

**The Efficiency of the London Gold Fixing:
From Gold Standard to Hoarded Commodity (1919-68)**

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ABSTRACT

This paper presents and explains the newly rediscovered and transcribed daily market gold price from 1919-1968 for the world's main gold market during the period, the London *Gold Fixing* Auction.

The paper highlights several novel features previously not discussed in the literature, such as gold prices fluctuating at the daily *Gold Fixing* even during the two Gold Standard periods when gold prices are often thought of as 'fixed'. It also describes key turning points during the evolution of the *Gold Fixing* such as its formation and the daily price reactions when Britain went on or came off the Gold Standard.

This paper offers the first long-run examination of the weak form efficiency of the *Gold Fixing* from its inception, at a time when gold was the centre of the world's monetary system. We find that the *Gold Fixing* price was informationally efficient at its inception in 1919 but by the 1930s, when there was increased buying for speculation and investment (referred to as *hoarding*) the market became more predictable and inefficient. We also find that the market was inefficient during gold standard periods when central banks were limiting gold's ability to react to new information.

Keywords: Daily Gold Price Data, London Market, Market Efficiency, Gold Fixing, Hoarding.

JEL codes: F3, G1, G2, N2, Q3.

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1. Introduction

Despite the importance of gold in international monetary affairs in the 20th century, the daily price of gold pre-1968, as set at the benchmark London *Gold Fixing* auction, was believed to be lost and has not been part of the discussion of this period when gold was central to international exchange rate regimes. This paper's first contribution to the literature is reconstructing this "elusive"¹ dataset using archival sources.

The *Gold Fixing* auction was a daily meeting of the Bank of England, four major London bullion brokers² of this period and Rothschilds bank. Each day the chair of the meeting would set an opening price for gold which was followed by offers to buy and sell quantities of gold from each broker at that price. The chair would then adjust the price until supply and demand were in balance. The *Gold Fixing* price from this auction served as the benchmark for gold contracts worldwide through depressions, world wars and changes in the world's monetary regime (Harvey, 2008). Over 100 years later this auction still takes place, though its name has changed to the London Bullion Market Association (LBMA) Gold Price and it now runs through an online platform.

To make effective use of this data requires that researchers understand the context of what a very different market this was, relative to its modern counterpart, and this is our paper's second contribution. Using contemporary published sources, such as the annual bullion letters published by the London bullion banks of the day and their weekly notes published in newspapers, we explain the operation of the *Gold Fixing* in the different periods examined. We discuss the official formation of the *Gold Fixing* in 1919, during periods of both free and officially set gold prices up to the closure of the gold market in 1939 at the outbreak of World War II, finishing at the closure of the market in 1968 before it reopened in its modern form.

This discussion has a particular focus on the turning points in the London Gold Market including the return of the gold standard in 1925 and the subsequent shift to a freely floating price in 1931. London had already been the world's main market for gold for two centuries with the majority of newly mined gold sold there (Evitt, 1938).

The pre-1968 *Gold Fixing* is an under researched topic in financial history, particularly quantitative aspects of the market due to the lack higher-frequency data. Economic historians have analysed gold in the early twentieth century within the context of monetary economics and exchange rate regimes, particularly the restoration of the interwar gold standard (e.g. Eichengreen, 1996). Harvey (2008) provides a detailed discussion of the socioeconomic underpinning and development of the *Gold Fixing* from its inception using archival sources such as the Bank of England, while Blagg (2013) and Bott (2013) provide insights into the impact of the actions of refiners and miners on the gold market in the early 20th century.

¹ The investment bank NM Rothschilds & Son, who ran the *Gold Fixing* up to 2004, said that a "complete record of the daily gold prices from the New Court Gold Fixing 1919-2004 has proved surprisingly elusive" (Rothschilds, n.d.).

² They are: Mocatta and Goldsmid; Pixley and Abell; Sharps and Wilkins; and Samuel Montagu & Co.

The focus of pre-1968 research on gold's monetary function stems from an assumption that gold was not an investible asset during this period. But the demand for gold pre-1968 did not just come from the official sources that many will be familiar with, such as central banks, but to a large degree from 'hoarders', as gold investors and speculators were referred to up to the 1970s. Eccles (1936) estimated that by that time, there was \$2 billion worth of gold in international private 'hoards', two-thirds of this held in London vaults with only a minority owned by English residents. Tamagna (1954) looked at private gold demand globally from 1931-54 and found the scale of worldwide private demand for gold in this period was "unprecedented", with western hoarders increasing their holdings by over 600 tonnes, worth £240 million in 1954.

Our final contribution will be to address the fundamental question of whether the London *Gold Fixing* was informationally efficient, as per the weak form of the Efficient Markets Hypothesis (Fama, 1970). We will look at the efficiency of this market in the sub-periods where it operated at times with differing degrees of freedom from central banking intervention. This will allow us to see whether the market became more efficient over time, as participants' knowledge grew (Bassino and Lagoarde-Segot, 2015) or if shocks to the market, such as coming on and off the Gold Standard meant that the development of the market's efficiency suffered setbacks. Predictable patterns in price changes are an indication of an inefficient market, as this allows traders who exploit the patterns to obtain an economic surplus at the expense of participants who did not have this knowledge but traded anyway; commonly referred to as Noise Traders (Dow and Gorton, 2006).

Section 2 discusses the newly transcribed daily *Gold Fixing* price data. Section 3 discusses the development of this new market and its features under periods where the Gold Exchange Standard was in operation (1925-31 and 1954-68) versus when the gold price floated (1919-25 and 1931-39). We will then discuss the literature on gold market efficiency pre- and post-1968, and the range of methods used to assess whether this market was efficient. Finally, we show the results of our empirical study in the context of what we know about its operation.

We find that the first phase of this newly formed auction (1919-1925) was weak form efficient, a time when the market was dominated by professional traders at the London bullion and central banks, though prices did float freely in the daily auction. The market is conclusively shown to be inefficient when the gold price varied under a ceiling set by the Bank of England from 1925-31, a time when prices varied but by very small amounts from day to day. The next period of fixed gold prices (1954-68) is also found to be inefficient. When gold prices again floated freely (1931-39) the market remains inefficient though this is the most active and liquid gold market period examined here. We attribute this finding to the increased investment or 'hoarding' activity seen in gold during this period by private investors.

2. Reconstructing the early 20th century Gold Fixing: Quantitative and Qualitative Data sources

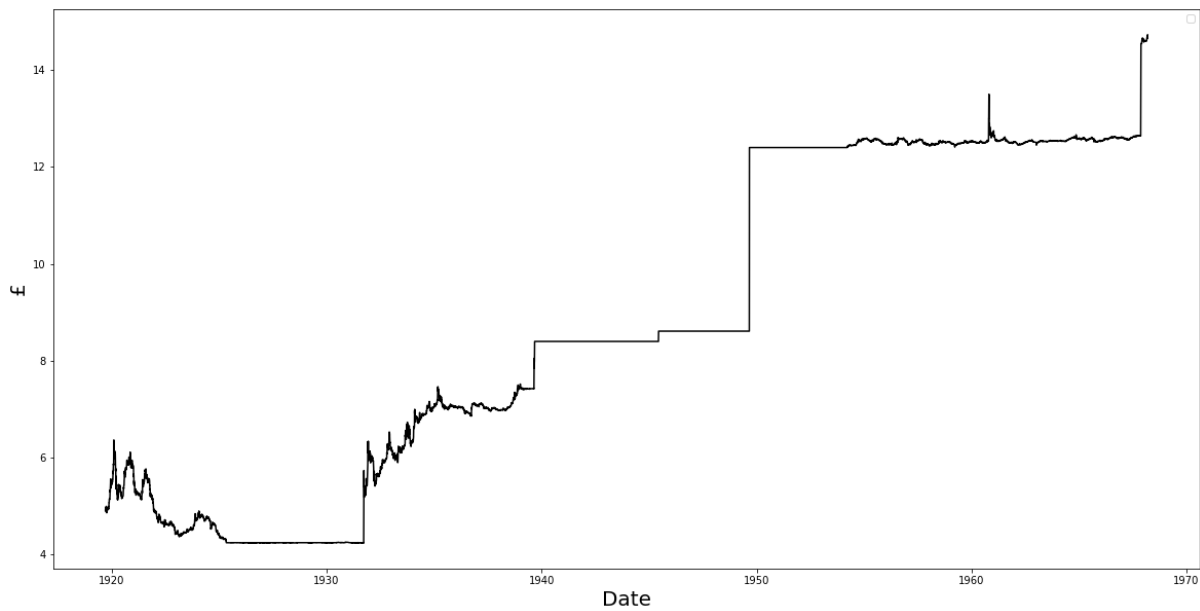
Daily gold price data used here was reconstructed from three sources. The *56th Annual Report of the Deputy Master and Comptroller of the Royal Mint* contributed the data for the 1919-1925 period. The *Quins Metals Handbook and Statistics*, published annually, provides data covering the period from 1921-1965, and the *Metal Bulletin*, a trade magazine published twice weekly with daily process for many commodities for the London metals market, covers the remainder of the period up to April 1968 when the sterling-based *Gold Fixing* ended³. Daily data from April 1968 are freely available to researchers from online sources such as the London Bullion Market Association website.

Other sources of gold price data pre-1968 do exist. Measuringworth.com provide very accurate data at an annual level for sterling gold prices back to 1257 (Officer and Williamson, 2022), but the higher frequency data available has limitations.

Monthly data for the London gold price is available from subscription services such as the Global Financial Database but this is not the market price for gold. Instead, it is based on converting the fixed US Dollar gold price to Pounds Sterling at the market exchange rate for Dollar-Sterling on that day. This is an imperfect measure when compared to the *Gold Fixing* price which was the market price for gold that traders could really buy and sell at on that day. The *Fixing* price was frequently, as will be discussed below, driven by factors other than the Dollar-Sterling exchange rate. In particular, using data other than the *Fixing* price data provided here means that there will be significant errors in the series for the 1930s and 1960s, when other factors drove the *Gold Fixing* price away from its official level as will be discussed below.

³ The data is available at <https://data.mendeley.com/datasets/ddcsmwkfxw/2> and is freely downloadable.

Figure 1: Gold Price in Sterling (1919-1968)



Source: 56th Annual Report of the Deputy Master and Comptroller of the Royal Mint (1919-25), Quins Metals Handbook and Statistics (1926-1965), Metal Bulletin (1965-1968).

Daily data from 1961-1968 does exist from Bordo, Monnet, and Naef (2019) transcribed from Bank Of England traders files. However, these are expressed in US Dollars rather than Pounds Sterling (the currency of the London *Gold Fixings* Auction was denominated in). As this data comes from traders' internal reports it is unclear whether these were the market price for that day, or the price executed by the traders in the Bank of England on the OTC market that operated around the *Gold Fixing* during each day. However, this recording of the dollar price for gold transactions prior to 1968 (when the Fixing would change to US Dollar prices) does show that the demand for a change of base currency was growing.

Figure 1 graphs the daily price of gold on the London market from 1919 to 1968. The periods of relatively fixed gold prices are clearly visible with little or no volatility, as well as the more volatile periods floating prices. Extreme returns can be seen due to large official revaluations, such as the large official revaluation in the price of gold in 1949.

Table 1 shows descriptive statistics for each of the sub-periods to be examined in the following sections, broken into periods when gold prices were fixed or floated freely. The Gold Fixing did not operate from the outbreak of World War II to 1954. These all represent market prices. Gold's returns are notably non-normal with very large and significant Jarque-Bera statistics in all sub-periods, reaching over 1 billion in one case. This means that the size of the one-day changes in the gold price, that occur when prices were revalued unilaterally by the government, are frequently much more positive or negative than would be expected from a standard normal distribution. There are a good number of daily price changes of more than 10% - where under a standard normal distribution we would expect to see returns between +/- 3% around 99% of the time over the full sample.

Table 1: Descriptive Statistics for Daily Gold returns

Daily Gold Return's	Full sample	1919-1925	1925-1931	1931-1939	1954-1968
Mean	0.0002	-0.0001	-0.0000	0.0003	0.0001
Min	-0.1273	-0.0410	-0.0121	-0.0580	-0.0370
Max	0.4397	0.0458	0.0121	0.1770	0.1497
Standard Deviation	0.0092	0.0056	0.0003	0.0068	0.0024
Skewness	5.0642	0.2531	-3.3111	10.593	47.888
Kurtosis (excess)	215.7	12.58	207.1	254.4	2860
Jarque-Bera [P-Value]	52,208,899 [0.000]	9,390 [0.000]	3,333,600 [0.000]	5,706,204 [0.000]	1,486,636,649 [0.000]
Obs.	27340	1420	1863	2101	4357

Gold returns post-1968 are notable for being consistently, positively skewed, unlike many other financial assets, a characteristic that significantly adds to gold's ability to diversify investors' portfolios in research on modern markets (Lucey, Poti, & Tully, 2006). This characteristic of gold returns persists in all sub-periods when the gold price floats freely and is only negative during the gold standard period from 1925 to 1931 when the Bank of England intervened in the market regularly.

3. The Operation of the London Gold Fixing

3.1 The Pre-Fixing London Gold Market

At the beginning of the 20th century London had been the centre of the world's gold market over two centuries, at least partly due to a series of historical chances (Evitt, 1938). One was Isaac Newton's choice of a gold to silver ratio that led to a large inflow of gold into England after 1696 (Craig, 1946), and the other its unique position of power within the British Empire. This gave London unique access to the world's largest gold producing country, South Africa, whose gold subsequently flowed predominantly to London for sale.

The *Gold Fixing* auction that began in September 1919 appears to be a formalisation of an earlier meeting which had taken place daily at an undisclosed location in London since at least 1907.⁴ The participants in this early version are not known with certainty. The reason for

⁴ Wall Street Journal, "The Worlds Gold Market", April 20, 1907

the lesser level of discussion in financial newspapers probably stemmed from gold's relatively fixed value during the heyday of the classic gold standard, and from that a lack of news to discuss relative to other assets.⁵

Before World War I, the official gold price was 77s 9d⁶ on a 11/12^{ths} *fine* basis (91% pure gold) and this had been the price since the early 1700s. This price was a constant for all of 1913, with only three days in 1912 where the price was 1/8d higher due to "keen" demand from New York (Mocatta and Goldsmid, 1913). When the *Gold Fixing* was founded, it operated on a *pure* basis (99.5% pure gold) to match the standard in America meaning that the equivalent pre-war pure gold price was just under 84s 10d.⁷

The genesis of the formation of the *Gold Fixing* was unrest from South African gold miners who, since the outbreak of the World War I, had been at a disadvantage relative to other commodity producers. The price of gold was fixed by the government, but gold miners' costs had exploded with the war. Miners wanted a free gold market where prices could rise to compensate them for the falling value of Sterling (Ally, 1994) and the South African miners had begun looking for another outlet through which to sell their gold at a better price.

An agreement to establish a free market for the gold produced by the South African mining industry was made with the Bank of England in late July of 1919 (Ally, 1994). Rothschilds were instructed to sell this gold at "the best price obtainable in the London market" (Green 1984:114). This was extended to the Rhodesian, West African and Indian gold mining companies in early September.⁸

The backdrop for formally setting up this daily gold auction was set against an increasingly important market in New York. The creation of the Federal Reserve in 1913 and large inflows of gold bullion during and after World War I meant that London's long running and seemingly natural supremacy as the world's financial centre was under threat (Eichengreen, 1996).

In the days before the newly official *Gold Fixing* opened "much interest" was been taken in the newly free gold market.⁹ The market in South African Gold Miners shares (the "Kaffir's") was "blazing" even before the free market started.¹⁰ This optimism had its basis in the fact that gold shipped from South Africa to America directly, bypassing the fixed price London market, was commanding a 16% premium on pre-war prices at the time, encouraging speculators hopes that once the market was freed the Kaffirs profitability would surge.

⁵ The Bank of England bought gold at £3.17.9d and sold at £3.17.10½d in any and all circumstances, meaning that the early fixing could only execute trades between a 1.5 pence margin (Green, 1984).

⁶ This translates to 77 shillings and 9 pence in old money, which is 933 pence. This is £3.89 in modern terms with 240 pence in a pound.

⁷ *Financial Times*, "The Price of Gold", 16th Sept 1919, p. 2.

⁸ *Financial Times*, "The Gold Problem", 4th Jan 1919, p. 3

⁹ *Financial Times*, "Gold at a Premium", 19 Sept 1919, p. 3.

¹⁰ *The Economist*, "Stock Exchange News", 11th October 1919, p. 20.

There was considerable excitement relating to the first consignment of gold from South Africa destined to be sold at the *Gold Fixing* which had arrived in London in the week before the first auction was to take place. Newspapers were also reporting an “experimental sale” which was made some weeks before at a price of 85s 6d, on the lower purity standard ounce.¹¹

3.2 1919 - 1925: Free Floating Gold

The new *Gold Fixing* began to operate from September 12th 1919, with a price set at 98d 6s (£4.93). This was the first-time gold prices in the Brittan had floated freely since the 1700’s. The members participating at the *Gold Fixing* auctions were the four bullion brokers and Rothschilds. In the beginning Rothschilds were the sellers of all the gold that came in each week from the South Africa miners, giving them a near monopoly on new gold sales (Harvey, 2014).

In their annual letter of 1919, the bullion bank Samuel Montagu and Co. referred to the formation of the new *Gold Fixing* with an air of despair, saying a free-floating gold price would make gold a “mere” commodity. Though it took nearly another 50 years for gold to be removed as the anchor of the monetary system, there seems to be some truth that allowing the gold price in its main market being driven by the laws of supply and demand like any other commodity was an early crack in Gold Exchange Standard edifice. By the 1960’s their fears were coming to pass, as surging demand from ‘Hoarders’ at the *Gold Fixing* forced central banks to sell so much gold that the floor of the gold weighing room in the Bank of England literally collapsed while trying to process the unprecedented volume of transactions (Green, 2007), foreshadowing the imminent fate of the Gold Exchange Standard itself.

The format at this auction which set the world’s price for gold each day were “curiously informal”, even to commentators of that time period (Evitt, 1938:240), with no publicly discussed rules and a process which evolved over the years. As the selling on the *Gold Fixing* was mainly through Rothschilds, there was little competition in this period between the bullion houses. The daily auction allowed buying at or above an opening price set by NM Rothschilds, who operated for the Bank of England, using the fixed Dollar gold price and the Dollar-Sterling exchange rate as a starting point less the cost of insurance and shipping.

Oddly, in Samuel Montagu and Co.’s *Annual Bullion Letter* for 1919 they do not mention the founding of the *Gold Fixing*, instead only the freeing of gold for import and export under licence from the government is discussed. Their weekly circular in the week before the opening of the *Gold Fixing* also did not mention the establishment of the *Gold Fixing*, though they did in passing the following week. This points to this market being dominated by the bullion banks, with little speculative activity to attract excitement. This is despite 1919-20 seeing an explosion in the value of transactions that were processed by the Bullion Banks (Arnold, 2016).

¹¹ *The Financier and Bullionist*, “Bullion Market: Gold Shipments from New York.” 13rd Sept 1919, p.1.

On the second day of the *Gold Fixing*, the rate of exchange between London and New York was £4 17 5d, and the official US gold price was \$20.67. Based on this, the London price would have been £4 19s per ounce fine, but the gold price was fixed at £4 18d 6s.¹² This difference of 6s reflects transport, insurance, or brokerage costs – about 0.5%. This is similar to estimates of between 0.4% (Dunbar and Sprague, 1917) and 0.6-0.7% (Officer, 1989).

Figure 2: Gold Fixing Price from 1919 – 1925, £'s



Source: 56th Annual Report of the Deputy Master and Comptroller of the Royal Mint.

While there was a daily auction, Tuesday was reported the busiest day in this period as this was the day when new South African shipments were auction (Evitt, 1938). Though the market had operated for two days already, Sept 16th 1919 saw the first large consignment of gold bullion (£1.75m) from South Africa come up for sale at the Gold Fixing¹³. This was seen as bringing the free market for gold back in to “actual being” by the *Financial Times*, implying a low level of liquidity had prevailed in the first days of the new Gold Fixing¹⁴.

In the first years of the *Gold Fixing*, the only gold that could be auctioned came from African Mines’ and that had a licence for export from the Treasury.¹⁵ For 1919 and 1920 about 50% of the gold bought at the *Gold Fixing* was exported to the US, with 25% going to India (Montagu Annual, 1920). Sales were mentioned as being to countries as opposed to individual investors, for example “fresh supplies” would be reported to be secured by India or

¹² *Financial Times*, “Gold at a Premium”, 19 Sept 1919, p. 3.

¹³ *The Financier and Bullionist*, “Money Market: Pressure for Loans Continues”, 17th Sept 1919, p. 1.

¹⁴ *The Financial Times*, “The Gold Price”, 16th September, p.2

¹⁵ A parallel market for domestic gold is mentioned in Montagu Annual (1920) where gold that was not exportable was traded. Up to late 1920 its price mirrored the *Gold Fixings* price but towards the end of 1920 the price on this market fell to 20 shillings or more below the exportable Gold Fixings Price. It is not mentioned again these annual letters.

America,¹⁶ underlining the monetary nature of the market at this time, with speculation concentrated in the gold miners' stocks.

The liquidity of the market during this time is unclear. Two weeks into the Gold Fixing it was reported that about £1.5 million would be available in the market at the beginning of the next week. As it seems most of the volume went through on a Tuesday the liquidity between days would have varied widely. Green (1979) states that based on the internal records of Mocatta and Goldsmid over the first 5 weeks of the *Gold Fixing* 660,000 ounces were sold, the majority of which this was purchased for the India Office. October 1919 saw reports that "a very small amount of gold" was transacted and that it went to "the trade" rather than national buyers.¹⁷ Buyers from trade, such as jewellers, were satisfied first at the Gold Fixing's price while the major buyers were arbitrageurs (Evitt, 1938). By 1920, the bulk of the gold being sold was destined for either India or China (Samuel Montagu and Co., 1920).

The relative price of the US Dollar versus the Indian Rupee was a primary factor determining the price of gold during this early period. Depending on the strength of each currency relative to Sterling on any day determined where the gold sold on the open market was exported to, in the early days of the *Gold Fixing*. India was a consistent buyer and a good portion of the gold exported there was purchased on a speculative basis with demand from small speculators being about 7,500 ft/oz¹⁸ per day.¹⁹ Grewe (2013) argues that the gold price dominated by the Dollar-Sterling exchange rate with some deviations at different periods during periods of high demand from India.

Aside from occasional mentions of gold shipment destinations, the *Gold Fixing* this period seemed to warrant little discussion. It was dominated by market professionals like the Bank of England, the Bullion Banks and Rothschilds, who had been trading gold in London before the *Gold Fixing* existed, and who seemed to be just waiting for the Gold Standard to return.

3.3 Great Britain returns to the Gold Standard: 1925 to 1931

When the *Gold Fixing* was formed it was widely assumed that Great Britain would soon be returning to a Gold Standard and the floating price was a stopgap to satisfy the South African Miners. But in the end it took 6 years before Great Britain returned to the Gold Standard - on 28 April 1925. The announcement was made after the *Gold Fixing* had already taken place that day (Clough, Moodie, and Moodie, 1968).

The price on the morning of the return to the Gold Standard had fixed at 86s, up from 85s 6d on the previous day. This might seem to suggest that the return caught the gold market off guard as the newly regulated price announced in the afternoon was set at 84s 11.5d – 1.2% below the previous day's price. This was however an example of a price marked as

¹⁶ *The Financier and Bullionist*, 'Silver Steady: Gold Higher', 21st June 1922, p. 1.

¹⁷ *The Financier and Bullionist*, "Money Market: Sales of Treasury Bills", 16th Oct 1919, p. 1.

¹⁸ 20,000 tolas

¹⁹ *The Financier and Bullionist*, "Money Market", 9th May 1922, p. 1.

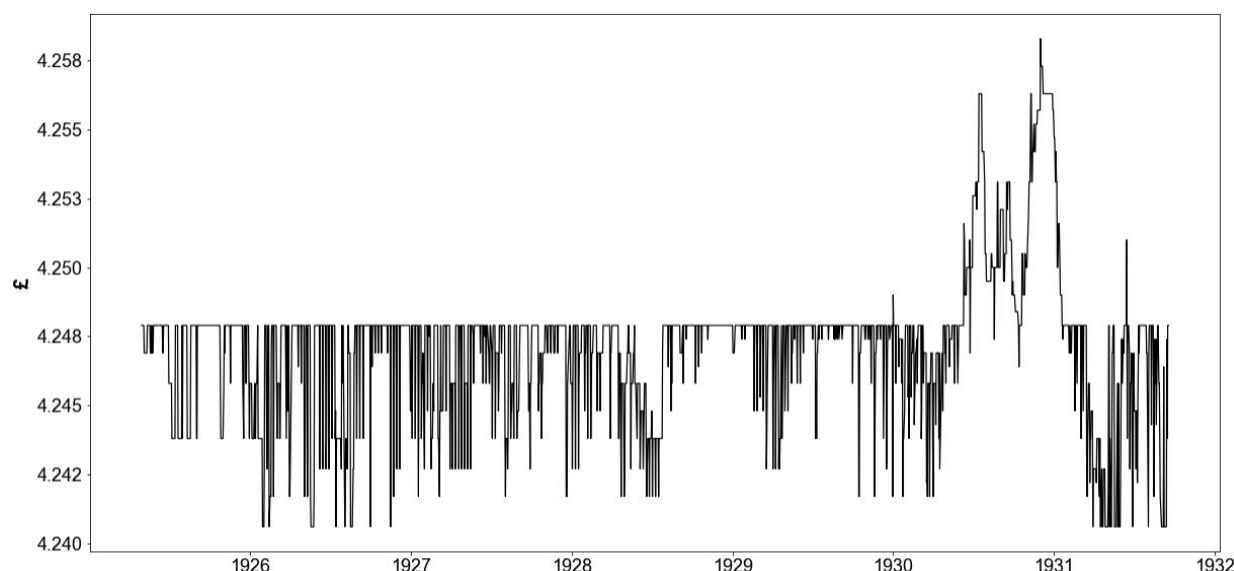
“Nominal” in the data set, calculated based on the US Dollar gold price and the exchange rate that day, as no trading had occurred that day and there was no market price available.

As more countries began re-entering the gold standard in 1927, the London market had a larger than normal number of significant gold purchases by “Undisclosed buyers” (Samuel Montagu and Co., 1928). These were normally held in London until the transition to a Gold Standard for that country was confirmed and this trend of undisclosed purchases continued in 1928. In 1928, supplies of newly mined gold from the USSR also started to arrive on the London Market (Samuel Montagu and Co., 1929)²⁰. The gold market was still busiest on Tuesday’s as it dealt with the latest shipment of South African gold generally worth over £500,000 (Samuel Montagu and Co. 1928). Very little other discussion of the market’s liquidity appears in this period.

The gold price has been assumed to have been relatively static in this period, held in a range by the actions of the Bank of England. This new data shows this was not always the case and that prices did rise above the Bank of England threshold as in Figure 3 below.

Until June 1930, gold had traded in a tight range between £4.25 and £4.24, but on June 11th the gold price fixed at £4.2516 – a significant upward deviation that persisted. Large outflows of gold to France had lowered the Bank of England’s stock of fine gold (99.5%) and it began selling bar gold that was of the old standard fineness (91%). Normally the price of a bar would simply have been adjusted to reflect the lower quantity of gold delivered, but the Bank of France refused to accept anything but fine gold bars.

Figure 3: Gold Fixing Price from 1925 – 1931, £’s



²⁰ Montagu’s annual letter notes large exports to India on private account.

This created a bottleneck for the refiners who were already operating at full capacity converting London's *standard quality* gold bars to *fine quality* bars. The peak price recorded in 1930 was £4.459 on 2 December (Samuel Montagu and Co., 1931). This ended on the 15th of January 1930 when the Bank of France relented and accepted standard bars – resulting in the quantity of gold being shipped to France increasing with the refining capacity no longer being an issue (Samuel Montagu and Co., 1932).

By June 1931, the London market had seen a serious increase in activity due to buyers from the Continent. In September, the Bank of England seems to have begun buying gold covertly at above the statutory price with increases in Bank Of England holdings later matching these purchases (Samuel Montagu and Co., 1932).

On September 20th, the UK Treasury announced that it advised a departure from the Gold Standard (Government, 1932).²¹ A bill was debated on September 21st after the *Gold Fixing* had taken place for that day and prices started freely floating the following day. The *Financial Times* reported that “a large number of people had an intuition of what was to happen” in advance.²² However, this price data argues against this suggestion.

Firstly, the price on the morning before the vote occurred fell from 84s 11.5d to 84s 9.75d, the expected devaluation in sterling and thereby rise in the gold price should have encouraged buying and possibly a price increase as a result. Also, this price is marked as “Nominal” indicating another day when no trading took place on the *Gold Fixing*, with the quoted price calculated from the Dollar-Sterling parity. As gold trading does not seem to have been barred, the lack of buying by the auction participants implies their “intuition” was not strong enough to overcome their uncertainty about what would happen, to the gold standard or the gold price, and put their money at risk.

3.4 Gold Hoarding/Investment - 1931 to 1954

The gold price rose 17% on the morning after the vote to leave the Gold Standard, rising to 99s 7d, but again no trading appears to have taken place at this “nominal” price. This lack of action seems to indicate an unusually high level of uncertainty in the market. Gold finally began changing hands again at 100s on September 23rd and by the end of the week the gold price was fixed at 114s 9d - up 27 percent.

By 1931 the *Gold Fixing* had been in operation for 12 years, but it seems to have taken until then for the newly re-freed gold market to begin to attract more “general interest” from investors.²³ London was not only an important trading center for gold through the over-the-counter market but also as a place where ‘hoarded’ gold was held, the term used for all owners of gold who were not official buyers.

²¹See Eichengreen (1996) for a discussion of the macroeconomic reasons for their departure.

²² *The Financial Times*, “Effect of Gold Decision.” 4th Sept 1932, p. 4.

²³ *The Economist*, “The London Gold Market,” 1937 (4912):6–7

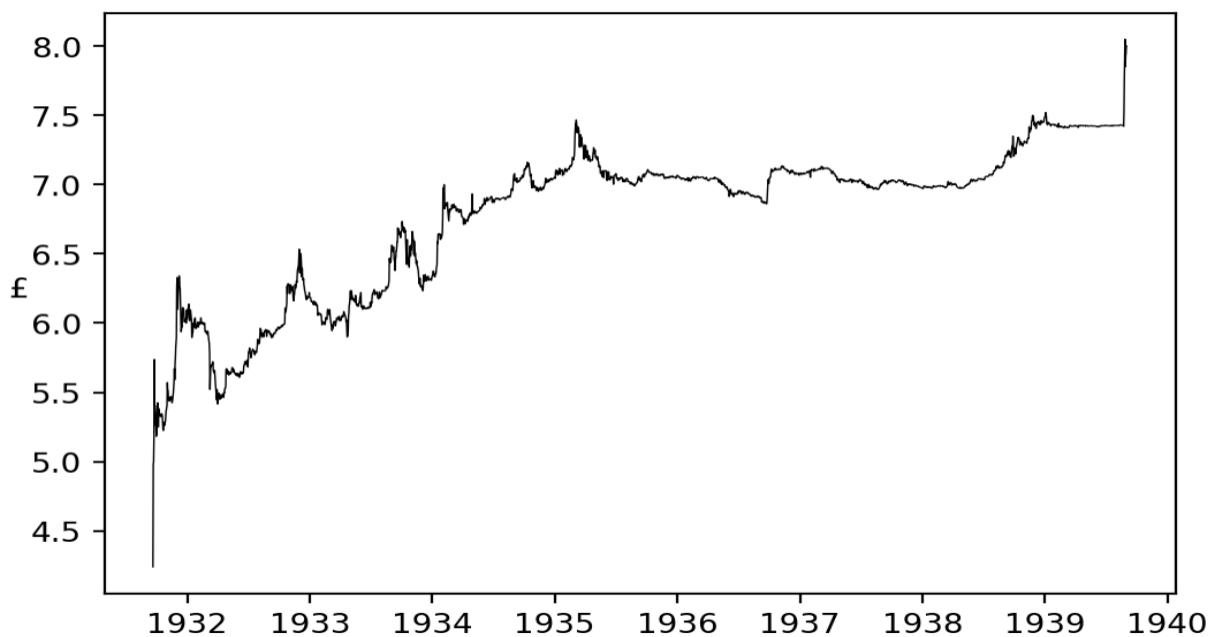
Montagu's Bullion Letter for 1932 says that the price of gold was frequently set above the American parity due to "Foreign enquiry for hoarding" (Samuel Montagu and Co., 1933:4).²⁴ *Hoarding* becomes increasingly prominent in discussions about the gold market from this time on, reflecting its new importance to the functioning of the market. In its review of 1936, the *Financial News* said one of the main features of this period was the "enormous increase" in private demand for gold coupled with massive increases in the overall scale of dealings on the London gold market. Harvey (2008) finds that speculative forces became more prominent in the *Gold Fixing* during this period and more telephones were installed in the room where the auction took place to allow the participants to call back to their offices as prices changed mid-auction. Arnold (2016) corroborates this with evidence that for the bullion banks 1930-39 were peak years in their gold transactions pre-World War II.

By the end of 1936, most countries were limiting private buying so that only London and Amsterdam were left as free gold markets. Uncertainty in this period was unusually high for investors, as countries came and went from the Gold Standard regularly. Gold was fulfilling its role as a safe haven asset (He et al., 2018) for investors and London was the most important venue to buy and store gold globally.

Up to 1933, most gold trading in London still took place outside the *Gold Fixing* in the Over-The-Counter market (OTC), that is directly between a buyer and a seller without an intermediary – though the *Gold Fixing* Price was used as their reference price. But by 1938, the *Gold Fixing* had begun to monopolise gold trading so much that the Bank of England began encouraging trading to take place throughout the day in the OTC market, rather than all in the roughly 20-minute window in which the *Gold Fixing* occurred (Harvey, 2008).

²⁴ *The Economist* (1937) also reported that *hoarding* demand had been very prominent since 1934, while the *Financial News* reported in its review of 1933 that that was the year that a "worldwide resumption" in *hoarding*.

Figure 4: Gold Fixing Price from 1931 – 1939, £'s



A new source of supply in the 1930's was dishoarding from Middle and Far Eastern markets, where there was a very large buildup of gold from long-term historical buying, attracted to sell due to the new all-time high prices available (Tamagna, 1954). Where India had normally imported gold from the UK, in 1931 it exported £65mn, and was the largest source of supply to the London market in 1932, ahead of South African miners (Samuel Montagu and Co. 1933).²⁵

The suspension of the US Gold Standard in April 1933 was another factor which increased uncertainty, leading to a significant increase in the ambiguity of the future direction of the gold price. The *Financial News*, in its review of 1933, says that up to the March suspension there were heavy withdrawals of hoarded gold from Federal Reserve banks as exchange rate uncertainty increased. By April it was illegal for US citizens to hoard gold (York, 1933). This led to increased buying by US citizens on the London Market to avoid these restrictions (Samuel Montagu and Co., 1933).

Following the suspension of the US Gold standard the *Financial News* reported that most of the new gold being offered on the *Gold Fixing* was being taken up for *hoarding* with London serving hoarders from “every part of the Earth”. From 1934-1940 official gold holdings in the US went from \$4bn to over \$18bn, and \$10bn of this rise came from gold imports which primarily came through the *Gold Fixing*²⁶.

At times when gold prices rose above its exchange rate determined parity, gold being held by small UK investors was drawn out into the market, as in 1934 when large quantities of gold

²⁵ The late 1930's saw large flows of supply onto the fixings from “continental sellers”, as noted frequently in the *Financial News*.

²⁶ *The Financial News*, “America Faces Gold Avalanche”, 22nd April 1940.

being held as Sovereigns were sold. Recycled gold jewelry also came onto the market during these high price periods (Samuel Montagu and Co., 1933), so much so that gold for trade purposes was no longer a source of demand on the *Gold Fixing*, as this was satisfied directly through recycled gold.²⁷

Montagu's 1934 letter says that the average daily turnover on the *Gold Fixing* was £406,000 for that year. But 1935 seems to have marked a change in *hoarding* activity with a significant reduction in volume on the *Gold Fixing*. This was ascribed to national governments trying to discourage gold holdings and due to the activities of the Exchange Equalization Fund (EEF) in Great Britain which took over the role previously played by Arbitrageurs. Cooperation between countries did reduce the volatility of the *Gold Fixing*'s price from 1935 but also made the EEF the most important buyer on the market by 1936, limiting the ability of private individuals to trade profitably in gold (Samuel Montagu and Co., 1936). Though still a free market, the authorities were actively discouraging *hoarding*.

This situation reversed in 1938, which saw an average daily turnover on the *Gold Fixing* of over £330,000 more than double the previous year. As hoarders were also frequently small investors for whom gold bars would be too large an investment, their demand was satisfied by gold coins, which in 1938 were commanding a premium of 7% over their gold value (Samuel Montagu and Co., 1939).

Following the ending of the Gold Standard, newly mined South African gold did continue to come to London but Samuel Montagu and Co. (1931) say it was "not made available to buyers as heretofore". Now all Transvaal (and Russian) mine production was sold directly to the Bank of England who could sell it on the *Gold Fixing*, through Rothschilds, if they wished. West African and Rhodesian gold was still sold directly through the *Gold Fixing*. But from 1938 the South African mine production stopped being shipped to London, as the government began a policy to hold some of its gold reserves abroad.²⁸

Exchange rate parities with a country operating a fixed gold price were still the most common driver of gold prices in the *Gold Fixing*, through arbitrage activities. However, in the short-term, political uncertainty frequently caused prices to trade above or below the US parity unexpectedly. The reference price for the *Gold Fixing* in 1933 switched to the French Franc Parity, though the London gold price traded frequently above this parity as well.²⁹ For example, the 1932 high of 134s 8d was 5d higher than the simple French parity price. With the suspension of the Gold Standard in the US, the London gold price followed the Sterling-Franc rate within a 1s margin of error for the rest of the year. The Annual Bullion Letters of Samuel Montagu and Co. for 1937-1939 are full of the turbulent economic, political, and potential war threats and their direct impact on the gold price and its volatility³⁰.

²⁷ *The Economist*, "The London Gold Market," 1937 (4912):6-7

²⁸ *The Financial News*, "The Money Market" 7th Feb 1939, p. 4

²⁹ *The Financial News* "Lombard Street, Gold in 1933: Prospects for 1934" 2nd January 1934, p. 4.

³⁰ See Rana and O'Connor (2023) for a discussion of modern gold price drivers.

An example of uncertainty specific to the market was the Gold Clause Cases (Dawson, 1935) which heightened uncertainty as the legality of the ban on US citizens owning gold was challenged. In the end it was ruled the ban was lawful, but in the run up to the decision the price was 7 pence below the shipping parity as arbitragers were unwilling to maintain the Dollar-Sterling gold price parity.³¹ When the US resumed quoting a daily price for gold it did not reassert its importance as the Federal Reserve did not buy at that price regularly enough.

As the gold bloc broke up in 1936, the price went well above the American parity again due to *hoarding*. In 1937, rumors of a reduction in the price at which the US would buy gold at, due to the vast quantities of gold that the US Government had bought in the previous years, resulted in a period where gold traded significantly below its US parity.

In the 9 months of 1939 before the London gold market closed with the outbreak of World War II, the market traded seven times more gold than the previous year as a whole, around £480,000 per day on average. This average hides wide variations; for example it was reported that only \$41,580 worth of gold was traded on April 29th 1939 (Samuel Montagu and Co., 1940), but a daily data on the business of the market does not exist.

August 1939 was a month characterized by surging gold prices following the relative stability of the previous year, shown in Figure 4 above. Prices peaked at 161s on the 28th of August, up from 148s 7d just seven days previously. However, the threat of war had already been felt throughout the year with unease about the value of sterling leading to the majority of the 565,000 ft/oz of gold exchanged at the first *Gold Fixings* of 1939 being purchased for *hoarding* purposes rather than on official government accounts.³²

The gold market did not open for business on the September 2nd or the following Monday as World War II began to affect financial markets. Gold dealings from Tuesday were prohibited except through official channels – marking the end of London as a free gold market, for the second time in the twentieth century. This contrasts with the stock market which reopened on the 7th of September and the silver market where the price continued to float freely, and speculative activity continued.³³ Gold was an asset of primary importance to the functioning of the world economy.

The official gold price was increased from 160s to 168s by the Bank of England, a price that remained fixed until the 11th of June 1945. On September 4th the government ordered that UK citizens sell their gold coin and bars to the Treasury. From the 6th, the Bank of England took control of the Bullion Market in London at the fixed price of 168s, buying up all the private gold at that price. Privately held gold was flowing into the Bank of England at a “moderate

³¹ *The Financial News* “The Money Market”, *Financial News*, 7th Feb 1935, p. 7.

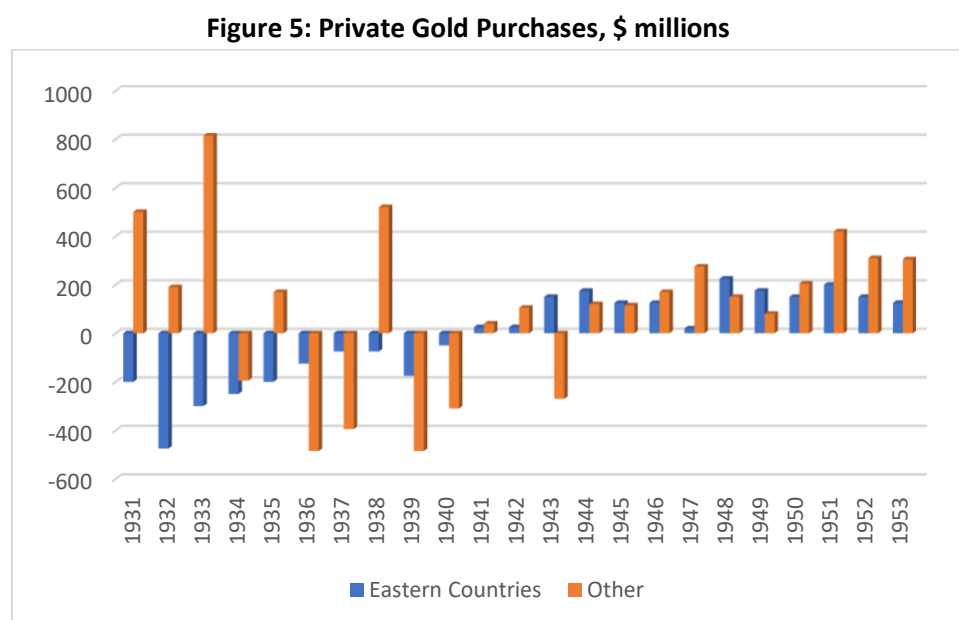
³² *The Financial News*, “Money Market”, 2nd Jan 1939, p. 2.

³³ *The Financial News*, “City and the War: New Measures”, 5th Sept 1939, p. 1.

scale” by September 7th. Gold held in the UK by foreign individuals was exempt from this forced sale.

The *Gold Fixing* did not reopen again until 1954. This was a period where the gold trade moved off to other markets where the price was not officially controlled (Lombard, 1954), though a significant proportion of South African gold was still sold in London to official buyers.

Figure 5 shows the volumes of gold bought each year by private investors, using data compiled by the Federal Reserve Bank of St. Louis (Tamagna, 1954). This was gold purchases, excluding: official buyers (such as central banks), purchases of gold jewellery, and other non-financial uses such as dentistry. This buying is referred to as *hoarding* at the time in all the discussions of private purchases of gold we have found, whether it is being considered by official agencies like the IMF or bullion banks such as Samuel Montagu and Co.³⁴



Source: Tamagna (1954)

The early 1930’s saw *hoarding* in countries grouped into “Other” by Tamagna (1954) and dishoarding as “Eastern Countries” sold private gold holdings over the same period. Eccles (1936) states that the Hoarding of gold began in earnest from 1931 due to international currency crises and that much of the dishoarding seen by eastern countries in the early 1930’s was due to India. After 1943 a shift occurred and private gold purchases outweighed sales in

³⁴ There was no distinction made between purchases for long-term holding that would today be described as investment, or short-term market activities that we would now describe as speculation. We will describe private demand for gold for financial purposes as hoarding in keeping with those historical discussions.

every year after that, with these private gold hoards growing ever larger.³⁵ This data shows that gold was used as a private financial asset pre-1968 and was not solely a monetary asset.

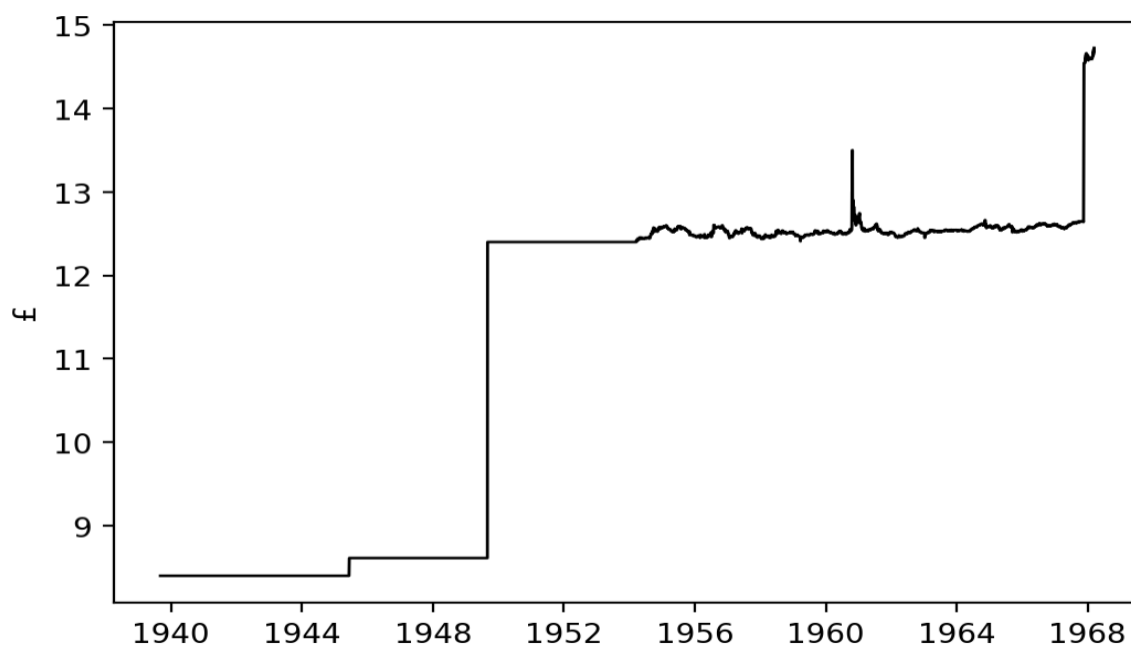
These buyers were satisfied through sellers in markets such as: Hong Kong, Beirut, Paris, Tangier and the most notably Zurich, which remains a market of importance to this day. Their prices were well above the London price in 1945 but the London Brokers were barred in 1947 from being involved in these premium transactions (Bott, 2013). By 1953, an equilibrium had been restored, with all these markets trading at roughly the same price as London (Tamagna, 1954).

The cessation of activity on the London Market is highlighted by the sudden reduction in the discussion of the gold market in the Annual Bullion Letters of Samuel Montagu, which went from 8 pages about gold in 1939 to less than a page in 1940. By the 9th of Sept 1939, the daily Bullion Notes in the *Financial News* discussed silver every day, but gold was only occasionally mentioned, as the gold market was now merely the actions of the Bank of England and other official buyers.

3.5 Open for Business Again: 1954-68

Reopening the London Gold Market in 1954 was a central part of the Bank of England's plan to resuscitate London as an international financial centre (Harvey, 2008). This, however, was not going to be the free market of the 1930's – Sterling Area residents were allowed to sell through the *Gold Fixing* but only buy for industrial use, only non-residents had unrestricted access to the *Gold Fixing* (Bott, 2013).

Figure 6: Gold Price from 1939 – 1968, £'s



³⁵ These figures exclude jewellery and other non-financial uses for gold.

This market would be best characterised as dull, as seen in Figure 6, the price was generally set through the fixed US Dollar gold price and a stable exchange rate, but intermittent revaluations in the Sterling gold price.

The exception was October 1960 when prices moved substantially above their official level for several reasons. There was a burst of buying interest as the market began to worry that the US would soon have to increase its official price. There was also a growing pool of “hot money” in Europe looking for profitable speculative opportunities. Lastly central banks, including the Bank of England, did not want to use their reserves to intervene in the London market even as price pressures started to build – and the US treasury seem to be unconcerned about the price action in London.

The US Treasury finally stepped in, following record prices on October 18th, and calmed the market (Samuel Montagu and Co., 1961). While this market pressure did not end Bretton Woods, it was a sign of another serious crack in the architecture. The inaction of central banks to maintain the official gold price allowed the thought that gold prices could substantially increase above the set price to seem more plausible.

1967 saw the London markets’ largest-ever turnover since reopening in 1954, as pressure from hoarders started to build (Samuel Montagu and Co., 1967). The brewing international monetary crisis led to sterling revaluing in November, with the gold pricing rising 15% to £14.55. The liquidation of the Gold Pool in March 1968 spelt the end of the sterling-denominated *Gold Fixing*. The London market was closed on 14 March 1968 with the final price fixed at £14.73, but London dealers continued to execute orders for foreign principals (Samuel Montagu and Co., 1968).

The London market began the modern twice daily *Gold Fixing* on April 1st 1968 and prices were quoted in US dollars from then on - in an effort to better attract participants in the US Dollar dominated financial system. A discussion of the market post-1954 can also be found in Naef (2022) and the operation of the modern gold market is discussed in Green (2007) and O’Callaghan (1991).

5 Gold Market Efficiency

In the context of the chronological narrative outlined above, the fundamental question to be answered using this new daily dataset is whether the gold market was weak-form efficient during the period 1919-1968, and in the different sub-periods discussed.

A priori it is unclear whether the greater influence of central banks before 1968 would increase or reduce market efficiency relative to the present-day free markets for gold. Officer (1986) discusses the efficiency of the Dollar-Sterling Gold Standard from 1890-1906, but in terms of efficient allocation of gold across countries under the rules of the gold standard before World War I, rather than the efficient markets hypothesis which is the focus of this study on the post World War I market.

He finds this older system to be efficient, in that arbitrageurs importing or exporting gold from London to New York made generally profitable decisions. Gold flows moved in the correct direction (London to New York, or vice versa) in months when the exchange rate allowed profit to be made. This differs significantly from the idea of “efficiency” under the Efficient Markets Hypothesis being tested here, where profits for traders would be evidence of inefficiency. In a development of this study Officer (1989:3) defines “Equilibrium Expected Profit” as when “all information available to arbitrageurs and speculators in the previous period is fully reflected in the previous period's exchange rate”. This again relates to the ability of arbitrageurs to make a profit moving gold rather than the predictability of price changes, as is the focus of this paper.

This is the first empirical paper to address the issue of whether the gold market was efficient in periods when central banks were intervening. However from a theoretical standpoint Levich (1985) argues that as officially set prices can't react to all available information, they are less likely to be efficient. A reply to this would be that during the pre-1968 period for gold – central banks were themselves very much a part of the information that drove price interventions, as endogenous actors in the system.

But this provides no indication whether the free-market periods should be expected to be efficient. From the evolutionary perspective of the Adaptive Market Hypothesis (Lo, 2004), the market should move towards higher level of efficiency as market participants learned from their past errors. Equally, the shock of leaving the Gold Standard in 1931 does seem to have shifted a portion of market demand towards private hoarders/investors, who bought gold as a safe-haven from the uncertainty of the times. These may have fitted the role of Noise Traders mentioned above, reducing efficiency even though the volume of gold changing hands increased in this period.

Studies have found mixed results on the efficiency of the modern gold market. Early papers like Tschoegl (1980) found that after accounting for trading costs the market did not present any inefficiency. Cheung and Lai (1993) did find evidence of inefficiency as gold market returns displayed long memory, but went on to show that this result was driven by a few days driven by regional tensions in the Middle East and the actions of the Hunt brothers (see Bredin, Potì, and Salvador, 2023). Bariviera et al. (2019) use Information Theory to in their analysis and find three periods of waxing and waning efficiency. They find that from 1968-80, and again from 2003-2017, the gold market had a low level of efficiency but a higher level of efficiency from 1981-2002.

Below we detail the tests employed here to address the question of whether the pre-1968 market for gold was weak form efficient overall and in each of the sub periods examined above.

5.1 Weak form efficiency Tests: Independence of past price changes

In an Efficient Market price changes are independent of past price changes. A runs test (Urquhart & Hudson, 2013) is a non-parametric test of whether past price changes influence current and future price changes. A run is defined as “a sequence of price changes of the

same type preceded and followed by price changes of the other types” (Solt & Swanson, 1981:471). Since we can see from Figure 1 and the above discussion of the data that gold’s returns in all periods under examination were significantly non-normal non-parametric testing is appropriate.

In the runs test shown in (1) below, a positive return is symbolised by P, the negative return by N,

$$E(r) = \frac{2PN}{(P+N)} + 1 \quad (1)$$

$E(r)$ is the expected number of runs for the sample and r is the actual number of runs. The formulae for the variance of the runs is shown in (2) below.

$$\sigma_r^2 = \frac{2PN(2PN-P-N)}{(P+N)^2(P+N+1)} \quad (2)$$

$$Z - stat = \frac{(r-E(r))}{\sigma_r} \quad (3)$$

The null hypothesis of the test is $H_0: r = E(r)$ against an alternative that they are not equal. If the z-stat calculated is greater in (3) than the critical value the null of independence is rejected, and the market is characterised as inefficient – as a day the gold price rise is more likely to be followed by another day of positive returns than should be expected. This lack of independence might allow market operators to predict the direction of movement in gold prices profitably.

The Ljung-Box Q test is a test in a similar vein, which looks at the correlation between current and past price changes. The Ljung-Box Q test-statistic (Ljung and Box, 1978) is given by:

$$Q_{LB} = T(T+2) \sum_{j=1}^k \left(\frac{\rho_j^2}{T-j} \right) \quad (4)$$

Where ρ_j is the j^{th} order autocorrelation of the asset’s returns and T is the total number of observations. The null hypothesis is that the returns are independently distributed, against an alternative that they are not, and therefore exhibit serial correlation. The Q-stat follows a chi-squared distribution and the null hypothesis is of zero autocorrelation (Fawson et al., 1996).

5.3 Weak form efficiency Tests: Mean Reversion

Another way to assess if a financial market is efficient is whether the returns on an asset are mean reverting. If they are, they will follow a random walk, where future prices are unpredictable, and the market can be characterised as efficient. Lo & MacKinlay (1988) provide the most common test of market efficiency from this perspective, if the price of an asset follows a random walk, then the variance of the k-period return is equal to k times the variance of the single period return. They show that if an asset’s returns (r_t) are independent and identically distributed (iid) then the Variance Ratio can be calculated as:

$$VR(k) = \frac{\sigma_k^2}{k\sigma^2} \quad (5)$$

Where σ_k^2 is equal to the variance of the k period return. This can be rewritten in terms of the autocorrelation of r_t :

$$VR(k) = 1 + 2 \sum_{j=1}^{k-1} \left(1 - \frac{j}{k}\right) \rho_j \quad (6)$$

where ρ_j is the j^{th} autocorrelation of the asset's returns. In an efficient market, all $VR(k)$'s will equal one. A finding that $VR(k)$'s are greater than 1 points to positive autocorrelation in the data and values of less than 1 show that negative autocorrelation is present in the return's series (mean reversion). Lo & MacKinlay (1988) define two test statistics to test the null hypothesis of a Random Walk, M_1 and M_2 , where the second is robust to heteroscedasticity. We only employ M_2 here as gold's returns in all periods suffer from heteroscedasticity.

$$M_2(k) = \frac{VR(x;k)-1}{\Phi(k)^{1/2}} \quad (7)$$

Where the asymptotic variance is given by:

$$\Phi = \sum_{j=1}^{k-1} \left(\frac{2(k-j)}{k}\right)^2 \delta(j) \quad (8)$$

$M_2(k)$ follows the standard normal distribution with a null of $VR(k)=1$. This test requires a choice of holding period, k and we test a number of holding periods as per the literature (Urquhart & Hudson, 2013).

To deal with this issue, Choi (1999) proposed a test where the lag length selection is data driven, using Andrews (1991) method to select the lag length to compute the VR test. The Automatic Variance Ratio (AVR(K)) statistic given as is:

$$AVR(k) = \frac{VR(k)-1}{(2)^{\frac{1}{2}} \left(\frac{T}{k}\right)^{-1/2}} \quad (9)$$

This test also follows the standard normal distribution asymptotically.

Wright (2000) provides three non-parametric alternatives to the above Variance Ratio tests. According to Hoque, Kim, and Pyun (2007), a major advantage of these tests is increased power when the data's distribution is highly non-normal, and as is the case in all sub-periods for gold returns these are particularly appropriate here. Wright (2000) shows that the R1, R2 and S1 statistics also do not suffer significantly if the data is heteroscedastic.

5 Results

5.1 Independence of past price changes - Runs Tests

Table 2 below assesses the efficiency of the *Gold Fixing* during the different regimes it operated under during its lifetime, as discussed above. An oddity of the data relative to modern financial markets are the frequent days on which there is no price change. 14% of days show a return of zero with the vast majority of these coming in the pre-World War II period³⁶. To deal with this issue we remove zero return days from the sample, so that a positive return followed by a zero day and then another positive day is treated as a positive run of two days. This assumes that traders would view a zero-return day there being no change to the direction of the price.

Only two periods are shown to be efficient using this testing, meaning past price direction could not have been used to predict future return direction. The earliest and last periods examined, are found to be efficient, in all others there are more runs than would be expected. This implies that even though the market was more active post-1931, as discussed above, it seems that the hoarders/speculators were not as informed and did not contribute to making the market efficient in the way that the bullion banks and Bank of England dominance in the 1919-25 period did. Both gold standard periods are both found to be inefficient.

Table 2: Runs Tests of Market Efficiency

	Observed Runs	Expected Runs	Standard Dev. Runs	Z-Stat
1919-25	578	609	18.24	-1.7050
1925-31	502	335	12.89	12.952***
1931-39	1086	1024	22.60	2.7421***
1919-39	2166	1943	31.14	7.1495***
1954-68	1474	1519	27.54	-1.6488

*Note: ***, **, * denote significance at the 1%, 5% and 10% level,
 $H_0: r = E(r)$*

5.2 Ljung-Box Q Test

Table 3 below shows that in all time periods these markets are found to suffer from autocorrelation at some lags, and the market would therefore be seen as failing to be efficient. Again, the 1919-25 period sees no autocorrelation at a low level of lags. The choice of lag length is arbitrary but including too long a lag length can reduce the tests power due to including a number of individually insignificant autocorrelations (Campbell, Lo, and MacKinlay, 1997) so the insignificant results at 2 lags in 1919-25 again show some evidence that this market was efficient.

³⁶ This is unrelated to the issue of Nominal prices mentioned above.

Table 3: Ljung-Box Q test for Serial Autocorrelation

	K=2	K=5	K=8
1919-25	2.91	19.75***	35.56***
1925-31	182.4***	227.0***	407.28***
1931-39	5.12*	93.08***	97.85***
1919-39	7.51**	98.49**	117.65**
1954-68	22.9***	35.17***	42.31***

*Note: ***, **, * denote significance at the 1%, 5% and 10% level,
 H_0 : returns are independently distributed.*

5.3 Variance Ratio Tests, Parametric

Table 4 shows the results of Lo & MacKinlay's (1988) M_2 VR test at three different lag lengths for robustness, as well as the Automatic VR test. The M_2 tests contrast to the earlier results, showing that the *Gold Fixing* was mostly efficient, with some weaker evidence of inefficiency at the 10% level of statistical significance in the fixed gold price period between 1925-31.

Table 4: Variance Ratio Tests

Sample Period	VR: M_2 Statistics			Automatic VR Test
	K=2	K=5	K=8	
1919-25	-0.1049	0.1590	0.9027	0.0144
1925-31	-1.419	-1.682*	-1.746*	-11.76***
1931-39	-0.6367	-1.370	-1.221	-2.785***
1919-39	0.0588	0.3564	0.2835	-0.5386
1954-68	0.6140	-0.3035	-0.6555	-0.1586

*Note: ***, **, * denote significance at the 1%, 5% and 10% level, H_0 : $VR(k)=1$.*

The Automatic VR test finds that the market was inefficient between 1925-39 but on average was efficient between 1919-1939 and when the market reopened in 1954. As these tests can suffer from low power in small samples the overall conclusion for the whole period from when the market was active is that a trader who worked in the gold market from 1919-1939 faced an efficient market. These tests however rely on the assumption of normality and are therefore superseded by their non-parametric version below.

5.4 Variance Ratio Tests, Non-Parametric

Wright's (2000) non-parametric Rank Variance Ratio tests are the test the best suited to testing whether this market was efficient during its different phases, due to the non-normality of the data. Table 5 shows strong evidence again that the market was efficient in the first sub-period. While there is some evidence at longer lags of inefficiency, most tests point to an efficient market. The fixed price 1925-31 market is again shown as inefficient. In the 1931-39 period, there is again evidence of inefficiency, as at both shorter lags the null of an efficient market is rejected in two of the three tests. The 1954-68 market has an inconclusive set of results using this non-parametric methodology but since these tests are more reliable with a shorter number of lags, it seems that on balance the market is again shown as inefficient at that time. Bootstrapped critical values for these tests are presented in tables in Appendix 1.

Table 5: Wright's Non-Parametric Variance Ratio Tests: Rank Tests

	K=2			K=5			K=8		
	R1	R2	S1	R1	R2	S1	R1	R2	S1
1919-25	0.365	0.193	1.2538	0.2595	0.625	2.122 **	1.041	1.798 *	2.241 **
1925-31	-10.15 ***	-10.79 ***	15.54 ***	-10.06 ***	-10.84 ***	27.80 ***	-7.642 ***	-8.508 ***	42.34 ***
1931-39	-2.150 **	-1.856 *	-1.876 *	-2.488 **	-2.265 **	-0.9960	-1.012	-1.066	1.2538
1919-39	-3.037	-2.130	9.158 ***	-3.641	-2.305	17.23 ***	-1.663	-0.371	28.19 ***
1954-68	5.014 ***	4.572 ***	9.575 ***	-1.157	-1.520	6.710 ***	0.017	-0.149	13.05 ***

Note: ***, **, * denote significance at the 1%, 5% and 10% level, $H_0: VR(k)=1$.

6 Conclusions

This paper presents, for the first-time, daily gold prices traded at the London *Gold Fixing* auction from 1919-1968, the world's reference price for gold during this period. This data, previously considered lost by archivists and researchers, allows a wide range of questions about the functioning of this market to be addressed.

Gold price data constructed to study this period has, up to now, assumed the price for gold on the London market was equal to the official US gold price converted at the exchange rate. While this is normally a fair approximation as gold prices on the *Gold Fixing*, it did vary outside this range even in a fixed price Gold Standard period as in 1930 and 1961. This data allows us to see that prices could deviate significantly from the official parity due to shocks, such as the French demands for 99% pure bars in the 1930s and the extraordinary level of demand for gold *hoarding* in 1961.

Annual Bullion Bank reports, newspaper articles and IMF research help us to develop a picture of the market during this period showing that there was significant private demand

from “hoarders”, which affected the price. This coupled with a daily gold price data will allow for a range of research in relation to gold’s place in an investment prior to 1968 for the first time.

Finally, we address the most fundamental question that can be asked when beginning to study any financial market – is the market informationally efficient – in the weak form sense (Fama 1970). We show that from its opening in 1919 to the resumption of the gold standard in 1925 this market was unpredictable and therefore efficient based on a wide range of tests. As the qualitative section of this paper discusses this was a market dominated by market professionals and official gold buyers - limiting the speculative or noise trader aspect of the market that would be a reason for inefficiency.

The evidence above shows the 1931-39 gold market to be freer and more liquid which might predispose us to assume that this too would be a relatively efficient market but based on the above results it seems clear that it was inefficient. Only one of the test (Lo & MacKinlay's (1988) M₂ VR test) points to an efficient market and as it is the weaker than Wright's (2000) non-parametric Rank Variance Ratio when applied to non-normal data, as is the case here, it seems clear that this period was also inefficient. The development of speculative forces in the 1930s, as private buyers began to hoard and dishoard gold across the globe based on their perceived level of uncertainty, seems to be what introduced a large increase in the amount of gold traded on the *Gold Fixing*.

These traders appear to have been less informed with runs of positive and negative returns being longer than would be expected, indicating traders reinforcing trends. These new traders seem to have reduced the efficiency that characterised the professionally dominated free market in 1919-25 and introduced a predictability into the price changes of gold. This predictability of prices seems to add weight to Arnold's (2016) finding of extraordinary profitability of Mocatta and Goldsmid during this period. It also adds to their findings that high leverage was a driver, indicating that their insight from regular dealing in the *Gold Fixing* will have given them an extra help.

Why the gold market was more inefficient when the gold price was controlled by central banks is a matter for future study but it is not completely unexpected with Levich (1985) arguing that as floating prices can react to all information they would be more efficient than an officially managed price. Overall the *Gold Fixing's* efficiency seems to evolve as circumstances change, along the lines of the Adaptive Market Hypothesis of Lo (2004), but not in a linear fashion from inefficient to efficient, as has been found by Urquhart and McGroarty (2016) in modern markets.

The daily gold price data made available through this research will allow a range of future analysis on a wide range of financial issues. These include issues such as the usefulness of the addition of gold to an investor’s portfolio using market prices pre-1968, whether it acted as a safe haven as has been found in modern research, and any other question which requires a daily market prices for gold.

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Table A1: Runs Tests of Market Efficiency

	Observed Runs	Expected Runs	Standard Dev. Runs	Z-Stat
Panel A. Greater than Zero				
1919-25	676	690	18	-0.750
1925-31	603	591	13	0.9134
1931-39	1212	1192	24	0.8218
1954-68	1863	2003	30	-4.628***
Panel B. Greater or equal to Zero				
1919-25	652	694	18.3264	-2.318***
1925-31	554	521	11.8037	2.767***
1931-39	1197	1165	23.7015	1.349
1954-68	1952	1955	29.6066	-0.0857

Note: ***, **, * denote significance at the 1%, 5% and 10% level,
 $H_0: r = E(r)$

Table A2: Wright's non-parametric variance ratio test (Rank, R1 and R2) Bootstrapped critical values

		K=2		K=5		K=8	
		R1	R2	R1	R2	R1	R2
1919-1925	0.5%	-2.6155	-2.6928	-2.4868	-2.5330	-2.5488	-2.5499
	2.5%	-2.0066	-2.0218	-1.9890	-1.9565	-1.9692	-1.9624
	5%	-1.7078	-1.6855	-1.6783	-1.6626	-1.6972	-1.6962
	95%	1.5937	1.5868	1.5742	1.5239	1.5498	1.5239
	97.5	1.9440	1.9010	1.8914	1.8528	1.8634	1.8349
	99.5%	2.5441	2.5870	2.5150	2.5078	2.6320	2.5772
1925-1931	0.5%	-2.6148	-2.5640	-2.5645	-2.5126	-2.5237	-2.4791
	2.5%	-2.0334	-2.0097	-1.9977	-1.9813	-1.9904	-1.9631
	5%	-1.7082	-1.6741	-1.6997	-1.7077	-1.7191	-1.7054
	95%	1.6131	1.6228	1.6051	1.5996	1.5784	1.5569
	97.5	1.9645	1.9305	1.9501	1.9236	1.9280	1.8955
	99.5%	2.6293	2.5991	2.6529	2.6798	2.6487	2.6997
1931-1939	0.5%	-2.6606	-2.5711	-2.4996	-2.5194	-2.4675	-2.4471
	2.5%	-2.0365	-2.0262	-1.9535	-1.9469	-1.9487	-1.9643
	5%	-1.6961	-1.7101	-1.6645	-1.6643	-1.6649	-1.6960
	95%	1.5911	1.6039	1.5894	1.5905	1.5505	1.5419
	97.5	1.9450	1.9010	1.8938	1.8886	1.8789	1.8858
	99.5%	2.5389	2.5114	2.5416	2.5141	2.5642	2.5345

1954-1968	0.5%	-2.5638	-2.5492	-2.5668	-2.5766	-2.5617	-2.5472
	2.5%	-2.0158	-2.0093	-1.9925	-1.9915	-1.9571	-1.9762
	5%	-1.6952	-1.6946	-1.6885	-1.6829	-1.6949	-1.6796
	95%	1.6092	1.5980	1.6075	1.6058	1.5917	1.5627
	97.5	1.9173	1.9358	1.9195	1.9333	1.8968	1.8920
	99.5%	2.5310	2.5796	2.5804	2.5157	2.5866	2.58047
1919-1939	0.5%	-2.6511	-2.6474	-2.5135	-2.5323	-2.5201	-2.5278
	2.5%	-1.9991	-2.0137	-1.9916	-1.9846	-1.9595	-1.9604
	5%	-1.6734	-1.7069	-1.6906	-1.6889	-1.6721	-1.6621
	95%	1.5818	1.5987	1.5556	1.5686	1.5674	1.5705
	97.5	1.9228	1.9612	1.8862	1.8822	1.9078	1.9306
	99.5%	2.4898	2.5195	2.5403	2.5427	2.5602	2.5688

Note: Bootstrapped Critical values estimated based on 10,000 repetitions

Table A3: Wright's non-parametric variance ratio test (Sign, S1) Bootstrapped critical values

Sample Period		K=2	K=5	K=8
1919-1925	0.5%	-2.520	-2.499	-2.487
	2.5%	-1.989	-1.956	-1.884
	5%	-1.6712	-1.646	-1.648
	95%	1.618	1.666	1.651
	97.5	1.936	2.014	2.034
	99.5%	2.679	2.770	2.760
1925-1931	0.5%	-2.564	-2.527	-2.446
	2.5%	-1.967	-1.927	-1.918
	5%	-1.668	-1.654	-1.659
	95%	1.618	1.618	1.632
	97.5	1.917	1.982	2.001
	99.5%	2.564	2.600	2.709
1931-1939	0.5%	-2.552	-2.533	-2.482
	2.5%	-1.985	-1.975	-1.955
	5%	-1.636	-1.641	-1.647
	95%	1.636	1.625	1.624
	97.5	1.941	1.943	1.994
	99.5%	2.596	2.644	2.671
1954-1968	0.5%	-2.530	-2.489	-2.486
	2.5%	-2.014	-1.947	-1.907
	5%	-1.681	-1.659	-1.652
	95%	1.621	1.615	1.637

	97.5	1.893	1.936	1.959
	99.5%	2.560	2.710	2.703
1919- 1939	0.5%	-2.548	-2.547	-2.498
	2.5%	-2.003	-1.950	-1.959
	5%	-1.648	-1.671	-1.655
	95%	1.621	1.622	1.601
	97.5	1.921	1.960	1.928
	99.5%	2.602	2.627	2.608

Note: Bootstrapped Critical values estimated based on 10,000 repetitions

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