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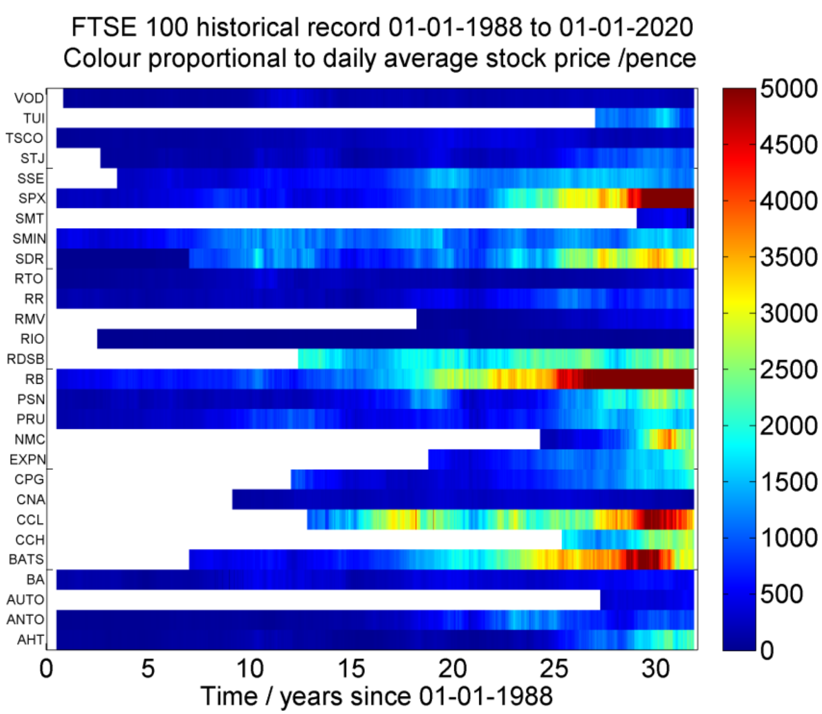
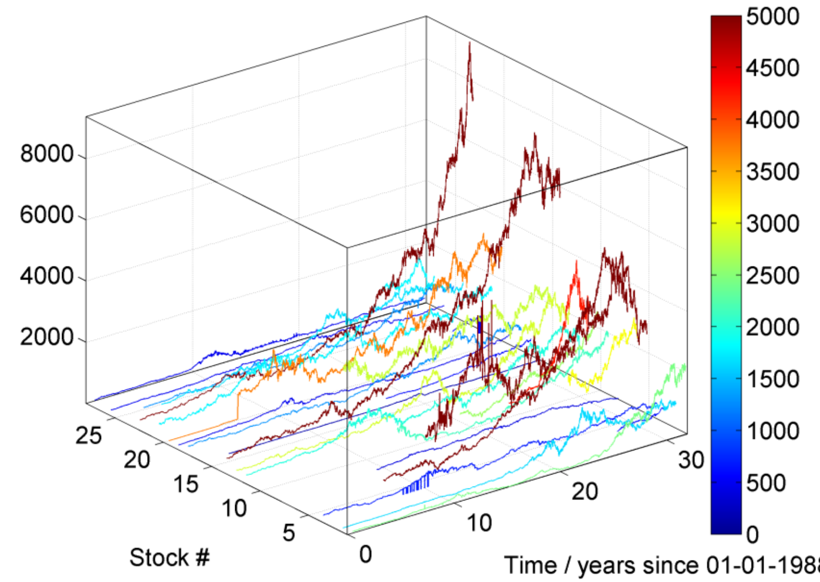
zbroker computational trading challenge



Devised by Dr French. August 2025.

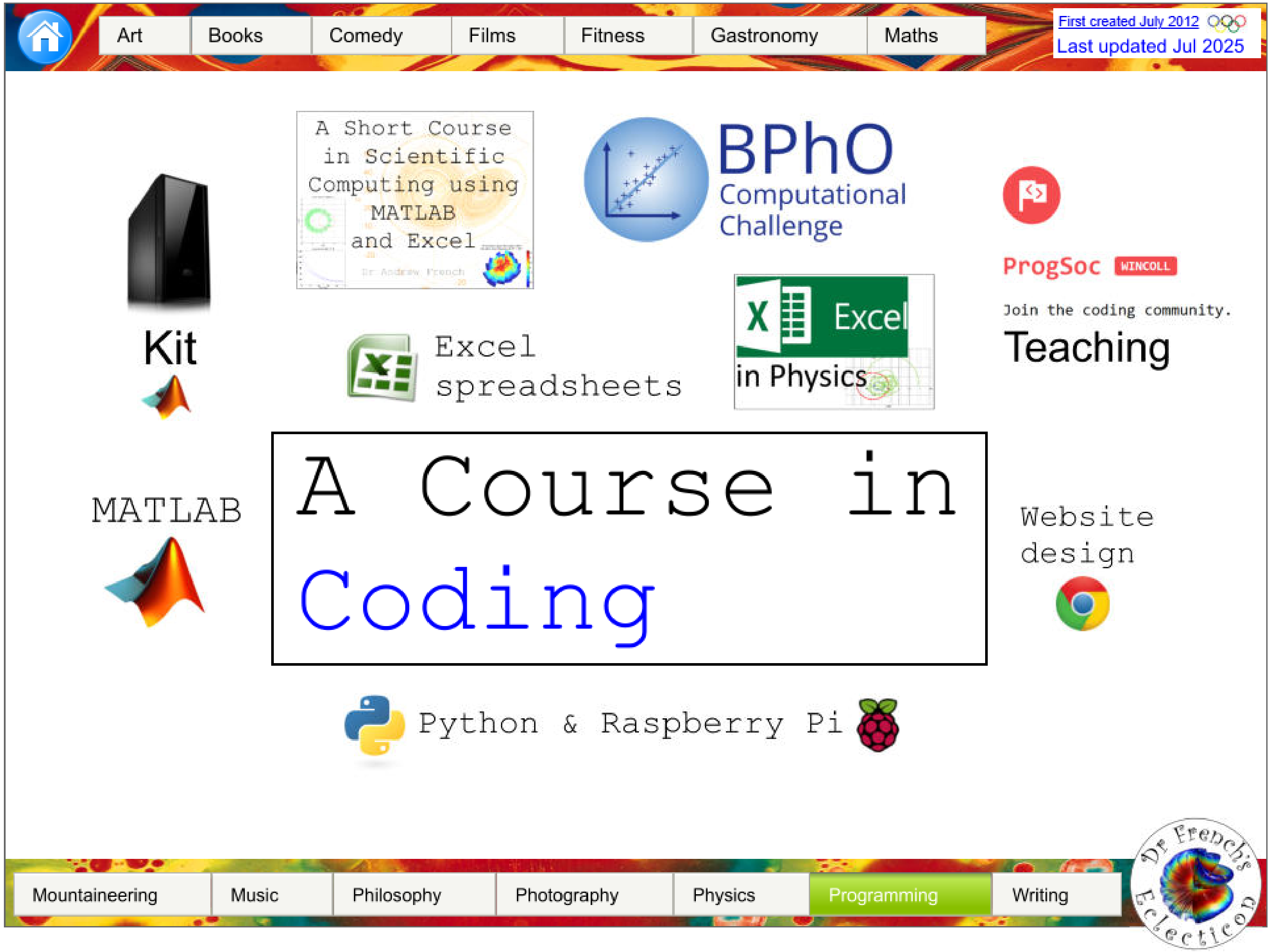


Welcome to the zbroker computational trading challenge! This initiative works a bit like the [British Physics Olympiad (BPhO) Computational Challenge.]

- You can work individually or in pairs
- You have a few months to complete as many of the tasks as possible
- You have a free choice of computational tools (although we recommend MATLAB and/or Python). For maximum enjoyment, you will need to develop programming skills, rather than just using a spreadsheet.
- Tasks all involve the development of useful computational skills (see below)
- Output is a **two minute** (MAX) **YouTube video** describing your solutions to the tasks.
- The **best five** will have **five minutes** to present their work at a live event, and the overall winner and runner-up will be decided by the judges.

Computational skills you will need

- Use of spreadsheets
- Importing spreadsheet (.xlsx, .csv) data into a programming environment like Python or MATLAB
- Statistical computation
- Apps / GUIs
- Efficient download of web data, and, ideally, automated download of live data
- Use of iteration (loops) to run a trading algorithm using historical (or live) data
- Visualization using graphs



Dr F's PROGRAMMING RESOURCES

FTSE100

There are many other famous stock exchanges such as the New York Stock Exchange (NYSE), which is the largest.

Shares (or 'equities') in corporations are traded in **stock exchanges** like the London Stock Exchange **(LSE).** Using automated trading algorithms, trades can occur *extremely fast*, potentially at time intervals of only a few hundred microseconds!

The 100 largest companies traded on the LSE comprise the **Financial Times Stock Exchange, or FTSE100.** The total value of the FTSE100 'ticker' is the **share price** of each of the 100 listed companies **multiplied by the number of shares** in circulation per company, and then **divided by an arbitrary number** to keep the index at a manageable value.

As of 19/8/25, the total 'market capitalization' of The FTSE 100 is £2.225 trillion.

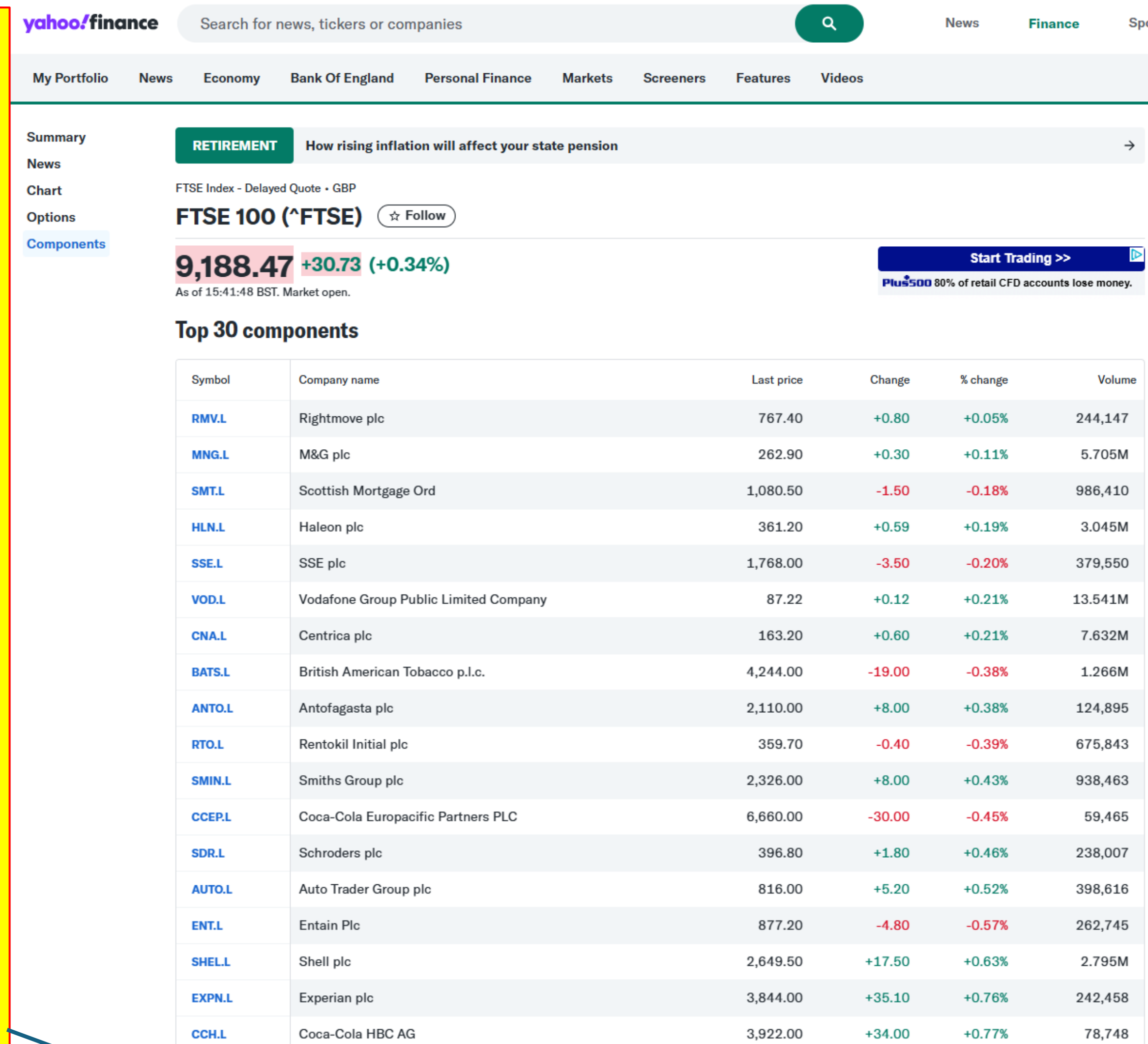
TASK 1: Download historical FTSE100 **indices** (at close per day) and **market capitalization**. and paste the data into a spreadsheet. Plot index, market capitalization and their ratio vs time.

How constant is the 'arbitrary number' which divides total market capitalization to yield the FTSE100 index?

TASK 2: Download historical FTSE100 closing share price vs time for the top 30 'components' of the FTSE100. (Challenge: download the **whole 100** – although note individual companies may move in and out of the FTSE100). Chose a time interval of **at least ten years**.

Note the FTSE100 index started on **3rd January 1984.** A sensible idea might be to download a dataset to an individual .csv file, then combine into a **data structure** in MATLAB/Python etc.

Then **plot share price (in £) vs time for each company.**



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Summary
News
Chart
Options
Components

RETIREMENT How rising inflation will affect your state pension

FTSE Index - Delayed Quote • GBP

FTSE 100 (^FTSE) ☆ Follow

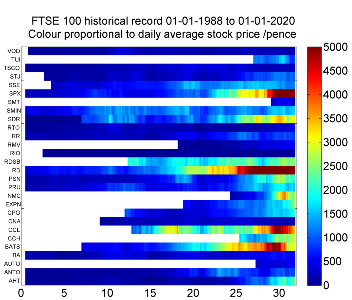
9,188.47 +30.73 (+0.34%)

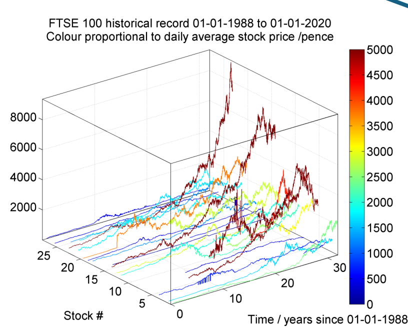
As of 15:41:48 BST. Market open.

Start Trading >>
Plus500 80% of retail CFD accounts lose money.

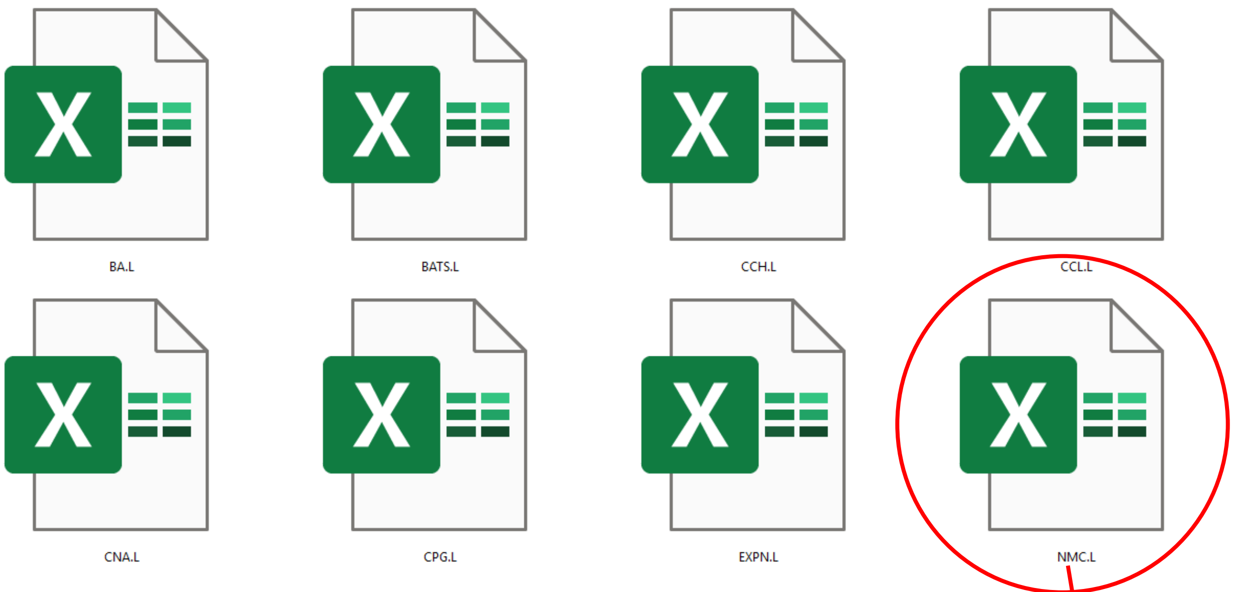
Top 30 components

Symbol	Company name	Last price	Change	% change	Volume
RMV.L	Rightmove plc	767.40	+0.80	+0.05%	244,147
MNG.L	M&G plc	262.90	+0.30	+0.11%	5.705M
SMT.L	Scottish Mortgage Ord	1,080.50	-1.50	-0.18%	986,410
HLN.L	Haleon plc	361.20	+0.59	+0.19%	3.045M
SSE.L	SSE plc	1,768.00	-3.50	-0.20%	379,550
VOD.L	Vodafone Group Public Limited Company	87.22	+0.12	+0.21%	13.541M
CNA.L	Centrica plc	163.20	+0.60	+0.21%	7.632M
BATS.L	British American Tobacco p.l.c.	4,244.00	-19.00	-0.38%	1.266M
ANTO.L	Antofagasta plc	2,110.00	+8.00	+0.38%	124,895
RTO.L	Rentokil Initial plc	359.70	-0.40	-0.39%	675,843
SMIN.L	Smiths Group plc	2,326.00	+8.00	+0.43%	938,463
CCEP.L	Coca-Cola Europacific Partners PLC	6,660.00	-30.00	-0.45%	59,465
SDR.L	Schroders plc	396.80	+1.80	+0.46%	238,007
AUTO.L	Auto Trader Group plc	816.00	+5.20	+0.52%	398,616
ENT.L	Entain Plc	877.20	-4.80	-0.57%	262,745
SHEL.L	Shell plc	2,649.50	+17.50	+0.63%	2.795M
EXPN.L	Experian plc	3,844.00	+35.10	+0.76%	242,458
CCH.L	Coca-Cola HBC AG	3,922.00	+34.00	+0.77%	78,748





Can you write a computer program that downloads stock prices to a file at a pre-determined time interval?
e.g. every minute or hour or day?

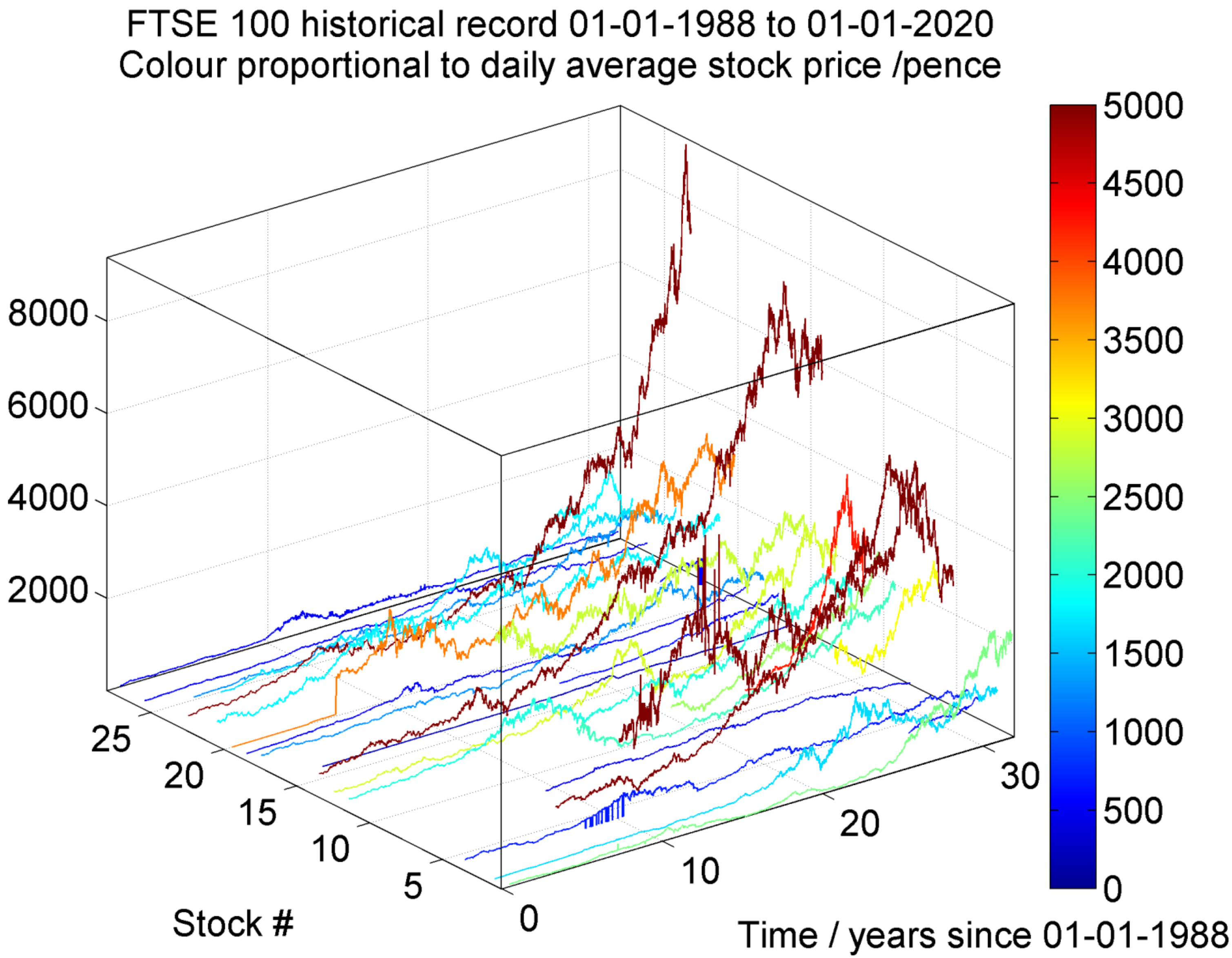


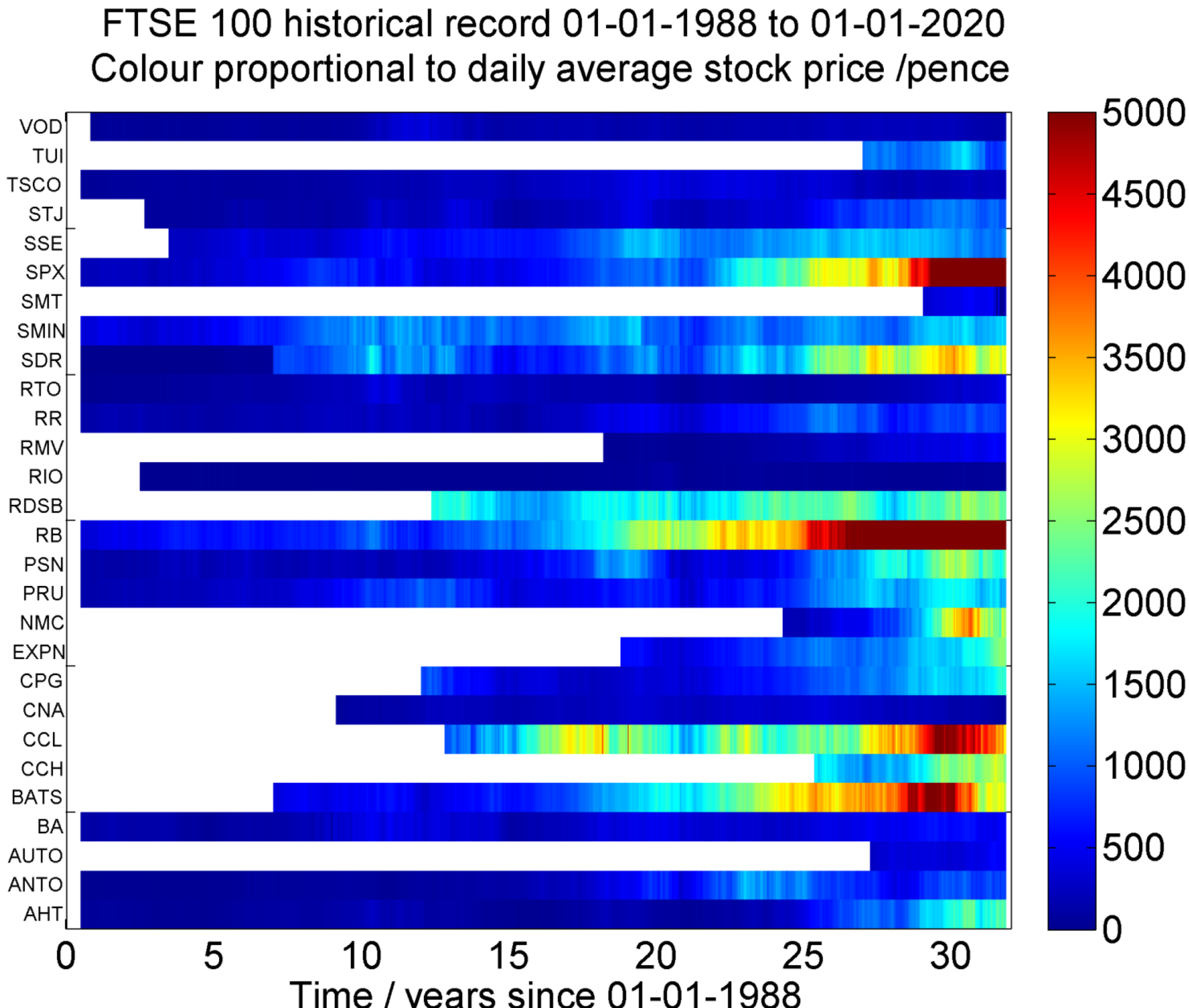
In my case, I formed .xlsx files with **daily stock prices** for each 'component' of the FTSE100. You might choose a different time interval, although shorter time-period data might be harder to obtain.

TASK 2: Download historical FTSE100 closing share price vs time for the top 30 'components' of the FTSE100. (Challenge: download the **whole 100** – although note individual companies may move in and out of the FTSE100).
Chose a time interval of **at least ten years**.

Note the FTSE100 index started on **3rd January 1984.** **A sensible idea might be to download a dataset to an individual .csv** file, then combine into a **data structure** in MATLAB/Python etc.

	A	B	C	D	E	F	G
1	Date	Open	High	Low	Close	Adj Close	Volume
2	02/04/2012	210	225	207	210	199.3336	5149051
3	03/04/2012	211	224.25	209.75	224.25	212.8598	2668686
4	04/04/2012	222	224.5	219	224.25	212.8598	95266
5	05/04/2012	225	225.25	223.75	229.75	218.0805	2002829
6	10/04/2012	227	234	225	230	218.3177	55816
7	11/04/2012	215	220	214.5	220	208.8257	638447
8	12/04/2012	220	220	215	219	207.8765	580616
9	13/04/2012	220	220	214	215	204.0796	327874
10	16/04/2012	215	215	214.8	220	208.8257	643835
11	17/04/2012	214	216.5	212	215	204.0796	1227748
12	18/04/2012	217.5	225	214	222	210.7241	151298
13	19/04/2012	230	230	216.75	216.75	205.7407	112938
14	20/04/2012	220	230	218	224	212.6225	2144
15	23/04/2012	223	223	215	217	205.9781	12538
16	24/04/2012	217	217	214	215	204.0796	237395

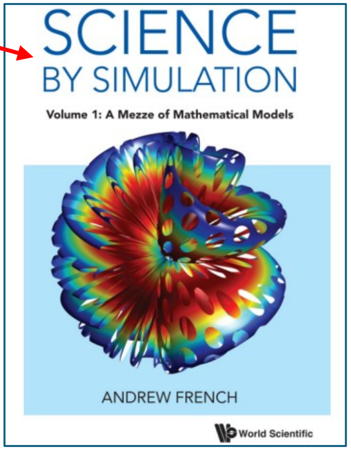

FTSE 100 historical record 01-01-1988 to 01-01-2020
Colour proportional to daily average stock price /pence
8000
6000
4000
2000
25
20
15
10
5
Stock #
0
10
20
30
Time / years since 01-01-1988
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0



FTSE 100 historical record 01-01-1988 to 01-01-2020
Colour proportional to daily average stock price /pence
VOD
TUI
TSCO
STJ
SSE
SPX
SMT
SMIN
SDR
RTO
RR
RMV
RIO
RDSB
RB
PSN
PRU
NMC
EXPN
CPG
CNA
CCL
CCH
BATS
BA
AUTO
ANTO
AHT
0
5
10
15
20
25
30
Time / years since 01-01-1988
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0

TASK3: Now you have access to share price vs time data (historical, and ideally updated every second or hour or day via an automated program – see TASK4), code up the **zbroker share trading algorithm.** This is a very simple process, designed to understand the concept of share trading, and was published in ***Science by Simulation: A Mezze of Mathematical Models.***

Example graphs are those published in this book.



Start with £x_0 portfolio at time t = 0. Assign this to stocks within the FTSE100. e.g. £1000, at £10 for each company. Or choose your own initial stock-picking assignment. e.g. ‘random’, ‘top 30…’

Build up N stock prices for companies in a particular stock exchange (e.g. the FTSE100) at time interval Δt. Determine **moving averages** and **standard deviations** over this period.

Compute:

$$\boxed{z = \frac{\text{stock price} - \text{mean value of stock price}}{\text{standard deviation of stock price}}}$$

For subsequent Δt time intervals, add most recent prices into the array of N prices, and remove the oldest.

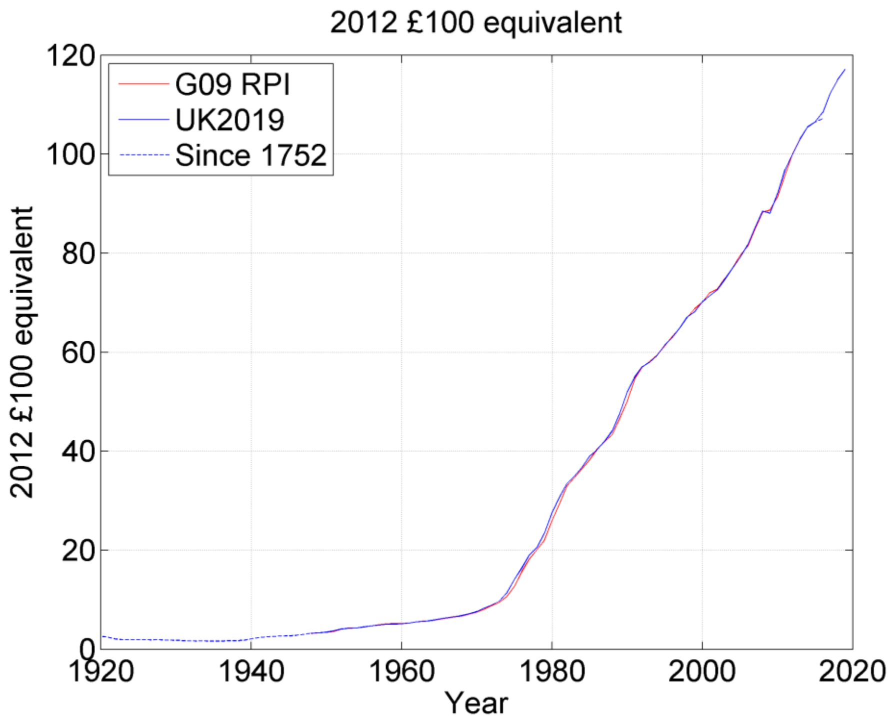
Now **order stocks by size of z** and **sell up to T %** of the total portfolio of those with **z values above z_{sell}**. This will generate some cash. Assume a L% **transaction loss.**

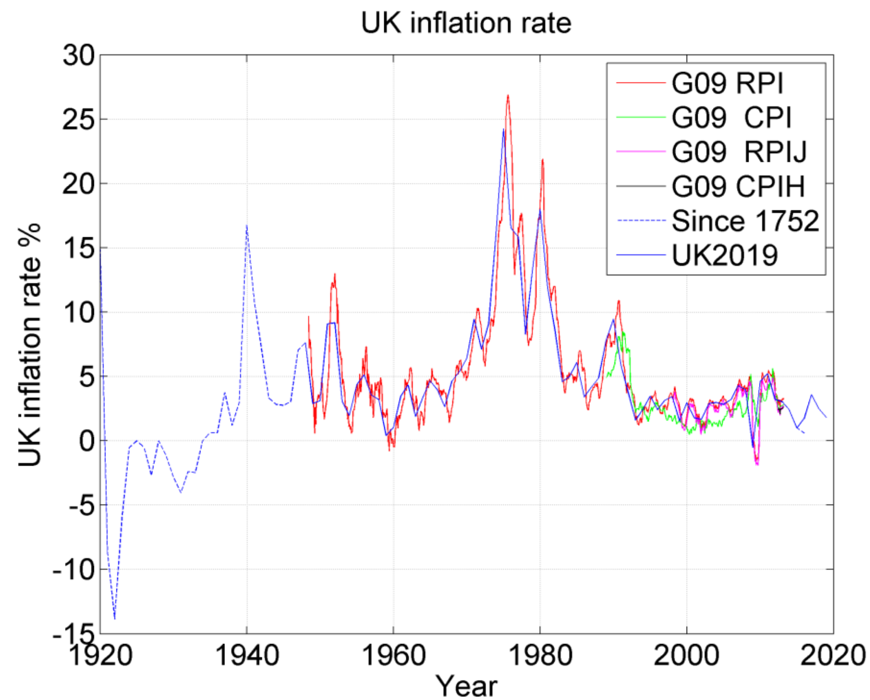
Now **use this cash to buy stocks** which have z values **less than** z_{buy}. Assume a L% **transaction loss.**

Repeat process, and **plot graphs** of portfolio value vs time.

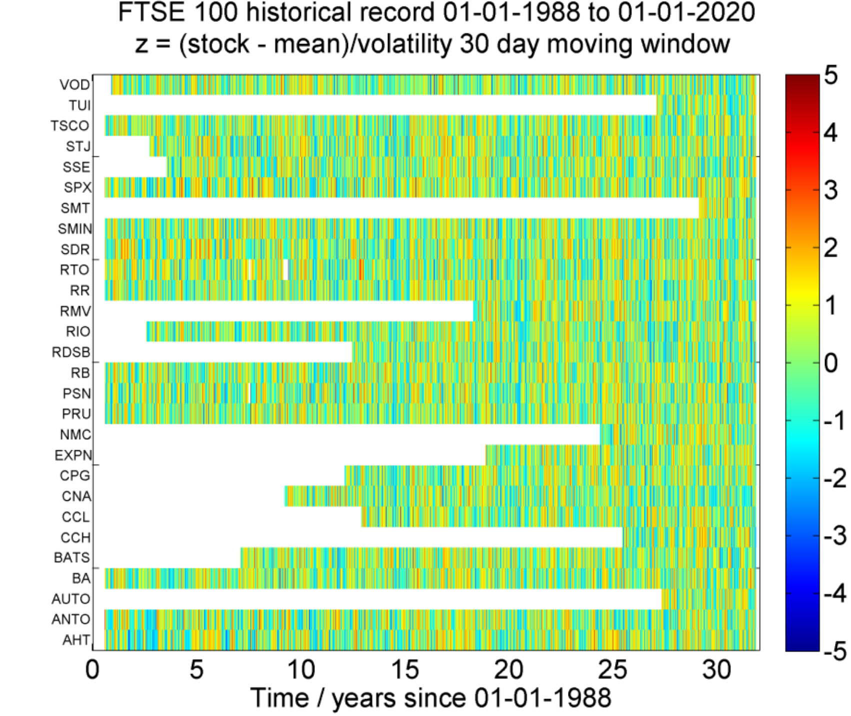
Experiment with different L, T, z_{buy}, z_{sell} and N (and or Δt) values.

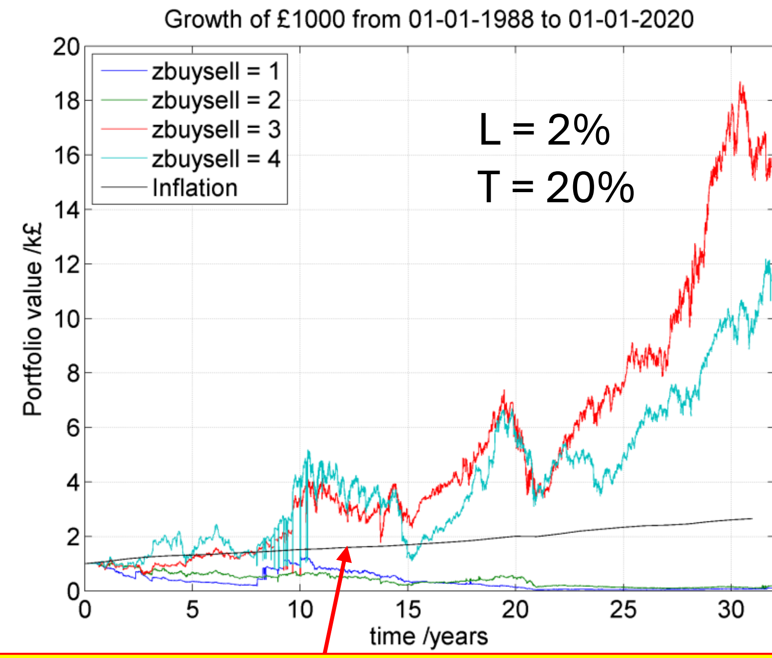
We shall assume our small volume of trades don’t affect the stock market!



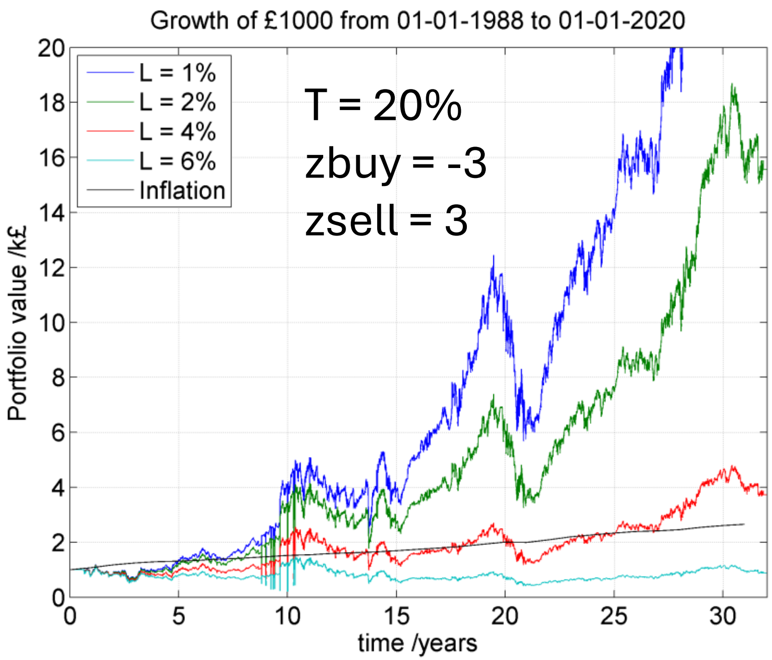


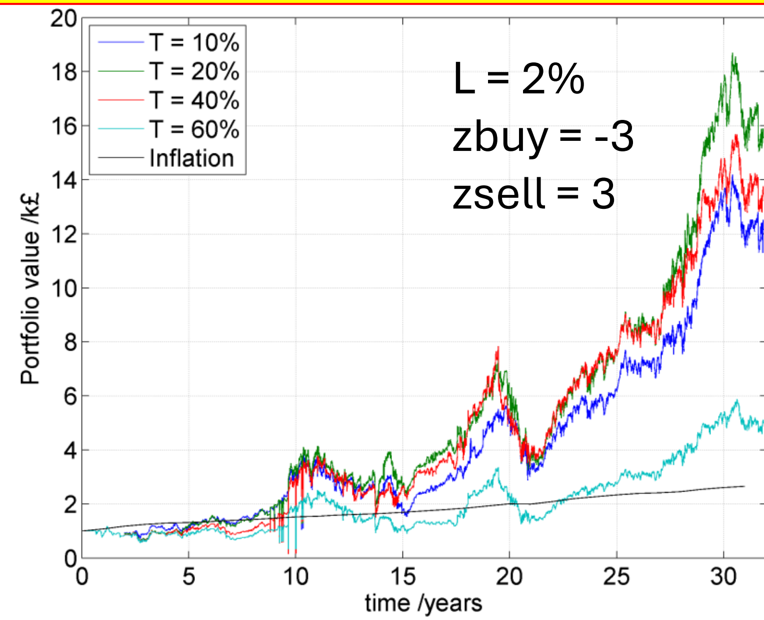
TASK3a: Download data on the UK inflation rate, and use to determine the equivalent value of £*x* at time *t*, compared to time *t* = 0.





Compare graphs to the original portfolio value £x_0, subject to **inflation**. Your investments need to exceed this line to 'have made money.'





TASK4: Build an <u>automated virtual trading program</u> based upon zbroker that:

- **Extracts live FTSE100 (or other stock exchange) share prices at time interval Δt using an elegant, automated method.**
- **Runs the z-broker algorithm (or a modified version, or indeed your own idea!)**
- **Displays history of portfolio value in some form of GUI or website or app**
- **Enable user to be able to dynamically change L, T, z_{buy}, z_{sell}, Δt, N**
- **Refine algorithm to optimize portfolio gain – perhaps with extra rules that automatically adjust the parameters L, T, z_{buy}, z_{sell}, Δt, N.**

The **winner** of the competition will *probably* be the one that makes the most virtual money (i.e. has the largest portfolio % gain over the competition time period), although significant weight will be given to:
(i) the quality of the YouTube (and live presentation),
(ii) the clarity and elegance and inventiveness of the programming solutions to the tasks (especially TASK 4).

Note: **zbroker** is based upon the share prices being **normally distributed** over a time interval $N\Delta t$. An **extension** could be to guess a *different distribution*, and adapt z_{buy}, z_{sell} accordingly.

e.g. log-normal, or skew-normal…

Another extension could be to model a regular (external) cash investment into the portfolio. This is how a stocks & shares ISA savings scheme works in the UK.