
  - Model internal consumption habit
  - Improve calibration to better fit pre-lottery portfolio allocations
  - Improve replication of alternative estimation approaches
  - More to unify findings with literature

$$L_{i,0} = X_i \times \Gamma + \mathbf{Z}_{i,-1} \times \rho_{-1} + \epsilon_i$$

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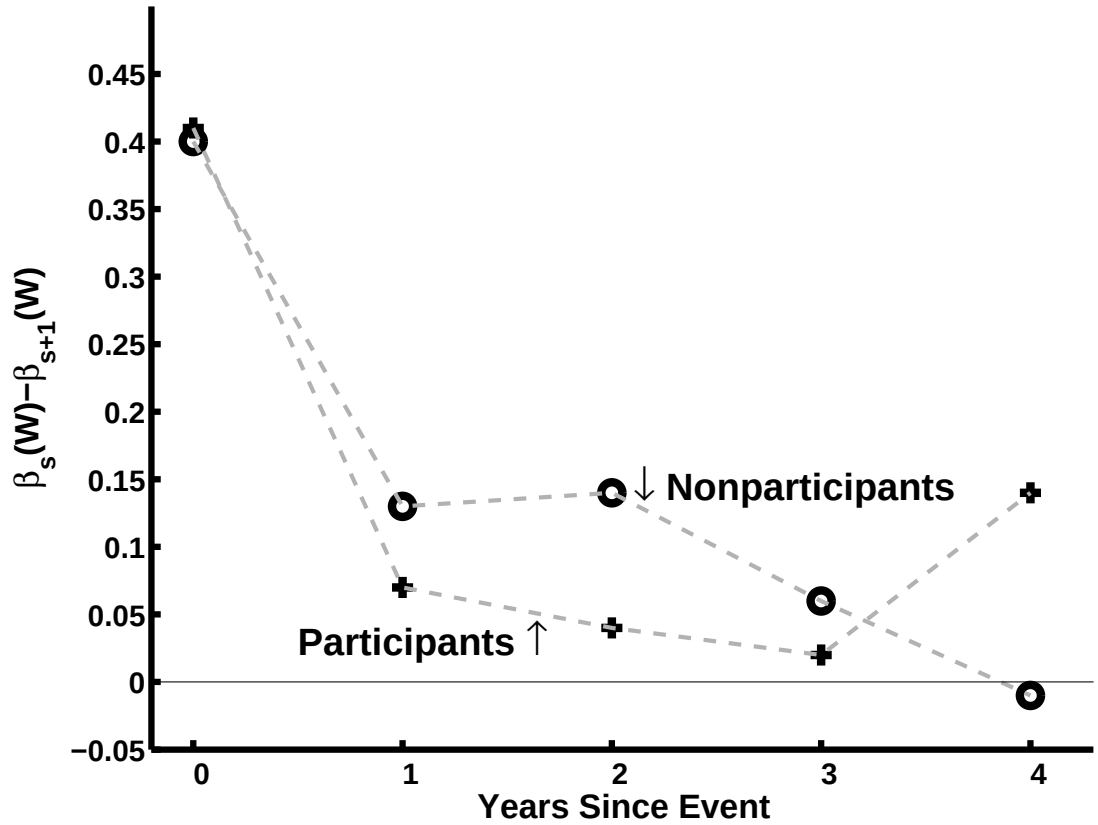
# Marginal Propensity to Consume

## Upper Bound of MPC from Lottery Wealth**




**Important caveat: Wealth measures cover only approximately 86% of total wealth. Furthermore, home improvements, car and other durables, donations, and money transferred to non-spouse family members are not accounted for.

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