Data-driven portfolio management

Back-testing and analysis of investing strategies

Programming for Data Processing Final Project

Author: Guillermo Vigueras & Raúl Gutiérrez

Institute: Computer Science Faculty - UPM

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Disclaimer

It should be noted that concepts, investment methods and assets data described in this document are provided with education purposes only and are not intended to provide specific advice or recommendations for any individual or on any specific security or investment product. Thus, it is only intended to provide an academic example of data harvesting, manipulation and analysis.

Chapter 1 Data-driven portfolio management

This chapter introduces and states the context and main concepts that will be used for completing the tasks of the project.

1.1 Introduction

Smallville Asset Management (or SAM in abbreviated form) is an investment advice firm, that wants to improve their advice services provided to their customers, mainly individual investors. SAM managers tasks mainly consist of defining the type of financial assets a customer should invest in depending on the personal profile of the customer. Thus, after some interviews with the customer, the manager obtains a profile with aspects like return or profit expected, risk tolerance, ... Based on this profile, the manager proposes to the customer the type of assets to invest in, with an explanation according to customer expectations and profile.

So far, Smallville Asset Management relays heavely on the intuition and long experience of their portfolio managers to control and define the investment strategies used in the firm. However, with recent rise of Big Data and Data Analytics, they are thinking to complement the human expertise and perform data-driven portfolio management.

In order to leverage the power of Data Analytics, at SAM are planning to develop a *Back testing* tool. This tool basically allows to evaluate how an investment strategy has performed in the past, taking into account the previous behaviour (e.g. price evolution) of the financial assets included in the investment strategy. For that reason, managers at SAM have selected the different assets they daily work with. Main aspects of these assets are described in following section.

1.2 Asset description

At Smallville Asset Management are considering the following family of assets to carry out the study of data-driven portfolio construction:

Family of assets

- ❏ *Stocks*
- ❏ *Corporate bonds*
- ❏ *Public bonds*
- ❏ *Gold*
- ❏ *Cash*

Following sections describe main characteristics of each type of asset and the investment vehicle chosen by SAM for each asset family.

1.2.1 Global stocks

One of the assets chosen by Smallville Asset Management is a set of shares of companies publicly traded worldwide. The investment vehicle for the set of shares is a fund that automatically replicates the MSCI world index. For that reason, this way of investing is called passive since the fund simply replicates what the index does (buys/sells) as opposed to an active fund, where the investing strategy is delegated to the fund manager. For that reason, costs for passive funds are lower (i.e. « 1.0% of invested capital) with respect to active funds (typically 2.0% of invested capital) .

Definition 1.1. Fund

Funds pool money from interested investors and use that money to buy other securities, usually public company stocks and/or bonds. A fund issues a number a shares, that can be bought by people or institutions interested in that particular fund.

The value, over time, of the fund shares depends on the performance of the stocks the fund decides to buy. So, when investors buy a unit or share of a fund, they are buying the performance of its portfolio or, more precisely, a part of the portfolio's value. For that reason, the value of fund shares varies over time (up/down), according to the evolution of the stocks/bonds the fund is invested in. On the other hand, stocks/bonds share price varies (up/down) depending on how (well/bad) the business is performing (earnings, growth of sales, ...), economic expectations, market sentiment, ...

When trading (sell/buy) fund shares, its value is computed once a day, when markets close. Such value is the price at which fund shares are bought or sold, according to investors commands.

♣

Information of the stock fund chosen by Smallville Asset Management can be found in Table 1.1. For more information, check the URL in the table:

Table 1.1: Asset description of the stock fund

Feature	Value
ISIN	LU0996182563
Name	Amundi Index Msci World Ae-c
Inv. Vehicle	Fund
AssetType	Stocks
Cost	0.4 % of invested capital
URL	https://www.investing.com/funds/amundi-msci-wrld-ae-c

1.2.2 Corporate bonds

Another asset chosen by Smallville Asset Management is the debt issued by publicly traded companies worldwide, in the form of bonds. SAM has added this asset to the list of products as investors highly demand Corporate bonds since the perception of less risk with respect to company stocks. In reality, this is not always the case as explained following.

Definition 1.2. Corporate bonds

Corporate bonds are made up of the debt issued by companies to bondholders in order to raise capital. In this way, bondholders receive a fixed interest rate for the money lent during a period of time. Once the time expires, the bondholder receives the money lent to the company plut the interest agreed. However, the bondholder can potentially lose the investment in case of bankruptcy of the borrower company.

Due to the fixed interest paid by bonds, they are considered to be less risky than company stocks, since there is no a-priori knowledge of stock rentability as these are influenced by many factors (business performance, economic forecast, market sentiment, ...). However, bonds are also publicly traded, and thus the bond price can rise or fall due to different reasons: business performance, changes in interest rates, ... Potentially, a bondholder can lose the whole investment in case of bankruptcy, as mentioned before.

♣

Since Smallville Asset Management wants to diversify geographically the Corporate bonds offered to its customers, the investment vehicle chosen for Corporate bonds is an ETF managed by Blackrock investment corporation.

Definition 1.3. ETFs

Exchange-traded funds (ETFs) are similar to funds but traded on the public market like stocks. In the same way as funds, ETFs issue units or shares that are traded at a given price. Additionally, ETF shares can be assigned a price at a fraction of time (e.g. milliseconds), as opposed to funds shares that are assigned a price in a daily basis.

♣

Information about the ETF for Corporate bonds chosen by Smallville Asset Management can be found in Table 1.2. For more information, check the URL in the table:

Table 1.2: Asset description for Corporate bonds

Feature	Value
ISIN	IE00B7J7TB45
Name	iShares Global Corporate Bond UCITS (CRPS)
Inv. Vehicle	ETF
AssetType	Corporate Bonds
Cost	0.2 % of invested capital
URL	https://www.investing.com/etfs/ishares-global-corporate-bond-$

1.2.3 Public or government bonds

Smallville Asset Management has also selected as an asset the public debt issued by governments worldwide, in the form of bonds.

Definition 1.4. Public bonds

Government or public bonds are for investors looking to put their money away in low-risk investments through Treasury securities, such as Treasury bonds, or agency-issued debt. As for Corporate bonds, public bonds are considered as one of the least risky assets. The main risk associated to public bonds is the possibility of default (i.e. bankruptcy) of the government/agency issuing the bonds. Although, the probability of sovereign default is low for some countries, history has demonstrated that such probability can not be considered to be zero, forever.

♣

The investment vehicle chosen for Public bonds is an ETF managed by DWS Investments UK Limited. Information about the ETF for Public bonds can be found in Table 1.3. For more information, check the URL in the table:

Table 1.3: Asset description for Public bonds

Feature	Value
ISIN	LU0908508731
Name	Xtrackers II Global Government Bond UCITS ETF 5C (XG7S)
Inv. Vehicle	ETF
AssetType	Public Bonds
Cost	0.2 % of invested capital
URL	https://www.investing.com/etfs/db-x-trackers-ii-global-sovereign-5

1.2.4 Gold

Gold is an asset that has equally supporters and haters. The main arguments for haters is the fact that gold does not produce earnings and cannot pay dividends, some others argue that gold is a highly speculative asset. On the contrary, supporters consider that gold is a true store of value (as oppose to fiat money) and thus can provide profits to an investor in the long run.

The investment vehicle chosen for gold is an ETF managed by World Gold Council. Information about the ETF for gold can be found in Table 1.4. For more information, check the URL in the table:

Table 1.4: Features description for Gold

Feature	Value
ISIN	US78463V1070
Name	SPDR® Gold Shares (GLD)
Inv. Vehicle	ETF
AssetType	Gold
Cost	0.1 % of invested capital
URL	https://www.investing.com/etfs/spdr-gold-trust

1.2.5 Cash

Although cash is not a financial asset *per se*, SAM managers have also identified it as an asset since having some cash in an investment portfolio, allows to take advantage of buying opportunities that arise in markets.

Nevertheless, cash suffers from inflation (i.e. devaluation) and benefits from deflation (i.e. value appreciation). The fact that these economic phenomena exist should be taken into account when managing an investment portfolio.

The investment vehicle chosen for cash is an Index that represents the evolution of US dollar. At SAM has considered this currency since the rest of investment vehicles uses this currency. Information about the dollar index can be found in Table 1.5. For more information, check the URL in the table:

Table 1.5: Features description for Cash

Feature	Value
ISIN	US78463V1070
Name	US Dollar Index (DXY)
Inv. Vehicle	Index
AssetType	Cash
Cost	0.0 % of invested capital
URL	https://www.investing.com/indices/usdollar

Note *The US dollar index represents the evolution of the dollar value over time. Daily values registered by the US dollar index are expressed in base 100. This means, for example, if for a given day the index value is 96, it should be divided by 100 to compute the value of 1 US dollar for that day. Thus, for an index value of 96, the real value of* $1\$ = 1\$ * 0.96 = 0.96\$$

Chapter 2 Data harvesting

Smallville Asset Management is interested in generating different investment strategies for evaluating several aspects of portfolio performance. The main input data required by SAM is the price over time of each asset.

In order to reduce costs of accessing financial data, SAM has decided to freely obtain the data from investing.com. This website offers financial information about different types of assets and investment vehicles, publicly traded. Since `investing.com` has the same format for webpages for different assets, SAM has realized that data harvesting can be programmatically performed through web scrapping.

Following sections describe website locations in order to browse and get the required financial data. Locations are explained for the Corporate bonds ETF, but can be extrapolated for the rest of investment vehicles.

2.1 Asset main page

When accessing the main page for a given investment vehicle, a similar screen is shown as the one in Figure 2.1. Such screen contains a link to the historical data associated to the asset. Figure 2.1, magnifies the area of the webpage where the link to `historical data` is.

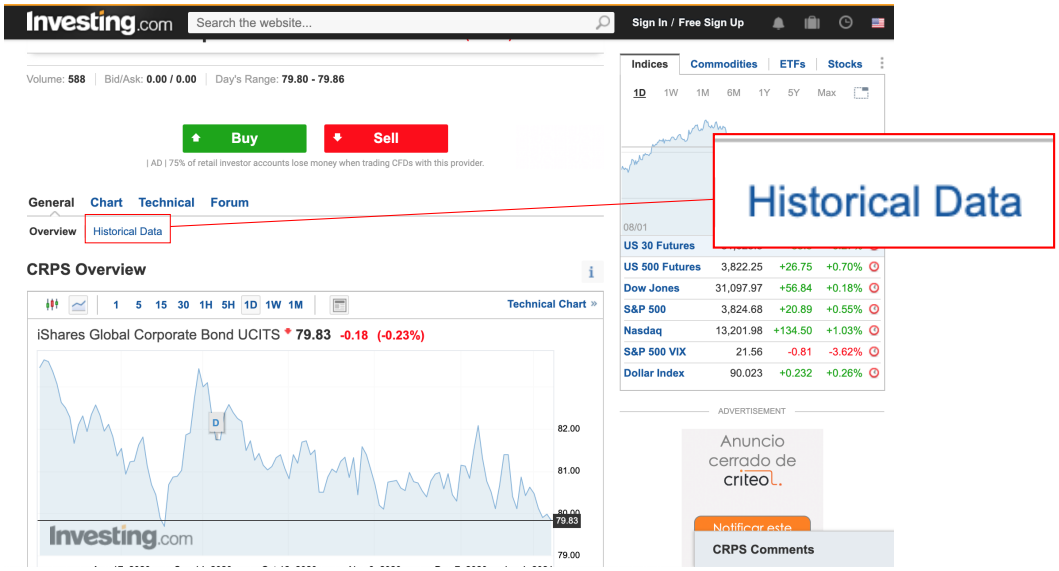

Figure 2.1: Main page of asset and access to historical data

2.2 Asset historical data

The page containing asset historical data is shown in Figure 2.2. When setting the `Time frame` to a daily basis (default set), the page shows historical data (prices, volume of trading and

% of change in price) for the last month. The range of dates can be changed by clicking on a button with a calendar icon. Such button is highlighted in Figure 2.2

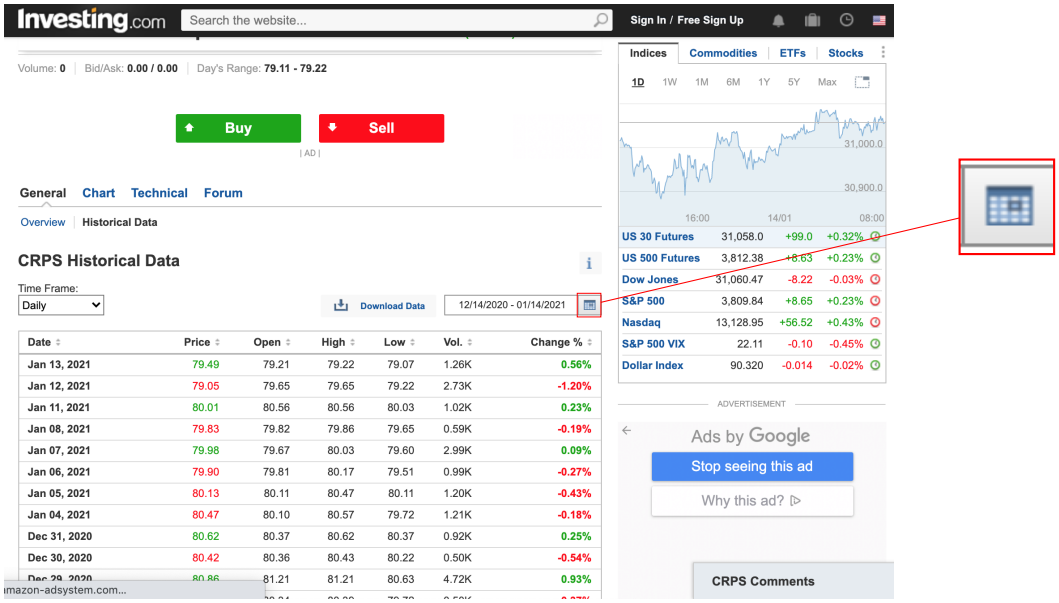

Figure 2.2: Webpage displaying asset historical data and detail of the button for date change

Once displayed the form for specifying the date range, the starting and ending dates can be changed using the input text fields `Start Date` and `End Date`. These fields are highlighted in Figure 2.3, where dates can be specified using the format `MM/DD/YYYY`.

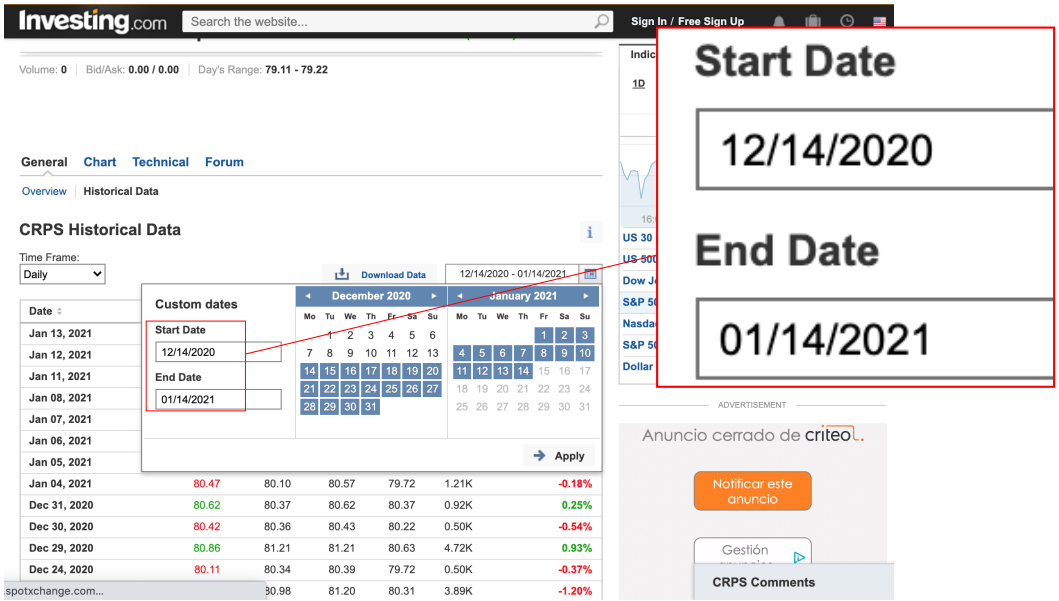

Figure 2.3: Webpage displaying the form for updating date ranges for asset prices

After input text fields for dates have been updated, these changes can be set by clicking on button `Apply`. This button is highlighted in Figure 2.4.

Once button `Apply` has been clicked, the table showing asset information over time is

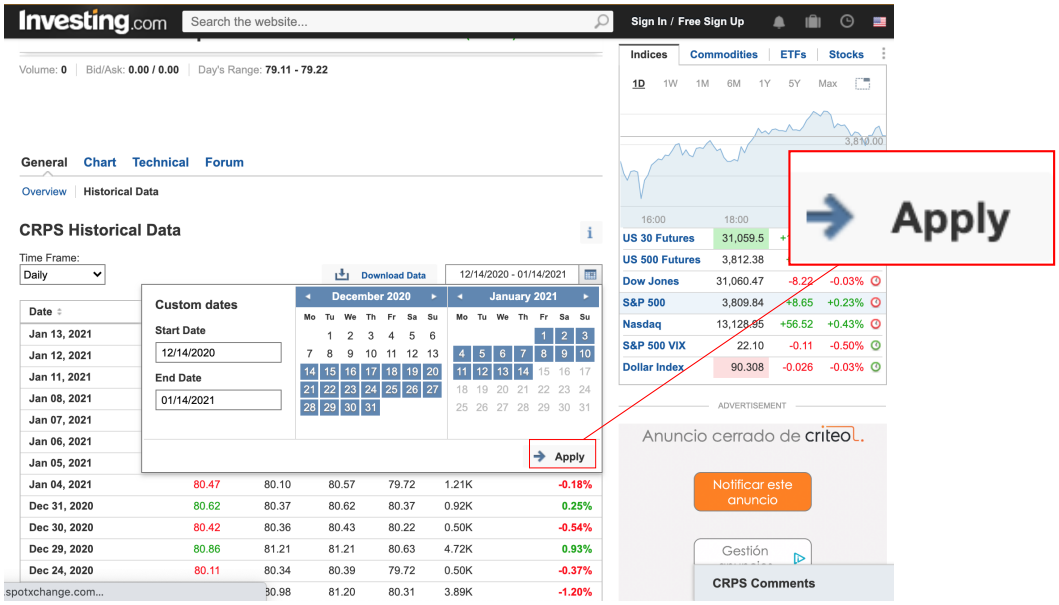

Figure 2.4: Detail of the `Apply` button for updating date ranges for asset data

updated to reflect the new date range set. This table is highlighted in Figure 2.5. Also, that table has several columns with asset price information. The column corresponding to the price for a given date is the one with column header `Price`. Columns with headers `Open`, `High` and `Low` can be discarded. The temporal evolution of asset prices can be obtained by accessing the DOM element corresponding to the HTML table mentioned before.

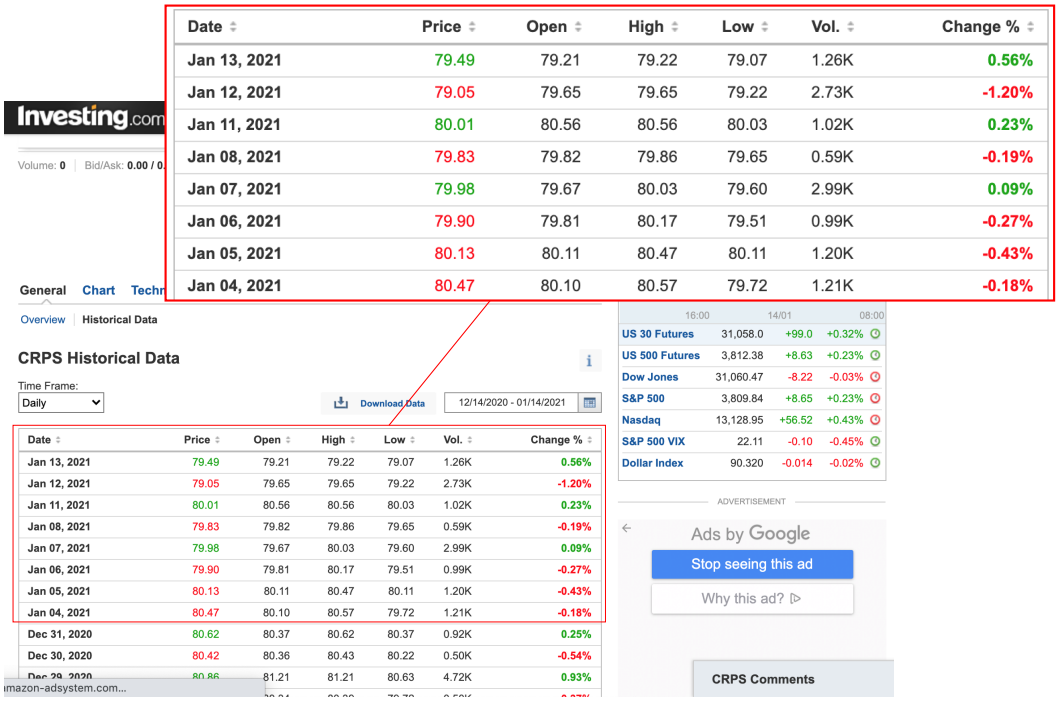

Figure 2.5: Detail of the table showing asset information over time

2.3 Assets prices

As a reference, Figure 2.6 shows price evolution over time of assets described in previous sections.

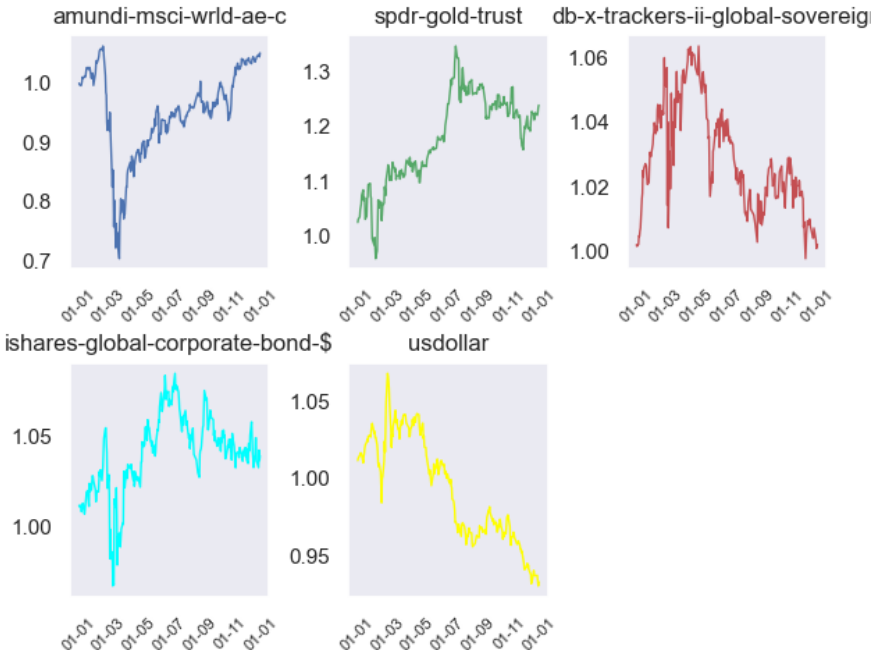

Figure 2.6: Price evolution of assets over time

2.4 Tasks related to data harvesting

Smallville Asset Management requires the harvesting of data from investing.com for obtaining the historical data of the assets described in Section 1.2. The dates SAM is interested in fall in the range: `01/01/2020` and `12/31/2020`, both inclusive.

For that purpose, historical data of assets should be harvested and stored in individual files (e.g. one file per asset) in order to be used in later tasks. This files should be stored in a Pandas friendly format (e.g. `.csv`) since tasks in following chapters are expected to be completed using Pandas.