**Trading strategy for gold: Strategic trading of gold using linear models**

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## Abstract 200

Understanding the relationships between financial assets and the economic climate is of significance to investors, policy makers and governments alike. Within financial markets, gold has long been believed to play an important role during financial crises, acting as a store for value. However, despite anecdotal evidence pervasive in financial media suggesting that gold serves as a safe haven in financial markets during times of economic instability, empirical evidence supporting this claim is inconsistent. This project seeks to evaluate the behaviour of gold prices within the world’s largest economy, the United States, during periods of economic recession. Historical gold and US stock market prices are analyzed to gain insights into the behaviour of investors with respect to the precious metal during periods of financial crisis. Descriptive and econometric analyses are used to identify potential correlations between the price of gold and S&P500 returns during recessionary periods in the US spanning a period of 50 years from 1970 to 2020. The NBER’s definition of a recessionary period is used to select 8 periods of recession within the USA: 1969, 1973, 1980, 1981, 1990, 2001, 2007 and 2020.

The results of this project have the potential for use in the establishment of a trading strategy by investors interested in the precious metal. My findings indicate that gold is both a hedge and a safe haven for the US, suggesting that the use of strategic entry or exit points will likely lead to profits, relative to any random entry/exit point. The novelty of this project lies in the analysis of trends in gold price over the whole of the 20th century, covering a total of 8 periods of economic recession. Further analyses should seek to explore whether this property holds in other markets, including other European markets, as well as large emerging markets, such as the BRIC countries, and in developing economies.

## 1. Introduction (500)

Economics

Gold

* global gold consumption
* gold reserves - gold reserves held by investors and governments alike support a general view as to the inherent value of the precious metal.
* supply and demand – supply is finite (aboveground stock of 200,000 mt tons), demand is variable (ref: World Gold Council).

Stock market

“The stock market is often a sentiment indicator that can impact gross domestic product (GDP) either negatively or positively. In a bull market—stock prices are rising—consumers and companies have more wealth and confidence—leading to more spending and higher GDP.”

The remainder of this paper is organized as follows. Section 2 comprises of a review on the literature concerning the behaviour of gold prices. In section 3, the study area and data, including site descriptions and field observations, are introduced in detail. Descriptions of the statistical model are provided in Section 3, including the governing equations, simulation setup, post-processing, and parameter analysis. The results and discussions are presented in Section 4, followed by the conclusions in Section 5.

## 2. Literature review (1000)

Techniques

* Gold price analysis
  + Bayesian analysis
  + linear regression
* Trading strategy analysis

Economic indicators

*Economic indicators*

Papers looking at gold and stocks.

Papers looking at gold and interest rates.

Papers looking at gold and inflation.

Papers looking at gold and employment.

Papers looking at gold and GDP.

Papers looking at gold and exchange rates.

Papers looking at gold and other commodities:

* “Volatility in natural gas prices helped one US hedge fund bag profits of more than $400m in October alone.” – volatility in other commodities has been used by investors to make huge profits.
* inflation
* macroeconomic news
* USD exchange rate
* stock prices
* interest rate
* oil
* bonds

Data

* Price daily returns
* Exchange rate returns

Countries

* Developed countries: UK, USA, Germany
* Emerging countries: India, China
* Developing countries: -

## 3. Research design (800)

#### Part 1 – Correlation analysis

find correlations between gold and economic health using regression

create a table of positive correlation vs. negative correlations

#### Part 2 – Trading strategy Let's summarise the general process we will be following throughout the series:

* Outline a hypothesis about a particular time series and its behaviour
* Obtain the correlogram of the time series (perhaps using R or Python libraries) and assess its serial correlation
* Use our knowledge of time series models and fit an appropriate model to reduce the serial correlation in the *residuals* (see below for a definition) of the model and its time series
* Refine the fit until no correlation is present and use mathematical criteria to assess the model fit
* Use the model and its second-order properties to make forecasts about future values
* Assess the accuracy of these forecasts using statistical techniques (such as [confusion matrices](https://en.wikipedia.org/wiki/Confusion_matrix), [ROC curves](https://en.wikipedia.org/wiki/Receiver_operating_characteristic) for classification or regressive metrics such as [MSE](https://en.wikipedia.org/wiki/Mean_squared_error), [MAPE](https://en.wikipedia.org/wiki/Mean_absolute_percentage_error) etc)
* Iterate through this process until the accuracy is optimal and then utilise such forecasts to create trading strategies.

<https://www.quantstart.com/articles/White-Noise-and-Random-Walks-in-Time-Series-Analysis/>

### Data

Correlation between gold price and economic indicators during economic booms and recessions.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Boom | | Recession | | Other | |
| Expected | Actual | Expected | Actual | Expected | Actual |
| GDP growth |  |  |  |  |  |  |
| USD exchange |  |  |  |  |  |  |
| Employment |  |  |  |  |  |  |
| Interest rate |  |  |  |  |  |  |
| **Stocks (S&P500)** | Negative |  | Negative |  | Uncorrelated |  |
| Inflation |  |  |  |  |  |  |
| Other commodities (crude oil) |  |  |  |  |  |  |

### Statistical analysis

* create an algorithm for buying into gold when certain indicators are triggered
* create an algorithm for selling gold and buying into stocks when certain indicators are triggered

1. choose economic indicators
   1. US economic indicators
   2. US is the largest economy in the world
2. explain economic theory behind each relationship
   1. gold and interest rates
   2. gold and inflation
   3. gold and stock market
   4. gold and unemployment
   5. gold and USD exchange rate
3. choose time periods for data
   1. Recession:
      1. Definitions:
         1. US government (NBER) – monthly indicators of economic activity, defined by a change in the direction of the rate of economic growth. Recession, “The period between a peak and a trough”, and expansion “the period between the trough and the peak”
         2. Financial press – two consecutive quarters of decline in real GDP.
         3. UK government – “The commonly accepted **definition** of an **economic** **recession** and that used by the UK  
            government is that of two consecutive quarters of negative **economic** growth.” “On the basis of this definition, the UK economy entered recession in January 2009 and emerged in January 2010.” (Houdmont, 2012)
         4. The NBER describes the concept as follows: “a recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in **real GDP, real income, employment, industrial production, and wholesale-retail sales**”
            1. <https://www.nber.org/research/business-cycle-dating>
            2. Abberger, Klaus; Nierhaus, Wolfgang (2008) : How to Define a Recession?, CESifo Forum, ISSN 2190-717X, ifo Institut für Wirtschaftsforschung an der Universität München, München, Vol. 09, Iss. 4, pp. 74-76
   2. Expansions
      1. Definitions:
         1. US government (NBER) – monthly indicators of economic activity, defined by a change in the direction of the rate of economic growth. Recession, “The period between a peak and a trough”, and expansion “the period between the trough and the peak”
         2. Financial press -
         3. UK government -
   3. Time in-between recessions and expansions
4. Graph change in gold price over time.

Graph growth of price over time.

Possible correlation between market volatility and increases in price

Hypothesis: gold price is correlated with market volatility

Gráfico, Gráfico de líneas, Histograma

Descripción generada automáticamente

Unemployment rate. NBER-dated recessions in gray. Source: Bureau of Labor Statistics via the Federal Reserve Bank of St. Louis.

1. run regression

## 4. Results and Discussion 2000

### Results 1000

### Analysis 1000

## 5. Conclusion 500

gold basics

limited supply

price determined by demand

demand governed by risk appetite

gold price changes because demand changed

price can change due to a one-time increase in supply, such as an exceptional sale of central bank gold stockpiles (e.g. sale of UK gold reserves 1999-2002 Gordon Brown)

theory:

* people buy gold during recession when confidence in the stock market is low
* relationship with inflation?
* relationship with interest rates?

economic recession/boom

* technical indicators (National Bureau of Economic Research)
  + inflation
  + interest rate
  + USD dollar
  + unemployment
  + inter-day change in GDP
  + inter-day change in stock market I’ndices
    - SP500
    - Dow Jones
    - Nasdaq

hypothesis

* sell stocks and switch into gold during recession
* sell gold and switch into stocks during boom

1. gold in the financial market
2. definition of recession and boom
3. indicators of recession
4. indicators of booms
5. correlation between gold and indicators
6. trading strategy

Primary literature

*Supply and demand*

The price of gold is ruled by consumers on the demand side. As a finite commodity, the supply of gold is limited by its mining activity. It’s price can be influenced by the supply side in extraordinary circumstance, such as due a one-time increase in supply (e.g. an exceptional sale of central bank gold stockpiles; sale of UK gold reserves by Gordon Brown in 1999-2002). Thus, according to the theory of supply and demand, the price of gold will increase with a rise in its demand, and vice versa.

*Gold as a store of value*

Gold is considered a store of value **(why?)**. The literature states that demand for gold increases in times of economic crisis as the appetite for capital markets and risk decreases. Thus, it is in the investor’s interest to know when to best choose between investing in these assets to maximise their returns.

*Economic booms and recessions*

According to the National Bureau for Economic Research (NBER), recessions are characterized by a slower economic growth, weak/strong USD. This paper will use a linear model to construct a trading strategy for the sell-off and purchase of gold/stocks according to these economic indicators. Statistical correlation based on regression analysis will be used to construct a trading strategy.

*Gold and the stock market*

Research using U.S., U.K. and German stock and bond returns and gold returns found that gold is a hedge against stocks on average and a safe haven in extreme stock market conditions. A portfolio analysis further showed that the safe haven property is short-lived.

Data

How many periods – all recessions on record (1920s, 2008, 2012, 2020)

* periods of recession within the 20th century
* periods between recessions within the 20th century

What data – gold price, NBER indicators

* economic recession
* economic boom
* interest rates and inflation
* monetary policy
* business cycle
* gold and stock markets
* gold as a hedge for inflation
* gold as a safe haven (store of value)
* trading strategy for gold

Statistical analysis

* regression
  + correlation (and significance)
* null hypothesis

**The narrative of gold:**

* hedge against inflation
* demand falls when interest rates are high (raised in reponse to inflation)
* futures vs. physical gold
* non-yielding asset vs. bonds and dividend-paying stocks

The narrative of inflation

The narrative of interest rates

The narrative of a store of value

The narrative of hedges for inflation

The narrative of assets: cryptocurrency

pick apart the concept of store of value

is gold really a store or value

are other assets/commodities taking over, e.g. crypto

The price of gold is determined by demand – supply side is restricted by low levels of production (finite resource). When gold is in high demand, its price goes up (supply and demand model). The conditions under which gold because attractive are the same as those under which stocks become less attractive (inflation, interest rates, etc.).

Unlike other commodities – copper, cocoa, oil, grains, beef, and natural gas – gold is not used as an input in the production of goods and service, meaning that, unlike other commodities, its value is not derived from its use. With the exception of jewellery (2233t, 52%), gold is held in its original form in bars and coins (1177t, 27%), technology (384t, 9%), financial products (147t, 3%), and central banks (341t, 8%).

Those conditions (low interest rates) are characteristic of economic crises. These are often reflected in corrections in the stock market (financial crises), due to a low appetite for risk, with investors taking their money out of stocks and putting them into safer assets, including gold.

Gold has been traded for its value since xx. However, it having monetary power over time (use of gold in coins, gold standard for currency). So why does it still hold value, enough for central banks and investors around the world alike to store billions of USD worth of it in their vaults and safety deposit boxes?

**Marking**

2.1. Writing and Scholarly conventions   
Is there: a clear structure overall; clarity in individual paragraphs and sentences; logical arguments; and careful use of evidence? Are spelling and grammar correct? Are any technical terms or abbreviations explained? The word limit is short so make every word count. Are sources of ideas and quotations properly acknowledged? Is there a list of references? Are data sources properly documented? Is the project written in an academic (as opposed to, say, journalistic) style? Copy the styles of articles in economics/Önance journals.

2.2. Originality/interest.   
Most topics can be made interesting if presented su¢ ciently well, but it is harder to Önd something interesting to say about a standard topic, than about a slightly more unusual topic.

*2.3. Analysis.*   
Does the work indicate a good understanding of the relevant context and literature? Does it use the appropriate concepts from relevant economic or Önance theory. Is there a a logical argument and e§ective use of evidence to support the argument? Did it answer the question posed?

2.4. Data collection/presentation  
Has the appropriate data been collected (given time limitations)? Have the data been checked? Does the work show understanding of what the data actually measure and the limitations of the data? If students indicate that they put an unusual amount of work into collecting data, they will get some credit for it. Does the work demonstrate the ability to summarize and present data in a clear and e§ective way? 4

2.5. Statistical Methods.   
Are the appropriate statistical methods used? Have any conclusions been suitably qualiÖed? Does the work show understanding of the methods.

2.6. Interpretation.   
How does the report answer the question it posed?

On successful completion of the project, you will have demonstrated that you have:

* selected a suitable topic for investigation
* conducted a literature review
* collected, described and analysed a relevant data set
* presented your results in an interesting and coherent manner
* met the project deadline
* submitted a piece of work that is entirely your own contribution.