



UNIVERSITY OF CALGARY
HASKAYNE SCHOOL OF BUSINESS

Corporate Finance

Which discount rate?

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The alternate use concept and opportunity cost of capital

Empirical facts regarding the risk and return trade-off

Which analytical framework?

Which realized return?

Which realized risk?

Diversification matters

Empirical facts regarding correlations and volatility

Only incremental risk matters

Practitioners' perspective

Chapter 10 of the textbook

The alternate use concept and opportunity cost of capital

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The NPV approach has been known for some time, but it **requires using a discount rate** to calculate the present value of future cash flows and the outcome of the analysis is sensitive to the discount rate (i.e. small changes to discount rate used for long-dated cash flows can change the sign of the NPV).

It was also intuitively known that the discount rate **has to reflect the riskiness of the project**, but for a long time there was no analytical answer to how to do that and which discount rate to use.

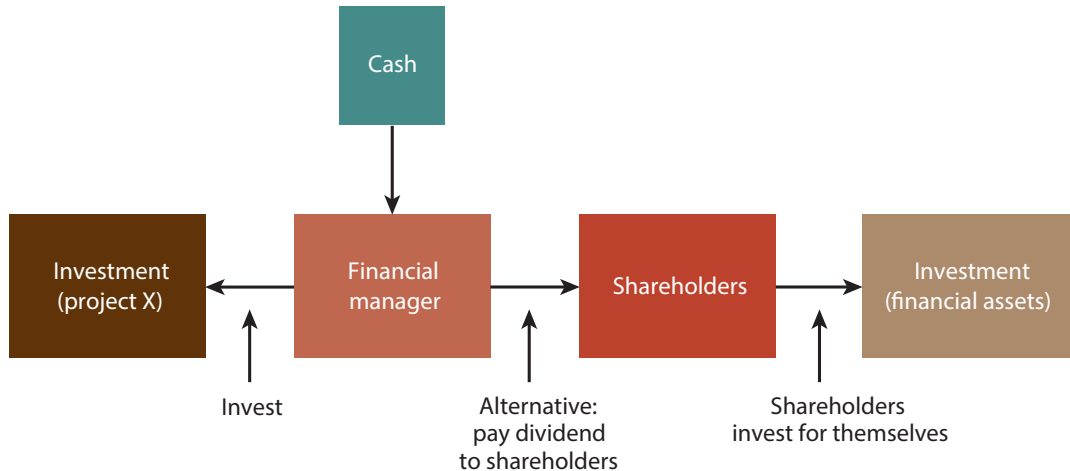
For [Jack Treynor](#), since the alternate use of investing the money in a given project was to return it to the providers of capital, the **appropriate discount rate** has to be benchmarked against the **return that could be earned** by the said providers of capital investing on their own **in a security of similar risk**.

The application of such opportunity-cost concept requires to identify financial assets having the same risk as the project, estimate the expected rate of return on these assets, and use this rate as the appropriate discount rate for the project.

Jack Treynor saw the usefulness to **model a risk-return relationship to get a general answer** (rather than having to repeatedly match projects to one or several securities of same risk profile again and again), and he provided the intuition of the CAPM which was eventually published by [William Sharpe](#).

The alternate use concept and opportunity cost of capital

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Empirical facts regarding the risk and return trade-off

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On average, investors are risk adverse and choose to invest with the goal and expectation of receiving returns commensurate with the risks borne (i.e. willing to bear more risk in exchange of more returns).

- Returns are volatile and difficult to measure (consider averaging over long periods).
- The evidence is that long run risk and returns are highly correlated.
- Over 2002 to 2016 US asset classes have shown such positive relationship.
- But, some assets deviated significantly (commodities, high-yield).
- Even for hedge funds the positive risk-return relationship manifest itself.

Asset class returns

GTM – U.S. | 60

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	YTD	2002 - 2016	Ann.	Vol.
Comdty.	EM Equity	REITs	EM Equity	REITs	EM Equity	REITs	Fixed Income	EM Equity	REITs	REITs	REITs	Small Cap	REITs	REITs	Small Cap	EM Equity	REITs	EM Equity	REITs
25.9%	58.3%	31.6%	34.5%	35.1%	39.8%	5.2%	79.0%	27.9%	8.3%	19.7%	38.8%	28.0%	2.8%	21.3%	18.6%	10.8%	23.8%	REITs	REITs
Fixed Income	Small Cap	EM Equity	Comdty.	EM Equity	Comdty.	Cash	High Yield	Small Cap	Fixed Income	High Yield	Large Cap	Large Cap	Large Cap	High Yield	DM Equity	EM Equity	REITs	REITs	REITs
10.3%	47.3%	26.0%	21.4%	32.6%	16.2%	1.8%	59.4%	26.9%	7.8%	19.6%	32.4%	13.7%	1.4%	14.3%	14.2%	9.8%	22.6%	REITs	REITs
High Yield	DM Equity	DM Equity	DM Equity	DM Equity	DM Equity	Asset Alloc.	DM Equity	EM Equity	High Yield	EM Equity	DM Equity	Fixed Income	Fixed Income	Large Cap	Large Cap	High Yield	Small Cap	DM Equity	DM Equity
4.1%	39.2%	20.7%	14.0%	26.9%	11.6%	-25.4%	32.5%	19.2%	3.1%	18.6%	23.3%	6.0%	0.8%	12.0%	9.3%	9.2%	20.1%	DM Equity	DM Equity
REITs	REITs	Small Cap	REITs	Small Cap	Asset Alloc.	High Yield	REITs	Comdty.	Large Cap	DM Equity	Asset Alloc.	Asset Alloc.	Cash	Comdty.	Asset Alloc.	Small Cap	DM Equity	DM Equity	DM Equity
3.8%	37.1%	18.3%	12.2%	18.4%	7.1%	-26.9%	28.0%	16.8%	2.1%	17.9%	15.9%	5.2%	0.0%	11.8%	6.8%	8.5%	19.2%	DM Equity	DM Equity
Cash	High Yield	High Yield	Asset Alloc.	Large Cap	Fixed Income	Small Cap	Small Cap	Large Cap	Cash	Small Cap	High Yield	Small Cap	DM Equity	EM Equity	High Yield	Asset Alloc.	Comdty.	Comdty.	Comdty.
1.7%	32.4%	13.2%	8.1%	15.8%	7.0%	-33.8%	27.2%	15.1%	0.1%	16.3%	7.3%	4.9%	0.4%	11.6%	6.5%	6.9%	19.0%	Comdty.	Comdty.
Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Comdty.	Large Cap	High Yield	Asset Alloc.	Large Cap	REITs	Cash	Asset Alloc.	REITs	Small Cap	Large Cap	Large Cap	Large Cap	Large Cap
-5.9%	28.7%	12.8%	4.9%	15.3%	5.5%	-35.6%	25.5%	14.8%	-0.7%	16.0%	2.9%	0.0%	-2.0%	8.6%	5.0%	6.7%	15.9%	Large Cap	Large Cap
EM Equity	Asset Alloc.	Large Cap	Small Cap	High Yield	Cash	Large Cap	Asset Alloc.	Asset Alloc.	Small Cap	Asset Alloc.	Cash	High Yield	High Yield	Asset Alloc.	REITs	DM Equity	High Yield	DM Equity	DM Equity
-6.0%	26.3%	10.9%	4.6%	13.7%	4.8%	-37.0%	25.0%	13.3%	-4.2%	12.2%	0.0%	0.0%	-2.7%	8.3%	4.9%	5.7%	11.7%	DM Equity	DM Equity
DM Equity	Comdty.	Comdty.	High Yield	Cash	High Yield	REITs	Comdty.	DM Equity	DM Equity	Fixed Income	Fixed Income	EM Equity	Small Cap	Fixed Income	Fixed Income	Fixed Income	Asset Alloc.	Asset Alloc.	Asset Alloc.
-15.7%	23.9%	9.1%	3.6%	4.8%	3.2%	-37.7%	18.9%	8.2%	-11.7%	4.2%	-2.0%	-1.8%	-4.4%	2.6%	2.3%	4.6%	11.0%	Asset Alloc.	Asset Alloc.
Small Cap	Fixed Income	Fixed Income	Cash	Fixed Income	Small Cap	DM Equity	Fixed Income	Fixed Income	Comdty.	Cash	EM Equity	DM Equity	EM Equity	DM Equity	Cash	Cash	Fixed Income	Fixed Income	Fixed Income
-20.5%	4.1%	4.3%	3.0%	4.3%	-1.6%	-43.1%	5.9%	6.5%	-13.3%	0.1%	-2.3%	-4.5%	-14.6%	1.5%	0.3%	1.3%	3.5%	Fixed Income	Fixed Income
Large Cap	Cash	Cash	Fixed Income	Comdty.	REITs	EM Equity	Cash	Cash	EM Equity	Comdty.	Comdty.	Comdty.	Comdty.	Cash	Comdty.	Comdty.	Cash	Cash	Cash
-22.1%	1.0%	1.2%	2.4%	2.1%	-15.7%	-53.2%	0.1%	0.1%	-18.2%	-1.1%	-9.5%	-17.0%	-24.7%	0.3%	-5.3%	1.2%	0.8%	Cash	Cash

Investing principles

Source: Barclays, Bloomberg, FactSet, MSCI, NAREIT, Russell, Standard & Poor's, J.P. Morgan Asset Management.

Large cap: S&P 500, Small cap: Russell 2000, EM Equity: MSCI EME, DM Equity: MSCI EAFE, Comdty: Bloomberg Commodity Index, High Yield: Barclays Global HY Index, Fixed Income: Barclays US Aggregate, REITs: NAREIT Equity REIT Index. The "Asset Allocation" portfolio assumes the following weights: 25% in the S&P 500, 10% in the Russell 2000, 15% in the MSCI EAFE, 5% in the MSCI EME, 25% in the Barclays US Aggregate, 5% in the Barclays 1-3m Treasury, 5% in the Barclays Global High Yield Index, 5% in the Bloomberg Commodity Index and 5% in the NAREIT Equity REIT Index. Balanced portfolio assumes annual rebalancing. Annualized (Ann.) return and volatility (Vol.) represents period of 12/31/01 – 12/31/16. Please see disclosure page at end for index definitions. All data represents total return for stated period. Past performance is not indicative of future returns.

Guide to the Markets – U.S. Data are as of June 30, 2017.

J.P.Morgan
Asset Management

Asset class returns

GTM – U.S. | 60

																	2002 - 2016	
2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	YTD	Ann.	Vol.	
Comdty.	EM Equity	REITs	EM Equity	REITs	EM Equity	Fixed Income	EM Equity	REITs	REITs	REITs	Small Cap	REITs	REITs	Small Cap	EM Equity	REITs	EM Equity	
28.9%	56.3%	31.6%	34.5%	35.1%	39.8%	5.2%	79.0%	27.9%	8.3%	19.7%	38.8%	28.0%	2.8%	21.3%	18.6%	10.8%	23.8%	
Fixed Income	Small Cap	EM Equity	Comdty.	EM Equity	Comdty.	Cash	High Yield	Small Cap	Fixed Income	High Yield	Large Cap	Large Cap	Large Cap	High Yield	DM Equity	EM Equity	REITs	
10.3%	47.3%	26.0%	21.4%	32.6%	16.2%	1.8%	59.4%	26.9%	7.8%	19.6%	32.4%	13.7%	1.4%	14.3%	14.2%	9.8%	22.6%	
High Yield	DM Equity	DM Equity	DM Equity	DM Equity	DM Equity	Asset Alloc.	DM Equity	EM Equity	High Yield	EM Equity	DM Equity	Fixed Income	Fixed Income	Large Cap	Large Cap	High Yield	Small Cap	
4.1%	39.2%	20.7%	14.0%	26.9%	11.6%	-25.4%	32.5%	19.2%	3.1%	18.6%	23.3%	6.0%	0.5%	12.0%	9.3%	9.2%	20.1%	
REITs	REITs	Small Cap	REITs	Small Cap	Asset Alloc.	High Yield	REITs	Comdty.	Large Cap	DM Equity	Asset Alloc.	Asset Alloc.	Cash	Comdty.	Asset Alloc.	Small Cap	DM Equity	
3.8%	37.1%	18.3%	12.2%	18.4%	7.1%	-26.9%	28.0%	16.8%	2.1%	17.9%	14.9%	5.2%	0.0%	11.8%	6.8%	8.5%	19.2%	
Cash	High Yield	High Yield	Asset Alloc.	Large Cap	Fixed Income	Small Cap	Small Cap	Large Cap	Cash	Small Cap	High Yield	Small Cap	DM Equity	EM Equity	High Yield	Asset Alloc.	Comdty.	
1.7%	32.4%	13.2%	8.1%	15.8%	7.0%	-33.8%	27.2%	15.1%	0.1%	16.3%	7.3%	4.9%	0.4%	11.6%	6.5%	6.9%	19.0%	
Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Comdty.	Large Cap	High Yield	Asset Alloc.	Large Cap	REITs	Cash	Asset Alloc.	REITs	Small Cap	Large Cap	Large Cap	
-5.9%	28.7%	12.8%	4.9%	15.3%	5.5%	-35.6%	25.5%	14.8%	-0.7%	16.0%	2.9%	0.0%	-2.0%	8.6%	5.0%	6.7%	15.9%	
EM Equity	Asset Alloc.	Large Cap	Small Cap	High Yield	Cash	Large Cap	Asset Alloc.	Asset Alloc.	Small Cap	Asset Alloc.	Cash	High Yield	High Yield	Asset Alloc.	REITs	DM Equity	High Yield	
-6.0%	26.3%	10.9%	4.6%	13.7%	4.8%	-37.0%	25.0%	13.3%	-4.2%	12.2%	0.0%	0.0%	-2.7%	8.3%	4.9%	5.7%	11.7%	
DM Equity	Comdty.	Comdty.	High Yield	Cash	High Yield	REITs	Comdty.	DM Equity	DM Equity	Fixed Income	Fixed Income	EM Equity	Small Cap	Fixed Income	Fixed Income	Fixed Income	Asset Alloc.	
-15.7%	23.9%	9.1%	3.6%	4.8%	3.2%	-37.7%	18.9%	8.2%	-11.7%	4.2%	-2.0%	-1.8%	-4.4%	2.6%	2.3%	4.6%	11.0%	
Small Cap	Fixed Income	Fixed Income	Cash	Fixed Income	Small Cap	DM Equity	Fixed Income	Fixed Income	Comdty.	Cash	EM Equity	DM Equity	EM Equity	DM Equity	Cash	Cash	Fixed Income	
-20.5%	4.1%	4.3%	3.0%	4.3%	-1.6%	-43.1%	5.9%	6.5%	-13.3%	0.1%	-2.3%	-4.5%	-14.6%	1.5%	0.3%	1.3%	3.5%	
Large Cap	Cash	Cash	Fixed Income	Comdty.	REITs	EM Equity	Cash	Cash	EM Equity	Comdty.	Comdty.	Comdty.	Comdty.	Cash	Comdty.	Comdty.	Cash	
-22.1%	1.0%	1.2%	2.4%	2.1%	-15.7%	-53.2%	0.1%	0.1%	-18.2%	-1.1%	-9.5%	-17.0%	-24.7%	0.3%	-5.3%	1.2%	0.8%	

Investing principles

Source: Barclays, Bloomberg, FactSet, MSCI, NAREIT, Russell, Standard & Poor's, J.P. Morgan Asset Management.

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2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	YTD	Ann.	Vol.	
Comdty.	EM Equity	REITs	EM Equity	REITs	EM Equity	Fixed Income	EM Equity	REITs	REITs	REITs	Small Cap	REITs	REITs	Small Cap	EM Equity	REITs	EM Equity	
28.9%	56.3%	31.6%	34.5%	35.1%	39.8%	5.2%	79.0%	27.9%	8.3%	19.7%	38.8%	28.0%	2.8%	21.3%	18.6%	10.8%	23.8%	
Fixed Income	Small Cap	EM Equity	Comdty.	EM Equity	Comdty.	Cash	High Yield	Small Cap	Fixed Income	High Yield	Large Cap	Large Cap	Large Cap	High Yield	DM Equity	EM Equity	REITs	
10.3%	47.3%	26.0%	21.4%	32.6%	16.2%	1.8%	59.4%	26.9%	7.8%	19.6%	32.4%	13.7%	1.4%	14.3%	14.2%	9.8%	22.6%	
High Yield	DM Equity	DM Equity	DM Equity	DM Equity	DM Equity	Asset Alloc.	DM Equity	EM Equity	High Yield	EM Equity	DM Equity	Fixed Income	Fixed Income	Large Cap	Large Cap	High Yield	Small Cap	
4.1%	39.2%	20.7%	14.0%	26.9%	11.6%	-25.4%	32.5%	19.2%	3.1%	18.6%	23.3%	6.0%	0.5%	12.0%	9.3%	9.2%	20.1%	
REITs	REITs	Small Cap	REITs	Small Cap	Asset Alloc.	High Yield	REITs	Comdty.	Large Cap	DM Equity	Asset Alloc.	Asset Alloc.	Cash	Comdty.	Asset Alloc.	Small Cap	DM Equity	
3.8%	37.1%	18.3%	12.2%	18.4%	7.1%	-26.9%	28.0%	16.8%	2.1%	17.9%	14.9%	5.2%	0.0%	11.8%	6.8%	8.5%	19.2%	
Cash	High Yield	High Yield	Asset Alloc.	Large Cap	Fixed Income	Small Cap	Small Cap	Large Cap	Cash	Small Cap	High Yield	Small Cap	DM Equity	EM Equity	High Yield	Asset Alloc.	Comdty.	
1.7%	32.4%	13.2%	8.1%	15.8%	7.0%	-33.8%	27.2%	15.1%	0.1%	16.3%	7.3%	4.9%	0.4%	11.6%	6.5%	6.9%	19.0%	
Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Comdty.	Large Cap	High Yield	Asset Alloc.	Large Cap	REITs	Cash	Asset Alloc.	REITs	Small Cap	Large Cap	Large Cap	
-5.9%	28.7%	12.8%	4.9%	15.3%	5.5%	-35.6%	25.5%	14.8%	-0.7%	16.0%	2.9%	0.0%	-2.0%	8.6%	5.0%	6.7%	15.9%	
EM Equity	Asset Alloc.	Large Cap	Small Cap	High Yield	Cash	Large Cap	Asset Alloc.	Asset Alloc.	Small Cap	Asset Alloc.	Cash	High Yield	High Yield	Asset Alloc.	REITs	DM Equity	High Yield	
-6.0%	26.3%	10.9%	4.6%	13.7%	4.8%	-37.0%	25.0%	13.3%	-4.2%	12.2%	0.0%	0.0%	-2.7%	8.3%	4.9%	5.7%	11.7%	
DM Equity	Comdty.	Comdty.	High Yield	Cash	High Yield	REITs	Comdty.	DM Equity	DM Equity	Fixed Income	Fixed Income	EM Equity	Small Cap	Fixed Income	Fixed Income	Fixed Income	Asset Alloc.	
-15.7%	23.9%	9.1%	3.6%	4.8%	3.2%	-37.7%	18.9%	8.2%	-11.7%	4.2%	-2.0%	-1.8%	-4.4%	2.6%	2.3%	4.6%	11.0%	
Small Cap	Fixed Income	Fixed Income	Cash	Fixed Income	Small Cap	DM Equity	Fixed Income	Fixed Income	Comdty.	Cash	EM Equity	DM Equity	EM Equity	DM Equity	Cash	Cash	Fixed Income	
-20.8%	4.1%	4.3%	3.0%	4.3%	-1.6%	-43.1%	5.9%	6.5%	-13.3%	0.1%	-2.3%	-4.5%	-14.6%	1.5%	0.3%	1.3%	3.5%	
Large Cap	Cash	Cash	Fixed Income	Comdty.	REITs	EM Equity	Cash	Cash	EM Equity	Comdty.	Comdty.	Comdty.	Comdty.	Cash	Comdty.	Comdty.	Cash	
-22.1%	1.0%	1.2%	2.4%	2.1%	-15.7%	-53.2%	0.1%	0.1%	-18.2%	-1.1%	-9.5%	-17.0%	-24.7%	0.3%	-5.3%	1.2%	0.8%	

Investing principles

Source: Barclays, Bloomberg, FactSet, MSCI, NAREIT, Russell, Standard & Poor's, J.P. Morgan Asset Management.

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																Ann.	Vol.
Comdty.	EM Equity	REITs	EM Equity	REITs	EM Equity	Fixed Income	EM Equity	REITs	REITs	REITs	Small Cap	REITs	REITs	Small Cap	EM Equity	REITs	EM Equity
28.9%	56.3%	31.6%	34.5%	35.1%	39.8%	5.2%	79.0%	27.9%	8.3%	19.7%	38.8%	28.0%	2.8%	21.3%	18.6%	10.8%	23.8%
Fixed Income	Small Cap	EM Equity	Comdty.	EM Equity	Comdty.	Cash	High Yield	Small Cap	Fixed Income	High Yield	Large Cap	Large Cap	Large Cap	High Yield	DM Equity	EM Equity	REITs
10.3%	47.3%	26.0%	21.4%	32.6%	16.2%	1.8%	59.4%	26.9%	7.8%	19.6%	32.4%	13.7%	1.4%	14.3%	14.2%	9.8%	22.6%
High Yield	DM Equity	DM Equity	DM Equity	DM Equity	DM Equity	Asset Alloc.	DM Equity	EM Equity	High Yield	EM Equity	DM Equity	Fixed Income	Fixed Income	Large Cap	Large Cap	High Yield	Small Cap
4.1%	39.2%	20.7%	14.0%	26.9%	11.6%	-25.4%	32.5%	19.2%	3.1%	18.6%	23.3%	6.0%	0.5%	12.0%	9.3%	9.2%	20.1%
REITs	REITs	Small Cap	REITs	Small Cap	Asset Alloc.	High Yield	REITs	Comdty.	Large Cap	DM Equity	Asset Alloc.	Asset Alloc.	Cash	Comdty.	Asset Alloc.	Small Cap	DM Equity
3.8%	37.1%	18.3%	12.2%	18.4%	7.1%	-26.9%	28.0%	16.8%	2.1%	17.9%	14.9%	5.2%	0.0%	11.8%	6.8%	8.5%	19.2%
Cash	High Yield	High Yield	Asset Alloc.	Large Cap	Fixed Income	Small Cap	Small Cap	Large Cap	Cash	Small Cap	High Yield	Small Cap	DM Equity	EM Equity	High Yield	Asset Alloc.	Comdty.
1.7%	32.4%	13.2%	8.1%	15.8%	7.0%	-33.8%	27.2%	15.1%	0.1%	16.3%	7.3%	4.9%	0.4%	11.6%	6.5%	6.9%	19.0%
Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Comdty.	Large Cap	High Yield	Asset Alloc.	Large Cap	REITs	Cash	Asset Alloc.	REITs	Small Cap	Large Cap	Large Cap
-5.9%	28.7%	12.8%	4.9%	15.3%	5.5%	-35.6%	25.5%	14.8%	-0.7%	16.0%	2.9%	0.0%	-2.0%	8.6%	5.0%	6.7%	15.9%
EM Equity	Asset Alloc.	Large Cap	Small Cap	High Yield	Cash	Large Cap	Asset Alloc.	Asset Alloc.	Small Cap	Asset Alloc.	Cash	High Yield	High Yield	Asset Alloc.	REITs	DM Equity	High Yield
-6.0%	26.3%	10.9%	4.6%	13.7%	4.8%	-37.0%	25.0%	13.3%	-4.2%	12.2%	0.0%	0.0%	-2.7%	8.3%	4.9%	5.7%	11.7%
DM Equity	Comdty.	Comdty.	High Yield	Cash	High Yield	REITs	Comdty.	DM Equity	DM Equity	Fixed Income	Fixed Income	EM Equity	Small Cap	Fixed Income	Fixed Income	Fixed Income	Asset Alloc.
-15.7%	23.9%	9.1%	3.6%	4.8%	3.2%	-37.7%	18.9%	8.2%	-11.7%	4.2%	-2.0%	-1.8%	-4.4%	2.6%	2.3%	4.6%	11.0%
Small Cap	Fixed Income	Fixed Income	Cash	Fixed Income	Small Cap	DM Equity	Fixed Income	Fixed Income	Comdty.	Cash	EM Equity	DM Equity	EM Equity	DM Equity	Cash	Cash	Fixed Income
-20.8%	4.1%	4.3%	3.0%	4.3%	-1.6%	-43.1%	5.9%	6.5%	-13.3%	0.1%	-2.3%	-4.5%	-14.6%	1.5%	0.3%	1.3%	3.5%
Large Cap	Cash	Cash	Fixed Income	Comdty.	REITs	EM Equity	Cash	Cash	EM Equity	Comdty.	Comdty.	Comdty.	Comdty.	Cash	Comdty.	Comdty.	Cash
-22.1%	1.0%	1.2%	2.4%	2.1%	-15.7%	-53.2%	0.1%	0.1%	-18.2%	-1.1%	-9.5%	-17.0%	-24.7%	0.3%	-5.3%	1.2%	0.8%

Investing principles

Source: Barclays, Bloomberg, FactSet, MSCI, NAREIT, Russell, Standard & Poor's, J.P. Morgan Asset Management.

Large cap: S&P 500, Small cap: Russell 2000, EM Equity: MSCI EME, DM Equity: MSCI EAFE, Comdty: Bloomberg Commodity Index, High Yield: Barclays Global HY Index, Fixed Income: Barclays US Aggregate, REITs: NAREIT Equity REIT Index. The "Asset Allocation" portfolio assumes the following weights: 25% in the S&P 500, 10% in the Russell 2000, 15% in the MSCI EAFE, 5% in the MSCI EME, 25% in the Barclays US Aggregate, 5% in the Barclays 1-3m Treasury, 5% in the Barclays Global High Yield Index, 5% in the Bloomberg Commodity Index and 5% in the NAREIT Equity REIT Index. Balanced portfolio assumes annual rebalancing. Annualized (Ann.) return and volatility (Vol.) represents period of 12/31/01 – 12/31/16. Please see disclosure page at end for index definitions. All data represents total return for stated period. Past performance is not indicative of future returns.

Guide to the Markets – U.S. Data are as of June 30, 2017.

J.P.Morgan
Asset Management

Asset class returns

GTM – U.S. | 60

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	YTD	2002 - 2016	
																Ann.	Vol.
Comdty.	EM Equity	REITs	EM Equity	REITs	EM Equity	Fixed Income	EM Equity	REITs	REITs	REITs	Small Cap	REITs	REITs	Small Cap	EM Equity	REITs	EM Equity
28.9%	58.3%	31.6%	34.5%	35.1%	39.8%	5.2%	79.0%	27.9%	8.3%	19.7%	38.8%	28.0%	2.8%	21.3%	18.6%	10.8%	23.8%
Fixed Income	Small Cap	EM Equity	Comdty.	EM Equity	Comdty.	Cash	High Yield	Small Cap	Fixed Income	High Yield	Large Cap	Large Cap	Large Cap	High Yield	DM Equity	EM Equity	REITs
10.3%	47.3%	26.0%	21.4%	32.6%	16.2%	1.8%	59.4%	26.9%	7.8%	19.6%	32.4%	13.7%	1.4%	14.3%	14.2%	9.8%	22.6%
High Yield	DM Equity	DM Equity	DM Equity	DM Equity	DM Equity	Asset Alloc.	DM Equity	EM Equity	High Yield	EM Equity	DM Equity	Fixed Income	Fixed Income	Large Cap	Large Cap	High Yield	Small Cap
4.1%	39.2%	20.7%	14.0%	26.9%	11.6%	-25.4%	32.5%	19.2%	3.1%	18.6%	23.3%	6.0%	0.5%	12.0%	9.3%	9.2%	20.1%
REITs	REITs	Small Cap	REITs	Small Cap	Asset Alloc.	High Yield	REITs	Comdty.	Large Cap	DM Equity	Asset Alloc.	Asset Alloc.	Cash	Comdty.	Asset Alloc.	Small Cap	DM Equity
3.8%	37.1%	18.3%	12.2%	18.4%	7.1%	-26.9%	28.0%	16.8%	2.1%	17.9%	14.9%	5.2%	0.0%	11.8%	6.8%	8.5%	19.2%
Cash	High Yield	High Yield	Asset Alloc.	Large Cap	Fixed Income	Small Cap	Small Cap	Large Cap	Cash	Small Cap	High Yield	Small Cap	DM Equity	EM Equity	High Yield	Asset Alloc.	Comdty.
1.7%	32.4%	13.2%	8.1%	15.8%	7.0%	-33.8%	27.2%	15.1%	0.1%	16.3%	7.3%	4.9%	0.4%	11.6%	6.5%	6.9%	19.0%
Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Asset Alloc.	Large Cap	Comdty.	Large Cap	High Yield	Asset Alloc.	Large Cap	REITs	Cash	Asset Alloc.	REITs	Small Cap	Large Cap	Large Cap
-5.9%	28.7%	12.8%	4.9%	15.3%	5.5%	-35.6%	25.5%	14.8%	-0.7%	16.0%	2.9%	0.0%	-2.0%	8.6%	5.0%	6.7%	15.5%
EM Equity	Asset Alloc.	Large Cap	Small Cap	High Yield	Cash	Large Cap	Asset Alloc.	Asset Alloc.	Small Cap	Asset Alloc.	Cash	High Yield	High Yield	Asset Alloc.	REITs	DM Equity	High Yield
-6.0%	26.3%	10.9%	4.6%	13.7%	4.8%	-37.0%	25.0%	13.3%	-4.2%	12.2%	0.0%	0.0%	-2.7%	8.3%	4.9%	5.7%	17.7%
DM Equity	Comdty.	Comdty.	High Yield	Cash	High Yield	REITs	Comdty.	DM Equity	DM Equity	Fixed Income	Fixed Income	EM Equity	Small Cap	Fixed Income	Fixed Income	Fixed Income	Asset Alloc.
-15.7%	23.9%	9.1%	3.6%	4.8%	3.2%	-37.7%	18.9%	8.2%	-11.7%	4.2%	-2.0%	-1.8%	-4.4%	2.6%	2.3%	4.6%	11.0%
Small Cap	Fixed Income	Fixed Income	Cash	Fixed Income	Small Cap	DM Equity	Fixed Income	Fixed Income	Comdty.	Cash	EM Equity	DM Equity	EM Equity	DM Equity	Cash	Cash	Fixed Income
-20.8%	4.1%	4.3%	3.0%	4.3%	-1.6%	-43.1%	5.9%	6.5%	-13.3%	0.1%	-2.3%	-4.5%	-14.6%	1.5%	0.3%	1.3%	3.5%
Large Cap	Cash	Cash	Fixed Income	Comdty.	REITs	EM Equity	Cash	Cash	EM Equity	Comdty.	Comdty.	Comdty.	Comdty.	Cash	Comdty.	Comdty.	Cash
-22.1%	1.0%	1.2%	2.4%	2.1%	-15.7%	-53.2%	0.1%	0.1%	-18.2%	-1.1%	-9.5%	-17.0%	-24.7%	0.3%	-5.3%	1.2%	0.8%

Investing principles

Source: Barclays, Bloomberg, FactSet, MSCI, NAREIT, Russell, Standard & Poor's, J.P. Morgan Asset Management.

Large cap: S&P 500, Small cap: Russell 2000, EM Equity: MSCI EME, DM Equity: MSCI EAFE, Comdty: Bloomberg Commodity Index, High Yield: Barclays Global HY Index, Fixed Income: Barclays US Aggregate, REITs: NAREIT Equity REIT Index. The "Asset Allocation" portfolio assumes the following weights: 25% in the S&P 500, 10% in the Russell 2000, 15% in the MSCI EAFE, 5% in the MSCI EME, 25% in the Barclays US Aggregate, 5% in the Barclays 1-3m Treasury, 5% in the Barclays Global High Yield Index, 5% in the Bloomberg Commodity Index and 5% in the NAREIT Equity REIT Index. Balanced portfolio assumes annual rebalancing. Annualized (Ann.) return and volatility (Vol.) represents period of 12/31/01 – 12/31/16. Please see disclosure page at end for index definitions. All data represents total return for stated period. Past performance is not indicative of future returns.

Guide to the Markets – U.S. Data are as of June 30, 2017.

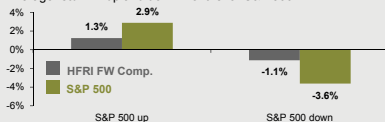
J.P.Morgan
Asset Management

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	YTD	2002 - 2016	
																Ann.	Vol.
Global Bond 16.6%	Large Cap 28.7%	Event Driven 14.2%	Equity L/S 10.0%	Large Cap 15.8%	Macro 11.4%	Global Bond 4.8%	Large Cap 26.5%	Large Cap 15.1%	Global Bond 5.6%	Large Cap 16.0%	Large Cap 32.4%	Large Cap 13.7%	Market Neutral 4.5%	Large Cap 12.0%	Large Cap 8.7%	Large Cap 6.7%	Large Cap 15.9%
Macro 5.5%	Event Driven 23.0%	Large Cap 10.9%	HFRI FW Comp. 9.1%	Event Driven 15.2%	Equity L/S 11.4%	Macro 4.7%	Relative Value 23.0%	Relative Value 12.5%	Large Cap 2.1%	Relative Value 9.7%	Equity L/S 14.5%	Macro 5.8%	Large Cap 1.4%	Event Driven 10.6%	Equity L/S 5.0%	Event Driven 6.4%	Equity L/S 9.9%
Relative Value 5.3%	Macro 21.5%	HFRI FW Comp. 9.3%	Event Driven 8.6%	HFRI FW Comp. 13.3%	HFRI FW Comp. 11.0%	Market Neutral -3.0%	Equity L/S 22.3%	Event Driven 11.5%	Relative Value 0.8%	Event Driven 6.5%	Event Driven 13.4%	Relative Value 5.3%	Macro 9.4%	Relative Value 7.7%	Global Bond 4.5%	Relative Value 6.0%	Event Driven 8.6%
Market Neutral 0.9%	HFRI FW Comp. 17.1%	Global Bond 9.3%	Market Neutral 6.1%	Equity L/S 12.8%	Relative Value 10.0%	Relative Value -17.3%	Event Driven 20.3%	Equity L/S 8.9%	Event Driven -0.5%	Equity L/S 4.7%	HFRI FW Comp. 9.6%	HFRI FW Comp. 4.3%	Relative Value 0.2%	Equity L/S 5.5%	Event Driven 3.5%	HFRI FW Comp. 5.4%	HFRI FW Comp. 7.4%
HFRI FW Comp. 0.4%	Equity L/S 16.9%	Equity L/S 7.9%	Macro 6.1%	Relative Value 12.2%	Global Bond 9.5%	HFRI FW Comp. -18.7%	HFRI FW Comp. 18.6%	HFRI FW Comp. 8.5%	Macro -0.7%	HFRI FW Comp. 4.4%	Relative Value 7.5%	Equity L/S 3.6%	Equity L/S -0.2%	HFRI FW Comp. 5.4%	HFRI FW Comp. 3.3%	Macro 5.0%	Global Bond 6.3%
Equity L/S -1.7%	Global Bond 12.5%	Macro 7.5%	Relative Value 5.3%	Macro 8.2%	Event Driven 8.7%	Event Driven -25.8%	Global Bond 6.9%	Global Bond 5.5%	Market Neutral -1.5%	Global Bond 4.3%	Market Neutral 6.4%	Market Neutral 3.2%	HFRI FW Comp. -0.2%	Market Neutral 2.2%	Relative Value 2.5%	Equity L/S 4.9%	Relative Value 6.2%
Event Driven -3.1%	Relative Value 9.1%	Relative Value 6.1%	Large Cap 4.9%	Market Neutral 7.0%	Market Neutral 6.7%	Equity L/S -26.4%	Macro 6.9%	Macro 3.2%	HFRI FW Comp. -2.0%	Market Neutral 3.1%	Macro 0.1%	Event Driven 2.6%	Event Driven -2.8%	Global Bond 2.1%	Market Neutral 0.7%	Global Bond 4.8%	Macro 5.1%
Large Cap -22.1%	Market Neutral 3.3%	Market Neutral 3.4%	Global Bond -4.5%	Global Bond 6.6%	Large Cap 5.5%	Large Cap -37.0%	Market Neutral -1.7%	Market Neutral 2.5%	Equity L/S -4.3%	Macro -1.3%	Global Bond -2.6%	Global Bond 0.6%	Global Bond -3.2%	Macro 1.0%	Macro 0.2%	Market Neutral 2.7%	Market Neutral 2.7%

Other
asset classes

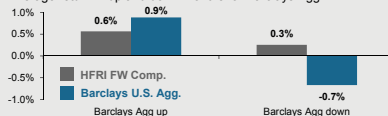
Hedge fund returns in different market environments

Average return in up and down months for S&P 500



Hedge fund returns in different market environments

Average return in up and down months for Barclays Agg.



Source: Barclays, FactSet, HFRI, Standard & Poor's, J.P. Morgan Asset Management.

Large Cap equities is represented by the S&P 500. Returns in different market environments are based on monthly returns over the past 15 years through May 31, 2017, due to data availability.

Guide to the Markets - U.S. Data are as of June 30, 2017.

Empirical facts regarding the risk and return trade-off

5/18

On average, investors are risk adverse and choose to invest with the goal and expectation of receiving returns commensurate with the risks borne (i.e. willing to bear more risk in exchange of more returns).

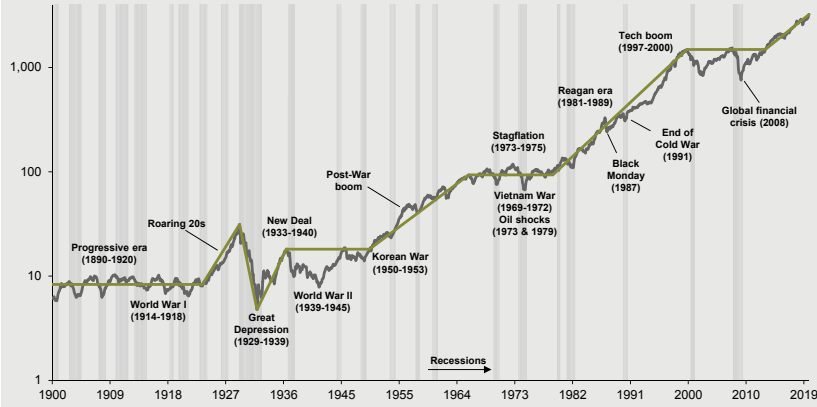
- Returns are volatile and difficult to measure (consider averaging over long periods).
- The evidence is that long run risk and returns are highly correlated.
- Over 2002 to 2016 US asset classes have shown such positive relationship.
- But, some assets deviated significantly (commodities, high-yield).
- Even for hedge funds the positive risk-return relationship manifest itself.

But beware, averages can be misleading or easily misinterpreted.

- The stock market can sometimes be seen to move up nicely and regularly (e.g. 1981 to 2000).
- But it could also move erratically sideways (e.g. stagflation of the 1970s).
- And it can also crash (e.g. the 1929 crash).
- While large ups and downs can be seen in quick succession (e.g. 1996 to 2019: double, halve, double, halve, almost quadruple).

S&P Composite Index

Log scale, annual

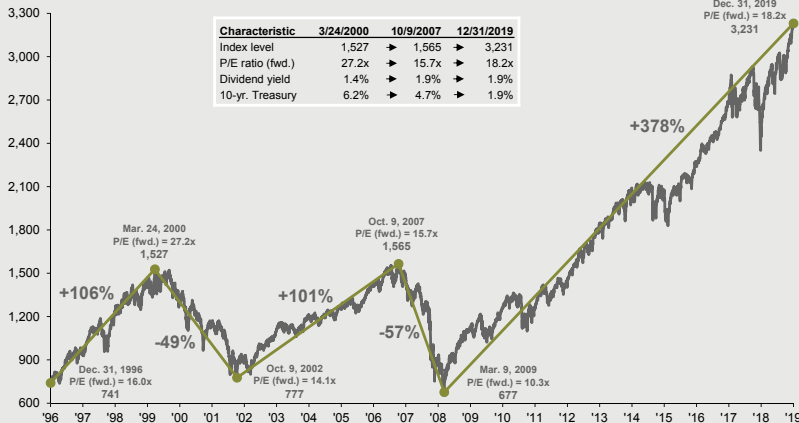


Source: FactSet, NBER, Robert Shiller, J.P. Morgan Asset Management.

Data shown in log scale to best illustrate long-term index patterns. Past performance is not indicative of future returns. Chart is for illustrative purposes only.

Guide to the Markets – U.S. Data are as of December 31, 2019.

S&P 500 Price Index



Source: Compustat, FactSet, Federal Reserve, Standard & Poor's, J.P. Morgan Asset Management. Dividend yield is calculated as consensus estimates of dividends for the next 12 months, divided by most recent price, as provided by Compustat. Forward price to earnings ratio is a bottom-up calculation based on the most recent S&P 500 Index price, divided by consensus estimates for earnings in the next 12 months (NTM), and is provided by FactSet Market Aggregates. Returns are cumulative and based on S&P 500 Index price movement only, and do not include the reinvestment of dividends. Past performance is not indicative of future returns. *Guide to the Markets* – U.S. Data are as of December 31, 2019.

Which analytical framework?

Capital budgeting is a rational exercise to choose projects expected to meet or exceed the risk-adjusted returns required by the providers of capital to the firm (e.g. shareholders and bondholders).

- We have seen that the net present value approach (NPV) is the best methodology available, but nevertheless might need to be adapted to the circumstances (e.g. do not ignore real options).
- The discount rate is one key input which has to be chosen with care.
- If some cash flows of a given project carry significantly different risk, it could be argued that different discount rates should be used according to the riskiness of each cash flow.

Issues for estimating/choosing the appropriate discount rate.

- How risky is the project?
- But which measure of risk shall be used under which circumstances and from which perspective?
- What is the return investors expect to receive for such level of risk?
- Since investors are funding firms with debt and equity, what is the expected return for each such capital? What is the optimal mix?

An analytical framework use market data to provide relevant quantitative answers to these questions.

Which analytical framework?

7/18

An analytical framework for capital budgeting requires

- Definitions (e.g. return, risk);
- To encompass the perspective of investors (i.e. an asset pricing model, for example CAPM)
 - ▶ Identification of the relevant risk metric(s);
 - ▶ Identification of the relevant risk-return trade-off(s);
- How to estimate risk and the risk-return trade-off from market data;
- How to identify the optimal mix of debt and equity capital;
- How to estimate an appropriate discount rate from the above.

An analytical framework is based upon theoretical foundations (e.g. CAPM) to allow predictions to be tested empirically in such a manner that the framework can be validated.

Which realized return? (i.e. ex-post/retrospectively)

8/18

Arithmetic mean of realized returns (also noted u):

$$\overline{R}_a = \frac{R_1 + R_2 + \dots + R_T}{T} = \frac{1}{T} \sum_{i=1}^T R_i$$

- 'typical' return for a single period over the holding period

Geometric mean of realized return:

$$\overline{R}_g = [(1 + R_1) \times (1 + R_2) \times \dots \times (1 + R_T)]^{\frac{1}{T}} - 1 = \left[\prod_{i=1}^T (1 + R_i) \right]^{\frac{1}{T}} - 1$$

- 'earned' return over the holding period as if a single period

$\overline{R}_a = \overline{R}_g$ only if riskless (R is constant), if not (assuming normality of R):

$$\overline{R}_a > \overline{R}_g \leftrightarrow \overline{R}_a - \sigma^2/2 \simeq \overline{R}_g$$

$\sigma^2/2$ is known as the 'volatility drag' (higher actually since non-normality).

Which realized risk? (i.e. ex-post/retrospectively)

9/18

Intuitively, the concept of risk for a single asset in isolation refers to its dispersion of realized returns.

The variance of realized returns of a **single asset in isolation** is used to measure risk ex-post, and is reported in standard deviations (σ):

$$\text{Var}(R) = \frac{1}{T-1} \sum_{i=1}^T (R_i - \mu)^2 \quad u = \overline{R_a}$$

$$\sigma = \sqrt{\text{Var}(R)}$$

Which expected risk? - Diversification matters

10/18

One project at a time ex-ante (before it takes place, i.e. prospectively)

- Undertake the project if the expected return is high enough ($NPV > 0$).
- Riskier projects require an higher return (high probability of failure).

Low Return \times High Prob. of Success \simeq High Return \times Low Prob. of Success

$$10\% \times 90\% \simeq 30\% \times 30\% \simeq 9\%$$

Many projects - or one additional project to many existing projects

- One low risk project pays 122% 9 times out of 10 and zero otherwise
- Two high risk project, paying 220% 5 times out of 10 and zero otherwise but perfectly negatively correlated.

$$R_{low} = [(122\% \times 90\%) + (0\% \times 10\%)] - 1 = 9.8\%$$

$$\overline{R_{high1} + R_{high2}} = [(220\% + 0\%) \times 50\% + (0\% + 220\%) \times 50\%] - 1 = 10\%$$

- Same expected return, but do the alternatives carry the same risk?

Which expected risk? - Diversification matters

11/18

Low risk project

Invest	Outcome 1	Outcome 2	Prob. of 1	Prob. of 2	Exp. payoff	Return	Variance
100	122	0	90%	10%	109.8	9.8%	1340

High risk projects (with correlation of -1)

Invest	Outcome 1	Outcome 2	Prob. of 1	Prob. of 2	Exp. payoff	Return	Variance
50	110	0	50%	50%	55	10.0%	3025
<u>50</u>	<u>0</u>	<u>110</u>	50%	50%	<u>55</u>	10.0%	3025
100	110	110	50%	50%	110	10.0%	0

On their own, the two high risk projects are indeed riskier than the low risk project (as indicated by their respective variance).

$$\text{Discrete random variable: } \text{Var}(X) = \sum_{i=1}^n p_i \cdot (x_i - u)^2 \quad u = \sum_{i=1}^n p_i \cdot x_i$$

But given the negative correlation, a portfolio of equal weight of the two high risk projects deliver the same expected return with no risk.

Empirical facts regarding correlations and volatility

12/18

Correlations between asset classes can be found to be negative, which in a given time frame provides an opportunity to reduce risk greatly through diversification.

Annual volatility of some asset classes could be found to be quite high, which is typically the case for commodities and emerging markets.

	U.S. Large Cap	EAFE	EME	Bonds	Corp. HY	Munis	Currncy.	EMD	Cmdty.	REITs	Hedge funds	Private equity	Ann. Volatility
U.S. Large Cap	1.00	0.89	0.79	-0.29	0.75	-0.10	-0.45	0.62	0.53	0.79	0.82	0.84	16%
EAFE		1.00	0.91	-0.13	0.80	0.02	-0.64	0.73	0.60	0.68	0.86	0.82	20%
EME			1.00	-0.01	0.88	0.12	-0.68	0.85	0.67	0.59	0.86	0.78	24%
Bonds				1.00	-0.06	0.80	-0.23	0.26	-0.11	0.00	-0.19	-0.25	3%
Corp. HY					1.00	0.11	-0.51	0.88	0.66	0.67	0.82	0.72	12%
Munis						1.00	-0.22	0.45	-0.09	0.07	0.01	-0.13	4%
Currencies							1.00	-0.62	-0.62	-0.40	-0.47	-0.55	8%
EMD								1.00	0.59	0.60	0.71	0.62	8%
Commodities									1.00	0.40	0.72	0.71	21%
REITs										1.00	0.56	0.66	25%
Hedge funds											1.00	0.86	7%
Private equity												1.00	11%

Source: Barclays Inc., Bloomberg, Cambridge Associates, Credit Suisse/Tremont, FactSet, Federal Reserve, MSCI, NCREIF, Standard & Poor's, J.P. Morgan Asset Management.
 Indexes used – Large Cap: S&P 500 Index; Currencies: Federal Reserve Trade Weighted Dollar; EAFE: MSCI EAFE; EME: MSCI Emerging Markets; Bonds: Barclays Aggregate; Corp HY: Barclays Corporate High Yield; EMD: Barclays Emerging Market; Cmdty.: Bloomberg Commodity Index; Real Estate: NAREIT ODCE Index; Hedge Funds: CS/Tremont Hedge Fund Index; Private equity: Cambridge Associates Global Buyout & Growth Index.
 Private equity data are reported on a two quarter lag. All correlation coefficients and annualized volatility calculated based on quarterly total return data for period 6/30/07 to 6/30/17. This chart is for illustrative purposes only.
 Guide to the Markets – U.S. Data are as of June 30, 2017.

Empirical facts regarding correlations and volatility

12/18

Correlations between asset classes can be found to be negative, which in a given time frame provides an opportunity to reduce risk greatly through diversification.

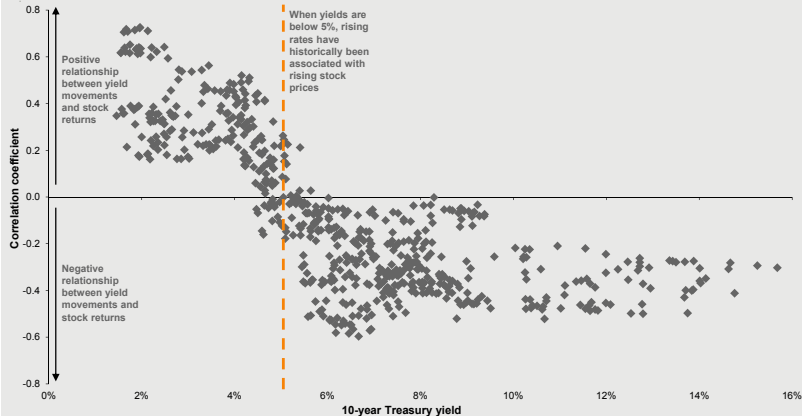
Annual volatility of some asset classes could be found to be quite high, which is typically the case for commodities and emerging markets.

Of note, correlations are not necessarily stable through time.

- Over long period of time (1963 to 2017), the correlation between the equity market (stock returns) and interest rate (changes in yield) has been found to be positive when the 10-year yield is below 5% and negative otherwise.
- So, not only past returns are not necessarily indicative of future returns, but this applies also to correlations.

Correlations between weekly stock returns and interest rate movements

Weekly S&P 500 returns, 10-year Treasury yield, rolling 2-year correlation, June 1963 – June 2017



Source: FactSet, Standard & Poor's, FRB, J.P. Morgan Asset Management.
Returns are based on price index only and do not include dividends. Markers represent monthly 2-year correlations only.
Guide to the Markets – U.S. Data are as of June 30, 2017.

Only incremental risk matters under CAPM

13/18

Given arguments to be presented later, under CAPM

- The risk that matters for a given investment is its risk contribution to the portfolio of the investor;
- The marginal investor that matters is well diversified;
- So, the risk that matters for a given investment is its risk contribution to the 'market' (i.e. universe of assets);
- That incremental risk can be quantified by β (or by many β if using a multi-factor asset pricing model rather than CAPM);
- For investment i , under CAPM, its expected return ER_i shall be equal to the risk-free rate R_f plus a risk premium estimated as the risk β_i multiplied by the market price of risk being the expected return for the market minus the risk-free rate ($ER_m - R_f$).

$$ER_i = R_f + \beta_i (ER_m - R_f)$$

Survey evidence shows that most firms use WACC as the baseline hurdle rate.

Survey	Country	% of firms using each method			
		Cost of equity	WACC	Financing cost	Other
Gitman & Vandenberg (2000)	U.S.	-	92	8	-
Block (2003)	U.S.	6	85	-	8
Baker, Dutra, & Saadi (2009)	Canada	-	64	38	69
Arnold & Hatzopoulos (2000)	U.K.	8	54	-	29
Kester & Al. (1999)	Australia	-	48	14	38

Textbook sections covered

- 10.1 to 10.6

Worked examples

- 4 worked examples are provided in chapter 10 of the textbook.

Exercises

- 22 exercises are provided in chapter 10 of the textbook.
- You should practice your Excel skills with a few of those.
- Suggest 10.15, 10.16 and 10.21

Year	Price	Dividend	Return
1	61.18		
2	64.83	0.72	7.14%
3	72.18	0.78	12.54%
4	63.12	0.86	-11.36%
5	69.27	0.95	11.25%
6	76.93	1.08	12.62%
Arithmetic Average			6.44%
Geometric Average			6.01%

To calculate the arithmetic and geometric average returns, first calculate the return for each year.

10.16 Solution

17/18

Year	Nominal Return	Inflation	Real Return
1973	4.78	9.36	-4.58
1974	7.68	12.30	-4.62
1975	7.05	9.52	-2.47
1976	9.10	5.87	3.23
1977	7.64	9.45	-1.81
1978	7.90	8.44	-0.54
1979	11.01	9.69	1.32
1980	12.23	11.20	1.03
Avg.	8.42	9.48	-1.06
St. Dev.	2.34	1.89	2.84

'T-bills have no risk' refers to the fact that there is only an extremely small chance of the government defaulting, so there is little default risk. Since T-bills are short term, there is also very limited interest rate risk. However, there is inflation risk (i.e. the purchasing power of the investment can actually decline over time even if the investor is earning a positive return).

Average return	10.30%
Standard deviation	16.45%
Return less than	0.00%
Probability	26.56%

$$z = \frac{(X - \mu)}{\sigma} = \frac{(0\% - 10.30\%)}{16.45\%} = -0.621$$

$$p(R < 0\%) = p(Z < -0.621) = 26.56\%$$