A Brief Historical Analysis of Asset Returns

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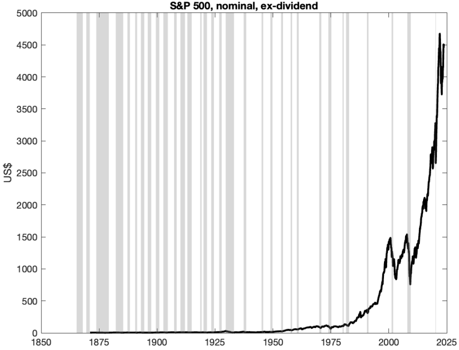
EXECUTIVE
ACADEMY

This class

A brief historical analysis of the **risk and return** of different financial instruments.

$\hookrightarrow$ Main focus: the US equity market & quick look at other markets as well.

The long . . . long . . . run I



Notes: S&P Composite nominal index ex-dividends normalized to 1 at inception. Data from Robert Shiller's website, at monthly frequency, for the period 1871.01–2023.09. Shaded bars correspond to NBER US recessions.

The long . . . long . . . run II

↪ Data visualization is not necessarily *neutral*!

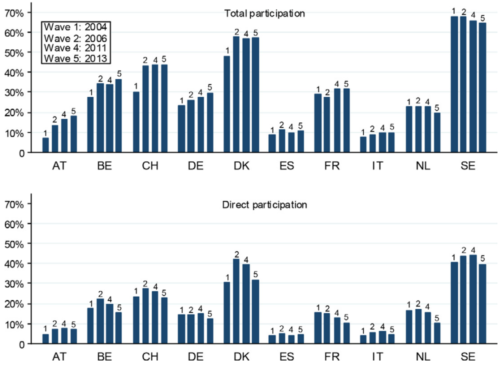
Notes: Logged S&P Composite nominal index ex-dividends normalized to 1 at inception (y-ticks $exp(y)$). Data from Robert Shiller's website, at monthly frequency, for the period 1871.01–2023.09. Shaded bars correspond to NBER US recessions.

The long . . . long . . . run III

$\hookrightarrow$ Adjusting for inflation is important especially over the long-run

Notes: Logged S&P Composite real index ex-dividends, normalized to 0 at the start of the sample and x100. Data from Robert Shiller's website, at monthly frequency, for the period 1871.01–2023.09. Shaded bars correspond to NBER US recessions. Note how the numbers on vertical axis denote cumulated real log returns (percent).

Low stock market participation in most advanced economies: a puzzle?



Notes: Kaustia et al. (2023). Data from the Survey of Health, Ageing and Retirement in Europe (SHARE) database.

First, we need for a benchmark: the equity premium

Table: US returns (cum dividends): 1871-2016.

time period	real return market index mean (%)	real return risk-free mean (%)	risk premium mean (%)
1871 – 2016	10.56	4.72	5.73
1871 – 1978	9.64	4.26	5.40
1926 – 2016	12.04	4.49	7.41
1946 – 2016	12.53	5.26	7.13
	std (%)	std (%)	std (%)
1871 – 2016	18.17	2.79	18.61
1871 – 1978	18.81	2.14	19.28
1926 – 2016	19.42	3.43	19.99
1946 – 2016	16.25	3.45	17.01

Source: My elaborations on data available on Bob Shiller's website. See also Mehra (2012).

risk premium → difference between expected return (i.e., *sample average*) on risky asset (e.g., S&P 500) and return on risk-free alternative (e.g., US T-bill).

The power of compounding

- Returns in the previous table are *real*, and denote variations in purchasing power.
- In the very long-run, small differences in average returns generate huge variations in the value of a hypothetical investment in stocks that started, for example, in 1889:

$$\underbrace{\$100}_{t=1871} \rightarrow \underbrace{\$100 \times (1 + 10\%)^{145}}_{t=2016} = \$100,447,550$$

  where 145 are the number of years between 2016 and 1871.
- The same initial investment amount, but allocated to U.S. Treasury bonds, would have returned only \$118,153 (i.e., $100 * (1 + 5/100)^{145}$)!

$\hookrightarrow$ This is the **power of compounding**!

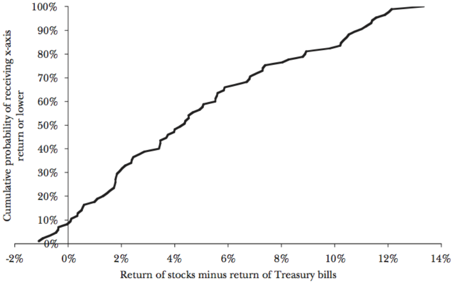
“*Compound interest is the eighth wonder of the world. He who understands it, earns it; he who doesn’t, pays it*”

(this is a quote–perhaps apocryphal–by Albert Einstein)

Average excess returns over realistic holding periods

Figure 1

Cumulative Distribution Function for the Relative Returns of a Diversified Equit
Portfolio Strategy versus a Short-term Treasury Bill Portfolio Strategy
(across cases starting in each year since the start of the twentieth century)



Source: The source of the underlying data is Shiller (2006), and an updated version is available at ⟨http://www.econ.yale.edu/~shiller/data.hem⟩.
Note: Consider the choice between: 1) investing in a diversified portfolio of equities, reinvesting payouts, an rebalancing periodically to maintain diversification; and 2) investing in short-term, safe Treasury bills an rolling the portfolio over into similar short-term debt instruments as pieces of the portfolio mature. Figur 1 plots the cumulative distribution function for the relative returns for these two 20-year portfolio strategie starting in each year since the start of the twentieth century. The horizontal axis shows the returns of stock minus the return of Treasury bills over these 20-year horizons, expressed as an annual rate. The vertical axi shows the cumulative probability in this data of receiving that return or a lower outcome.

Notes: Source: DeLong and Magin (2009). Cumulative distribution function of equity excess return over all possible 20-year portfolio strategies starting every year since 1900.

Stocks for the long run?

⟶ “Fear has a far greater grasp on human action than the impressive weight of historical evidence” (Jeremy Siegel, *Stocks for the long run*, see also Choi (2022))

Notes: Image created with DALL-E.

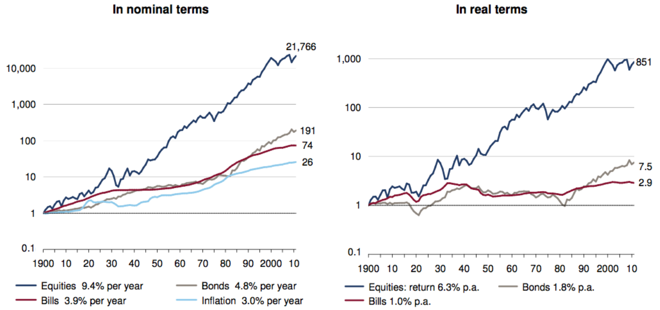
Is the US equity market an exception?

Table: The equity premium: the principal capital markets (Dimson et al. (2011)).

country	time-period	risk-premium (%)
Belgium	1900-2010	5.5
Holland	1900-2010	6.6
France	1900-2010	8.7
Germany	1900-2010	9.8
Ireland	1900-2010	5.3
Italy	1900-2010	9.8
Sweden	1900-2010	6.6
UK	1900-2010	6.0
Australia	1900-2010	8.3
Canada	1900-2010	5.6
India	1900-2010	11.3
Japan	1900-2010	9.0

$\hookrightarrow$ US does not seem an exception, but ... **what is the right risk-free rate?**

Nominal vs real returns



Source: Elroy Dimson, Paul Marsh, and Mike Staunton, *Triumph of the Optimists*, Princeton University Press, 2002, and subsequent research

Figure: Cumulative returns on US equities, bonds, bills and inflation, 1900-2010 (Dimson et al. (2011)).

↪ Inflation *eats up* a large chunk of return even in an advanced economy such as the US.

Risk-free rates can be *risky* after all!

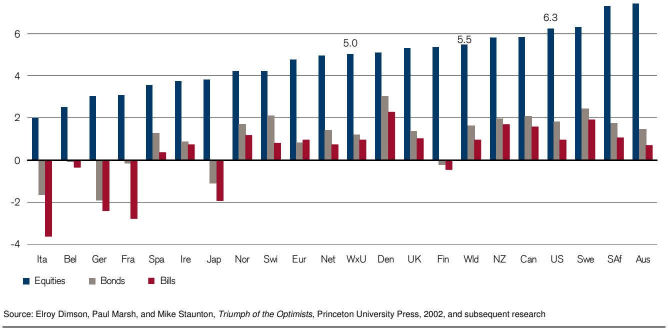
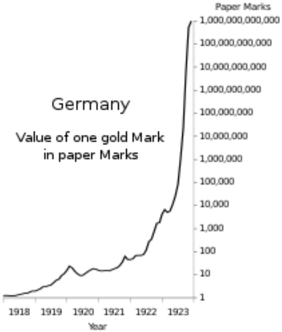


Figure: Real annualized returns (%) on equities versus bonds and bills internationally, 1900-2010 (Dimson et al. (2011)).

↪ Inflation and default are important risks for fixed income assets.

Hyperinflation in the Weimar Republic 1921-23



⟶ The *real* value of a fixed income asset is wiped out in a hyperinflation episode.

Caveat I

- Most of the evidence comes from the US or, at most, from advanced and developed economies.

- The risk is that conclusions suffer from the, so called, **survivorship bias**: i.e., the risk of excluding from the sample just the countries with less attractive performances, thereby biasing upward the estimates.

- Jorion and Goetzmann (1999) look at 39 countries (developed and emerging), for the period 1921-1996, and observe that the risk-premium (real and net of dividends) is the largest for the US (4.3% per year), while the median is only 0.8% per year.

Survivorship Bias during WWII

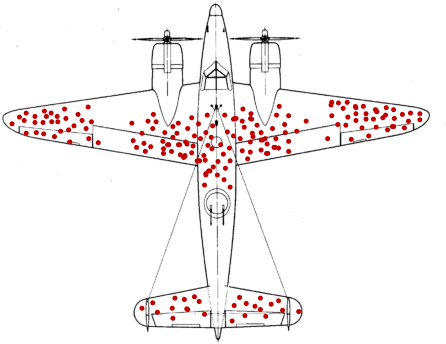


Figure: Damage to bombers returned from missions

The damaged portions of returning planes show locations where they can take a hit and still return home safely; those hit in other places do not survive (source: wikipedia).

Caveat II

- In the long-run, even small differences in average returns have large consequences. Therefore, it is very important to take into account *confidence intervals*.
- For example[1], consider a market with $E(R) = 6\%$ and $\sigma = 20\%$. How many years (N) do we need to safely conclude that the average return is ≥ 0 according to standard significance levels (i.e., 5%)?
- We need to find the value of N such that two times the SE is less than 6% (recall: $SE = \sigma/\sqrt{N}$ if returns are i.i.d.) or $N \geq 44$.
- If the average return was 3%, we would need $N = 178$ years of data!

[1] This example is based on Jorion and Goetzmann (1999).

Caveat III

"*History rhymes; it does not repeat*"

(Mark Twain)

We implicitly assume that the historical returns are a representative sample from the actual distribution of returns.

The rate of return on everything

What is the **aggregate** real return in the economy?

- Jordà et al. (2019) compile a fantastic new dataset which contains *all* asset classes, including housing.
- Their main contribution is related to building data on housing (residential real estate), which is crucial as housing accounts for **half of national wealth** in many advanced economies.

Data I

- Annual data on total returns for **equity, housing, bonds and bills** for 16 advanced economies from 1870 to 2015 (no commodities and non-residential real estate).
- Split in income (yield) and capital gains for four asset classes: equities, housing, government bonds and T-bills (for housing: **imputed rents**).
- Asset returns are from **market data** and not inferred fro wealth estimates.

Data II

TABLE I
DATA COVERAGE

Country	Bills	Bonds	Equity	Housing
Australia	1870–2015	1900–2015	1870–2015	1901–2015
Belgium	1870–2015	1870–2015	1870–2015	1890–2015
Denmark	1875–2015	1870–2015	1873–2015	1876–2015
Finland	1870–2015	1870–2015	1896–2015	1920–2015
France	1870–2015	1870–2015	1870–2015	1871–2015
Germany	1870–2015	1870–2015	1870–2015	1871–2015
Italy	1870–2015	1870–2015	1870–2015	1928–2015
Japan	1876–2015	1881–2015	1886–2015	1931–2015
Netherlands	1870–2015	1870–2015	1900–2015	1871–2015
Norway	1870–2015	1870–2015	1881–2015	1871–2015
Portugal	1880–2015	1871–2015	1871–2015	1948–2015
Spain	1870–2015	1900–2015	1900–2015	1901–2015
Sweden	1870–2015	1871–2015	1871–2015	1883–2015
Switzerland	1870–2015	1900–2015	1900–2015	1902–2015
United Kingdom	1870–2015	1870–2015	1871–2015	1896–2015
United States	1870–2015	1871–2015	1872–2015	1891–2015

Main result: housing offers high average return with low volatility

TABLE II

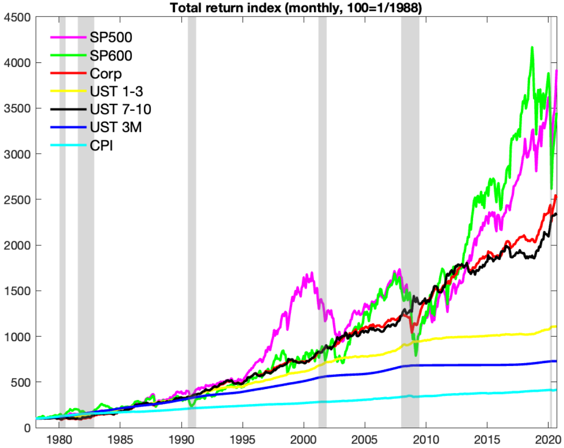
GLOBAL REAL RETURNS

	Real returns				Nominal returns			
	Bills	Bonds	Equity	Housing	Bills	Bonds	Equity	Housing
Panel A: Full sample								
Mean return p.a.	1.03	2.53	6.88	7.06	4.58	6.06	10.65	11.00
Standard deviation	6.00	10.69	21.79	9.93	3.32	8.88	22.55	10.64
Geometric mean	0.83	1.97	4.66	6.62	4.53	5.71	8.49	10.53
Mean excess return p.a.		1.51	5.85	6.03				
Standard deviation		8.36	21.27	9.80				
Geometric mean		1.18	3.77	5.60				
Observations	1,767	1,767	1,767	1,767	1,767	1,767	1,767	1,767
Panel B: Post-1950								
Mean return p.a.	0.88	2.79	8.30	7.42	5.39	7.30	12.97	12.27
Standard deviation	3.42	9.94	24.21	8.87	4.03	9.81	25.03	10.14
Geometric mean	0.82	2.32	5.56	7.08	5.31	6.88	10.26	11.85
Mean excess return p.a.		1.91	7.42	6.54				
Standard deviation		9.21	23.78	9.17				
Geometric mean		1.51	4.79	6.18				
Observations	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022

Notes. Annual global returns in 16 countries, equally weighted. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for all four asset returns. Excess returns are computed relative to bills.

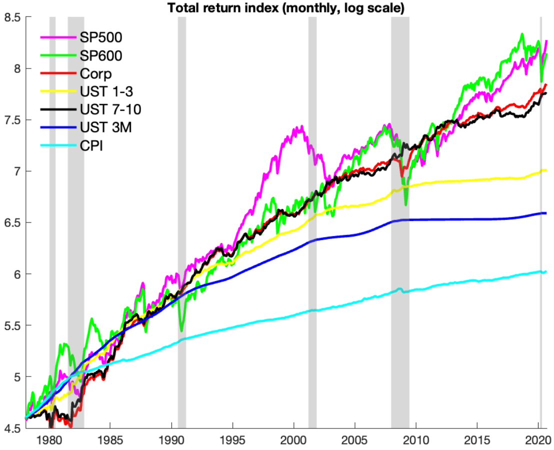
Zooming in on equities and bonds

Historical perspective: equities and bonds



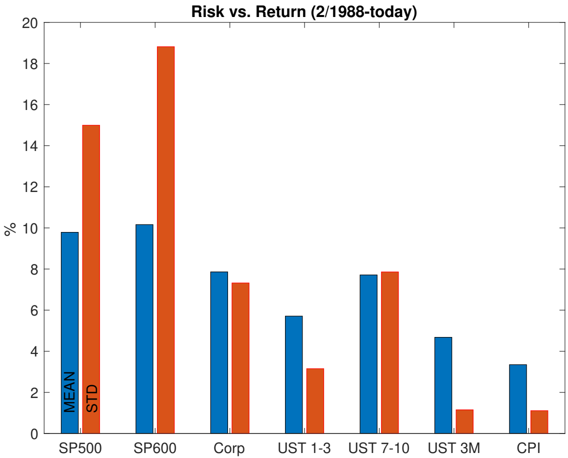
Notes: shaded ares are official NBER recessions. Data end 9/2021.

Historical perspective: equities and bonds (logged returns)



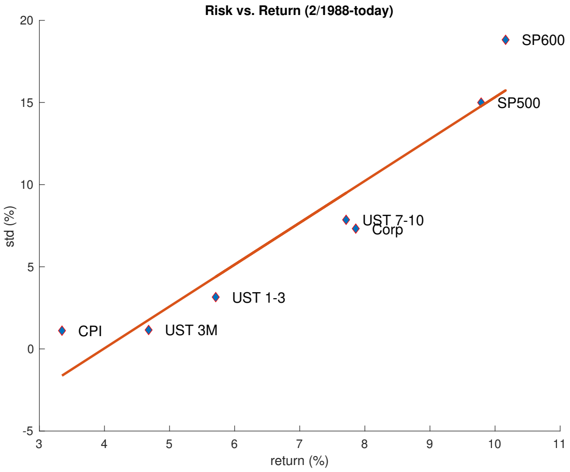
Notes: shaded ares are official NBER recessions. Data end 9/2021.

Risk vs. Return I



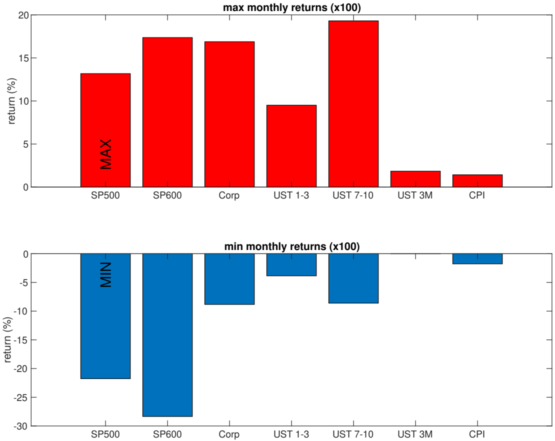
↪ Standard deviation (aka volatility) is a traditional measure of risk.

Risk vs. Return II



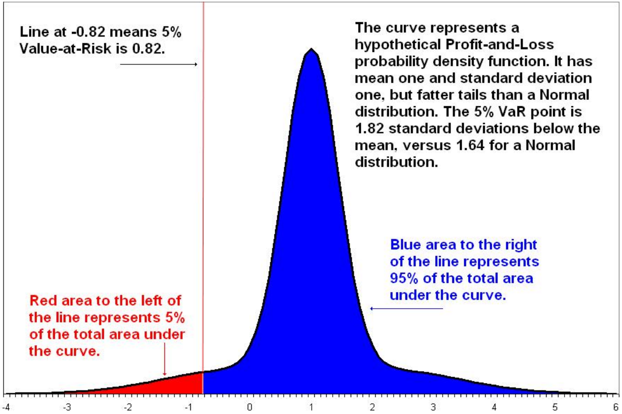
$\hookrightarrow$ High risk $\approx$ high return. **Is risk just STD?**

Extreme returns



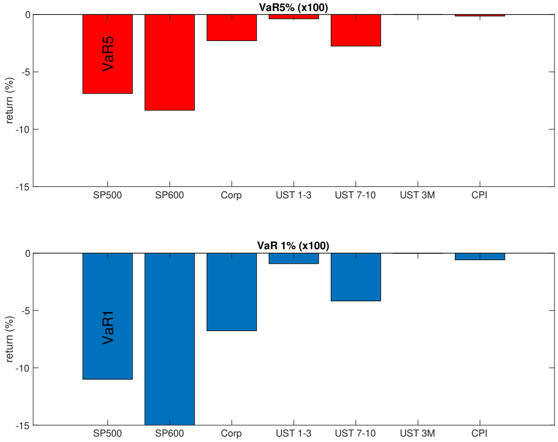
$\hookrightarrow$ The frequency of **extreme returns** is likely to affect risk premia and investment decisions.

A common measure of tail-risk: Value-at-Risk (VaR)

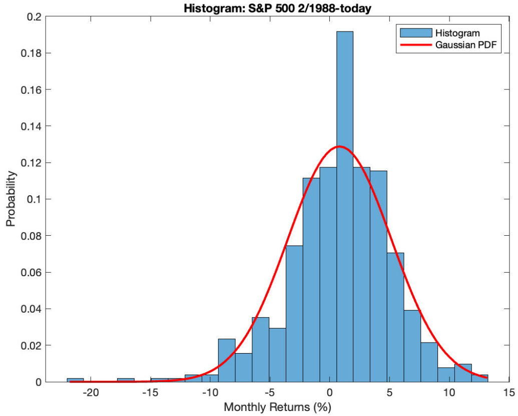


Es. $VaR_{5\%}$: $\quad Prob\{Ret \leq VaR_{5\%}\} = 5\%$

Value-at-risks (i.e., tail-losses) might be quite large for some assets



Return distribution



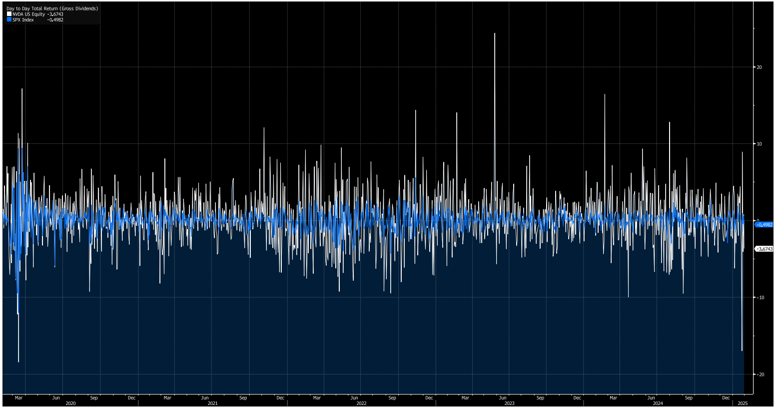
$\hookrightarrow$ if returns were normal, the likelihood of observing a monthly annualized return greater than ≈ 12 in absolute value is less than 1%. In the sample (390 months), this happens 5 times. In fact, the kurtosis of returns is 4.5.

Eugene Fama on “outliers”

“*If the population of price changes is strictly normal, on the average for any stock ... an observation more than five standard deviations from the mean should be observed about once every 7,000 years. In fact, such observations seem to occur about once every three to four years.*”

(Eugene Fama)

NVDA US Equity (NVIDIA Corp)
SPX Index (S&P 500 INDEX)

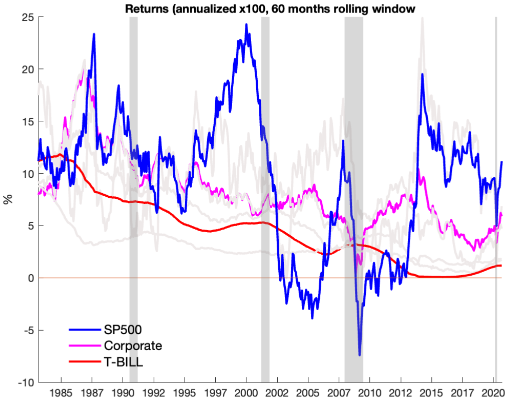


Former employee of HBOS

"*We actually got an external advisor to asses how frequently a particular event might happen and they came out with one in 100,000 years and we said "no", and I think we submitted one in 10,000 years. But that was a year and a half before it happened. It does not mean to say it was wrong: it was just unfortunate that the 10,000th year was so near.*"

(from official documents in preparation of Basel II)

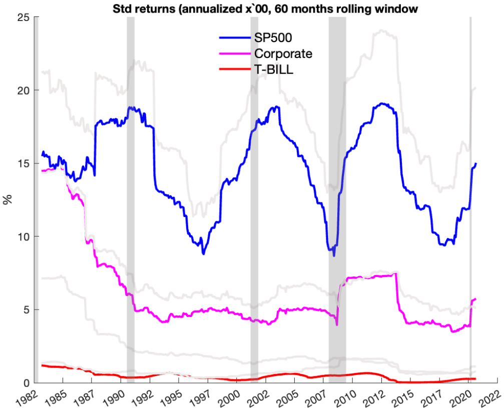
Time-variation in risk premia



⟶ Sample average (i.e., unconditional means) can hide time-variation in returns.

Notes: shaded ares are official NBER recessions. Data end 9/2021.

Time-variation in risk



↪ Sample volatility (i.e., unconditional SD) can hide time-variation in risk.

Notes: shaded ares are official NBER recessions. Data end 9/2021.

"Unconditional" correlation between assets

Table: Returns correlation matrix: 2/1988-today.

	SP500	SP600	CORP	UST 1-3	UST 7-10	UST 3M	CPI
SP500	1.00	0.86	0.27	0.03	0.02	0.01	-0.02
SMALL CAPS	0.86	1.00	0.21	-0.03	-0.06	-0.04	-0.01
CORP	0.27	0.21	1.00	0.76	0.84	0.15	-0.12
GOV ST	0.03	-0.03	0.76	1.00	0.84	0.45	0.03
GOV LT	0.02	-0.06	0.84	0.84	1.00	0.19	-0.16
T-BILL	0.01	-0.04	0.15	0.45	0.19	1.00	0.47
INFL	-0.02	-0.01	-0.12	0.03	-0.16	0.47	1.00

$\hookrightarrow$ Correlations are critical for diversifying risk. Should we use "unconditional correlation" (i.e., long-sample) estimates?

Correlations between assets during the GFC

Table: Returns correlation matrix: 12/2007-12/2009 (Great Financial Crisis).

	SP500	SP600	CORP	UST 1-3	UST 7-10	UST 3M	CPI
SP500	1.00	0.93	0.60	-0.35	-0.04	-0.37	0.17
SMALL CAPS	0.93	1.00	0.51	-0.37	-0.09	-0.27	0.20
CORP	**0.60**	0.51	1.00	-0.08	0.30	-0.36	-0.10
GOV ST	**-0.35**	-0.37	-0.08	1.00	0.73	0.58	-0.37
GOV LT	-0.04	-0.09	0.30	0.73	1.00	0.26	-0.50
T-BILL	-0.37	-0.27	-0.36	0.58	0.26	1.00	0.10
INFL	0.17	0.20	-0.10	-0.37	-0.50	0.10	1.00

↪ **Also correlations can be time-varying!** And the time-variation matters for investors!

Correlation heatmap: normal times

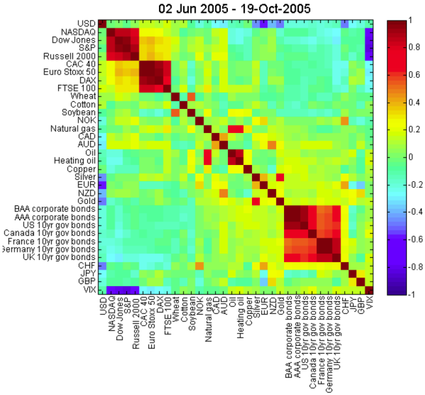


Figure: Correlation heatmap 2 June 2005 to 19 October 2005. Source: FT Alphaville and HSBC.

↪ In normal times, the correlation matrix reveals the existence of **different asset classes**.

Correlation heatmap: crisis times

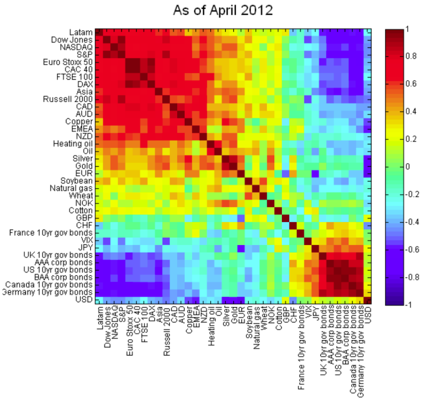


Figure: Correlation heatmap as April 2012. Source: FT Alphaville and HSBC.

↪ In crisis times, the correlation matrix reveals **only two asset classes: risky and risk-less assets** (i.e., the red and blue regions).

Risk-on—risk-off (RORO)

- Motivated by the evidence that the correlations across many assets increase in *bad times*, HSBC developed the idea of **risk-on—risk-off** and a related index (i.e., the RORO index).
- The intuition is that in *bad times* some assets become risk-on (i.e., risky assets) and others risk-off (i.e., safe havens) regardless of idiosyncratic factors.
- The risk-on—risk-off world is bi-polar, with two subsets of assets (risky & safe) and a high correlation across assets within each group, and a negative or small correlation between assets across the two groups.

RORO index

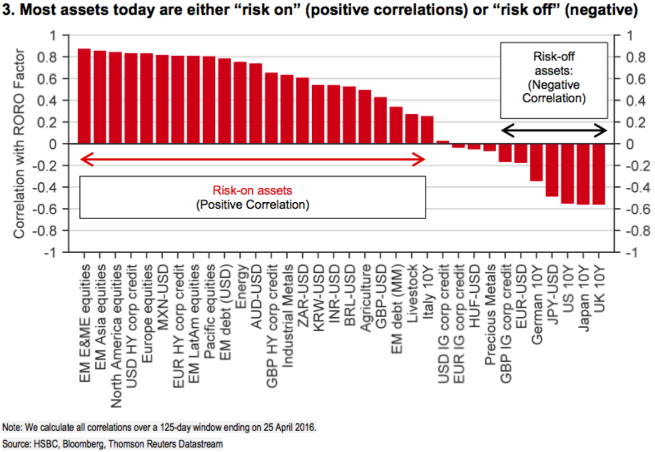


Figure: Correlation different assets with RORO index. Source: HSBC.

Summary stylized facts

	Stocks (real)	Bonds (real)	Stocks-Bonds	GDP	C
E	8.6	1.3	7.4	3.2	3.3
σ	17.6	2.6	18.1	2.6	2.1
ρ	0.99	-0.03	1.00	0.32	0.39

- equity premium (E) $\approx$ 7%
- volatility stock returns (σ) $\approx$ 18%
- sharpe ratio (E/σ) $\approx$ 50%
- stocks correlated with economy (ρ) $\rightarrow$ **a different dimension of risk (see, e.g., CAPM)?**
- why stocks “risky”? Going beyond σ

Conclusion

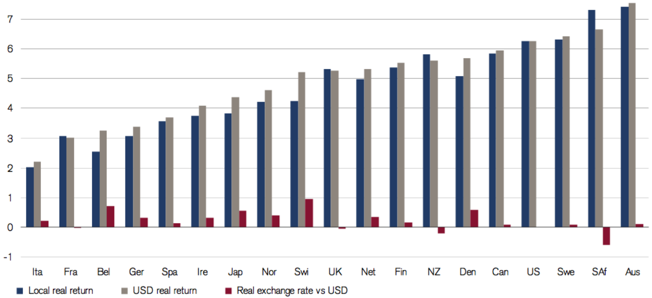
- Performance of some “assets” very interesting, despite the fact we are not all buying stocks (in the US, in 2022, 42% of households—but only 6% of high-income households ($> 100K$)—held no stock)?

- Risk increases with returns & Inflation *eats up* much of the returns from risk-less instruments.

- We need to better understand the sources of **risk**.

APPENDIX

Local vs. Foreign Currency Returns



Source: Elroy Dimson, Paul Marsh, and Mike Staunton, *Triumph of the Optimists*, Princeton University Press, 2002, and subsequent research.

Source: Dimson et al. (2011).

Equity premium around the world

Table2: Worldwide equity risk premiums relative to bills, 1900–2010

Country	Geometric mean%	Arithmetic mean%	Standard error%	Standard dev.%	Minimum return%	Min year	Maximum return%	Max year
Australia	6.7	8.3	1.7	17.6	-44.4	2008	49.2	1983
Belgium	2.9	5.5	2.3	24.7	-58.1	2008	130.4	1940
Canada	4.2	5.6	1.6	17.2	-34.7	2008	49.1	1933
Denmark	2.8	4.6	1.9	20.5	-50.6	2008	95.3	1983
Finland	5.9	9.5	2.9	30.2	-53.6	2008	159.2	1999
France	6.0	8.7	2.3	24.5	-44.8	2008	85.7	1941
Germany*	5.9	9.8	3.0	31.8	-45.3	2008	131.4	1949
Ireland	3.0	5.3	2.0	21.5	-66.7	2008	72.0	1977
Italy	5.8	9.8	3.0	32.0	-49.1	2008	150.3	1946
Japan	5.9	9.0	2.6	27.7	-48.3	1920	108.6	1952
The Netherlands	4.2	6.5	2.2	22.8	-51.9	2008	126.7	1940
New Zealand	4.1	5.7	1.7	18.3	-58.3	1987	97.3	1983
Norway	3.0	5.9	2.5	26.5	-55.1	2008	157.1	1979
South Africa	6.2	8.3	2.1	22.1	-33.9	1920	106.2	1933
Spain	3.2	5.4	2.1	21.9	-39.9	2008	98.1	1986
Sweden	4.3	6.6	2.1	22.1	-41.3	2008	84.6	1905
Switzerland	3.4	5.1	1.8	18.9	-37.0	1974	54.8	1985
United Kingdom	4.3	6.0	1.9	19.9	-54.6	1974	121.8	1975
United States	5.3	7.2	1.9	19.8	-44.1	1931	56.6	1933
Europe	3.8	5.8	2.0	21.0	-47.4	2008	76.3	1933
World ex-USA	4.0	5.9	1.9	19.9	-44.2	2008	79.6	1933
World	4.5	5.9	1.6	17.1	-41.3	2008	70.3	1933

*All statistics for Germany are based on 109 years, excluding hyperinflationary 1922–23. Source: Elroy Dimson, Paul Marsh, and Mike Staunton, *Triumph of the Optimists*, Princeton University Press, 2002, and subsequent research.

Source: Dimson et al. (2011).

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