



Portfolio Optimization Techniques

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Agenda

- Project Overview
- Data Inputs
- Portfolio Design
- Risk Control Method
- Backtesting System
- Backtesting Results

Project Overview

Selecting Bucket: Reason for choosing global investable equities:
 Combination of active management on sophisticated passive index

Table: MSCI Countries index

MSCI ACWI & FRONTIER MARKETS INDEX											
MSCI ACWI INDEX			MSCI EMERGING & FRONTIER MARKETS INDEX								
MSCI WORLD INDEX			MSCI EMERGING MARKETS INDEX			MSCI FRONTIER MARKETS INDEX					
DEVELOPED MARKETS			EMERGING MARKETS			FRONTIER MARKETS					
Americas	Europe & Middle East	Pacific	Americas	Europe, Middle East & Africa	Asia	Americas	Europe & CIS	Africa	Middle East	Asia	
Canada	Austria	Australia	Brazil	Czech Republic	China	Argentina	Croatia	Kenya	Bahrain	Bangladesh	
United States	Belgium	Hong Kong	Chile	Egypt	India		Estonia	Mauritius	Jordan	Sri Lanka	
Denmark	Denmark	Japan	Colombia	Greece	Indonesia		Lithuania	Morocco	Kuwait	Vietnam	
Finland	Finland	New Zealand	Mexico	Hungary	Korea		Kazakhstan	Nigeria	Lebanon		
France	France	Singapore	Peru	Poland	Malaysia		Romania	Tunisia	Oman		
Germany				Qatar	Pakistan		Serbia	WAEMU ²			
Ireland				Russia	Philippines		Slovenia				
Israel				South Africa	Taiwan						
Italy				Turkey	Thailand						
Netherlands				United Arab Emirates							
Norway											
Portugal											
Spain											
Sweden											
Switzerland											
United Kingdom											

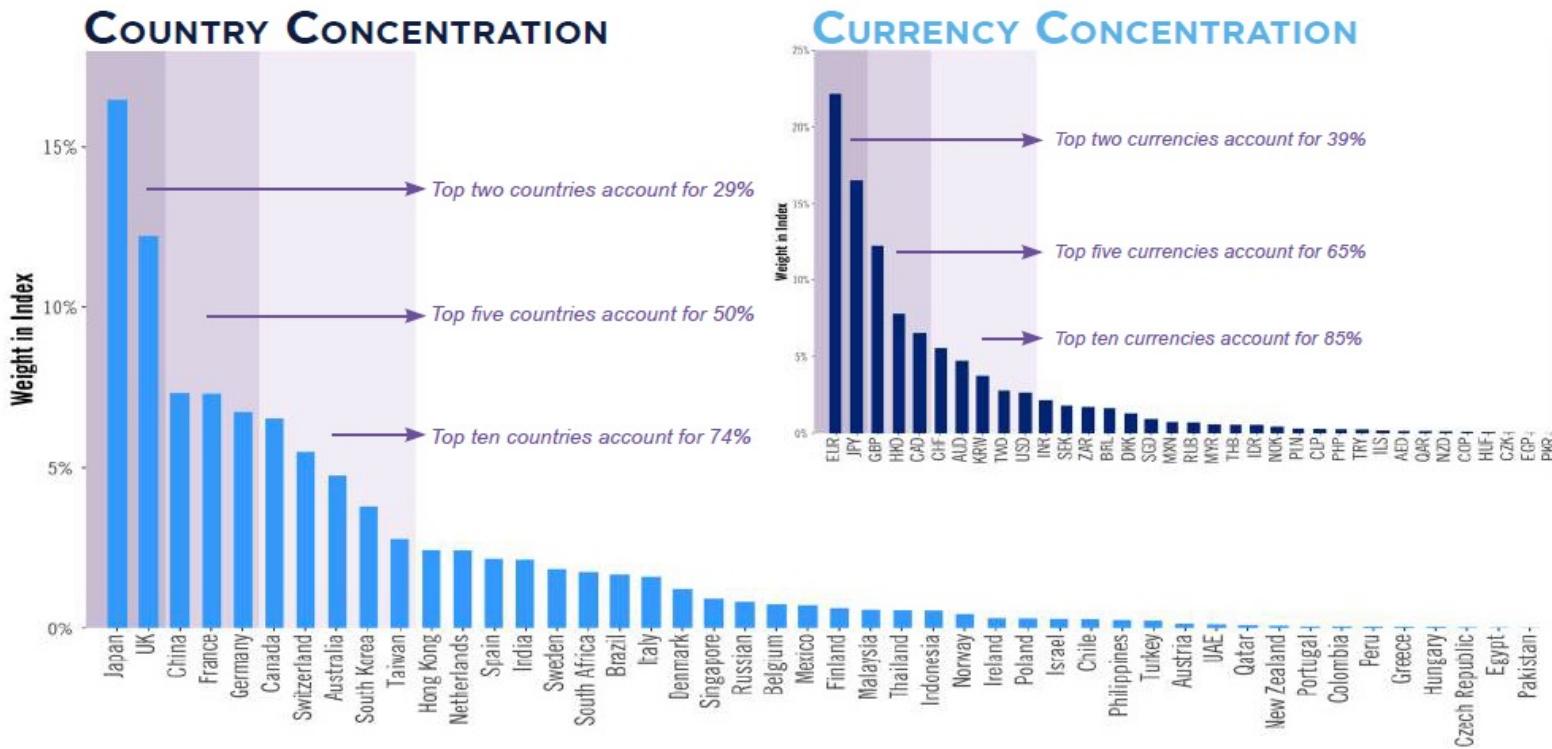
MSCI STANDALONE MARKET INDEXES ¹											
	Saudi Arabia			Jamaica	Panama ³	Trinidad & Tobago	Bosnia Herzegovina	Bulgaria	Botswana	Ghana	Palestine

Source: MSCI

Project Overview

Reason of not only investing in pure passive index

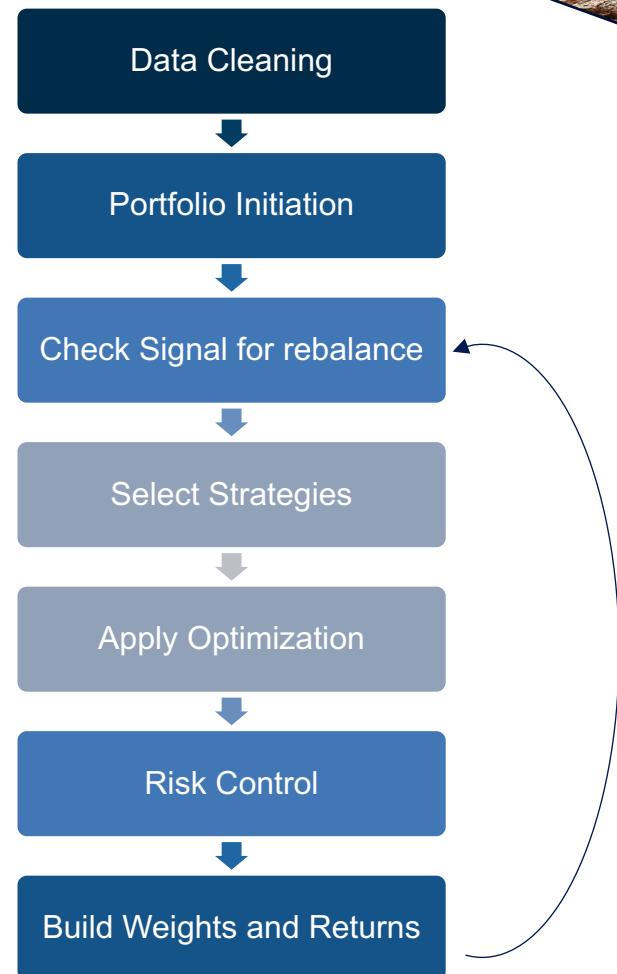
Graph: MSCI ACWI EX USA INDEX in USD (Bloomberg ticker: NDUEACWZ)



Source: MSCI as of 12/31/17

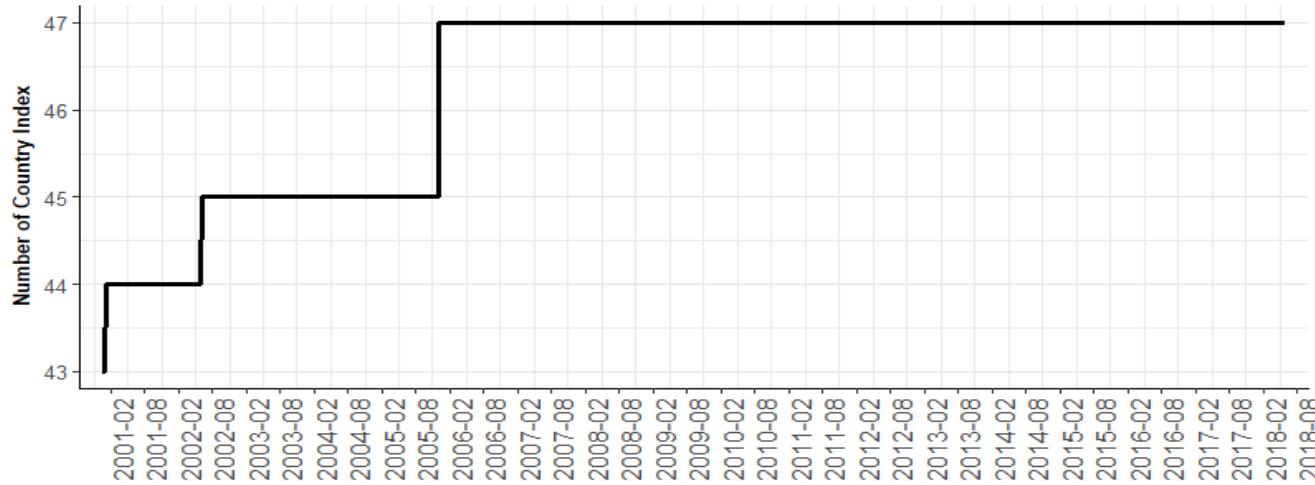
Project Overview-Process

- **Strategy- Build portfolios with:**
 - Optimization
 - Risk Factor
 - Risk Control
- **Execution - R programming techniques:**
 - Build code in functional modules
 - Apply parallel computation
- **Result:**
 - All simulated portfolios outperformed benchmarks and Equal-weighted portfolio in two backtesting periods
 - Risk control module enhanced Sharpe ratio



Data Inputs

- Up to 47 country total net return in USD indexes
- Period: From 12/19/2000 to 05/31/2018
- Varying basket:
Graph: Index universe inclusion



- Benchmark:
 - MSCI ACWI EX USA INDEX in USD (Bloomberg ticker: NDUEACWZ)
 - S&P 500 Total Net Return Index (Bloomberg ticker: SPXT)

Portfolio Design

➤ Risk factor

- Momentum:

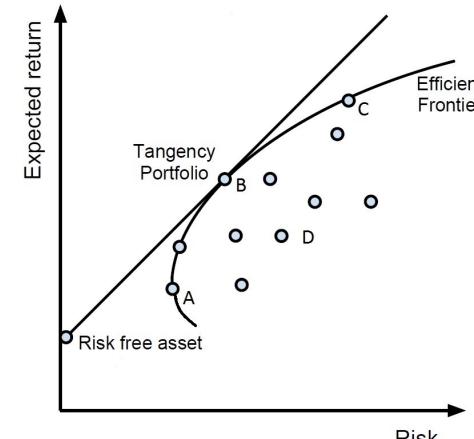
- A well-known behavior risk factor discovered by Narasimhan Jegadeesh and Sheridan Titman

- Enhanced weighting: z-score

- Rank the top 20% by 12-month return
- Calculate Sharpe ratio and scale the sample
- Calculate cumulative probability under normal distribution
- Calculate weights by dividing each probability by its sum of all probabilities

➤ Optimization

Tangent graph



Source: <http://www.ipastrategic.com/blog/portfolio-risk-targets>

Quadratic Programming under constraints

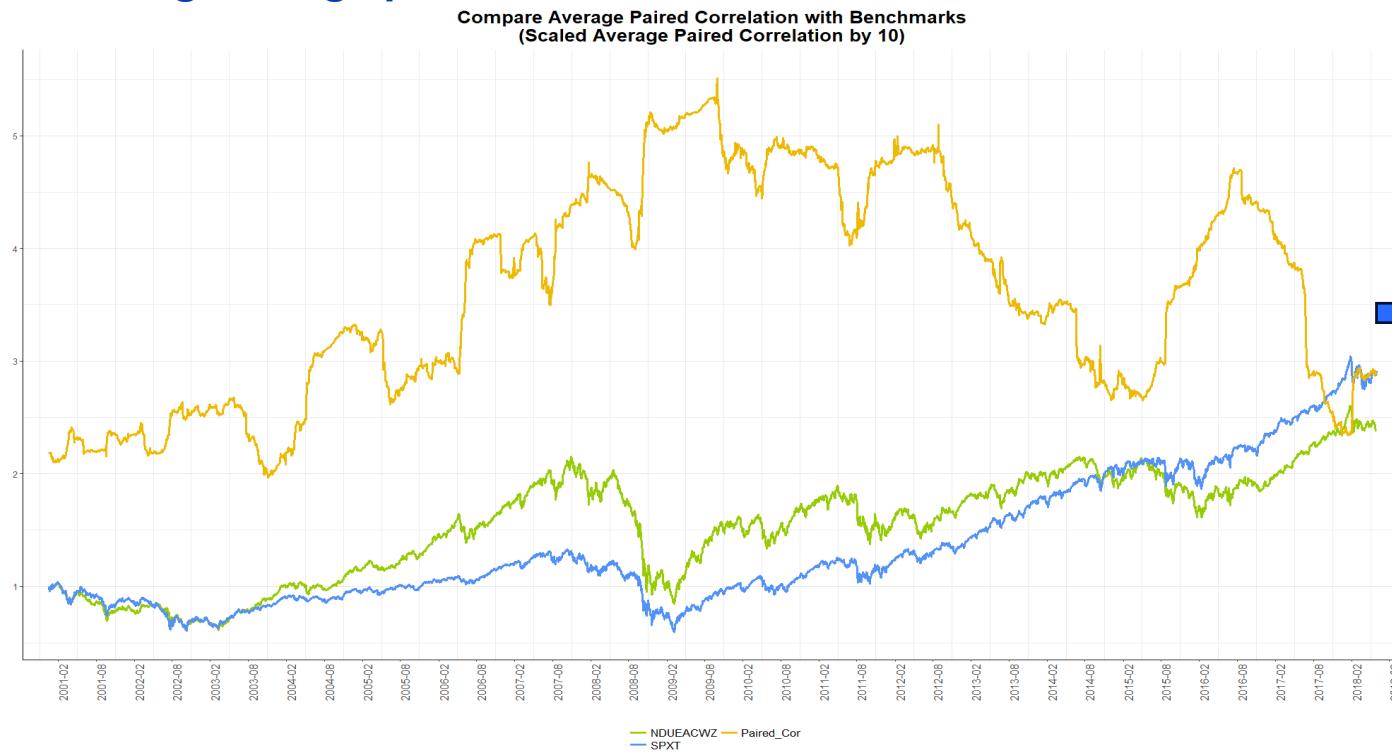
$$\min_{\mathbf{x}} \sigma_{p,x}^2 = \mathbf{x}' \boldsymbol{\Sigma} \mathbf{x} \quad \text{s.t.}$$

$$\begin{aligned}\mu_{p,x} &= \mathbf{x}' \boldsymbol{\mu} = \mu_p^0 \\ \mathbf{x}' \mathbf{1} &= 1\end{aligned}$$

$$\text{Max} \geq x_i \geq \text{Min}$$

Risk Control Method

➤ Trailing average pairwise correlation Vs. Benchmarks



Assets correlation tends to increase during highly volatile periods

➤ Method

- Trailing average pairwise correlation
- Method; allocate certain percentage of cash from the divergence between top percentile and sample mean in the average pairwise correlation

Results

➤ Key Points

- All simulated portfolios outperformed benchmarks and Equal-weighted portfolio in two backtesting periods
- Risk control module enhanced Sharpe ratio

➤ Statistic graphs

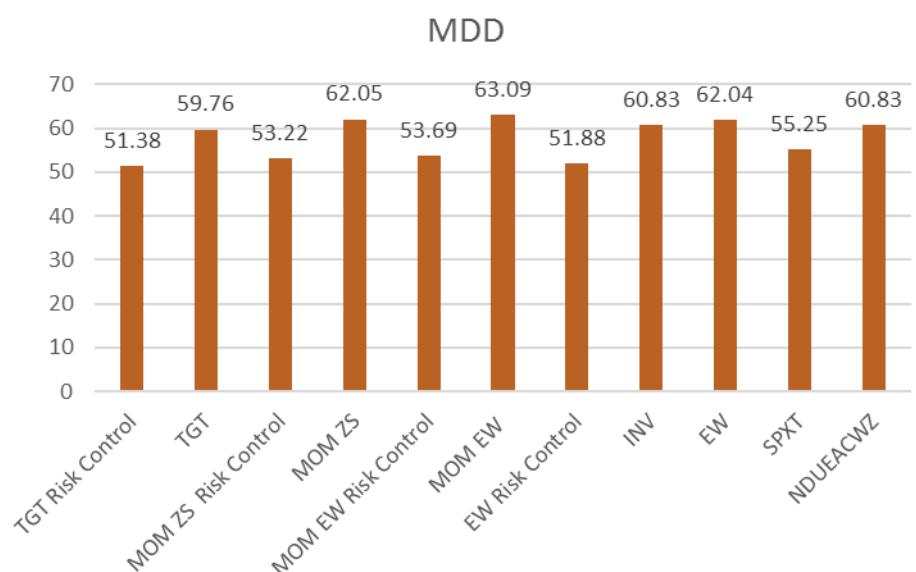
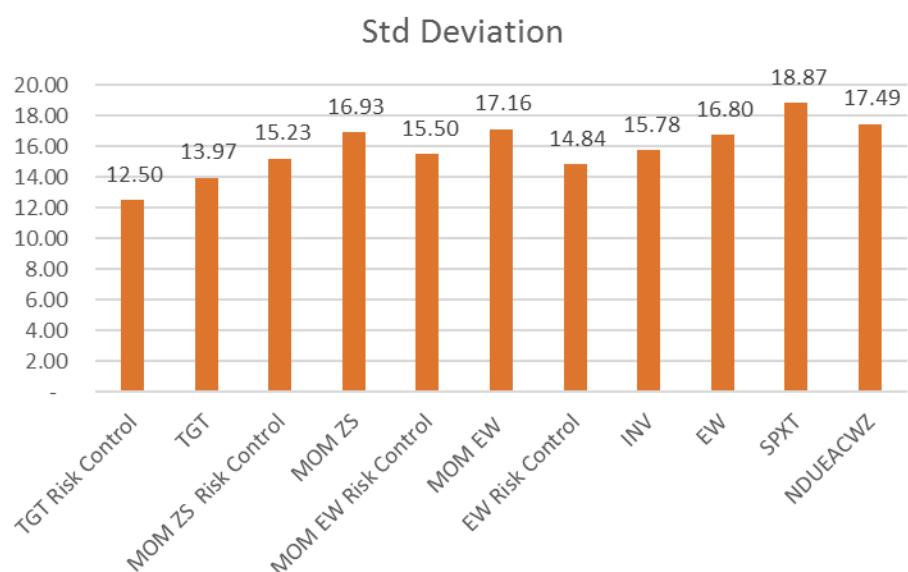
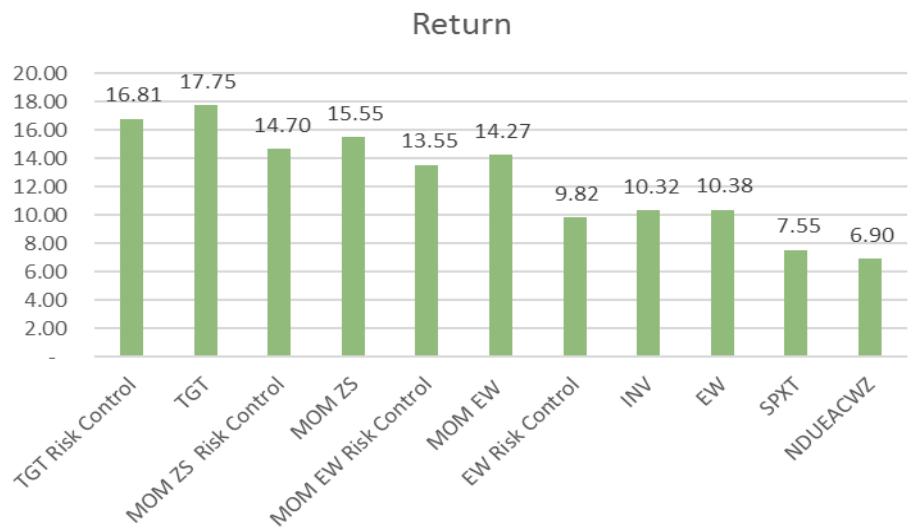
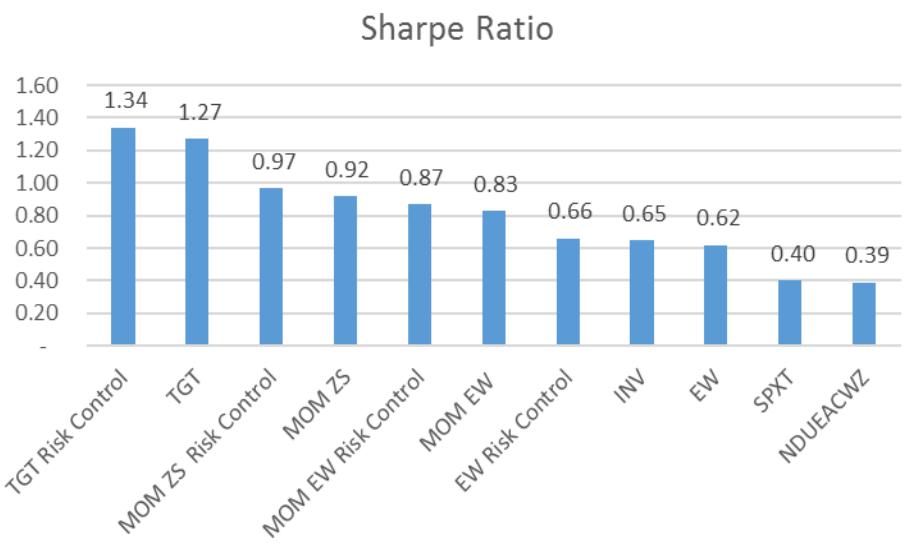
➤ Portfolio growth graphs

➤ Bloomberg confirmation graph

(Please see graphs on following slides)

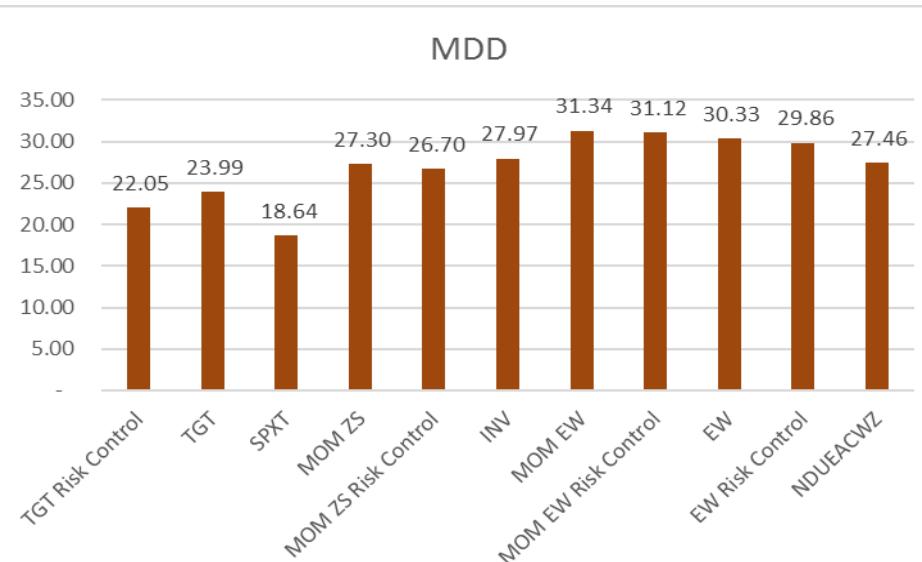
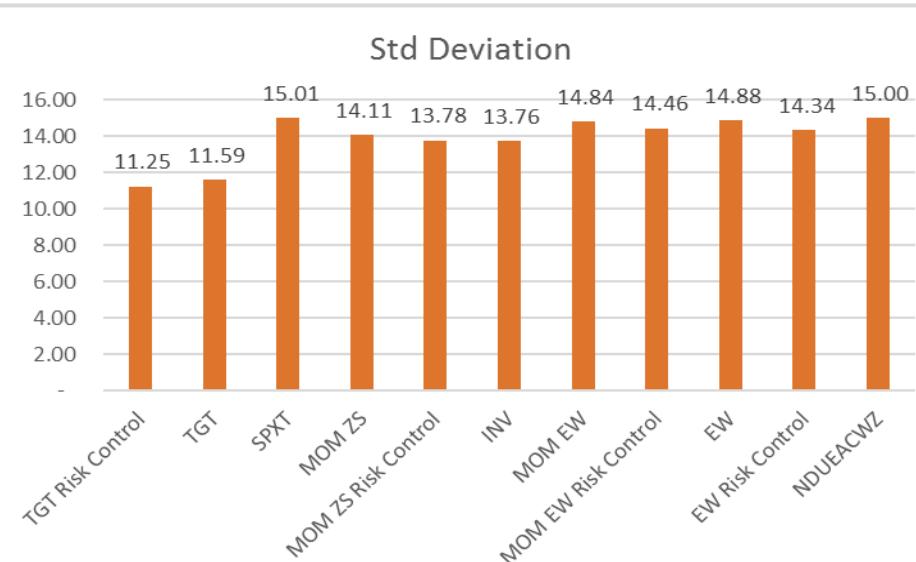
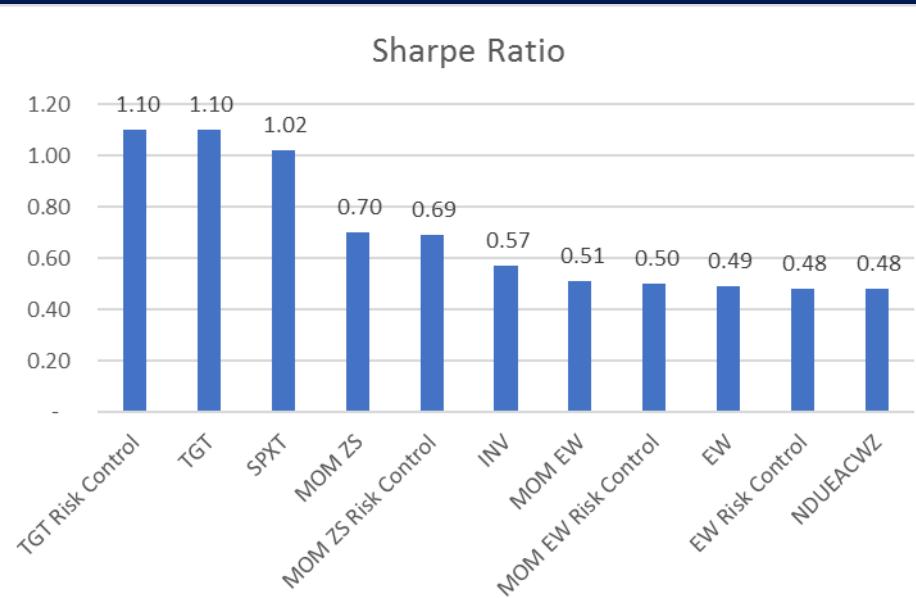
Statistic tables

Period 2001-12-19 to 2018-05-30



Statistic tables

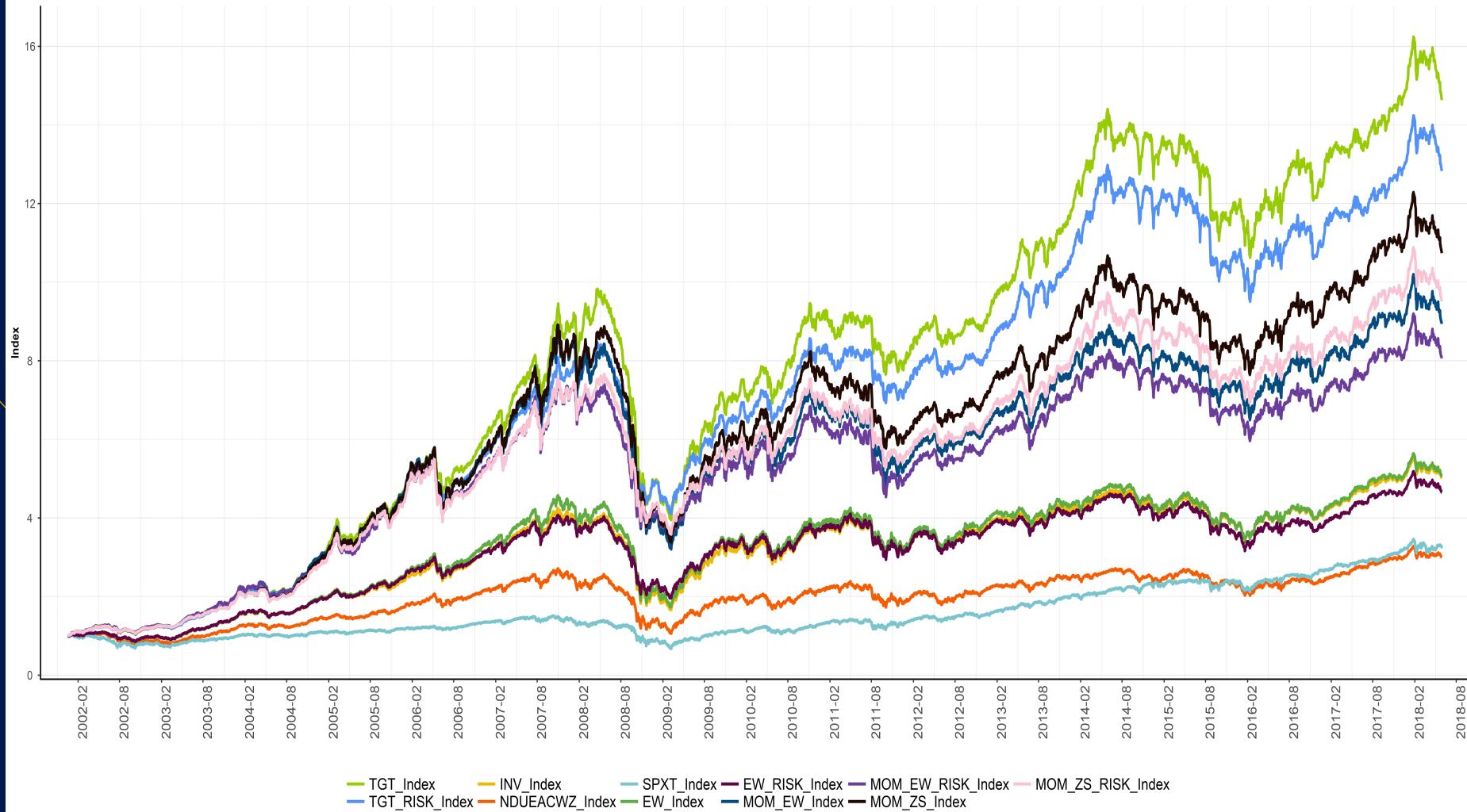
Period 2009-07-01 to 2018-05-30



Result Graphs

Full period

Growth of Portfolios
2001-12-19 to 2018-05-30

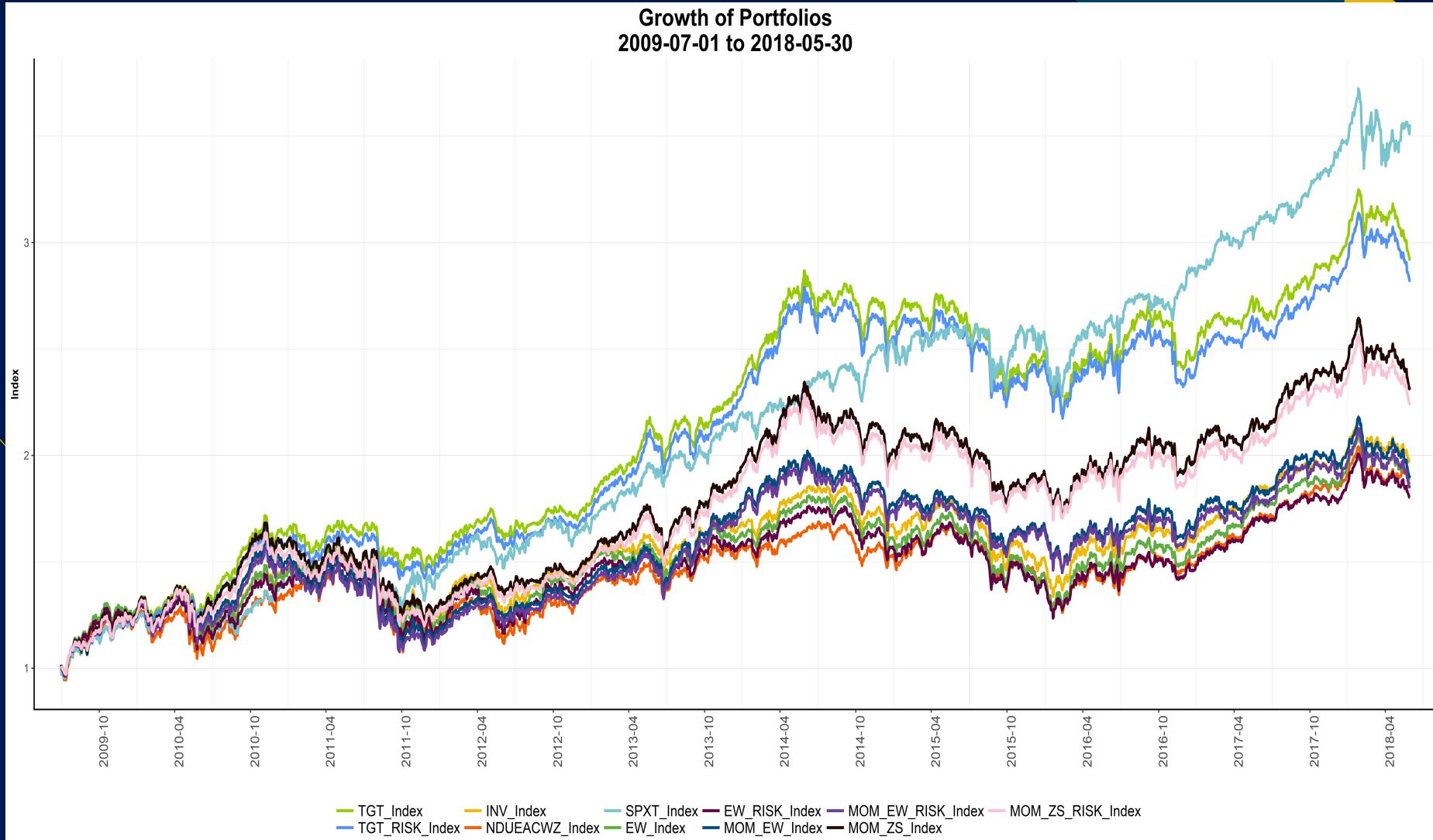


Sources: Bloomberg and MSCI

Result Graphs-continued

Post 08-crisis

Growth of Portfolios
2009-07-01 to 2018-05-30



Sources: Bloomberg and MSCI

Bloomberg Confirmation Graph

The tangent portfolio growth w/o risk control during full period:

My portfolio accumulative return is 13.64

Bloomberg accumulative return is 13.68





Thank you!