# Income Volatility and Hedging Motive: Depopulation in Stock Market

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May 2023

# What this paper is about

- Economic theory predicts that
  - H1: The market participation propensity should increase as the correlation between income growth and stock market returns decreases.
  - H2: The higher a worker's wage volatility, the lower her exposure to the stock market.

- However, empirical studies find limited support for
  - Why do so few hold stocks?
  - What is the main driver when people make decision on holding stocks or not? For the purpose of hedging income risk (risk averse) or reaching for yield (risk seeker)?

- Thus, this paper provides new empirical evidence by
  1. Showing that the SIPP is suitable for doing research in this filed.
  2. Using individual level risk volatility and correlation estimated out of SIPP to test the hypothesis.

# What this paper is (not) about

- I am mainly using
  - A binary variable to identify whether people participate in the stock market or not, but I do not have the intensity of the participation for the all the survey waves.
  - Hence, the empirical model I am using can only capture people that enter or leave the market but cannot observe when they are adjusting their portfolio. But I considered it already contained sufficient information to answer the research question.

- So, this paper is not going to tell the story about precise portfolio decisions, but rather trying to show what triggered people to enter or exit the market.

- I will still provide some tests related to the risky share in investors' portfolio using a truncated sample but that won't be the main take away from this research.

# Nationally Representative Sample

- SIPP (Survey of Income and Program Participation)
  - Monthly data from 2004-2020. With 2004 Panel-(2004.02-2008.01), 2008 Panel (2008.09-2013.12), 2014 Panel (2013.01-2016.12), data are provided annually after 2014 Panel
  - Information about stock: Y/N question before 2013, numerical questions after 2013
  - Demographic: Age, Location, Education, Hours worked, Type of job…
  - Why SIPP over PSID? Monthly level captures extra information about wage, i.e., people who earned the same amount of income each year might have different level of volatility within the year. For example, someone earned 50,000 USD in 2008, but he earned it from the first 4 months at lost his job in May, we won't observed this in annual panel.
- SCF (Survey of Consumer Finances)
  - Data available triennially, 2004, 2007, 2010, 2013, 2016, 2019
  - Information about stock: Y/N question
- SOI (Statistics of Income) Tax Stats
  - Country level data available annually from 2011
  - Information about stock: Dividend tax

# Data Selection

- SIPP (to select the representative working group in the U.S.)
  - Age from 18 to 66
  - Monthly labor income from 500 to 50,000
  - Only self-reported value (no imputed or proxy value)

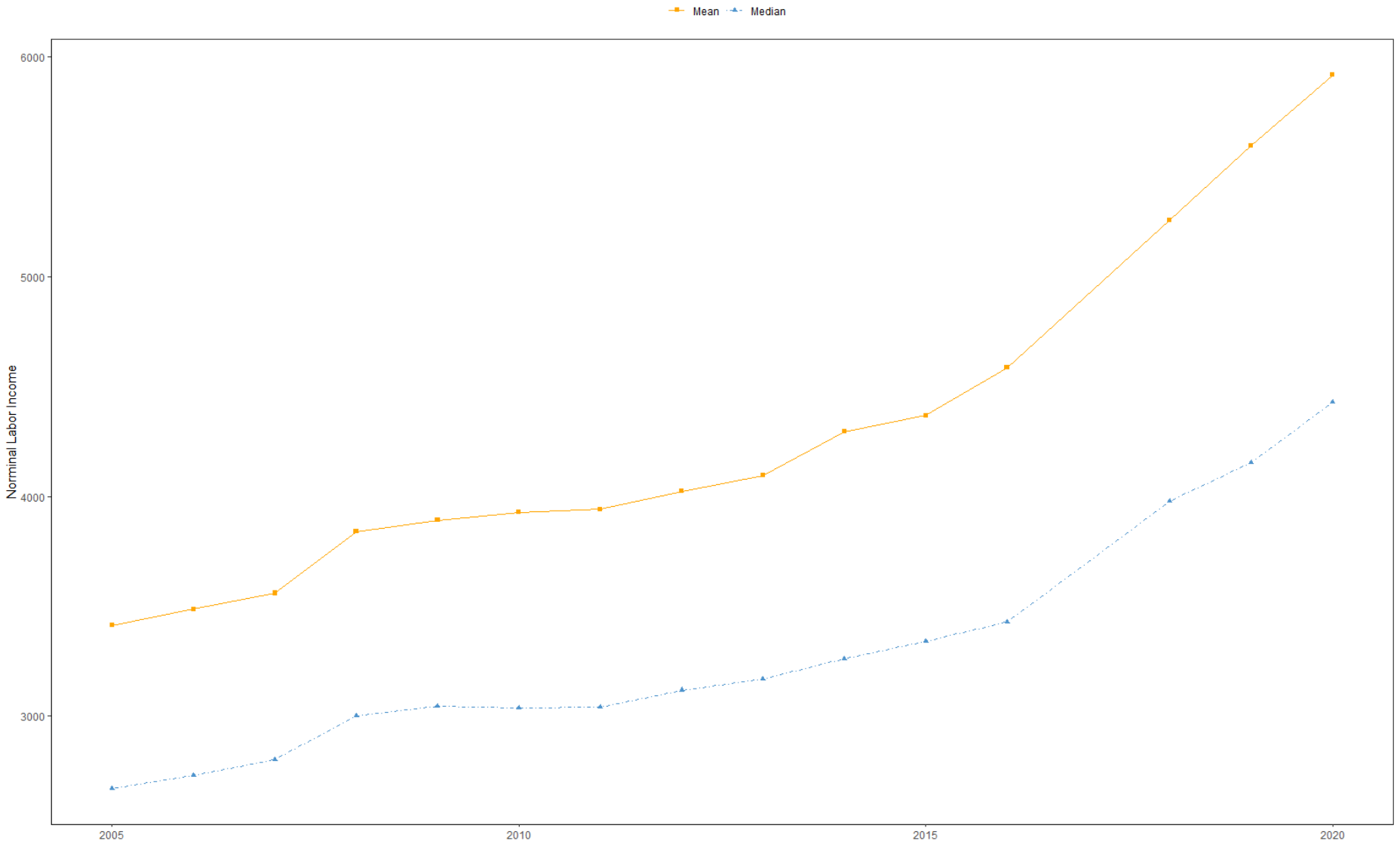
Table 2: Summary Statistic (SIPP)

| | Mean | Std. dev | Median |
|---|---|---|---|
| Demographics | | | |
| Age | 42.5 | 14.3 | 43 |
| Male | 0.51 | 0.5 | 1 |
| Hispanic | 0.13 | 0.33 | 0 |
| Citizen | 0.93 | 0.26 | 1 |
| Education Level | 41 | 2.82 | 41 |
| Income & Wealth ($) | | | |
| Salary | 3616 | 4626 | 2598 |
| Participation | | | |
| Participates in STMF | 0.17 | 0.38 | 0 |
| Observations (N $= n \times T$) | 5763503 | | |
| Households (n) | 216706 | | |
| Average Months (T) | 26.6 | | |

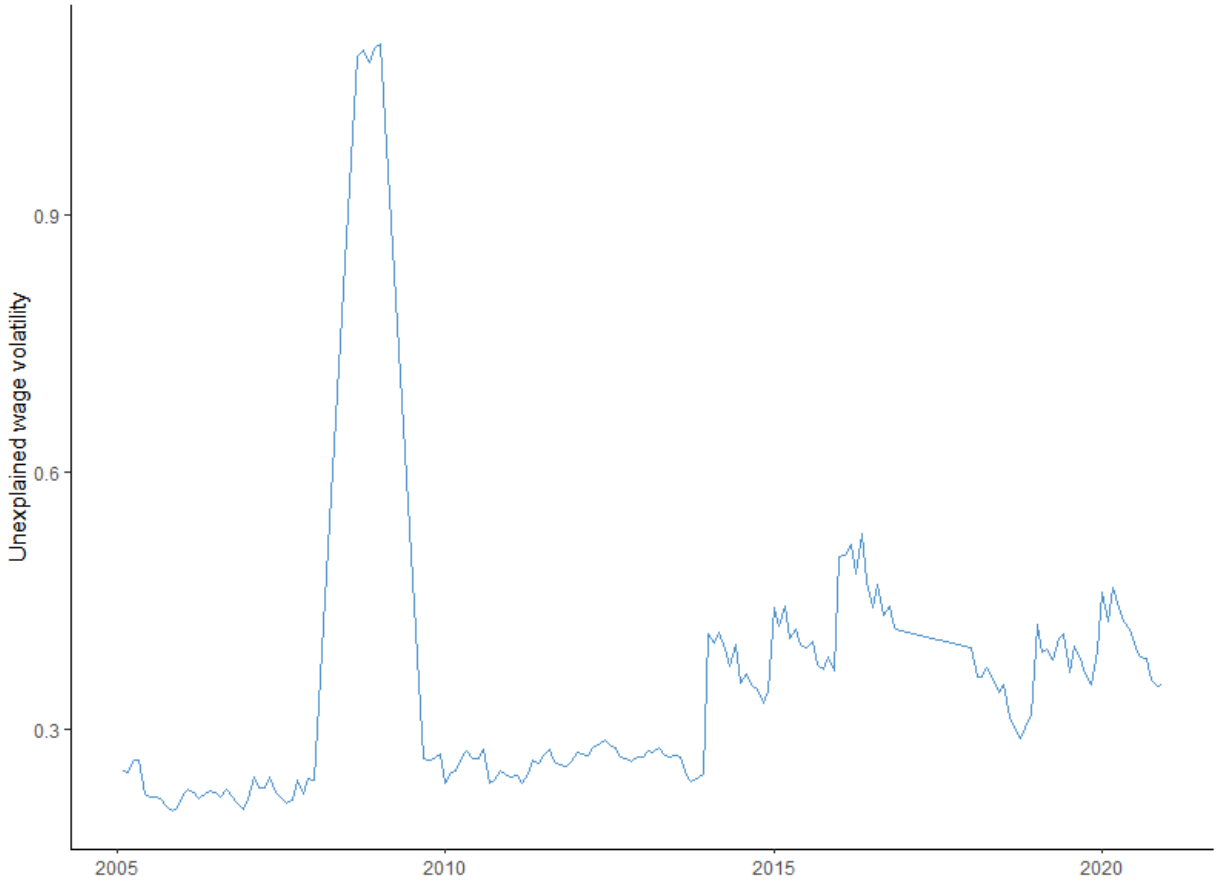
Table 20: Summary Statistic (This Paper)

| | Mean | Std. dev | Median |
|---|---|---|---|
| Demographics | | | |
| Age | 43.7 | 11.8 | 44 |
| Male | 0.46 | 0.5 | 0 |
| Hispanic | 0.11 | 0.31 | 0 |
| Citizen | 0.94 | 0.24 | 1 |
| Education Level | 41.5 | 2.69 | 41 |
| Income & Wealth ($) | | | |
| Salary | 4138 | 3914 | 3157 |
| Participation | | | |
| Participates in STMF | 0.19 | 0.39 | 0 |
| Observations (N $= n \times T$) | 1845180 | | |
| Households (n) | 93091 | | |
| Average Months (T) | 19.8 | | |

# Trend of Labor Income 2004-2020



# Trend of Labor Income 2004-2020




## From Berthold (2023, EER)

**Figure 1** Uncertainty and Risk Aversion measures from Bekaert et al. (2021)


Note. This Figure displays the Uncertainty and Risk Aversion variables from Bekaert et al. (2021) as well as the likely sources of the different spikes. While the raw correlation between the two series is high (0.81), there are also periods with distinctly different behaviour.

# Measurements of Market Participation Rate

- From SCF

$$Participation\ Rate_t = \frac{\#\ Have\ a\ brokerage\ account\ (or\ have\ stock\ holding)}{\#\ Returns}$$

- From SOI

$$Participation\ Rate_t = \frac{\#\ Returns\ with\ Ordinary\ Divedends}{\#\ Returns}$$

- From SIPP (After 2013)

$$Participation\ Rate_t = \frac{\#\ Value\ Invested\ in\ Stock\ and\ Fund\ Market > 0}{\#\ Returns}$$

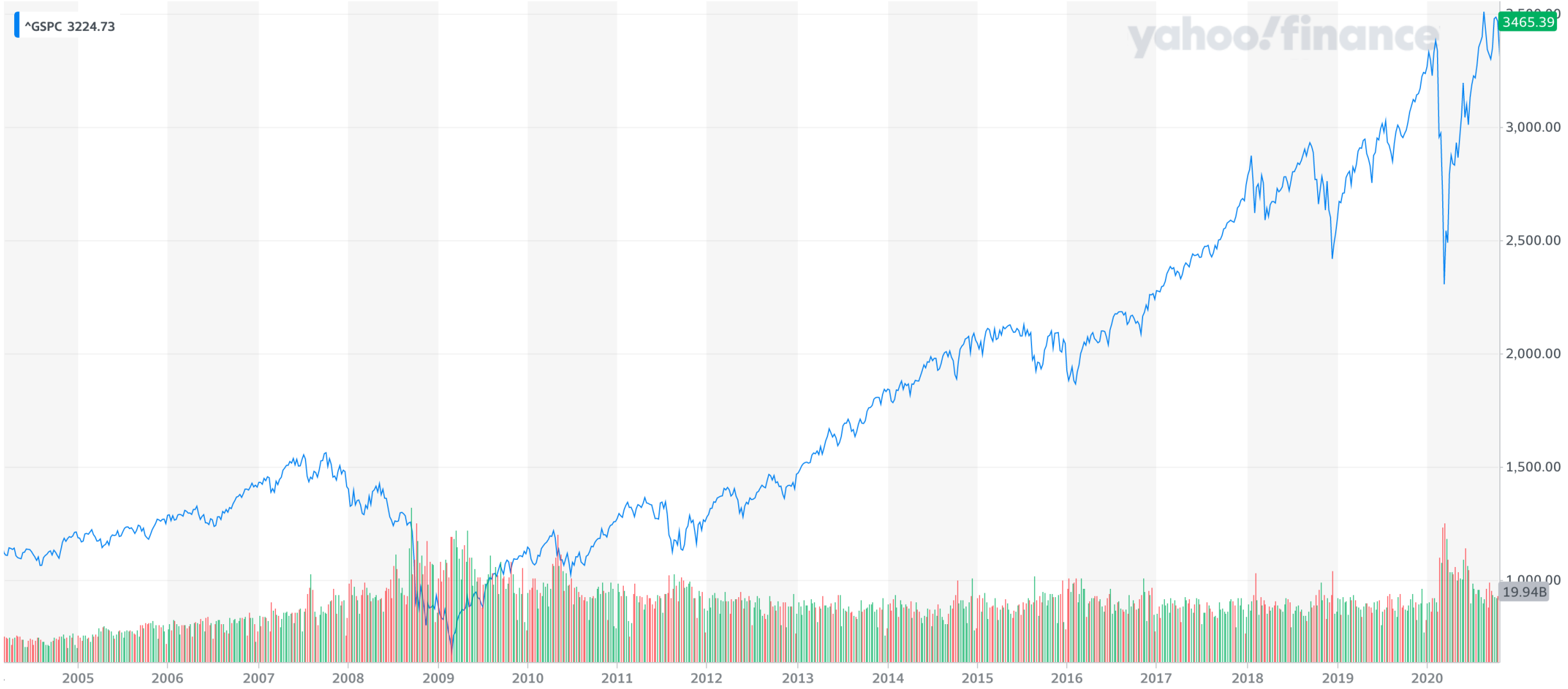
# Measurements of Market Participation Rate

- From SCF
  - Advantage: Tested and used by numerous research before.
  - Drawback: Only available every 3 years.

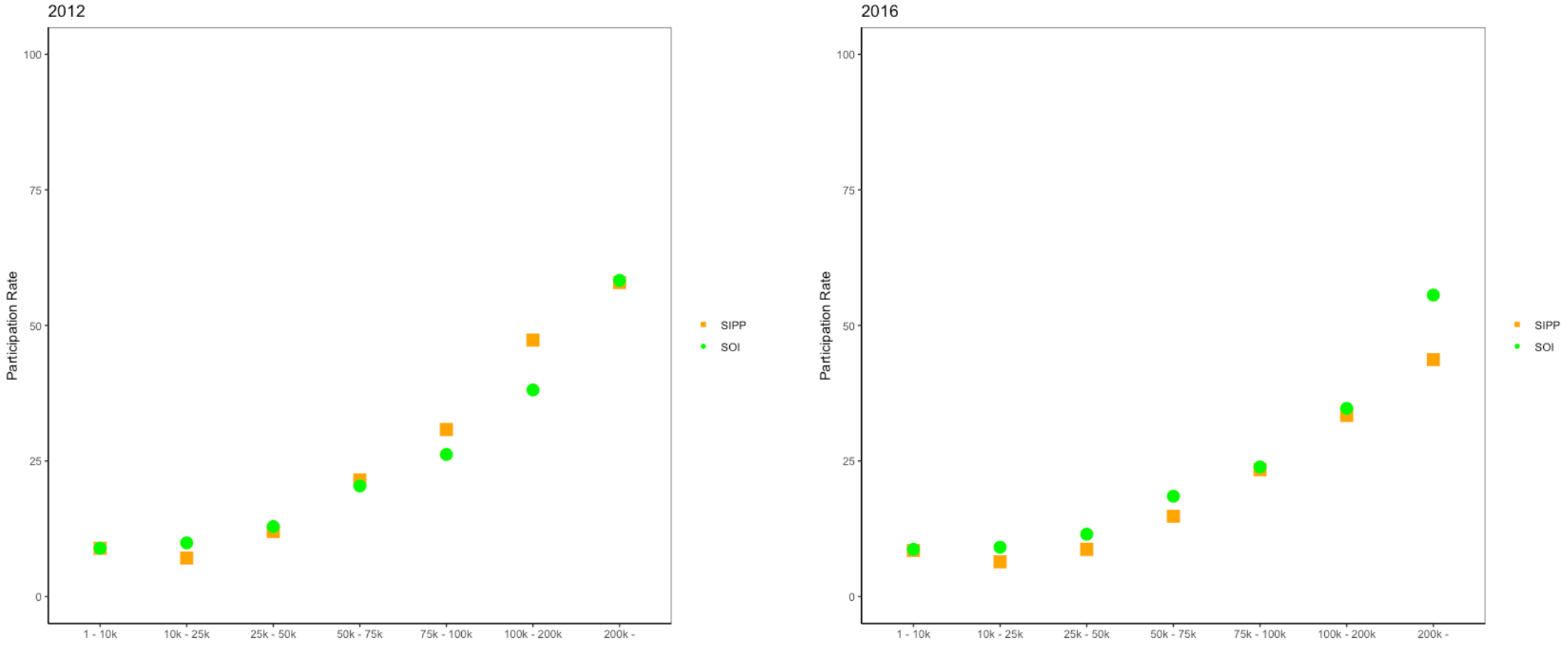
- From SOI
  - Advantage: It's tax report.
  - Drawback: It only contains those who buy and hold stocks with dividends payment (However 80% of the stocks out of S&P 500 pay dividends), so it can be treated as of a proxy of the lower bound of stock market participation rate.

- From SIPP
  - Advantage: Have detailed labor market microdata, getting more attention recently, 2 paper using the SIPP market participation data from JFQA, 2022 December.
  - Drawback: The questionnaires are different across waves (especially before/after 2013).

# Market Participation Rate 2004 - 2020



# Market Participation Rate by Income



# Market Participation Rate 2004 - 2020

# Market Participation Rate 2004 - 2020

# Literature: Income Risk & Portfolio Choice

- *Income Risk, Borrowing Constraints, and Portfolio Choice,* Guiso et al. (1996 AER)
  - Data: 1989 Italian Survey of Household Income and Wealth (SHIW)
  - Method: Income risk as subjective variance of real income growth
  - Conclusion: When confronted with uninsurable income risk, proportion of risky assets gets lower
- *Income Risk and Portfolio Choice: An Empirical Study*, Angerer & Lam (2009 JF)
  - Data: National Longitudinal Survey on Youth (NLSY79)
  - Method: Construct a group-specific risk using income variance
  - Conclusion: First paper attempts to measure permanent and transitory income risks and estimate their effects on risky asset holding and shows that permanent risk shifts household's portfolio toward risk-free asset.
- *Household Portfolio Choices under (Non)linear Income Risk: An Empirical framework*, Galvez (2022 WP)
  - Data: Panel Study of Income Dynamics (PSID) from 1999 to 2009
  - Method: Developed a semi-structural LC framework to empirically quantify the transmission, portfolio choice is an age-dependent functions of persistent and transitory components of income and assets.

# Literature: Hedging & Portfolio Choice

- *Hedging Labor Income Risk,* Betermier et al. (2012 JFE)
  - Data: Longitudinal Individual Data Base (LINDA, Swedish) from 1999 to 2002.
  - Method: Wage volatility by industry as a proxy for all households working in that industry.
  - Conclusion: Household going from a low wage volatility industry to a high one would decrease its exposure to risky asset.
- *Income Hedging and Portfolio Decisions*, Bonaparte et al. (2014 JFE)
  - Data: DNB Household Survey 1993 to 2011 (+ NLSY79 for robustness)
  - Method: The correlation between market return and labor income, Corr(Rm, dy).
  - Conclusion: When income-return correlation is low, individuals exhibit a greater propensity to participate in the market and with larger proportion of resources allocate to risky assets.
- *This paper* (2023 WP)
  - Data: Survey of Income and Program Participation (SIPP) from 2004 to 2020
  - Method: Monthly level income volatility and new measures for the correlation.
  - Conclusion: Household with high wage volatility (both occupation and individual level) has less exposure to the stock market; Provided extra empirical evidence to support the correlation hypothesis.

# Construction of Income Volatility

- Generic structure of labor income process

$$w_{i,t} = z_{i,t} + e_{i,t}$$
$$\Delta w_{i,t} = \Delta z_{i,t} + \Delta e_{i,t}$$

- Where $w_{i,t}$ is the log labor income for household $i$ at time $t$, $z_{i,t}$ and $e_{i,t}$ represent the predictable and stochastic component, respectively.
- $\Delta e_{i,t}$ can be simply imputed by running a regression to remove the demographic factors $x'_{it}$:

$$\Delta w_{i,t} = d_t + x'_{it}\eta + \Delta e_{i,t}$$

- And the wage volatility at aggregate level can be shown as, under Full-Information Rational Expectation (FIRE):

$$Var_i(\Delta w_{i,t}) = Var_i(\Delta e_{i,t})$$
$$Var_{IND}(\Delta w_{i,t}) = Var_{IND}(\Delta e_{i,t})$$

# Background Theory

- Campbell and Viceira (2001, p.144), model of one period portfolio decision:

$$\max_{\alpha_t} E_t\left[\beta \frac{C_{t+1}^{1-\gamma}}{1-\gamma}\right]$$

$$s.t.\ \ C_{t+1} = W_t\left(1 + R_{p,t+1}\right) + Y_{t+1}$$
$$R_{p,t+1} = \alpha_t\left(R_{t+1} - R^f\right) + R^f$$

  - $R_{p,t+1}$: return on portfolio
  - $\delta$: discount factor
  - $\alpha_t$: weight on the risky portfolio

- Risk-averse investor with CRRA, cannot trade labor income (uninsurable labor income risk), has access to risk-free and risky asset.

# Background Theory

- From F.O.C. and assuming for joint log normality between consumption and returns gives:

$$\beta E_t[C_{t+1}^{-\gamma} R_{t+1}] = \beta E_t[C_{t+1}^{-\gamma} R^f]$$

$$\Longrightarrow E_t r_{t+1} - r^f + \frac{1}{2} Var(r_{t+1}) = \gamma cov(r_{t+1}, c_{t+1})$$

- Solving it for portfolio rule:

$$\alpha = \frac{1}{\rho}\left(\frac{\mu + \frac{\sigma_r^2}{2}}{\gamma \sigma_r^2}\right) + (1 - \frac{1}{\rho})(\frac{\sigma_{yr}}{\sigma_r^2})$$

# Background Theory

- Replace the covariance with correlation:

$$\alpha = \frac{1}{\rho}\left(\frac{\mu + \frac{\sigma_r^2}{2}}{\gamma\sigma_r^2}\right) + (1 - \frac{1}{\rho})(corr_{yr})(\frac{\sigma_y}{\sigma_r})$$

  - $\alpha$: optimal weight on the risky portfolio
  - $corr_{yr}$: correlation between portfolio return and wage growth
  - $\rho$: elasticity of consumption w.r.t. financial wealth ($\rho \in (0,1)$)
  - $1 - \rho$: elasticity of consumption w.r.t. labor income
  - $\mu$: expected log excess return
  - $\gamma$: coefficient of relative risk aversion
  - $\sigma$: standard deviation

- First part related to the sharp ratio and risk aversion (most empirical studies in finance focus on this part, by letting $corr_{yr} = 0$); second part related to the income hedging motive, where this paper is focused on.

# Empirical Model 1 (General)

- Probit

$$PR_{i,t} = \alpha + \beta_1 \cdot corr_{yr} + \beta_2 \cdot \sigma_y + \beta_3 \cdot (corr_{yr} \times \sigma_y) + \gamma \cdot X'_{i,t} + \epsilon$$

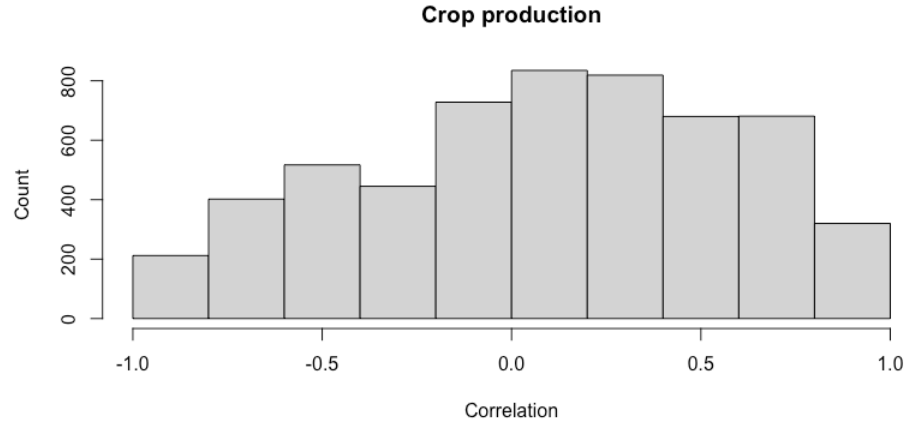
  - $PR_{i,t}$: 0/1 dummy for participation in risky asset market
  - $X'_{i,t}$: Demographic variables

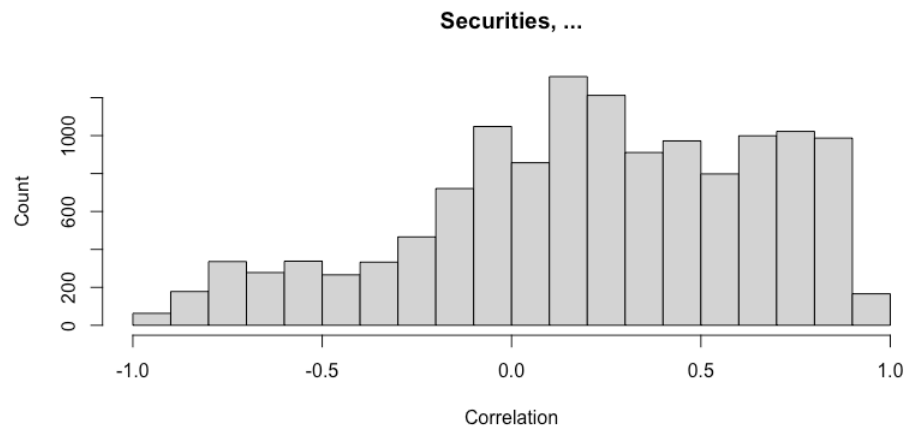
- Assumption: $corr_i(M, Y)$ is fixed by individual within a time span:

$$corr_{yr} = corr_i(M, Y) = \sum_{t=1}^{T} \frac{(SP500_t - \overline{SP500})(Y_t - \bar{Y})}{(T-1)(\sigma_Y \cdot \sigma_M)}$$

Table 2: Correlation by Occupation

| IND | Description | Estimate |
|---|---|---|
| Financial | | |
| 6870 | Banking and related activities | 0.2123 |
| 6880 | Savings institutions, including credit unions | 0.3165 |
| 6970 | Securities, commodities, funds, trusts, and other financial investments | 0.2116 |
| 6992 | Agencies, brokerages, and other insurance related activities | 0.2034 |
| Necessity | | |
| 0170 | Crop production | 0.0921 |
| 0380 | Coal mining | -0.0488 |
| 0770 | Construction | 0.1369 |
| 2390 | Rubber products, except tires, manufacturing | 0.0490 |
| Luxury | | |
| 1691 | Cut and sew, and apparel accessories and other apparel manufacturing | 0.3003 |
| 1770 | Footwear manufacturing | 0.3182 |
| 2890 | Coating, engraving, heat treating, and allied activities | 0.2472 |
| 3690 | Other transportation equipment manufacturing | 0.3035 |
| 25th | 50th | 75th |
| 0.1182 | 0.1625 | 0.2049 |



# Results

Table 3

| | *Dependent variable:* | | |
|---|---|---|---|
| | Own STMF | | |
| | (1) | (2) | (3) |
| $\sigma_y \times corr_{yr}$ | $-0.198^{***}$ | $-0.142^{***}$ | $-0.090^{***}$ |
| | (0.007) | (0.007) | (0.007) |
| Wealth FE | N | Y | Y |
| Individual FE | N | N | Y |
| N | 1,679,287 | 1,679,287 | 1,679,287 |

# Results

Table 3

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Entering Market | | | |
| | (1) | (2) | (3) | (4) |
| dy | 0.041*** | 0.042*** | 0.048*** | 0.026*** |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| Market Index FE | N | Y | Y | Y |
| Individual FE | N | N | Y | Y |
| Time FE | N | N | N | Y |
| N | 1,845,180 | 1,845,180 | 1,845,180 | 1,845,180 |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

Table 4

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Exiting Market | | | |
| | (1) | (2) | (3) | (4) |
| dy | −0.048*** | −0.046*** | −0.040*** | −0.051*** |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| Market Index FE | N | Y | Y | Y |
| Individual FE | N | N | Y | Y |
| Time FE | N | N | N | Y |
| N | 1,845,180 | 1,845,180 | 1,845,180 | 1,845,180 |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# Empirical Model 2 (Volatility by Occupation)

- Probit

$$PR_{i,t} = \alpha + \beta_1 \cdot corr_{yr} + \beta_2 \cdot \mathrm{dy} + \beta_3 \cdot \ln(\mathrm{y}) + \gamma \cdot X'_{i,t} + \epsilon$$

  - $PR_{i,t}$: 0/1 dummy for participation in risky asset market
  - $dy$: log change in labor income
  - $X'_{i,t}$: Demographic variables

- The wage volatility at individual level:

$$volatility_i = var_i(dy_{i,t})$$

- Occupation level:

$$volatility_{IND} = var_{IND}(dy_{IND,t})$$

Table 13: Ranking of occupations by wage volatility

| IND | Description | Estimate | N |
|---|---|---|---|
| Bottom 10 | | | |
| 6675 | Internet publishing and broadcasting | 0.0506 | 8 |
| 3095 | Commercial and service industry machinery manufacturing | 0.0632 | 25 |
| 1670 | Knitting fabric mills, and apparel knitting mills | 0.0966 | 24 |
| 1470 | Fiber, yarn, and thread mills | 0.0974 | 25 |
| 0480 | Not specified type of mining | 0.0978 | 7 |
| 2680 | Aluminum production and processing | 0.1044 | 54 |
| 1690 | Apparel accessories and other apparel manufacturing | 0.1073 | 17 |
| 7181 | Other consumer goods rental | 0.1112 | 10 |
| 0580 | Natural gas distribution | 0.1179 | 107 |
| 3770 | Sawmills and wood preservation | 0.1276 | 139 |
| Top 10 | | | |
| 8891 | Personal and household goods repair and maintenance | 2.7035 | 14 |
| 0280 | Fishing, hunting and trapping | 2.3729 | 28 |
| 5295 | Musical instrument and supplies stores | 1.3572 | 12 |
| 7071 | Lessors of real estate, and offices of real estate agents and brokers | 0.8310 | 201 |
| 8990 | Nail salons and other personal care services | 0.7580 | 157 |
| 5690 | Other direct selling establishments | 0.7450 | 102 |
| 6190 | Taxi and limousine service | 0.7127 | 167 |
| 6590 | Sound recording industries | 0.7000 | 23 |
| 8563 | Promoters of events, agents and managers for public figures | 0.6813 | 19 |
| 8970 | Barber shops | 0.6482 | 25 |
| Financial | | | |
| 6870 | Banking and related activities | 0.2727 | 1814 |
| 6970 | Securities, commodities, funds, trusts, and other financial investments | 0.3792 | 919 |
| 25th | 50th | 75th | |
| 0.2292 | 0.2911 | 0.3730 | |

# Results

Table 12: Probit Regression (Individual Level with $sd(dy) > 0$)

| | *Bottom 10* | | *Top 10* | |
|---|---|---|---|---|
| | Own STMF | | Own STMF | |
| | (1) | (2) | (1) | (2) |
| $corr_{yr}$ | 0.338*** | 0.277*** | −0.079*** | −0.057*** |
| | (0.011) | (0.011) | (0.007) | (0.007) |
| dy | −0.342*** | −0.232*** | −0.126*** | −0.061*** |
| | (0.011) | (0.011) | (0.003) | (0.003) |
| ln(y) | 0.654*** | 0.408*** | 0.370*** | 0.182*** |
| | (0.006) | (0.008) | (0.004) | (0.005) |
| Individual FE | N | Y | N | Y |
| N | 146,498 | 146,498 | 181,166 | 181,166 |

Table 13: Probit Regression (Industrial Level)

| | *Bottom 10* | | *Top 10* | |
|---|---|---|---|---|
| | Own STMF | | Own STMF | |
| | (1) | (2) | (1) | (2) |
| $corr_{yr}$ | 0.022 | 0.036* | −0.014 | −0.025* |
| | (0.018) | (0.019) | (0.013) | (0.014) |
| dy | −0.346*** | −0.236*** | −0.153*** | −0.080*** |
| | (0.026) | (0.026) | (0.010) | (0.010) |
| ln(y) | 0.872*** | 0.585*** | 0.486*** | 0.269*** |
| | (0.017) | (0.020) | (0.009) | (0.010) |
| Individual FE | N | Y | N | Y |
| N | 29,511 | 29,511 | 61,607 | 61,607 |

# Empirical Model 3 (Hedging Motive)

- Probit

$$PR_{i,t} = \alpha + \beta_1 \cdot LOC + \beta_2 \cdot HIR + \beta_3 \cdot LOC \cdot HIR + \gamma \cdot X'_{i,t} + \epsilon$$

- $PR_{i,t}$: 0/1 dummy for participation in risky asset market
- $LOC$: 0/1 dummy for individuals with low income growth-market returns correlation
- $HIR$ : 0/1 dummy for individuals with high income growth volatility

# Results

Table 7: Probit Regression with Personal Level Risk

| | *Dependent variable:* | | |
|---|---|---|---|
| | Own STMF | | |
| | (1) | (2) | (3) |
| *Low Corr* × *High Risk* | $0.110^{***}$ | $0.060^{***}$ | $0.026^{***}$ |
| | (0.006) | (0.006) | (0.006) |
| $LowCorr_{25}$ | $-0.098^{***}$ | $-0.014^{***}$ | $-0.013^{***}$ |
| | (0.003) | (0.003) | (0.003) |
| $HighRisk_{75}$ | $-0.061^{***}$ | $0.027^{***}$ | $0.030^{***}$ |
| | (0.003) | (0.003) | (0.003) |
| Wealth FE | N | Y | Y |
| Individual FE | N | N | Y |
| N | 1,679,287 | 1,679,287 | 1,679,287 |

Table 8: Probit Regression with Occupation Level Risk

| | *Dependent variable:* | | |
|---|---|---|---|
| | Own STMF | | |
| | (1) | (2) | (3) |
| *Low Corr* × *High Risk* | 0.008 | $0.025^{***}$ | $0.022^{***}$ |
| | (0.006) | (0.006) | (0.006) |
| $LowCorr_{25}$ | $-0.065^{***}$ | 0.004 | $-0.006^{*}$ |
| | (0.003) | (0.003) | (0.003) |
| $HighRisk_{75}$ | $-0.201^{***}$ | $-0.117^{***}$ | $-0.027^{***}$ |
| | (0.003) | (0.003) | (0.003) |
| Wealth FE | N | Y | Y |
| Individual FE | N | N | Y |
| N | 1,679,287 | 1,679,287 | 1,679,287 |

# Results

Table 9: Probit Regression with Time Variant Occupation Level Risk

| | *Dependent variable:* | | |
|---|---|---|---|
| | Own STMF | | |
| | (1) | (2) | (3) |
| *Low Corr* × *High Risk* | 0.067*** | 0.052*** | 0.060*** |
| | (0.006) | (0.006) | (0.007) |
| $LowCorr_{25}$ | −0.083*** | −0.002 | −0.014*** |
| | (0.003) | (0.003) | (0.003) |
| $HighRisk_{75}$ | −0.158*** | −0.158*** | −0.126*** |
| | (0.003) | (0.003) | (0.003) |
| Wealth FE | N | Y | Y |
| Individual FE | N | N | Y |
| N | 1,679,283 | 1,679,283 | 1,679,283 |

Table 10: Probit Regression with Time Variant Correlation and Occupation Level Risk

| | *Dependent variable:* | | |
|---|---|---|---|
| | Own STMF | | |
| | (1) | (2) | (3) |
| *Low Corr* × *High Risk* | 0.024*** | 0.039*** | 0.024*** |
| | (0.008) | (0.008) | (0.008) |
| $LowCorr_{25}$ | −0.017*** | 0.068*** | 0.074*** |
| | (0.004) | (0.004) | (0.004) |
| $HighRisk_{75}$ | −0.152*** | −0.165*** | −0.127*** |
| | (0.004) | (0.004) | (0.004) |
| Wealth FE | N | Y | Y |
| Individual FE | N | N | Y |
| N | 1,157,427 | 1,157,427 | 1,157,427 |

# Empirical Model EX (Risky Share)

- Since the risky share information is only available after 2013, so this part of the empirical research will have less observations. The risky share is measured as:

$$Risky\ Share_{i,t} = \frac{Value\ of\ stock\ and\ mutual\ fund_{i,t}}{Value\ of\ total\ financial\ assets_{i,t}}$$

# Conclusion & Next Step

- This paper has examined the relation between income volatility and portfolio decision. Theory model have shown that people can hedge their labor income risk though stock market. The evidence from the first test offers support for this theory.
- As a second test, I divided the sample into different groups, corresponding to the volatility level. The results provide extra support to the first exercise. On top of that, I tested the hypothesis that "the higher a worker's wage volatility, the lower his exposure to the stock market", by showing that people facing the lowest level of income risk (both at individual and occupation level) are more "exposed" to the stock market.

- Use other data to support my results, i.e., NLSY97, PSID, DNB (Netherland)…
- Robustness test with more dimensions
- Structural LC model

# Other projects (if time allows)

- I am interested in the **consumption and income dynamic**, **risk and uncertainty**, and **inequality** of households.

1. The Disaggregated Household Inequality (Brown bag November 2022)
   - Japanese data 2000-2018
2. Consequences of Speculation in Housing Market (10%)
3. The Price of Uncertainty in Macroeconomic and Financial Market (1%)

- In short, what I want to do is to use micro data to answer macro questions, and to develop computational solution for HA model.

# Plots


Table 3: Engel Curves from Family Income and Expenditure Survey

| | | *Elasticity* | |
|---|---|---|---|
| Good Category | Share (L/H) | Low Income | High Income |
| Food | 19.3/15.7 | 0.69(0.05) | 0.45(0.05) |
| Food (Outside) | 4.4/4.6 | 0.85(0.08) | 0.36(0.08) |
| Entertainment | 2.1/2.1 | 2.01(0.14) | 1.26(0.11) |
| Entertainment (Durable) | 0.9/1.2 | 2.18(0.42) | 2.23(0.31) |
| Book | 1.2/1.2 | 0.45(0.08) | 0.59(0.08) |
| Service | 4.8/6.3 | 0.82(0.13) | 0.34(0.13) |
| Housing (Rent/Land) | 6.2/2.5 | 0.13(0.05) | −0.03(0.08) |
| Housing (Maintenance) | 2.0/2.1 | 3.22(0.53) | 1.78(0.39) |
| Transportation | 1.7/3.0 | 0.67(0.20) | 1.37(0.14) |
| Vehicle | 8.8/7.5 | 1.82(0.22) | 1.27(0.19) |
| Network | 5.1/3.8 | 0.09(0.09) | −0.03(0.08) |
| Clothing | 4.0/5.0 | 1.41(0.15) | 1.10(0.13) |
| Furniture | 3.3/3.2 | 1.50(0.16) | 0.78(0.15) |
| Health | 3.7/3.3 | 0.54(0.12) | 0.26(0.10) |
| Utility | 7.6/5.5 | 0.48(0.14) | 0.44(0.13) |
| Education | 3.9/8.1 | 0.47(0.26) | 1.95(0.28) |
| Extra | 7.4/6.7 | 0.66(0.12) | 0.52(0.09) |
| Social | 6.5/6.8 | 1.82(0.18) | 1.41(0.16) |

# Appendix

- If $X_t$ is conditionally lognormal distributed:

$$lnE_t[X_t] = E_t[\ln(X_t)] + \frac{1}{2}Var_t[\ln(X_t)]$$

- Recall:

$$\ln E_t[C_{t+1}^{-\gamma} R_{t+1}] = \ln E_t[C_{t+1}^{-\gamma} R^f]$$

$$\Longrightarrow E_t\left[\ln\left((C_{t+1})^{-\gamma}(R_{t+1})\right)\right] + \frac{1}{2}Var_t\left[\ln\left((C_{t+1})^{-\gamma}(R_{t+1})\right)\right]$$

$$= E_t\left[\ln\left((C_{t+1})^{-\gamma}(R^f)\right)\right] + \frac{1}{2}Var_t\left[\ln\left((C_{t+1})^{-\gamma}(R^f)\right)\right]$$

$$\Longrightarrow -\gamma E_t C_{t+1} + E_t r_{t+1} + \frac{1}{2}\left(\sigma_r^2 + \gamma^2\sigma_c^2 - 2\gamma\sigma_{cy}\right)$$

$$= -\gamma E_t C_{t+1} + r^f + \frac{1}{2}(\gamma^2\sigma_c^2)$$