Household Finance
PhD Course

Diversification

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Outline: Diversification

- Variance decomposition
  - Idiosyncratic vs systematic risk
  - Evidence
- Asset Pricing Models
  - Only systematic risk is priced - diversification
  - First vs second empirical moments
  - Measurement of expected returns
- Welfare loss
  - The role of risk taking
- Sophistication, diversification and risk taking
  - behavioral vs household finance
  - mistakes

Previous Findings

Blume and Friends (1975, 1978)

- 1971 Tax Records and 1962 Fed Survey
- no information on funds
- households hold directly few stocks on average

Kelly (1995)

- 1983 wave of the SCF
- no information on size of fund investments
- households without funds do not hold more stocks

Goetzmann and Kumar (2008)

- US brokerage house data
- households hold undiversified directly held stock portfolios

Methodology

Compare household portfolios with diversified indexes

Benchmarks (83-04)

- MSCI All Country World Index
  - hedged for currency risk
  - unhedged
- Swedish Stock Index

Calculate underdiversification losses

Statistical Risk Decomposition

- **Mean-Variance analysis** (Markowitz - 1952)
- **Sharpe Ratio Loss**
  - Measure of efficiency in risky portfolio
- **Return Loss**
  - Takes into account risk exposure

Risk exposure

Statistical Decomposition (risky portfolio)

Excess Return

$$r_{h,t}^{e} = \alpha_h + \beta_h r_{B,t}^{e} + \varepsilon_{h,t}$$

Variance

$$\sigma_h^2 = \beta_h^2 \sigma_B^2 + \sigma_{i,h}^2$$

Total risk

Systematic risk

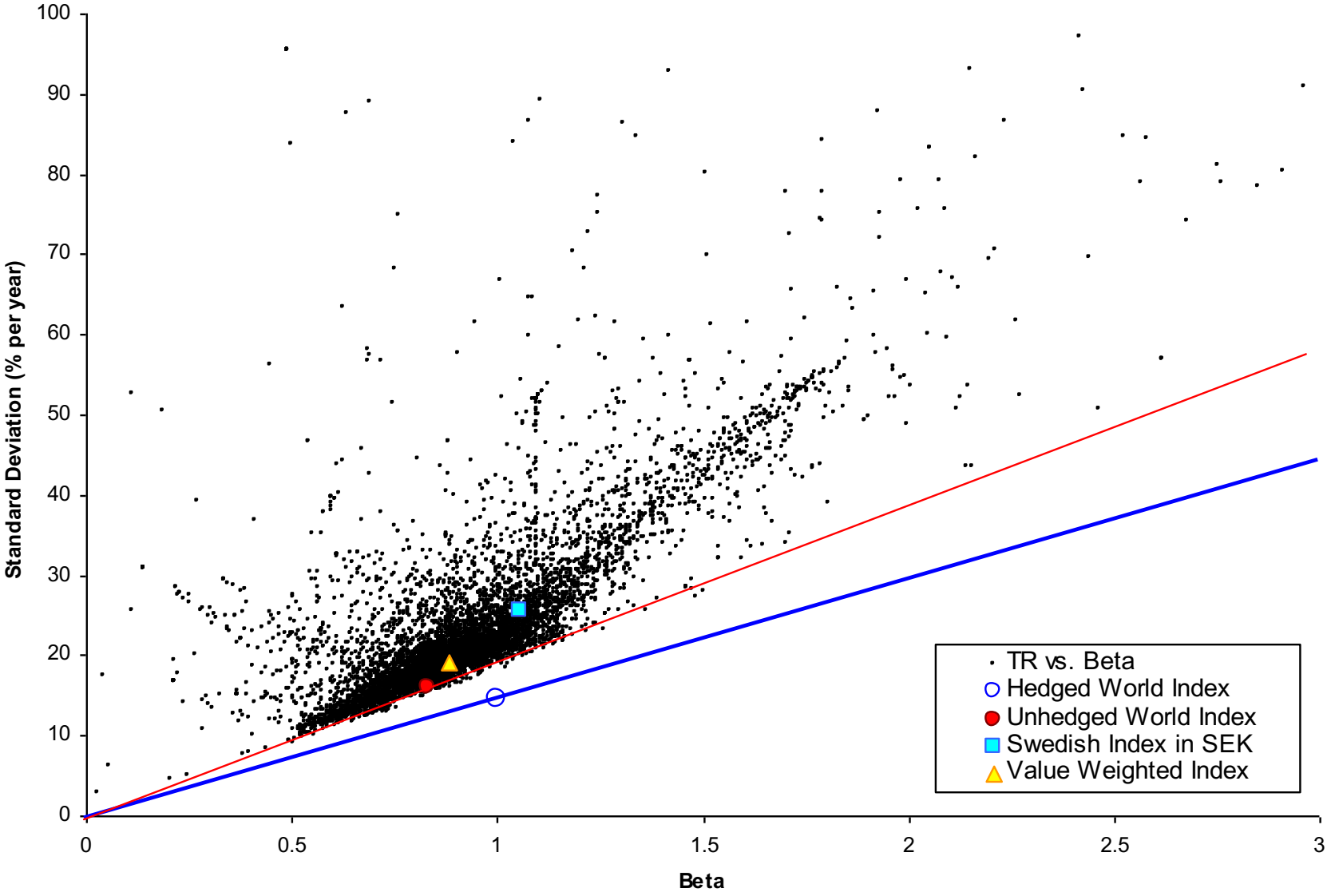
Idiosyncratic risk

$$\sigma_h \geq \beta_h \sigma_B \quad \Rightarrow \quad \sigma_h = \beta_h \sigma_B$$

Full Diversification

Plot σ_h on β_h

Volatility and Beta of Risky Porfolios



Risk Exposure

In their risky portfolio, the majority of households have

- more than 19.5% total volatility
- more than 14.4% idiosyncratic risk (wrt hedged world index)
- an idiosyncratic variance share $\sigma_{i,h}^2 / \sigma_h^2$ of at least 54.9%

Idiosyncratic risk is a large component of Swedish household risky portfolios. How?

Households with

- low idiosyncratic risk, have portfolio concentrated in mutual funds
- high idiosyncratic risk, have portfolios concentrated in stocks
- average idiosyncratic risk, have diversified portfolio of correlated stocks and mutual funds

Estimation of First and Second Moments

- Financial asset returns are very volatile
- High estimation errors of sample means
  - World index vol of 15% implies that one needs **3000** years of data to reach a 90% confidence interval of +/-**50bp**
  - With **100** years of data the 90% confidence interval is +/- **2.5%** of 6.5%!
- Need long time series to estimate means reasonably
- Second moments estimated accurately
  - precision increases with frequency
  - 90% confidence interval of 2.5% on vol with only **5** years of monthly returns, less than 50bp with **3** years of daily returns!

Standard Error of Mean

Standard error for sample means, *T* years:

$$StdErr_y = \frac{StdDev_y}{\sqrt{T}}$$

- With monthly data $StdErr_m = \frac{StdDev_m}{\sqrt{12 \times T}}$, and annualized:

$$StdErr_m^{annual} = 12\frac{StdDev_m}{\sqrt{12 \times T}} = 12\frac{\sqrt{12}\,StdDev_m/\sqrt{12}}{\sqrt{12 \times T}} = \frac{StdDev_m^{annual}}{\sqrt{T}}$$

No gain in precision

- Need long time series to estimate means reasonably
- Precision is independent from frequency

Standard Error of Volatility

Standard error for sample volatility

$$StdErr_y = \frac{StdDev_y}{\sqrt{2(T-1)}}$$

- With monthly data $StdErr_m = \frac{StdDev_m}{\sqrt{2(12\times T-1)}}$, and annualized

$$StdErr_m^{annual} = \sqrt{12}\frac{StdDev_m}{\sqrt{24T-2}} = \sqrt{12}\frac{\sqrt{12}\,StdDev_m/\sqrt{12}}{\sqrt{24T-2}} = \frac{StdDev_m^{annual}}{\sqrt{24T-2}}$$

$\sqrt{24T-2} - \sqrt{2T-2}$ gain in precision

- Higher frequency data implies better precision for volatility estimates

Asset Pricing Models: Merton (1980)

Assume that asset pricing models hold

$$E(r^e_{h,t}) = \beta_h E(r^e_{B,t})$$

- $\beta_h = Cov\left(r^e_{h,t}, r^e_{B,t}\right) \Big/ Var\left(r^e_{B,t}\right)$ estimated only through second moments

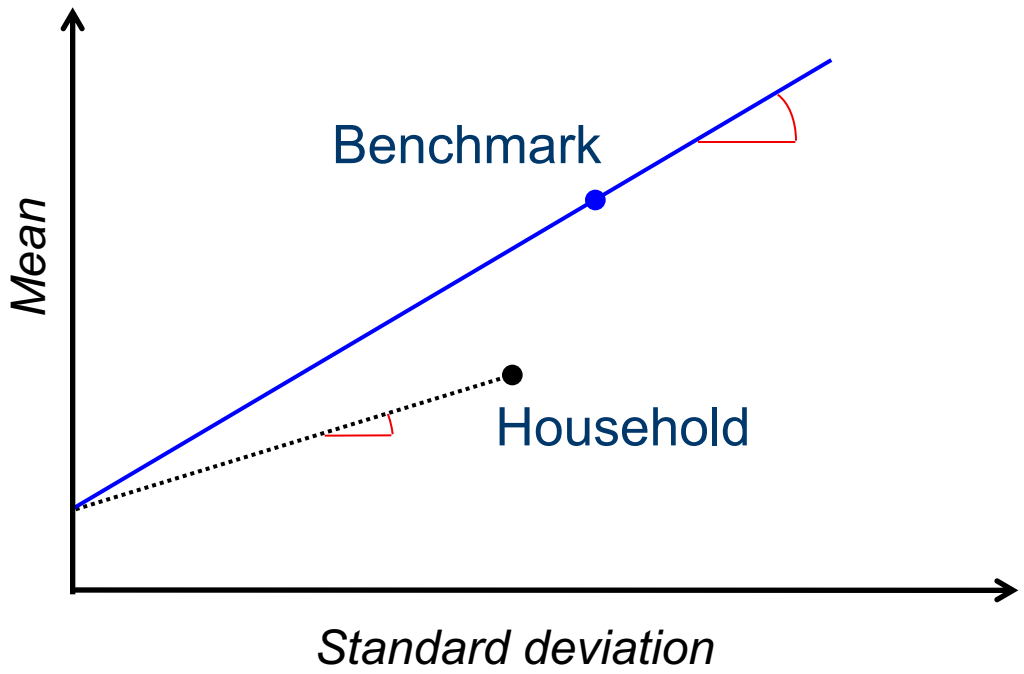
Use long-term estimated premia for each factor

- Best estimate of sample means
- Easy to perform robustness checks

Use different asset pricing models

- **CAPM**
  - Hedged world index is mean-variance efficient
- **Fama-French** three-factor model
  - Market, size, and value factors

Relative Sharpe Ratio Loss



Sharpe ratios

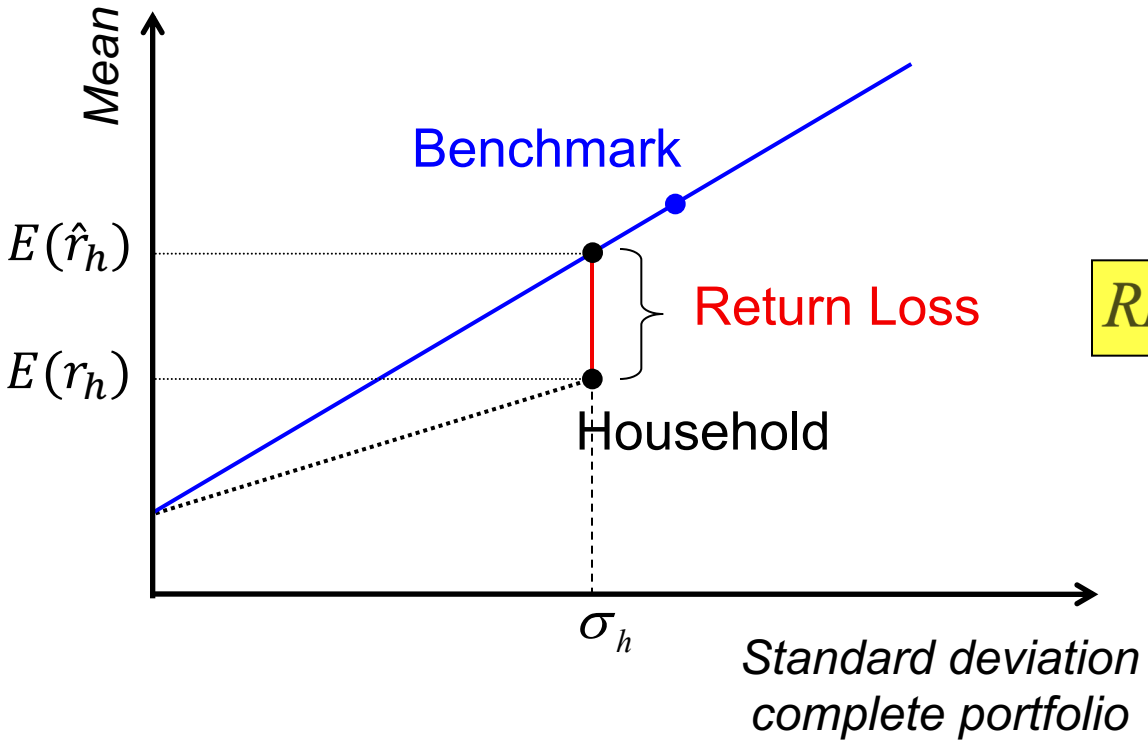
slopes of capital allocation lines

Household h **relative Sharpe ratio loss** wrt benchmark S_B

$$RSRL_h = 1 - \frac{S_h}{S_B}, \qquad S_h = \frac{\mu_h}{\sigma_h}$$

Return Loss

- Relative Sharpe ratio loss does not consider the amount of risk a household is taking
- Return the investor is giving up by choosing a suboptimal portfolio compared to a benchmark



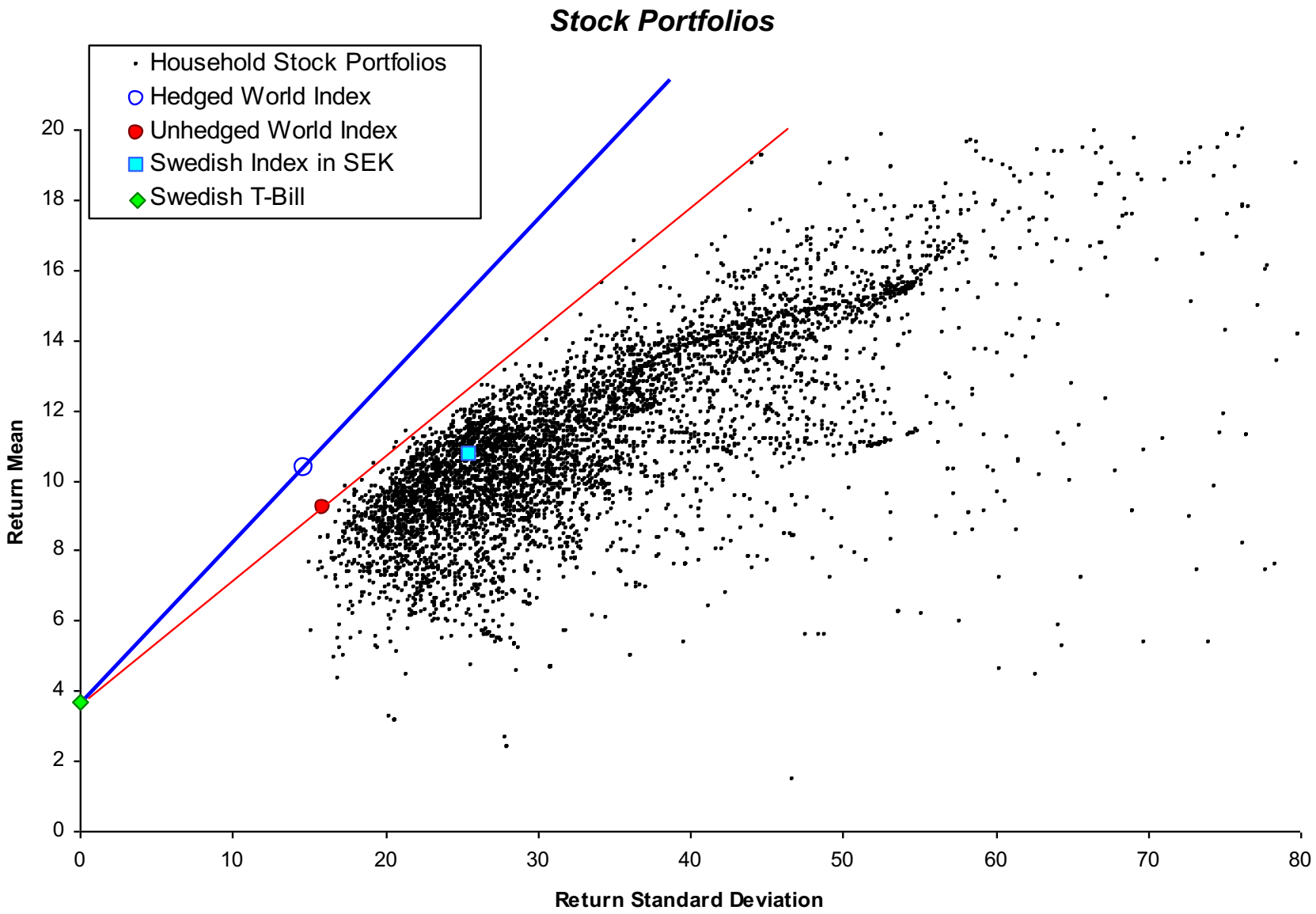
$$RL_h = S_B\sigma_h - S_h\sigma_h$$

$E(\hat{r}_h^e)$ $E(r_h^e)$

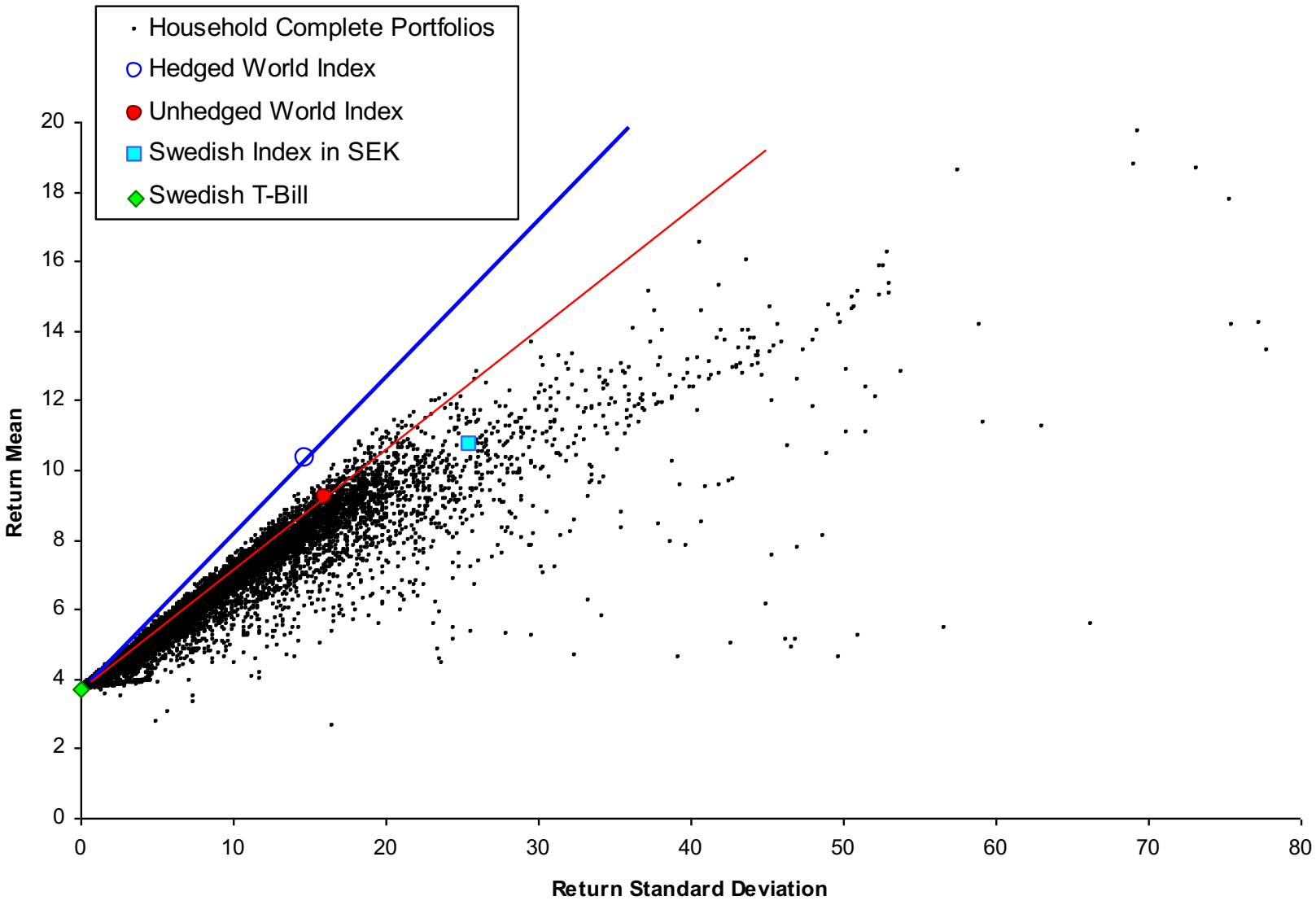
Return Losses

- The majority of Swedish households loose less than 30bp (or 33$) per year with respect to the unhedged world index
- Risky portfolios have return losses three times as large as complete portfolios
- 5% of households sustain substantial losses (>2.5% or 851$ per year)
- We do not account for mutual fund fees

Scatter Plots of Household Portfolios



Complete Portfolios



Return Loss Decomposition

- Decompose the complete portfolio return loss

$$RL_{complete,h} = E(r_m^e)\ w_h\ \beta_{risky,h}\ \frac{RSRL_h}{1-RSRL_h}$$

Risky asset share (aggressiveness)

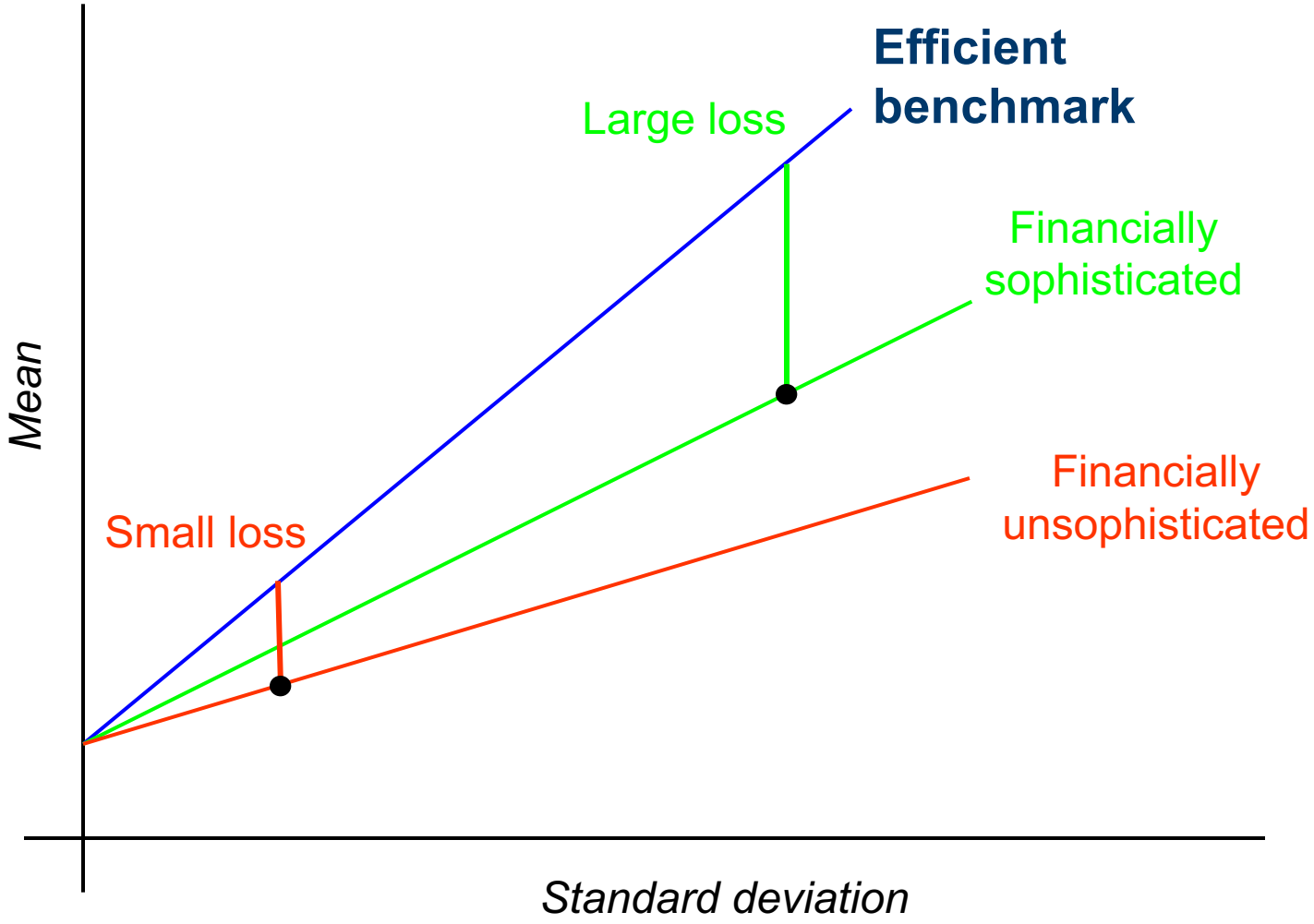
Systematic exposure of risky portfolio

Diversification loss Portfolio Inefficiency

Contributors to Complete Return Loss

	Return Loss $\ln(RL_{complete,h})$			Risky Share $\ln(w_h)$			Risky Portfolio Beta $\ln\|\beta_h\|$			Diversification Loss $\ln\| RSRL_h/(1-RSRL_h) \|$		
	Estimate	Std Err	Change	Estimate	Std Err	Change	Estimate	Std Err	Change	Estimate	Std Err	Change
Intercept	-1.093	0.055	–	-2.752	0.053	–	-0.108	0.027	–	-0.127	0.030	–
Disposable Income	0.007	0.002	2.1%	-0.007	0.002	-2.1%	0.009	0.001	2.7%	0.005	0.001	1.5%
Log of Financial Wealth	0.090	0.004	14.1%	0.137	0.004	22.3%	-0.016	0.002	-2.2%	-0.032	0.002	-4.5%
Log of Real-Estate Wealth	0.008	0.001	5.1%	0.005	0.001	3.2%	0.003	0.001	2.1%	0.000	0.001	-0.3%
Age	-0.001	0.001	-1.9%	-0.001	0.001	-1.9%	-0.002	0.000	-3.7%	0.002	0.000	3.8%
High-School Dummy	0.111	0.016	10.5%	0.107	0.016	10.2%	0.057	0.008	5.6%	-0.053	0.009	-5.5%
Post High-School Dummy	0.173	0.013	18.9%	0.124	0.013	13.2%	0.042	0.007	4.3%	0.006	0.007	0.6%
Missing Education	0.112	0.024	11.9%	0.087	0.024	9.1%	-0.037	0.012	-3.7%	0.063	0.013	6.5%
Immigration Dummy	0.043	0.017	4.4%	-0.112	0.017	-10.6%	0.045	0.009	4.6%	0.110	0.009	11.6%
Household Size	-0.143	0.005	-16.9%	-0.086	0.005	-10.5%	-0.010	0.002	-1.3%	-0.047	0.003	-5.9%
Retired Dummy	-0.043	0.022	-4.2%	-0.023	0.021	-2.3%	-0.050	0.011	-4.9%	0.031	0.012	3.1%
Unemployment Dummy	-0.086	0.021	-8.2%	-0.105	0.021	-9.9%	-0.001	0.011	-0.1%	0.020	0.012	2.0%
Entrepreneur Dummy	-0.115	0.029	-10.8%	-0.261	0.028	-22.9%	0.097	0.014	10.2%	0.049	0.016	5.0%
Student Dummy	0.020	0.031	2.0%	0.069	0.030	7.1%	-0.053	0.015	-5.2%	0.004	0.017	0.4%
Private Pension Premia/Incom	0.248	0.074	1.8%	0.352	0.071	2.6%	-0.016	0.037	-0.1%	-0.087	0.040	-0.6%
Log of Total Liabilities	0.012	0.001	7.0%	0.004	0.001	2.3%	0.010	0.001	5.6%	-0.002	0.001	-0.9%
Adjusted R^2	0.034			0.039			0.050			0.030		

Intuition


Efficient benchmark
Large loss
Financially sophisticated
Financially unsophisticated
Small loss
Mean
Standard deviation

Who Incurs Return Losses?

- Financially sophisticated households (rich, educated, …) invest **efficiently** (more in mutual funds) but **take more risk** and loose more from underdiversification

- Unsophisticated households (poor, less educated, …) invest **inefficiently** but limit their losses by **taking less risk**

Interpretation: less sophisticated households are aware of their limitations and take less financial risk

Implication: confidence in financial products might encourage investment in risky assets

Conclusions

- At least 50% of portfolio risk is idiosyncratic for the majority of Swedish households
- Swedish households suffer modest losses from diversification
  - Mutual funds play a vital role in improving diversification
  - Losses in risky portfolios are contained by reduced risk taking
- Financial sophistication improves portfolio efficiency but also increases risk-taking resulting in higher return losses
- Less sophisticated households might be simply aware of their limitations
- Why do households tilt their portfolio away from diversified benchmarks?
  - e.g. entrepreneurs