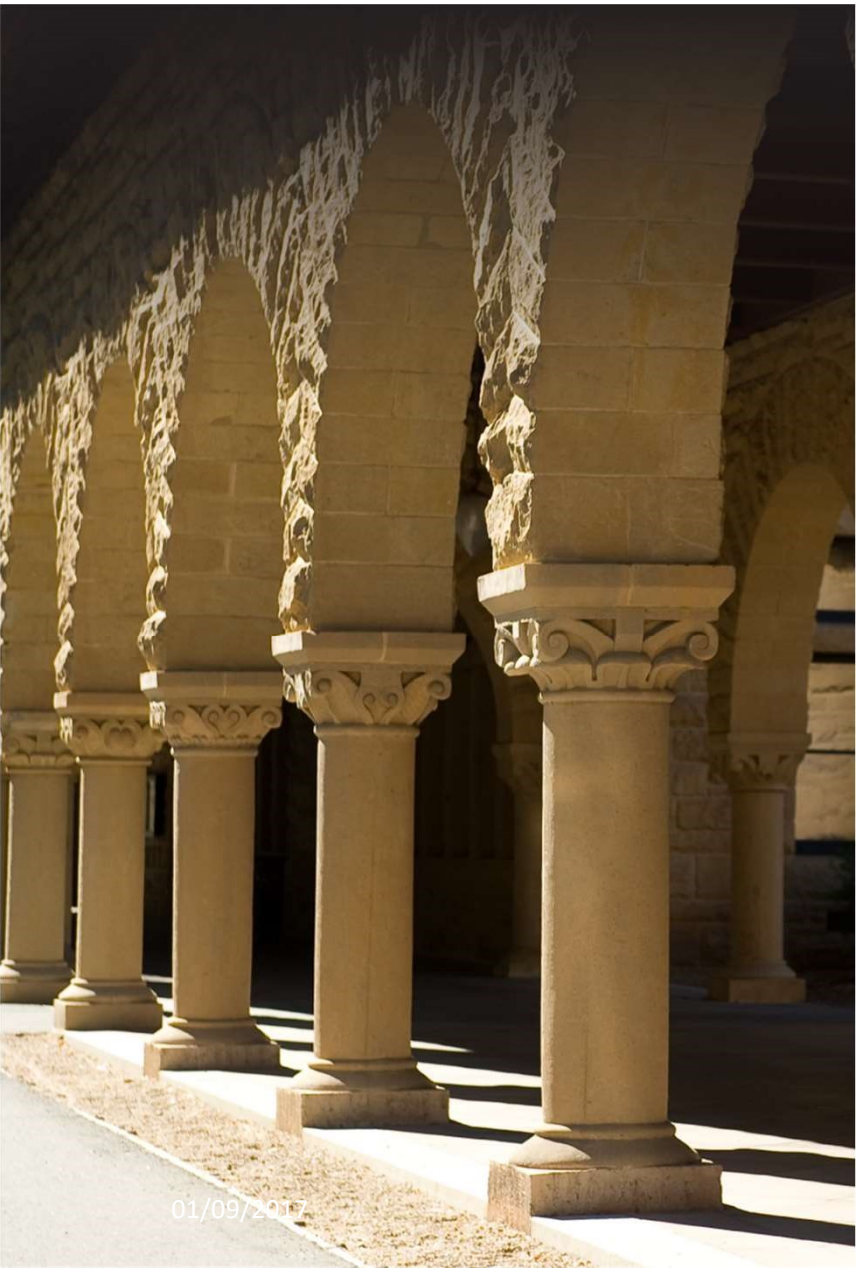

Stanford | Continuing Studies

Optimal Asset Allocation with MS-Excel

Final Assignment

Course Title:	Financial Modeling and Business Decisions
Course Code:	BUS 150 W
Instructor:	Iddo Hadar
Quarter:	Summer 2017
Grade Option:	Letter Grade

Student name:	Peter Hermann Schuld
Student ID:	90980339
Date:	09/01/2017

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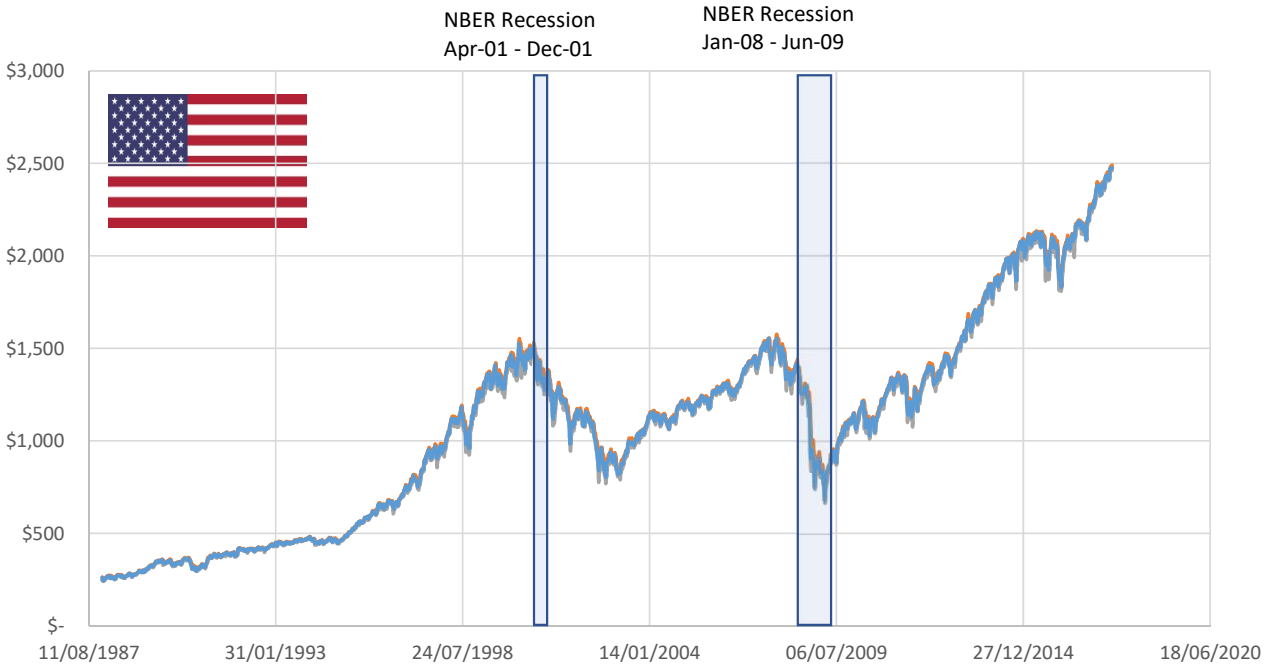
Proposal for an analytical Asset Allocation Model

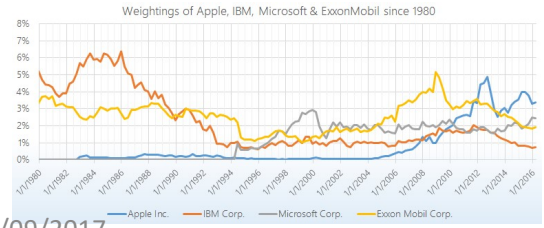
Customer/Decision Maker	Members of the Senior Management of a US Pension Fund (Asset Allocation Comitee)
Decision	Strategic Asset Allocation Decision of Portfolio weights for various stock markets, taken quarterly.
Goal/Objective/Target	Invest in efficient portfolios with the highest Expected **Excess Return = E(Return_PF) - E(Risk_Free_Return)** for a given level of Expected Risk E(Vola). If the pension fund can invest in credit risk free fixed income instruments as well (e.g. US government bonds), than only invest in the most efficient PF (Market Portfolio) that has the highest possible **Sharpe Ratio = E(Excess Return_PF) / E (Vola_PF)** for any level of risk.
Key Relationships/Drivers	Stock market returns are stochastic variables and stock returns follow a log normal distribution (LN)
Key Assumptions	Expected Future Return of a Portfolio **μ** = E(Return_PF) = Geometric Average Past Returns of weighted stock constituents. Expected Future Standard Derivation of a portfolio **δ** = E(STD) = Past STD of that portfolio, Expected Correlation **ρ** = E(Corr) between two or more stocks is equal to past correlations. Therefore, the Expected future stock price and it's distribution is fully determined by it's past μ and δ. μ(PF) = weight (stock_1) * μ(stock_1) + weight (Stock_2) * μ(stock_2). δ (PF) = weight (stock_1)^2 * δ (stock_1)^2 + weight(stock_2)^2 * δ (stock_2)^2 + 2 * δ (stock_1) * δ (stock_2) * ρ (Stck_1, Stock_2)
Cey Constraints	Sum of weights = 100 (i.e. no leverage). Weight of USD (incl. HKD) min. 40%.
Model User(s)	Senior Analyst or Portfolio Manager at a Pension Fund
Source for Raw Data	Yahoo Finance (Indices) and FXTOP for currencies

Content

❶ Problems of domestic Asset Allocations

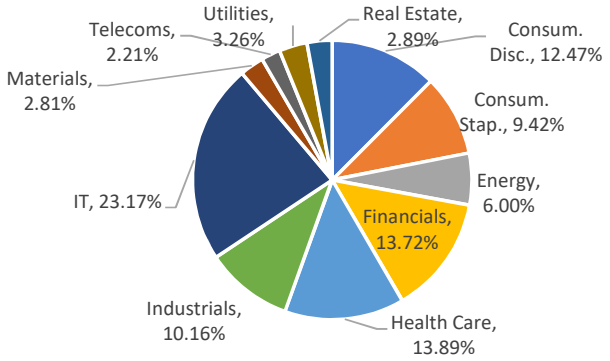
The S&P 500 index is Traditional „Default Option“ for US asset allocation





Problems:
High concentration of „large cap“ issuers and strong industry concentration (IT).

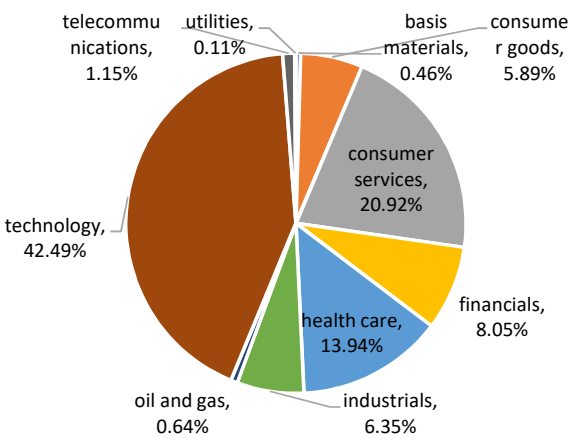
STANDARD &POOR'S



The Standard & Poor's 500, often abbreviated as the S&P 500, or just "the S&P",is an American stock market index based on the market capitalizations of 500 large companies having common stock listed on the NYSE or NASDAQ. The S&P 500 index components and their weightings are determined by S&P Dow Jones Indices. It differs from other U.S. stock market indices, such as the Dow Jones Industrial Average or the Nasdaq Composite index, because of its diverse constituency and weighting methodology. It is one of the most commonly followed equity indices, and many consider it one of the best representations of the U.S. stock market, and a bellwether for the U.S. economy. **The National Bureau of Economic Research has classified common stocks as a leading indicator of business cycles.**

Traditional „admixture“ to US asset allocation

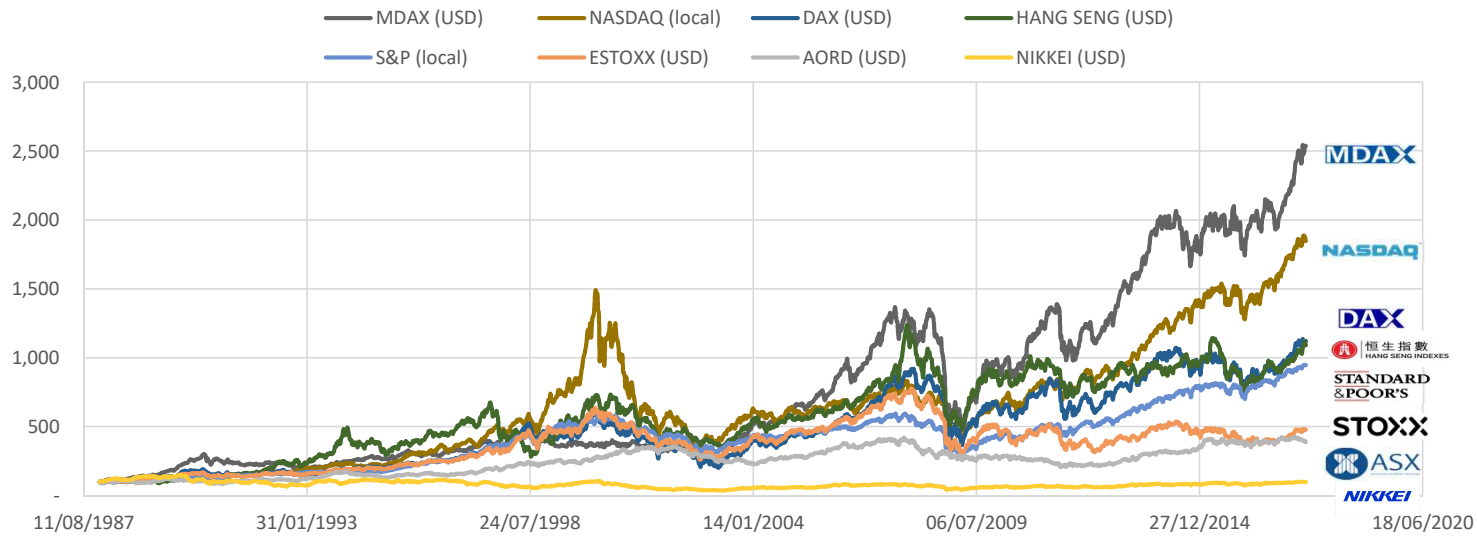
NASDAQ®



The NASDAQ Composite is a stock market index of the common stocks and similar securities (e.g. ADRs, tracking stocks, limited partnership interests) listed on the NASDAQ stock market.

Along with the Dow Jones Average and S&P 500 it is one of the three most-followed indices in US stock markets. The composition of the NASDAQ Composite is **heavily weighted towards information technology companies.**

❶ Screaning of International Stock Markets & Data Collection



World's Top 10 Countries by Market Cap

Rank	Market	Mkt Cap (US$ trillion) October 2016	Mkt Cap (US$ trillion) October 2003	% Change
1	U.S.	23.8	12.70	*87%*
2	China	6.6	0.42	*1479%*
3	Japan	5.2	3.10	*68%*
4	Hong Kong	4.1	0.83	*394%*
5	U.K.	3.0	2.20	*36%*
6	Canada	1.9	0.74	*157%*
7	France	1.9	1.30	*46%*
8	Germany	1.8	0.94	*91%*
9	India	1.7	0.23	*639%*
10	Switzerland	1.4	0.66	*112%*
	Top 10	***51.4***	***23.12***	***122%***
	World	***65.6***	***28.10***	***133%***

Source: Bloomberg *www.truewealthpublishing.asia*

Geometric Mean	E (S&P)	E (NASDAQ)	E (HANG SENG)	E (DAX)	E (MDAX)	E (ESTOXX)	E (NIKKEI)	E (AORD)
annual	7.9%	10.4%	8.4%	8.5%	11.5%	5.4%	0.0%	4.7%
Standard Deviation	Vola (S&P)	Vola (NASDAQ)	Vola (HANG SENG)	Vola (DAX)	Vola (MDAX)	Vola (Euronext)	Vola (NIKKEI)	Vola (AORD)
annual	16.0%	21.5%	23.8%	23.3%	19.9%	21.7%	22.9%	15.5%
Sharpe Ratio	SharpeRatio (S&P)	SharpeRatio (NASDAQ)	SharpeRatio (HANG SENG)	SharpeRatio (DAX)	SharpeRatio (MDAX)	SharpeRatio (ESTOXX)	SharpeRatio (NIKKEI)	SharpeRatio (AORD)
(Risk Free Rate = 1%)	0.43	0.44	0.31	0.32	0.53	0.20	-0.04	0.24
Log Normal Total Return	ln TR (S&P)	ln TR (NASDAQ)	ln TR (Hang Seng)	ln TR (DAX)	ln TR (MDAX)	ln TR (ESTOXX)	ln TR (NIKKEI)	ln TR (AORD)
last 30 years	224.9%	291.7%	239.1%	241.8%	323.4%	156.6%	-0.3%	135.8%
STD of Log Normal Returns	STD_30yr (S&P)	STD_30yr (NASDAQ)	STD_30yr (HANG SENG))	STD_30yr (DAX)	STD_30yr (MDAX)	STD_30yr (ESTOXX)	STD_30yr (NIKKEI)	STD_30yr (AORD)
last 30 years	87.3%	116.9%	129.4%	126.5%	108.3%	118.3%	124.4%	84.6%
min. TR (95% Confidence)	MinReturn (S&P)	MinReturn (NASDAQ)	MinReturn (Hang Seng)	MinReturn (DAX)	MinReturn (MDAX)	MinReturn (ESTOX)	MinReturn (NIKKEI)	MinReturn (AORD)
p.a.	2.0%	2.4%	0.8%	1.0%	3.1%	-1.6%	#NUM!	-0.1%

Start	01 January 1988
End	04 August 2017
Years of Data	29.6
Frequency	weekly
Data points	1,545
Data type	Index values (local currency)
Data source:	Yahoo Finance
FX data (monthly)	FXTOP

❷ Mean-Variance Optimization

Portfolio Valuation (monthly rebalancing)				
	Weight (w_n)	Annual volatility (σ_n)	Expected returns	$w_n\sigma_n$
S&P500	10%	16.0%	7.9%	1.60%
NASDAQ	25%	21.5%	10.4%	5.37%
HANG SENG	5%	23.8%	8.4%	1.19%
DAX30	0%	23.3%	8.5%	0.00%
MDAX50	55%	19.9%	11.5%	10.94%
EuroSTOXX50	0%	21.7%	5.4%	0.00%
Nikkei 225	0%	22.9%	0.0%	0.00%
AORD	5%	15.5%	4.7%	0.78%
US T-Notes	0%	0.0%	1.0%	0.00%
Sum	100.0%			

Correlation matrix								
	S&P500	NASDAQ	HANG SENG	DAX30	MDAX50	EuroSTOXX50	Nikkei 225	AORD
S&P500	**1**	0.7	0.5	0.6	0.6	0.6	0.5	0.5
NASDAQ	**0.7**	**1**	0.4	0.6	0.5	0.6	0.4	0.4
HANG SENG	**0.5**	**0.4**	**1**	0.5	0.5	0.5	0.4	0.4
DAX30	**0.6**	**0.6**	**0.5**	**1.0**	0.8	0.9	0.5	0.3
MDAX50	**0.6**	**0.5**	**0.5**	**0.8**	**1.0**	0.8	0.5	0.3
EuroSTOXX50	**0.6**	**0.6**	**0.5**	**0.9**	**0.8**	**1.0**	0.5	0.3
Nikkei 225	**0.5**	**0.4**	**0.4**	**0.5**	**0.5**	**0.5**	**1.0**	0.3
AORD	**0.5**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**1.0**

Expected returns	μ	10.4%
Annual variance		0.0279
Standard Derivation	δ	16.7%
Risk Free Rate		1%
Sharpe Ratio =		0.56

$$= [w_1\sigma_1 \ \cdots \ w_n\sigma_n] \times \begin{bmatrix} 1 & \rho_{12} & \cdots & \rho_{1n} \\ \rho_{21} & 1 & \cdots & \rho_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{n1} & \cdots & \cdots & 1 \end{bmatrix} \times \begin{bmatrix} w_1\sigma_1 \\ \vdots \\ w_n\sigma_n \end{bmatrix}$$

← Example of an efficient portfolio with the highest possible Sharpe Ratio in this data sample

Mean-Variance Optimization Description

1. Set Risk Free Interest Rate

2. **Run Solver**
   max. Expected Return by changing stock markets' weights

   Constraints
   Asset Allocation weight = 100% (no leverage)
   Asset Allocation volatility <= Risk Tolerance
   USD weight (incl. HKD) => 40% (i.e. S&P, NASDAQ, NANG SENG)

3. Compare graphically Solver's risk/return output with Efficient Frontier and Security Market line (Chart Asset Allocation) .

4. Make sure Solver's output's Sharpe Ratio is higher than 0.5

5. run Sover again with different risk tolerance until you reach the highest Sharpe Ratio (Efficent Portfolio)

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❸ Create efficient and investable Model Portfolios in accordance with investment guidelines

(e.g. only investment grade, no leverage, min.40% USD)

Asset Allocation Decision							
	(3) Blue Ships plus	**(2) Global Broad**	**(1) Opportunity**	S&P500	MDAX50	NASDAQ	**Typical Solver-Output**
δ (% p.a.)	16.1%	16.7%	18.1%	16.0%	19.9%	21.5%	16.8%
μ (% p.a.)	9.8%	10.4%	11.1%	7.9%	11.5%	10.4%	10.4%
Sharpe Ratio	**0.55**	**0.56**	**0.56**	0.43	0.53	0.44	**0.56**
S&P500	40%	10%	0%	100%			16.7%
NASDAQ	20%	25%	40%			100%	28.3%
HANG SENG	0%	5%	0%				1.7%
DAX30	0%	0%	0%				0.0%
MDAX50	40%	55%	60%		100%		51.6%
EuroSTO XX50	0%	0%					0.0%
Nikkei 225	0%	0%					0.0%
AORD	0%	5%					1.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
USD weight	60.0%	40.0%	40.0%	100.0%	0.0%	100.0%	46.6%

← Highest Sharpe Ratio (=most efficient Portfolios)

Business Decisions

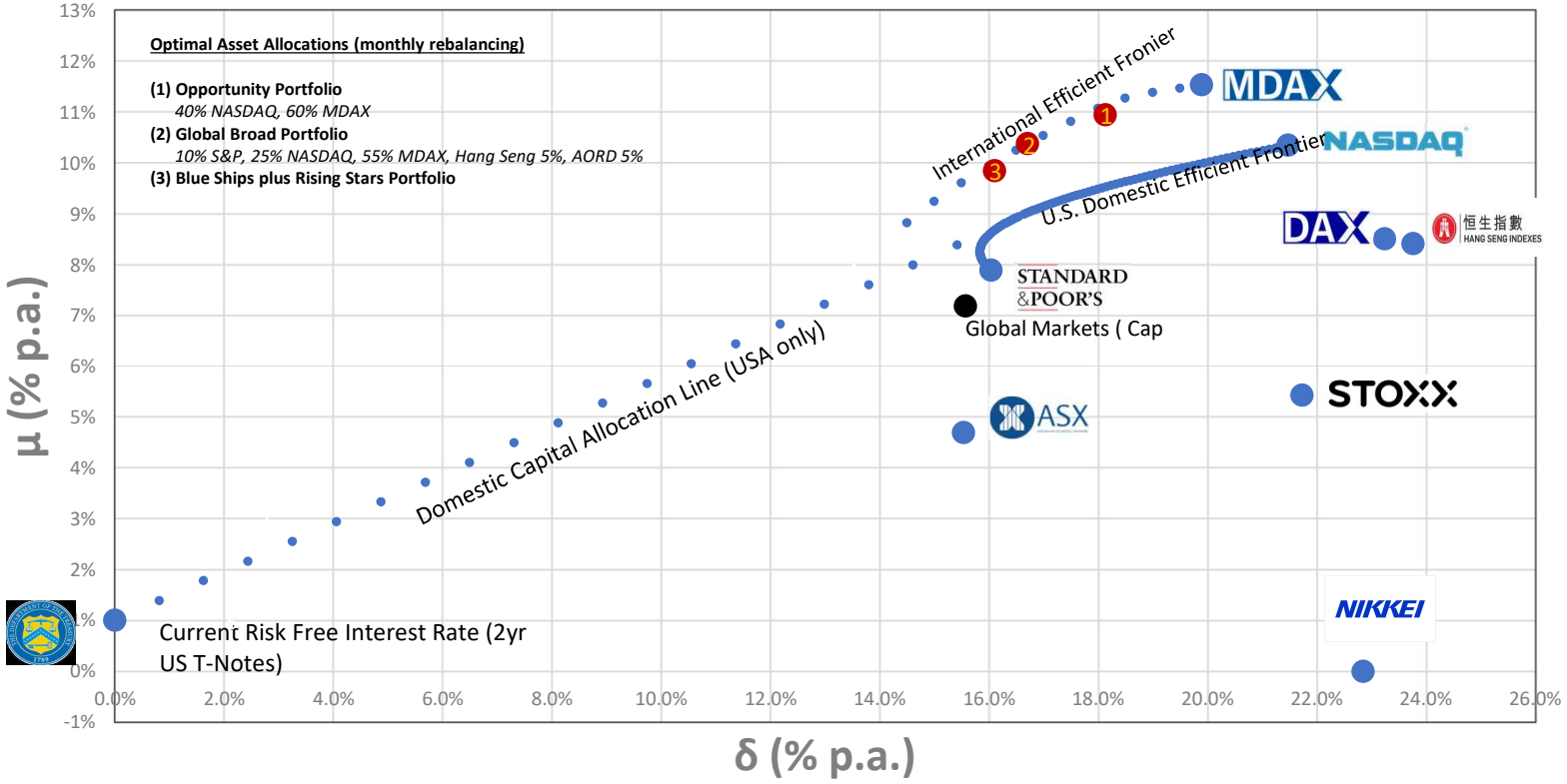
Invest only in efficient portfolios and combine them with investments in credit risk free US-Treasury Notes of an appropriate maturity to reduce the portfolio volatility if necessary (i.e. move along the „International Efficient Frontier Incl. Risk Free Investments “).

For example, 10 years before out payment starts at age 65 a defined contribution pension plan starts shifting 10% of a policy holder ‘s assets into 10yr T-Notes. The following year the risk-free allocation is increased to 20% by buying 9yr T-Notes

Asset Allocation Mean-Variance Optimization

Risk-Return Expectation (in USD)

1988-2017 (weekly)



Financial Model

Modern Portfolio Theory
(Harry Markowitz, Merton H. Miller, William F. Sharpe, Nobel Price in Economics 1990).

Conclusion from Model

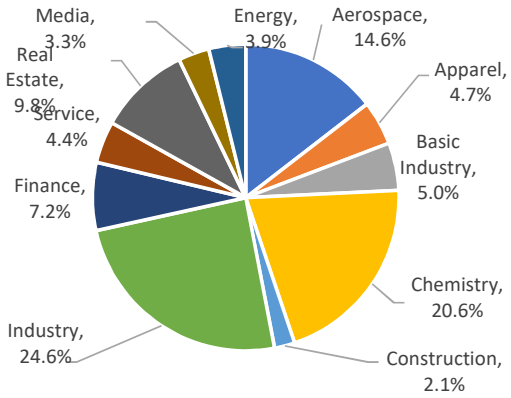
The inclusion of international stock markets into the asset allocation of US investors improves their risk/return profile. Portfolios on the Internaltional Efficient Frontier have higher Sharpe Ratios than what is available from domestic diversification (i.e. higher Sharpe Ratios than portfolios on the domestic Efficient Frontier).

Business Decisions

The inclusion of the German MDAX index (Mid-Cap ex. Technology), HK Chinese HENG SENG (Exposure to Mainland China) and Sydney All Ordinary (Comodities) is most attractive.

❹ Analyse industry Risk/Return factors

MDAX



The MDAX is a stock index which lists German companies. The index is calculated by Deutsche Börse.

It includes the 50 Prime Standard shares from sectors **excluding technology** that rank immediately below the companies included in the DAX index. The company size is based on terms of order book volume and market capitalization.

Analyse industry Risk/Return factors for stocks in indices

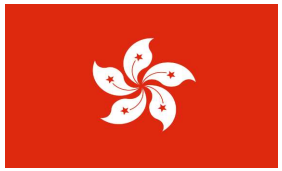
MDAX

AIRBUS MTU Aero Engines Fraport RHEINMETALL ← Civil Aerospace demand & Defense spending (NATO)

DÜRR HELLA SCHAEFFLER LEONI ← Automotive supplier demand driven by OEMs (OEM demand growth above GDP globally)

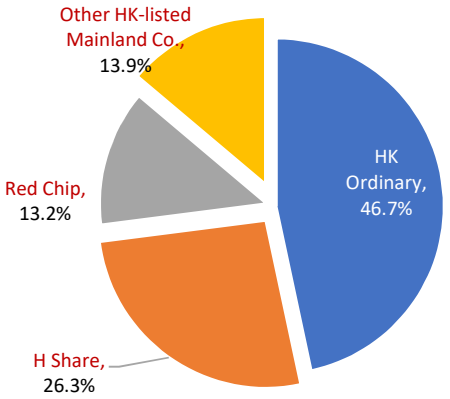
KION GROUP JUNGHEINRICH KRONES GEA ← Capital equipment demand is highly exposed to business climate, but strong growth trend

LANXESS Energizing Chemistry WACKER FUCHS EVONIK POWER TO CREATE ← Demand for chemical industry products worldwide (Supply side: price of oil)



❺ Analyse country risk/return

恒生指數 HANG SENG INDEXES



The Hang Seng Index (恒生指數) is a freefloat-adjusted market capitalization-weighted stock market index in Hong Kong. These 50 constituent companies represent about 58% of the capitalisation of the Hong Kong Stock Exchange.

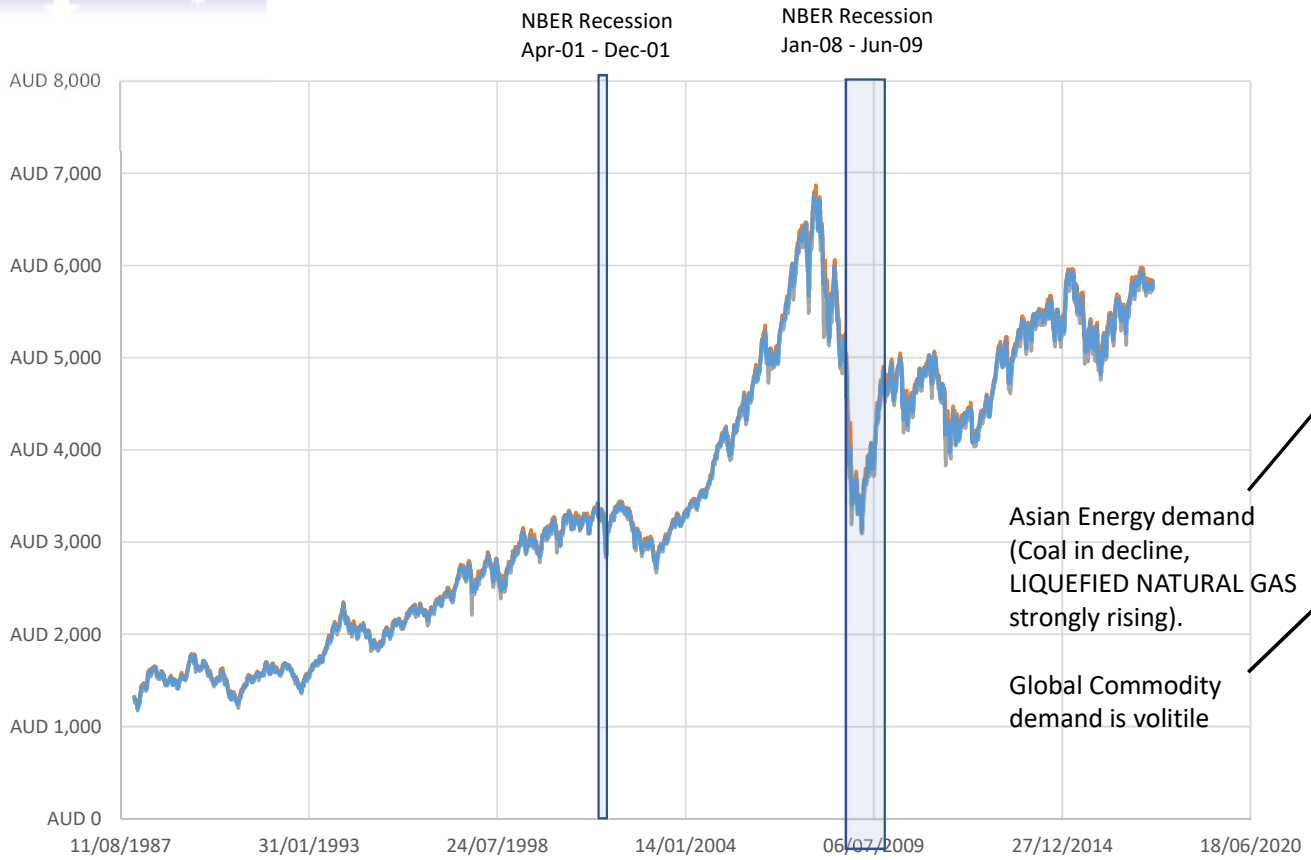
❺ Analyse country risk/return

恒生指數 HANG SENG INDEXES

		Components				
		www.hsi.com.hk				
No.	Stock Code	ISIN Code	Company Name	Industry Classification	Share Type	Weighting (%)
1	700	KYG875721634	Tencent	Information Technology	Other HK-listed Mainland Co.	11.0%
2	5	GB0005405286	HSBC Holdings	Financials	HK Ordinary	10.9%
3	1299	HK0000069689	AIA	Financials	HK Ordinary	8.6%
4	939	CNE1000002H1	CCB	Financials	H Share	8.1%
5	941	HK0941009539	China Mobile	Telecommunications	Red Chip	6.0%
6	1398	CNE1000003G1	ICBC	Financials	H Share	4.7%
7	3988	CNE1000001Z5	Bank of China	Financials	H Share	3.5%
8	2318	CNE1000003X6	Ping An	Financials	H Share	3.5%
9	1	KYG217651051	CKH Holdings	Conglomerates	HK Ordinary	3.2%
10	388	HK0388045442	HKEx	Financials	HK Ordinary	3.0%
11	2628	CNE1000002L3	China Life	Financials	H Share	2.1%
12	1113	KYG2103F1019	CK Property	Properties & Construction	HK Ordinary	2.0%
13	2	HK0002007356	CLP Holdings	Utilities	HK Ordinary	1.8%
14	16	HK0016000132	SHK Ppt	Properties & Construction	HK Ordinary	1.8%
15	883	HK0883013259	CNOOC	Energy	Red Chip	1.8%
16	386	CNE1000002Q2	Sinopec Corp	Energy	H Share	1.8%
17	2388	HK2388011192	BOC Hong Kong	Financials	HK Ordinary	1.6%
18	823	HK0823032773	Link REIT	Properties & Construction	HK Ordinary	1.6%
19	11	HK0011000095	Hang Seng Bank	Financials	HK Ordinary	1.5%
20	3	HK0003000038	HK & China Gas	Utilities	HK Ordinary	1.4%
						79.9%

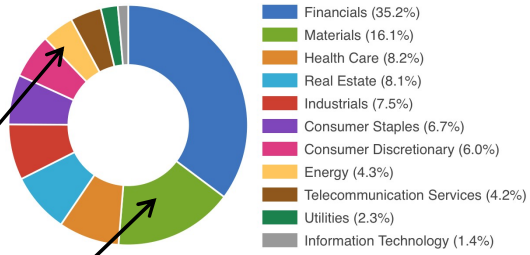
H-shares are shares of a company incorporated in the Chinese mainland that is listed on the Hong Kong Stock Exchange or other foreign exchange.

Red Chip'A company based in Mainland China that is incorporated internationally and listed on the Hong Kong Stock Exchange. Red chip stocks are expected to maintain the filing and reporting requirements of the Hong Kong exchange, which makes them a main outlet for foreign investors who wish to participate in the rapid growth of the Chinese economy. Red chips may be issued in addition to A-shares in the same companies, although only Chinese citizens can invest in A-shares



Asian Energy demand (Coal in decline, LIQUEFIED NATURAL GAS strongly rising).

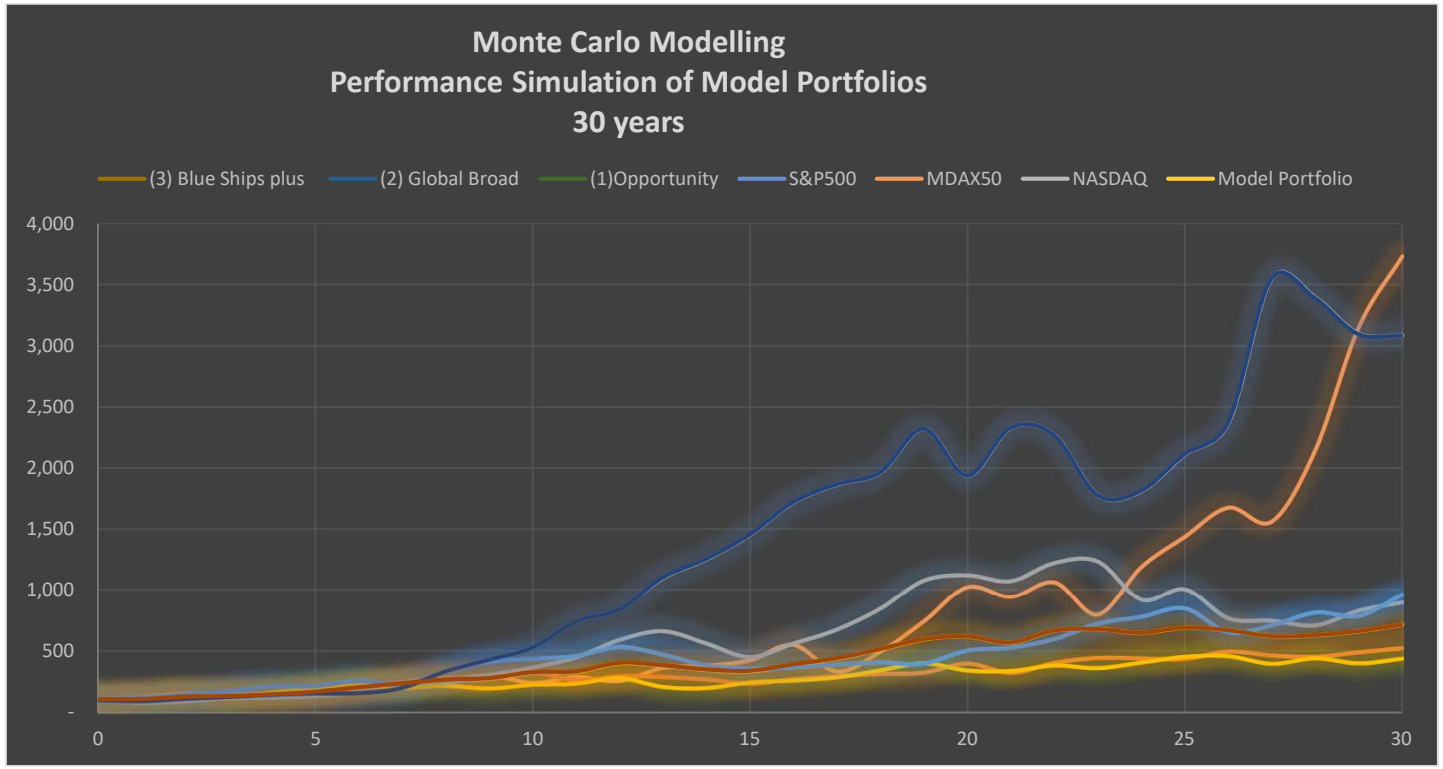
Global Commodity demand is volitile



Established in January 1980, the All Ordinaries (colloquially known as the "All Ords"; also known as the All Ordinaries Index, AOI) is the oldest index of shares in Australia. It is made up of the share prices for 500 of the largest companies listed on the Australian Securities Exchange (ASX).

The market capitalization of the companies included in the All Ords index amounts to over 95% of the value of all shares listed on the ASX. The 3-letter exchange ticker in Australia for the All Ordinaries is "XAO".

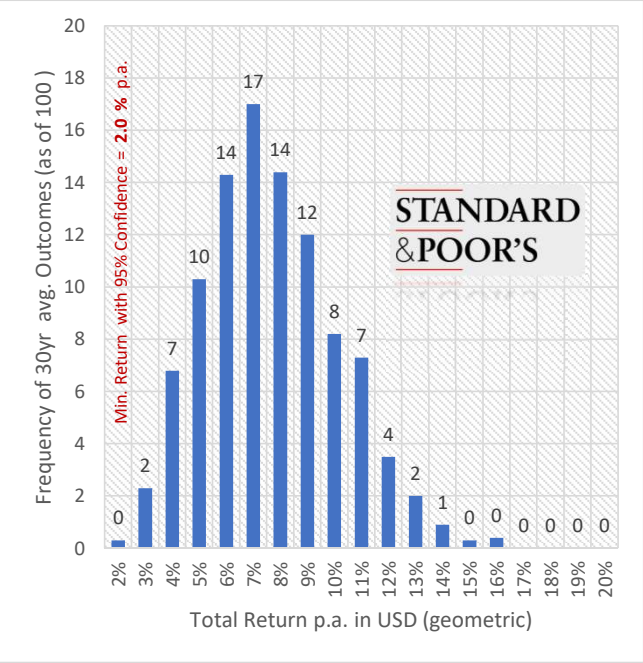
6 Monte Carlo Simulations

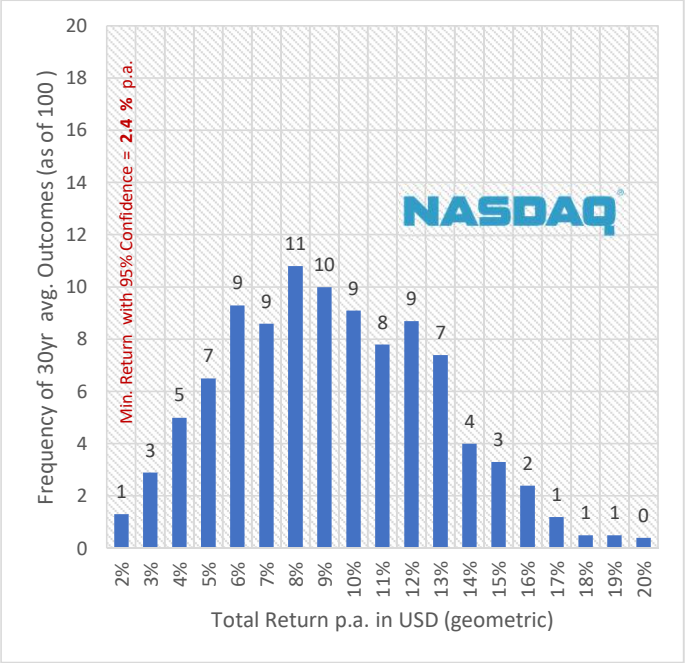


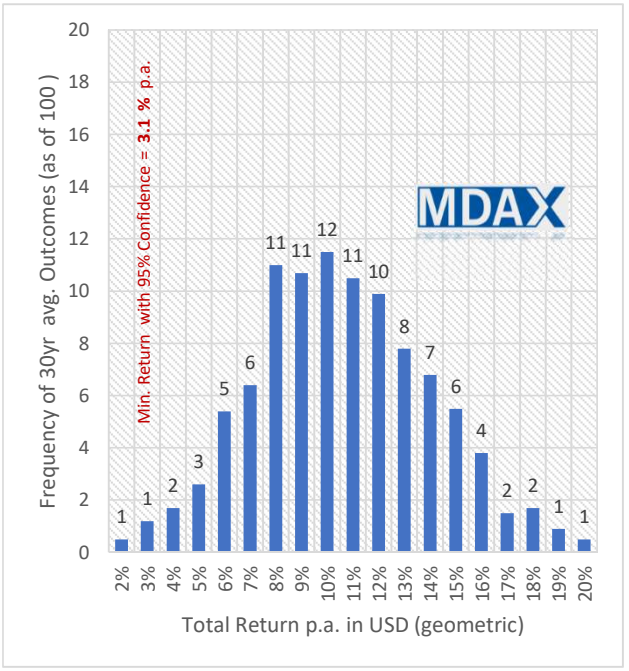
WINSTON, Wayne (2016) »Microsoft Excel Data Analysis and Business Modeling«, 5th edition, Chapter 74

30-year Monte Carlo Simulation (1000-points)

Histogram of Average 30yr performance







S&P 500			
		Cyclical Gain	
	Period-end	Best	Worst
Average	973%	1046%	91%
Annualized	7.9%	8.1%	-0.3%
Most Extreme		8198%	25%

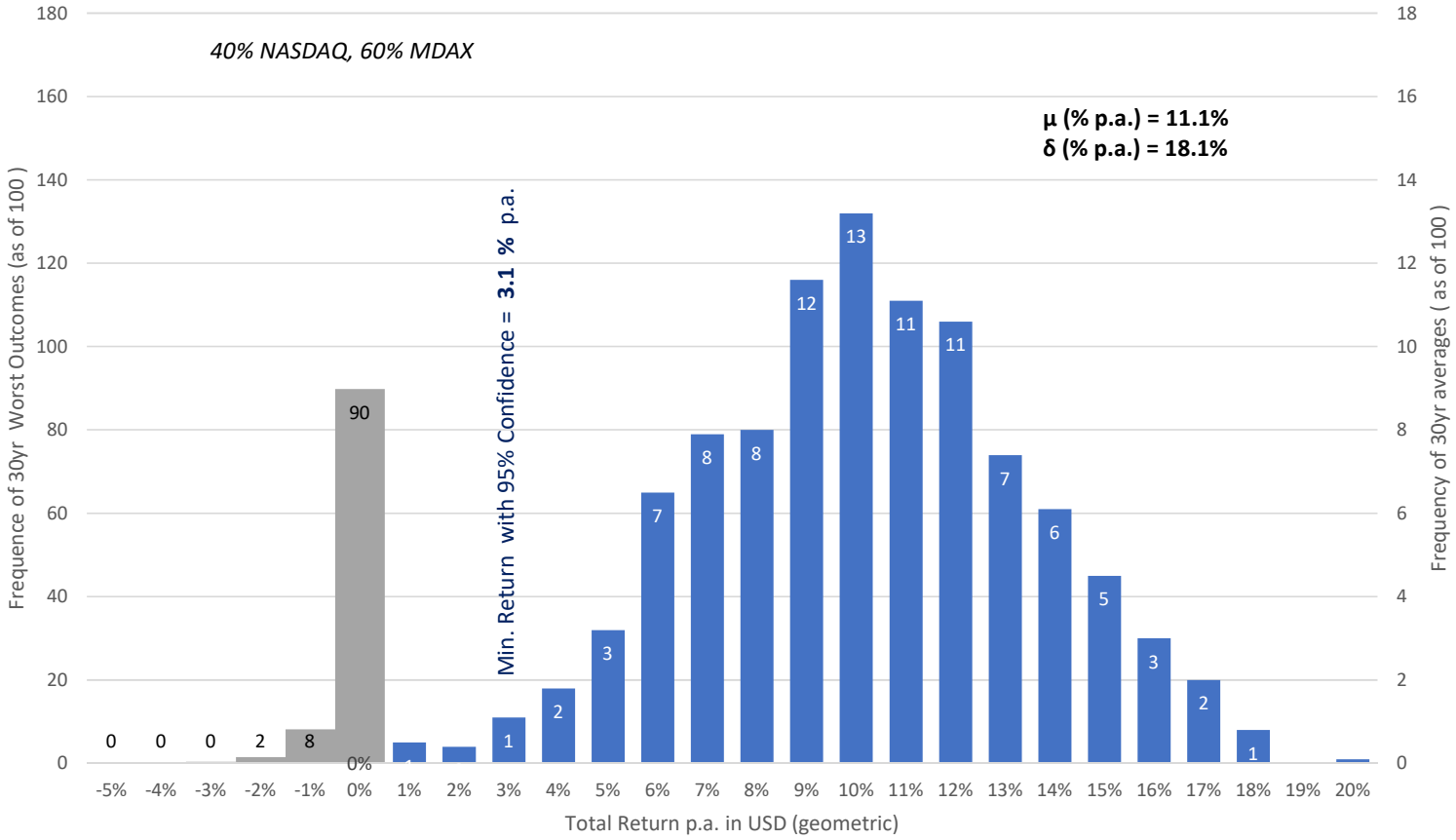
NASDAQ			
		Cyclical Gain	
	Period-end	Best	Worst
Average	1842%	2023%	86%
Annualized	10.2%	10.5%	-0.5%
Most Extreme		30841%	9%

MDAX			
		Cyclical Gain	
	Period-end	Best	Worst
Average	2438%	2623%	90%
Annualized	11.2%	11.5%	-0.3%
Most Extreme		37579%	14%

(1) Opportunity Portfolio

30-year Monte Carlo Simulation (1000-points)

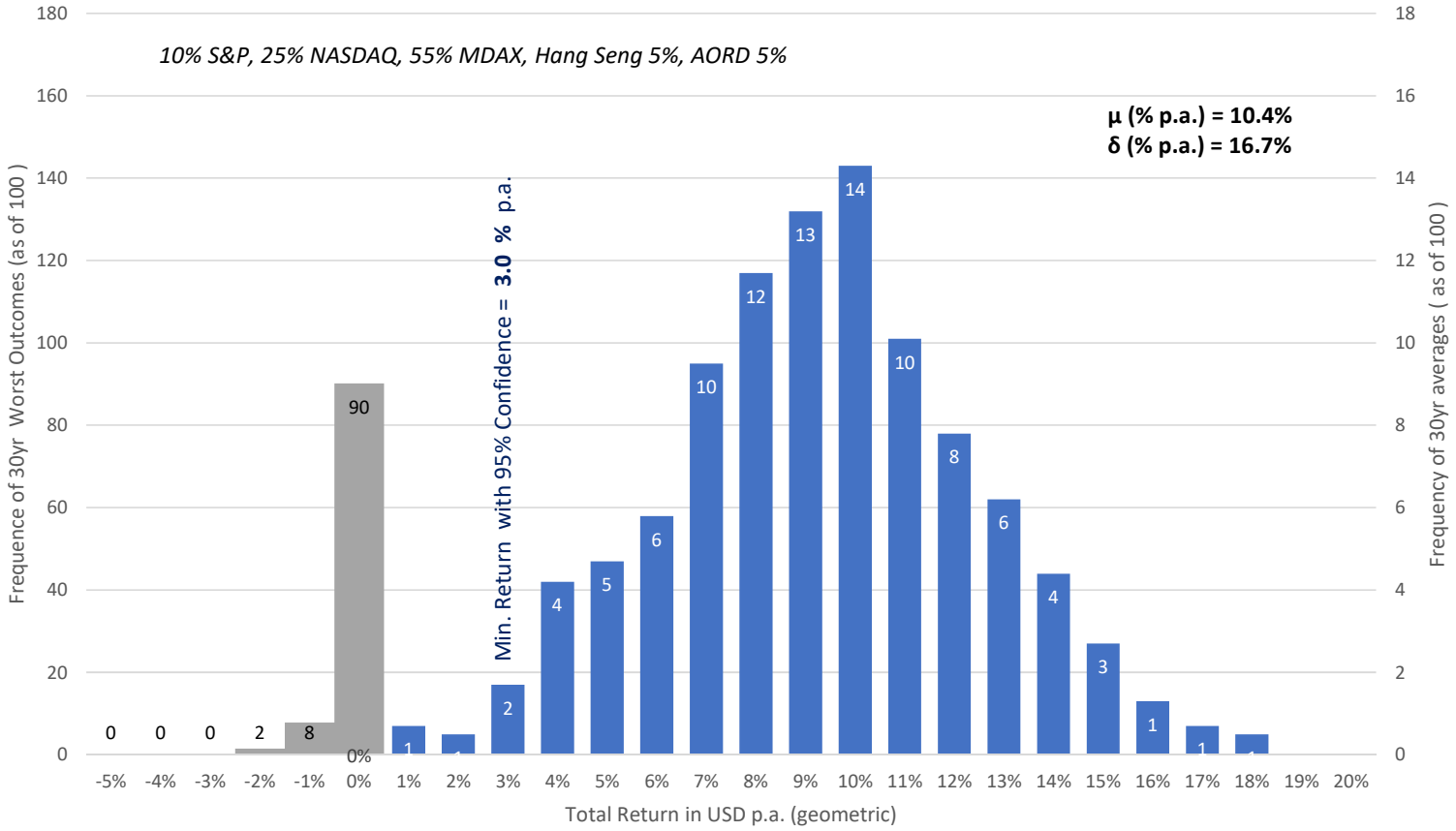
Histogram of Worst 30yr performance (left) and of Average 30yr performance (right)



(2) Global Broad Portfolio

30-year Monte Carlo Simulation (1000-points)

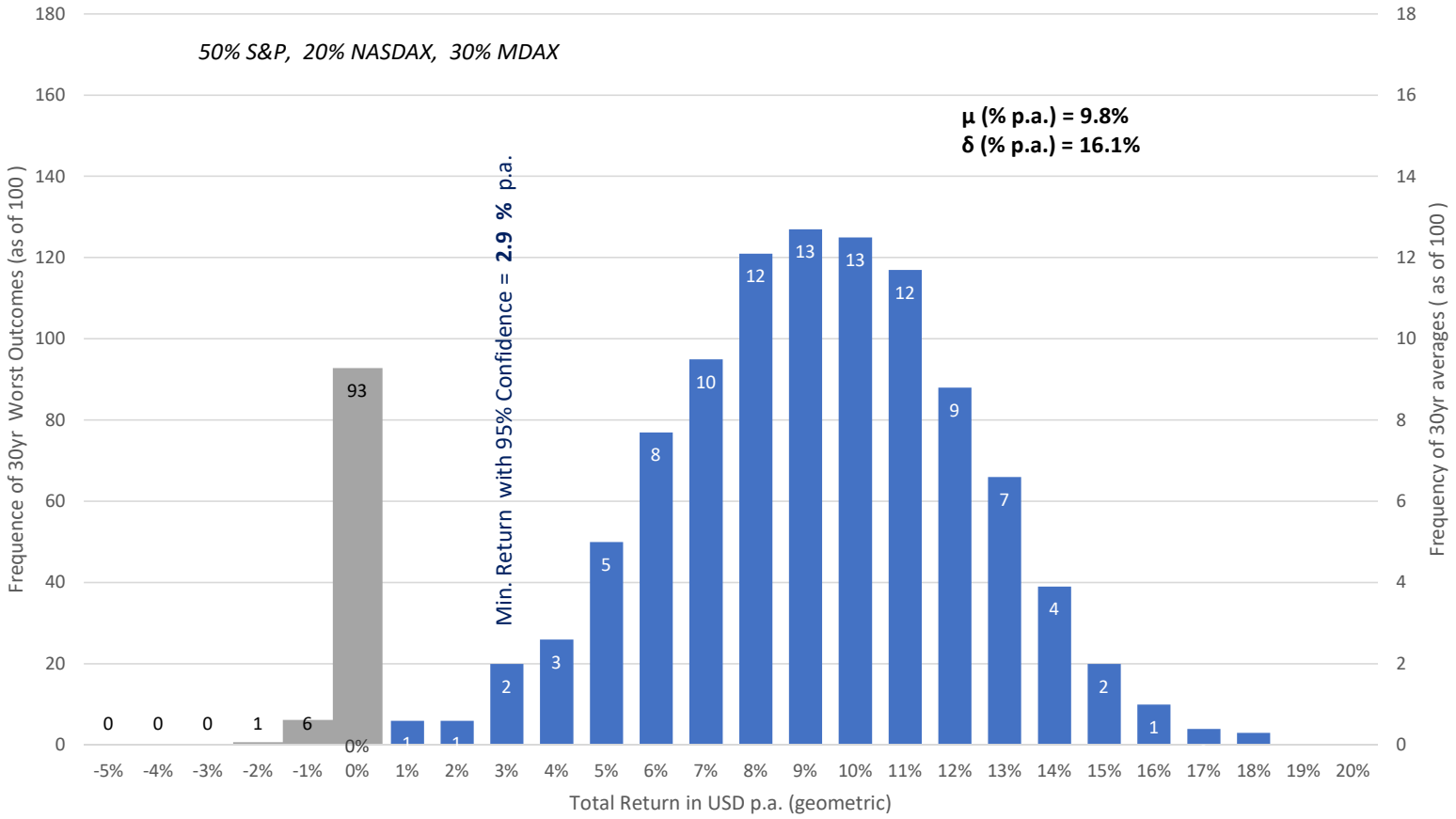
Histogram of Worst 30yr performance (left) and of Average 30yr performance (right)



(3) Blue Ships + Rising Stars Portfolio

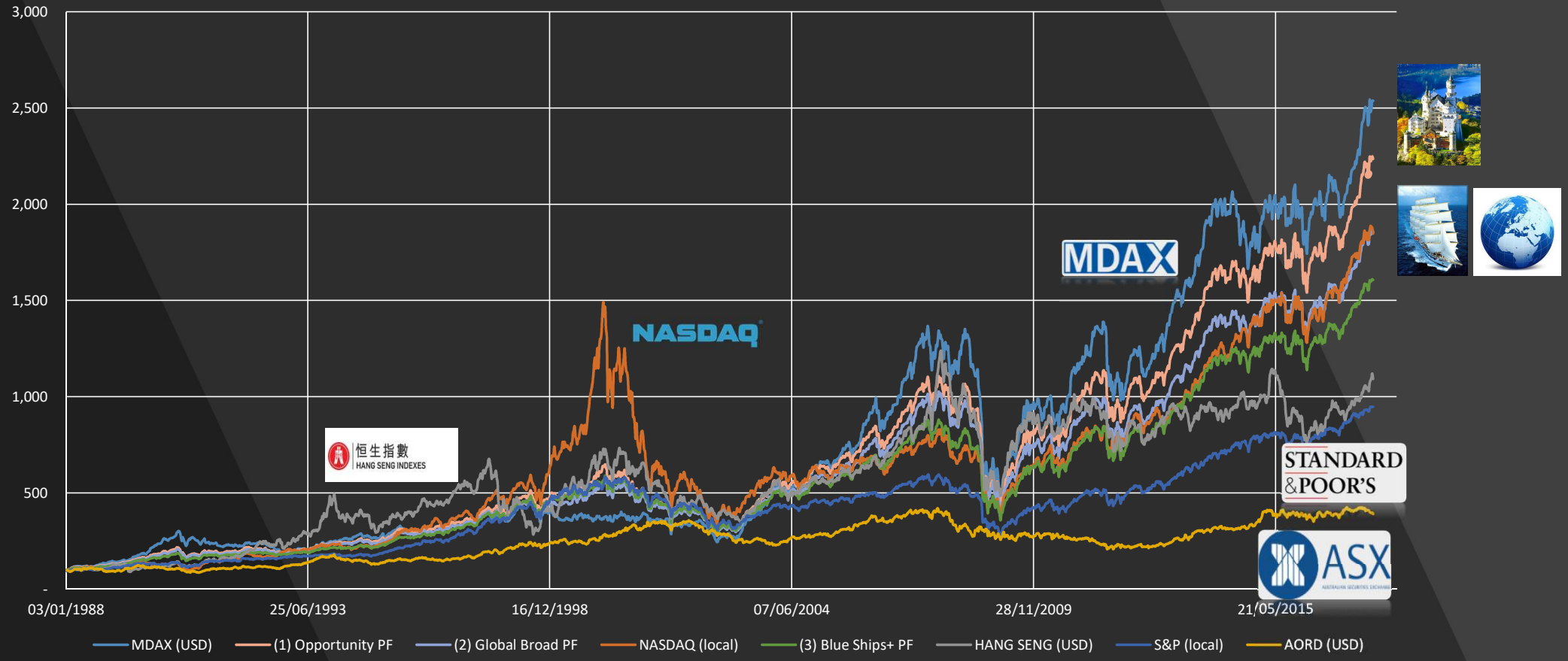
30-year Monte Carlo Simulation (1000-points)

Histogram of Worst 30yr performance (left) and of Average 30yr performance (right)

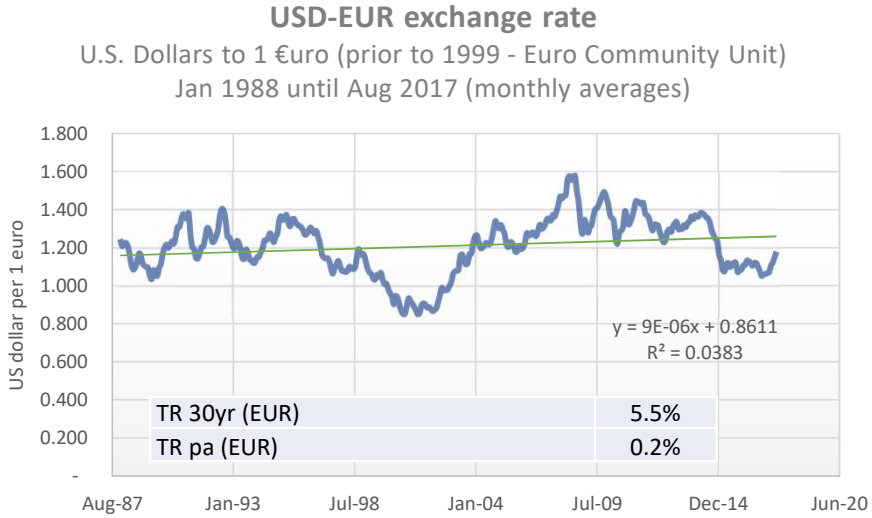


7 Back Testing Model Portfolios

Total Return in US$ (last 30 years)

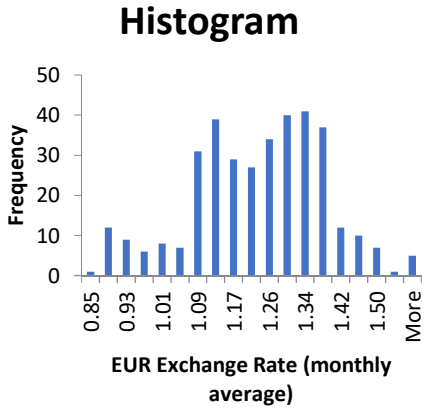


8 Currency Risk Modeling



Characteristics of distribution	
Currenty EUR exchange rate	1.1896
Standard Deviation	14.9%
Simulated EUR exchange rate	**1.0000**

is -1.28 standard deviations from the mean



Likelihood of 1.0000 or lower being the exchange rate? 10% Confidence

90% chance for EUR exchange rate to stay above 1.0000 or better

Assumption:

EUR Exchange Rate is random without a trend due to similar inflation rates in Euroland and in the USA. The Bretton Woods Quasi Gold Standard ended in early 1970's followed by a period of a high inflation rates. In the 1980's a system of independent central banks was established in both the USA and in most Western European Countries. Those independent Central Banks target money supply (e.g. German Bundesbank broad money supply M3) or inflation rates of 2% p.a. (e.g. US Federal Reserve, ECB). Therefore, EUR is volatile but mean reversing to Purchasing Power Parity (PPP) levels (currently at approx. 1.2200 according to OECD research.

JYP-USD Exchange Rate
(How many JPY does 1 USD buy)

Assumption:

The JPY exchange rate is random with an appreciating trend due to lower inflation rates and lower nominal interest rates in Japan. Nevertheless, this exchange rate is highly political and levels below 100 are generally perceived to harm Japanese exports.
Economic Theory: Uncovered Interest Parity

Uncovered Interest Rate Parity Formula and Example

The formula for uncovered interest rate parity takes into account the following variables:

E(t + k) / S(t) = the expected rate of change in the exchange rate, which is simply the projected exchange rate at time (t + k) divided by the spot rate at time t

k = the number of time periods into the future from time t

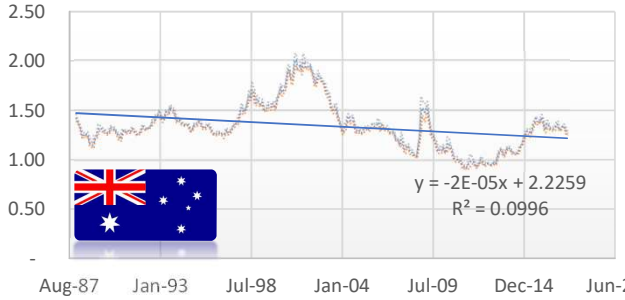
i(c) = the foreign interest rate

i(d) = the domestic interest rate.

Using these variables, the formula is:

(1 + i(d)) = E(t + k) / S(t) x (1 + i(c))

AUD-USD Exchange Rate
(How many AUD does 1 USD buy)

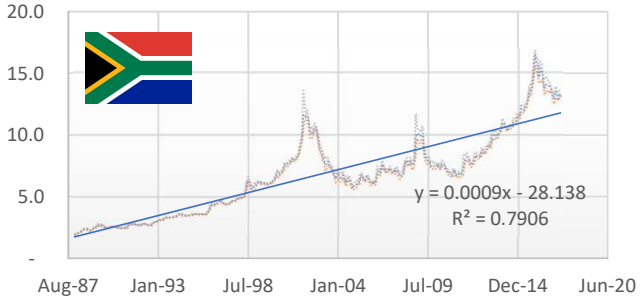


Assumption:
The AUD Exchange Rate is random with an small appreciating trend due to the "Dutch disease".

The term "**Dutch disease**" was coined by The Economist magazine in 1977. The magazine was analyzing a crisis taking place in the Netherlands following discoveries of vast natural gas deposits in the North Sea in 1959. The newfound wealth and massive exports of oil caused the Dutch guilder to rise sharply, making exports of all nonoil products less competitive on the world market. Unemployment rose from 1.1% to 5.1%, and capital investment in the country dropped.

Dutch disease became widely used in economics to describe the paradoxical situation where seemingly good news, such as the discovery of large oil reserves, turns out to have a negative impact on a country's broader economy.

ZAR-USD Exchange Rate
(How many ZAR does 1 USD buy)



Assumption:
The ZAR exchange rate is random with an strongly depreciating trend due to significantly higher inflation rates and higher nominal interest rates in South Africa. In addition, domestic political uncertainty (e.g. Banking crisis, elections) and falling commodity prices depress this exchange rate.

Economic Theory: Uncovered Interest Parity, Emerging Markets risks

Recent News on Financial Times (JULY 21, 2017) by: Nicholas Megaw :

The government's **credit rating** has already been **downgraded to junk status by Fitch and S&P** since president Jacob Zuma sacked his respected finance minister earlier this year. Moody's also cut the government to one notch above speculative grade, and a further downgrade from would force South Africa's expulsion from the widely-tracked World Government Bond Index, a move that would likely cause a sharp outflow from South African assets.

Step ❾ Conclusion

⑩ Literature

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