Using data science tools and techniques for creating and maintaining a passive investment portfolio

CITRENZ 2021 Workshop, facilitated by Arthur Valle

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Arthur Valle, PhD

- PhD in Production and System Engineering: **Process Mining**
- **Six Sigma** Black Belt
- 23+ years of experience in IT Management: Lean Six Sigma, **CMMI**, ITIL, PMBOK, Agile/Scrum, etc
- DIY Investor (since 2016)
- Currently teaching and researching at Wintec-Waikato Institute of Technology, NZ
- Founder of **TRENDSET** (www.trendsetconsulting.com/en)

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Disclaimer

- I am not an authorised financial advisor.
- This is not an investment recommendation.
- Past performance does not guarantee future return.

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Content

- Why invest?
- Why passive investing?
- Key terminology
- Example of passive portfolio
- 3 steps to implement the passive strategy
- Data Science tools & techniques
- Research Project
- Conclusion

WHY INVEST?

"YOU, OWNER OF PROFITABLE COMPANIES ALL OVER THE WORLD"

- **You won't get rich** working for others - or even for yourself - from 9 am to 6 pm every day.

"FREE TIME IN THE FUTURE"

- For a decent retirement, you need to **put your money to work for you and wait the time act on it.**

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WHY PASSIVE INVESTING?

"IF YOU CAN'T BEAT IT, JOIN IT"

- In the long run, **very few investors are able to consistently "beat the market"**, with low risk.

Source: https://www.spglobal.com/spdji/en/research-insights/spiva/

"INVESTING SHOULD BE AS BORING AS WATCHING THE GRASS TO GROW"

- Do not waste your time reading balance sheets to find "the next Tesla": **it's the time in the market and regular contributions that will buy you "free time in the future".**
- Dedicate your hours for your current source of income (or even new ones), but **put your savings (and time) to work for you!**

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WHY PASSIVE INVESTING?

BFG_BurgerFuel (brown) + WHS_TheWareHouse (green) vs NZ Top 50 (blue)

https://www.nzx.com/instruments/BFG

AIA_AucklandAirport (blue) + BFG_BurgerFuel (brown) vs NZ Top 50 (green)

https://www.nzx.com/instruments/AIA

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Key terminology

Passive Investment:

- An investment strategy, **aiming to obtain the same average return as the stock market indexes**, such as S&P 500 or NZX 50.
- Implemented via index funds: greater diversification (and consequently less risky) than picking isolated companies' shares.
- Requires less effort (and knowledge):
  - it avoids unnecessary *buys* and *sells*
  - tends to have returns similar to active investing, in the long run.

ETFs (or index funds):

- ETF (Exchange Traded Fund) is a **financial asset traded on the stock exchange. It replicates the performance of a given index**.
- ETFs are used in the passive investment strategy as they are naturally diversified and have lower management fees.
- Examples of NZX's ETFs:
  - Smartshares NZ Top 50 (FNZ)
  - Smartshares Emerging Markets ETF (EMF)
  - Smartshares S&P/ASX 200 ETF (AUS)
  - Smartshares Global Equities ESG ETF (ESG)

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EXAMPLE OF A SIMPLE PASSIVE PORTFOLIO, WITH JUST 4 ETFs:

25% in **Developed Markets** Equities

- Invest in listed companies from developed markets: US, Europe, Japan, etc

25% in **Emerging Market** Equities

- Invest in listed companies from Emerging Markets: China, Russia, Brazil, Mexico, etc

25% in **New Zealand** Equities

- Invest in the local New Zealand listed companies.

25% in **Australian Equities**

- Invest in Australian listed companies.

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3 STEPS TO IMPLEMENT THE PASSIVE STRATEGY?

Step 1: Objectives, profile and portfolio

- Define your **investment goals** (ex: 12% return per year) and **build a portfolio with assets that have the capability** to achieve the goals but that also **fits your profile** as an investor (conservative, moderate, aggressive, etc)

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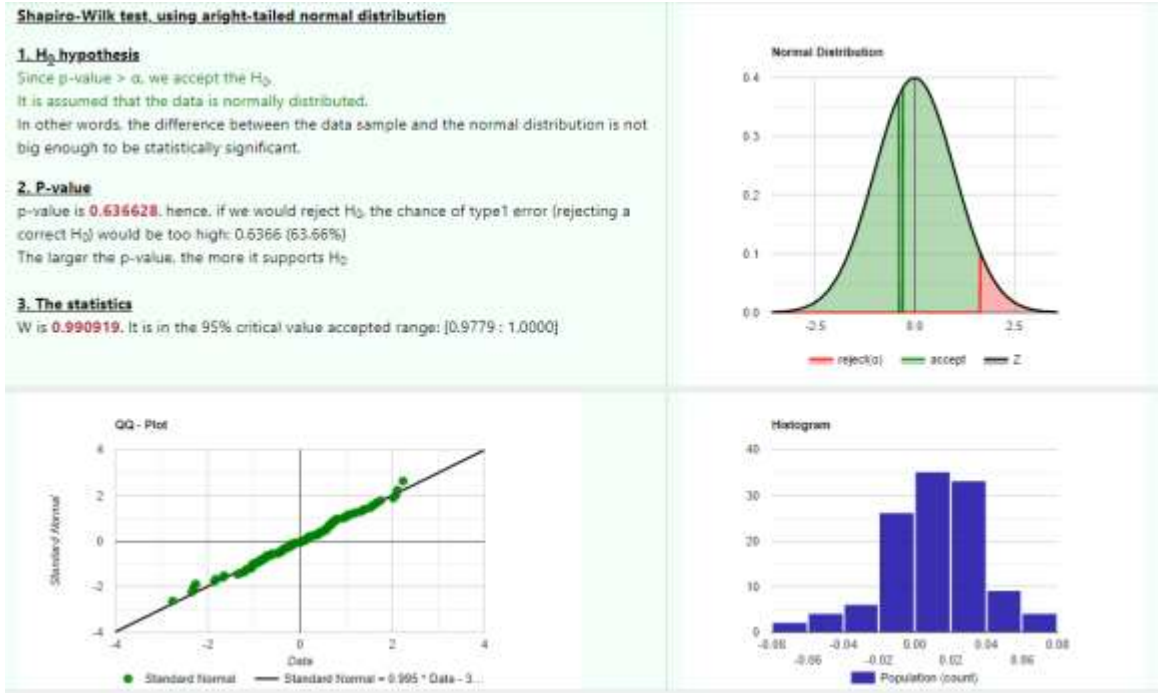
STEP1 DATA SCIENCE TOOLS & TECHNIQUES

- **For checking (statistical) capability:** *Normality Test, Mean, Standard Deviation,* ***Confidence Intervals****, Hypothesis Testing, Control Charts, Sigma level*
- **For selecting assets classes and assets and composing the portfolio:** *(in addition to the ones above) DOE-Design of Experiments, ANOVA, Back testing, Correlation*

Sample size (n):	117
Average ($\bar{x}$):	0.0104894
Median:	0.011455171
Sample Standard Deviation (S):	0.0249749
Sum of Squares:	0.0723545
b:	0.267764
Skewness:	-0.182217
Skewness Shape:	Potentially **Symmetrical** (pval=1.585)
Excess kurtosis:	0.0576749
Tails Shape:	Potentially **Mesokurtic**, normal like tailes (pval=0.897)
P-value:	0.636628
Outliers:	-0.162790698, -0.061967027, 0.083333333

https://www.statskingdom.com/320ShapiroWilk.html



WHAT ARE EXAMPLES OF LONG-TERM FINANCIAL GOALS?

Example 1: **Preservation of capital**

- for example, a return target of around 1.5% per year.

Example 2: **Protection against inflation and/or devaluation of the currency**

- a return target of 3 to 5% per year.

Example 3: **Passive income**

- a target of 0.40% per month, similar to the returns of real estate rentals.

Example 4: **Monetizing capital**

- an average return expectation from 8 to 12% per year.

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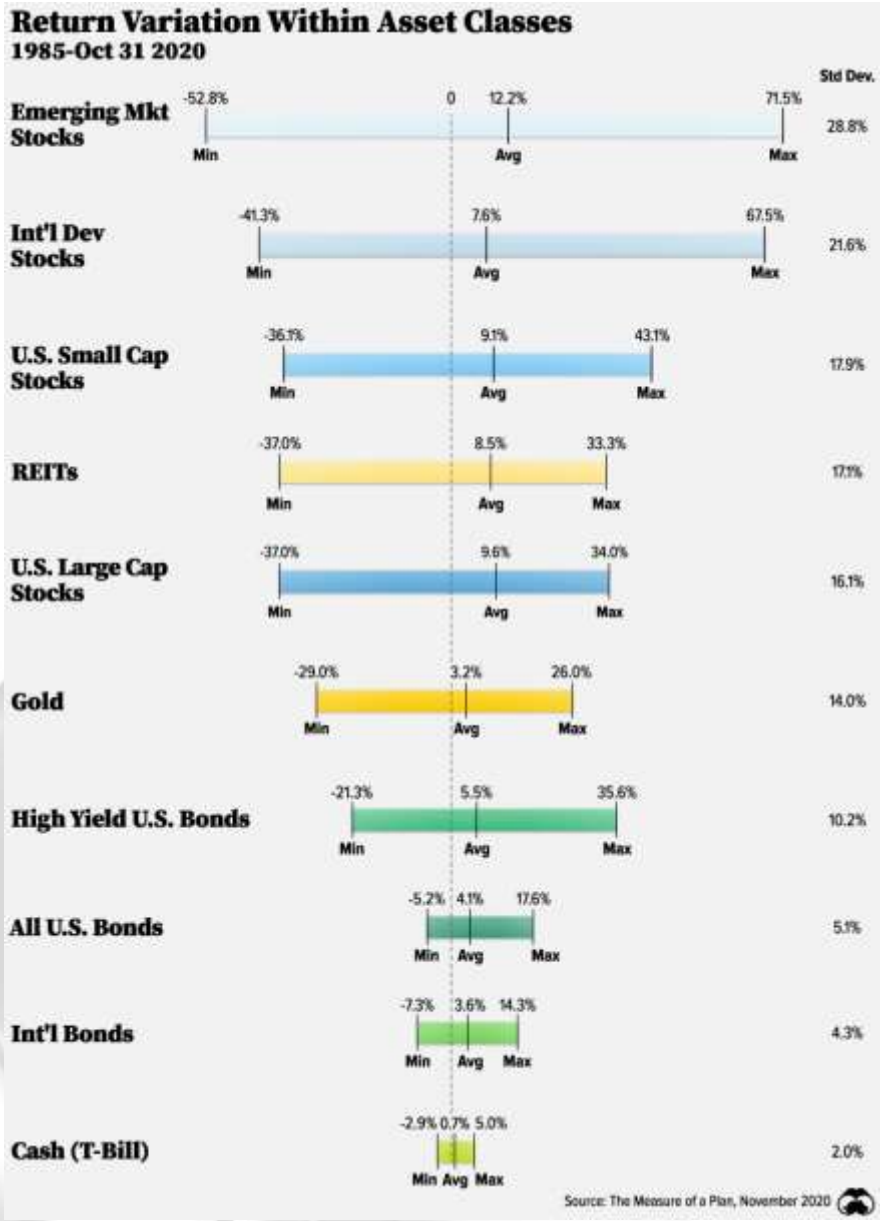
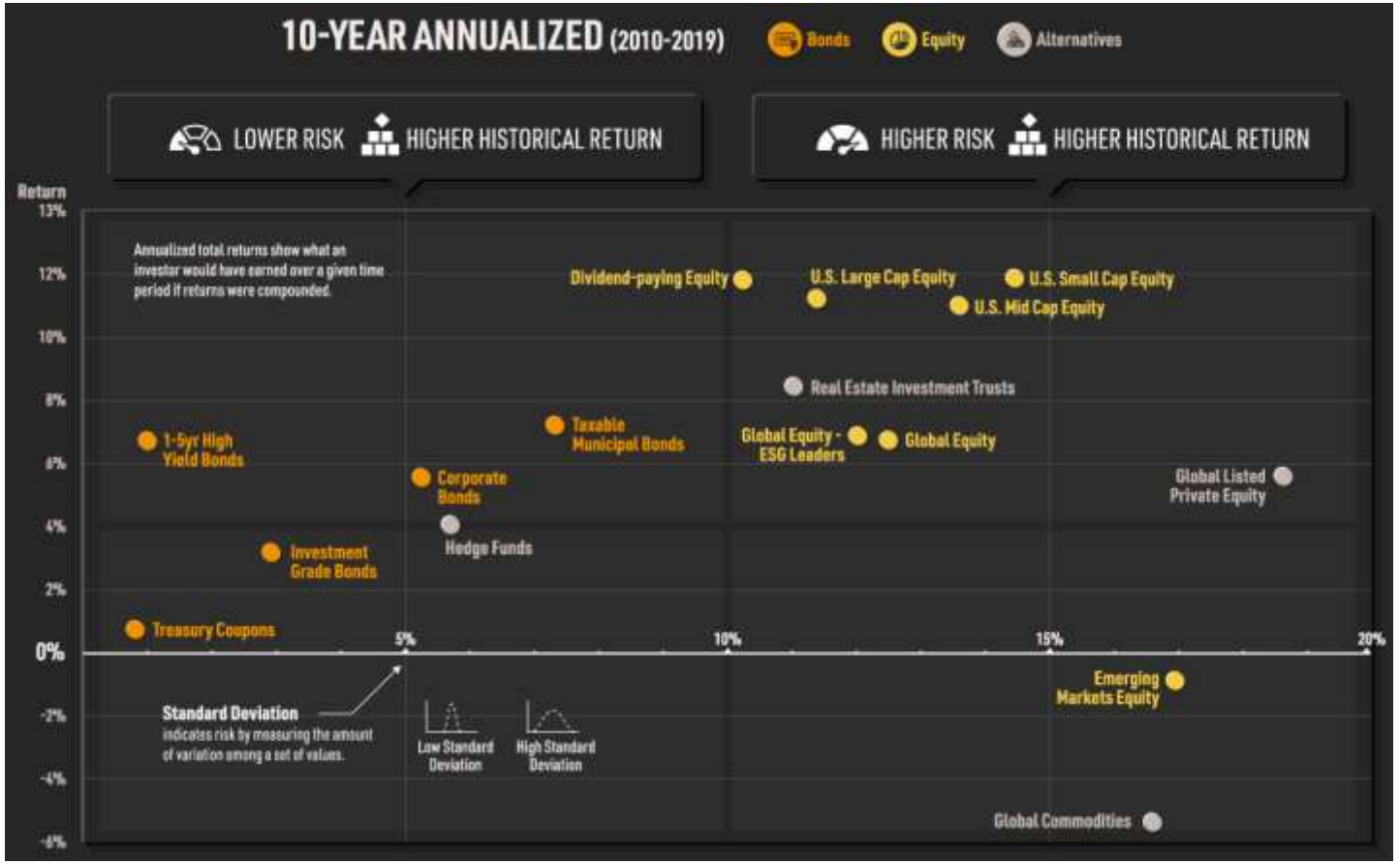
EXPECTED RETURNS (AND RISKS)





https://advisor.visualcapitalist.com/asset-class-risk-and-return/

https://www.visualcapitalist.com/historical-returns-by-asset-class/

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(GLOBALLY) DIVERSIFIED & LOW CORRELATED ASSETS

Vanguard

Global equity investing:
The benefits of diversification
and sizing your allocation

Vanguard Research

April 2021

Figure 1. Historical mix of global equity market capitalization

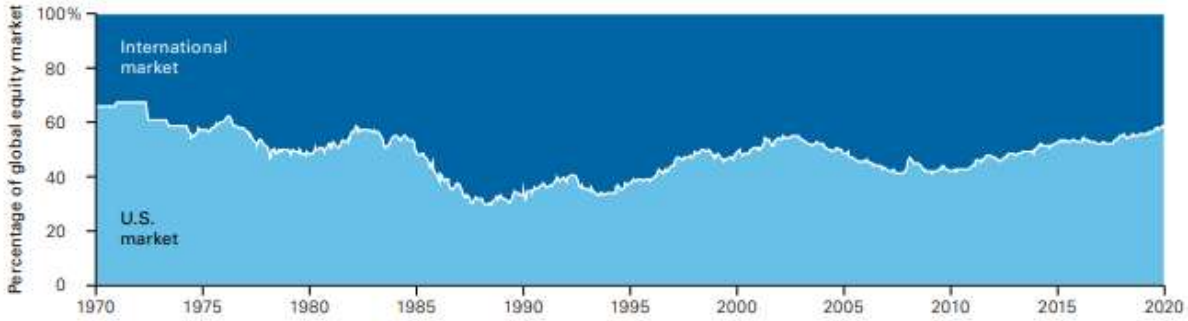


Figure 6. Trailing 12-month return differential between U.S. and non-U.S. stocks

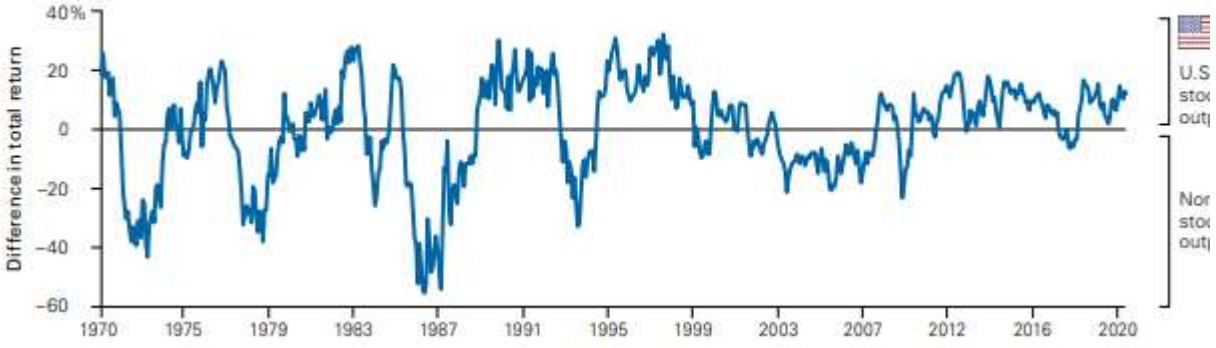
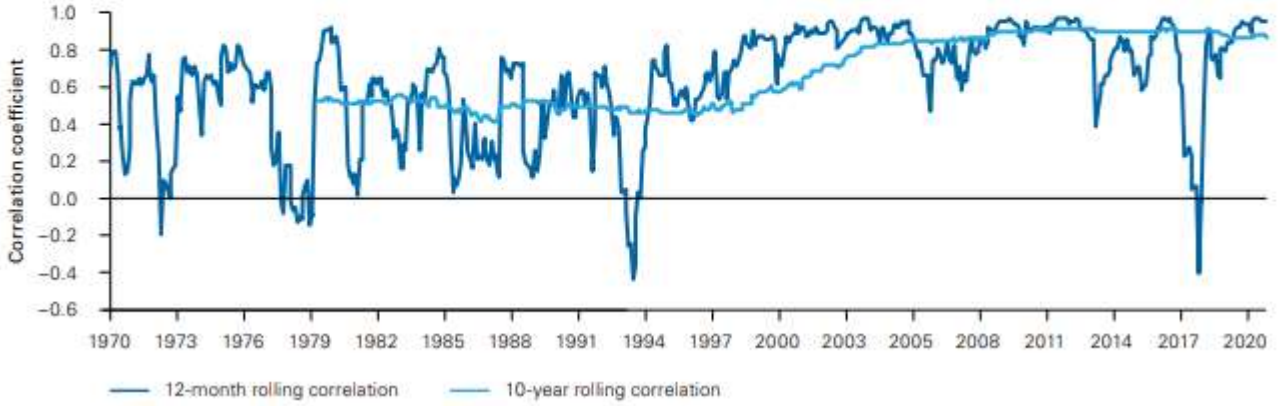


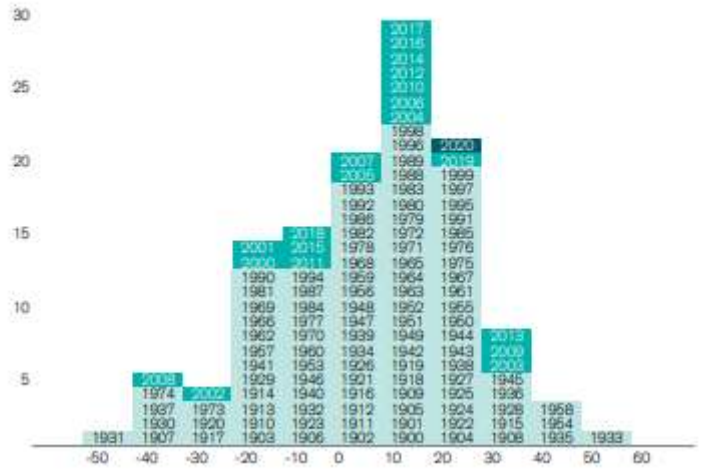
Figure 4. Historically, correlations have risen, meaning less impact from global diversification

12-month and 10-year rolling correlations between U.S. and international stocks



(GLOBAL) DIVERSIFICATION & CAPITALISATION WEIGHTED PORTFOLIO

Figure 10: US equity risk premium versus bills, 1900–2020



March 2021

CREDIT SUISSE

Research Institute

Credit Suisse Global Investment Returns Yearbook 2021 Summary Edition

Figure 19: EM versus DM weightings, 1980–2020

(a) GDP weights (at market exchange rates)

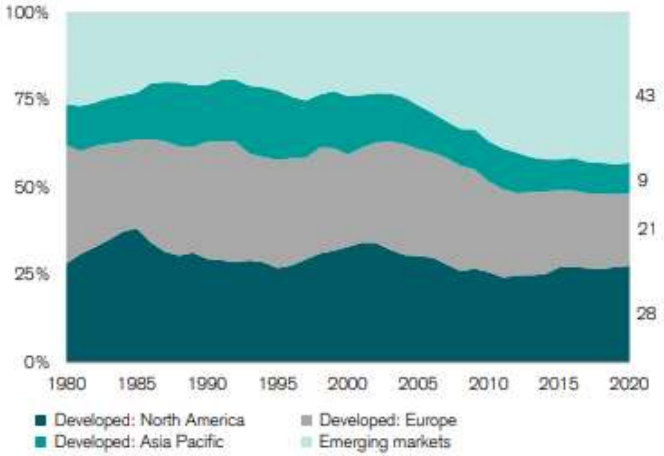
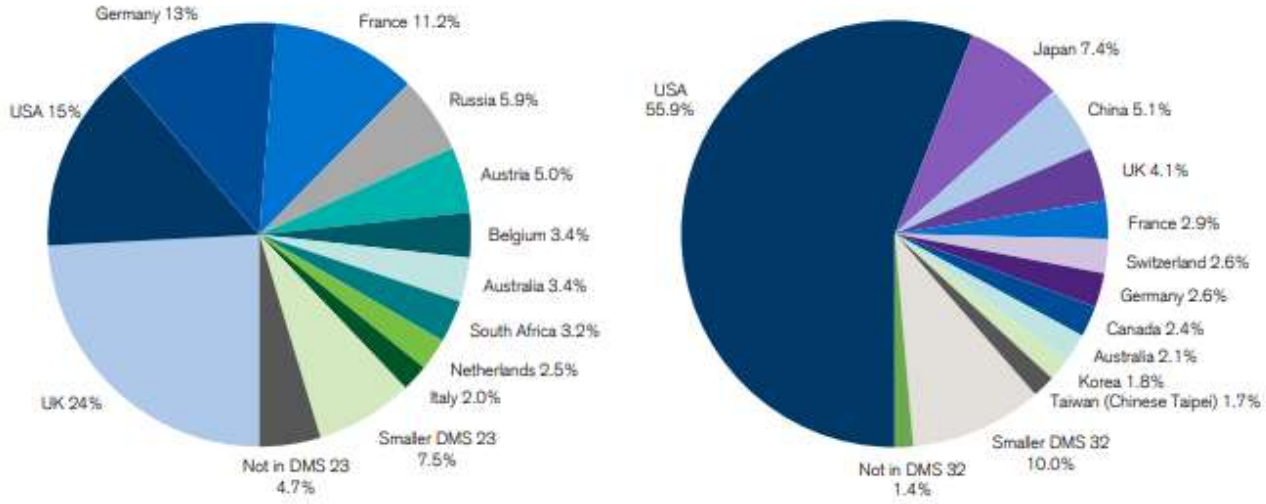
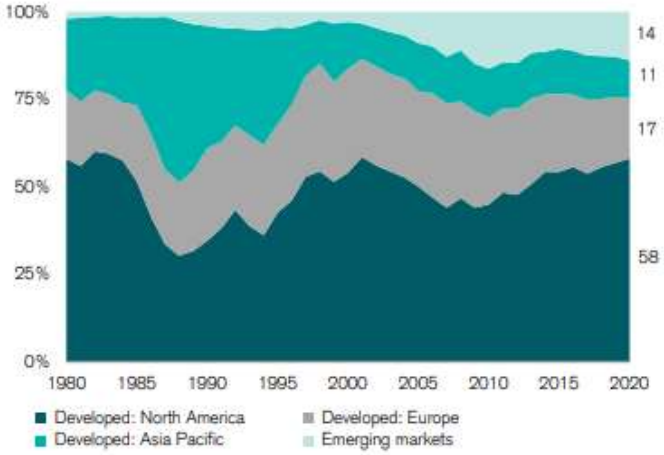


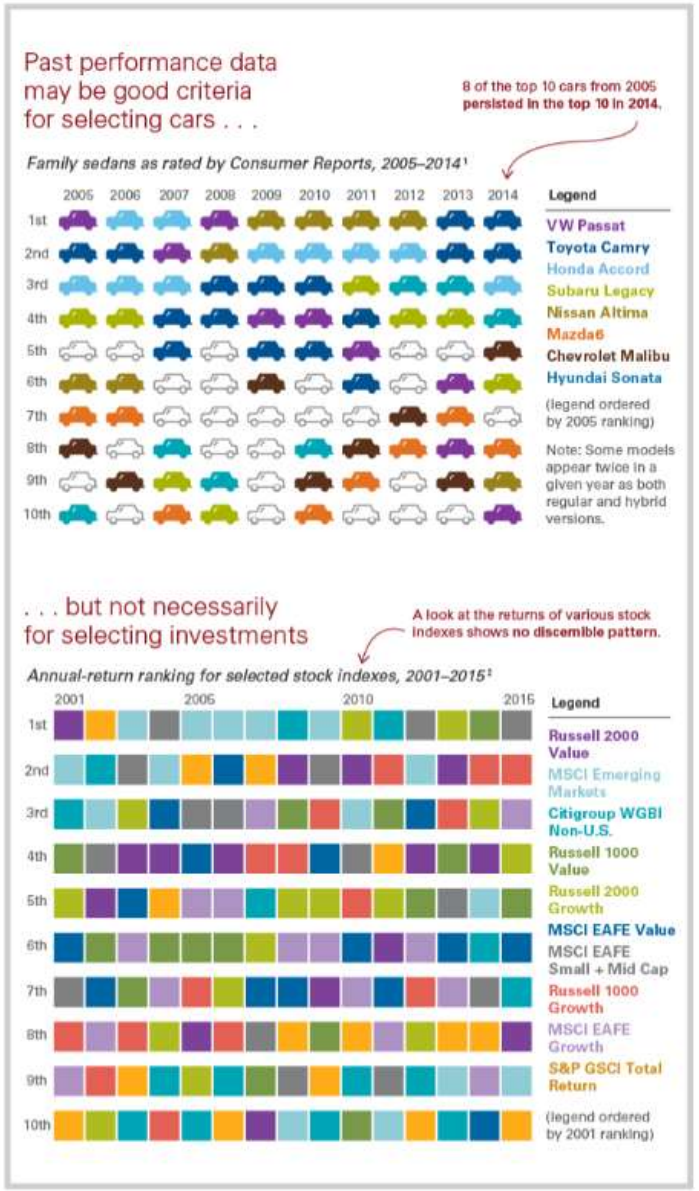
Figure 1: Relative sizes of world stock markets, end-1899 (left) versus start-2021 (right)



(b) Weightings in global equity indexes



ASSET CLASSES DIVERSIFICATION & EQUALLY WEIGHTED PORTFOLIO



Asset Class Returns

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	YTD
REIT 35.1%	EM 39.8%	HG Bnd 5.2%	EM 79.0%	REIT 28.0%	REIT 8.3%	REIT 19.7%	Sm Cap 38.8%	REIT 28.0%	REIT 2.8%	Sm Cap 21.3%	EM 37.8%	Cash 1.8%	Lg Cap 31.5%	Sm Cap 20.0%	REIT 21.4%
EM 32.6%	Int'l Stk 11.6%	Cash 1.7%	HY Bnd 57.5%	Sm Cap 26.9%	HG Bnd 7.8%	EM 18.6%	Lg Cap 32.4%	Lg Cap 13.7%	Lg Cap 1.4%	HY Bnd 17.5%	Int'l 25.6%	HG Bnd 0.0%	REIT 28.7%	EM 18.7%	Sm Cap 17.5%
Int'l Stk 26.9%	AA 7.6%	AA -22.4%	Int'l Stk 32.5%	EM 19.2%	HY Bnd 4.4%	Int'l Stk 17.9%	Int'l Stk 23.3%	AA 6.9%	HG Bnd 0.6%	Lg Cap 12.0%	Lg Cap 21.8%	HY Bnd -2.3%	Sm Cap 25.5%	Lg Cap 18.4%	Lg Cap 15.3%
Sm Cap 18.4%	HG Bnd 7.0%	HY Bnd -26.4%	REIT 28.0%	HY Bnd 15.2%	Lg Cap 2.1%	Sm Cap 16.4%	AA 11.5%	HG Bnd 6.0%	Cash 0.0%	EM 11.6%	Sm Cap 14.7%	REIT -4.0%	Int'l Stk 22.7%	AA 9.8%	Int'l 9.2%
AA 16.7%	Lg Cap 5.5%	Sm Cap -33.8%	Sm Cap 27.2%	Lg Cap 15.1%	AA 0.3%	Lg Cap 16.0%	HY Bnd 7.4%	Sm Cap 4.9%	Int'l Stk -0.4%	REIT 8.6%	AA 14.6%	Lg Cap -4.4%	AA 18.9%	Int'l Stk 8.3%	AA 7.7%
Lg Cap 15.8%	Cash 4.8%	Lg Cap -37.0%	Lg Cap 26.5%	AA 13.5%	Cash 0.1%	HY Bnd 15.6%	REIT 2.9%	HY Bnd 2.5%	AA -1.3%	AA 7.2%	REIT 8.7%	AA -5.6%	EM 18.9%	HY Bnd 7.5%	EM 7.6%
HY Bnd 11.8%	HY Bnd 2.2%	REIT -37.7%	AA 24.6%	Int'l Stk 8.2%	Sm Cap -4.2%	AA 12.2%	Cash 0.1%	Cash 0.0%	Sm Cap -4.4%	HG Bnd 2.7%	HY Bnd 7.5%	Sm Cap -11.0%	HY Bnd 14.4%	HG Bnd 8.1%	HY Bnd 3.7%
Cash 4.7%	Sm Cap -1.6%	Int'l Stk -43.1%	HG Bnd 5.9%	HG Bnd 6.5%	Int'l Stk -11.7%	HG Bnd 4.2%	HG Bnd -2.0%	EM -1.8%	HY Bnd -4.6%	Int'l Stk 1.5%	HG Bnd 3.5%	Int'l Stk -13.4%	HG Bnd 8.7%	Cash 0.6%	Cash 0.0%
HG Bnd 4.3%	REIT -15.7%	EM -53.2%	Cash 0.1%	Cash 0.1%	EM -18.2%	Cash 0.1%	EM -2.3%	Int'l Stk -4.5%	EM -14.6%	Cash 0.3%	Cash 0.8%	EM -14.3%	Cash 2.0%	REIT -5.1%	HG Bnd -1.6%

Source: https://novelinvestor.com/asset-class-returns/

Source: https://www.visualcapitalist.com/picking-investments-nothing-like-buying-new-car/

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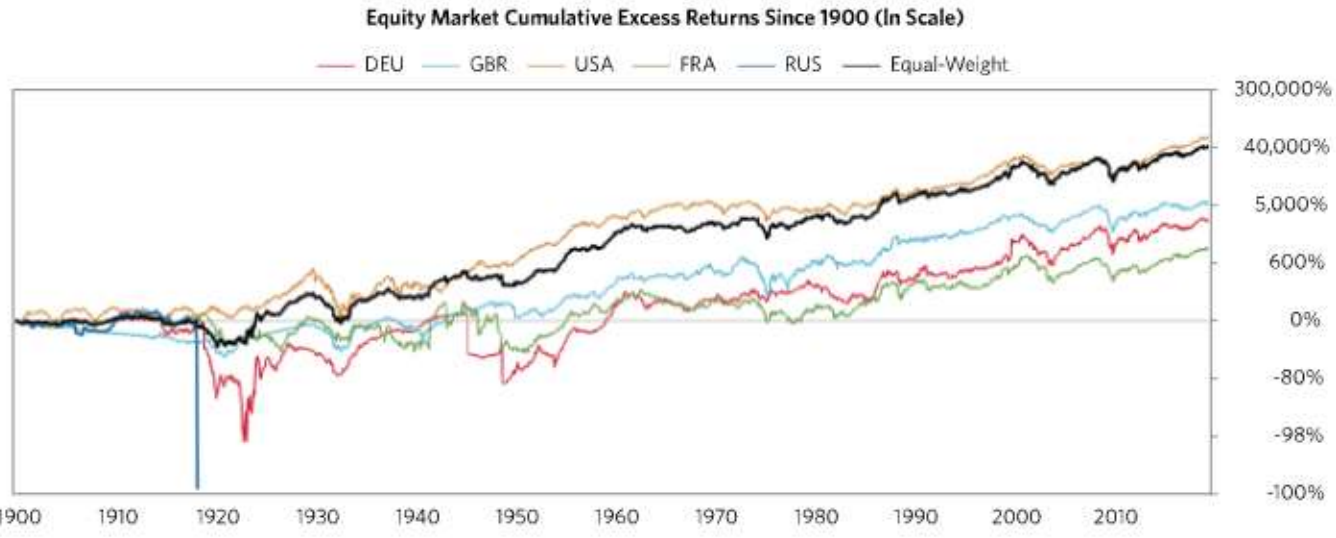
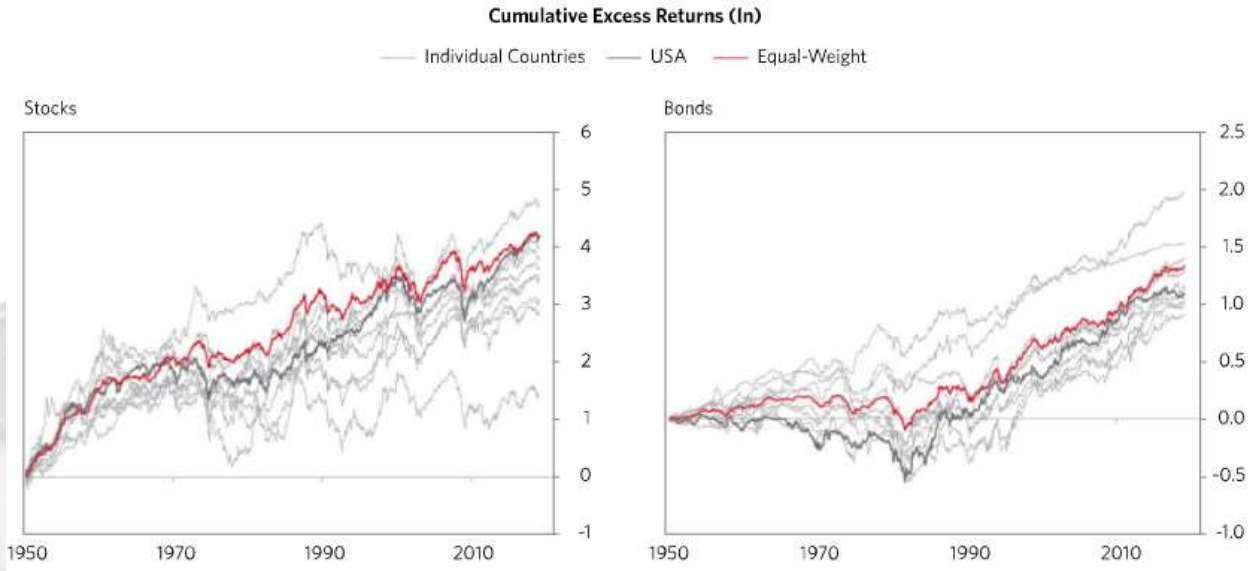
EQUALLY WEIGHTED PORTFOLIO



1980s		1990s		2000s		2010s	
Sweden	503%	Switzerland	231%	Norway	48%	United States	182%
Korea	354%	United States	217%	Brazil	45%	New Zealand	149%
Japan	310%	Sweden	190%	Canada	42%	Sweden	146%
Spain	188%	France	117%	Australia	36%	Japan	105%
Equal Weight	185%	United Kingdom	110%	Korea	22%	Germany	99%
Germany	179%	Spain	96%	Spain	17%	Switzerland	97%
United Kingdom	173%	Germany	92%	Equal Weight	1%	France	92%
Italy	169%	Australia	59%	New Zealand	-3%	United Kingdom	83%
France	158%	Equal Weight	53%	Switzerland	-4%	Norway	78%
Switzerland	96%	Canada	52%	Sweden	-13%	Equal Weight	74%
United States	96%	Italy	40%	Taiwan	-23%	Taiwan	55%
Australia	39%	Norway	2%	United Kingdom	-23%	Canada	54%
Norway	23%	New Zealand	-6%	United States	-27%	Australia	41%
Canada	-4%	Japan	-47%	France	-32%	Korea	27%
		Taiwan	-49%	Italy	-35%	Italy	20%
		Korea	-66%	Germany	-36%	Spain	11%
				Japan	-41%	Brazil	-26%
Avg. Correl.	46%	Avg. Correl.	50%	Avg. Correl.	74%	Avg. Correl.	65%
Best - Worst	507%	Best - Worst	296%	Best - Worst	89%	Best - Worst	209%



https://www.nzx.com/instruments/FNZ

Source: https://www.bridgewater.com/research-and-insights/geographic-diversification-can-be-a-lifesaver-yet-most-portfolios-are-highly-geographically-concentrated

3 STEPS TO IMPLEMENT THE PASSIVE STRATEGY?

Step 2: Stay invested

- **Contribute periodically** to your portfolio (**and re-balance it whenever needed**).

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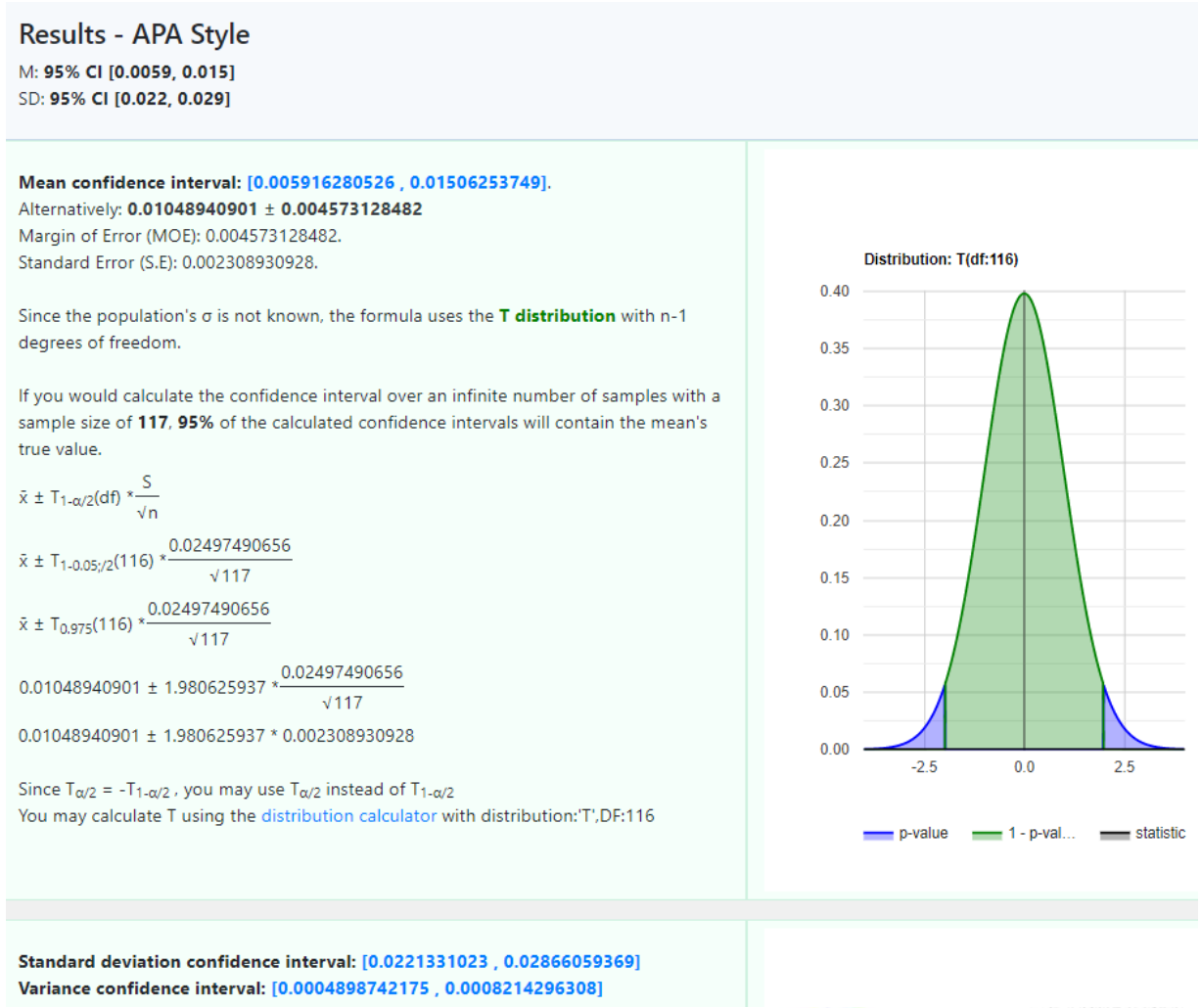
STEP2 DATA SCIENCE TOOLS & TECHNIQUES

- For **Predictions:** *(in addition to the previously mentioned ones)* ***Interval Plot,*** *Regression, Time Series, MonteCarlo Simulation, Machine Learning*



Results - APA Style

M: **95% CI [0.0059, 0.015]**
SD: **95% CI [0.022, 0.029]**

Mean confidence interval: [0.005916280526 , 0.01506253749].
Alternatively: **0.01048940901 ± 0.004573128482**
Margin of Error (MOE): 0.004573128482.
Standard Error (S.E): 0.002308930928.

Since the population's σ is not known, the formula uses the **T distribution** with n-1 degrees of freedom.

If you would calculate the confidence interval over an infinite number of samples with a sample size of **117**, **95%** of the calculated confidence intervals will contain the mean's true value.

$$\bar{x} \pm T_{1-\alpha/2}(df) * \frac{S}{\sqrt{n}}$$

$$\bar{x} \pm T_{1-0.05/2}(116) * \frac{0.02497490656}{\sqrt{117}}$$

$$\bar{x} \pm T_{0.975}(116) * \frac{0.02497490656}{\sqrt{117}}$$

$$0.01048940901 \pm 1.980625937 * \frac{0.02497490656}{\sqrt{117}}$$

$$0.01048940901 \pm 1.980625937 * 0.002308930928$$

Since $T_{\alpha/2} = -T_{1-\alpha/2}$, you may use $T_{\alpha/2}$ instead of $T_{1-\alpha/2}$
You may calculate T using the distribution calculator with distribution:'T',DF:116

Distribution: T(df:116)

0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-2.5
0.0
2.5

p-value 1 - p-val... statistic

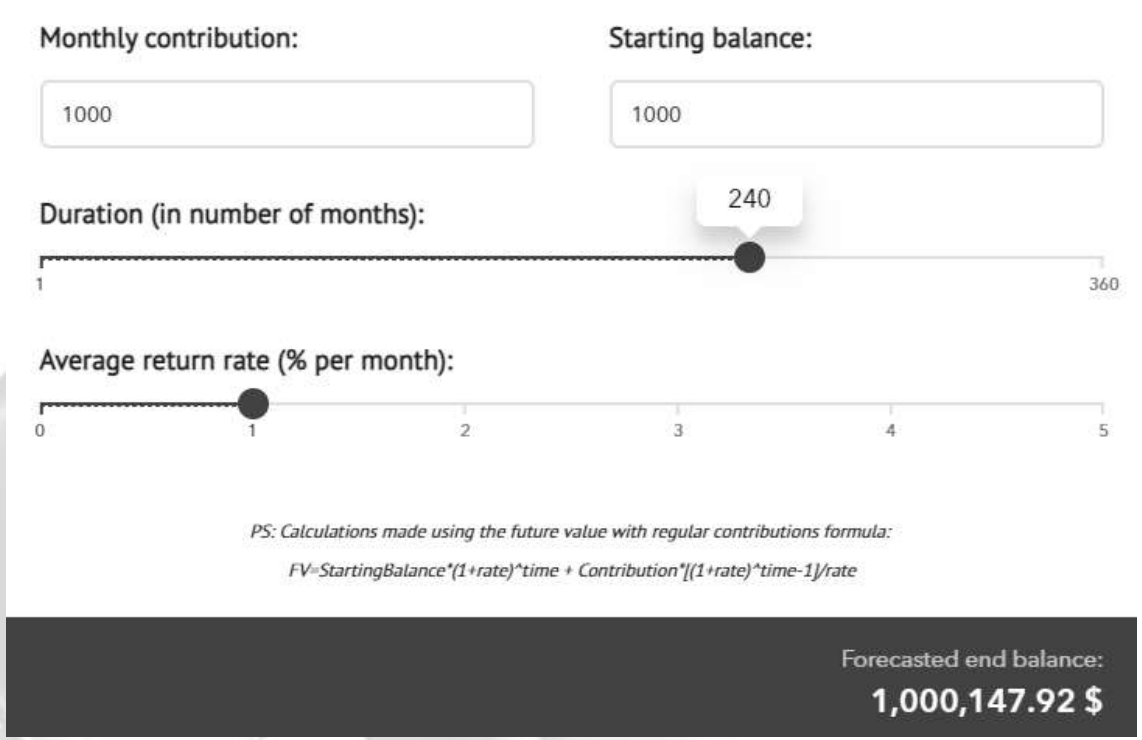
Standard deviation confidence interval: [0.0221331023 , 0.02866059369]
Variance confidence interval: [0.0004898742175 , 0.0008214296308]

https://www.statskingdom.com/confidence-interval-calculator.html

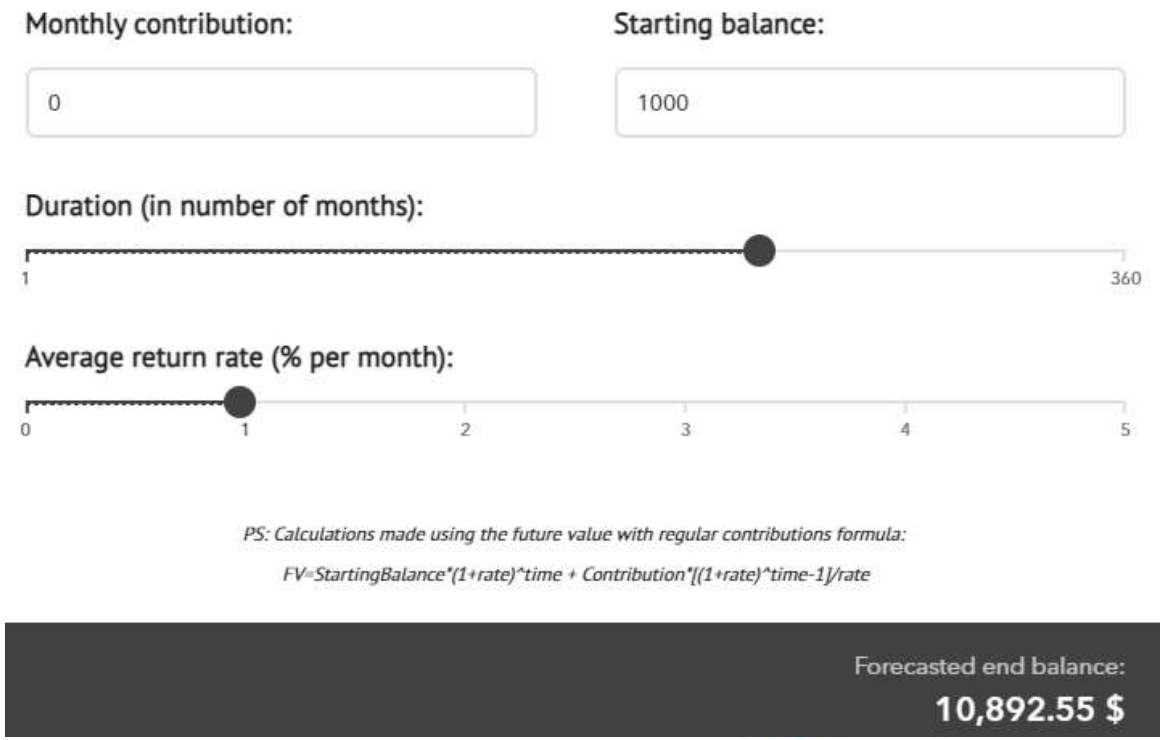
FUTURE-VALUE FORMULA

$$Future\,value = Starting\,Value \times (1+rate)^{time} + \frac{contribution \times \left((1+rate)^{time} - 1\right)}{rate}$$

With contributions:



Without contributions:



Source: https://www.trendsetconsulting.com/en

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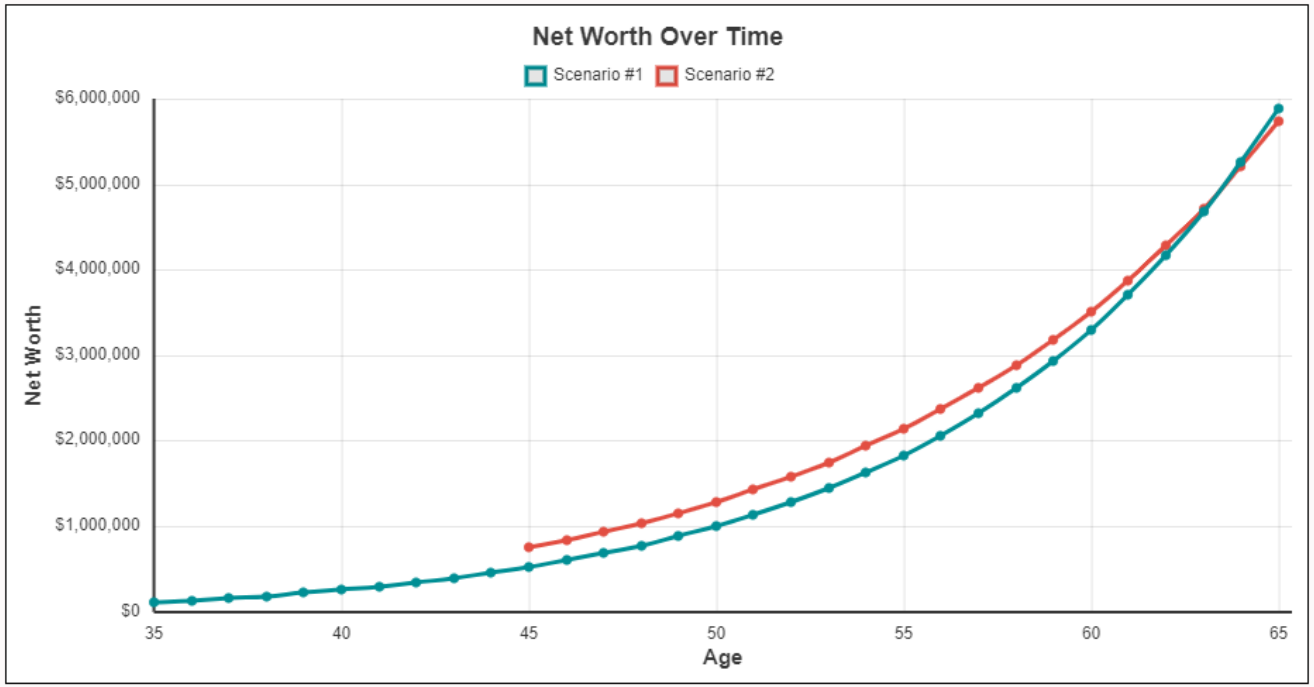
Comparing two brothers...

Assumption	Scenario #1	Scenario #2
Starting age	35	45
Starting net worth ($)	100000	750000
Annual savings (today's dollars)	12000	12000
Investment return (% per year in today's dollars)	12	10

Number of years to look ahead 30

+ ADVANCED OPTIONS



Source: https://themeasureofaplan.com/net-worth-scenario-tool/

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MonteCarlo Simulation

% of Strategies with Loss after 25 years	Mean Strategy Sharpe Ratio
5%	0.340

Source: https://tools.winton.com/thefuture/

3 STEPS TO IMPLEMENT THE PASSIVE STRATEGY?

Step 3: Time and opportunities

- Do not panic about crisis or negative news: **take advantage of opportunities and market conditions/cycles.**
- **Let the time (ie. compound interest!)** to act, protecting and monetizing your capital in the long run.

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STEP3 DATA SCIENCE TOOLS & TECHNIQUES

- For **recognizing opportunities:** *Hypothesis testing*, ***Control Charts***, *RSI-Relative Strength Index*

Method: Z-score

How to calculate the standard deviation?

Average = **0.00905**.

S = **0.0308**.

Lower = Average - k*S = 0.00905-3*0.0308 = **-0.08326924627490881**.

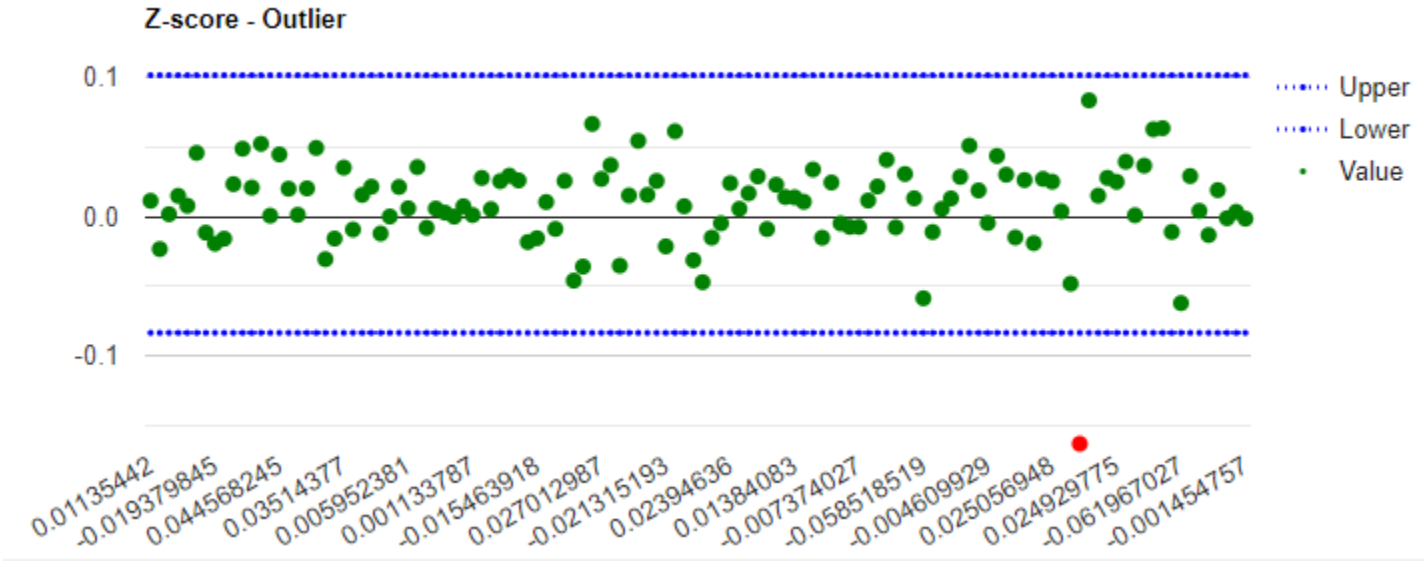
Upper = Average + k*S = 0.00905+3*0.0308 = **0.10136652064157547**.

Sample size (n) = **120**.

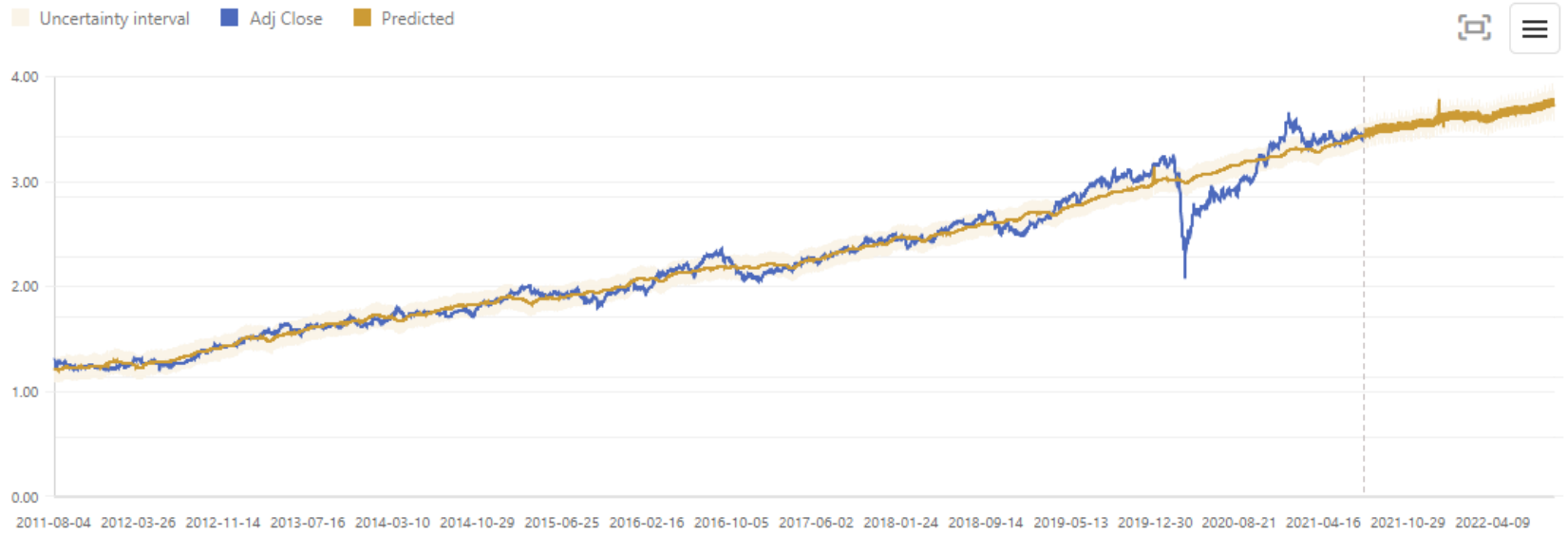
Outlier count: **1**.

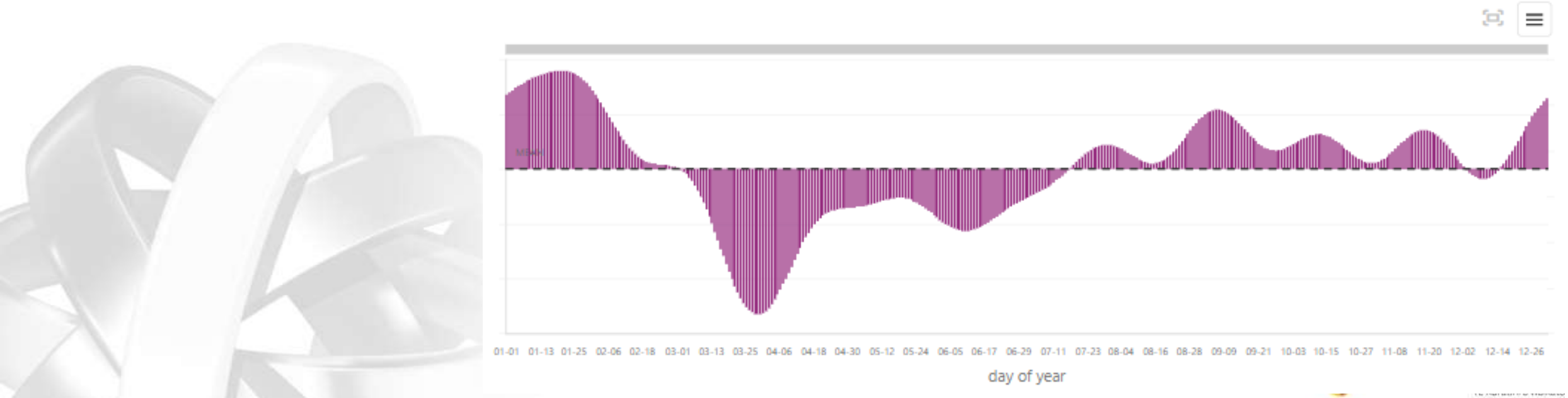
Outliers: -0.162790698.

https://www.statskingdom.com/outlier-calculator.html



Where is the market going to?

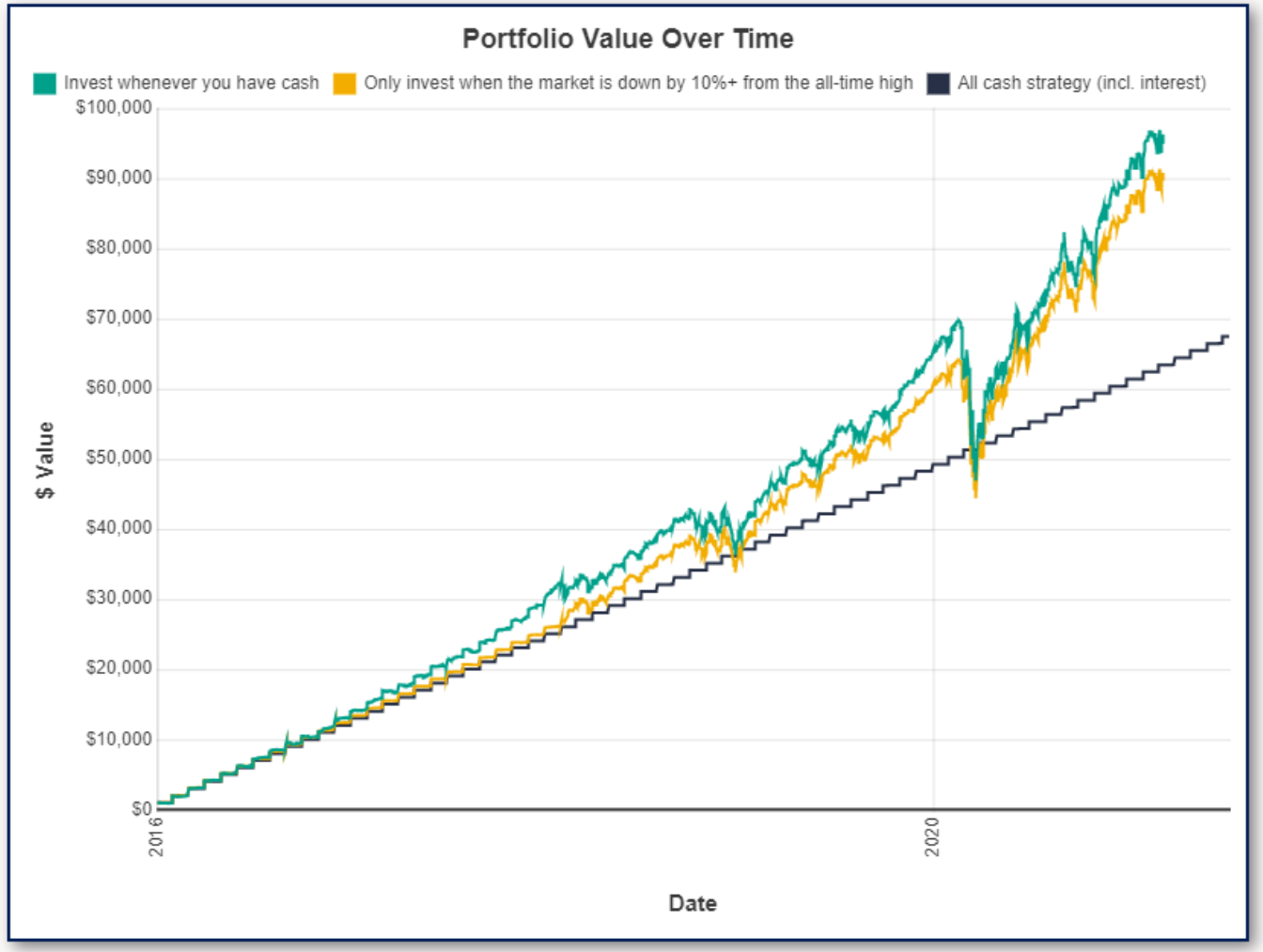




Tool: https://graphite-note.com/

Should I wait for corrections?

Your Current & Future Savings		
Initial Contribution	$	1000
Monthly Contribution	$	1000
Market Timing Strategy		
Only invest when the market is down by x%+ from the current all-time high	%	10
Time Period		
2016 – 2021 (1980 – 2021)		
- Advanced Options		
Other Assumptions		
Interest rate on cash	%	0.25
Trading transaction fee	$ per trade	5



https://themeasureofaplan.com/market-timing/

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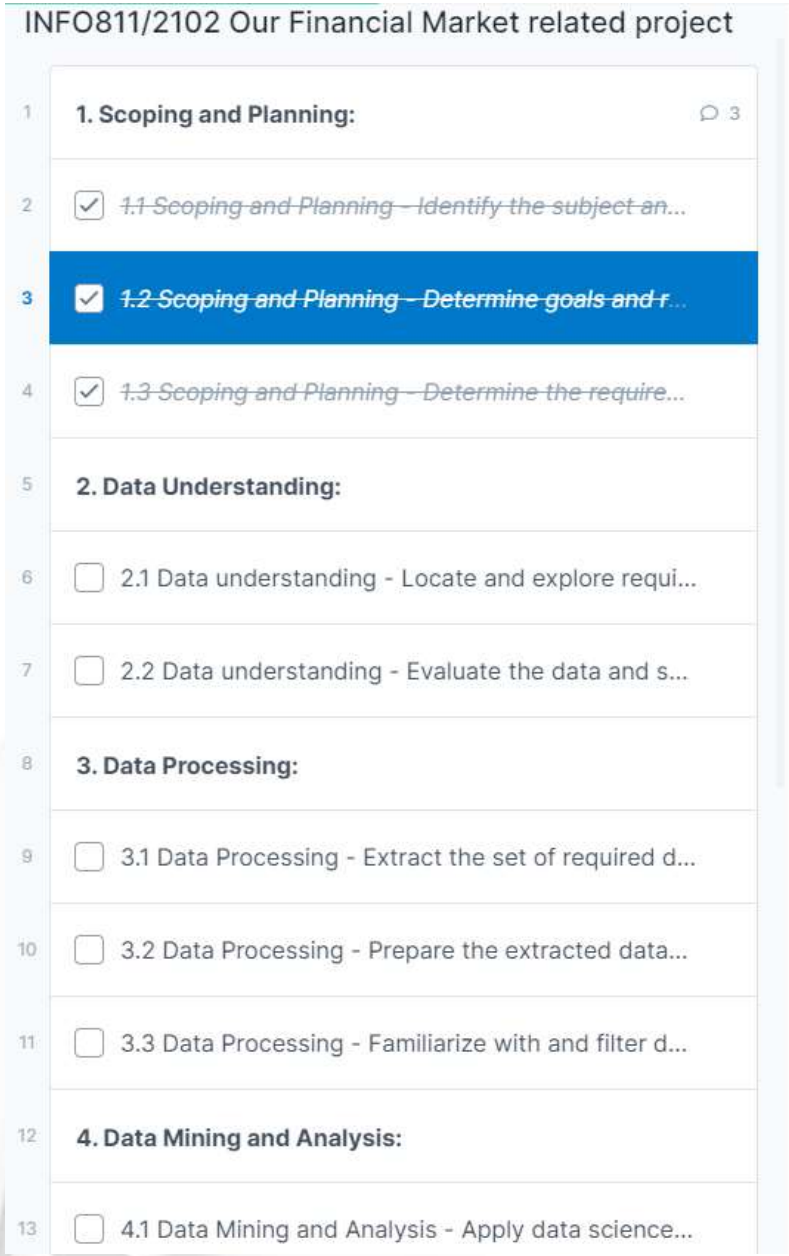
Research Project



organizational policies, business rules and standard processes")

- To what extent the performed processes, in general, follow the standard process of the organization? (based on goal: "Identify and address the cause of deviations from organizational policies, business rules and standard processes")

- What are the actual bottlenecks of the process? (based on goal: "Identify and remove bottlenecks")

- Are there activities in the process that may be eliminated? (based on goal: "Identify and eliminate unwarranted practices"

- What is the actual performance of the process, in terms of duration, cost and resources? (based on goal: "Improve aspects of process performance such as duration of process, costs involved, resources required, etc."

What are the goals for your Data Science project? *

Considering the region/country-based ETFs listed in the NZX-New Zealand Exchange, to identify which ones, and what percentage (ex: 25%) to allocate in each one in order to create a investor's profile and goals oriented passive investment portfolio that has the statistical capability of meeting the expected returns over the long term.

Updated by arthur 7 days ago

What are the relevant research questions (derived from the goals)? *

1) Considering the region/country-based ETFs listed in the NZX-New Zealand Exchange, which ones have the statistical capability of returning more than 1% per month over the long run?
2) From the resulting ETFs from 1), what is an optimum distribution (i.e percentages) to be able to create an passive investment portfolio that has the statistical capability of meeting the expected returns over the long term while aligned to the investor's profile and goals.
3) What is the forecast for the portfolio returns over 1, 5 and 10 years?

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INFO811/2102 Our Financial Market related project | Process Street

Conclusion

- Investing is a fascinating topic.
- Active (supp. by Industry) x Passive (supp. by Academia) Strategies is an interesting debate.
- Other disciplines, such as Data Science, can also be part of the investor´s toolbox (not only Macro-economics, Accounting, Company Valuations).

Thank You!

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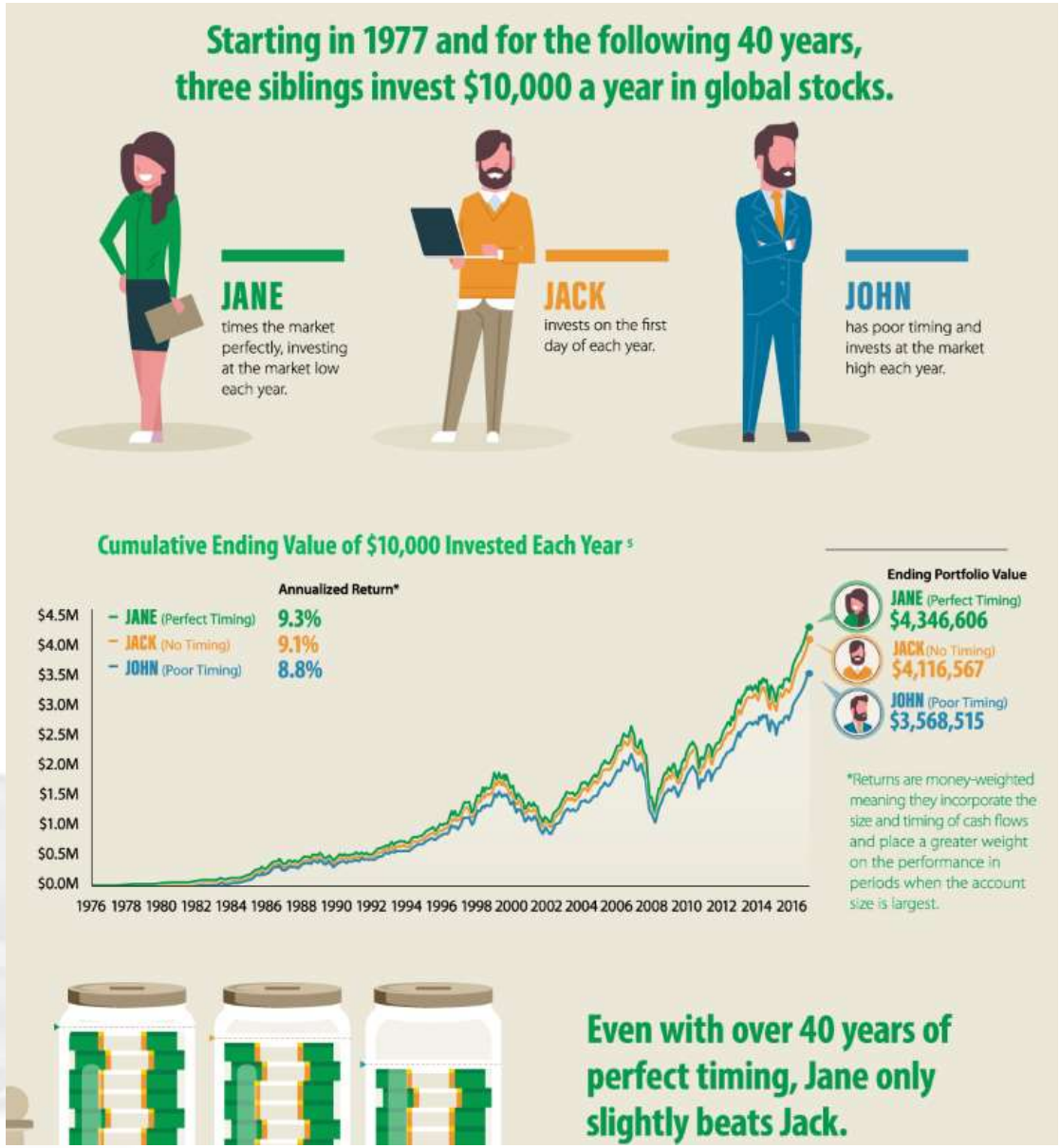
Bonus

Should I time the market?



Source: https://www.visualcapitalist.com/anatomy-market-correction/

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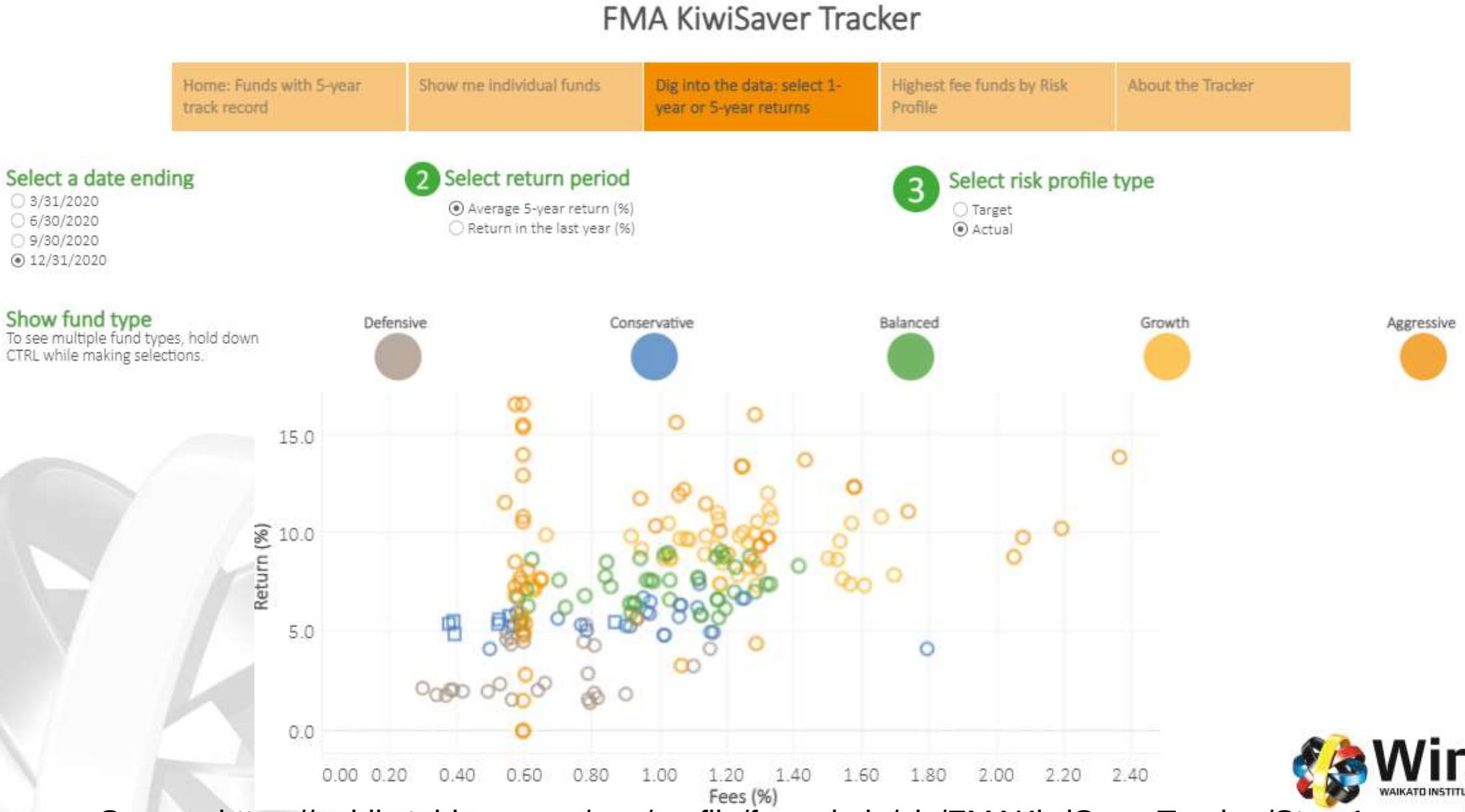
EXPECTED KIWISAVER RETURNS (AND FEES)



Source: https://public.tableau.com/app/profile/fmaadmin/viz/FMAKiwiSaverTracker/Story1

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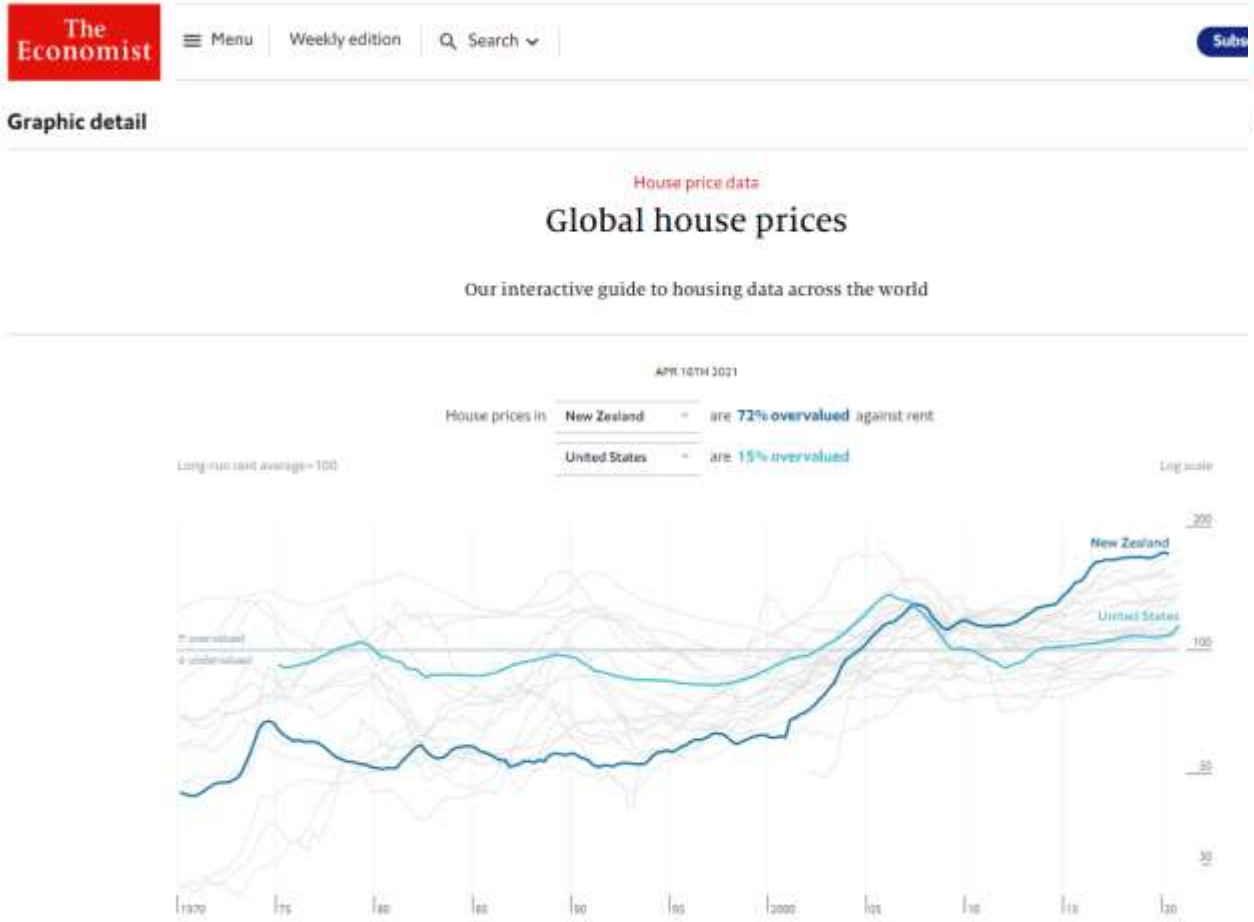
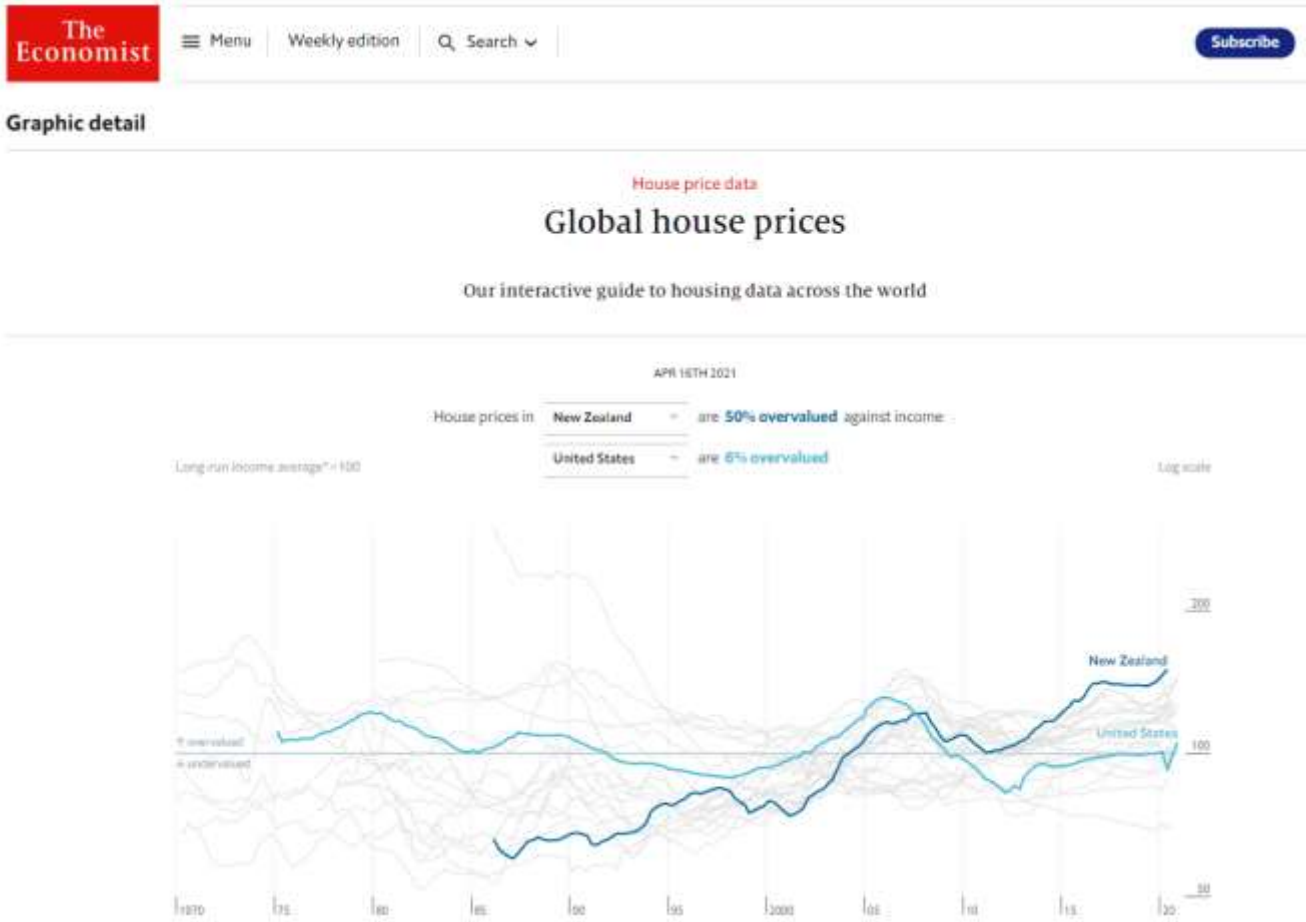
SHOULD I BUY OR SHOULD I RENT?





Source: https://www.economist.com/graphic-detail/global-house-prices

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