

15 Years of R in Quantitative Finance

rstudio::conf 2020

Brandon Farr
Senior Quantitative Analyst



Copper Rock
CAPITAL PARTNERS

We estimate that at least 99% of so-called “fundamental” models for individual companies **manifest themselves in Excel.**

– A | B Bernstein: *Global Quantitative Strategy*, October 4, 2018

My focus today

1. Using R to do better analysis.
 - *you spend more time interpreting data than manipulating data*
2. Using R to build what you can't buy.

Data

AAPL US \$

C 317.69

+8.74

Z317.69 / 317.76Q

1x2

📶

🕒

On 28 Jan c

Vol 40,558,486

0 312.60K

H 318.40D

L 312.19D

Val 12.863B

AAPL US Equity

95) Compare

96) Actions ▾

97) Edit ▾

Line Chart

01/29/2015 📅 - 01/28/2020 📅

Last Px

Local CCY ▾

☒ Mov Avgs ✎

☐ Key Events

1D 3D 1M 6M YTD 1Y 5Y Max Daily ▾

Table

Chart Content

⚙️



Reported data

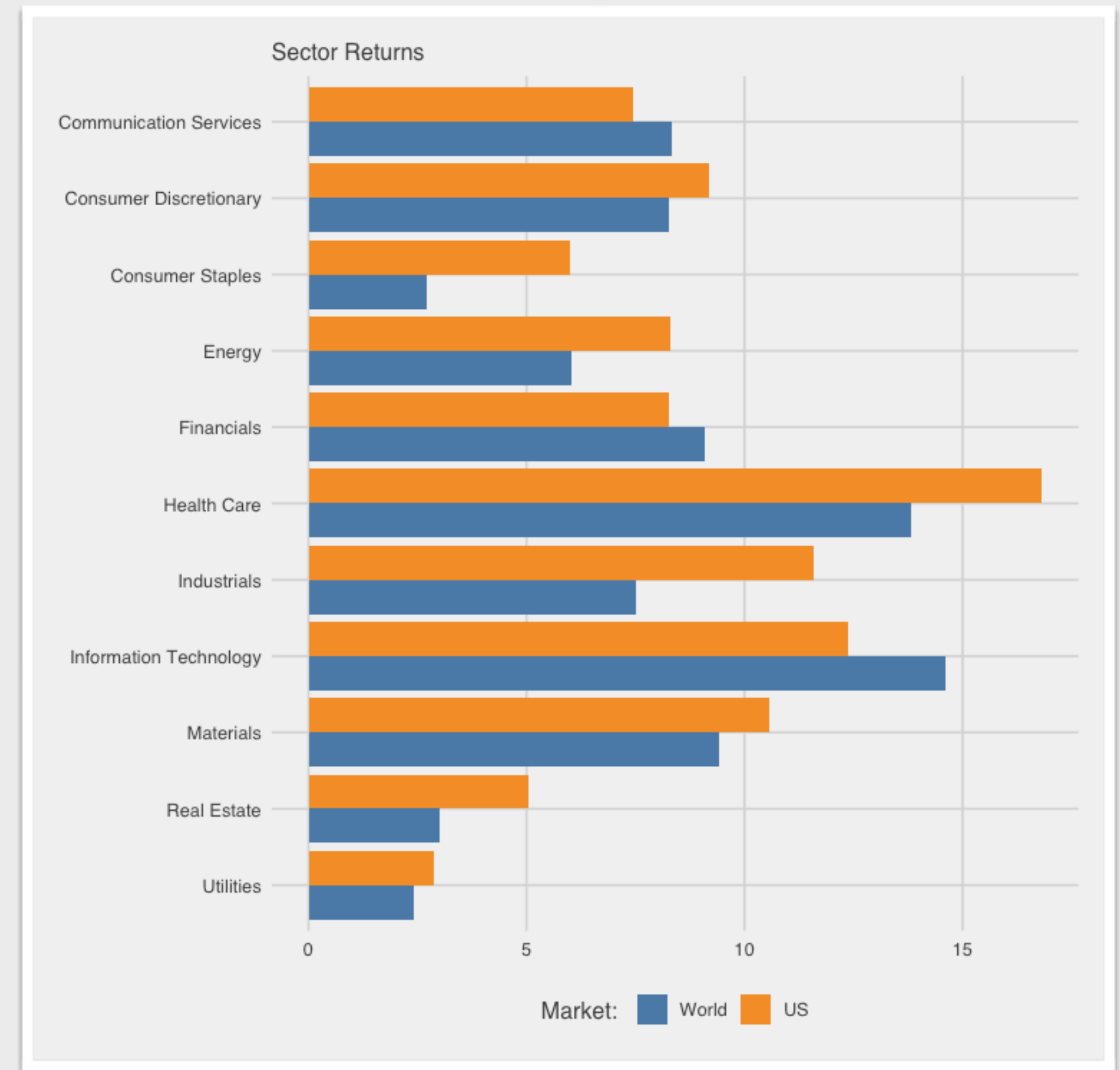
	A	B	C	D	E
1	MSCI World				
2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
6					
7			Bench. Average Weight	Bench. Total Return	
8	Total		100.00	9.07	
9					
10	Communication Services		8.77	8.34	
200	Consumer Discretionary		10.81	8.28	
550	Consumer Staples		8.28	2.72	
799	Energy		5.29	6.02	
944	Financials		16.76	9.08	
1465	Health Care		11.56	13.82	
1721	Industrials		10.46	7.51	
2193	Information Technology		16.74	14.61	
2500	Materials		4.71	9.43	
2794	Real Estate		3.26	3.00	
2979	Utilities		3.36	2.41	
3129					
3130					
3131					

pseudo data - for demonstration purposes only

What is driving markets?

	A	B	C	D	E
1	MSCI World				
2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
6					
7					
8	Total				
9					
10	Communication S				
200	Consumer Discret				
550	Consumer Staples				
799	Energy				
944	Financials				
1465	Health Care				
1721	Industrials				
2193	Information Techn				
2500	Materials				
2794	Real Estate				
2979	Utilities				
3129					
3130					
3131					

	A	B	C	D	E
1	S&P 500				
2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
6					
7					
8	Total				
9					
10			Bench. Average Weight	Bench. Total Return	
200					
550					
799					
944					
1465					
1721					
2193					
2500					
2794					
2979					
3129					
3130					
3131					



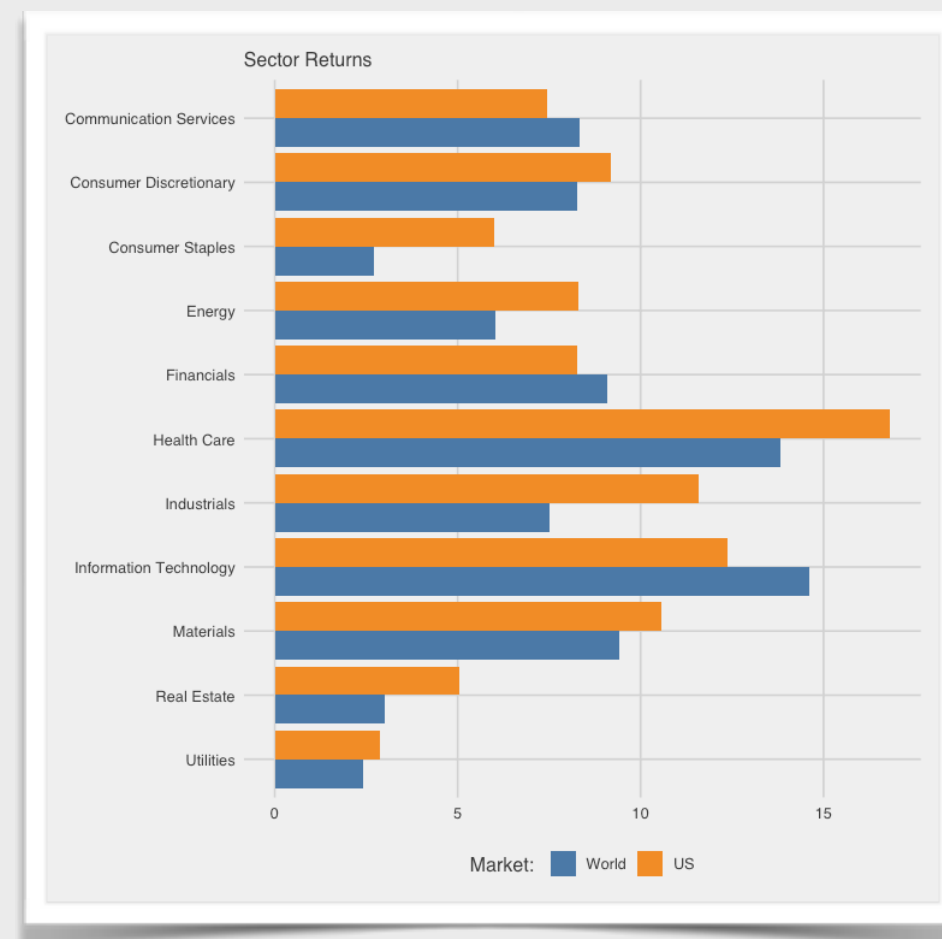
What is driving markets? — Excel

	A	B	C	D	E
1	MSCI World				
2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
6					
7					
8	Total				
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200	Consumer Discretionary				
550	Consumer Staples				
799	Energy				
944	Financials				
1465	Health Care				
1721	Industrials				
2193	Information Technology				
2500	Materials				
2794	Real Estate				
2979	Utilities				
3129					
3130					
3131					

	A	B	C	D	E
1	S&P 500				
2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
6					
7					
8	Total		100.00	9.87	
9					
10	Communication Services		3.59	7.45	
216	Consumer Discretionary		11.78	9.19	
838	Consumer Staples		4.43	6.00	
1073	Energy		3.13	8.30	
1291	Financials		13.86	8.25	
1879	Health Care		10.59	16.82	
2379	Industrials		17.54	11.57	
3203	Information Technology		13.15	12.36	
3698	Materials		6.91	10.58	
4042	Real Estate		11.95	5.03	
4457	Utilities		3.08	2.87	
4546					
4547					
4548					



1. Gather the data into a single tab
2. Create a plot referencing **group totals**
3. Customize the plot



Things change

- New questions:
 - “Ok, fine, but what worked in the Emerging Markets?”
 - “Did Healthcare and Technology lead in the 4th quarter of 2018?”
- How do we do answer these questions with our Excel process?

What is driving markets? — Excel

	A	B	C	D	E
1	MSCI World				
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4042	Real Estate				
4457	Utilities				
4546					
4547					
4548					

	A	B	C	D	E
1	MSCI Emerging Markets				
2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
6					
7					
8	Total				
9					
10	Communication Services				
91	Consumer Discretionary				
359	Consumer Staples				
485	Energy				
535	Financials				
702	Health Care				
869	Industrials				
1129	Information Technology				
1358	Materials				
1577	Real Estate				
1722	Utilities				
1798					
1799					
1800					



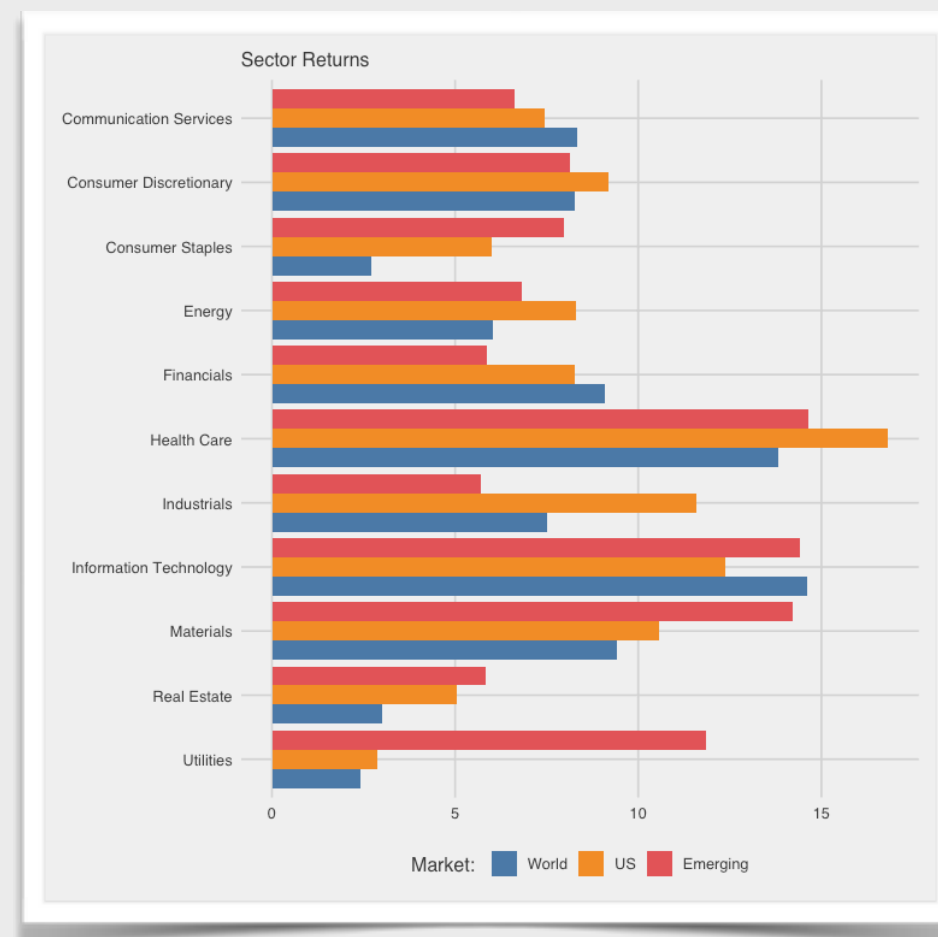
1. Gather data



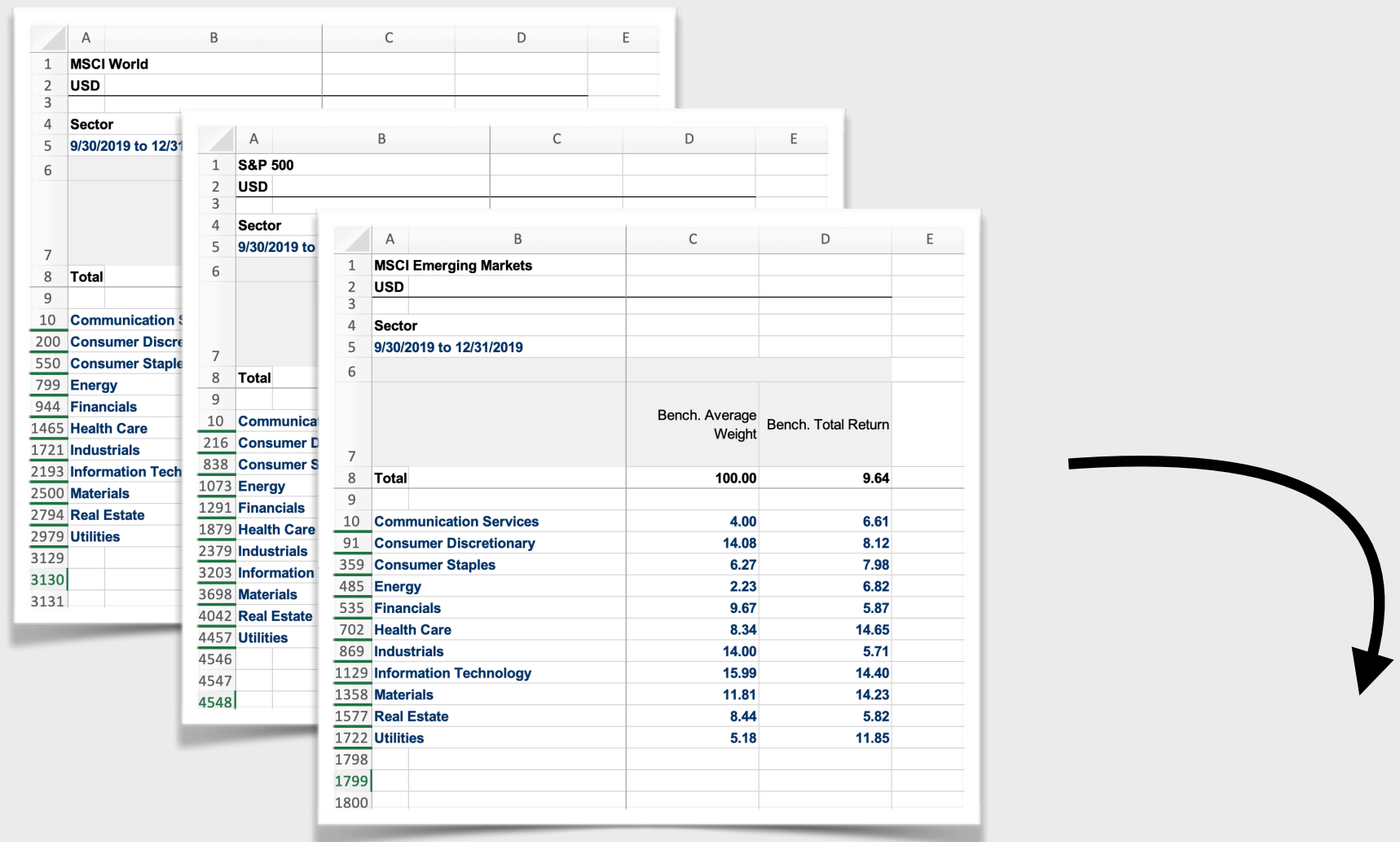
2. Create plot referencing **group totals**



3. Customize plot



What is driving markets? — R



	A	B	C	D	E
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2	USD				
3					
4	Sector				
5	9/30/2019 to 12/31/2019				
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3129					
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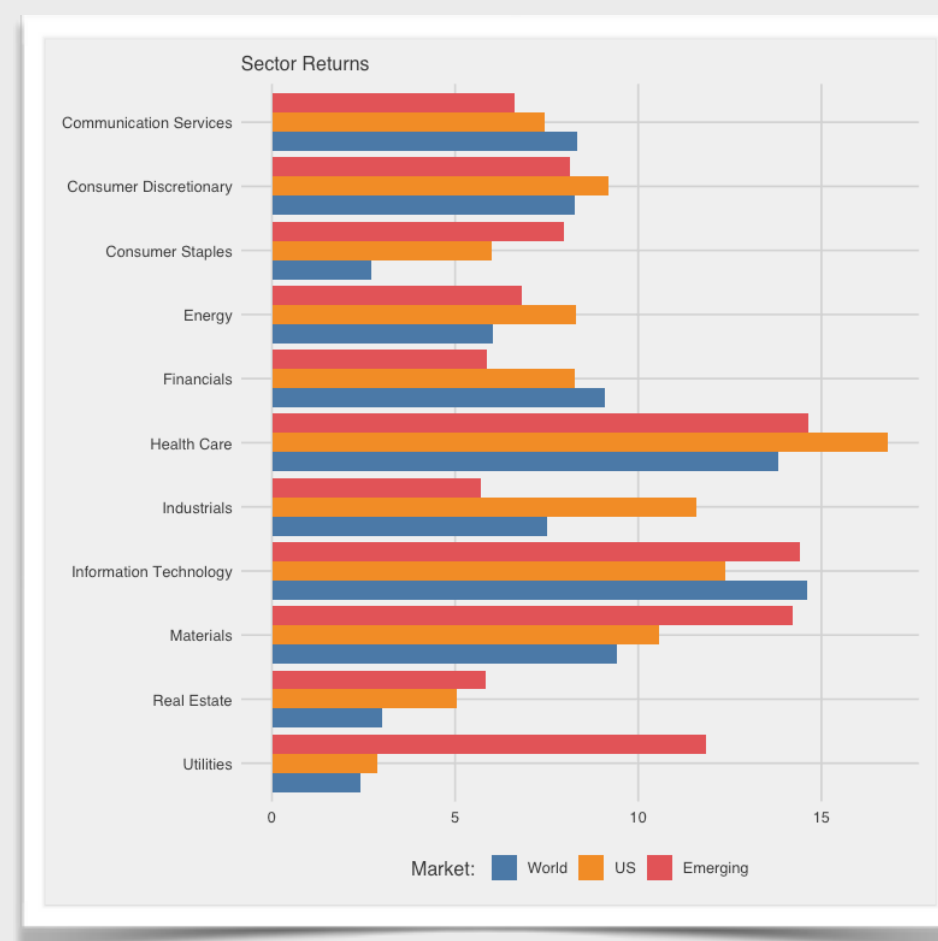
	A	B	C	D	E
1	S&P 500				
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3					
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6					
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702	Health Care				
869	Industrials				
1129	Information Technology				
1358	Materials				
1577	Real Estate				
1722	Utilities				
1798					
1799					
1800					

```
# Specify data file  
data_file <- "data/2019-12-sector.xlsx"
```

```
# pipe data thru custom functions  
data_file %>%
```

```
  prepare_market_data() %>%  
  collect_groups() %>%  
  plot_groups()
```



Code

```
data_file %>%  
  prepare_market_data() %>%  
  collect_groups() %>%  
  plot_groups()
```

prepare_market_data()

```
prepare_market_data <- function(file) {  
  excel_sheets(file) %>%  
    enframe(name = NULL, value = "Market") %>%  
    mutate(  
      Holdings = map(Market, ~read_grouped_data(file, .))  
    )  
}
```

```
R > excel_sheets(file) %>%  
...      enframe(name = NULL, value = "Market")  
# A tibble: 2 x 1  
  Market  
  <chr>  
1 World  
2 US
```

prepare_market_data() — cont.

```
prepare_market_data <- function(file) {  
  excel_sheets(file) %>%  
    enframe(name = NULL, value = "Market") %>%  
    mutate(  
      Holdings = map(Market, ~read_grouped_data(file, .))  
    )  
}
```

```
. . . %>%  
  mutate(  
    Holdings = map(Market, ~read_grouped_data(file, .))  
  )  
# A tibble: 2 x 2  
  Market Holdings  
  <chr>   <list>  
1 World <tibble [3,119 x 4]>  
2 US    <tibble [4,536 x 4]>
```

read_grouped_data()

8	Total		100.00	9.87
.879	Health Care		10.59	16.82
.880		ABCAM PLC	0.05	27.84
.881		Abeona Therapeutics, Inc.	0.00	29.42
.882		Acadia Healthcare Company, Inc.	0.05	6.89
.883		ACADIA Pharmaceuticals Inc.	0.08	18.87
.884		Accelerate Diagnostics, Inc.	0.01	-8.99
.885		Accelaron Pharma Inc	0.03	34.19

```
read_grouped_data <- function(file, sheet = 1) {  
  read_excel(file, sheet = sheet, skip = 9, col_names = FALSE) %>%  
    set_names(c("Sector", "Name", "Weight", "Return")) %>%  
    mutate(  
      Sector = zoo::na.locf(Sector),  
      Name = if_else(is.na(Name), "Group_Total", Name)  
    )  
}
```


collect_groups()

```
collect_groups <- function(tbl) {  
  tbl %>%  
    unnest() %>%  
    filter(Name == "Group_Total")  
}
```

plot_groups()

```
plot_groups <- function(tbl) {  
  tbl %>%  
    ggplot(  
      aes(x = Sector, y = Return, fill = Market)  
    ) +  
    geom_col(position = "dodge") +  
  
  ...  
}
```

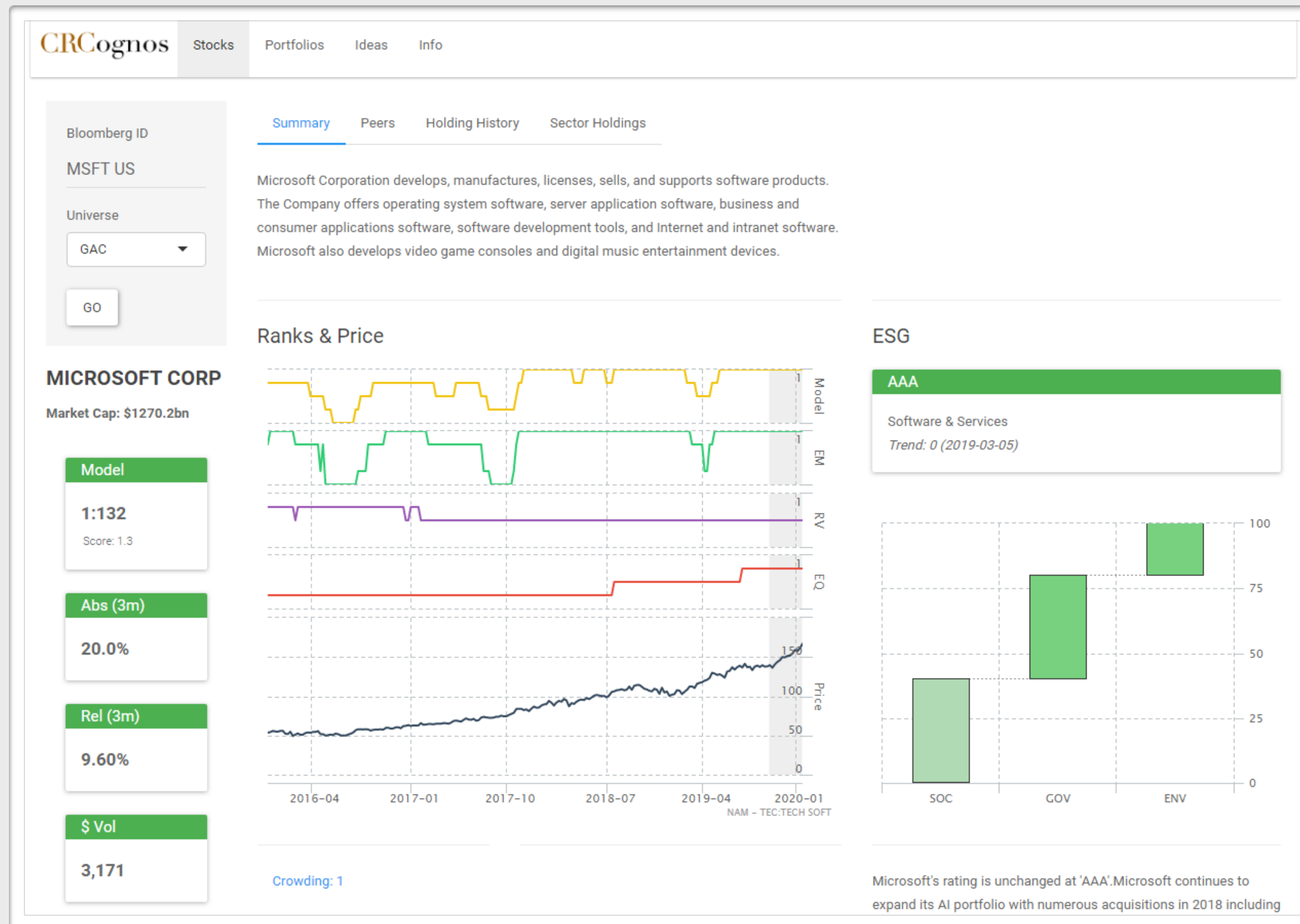
Better analysis with R

- Reliable
- Replicable & Efficient
- Robust to future change

A model delivery problem

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Global															
3	Company															
4	LI	CRV	BB ID	Name	SCT	SEG	RGT	Cap	ESC	Ranks	ESC	Ranks	GSC	Ranks	ISC	Ranks
5	12.8	9	DRI GR	1&1 Drillisch AG	COM	TELECOMM	EXU	5.9	-		0.5	2:511	-		-	
6	8.2	1	FLWS US	1-800-FLOWERS.COM, Inc. Class A	CDS	RETAILING	NAM	1.2	-		1.0	1:135	0.9	1:145	-	
7	0.8		11B PW	11 Bit Studios SA	COM	MEDIA & ENT	EMG	0.2	-0.9	5:445	-0.6	4:435	-0.6	4:435	-0.6	4:435
8	1.9	5	SRCE US	1st Source Corporation	FIN	BANKS	NAM	1.2	-		0.6	2:132	0.6	2:132	-	
9	4.2		VNET US	21Vianet Group, Inc. Sponsored ADR Class A	TEC	TECH SOFT	EMG	0.6	0.4	2:323	0.1	3:324	0.1	3:324	-0.0	3:334
10	2.8		XXII US	22nd Century Group, Inc.	CST	FOOD BEV & TOB	NAM	0.3	-		-2.0	5:355	-1.6	5:355	-	
11	40.8	3	TWOU US	2U, Inc.	TEC	TECH SOFT	NAM	2.4	-		0.3	2:152	0.3	2:152	-	
12	5.2		7777 JP	3-D Matrix, Ltd.	HEA	PHARMA BIOTECH	JP	0.1	-		-0.9	5:355	-0.7	4:345	-1.4	5:355
13	29.8		601360 C1	360 Security Technology, Inc. Class A	TEC	TECH SOFT	EMG	21.1	-		0.1	3:341	-		-	
14	14.7	6	DDD US	3D Systems Corporation	TEC	TECH HARD	NAM	1.1	-		-2.2	5:553	-2.2	5:553	-	
15	24.2	6	III LN	3i Group plc	FIN	DIV FINANCIALS	UK	13.7	-		0.5	2:222	-		-	
16	599	7	MMM US	3M Company	IND	CAPITAL GOODS	NAM	99.9	-		-1.8	5:531	-		-	
17	1.2		3M IN	3M India Limited	IND	CAPITAL GOODS	EMG	3.8	-0.1	3:341	0.1	3:341	0.1	3:341	0.2	3:341
18	13.9	5	1530 HK	3SBio, Inc.	HEA	PHARMA BIOTECH	EMG	4.3	0.4	2:222	0.7	2:222	0.8	1:222	0.7	2:222
19	0.8		2051 HK	51 Credit Card Inc.	FIN	DIV FINANCIALS	EMG	0.7	0.9	1:312	0.8	1:312	0.8	1:312	0.9	1:312
20	23.9		JOBS US	51job Inc Sponsored ADR	IND	COMM&PROF SRVC	EMG	4.7	0.2	2:332	0.2	2:332	0.3	2:332	0.3	2:332
21	58.7	3	WUBA US	58.com Inc. Sponsored ADR Class A	COM	MEDIA & ENT	EMG	7.8	-		0.1	3:431	-		-	
22			SEM MK	7-Eleven Malaysia Holdings Bhd	CST	FOOD & STPLS RET	EMG	0.4	0.2	2:231	0.1	3:241	0.2	3:241	0.2	2:241
23	4.7	8	8341 JP	77 Bank, Ltd.	FIN	BANKS	JP	1.1	-		1.0	1:213	1.0	1:213	1.1	1:113
24	1.6	7	888 LN	888 Holdings Plc	CDS	CONSUMER SRVC	UK	0.8	-		0.3	2:511	0.2	3:511	0.0	3:511
25	31.3	6	EGHT US	8x8, Inc.	TEC	TECH SOFT	NAM	2.3	-		-2.6	5:555	-2.7	5:555	-	
26	1.9		7745 JP	A&D Co Ltd	TEC	TECH HARD	JP	0.2	-		1.1	1:312	1.0	1:312	1.0	1:312
27	5.2		3319 HK	A-Living Services Co. Ltd. Class H	IND	COMM&PROF SRVC	EMG	2.3	1.6	1:121	1.5	1:121	1.7	1:111	1.8	1:111
28	78.8	7	AOS US	A. O. Smith Corporation	IND	CAPITAL GOODS	NAM	7.9	-		0.4	2:431	-		-	
29	1.8	4	BAG LN	A.G. BARR p.l.c.	CST	FOOD BEV & TOB	UK	1.3	-		-0.5	4:251	-0.5	4:251	-0.5	4:251
30	8.1	8	MAERSKA DC	A.P. Moller - Maersk A/S Class A	IND	TRANSPORTATION	EXU	24.1	-		-0.8	5:245	-		-	
31	33.3		MAERSKB DC	A.P. Moller - Maersk A/S Class B	IND	TRANSPORTATION	EXU	25.8	-		-0.8	5:255	-		-	
32	2.7	2	ATEN US	A10 Networks, Inc.	TEC	TECH SOFT	NAM	0.5	-		0.3	2:323	0.3	2:322	-	
33	7.1	3	ATM NZ	a2 Milk Company Ltd.	CST	FOOD BEV & TOB	PXJ	7.2	-		0.7	2:141	-		-	
34	32		A2M AU	a2 Milk Company Ltd.	CST	FOOD BEV & TOB	PXJ	7.1	-		0.8	1:141	-		-	
35	18.8	5	A2A IM	A2A S.p.A.	UTL	UTILITIES	EXU	5.4	-		0.2	2:423	-		-	
36	1.2	10	AA/ LN	AA Plc	CDS	CONSUMER SRVC	UK	0.4	-		0.7	2:214	0.7	2:213	0.8	2:213
37	76.2	9	2018 HK	AAC Technologies Holdings Inc.	TEC	TECH HARD	EMG	6.8	-		-0.8	5:523	-		-	
38	7.7	1	AAK SS	AAK AB	CST	FOOD BEV & TOB	EXU	4.8	-		0.2	2:154	0.2	3:154	0.4	2:154
39	12.1	5	AALB NA	Aalberts N.V.	IND	CAPITAL GOODS	EXU	4.4	-		0.2	2:322	0.3	2:322	0.3	2:322
40	1.3		AHCS QD	Aamal Holding Company	IND	CAPITAL GOODS	EMG	1.4	0.5	2:321	0.3	2:331	0.4	2:331	0.4	2:331
41	6.8	2	AAON US	AAON, Inc.	IND	CAPITAL GOODS	NAM	2.6	-		-1.5	5:554	-1.3	5:453	-	
42	9.2	5	AIR US	AAR CORP.	IND	CAPITAL GOODS	NAM	1.3	-		-0.5	4:533	-0.5	4:532	-	
43	11	4	ARL GR	Aareal Bank AG	FIN	BANKS	EXU	1.6	-		-0.8	5:525	-0.8	5:535	-0.9	5:535
44	28	1	AAN US	Aaron's, Inc.	CDS	RETAILING	NAM	4.2	-		1.1	1:131	1.1	1:141	-	
45	2.6		ARTO IN	AARTI Industries Ltd	MAT	CHEMICALS	EMG	2.2	-0.5	4:153	-0.4	4:252	-0.4	4:153	-0.4	4:153
46	1.3		AAVAS IN	Aavas Financiers Ltd.	FIN	BANKS	EMG	1.7	0.7	2:151	0.6	2:151	0.8	2:151	0.9	1:151
47	0.7		SAGAD SS	AB Sagax	REA	REAL ESTATE	EXU	1.6	-		1.5	1:311	1.4	1:311	1.5	1:311
48			AB FP	AB Science SA	HEA	PHARMA BIOTECH	EXU	0.2	-		-1.3	5:355	-1.1	5:345	-1.6	5:355
49	2.2	3	ABP AU	Abacus Property Group	REA	REAL ESTATE	PXJ	1.7	-		0.7	2:321	0.9	1:321	1.0	1:321
50	2.8		ABB IN	ABB India Limited	IND	CAPITAL GOODS	EMG	4.9	-0.6	4:451	-0.6	4:451	-0.5	4:451	-0.5	4:451
51	130	4	ABBN SW	ABB Ltd.	IND	CAPITAL GOODS	EXU	42.8	-		-0.6	4:533	-		-	
52	0.8		BOOT IN	Abbott India Limited	HEA	PHARMA BIOTECH	EMG	2.7	-1.2	5:552	-0.3	4:532	-0.3	4:522	-0.5	4:532
53	422	1	ABT US	Abbott Laboratories	HEA	HEALTH CARE E&S	NAM	148.4	-		1.1	1:123	-		-	
54	431	10	ABBV US	AbbVie, Inc.	HEA	PHARMA BIOTECH	NAM	107.5	-		1.9	1:111	-		-	

Cognos - A Shiny app



Bloomberg ID

MSFT US

Universe

GAC

GO

MICROSOFT CORP

Market Cap: \$1238bn

Model

1:132

Score: 1.2

Abs (3m)

18.3%

Rel (3m)

9.80%

\$ Vol

3,171

Summary

Peers

Holding History

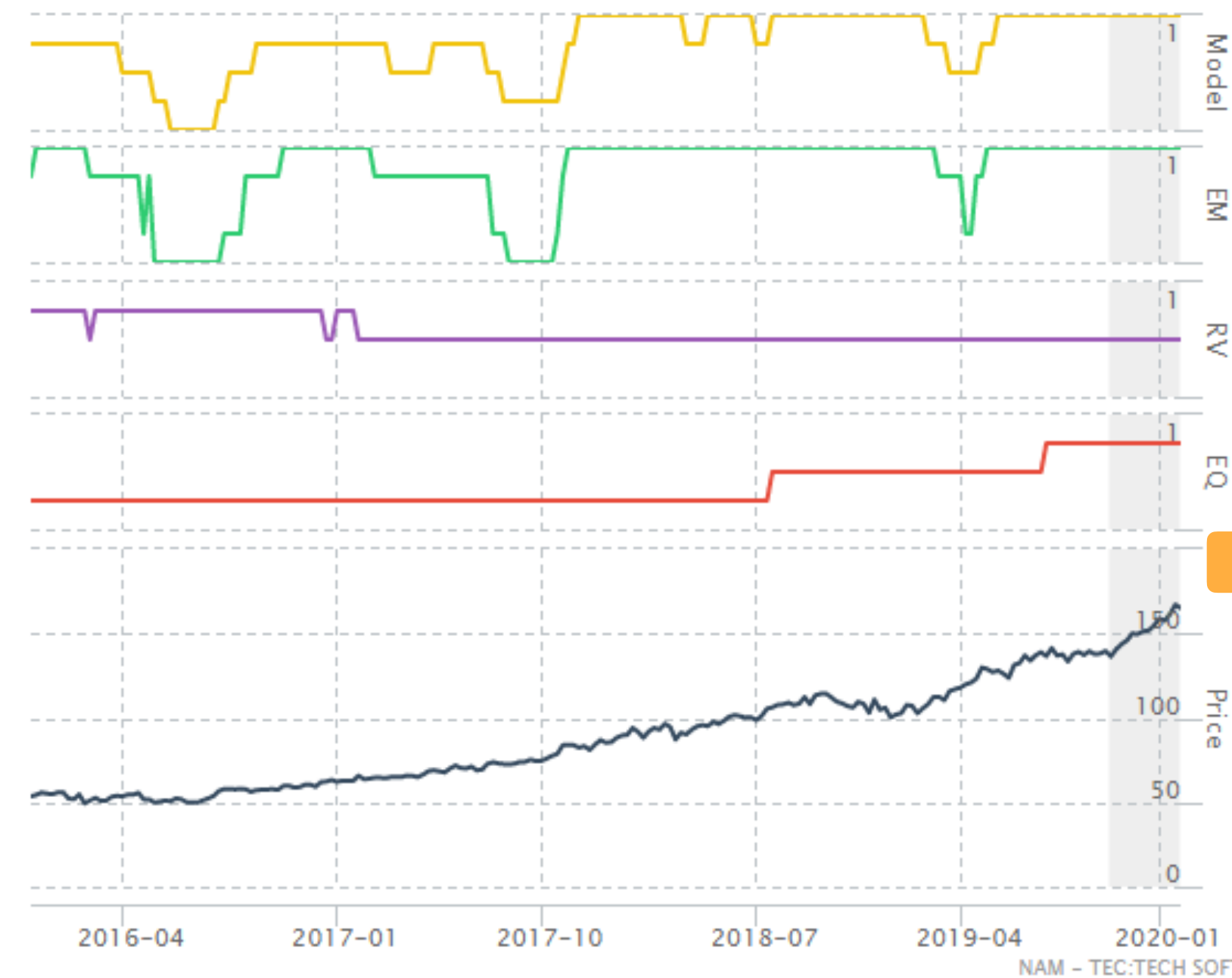
Sector Holdings

Bloomberg

Microsoft Corporation develops, manufactures, licenses, sells, and supports software products. The Company offers operating system software, server application software, business and consumer applications software, software development tools, and Internet and intranet software. Microsoft also develops video game consoles and digital music entertainment devices.

Ranks & Price

Copper Rock



Crowding: 1

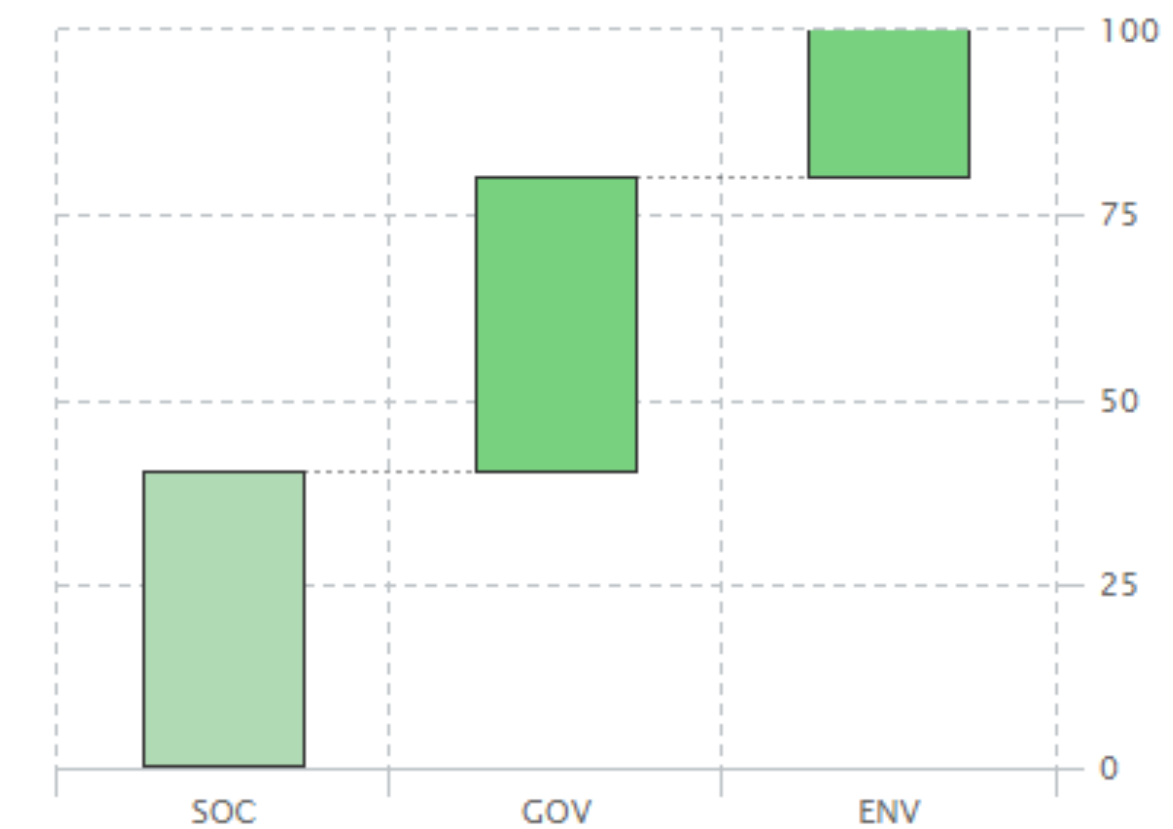
ESG

MSCI

AAA

Software & Services

Trend: 0 (2019-03-05)



Microsoft's rating is unchanged at 'AAA'. Microsoft continues to expand its AI portfolio with numerous acquisitions in 2018 including Bonsai, a machine training company. This comes close on heels of the GitHub acquisition for USD 7.5 billion, a world leading software development platform. Through the evolution of its research business, Microsoft continues to retain its status as a sought-after employer in the technology sector. Machine learning, which relies

Bloomberg ID

MSFT US

Universe

GAC

GO

MICROSOFT CORP

Market Cap: \$1238bn

Model

1:132

Score: 1.2

Abs (3m)

18.3%

Rel (3m)

9.80%

\$ Vol

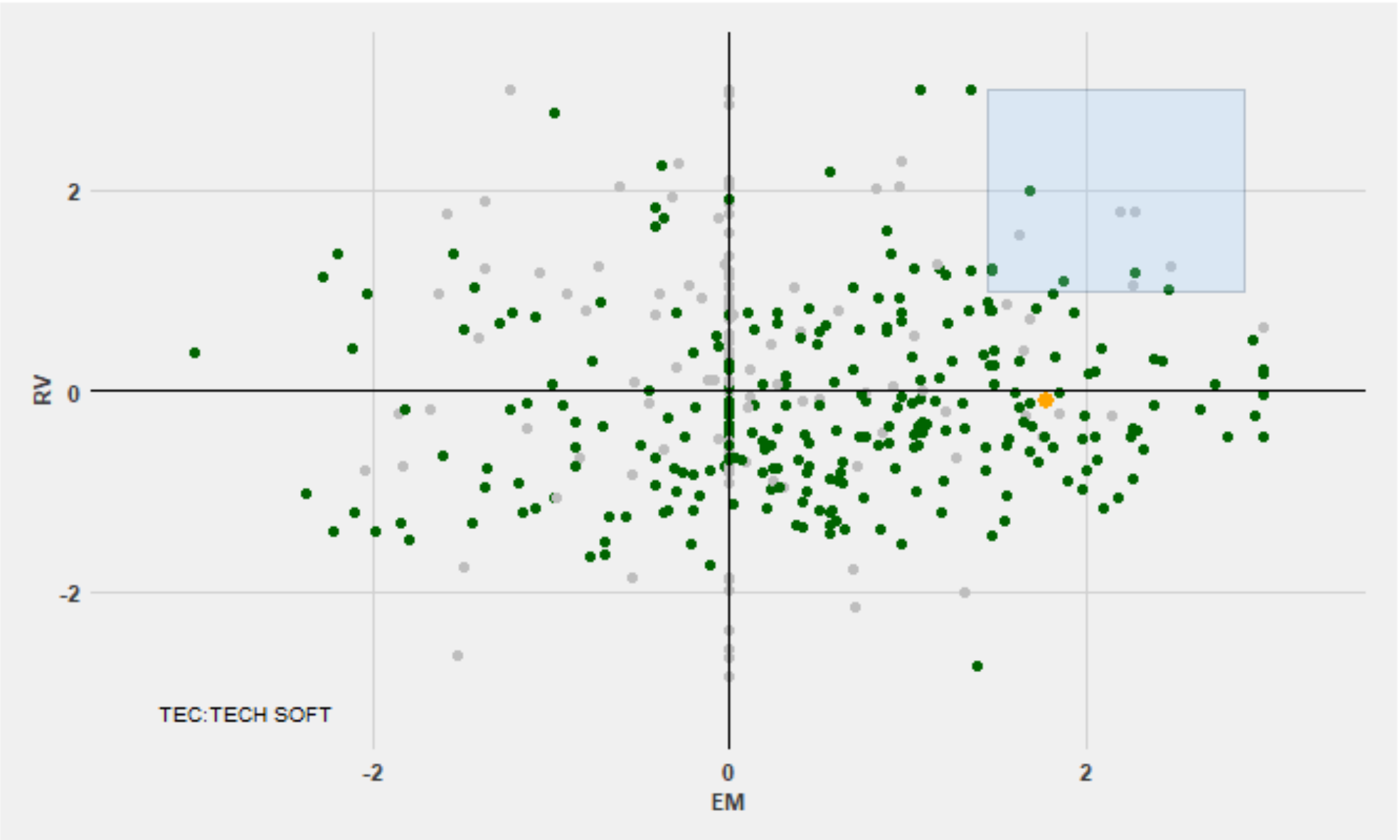
3,171

Summary

Peers

Holding History

Sector Holdings



BBID	Name	EM	RV	EQ	RobustVol
CATM US	Cardtronics plc C...	2.46	1.01	-0.85	15.5
354 HK	Chinasoft Interna...	1.88	1.09	-0.16	8.7
CVLT US	CommVault Systems...	2.27	1.18	0.1	20.6
CCC LN	Computacenter Plc	2.26	1.05	-0.62	2.8
6702 JP	Fujitsu Limited	1.68	1.99	-0.43	80.9
1973 JP	NEC Networks & Sy...	2.48	1.24	-0.4	3.6
7518 JP	Net One Systems C...	1.47	1.2	0.22	22.1
060250 KS	NHN KCP Corp.	2.19	1.79	-1.19	5.6
2327 JP	NS Solutions Corp	1.47	1.23	0.09	7.2

My focus today

1. Using R to do better analysis.
2. Using R to build what you can't buy.

Thank you

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