QF604: Econometrics of Financial Markets

Jin, Kim, Quek, Wang and Woon (2019)

The Dow Jones Utility Average & Smart Beta Alternatives

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2) Data Sources & Preparation
3) Smart Beta Index Construction, Methodology & Initial Findings
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1 Introduction

Introduction

- The Dow Jones Utility Average (DJUA), a member of the Dow Jones Global Indexes, was created in 1929 when utility stocks were removed from the Dow Jones Industrial Average.
- The DJUA tracks the overall performance of a small group of **15 utility stocks** traded in the U.S. by using a price-weighted average method.
- Constituent companies are primarily **producers of utility resources** such as electricity and natural gas.

Introduction

- In addition, these utility companies typically **pay sizable dividends** and provide a **steady stream of dividend income** relative to companies from other sectors as they face less uncertainty and minimal future volatility due to nature of their industry.
- This therefore results in utility sector stocks to be typically seen as a **favourite for retirees and other income-seeking investors**.
- In hope of constructing an index that outperforms the price-weighted DJUA, our team decided to **construct smart-beta indices** which weigh constituent stocks by fundamentals instead of price. We then analysed and appraised the findings of our endeavour.

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Data Sources & Preparation

Data Sources & Preparation

- Our data sample includes stock and relevant fundamentals data on all stocks which have ever been members of the Dow Jones Utility Average index for the period between 1963 and 2018 (the sample period).
- We obtained the bulk of our data from **Wharton Research Data Services (WRDS)**, from which the Center for Research in Security Prices (CRSP), Compustat - Capital IQ and CRSP/Compustat Merged Database (CCM) databases were utilised.
- We also tapped on the **Bloomberg database** for index price data and membership data on the Dow Jones Utility Average, though the information provided was incomplete and was supplemented by information from this article by Global Financial Data.

Center for Research in Security Prices (CRSP)

- The Center for Research in Security Prices (CRSP) provided us with relevant data on:
  - Monthly closing price,
  - Adjusted returns
  - Outstanding number of stocks.
- **PERMCOs and PERMNOs** as unique entity and issue-level identifiers when navigating the CRSP database.

Compustat - Capital IQ

- Compustat provided us with the relevant fundamentals data (e.g. Net Income, Operating Cash Flow etc) on the relevant constituent stocks of the Dow Jones Utility Average.
- We used **GVKEY** as unique entity-level identifiers when navigating the Compustat database.

CRSP/Compustat Merged Database (CCM)

- We used the CCM Database to obtain the **links between the unique PERMCO and GVKEY identifiers** for the CRSP and Compustat databases respectively.
- This allowed us to be able to **link stock price and market capitalisation data to other corresponding fundamentals** (e.g. computed ROCE, ROA numbers) data at the entity level. With that said, not all required data was found to be available for our sample period.

Computation of Fundamentals

Description	Equation	Price Return Index	Total Return Index	Comments
Market Capitalisation	Share Price x No. of Shares Outstanding	Yes	Yes	
Return on Assets	Net Income/Total Assets	Yes	Yes	
Return on Capital Employed	EBIT/Capital Employed	Yes	Yes	Capital Employed = Total Assets - Current Liabilities
Return on Invested Capital	NOPAT/Invested Capital	Yes	Yes	NOPAT = EBIT x (1-Tax Rate)
Gross Margin	Gross Profit/Revenue	Yes	Yes	
Profit Margin	Net Income/Revenue	Yes	Yes	
EBITDA Margin	EBITDA/Revenue	Yes	Yes	
Operating Cash Flow Margin	Operating Cash Flow/Revenue		Yes	
Current Ratio	Current Assets/Current Liabilities	Yes	Yes	
Long Term Debt to Total Equity	Long Term Debt/Total Equity	Yes	Yes	

Some Data Constraints

- We only started our smart beta Total Return indices from June 1988 owing to a **lack of prior price data on the relevant benchmark index** (the Dow Jones Utility Average Total Return) and on Operating Cash Flow Margin fundamentals data.
- As can be inferred, owing to a lack of data, **price return smart beta indices based on Operating Cash Flow Margin were not constructed**.

3

Smart Beta Index Construction, Methodology & Initial Findings

Weighting Method

We then proceeded to construct smart beta indices based on the 10 fundamentals we have selected. Our weighting method is as follows:

$$\boldsymbol{w_{i,t} = \frac{f_{i,t-1}}{\sum_{i=1}^{N\leq 15} f_{i,t-1}}}, \qquad \boldsymbol{\sum_{i=1}^{N\leq 15} w_{i,t} = 1}$$

where $w_{i,t}$ is the weight assigned for stock i for trading year t, based on its fundamentals data from fiscal year $t-1$, where the sum of the weights of the individual stocks for any year is 1.

Real-World Replicability

- Price and Total Return smart beta indices were first constructed on **June 1963** and **June 1988** respectively. Rebalancing took place every year at the **end of June**.
- The weighting approach using fundamentals data from fiscal year $t-1$ for weights for trading year t, coupled with our approach of performing annual rebalancing only in end-June allows for the **real-world replication** of our smart beta indices .
- This is because **full fiscal year fundamentals data are usually only released at the end of Q1 of every calendar year**.

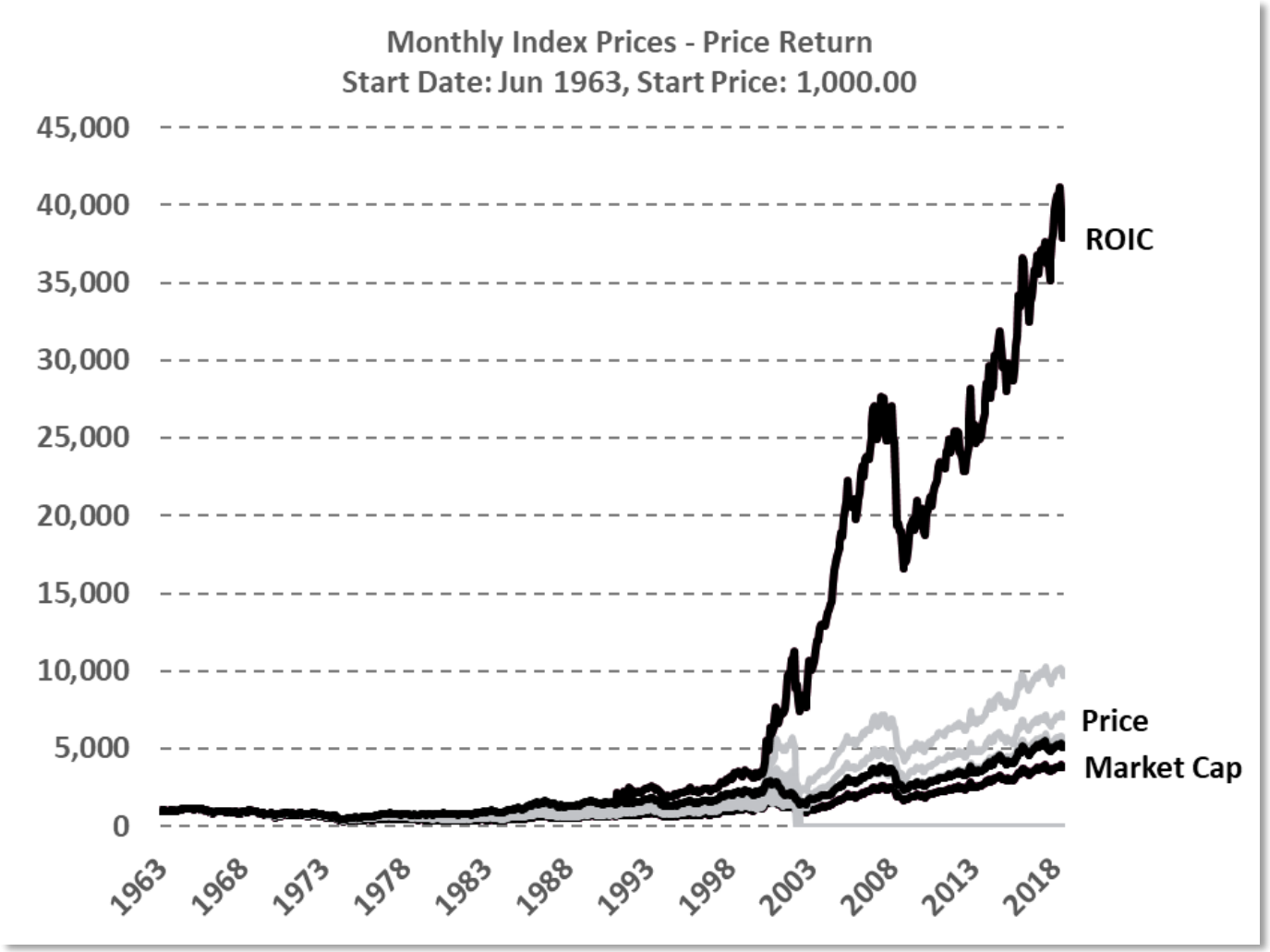
Just Some Rules..

- For every year, only stocks of companies which were **officially members of the benchmark index** (the Dow Jones Utility Average) were included in this weighting process.
- In the case of the problem of **missing data** encountered for certain eligible companies in certain years, said **companies will be excluded** from the Index for that year ($w_{i,t} = 0$).
- For that reason, our constructed indices may have less than 15 constituent stocks for some years, but **never more than 15 constituent stocks** for any year (as with the benchmark index).

Just Some More Rules..

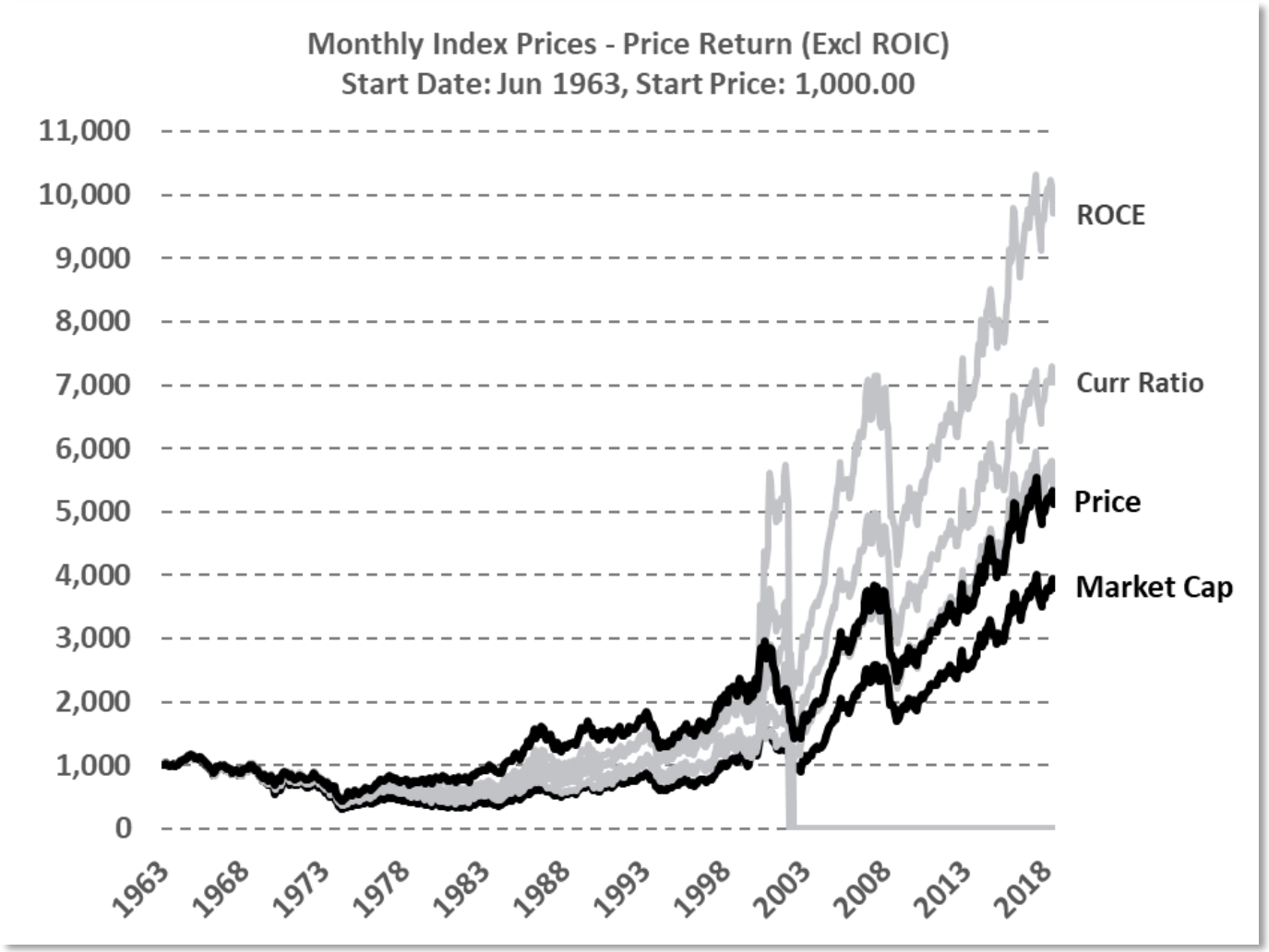
- Given how some of our chosen fundamentals (e.g. ROA, ROCE, ROIC etc) can take on negative values, we allowed our indices to be **fully unconstrained**.
- This means that long or short positions on eligible stocks were permitted **with no set limits**.
- **We also established an "absorbing state"** for the prices of the smart beta indices to be at 0 (indicating a total loss of initial capital), with any of our indices reaching or exceeding that floor deemed to be failed ones and as such excluded from further analysis.

Initial Findings



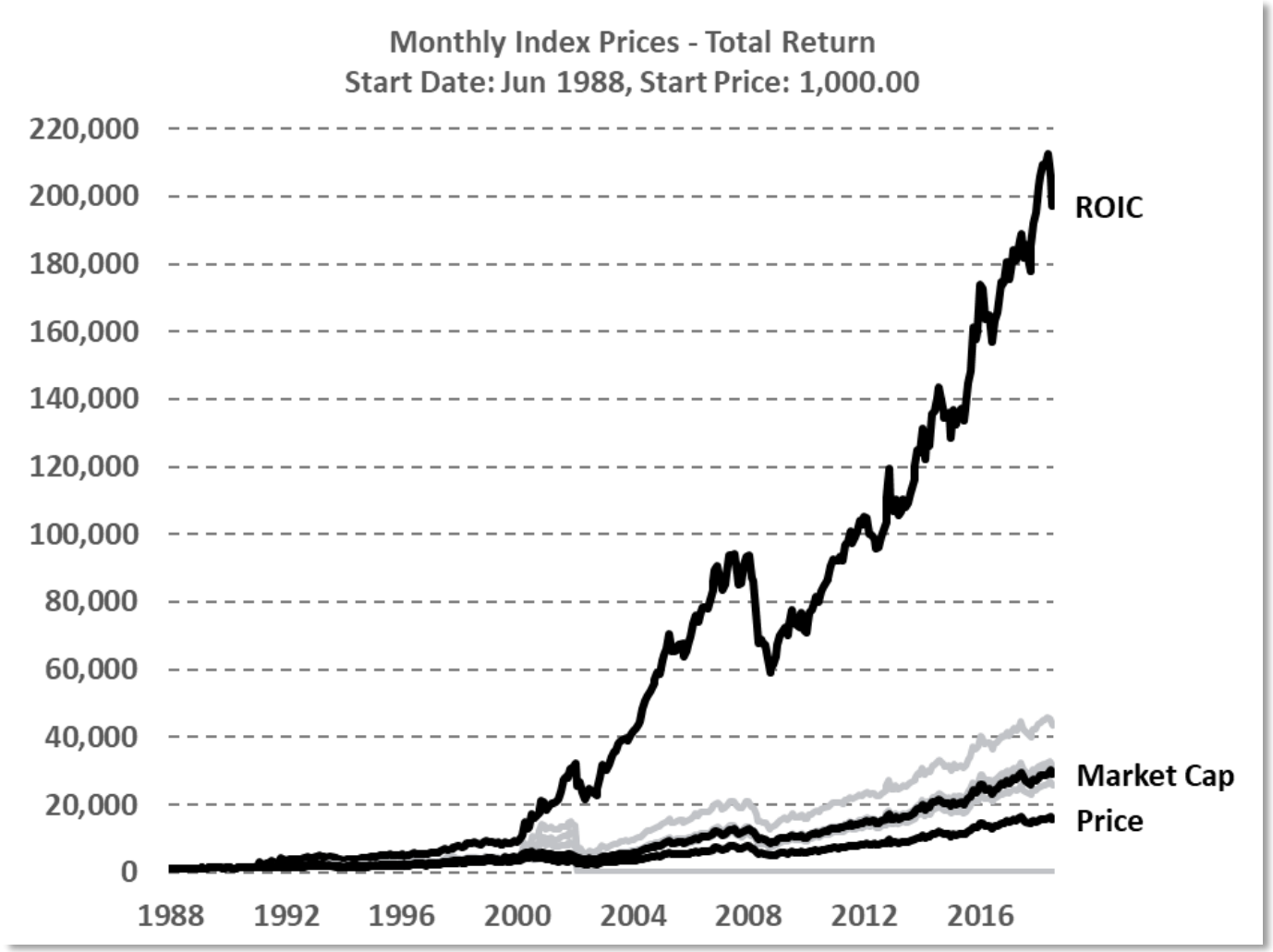
- The superior smart beta index become **clear as day** after the computed smart beta index prices were plotted over time.
- For both price return and total return smart beta portfolios, the portfolios with **ROIC-based weightings** achieved far superior returns over our other constructed indices.

Initial Findings



- Coming in as faraway second and third place were the **ROCE** and **Current Ratio**-based smart beta indices.
- Amongst the portfolios which survived the sample period, indices weighed based on **price** and **market capitalisation performed the worst**.

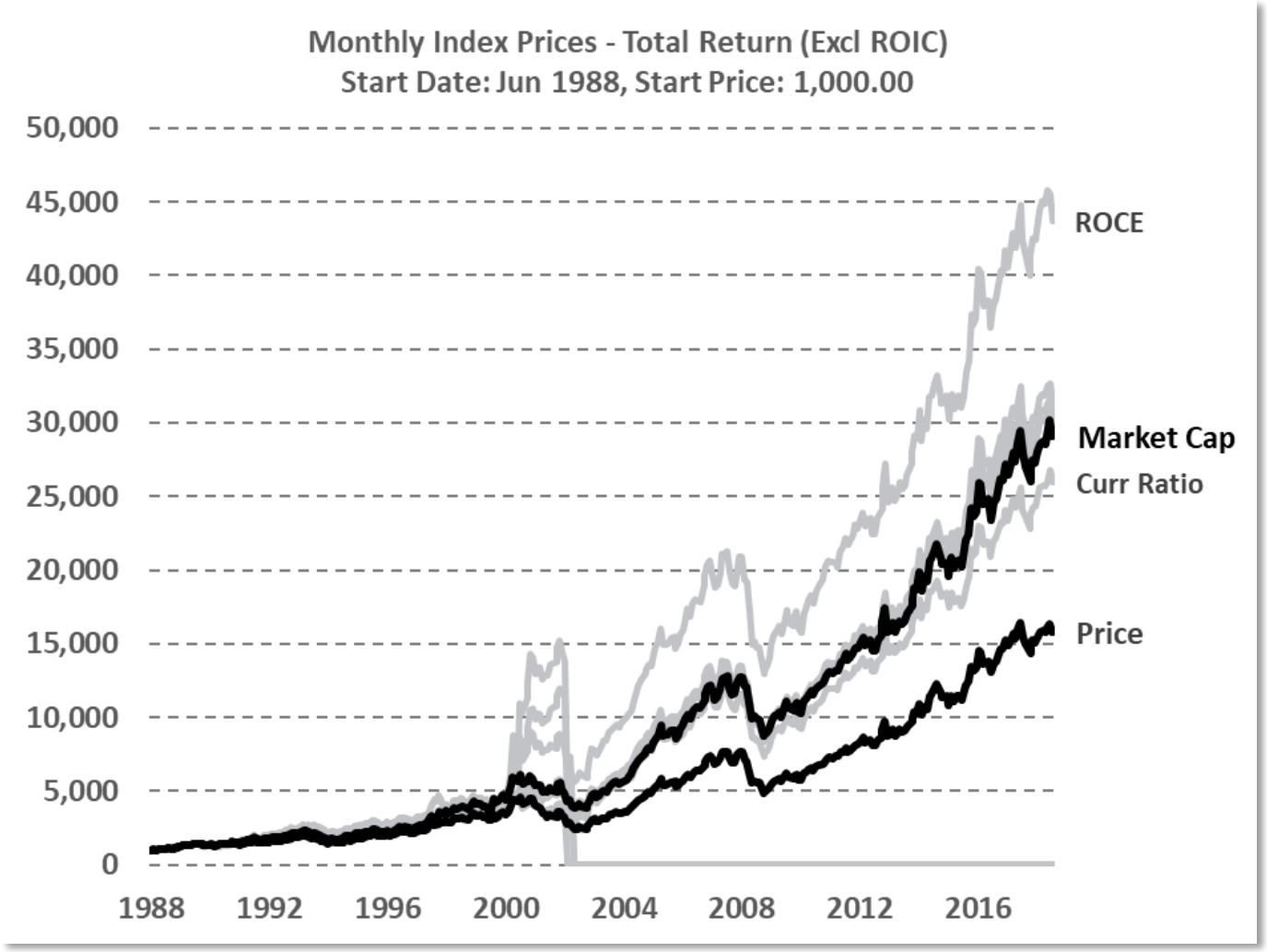
Initial Findings



To put things into perspective:

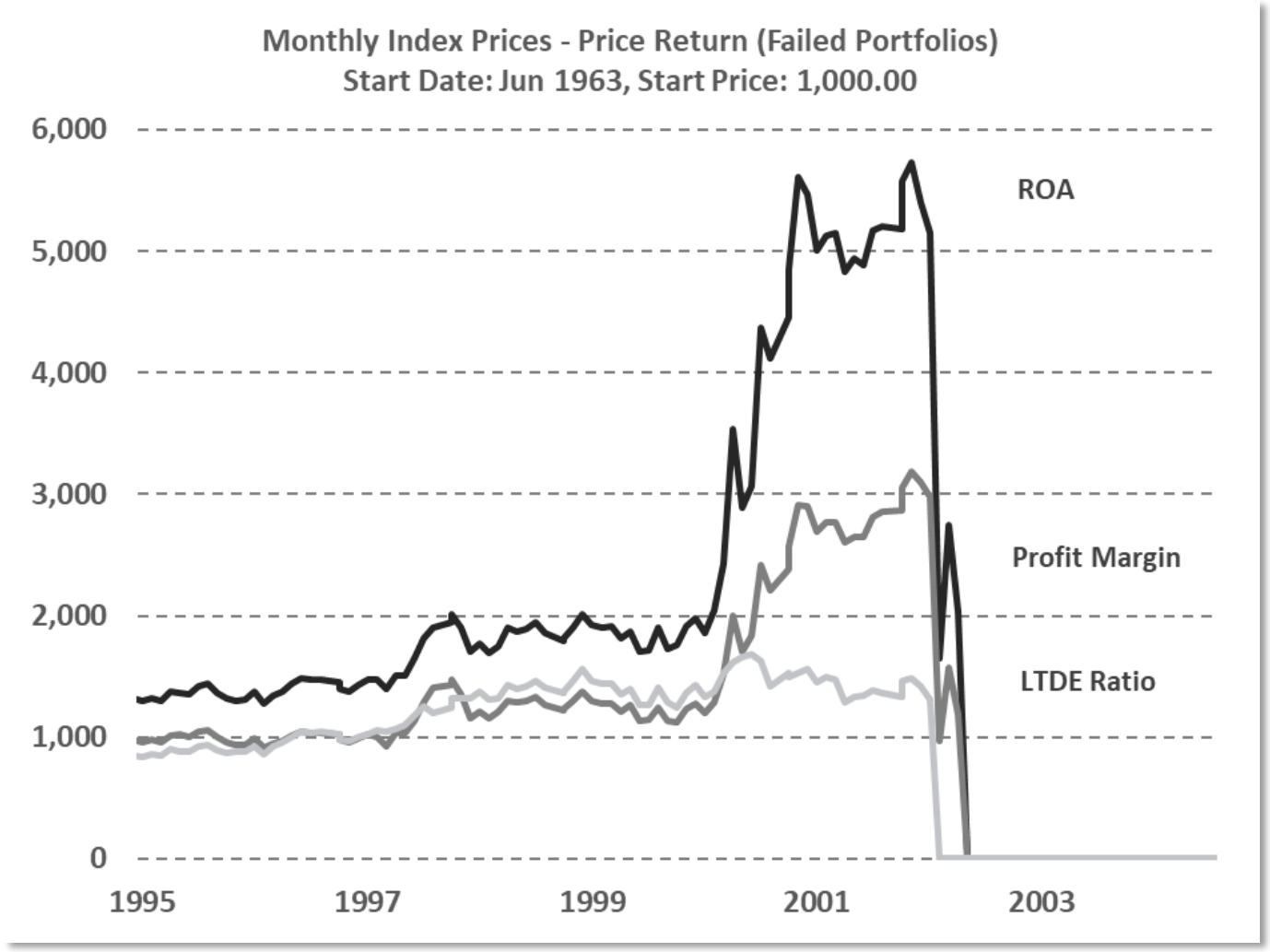
- The value of $1 invested in our constructed ROIC-based total return smart beta portfolio at Jun 1988 would be worth **$197.10** at the end of 2018 (excluding transaction costs).
- An identical $1 invested in the benchmark total return index over the same time period would be worth **"only" $15.77**.

Initial Findings



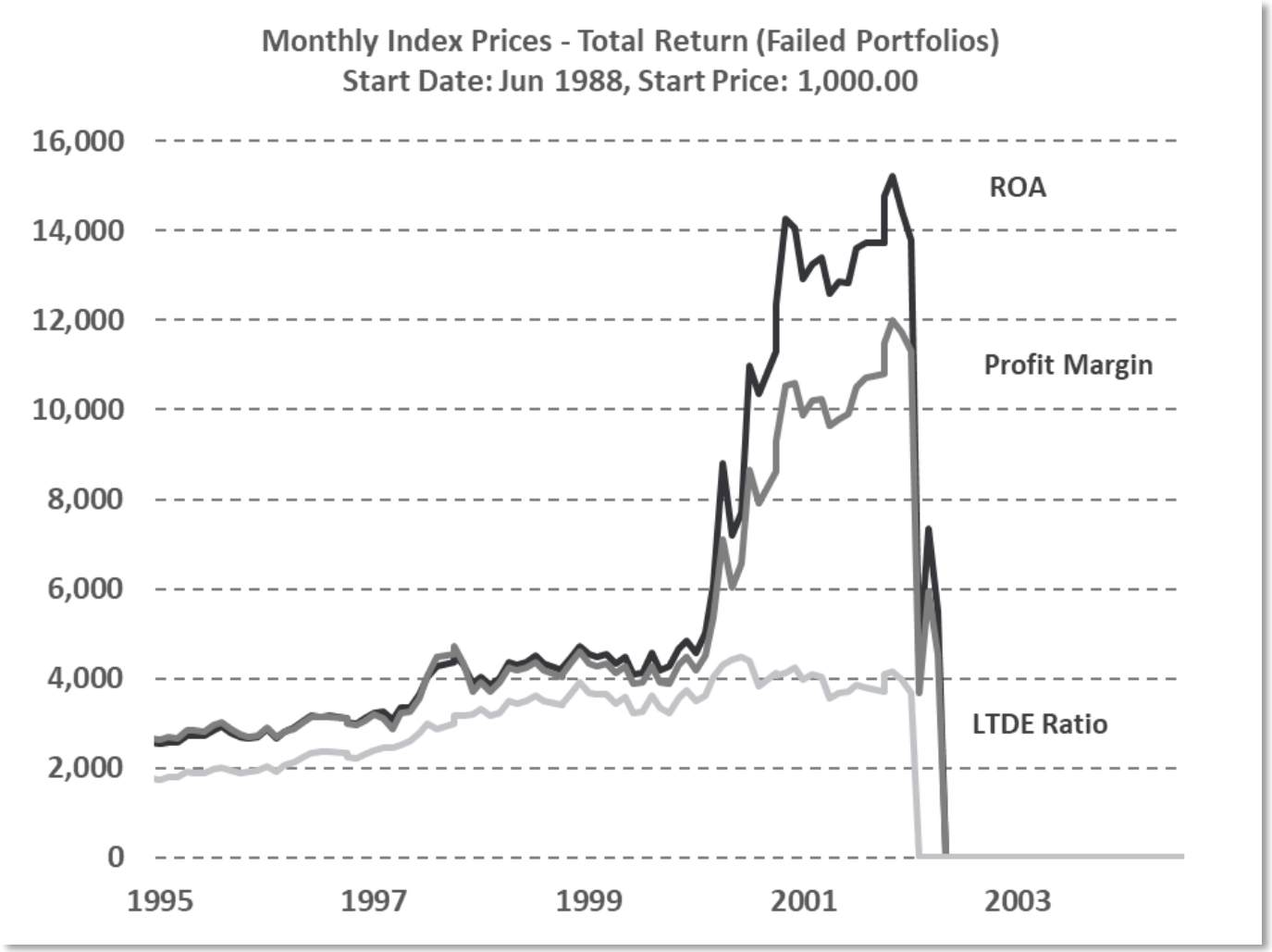
- As with the case of the price return smart beta indices, the second-best performing total return smart beta portfolio was the one weighted based on **ROCE**.
- The **Operating Cash Flow Margin**-based index came in third.
- The **price-weighted index was once again amongst the worst performing** but surviving ones.

Initial Findings



- We also observed a few constructed portfolios which have failed over our sample period (ROA, Profit Margin and LTDE Ratio).
- All of the failure cases were the result of a few extensive losses incurred from prescribed unprofitable and extremely large short positions taken on the same few constituent stocks
- This is the result of one of the drawbacks that come with allowing fully unconstrained portfolios.
- The failures were also observed to all have occurred in mid-to-late 2002.

Initial Findings



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4 Index Performance Appraisal

Price Return Indices

Performance of Fundamentally Weighted **Price Return Indices**

Based on **Geometric Mean Monthly Returns**, for Jan 1964 - Dec 2018

Index	Ending Value of 1$	Geometric Mean Return	Volatility	VS RF rate (3M US Treasury)			VS Original Index		
				Excess Return	Sharpe Ratio	t-Stat	Excess Return	Information Ratio	t-Stat
DJUAPR	$5.14	0.25%	**4.14%**	**-0.14%**	**-0.03**	-0.31	-	-	-
ROIC	**$37.61**	**0.55%**	**7.73%**	**0.16%**	**0.02**	**1.32**	**0.31%**	**0.05**	**1.80**
ROCE	$9.67	0.34%	4.79%	**-0.04%**	**-0.01**	0.39	0.10%	0.05	1.48
Gross Margin	$5.52	0.26%	4.53%	**-0.13%**	**-0.03**	-0.13	0.01%	0.01	0.40
EBITDA Margin	$5.34	0.25%	4.51%	**-0.13%**	**-0.03**	-0.16	0.01%	0.00	0.32
Operating Cash Flow Margin	-	-	-	-	-	-	-	-	-
Current Ratio	$6.99	0.30%	4.49%	**-0.09%**	**-0.02**	0.07	0.05%	0.03	0.90
Market Capitalisation	**$3.77**	**0.20%**	4.53%	**-0.18%**	**-0.04**	**-0.46**	**-0.05%**	**-0.03**	**-0.41**

Price Return Indices

Distribution of Fundamentally Weighted **Price Return Indices**

Based on **Geometric Mean Monthly Returns**, for Jan 1964 - Dec 2018

Index	Skewness	Kurtosis	Maximum Monthly Return	Minimum Monthly Return	Maximum 3-Month Return	Minimum 3-Month Return	Maximum 12-Month Return	Minimum 12-Month Return
DJUAPR	-0.23	0.82	**13.41%**	**-16.02%**	**27.68%**	**-24.55%**	**46.70%**	**-41.68%**
ROIC	8.30	138.22	**134.33%**	**-30.60%**	**125.15%**	-27.62%	**161.42%**	-43.59%
ROCE	0.26	2.48	27.47%	-17.66%	55.88%	-28.14%	100.79%	-41.76%
Gross Margin	-0.20	1.35	16.88%	-21.34%	40.09%	-30.76%	62.44%	-44.46%
EBITDA Margin	-0.18	1.19	16.88%	-20.12%	37.60%	-28.96%	56.73%	-44.46%
Operating Cash Flow Margin	-	-	-	-	-	-	-	-
Current Ratio	-0.21	1.67	19.25%	-21.33%	39.49%	**-34.02%**	67.16%	-44.29%
Market Capitalisation	-0.02	1.22	19.44%	-17.65%	34.76%	-30.31%	58.32%	**-49.46%**

Price Return Indices

Summary of Statistics of Fundamentally Weighted **Price Return Indices**

Based on **Arithmetic Mean Returns**, for Jan 1964 - Dec 2018

	DJU	Market Cap	ROIC	ROC	Gross Margin	EBITDA Margin	Op CF Margin	Current Ratio
Key Statistics (Based on Annual Returns)								
Mean Return (%)	4.34%	**3.91%**	**9.47%**	5.89%	4.68%	4.55%	-	5.20%
Volatility (%)	**16.31%**	17.38%	**27.20%**	19.49%	17.71%	17.27%	-	18.17%
Mean Risk Free Rate (%)	4.78%	4.78%	4.78%	4.78%	4.78%	4.78%	-	4.78%
Ending Value of $1 Investment	5.13	**3.77**	**37.61**	9.67	5.52	5.34	-	6.99
Ratios (Net of Rf)								
Sharpe Ratio	**-0.027**	**-0.048**	**0.171**	0.056	**-0.006**	**-0.013**	-	0.022
Downside Volatility (%)	11.39%	**10.75%**	**11.87%**	11.08%	11.05%	10.87%	-	11.59%
Sortino Ratio (%)	-0.039	**-0.081**	**0.395**	0.101	-0.009	-0.021	-	0.036
Extreme Risk Statistics								
Best Monthly Return (%)	45.45%	19.44%	**134.33%**	27.47%	**16.88%**	**16.88%**	-	19.25%
Worst Monthly Return (%)	-30.38%	**-17.65%**	**-30.60%**	-17.66%	-21.34%	-20.12%	-	-21.33%
% of Months with +ve Return (Not Net of Rf)	55.30%	55.12%	**56.73%**	56.14%	55.12%	55.85%	-	**54.82%**
Performance Relative to the DJUA (Net of Rf, Based on Annual Returns)								
Alpha	0.00%	**-0.41%**	**5.16%**	1.60%	0.36%	0.22%	-	0.89%
Beta to Market	1	1.03	1.07	1.1	1.03	1.02	-	1.06
Correlation with DJU	1	0.95	0.64	0.91	0.94	0.94	-	0.95

Total Return Indices

Performance of Fundamentally Weighted **Total Return Indices**

Based on **Geometric Mean Monthly Returns**, for Jan 1989 - Dec 2018

Index	Ending Value of 1$	Geometric Mean Return	Volatility	VS RF rate (3M US Treasury)			VS Original Index		
				Excess Return	Sharpe Ratio	t-Stat	Excess Return	Information Ratio	t-Stat
DJUAPR	**$ 14.71**	**0.75%**	**4.17%**	**0.51%**	**0.12**	**2.70**	-	-	-
ROIC	**$ 181.77**	**1.46%**	**9.32%**	**1.21%**	0.13	3.11	**1.07%**	**0.13**	**2.17**
ROCE	$ 40.60	1.03%	4.78%	0.79%	0.17	**3.58**	0.65%	0.27	3.20
Gross Margin	$ 28.79	0.94%	4.45%	0.69%	0.16	3.38	0.55%	0.27	3.11
EBITDA Margin	$ 28.19	0.93%	4.42%	0.69%	0.16	3.38	0.54%	0.27	3.10
Operating Cash Flow Margin	$ 29.46	0.94%	4.21%	0.70%	**0.17**	3.55	0.55%	**0.29**	**3.38**
Current Ratio	$ 24.56	0.89%	4.44%	0.65%	0.15	3.20	**0.51%**	0.26	2.34
Market Capitalisation	$ 26.76	0.92%	4.19%	0.67%	0.16	3.44	0.52%	0.29	3.23

Total Return Indices

Distribution of Fundamentally Weighted **Total Return Indices**

Based on **Geometric Mean Monthly Returns**, for Jan 1989 - Dec 2018

Index	Skewness	Kurtosis	Maximum Monthly Return	Minimum Monthly Return	Maximum 3-Month Return	Minimum 3-Month Return	Maximum 12-Month Return	Minimum 12-Month Return
DJUAPR	-0.48	0.55	**12.39%**	-13.33%	**30.78%**	**-21.63%**	**51.65%**	-31.80%
ROIC	8.43	117.26	**134.84%**	**-28.59%**	**129.33%**	-26.87%	**194.69%**	-32.58%
ROCE	0.29	3.80	27.36%	-17.55%	57.59%	-27.47%	108.80%	-33.09%
Gross Margin	-0.57	1.98	15.83%	-21.26%	40.81%	-30.14%	67.14%	-33.25%
EBITDA Margin	-0.53	1.63	14.40%	-20.04%	38.39%	-28.33%	61.74%	-31.42%
Operating Cash Flow Margin	-0.43	0.68	13.93%	-13.00%	33.52%	-22.70%	52.94%	-32.84%
Current Ratio	-0.58	2.15	15.34%	-21.28%	40.26%	**-33.44%**	71.58%	**-37.54%**
Market Capitalisation	-0.14	1.14	19.37%	**-11.18%**	35.80%	-22.07%	63.38%	**-27.70%**

Total Return Indices

Summary of Statistics of Fundamentally Weighted **Total Return Indices**

Based on **Arithmetic Mean Returns**, for Jan 1989 - Dec 2018

	DJU	Market Cap	ROIC	ROC	Gross Margin	EBITDA Margin	Op CF Margin	Current Ratio
Key Statistics (Based on Annual Returns)								
Mean Return (%)	**11.02%**	13.13%	**22.82%**	15.24%	13.61%	13.42%	13.39%	13.13%
Volatility (%)	18.70%	18.82%	**36.03%**	22.84%	19.73%	19.06%	**17.85%**	20.29%
Mean Risk Free Rate (%)	3.04%	3.04%	3.04%	3.04%	3.04%	3.04%	3.04%	3.04%
Ending Value of $1 Investment	**14.71**	26.76	**181.77**	40.60	28.79	28.19	29.46	24.56
Ratios (Net of Rf)								
Sharpe Ratio	**0.43**	0.54	0.56	0.54	0.54	0.55	**0.58**	0.50
Downside Volatility (%)	13.95%	**11.75%**	13.76%	13.57%	13.39%	12.94%	12.32%	**14.77%**
Sortino Ratio (%)	**0.57**	0.86	**1.44**	0.90	0.79	0.80	0.84	0.68
Extreme Risk Statistics								
Best Monthly Return (%)	50.76%	19.37%	**134.84%**	27.36%	15.83%	14.40%	**13.93%**	15.34%
Worst Monthly Return (%)	-27.84%	**-11.18%**	**-28.59%**	-17.55%	-21.26%	-20.04%	-13.00%	-21.28%
% of Months with +ve Return (Not Net of Rf)	**63.61%**	65.28%	65.56%	63.89%	64.17%	64.44%	**65.83%**	64.17%
Performance Relative to the DJUA (Net of Rf, Based on Annual Returns)								
Alpha	**0.00%**	2.33%	**12.19%**	3.64%	2.72%	2.74%	3.15%	2.00%
Beta to Market	1	0.97	0.95	1.07	0.98	0.96	0.90	1.01
Correlation with DJU	1	0.98	0.54	0.90	0.94	0.95	0.95	0.94

5 Conclusion

Conclusion

- **ROIC**-based smart beta index is the one of choice, as it delivers far **superior returns and decent risk-adjusted performance**.
- However, superior returns come at expense of greater **downside volatility** and **worst monthly return** (higher risk).
- **Op CF Margin**-based smart beta index also worth an honourable mention due to its **superior risk-adjusted return** in terms of Sharpe ratio, may be better suited for lower-volatility play.

- Possible Additional Avenues of Exploration
  - Analyses of more fundamental-weighted indices
  - Analyses of drivers of relative smart beta index outperformance

Thank you.