Economically irrational pricing
of 19th century British government bonds

Andrew Odlyzko
School of Mathematics
University of Minnesota
Minneapolis, MN 55455, USA
odlyzko@umn.edu
http://www.dtc.umn.edu/~odlyzko
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Abstract. British government bonds formed the deepest, most liquid, and most transparent financial market of the 19th century. This paper shows that those bonds had long periods, extending over decades, of anomalous behavior, in which Consols, the largest and best known of these instruments, were noticeably overpriced relative to equivalent securities which offered the same interest rate and the same guarantee of payment. This finding and similar ones for other comparable pairs of British gilts appear to provide the most extreme counterexamples documented so far to the Efficient Markets Hypothesis and to the Law of One Price, and point the way to further investigations on the origins and nature of the modern economy.

1 Introduction

19th century Britain led the world in the development of modern economic and financial institutions as well as of economic theory. This paper shows that these developments were accompanied by a striking example of large scale economic irrationality that adds a new dimension to the modern literature on market efficiency and pricing anomalies. (See Section 6 for a comparison with other results in that area.) The most notable instance involved relative mispricing of two extremely large British government bonds, which carried exactly the same interest rate and were backed by the full faith and credit of the government. They differed essentially only in name, volume, and dates interest was paid. The price difference, adjusted for accrued interest, reached as high as 2% for short periods, and averaged over 1% for several years, and over 0.5% for decades, as is shown in Fig. 1. (The notation is explained lightly in the figure caption, and in full detail in Section 2.) The potential arbitrage profits from eliminating the discrepancy reached 1% of UK GDP at the peak in the mid-1860s. The sizes of the British economy, national debt, and the main government securities of that period are shown in Table 1 based on standard sources.

While only one contemporary economist, Robert Giffen, appears to have written about this pricing anomaly (which by itself raises interesting questions), it was widely known among those involved in finance, even if not among the general public. Some Chancellors of the Exchequer (the equivalent of a finance minister in many countries, or the Secretary
of the Treasury in the U.S.) spoke about it in Parliament, and it was cited in a popular textbook on arithmetic. Several newspapers waged extended campaigns, attempting to persuade their readers to take advantage of this mispricing. One of the more colorful expressions in the press claimed that “the public mind has been sorely puzzled” by the anomaly\(^2\). Such efforts had little noticeable effect. This mispricing was eliminated only in 1888, when almost all gilts (the modern term for British government bonds) were converted to a single new class. The memory of this pricing anomaly faded away quickly afterwards. There does not seem to be any mention of it in the modern literature.

![Consols overpricing, 1823 – 1887](image)

**Fig. 1.** Average annual overpricing of Consols (CA) relative to Reduced Annuities (RA), 1823 to 1887. Stars denote market prices after subtraction of accrued interest, in pounds sterling for a unit of nominal value 100 pounds. In an efficient market, CAm* - RA* should have been zero. Also shown is the average annual market yield on Consols.

The City (the commercial and financial heart of London), the London Stock Exchange, and British financial markets of the 19th century in general have been investigated extensively, since London was the world’s dominant financial center during that century. Some of the basic references are [29][21][24][27][30][31]. In particular, the development of the key institutions and laws is well documented. The last few decades have also produced an extensive literature on some other aspects of those markets, such as that in [16].

This paper concerns another issue, one that has been not just neglected, but appears totally unknown to modern scholarly literature, namely the pricing anomalies of British
Table 1. British economy and national debt, 1840–1880.

All figures in millions of pounds sterling. CA, ..., R35 designate certain bonds, and entries in those columns are nominal values of outstanding debt in the corresponding security.

<table>
<thead>
<tr>
<th>year</th>
<th>GDP</th>
<th>debt</th>
<th>CA</th>
<th>RA</th>
<th>NR</th>
<th>N35</th>
<th>R35</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>566</td>
<td>798</td>
<td>362.2</td>
<td>126.1</td>
<td>-</td>
<td>157.6</td>
<td>67.2</td>
</tr>
<tr>
<td>1850</td>
<td>593</td>
<td>798</td>
<td>374.2</td>
<td>121.3</td>
<td>247.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1860</td>
<td>828</td>
<td>802</td>
<td>400.6</td>
<td>115.0</td>
<td>246.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1870</td>
<td>1153</td>
<td>748</td>
<td>393.6</td>
<td>102.7</td>
<td>220.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1880</td>
<td>1379</td>
<td>738</td>
<td>390.9</td>
<td>92.3</td>
<td>204.2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

gilts in the 19th century. Trading in those bonds was the reason the London Stock Exchange was created. (The word “Stock” referred primarily to government perpetual annuities, Consols the most prominent of them.) They provided almost all the trading volume on that exchange for the first two decades of the 19th century, with shares of companies such as the Bank of England, and then increasingly also canals, insurance companies, etc., being almost negligible. Around 1820, foreign government bond trading became prominent, and then, in the 1830s and 1840s, shares of joint stock companies, railways foremost among them, grew in importance. A contemporary compilation claimed that in the 1816–1820 period, UK national debt amounted to about 67% of all tradeable financial securities in the world, with the Dutch debt in second place at 11%. Even in the early 1860s, as other nations grew their debts, the UK accounted for about 40% of world total of national debts [23], at a time when such securities were still far larger in volume than equity investments.

The UK was the greatest exporter of capital in the 19th century, and gilts were initially most of its financial market, and remained its sizable and stable foundation until the end of that century. Hence those gilts played a major role in world finance. “For many decades before World War I the price of Consols was the single most important asset price in the world economy” ([20], p. 165).

Consols, denoted CA in Table 1 and in the rest of this paper, are a natural subject for study. In the words of a modern scholar, “[a]s a measure of the long-term rate of interest [CA] perhaps comes as close as we can get to that theoretical abstraction, which requires a loan of infinite duration without any risk of default” ([25], p. 649). Not only was their volume large, but they were book-entry entities, were long-lived (dating back to early 1750s, and replaced by a new but similar type of bond, with a lower interest rate, also called Consols, in 1888–89), were almost infinitely divisible (some accounts had just one penny, the old British penny, 1/240-th of a pound sterling, in them), and were traded all the time on the London Stock Exchange with low (for that time) transaction costs.
Modern authors who have looked at long term interest rates in Britain have studied CA to the almost complete exclusion of other gilts, cf. \[5\] \[12\] \[17\] \[18\] \[20\] \[25\] \[37\]. All published studies have found that the 19th century gilts markets passed those standard efficiency tests that were applied \[4\] \[5\] \[26\]. However, those studies used data just for CA.

While CA did constitute about half of the British national debt, there was another half. Even if we exclude short-term debt, for most of the 19th century there were between half a dozen and a dozen government securities on the market. They offer a rich subject for study. This paper concentrates just on what are called here the “major gilts” of the 1831–87 period, namely the ones listed in Table 1. They are explained in Section 2 and had the property that their capital was large, they were widely held, and we have prices for them for almost every day that the London Stock Exchange was open. It turns out that these major gilts displayed some striking and time-varying but persistent pricing anomalies, of which that of CA relative to RA, depicted in Fig. 1 is just one.

This paper is based on two new collections of data. One is an extensive dataset of gilts prices in the 1823–88 period, primarily of the major gilts, but also of some minor ones. It is publicly available on the author’s home page, \(\text{http://www.dtc.umn.edu/~odlyzko/19finance/}\)

The other collection is of notes and discussions about gilts mispricings in the contemporary literature, primarily the press, but also books, pamphlets, and official documents. They are cited frequently with full references in this paper, as well as in the supplementary manuscript \[32\]. That manuscript considers in more detail the behavior of CA overpricing during various interesting periods, the coverage of that phenomenon in the press, and the gilts investments of various groups, such as the universities of Cambridge and Oxford. It also has more details, in most cases not available in modern literature, about data sources, gilts ownerships, and the functioning of 19th century gilts markets.

Possible reasons for the observed mispricings are discussed in Section 12 (and at greater length in \[32\]). It is argued there that the standard candidates (liquidity, government actions, seasonality, ...) do not suffice to explain this phenomenon. The tentative conclusion is that most of the time it resulted from a combination of widespread ignorance (so inefficient information markets) and mass psychology that led British investors to think of CA as being more prestigious than RA, and be willing to pay a bit more for it. This was also the conclusion of Giffen and some other contemporary observers. But even this is not entirely satisfactory, as there were periods in the 18th century when RA was overpriced relative to CA.

In this paper, efficient markets are taken to be those that produce prices corresponding to fundamental values, namely the discounted values of payouts. Since we are dealing with bonds, the valuation problem is far simpler than for shares of the South Sea Company at the height of its bubble in 1720, say, or any other equity investment. Further, by considering only relative valuations of bonds with the same interest rate, we avoid the uncertainty involved in having to choose a discount rate. Therefore we can have greater confidence that the observed prices do prove that the 19th century gilts market was inefficient.

Current literature abounds in examples of inefficiencies in modern bond markets, cf. \[11\] \[28\]. Explanations have been offered for some of those inefficiencies as products of short-selling.
constraints, liquidity, etc. Some of those constraints may have applied to some of the British investors in the 19th century. However, we can show that most of those constraints were too small to be significant. Most important of all, there were many large and long-term investors with large amounts invested in CA who were not subject to any constraints over long periods. That they did not switch to the underpriced RA, even when there were suggestions in the financial press that they do so, demonstrates economically irrational behavior. Most of the extensive material in the supplementary manuscript [32] comes from a (mostly unsuccessful) attempt to divine the thinking that drove those irrational investment decisions.

Section 2 describes the major gilts that are the main subject of this study. Then Section 3 presents a detailed investigation of the underpricing of NR relative to both RA and CA in the late 1840s. Section 4 considers overpricing of CA relative to RA, and of NR relative to RA35 in the 1831–1844 period. Section 5 discusses CA overpricing relative to RA, which is pictured in Fig. 1 but over shorter periods, to demonstrate some of the features of this phenomenon in more detail. Section 6 compares the gilts mispricing discovered in this research to pricing anomalies that have been published earlier. Then come sections dealing with arbitrage and its limitations, government’s role in gilts mispricings, and the influence of liquidity. Section 10 summarizes the coverage of gilts mispricing in contemporary literature. Section 11 demonstrates the heterogeneity of market actions of several groups. Next comes a discussion of possible reasons for the observed mispricings, and finally the conclusions.

2 British gilts

This section reviews basic facts about gilts that are well-known to scholars who have studied that period. References and new material (such as studies on liquidity, gilt ownership, etc.) are available in [32].

The main subjects of this study are the three major gilts that formed the bulk of the British national debt in the 1844–88 period:

- CA = Consols, the Consolidated 3% Annuities of 1751, paying 3% annually, in early January and early July
- RA = Reduced 3% Annuities, also dating to the 1750s, paying 3% annually, in early April and early October
- NR = gilts created in the 1844 debt conversion, paying 3.25% from late 1844 to late 1854, and then 3%, with a guarantee of no redemption until late 1874, with interest payable on the same days as RA

After 1854 these three securities all paid 3% per year (actually about 3.02%, since they paid 1.5% twice a year, but we’ll follow the convention of the time and disregard this pedantic point) and were collectively often referred to as “the Three per Cents.” They were all perpetual, in that investors could not cash them in, but the government could call them by paying face value (following some rules discussed, with examples, in [32]). Such redemptions happened a number of times in the 19th century. In a recent book some of them are listed as examples of “domestic default or restructuring” ([33], p. 112). This is misleading, since the
British government was punctilious in observing all its legal obligations. These conversions took place in times of prosperity, following all legal rules, when interest rates were low. CA, RA, and NR were all redeemed in the 1888–89 Goschen conversion, during one of those periods, and replaced by a new gilt that initially paid 2.75%, declining to 2.5% in 1903.

In addition to the three major gilts listed above, we also consider, although only briefly, two other gilts that also deserve to be called major, namely N35 and R35. (There were also many “minor gilts,” a few of which are described in [32] and for which some market price data is available in the tables.) Both are listed in Table 1 and both were converted (together with two minor gilts) into NR in 1844:

- N35 = New 3.5% Annuity, paying 3.5% annually, in early January and early July
- R35 = Reduced 3.5% Annuity, paying 3.5% annually, in early April and early October

The nominal capital of these annuities in 1840 is given in Table 1. It was substantial, and as a result we have market prices for them for almost every day, unlike the minor gilts. (As is described in [32], only large transactions were recorded in the official lists, so for minor gilts, as well as for shares of most joint stock companies, including the Bank of England, there were often intervals of many days for which we have no prices.) What makes the relative prices of N35 and R35 especially worth investigating is that they were almost the same in their relation to each other as the pair CA and RA. N35 and R35 bore the same interest rate, and differed only in name, capital, and dates when interest was paid. So it is interesting to look for N35 vs. R35 mispricing, and that is done in Section 4.

Prices for gilts were universally quoted in units of nominal (par) value of £100.00, even though transactions could and were carried out in units as small as 1/240-th of £1.00. Transaction prices and quotes for the major gilts were almost always reported in increments of £0.125 (for a unit of par value £100). This was also the standard brokerage commission, and also the jobber (market maker, specialist) standard margin (difference between buy and sell quotes, then called the “turn”). Large customers could normally get better deals, while in times of stress, the jobber margin would increase, although very seldom above £0.25, or twice the standard. (For more details on this and other issues, see [32].) Thus differences in price of £0.125 during that period were in general not significant, and could often be due just to the drift of prices and the timing of transactions that were reported. (Averaged over longer periods, though, they could indicate a trend.) Fig. 1 based on daily data for 1864, gives a sense for the effect of this granularity in the data. (The tables have far more information.)

When retail investors sold a security and immediately purchased another one, they usually paid only one commission ([39], p. 14). Hence such investors could engage in profitable arbitrage when mispricing exceeded £0.25, but not below. Large investors and insiders could profit from smaller differences.

While almost all share transactions were subject to a stamp tax, gilts trading was exempt. Also, income tax (which was brought back in the early 1840s) was at low levels and did not apply to capital gains. Hence taxes are disregarded here in considering potential arbitrage.

Most gilts traded for immediate cash settlement. CA was exceptional among gilts (but similar to what was customary for shares) in having throughout this period trading “for
account,” to be settled later, a form of futures trading. Prices were reported separately for cash trading (denoted in this paper as CAm) and for account (denoted CAa). While tables report both, all studies have been carried out with CAm, in order to avoid the technical adjustments that would need to be made to obtain comparable figures from CAa.

Until 1861, each gilt had trading in it suspended for about a month before the interest payment date. This meant that we have prices simultaneously for both RA and CAm for only 8 months each year, and all the statistics that are reported reflect this. (Use of CAa to supplement CAm when CA was “shut” would increase the coverage period to 10 months, but was again not implemented to keep the arguments simple.)

Before 1861, we can find some published advice for banks to keep half of their reserve in CA and half in RA (see [32]). After 1861, that became irrelevant, and so there may have been a migration of large funds to CA. (We do find an increase in CA overpricing in 1861, but it is not certain it was due to this factor, as the increase in overpricing was already noticeable in 1860, and the all-time high occurred in 1864. We can show quantitatively, though, that CAa gradually became much less actively traded after the abolition of “shuttings,” cf. [32]).

Gilts traded in London with accrued interest, with prices dropping when interest (then usually called dividends) was paid. The * symbol is used to denote the price after subtraction of accrued interest. Rational pricing would call for CAm* - RA* to be close to zero.

The values of CAm* - RA* that are reported in the tables come from either subtracting or adding £0.75 to CAm - RA, depending on which security had an interest payment next. This would be exact if the interest payment dates were precisely a quarter of a year apart, interest accrued linearly, and interest rates were the same for all maturities (constant term structure). None of these assumptions is correct, but the difference between the approximation and the correct value was generally well under £0.05, so was ignored. (See [32] for more detail. That this was an approximation, but one “good enough” for practical purposes, was known two centuries ago, cf. [11].) For N35 vs. R35, 0.75 was replaced by 0.875, the appropriate value there.

The data for this study came primarily from two sources. The *Course of the Exchange*, abbreviated as *CoE*, provided most of the data for the period 1823–60, mainly in the form of closing prices on Fridays. The *Economist* was used to obtain the Friday closing quotes for 1861–87 (for some years for all Fridays, for some for samples of 16, usually 4 from each of February, May, August, and November), and the bid quotes were used in the statistical studies and graphing. However, for some periods additional, more detailed, data sets were collected (such as the daily closing prices used to prepare Fig. 4). At this point we just remark that these sources are standard ones that have been used in previous studies (*CoE* in [1] and *Economist* in [20], for example). An extended discussion of these sources and other ones is available in [32]. That discussion covers more topics, as the data sets that were assembled are far more extensive than mentioned above. *CoE* and *Economist* data lead to essentially identical estimates of gilts mispricings for the periods where they overlap.

Gilts prices were reported in practically all British papers in the 19th century, usually in either the *CoE* or the *Economist* form. Thus the data demonstrating pricing anomalies
was visible to all newspapers readers on a constant basis, although to realize it represented mispricings required the ability to calculate accrued interest.

3 The glaring NR pricing anomaly of the late 1840s

The main results of this paper concern the anomalies in the relative pricing of CA and RA. Their mispricing lasted, with just two interludes of at least two years, from 1831 to 1888. As a preliminary step, though, we show the economically irrational pricing of another pair of major gilts, RA and NR, in the 1847–49 period.

Fig. 2. Market value of NR non-callability, 1845 through 1854, in pounds sterling for units of nominal value £100.

NR before 1855 can be regarded as the sum of NR1 and NR2, where NR1 was a perpetual 3% annuity that could not be redeemed until after the October 1874 dividend was paid, and NR2 was a terminable annuity, paying £0.125 each April and October of 1845 through 1854. (It was regarded as such by contemporaries, too.) Except for the differences in redeemability which did not appear to have much effect on pricing, NR1 was superior to RA by virtue of the call protection. Hence (using italic versions of symbols of securities to denote prices) we should have

\[ NR1 = RA + C, \]
where \( C \) is the “option value” of not being callable until the end of 1874. Therefore rational pricing would force

\[
C = NR - RA - NR^2.
\]

The values \( NR \) and \( RA \) can be taken from market data, listed in the price tables, while \( NR^2 \), the value of the finite sequence of payments \( NR^2 \), can be computed explicitly if we are given a discount rate. This was done for each Friday from beginning of 1845 through early September 1854 (when RA and NR trading was shut, just prior to NR losing its extra interest). The prices for RA and NR were the closing prices from CoE. \( NR^2 \) was evaluated using the market yield of CA on each day (computed using the precautions of [20], as detailed in [32], with the resulting values in the tables) to discount the interest payments. (The values of \( NR^2 \) are not very sensitive to the discount rate, since this was a rather short annuity.)

Fig. 2 shows the results. The scatter plot displays the values of \( C \) that were computed for the 420 Fridays for which we have prices for both RA and NR. The solid line is a smoothed version, obtained with the lowess function in the R statistical package. The dotted line is a smoothed version (again, using lowess) but applied to a similar data set, in which the price of NR was compared not to RA, but to CA (after adjusting for accrued interest). From mid-1850 to mid-1853, CAm and RA were priced rationally in relation to each other, so the two lines overlap and cannot be distinguished.

The valuations of \( C \) shown for early 1845 are not unreasonable, as there were wide expectations interest rates would go lower, leading to redemption of CA and RA. Even the much higher values of \( C \) in late 1852 and early 1853 are plausible. Interest rates on gilts were declining to below 3%, the economy was booming, and there were wide expectations of further declines.

What is totally unrealistic are the negative values of \( C \). In an efficient market, the value of an option (in this case, protection from redemption) cannot be negative. Yet negative values is what we observe. Not only that, but in mid- to late-1848 those values were very large on the negative side, especially when we compare NR to CA. (CA was substantially overpriced relative to RA during this period.) As an example, tables show that on 28 July 1848, \( C \) was valued at a negative £1.46 relative to RA, and a negative £2.21 relative to CA. Since the price of CA (after removal of accrued interest) was £85.81, NR was underpriced relative to CA by over 2.5%, even if we value its call protection \( C \) at zero.

That \( C \) should have been close to zero at that time is not surprising. With market yield on CA close to 3.5%, the prospects of redemption were far from investors’ mind. But negative values should not have happened. Especially in this case, the markets could not stay irrational forever. The terminable annuity \( NR^2 \) was going to terminate in 6 years, so one would expect that sophisticated investors should have been able place leveraged bets on NR rising in price relative to CA. (According to news reports, some may have done this, but apparently not to a sufficient extent to bring about rational pricing.)

Discussions of the overpricing of CA relative to RA during this period have been found in several newspapers, cited later in this paper and in [32]. But much less discussion of the far more dramatic overpricing of CA and RA relative to NR has yet been found in any serial publication in Britain before the end of 1849. Still, one press organ has been found
that over an extended period of time kept pointing out the anomaly and urging readers to take advantage of it. This was *Freeman’s Journal*, a daily in Dublin, Ireland. Its gilts coverage is discussed in some detail in [32]. (The Irish gilts market at that time seemed to be somewhat less irrational than the English one.) Overall, though, the almost complete lack of attention to the very large CA vs. NR anomaly as compared to the still large but considerably smaller CA vs. RA anomaly suggests inefficiency in financial analysis available to the public.

NR underpricing provides a very striking example of economically irrational pricing. For the comparison of CA and RA, considerable effort is devoted in [32] to showing that differences in redemption features cannot account for the observed mispricing, and that features such as the term structure of interest rates can not be responsible either. But for the relative pricing of NR and RA, those issues do not arise, as interest was paid on the same dates. Further, NR capital was larger than that of RA, there were more NR than RA accounts, and the liquidity of NR was higher. Perhaps more important, for anyone looking at possible government action as a reason for the mispricing, it was the undervalued NR that had by far the better call protection. (It would have required strong faith in a very improbable scenario of interest rate trends and government actions, spread over several decades, to make RA preferable to NR.) The tens of thousands of holders of RA should have switched to NR. According to news reports, some did so, but again, clearly not in sufficient numbers to eliminate the inefficiency.

### 4 Other major gilts mispricings

Systematic overpricing of CA relative to RA makes its first appearance (in the post-1822 period that was investigated) in early 1831. It is shown in Fig. 3 together with the overpricing of N35 relative to R35, from the beginning of 1831 to the end of 1844, when the Goulburn conversion replaced N35 and R35 with NR. In this figure, the overvaluations that are plotted are averages over the four roughly two-month periods in each year that all the gilts were trading. The four averages for each year are plotted, separately for the two differences, but are multiplied by three, in order to show some details of how this overvaluation varied. (Therefore the highest overpricing portrayed is about £0.60, for N35 vs. R35.) Also shown are two interest rates, the long-term one represented by the market yield on CA, and the short-term one by rates on commercial paper at a London discount house.

As was noted in Section 2, the relation of N35 to R35 is similar to that of CA to RA with respect to size and dates interest was paid. However, the situation is not completely analogous. CA and RA both went back to the 1750s, both were callable under the same conditions, and both were extinguished in the Goschen conversion of 1888–89. R35 originated in 1824 (through conversion of higher coupon securities). During the period considered in this section, R35 was callable at short notice. N35 was created late in 1830, also through conversion of a higher coupon annuity, but was not redeemable until 5 January 1840. Therefore from 1831 through 1839, efficient pricing would call for N35 to carry some premium relative to R35, after adjusting for accrued interest. However, from the beginning
Fig. 3. Overpricing of Consols relative to Reduced Annuities, and of New 3.5% versus Reduced 3.5% Annuities, between 1831 and 1845, in pounds sterling per unit of £100 nominal value, adjusted for accrued interest, multiplied by 3, and averaged over two-month periods when all gilts traded. Also displayed are the market yields on Consols and on short-term commercial loans.

of 1840 to their conversion in mid-1844, there was no good reason for the prices of N35 and R35 to differ (once we adjust for accrued interest).

It is intriguing that for the 3% and the 3.5% annuities, it was in both cases the larger one and the one with January and July interest payments that was overpriced.

Because of the call protection that N35 enjoyed before 1840, it is natural to break up the period depicted in Fig. 3 into 1831 through 1839, when N35 was not callable, and 1840 through September 1844. The averages of CA_m* - RA* over the 284 Fridays of the first period and 126 of the second for which we have data shows average overpricing of £0.17 and £0.18, respectively. For N35* - R35* these averages are £0.33 and £0.15. The correlations between CA_m* - RA* and N35* - R35* are 0.22 for the first period and 0.50 for the second. Thus whatever drove those mispricings, it was not exactly the same factor for the two pairs of CA and RA and of N35 and R35.

As was mentioned in the Introduction, comparisons of pairs of minor gilts with the same coupon appear to show a variety of different patterns of mispricing. Before undertaking serious econometric studies of gilts pricing anomalies, it appears advisable to collect more...
complete data about minor gilts. Also very relevant are likely to be interest rates and government repurchases of gilts (discussed in Section 3).

5 Consols mispricings

Fig. 1 summarizes the evolution of CA overpricing during the period 1823 to 1887. The underlying data, as well as the annual averages that are displayed there, are all in the auxiliary tables. Here we consider some observations on this data. (There is far more, with tables and graphs, in the supplementary manuscript [32].)

It appears that not infrequently, increases in CA overpricing followed, with some delay, big economic shocks. This applies to the first appearance of extended CA overpricing that was observed in this (post-1822) study, which occurred in 1831. As is described in [32], in the fall of 1830 there was a dramatic increase in interest rates, followed by more turbulence in early 1831. But the largest overpricing of CA (with daily price data available in the tables) occurred in April and May of 1831, when the markets were rebounding. There was also an increase in the overpricing of N35 relative to R35 at that time, as is visible in Fig. 3 (There was a very high degree of overpricing of N35 relative to R35 at the end of 1830, right after N35 started trading, which is not shown in that figure, but is in the tables. That, however, could be ascribed to the call protection that N35 enjoyed and R35 did not, and possible expectations that the jump in interest rates that had just taken place was temporary. More investigation is needed to evaluate that case.)

Other instances of what may have been delayed responses to economic shocks occurred in late 1847 and in May 1866. On both occasions the British government suspended the gold standard to deal with threatened collapses of the financial system. CA overpricing in those instances, as well as others, is discussed, with price graphs, in [32]. In the 1866 case, there was a substantial increase in CAm*- RA* shortly before the crisis, some gyrations during the crisis, and then a gentle rise to very high levels, even as short term rates were collapsing and long term rates were declining.

Not all increases in CA overpricing can be associated to obvious economic or financial shocks. In particular, the record high levels of CAm* - RA* that were found in this study occurred in 1864, and are depicted in Fig. 4 (The scatter plot there presents the values of CAm* - RA* for each of the 305 trading days that year when prices of both CAm and RA were available, and the solid line is a smoothed version of the scatter plot. One reason for presenting this graph is to provide a sense for the quality of the data.) The only unusual feature of the economic scene, although one that attracted considerable attention in the press, was that short-term interest rates were high, and were fluctuating with great frequency. However, there were no serious economic or political threats. Although it was not yet certain how the American Civil War would be resolved, it was clear that Britain would not get involved in a military conflict there. (The Second Schleswig War, between Denmark on one hand, and Austria and Prussia on the other, was a source of some, but not very serious worry.) The shortage of cotton caused by the Union’s naval blockade of the South, which led to the disastrous “cotton famine” and substantial shutdown of the textile industry of England’s North-West, was on the way to being solved by developing alternate sources of supply in Egypt and India. Britain was very prosperous, with few bankruptcies,
and widespread speculation, primarily in new banks and railroads. (There were frequent warnings about a crash of the mania, but it took another two years to arrive, culminating in the Overend, Gurney crisis of 1866 mentioned above.) Yet in the space of about three months, CA overpricing doubled from an already high level. Then there was a substantial dip in this overpricing in September, just as interest rates spiked, and then the overpricing increased again.

If CA was more highly valued than RA (and NR, after 1854), what happened when the supply of CA increased suddenly? One large increase took place in early 1847, primarily to provide funds for the relief of the Irish Famine. It increased the supply of CA by about 2%. There was an even larger increase (about 4%) in early 1855, to provide funds for the Crimean War, and two smaller increases in early 1856, also for this conflict. All four incidents are studied, with graphs, in [32]. The loans for 1847 and 1855 may have contributed to the observed slight reductions in CA overpricing. The ones of 1856 appear to have had little if any effect, in that the overpricing seems to have increased afterwards.

The supplementary manuscript [32] contains discussions and graphs for several more examples of how CA overpricing behaved during various political, economic, or financial shocks. The tables have detailed pricing data for those and a number of additional periods. The hope is that with more data and deeper investigations, we will obtain insights into
gilts mispricings. (For example, daily data, including both closing prices and closing quotes, can provide us with insights into the efficiency of the market in dealing with unexpected developments, insiders leaks, and the like, as is shown in a few examples in [32].) The data we already have show that these mispricings tended to rise and fall in gentle waves. To what extent can we relate those to measurable economic factors?

6 Gilts mispricing and other financial anomalies

Before delving into the details of gilts pricing, data sources, and other background information, we first relate the results of this study to the existing literature on pricing anomalies and challenges to the Efficient Markets Hypothesis.

There are several important features to the mispricing of the major gilts documented in this paper. They

- lasted for decades
- involved risk-free government bonds
- mispricing was relative, not absolute
- securities were fundamentally perfect substitutes
- securities were widely held, actively traded, and represented huge capital
- there were no short selling constraints
- trading was completely transparent, with prices widely publicized
- trading was on the same exchange
- mispricings were widely recognized as anomalies
- there were many calls for investors to switch to the underpriced securities

(This list is a bit simplified. For example, while there was no practical restriction on selling CA short, there were the usual risks of short squeezes. Also, until 1860, there was the clearly purely theoretical possibility of prosecution, as the practice was officially illegal until then, even though it formed a very prominent although at the moment unquantified part of the business of the London Stock Exchange. Further, RA could not be shorted easily, as it did not trade “for account,” but this was irrelevant, as RA was the underpriced security.) There do not appear to be any anomalies in the literature that come close to having all or even most of these features.

As was noted in the Introduction, CA and RA formed the bulk of all the tradeable financial securities in the world at the start of the 19th century, and a very large part even after 1850. Hence they were very widely held, and were not just the preserve of a handful of large institutions (of which there were not many in those days, in any event). Therefore large fractions of investors had an interest in the performance of those gilts, and had not just the chance, but often the necessity, of making choices among them.

On the other hand, major gilts mispricings were rather modest, almost always under 2%, and most of the time under 1%. Many of the well-publicized anomalies, such as the closed end fund puzzle, or the twin shares mispricings, often feature larger price disparities.

There is a large literature on mispricings and bubbles. Most papers are devoted either to documenting the existence of an anomaly, and trying to fit it into some model, or else to
explaining away the observations as outcomes of rational trading. A few references, which,
with their references, provide an overview of this literature, are [3][6][11][15][22][34][35][36][42][43].

Most of the proposed anomaly mechanisms in the literature clearly do not apply to the
gilts mispricings of this paper. As just one example, rational bubbles require high growth
rates, which are not relevant to the case of CA and RA, which paid a constant interest
rate, and so had limited upside potential. Instead of taking a lot of space explaining why
various other concepts are not applicable to gilts, let us consider the few that appear to
have some relevance.

Fads and investor sentiments are usually presented in the economics and finance liter-
ature as resulting in high turnover, as investors chase after the next Facebook or Google,
and trade in and out. In the 19th century gilts market, though, the problem was not exces-
sive trading, but lack of trading. The long-term investors who owned overpriced CA were
simply not switching to underpriced RA and NR. For example, Chapter 5 of [35] builds a
model based on underreactions and overreactions to news. Some such mechanism may have
been involved in gilts mispricings (if the tentative observation about rises of CA overpricing
following economic shocks hold up as more evidence is collected), but to a small degree.
What we see in the data is not high volatility, but a steady preference for CA, with the
strength of that preference changing slowly.

Similarly, the concepts of noise traders and herding are most commonly applied to
short-term moves in the market, cf. [8]. We do see evidence of something like herding
among British gilts investors in the 19th century, but this mechanism seemed to operate
in different ways, far more slowly.

Still, the concepts of investor sentiments, noise traders, or popularity [19], in principle
can be stretched to cover the proposed explanation of CA being the more prestigious and
therefore more valuable security. However, those concepts do not have much explanatory
power, and it is not clear whether they are any improvement over Charles Mackay’s and
Gustave Le Bon’s crowd psychology ideas of the 19th century.

The role of heterogeneous beliefs in bubbles and crashes has received considerable atten-
tion lately, cf. [42][43]. This phenomenon was certainly at the core of gilts mispricing, with
different groups having different valuations. The results of this paper should add depth
to the current literature, since they show (see Section 11) several heterogeneous beliefs
coeexisting for a long time, and distorting market prices away from the fundamental values
that are unambiguously determined by standard theory.

As is noted in [35] (p. 25), much research has been devoted to limits to arbitrage, but
little is known about the psychological bases of shifting investor sentiments. It also ap-
ppears that little attention has been paid to even learning what information was possessed
by investors when they traded so as to perpetuate and intensify such well-known pricing
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7 Arbitrage and its limits

Why weren’t gilts mispricings eliminated by arbitrage by clever investors? The London Stock Exchange was a sophisticated operation, with membership rising from about 700 in 1840 to over 900 in 1850, and far higher later. In the words of the most famous book on the history of interest rates ([18], p. 184), “[a]lmost all the principal services provided by today’s City and today’s Wall Street were then available in London.” The members of the London Stock Exchange had a high reputation for sagacity. In a House of Commons debate over Gladstone’s 1853 proposal for a conversion of the national debt, Disraeli claimed that “[t]here is not a more crafty creature in existence than the public creditor,” and this sentiment was echoed by another participant in the debate. Those “crafty creature[s]” had to have known of the pricing anomalies, and from press reports we know they knew about them. However, this appears to be a perfect example of the claim that is usually ascribed to Keynes, namely that “markets can stay irrational longer than you can remain solvent.” (This pithy phrase is usually cited in a wider context, allowing for other obstacles to successful arbitrage, such as counterparty failures.) Some of the gilts mispricing episodes lasted for decades, and might have bankrupted many an investor.

The full story may be even more interesting. Some of the gilts mispricings (especially for the minor gilts, which are not discussed in this paper, but are treated briefly in the supplementary manuscript [32]) were short-lived, and there are many press reports of arbitrage moves. So it is possible that some investors made money from these pricing anomalies, and it is also possible that some did become insolvent as a result of trying to fight an irrational mispricing which persisted and grew for many years. But as yet we do not have hard evidence to substantiate such speculations. What we can be sure of, based on market price data, is that traders on the Stock Exchange had to be acutely aware of precisely how irrational the market was, and to adjust their action to take into account the prevailing level of irrationality. Mispricings were rather stable over extended periods of time, and even in crisis situations, when gilts prices gyrated wildly, pricing differentials were preserved fairly closely.

While classical arbitrage, selling short the overpriced CA and simultaneously buying the underpriced RA, say, was the road to ruin most of the time, there was another type of arbitrage that should have eliminated the price disparity. Long-term owners of CA should have sold them and bought RA or NR instead. Furthermore, long-term investors purchasing gilts should have bought RA, while those who owned both CA and RA, when forced to sell, should have sold CA. Contemporaries often claimed that much of the gilts volume (some said the overwhelming majority) was held by trusts, often set up in perpetuity, and thus with infinite investment horizons. We don’t have the precise breakdown of gilts ownership, but we do have evidence that such investors were a large factor, and often held large amounts of CA, as is shown in [32]. They included the universities of Cambridge and Oxford. There is evidence that some investors in this category did do what economic logic suggests, at least to some extent. For example, Greenwich Hospital, as it was diversifying out of gilts, was selling CA and keeping RA, see [32]. Also, the very small investors establishing their gilts accounts in the Post Office Savings Bank were biased towards the underpriced NR, as is shown in Section [11]. The big puzzle is why such moves were not practiced more widely.
As just one example, why didn’t Greenwich Hospital switch all its CA holdings for RA early on?

The language of various investment guides from the 19th century makes it clear that the writers regarded most of their readers as very unsophisticated, and unlikely to be familiar even with the simple calculations needed to compute accrued interest. However, even the least sophisticated investors should have seen the advantage of exchanging CA for RA once overpricing reached £1.00, as it did for extended periods. At that point, say in February of some year, after CA interest had been paid, the quoted price of a £100 unit of CA that was printed in any newspaper would be at least £0.25 higher than the price of RA. So, the commission and jobber’s “turn” involved in swapping a unit of CA for a unit of RA would be covered by that £0.25, potentially with a bit of cash to pocket if the overpricing exceeded £1.00. Afterwards, the amount paid out in interest would stay exactly the same, but the next interest payment would come on 5 April, instead of 5 July. Afterwards, all other interest payments would be similarly accelerated by a quarter. The benefits of that should have been clear to anyone, even those not able to do simple interest accrual computations. (It is worth noting that such examples show clearly, without doing any computations whatsoever, that factors such as seasonality or term structure of interest rates could not possibly have been responsible for these large mispricings.) So the great bulk of investors had incentives to act in ways that would have lessened the pricing anomalies. That they did not do this is a proof of their economic irrationality.

8 The gilts market and the government

Could the British government have been responsible for the observed gilts mispricing? This possibility has to be considered seriously, since there were some differences among the gilts. Furthermore, there was an interesting incident in 1884, described in detail in [32], in which a speech by Hugh Childers, the Chancellor of the Exchequer, laying out his understanding of the rules for gilts conversion, led to the price of NR shooting up more than 1% compared to either CA or RA. The former relative pricing of these gilts (in which RA and NR appeared essentially identical, and £0.25 below CA) took a couple of months to return, as the market apparently became convinced Childers’ claims were not going to make a difference. (In the end, in the 1888-89 Goschen conversion, it was the holders of CA and RA who were treated equally, based on the nominal value of their holdings, and received £0.25 more than those of NR, and in all three cases about 1% more than the nominal value they were entitled to, based on the market price of the new “Goschen consols.”) Most important of all, the government was a significant player in the market all the time, buying and selling its debt.

The executive branch of the British government generally (but with some puzzling exceptions, see [32]) took advantage of CA overpricing. When it did so, its moves should have served to lessen this anomaly. As was mentioned in Section 5 when large new loans were incurred in the 1847-56 period, they were made in CA, which should have served to mitigate CA overpricing. Also, when gilts were bought in the market with surplus revenues, purchases were skewed towards the underpriced RA and NR. As is shown in [32], during the period 1829-90, only 23% of these market repurchases were in CA, and those CA purchases were concentrated in periods when pricing was rational or close to it.
On the other hand, some judicial branches of the government pursued different courses, sometimes very irrational. The Court of Chancery, surely the largest holder of gilts (mostly on behalf of some tens of thousands of trusts it was administering) was among the worst investors, with most of its funds in CA, apparently due to some ancient rule meant to simplify its finances.

Government interactions with the gilts market are considered in much more detail in [32], and include how the government treated investors, how the market reacted to various proposals, and so on. No indication has been found that the government caused the mispricings.

There is still much more to be investigated. For example, from 1786 to 1829, Pitt’s Sinking Fund was in operation, in which the government regularly repurchased gilts, even when it had to borrow to do so. (As one of many critics of this scheme claimed in a Parliamentary debate in 1819, the government appeared to be “selling new Stock cheap in order to buy old Stock dear,” [10], p. 42.) The repurchases of that Fund were weighted heavily towards RA and the minor gilts administered by the South Sea Company, which tended to be underpriced relative to CA. Was it the activities of this Fund that were responsible for the almost perfectly rational pricing of RA and CA in 1823–29? This will require collection of more data, in particular about the details of the Sinking Fund purchases. It should be noted that even while this Fund was in operation, there did seem to be frequent instances (before 1823) of anomalous pricing.

In the interests of brevity, we conclude with one brief, high-level, argument as to why the British government should not be blamed for the observed gilts mispricing. It is based on the behavior of market prices. Basically the only government action that investors had to be concerned with (since default or repudiation were out of the question) were conversions, and those were likely to occur only when interest rates were low. Yet, as can be seen in Fig. 1 and in more detail in the tables, the two years 1843 and 1844, and the three-year period from mid-1850 to mid-1853, when interest rates were low, and there was widespread speculation about conversion of the 3% gilts to lower interest rates, were also periods of almost perfectly rational relative pricing of CA and RA. The period 1885–87, preceding the Goschen conversion, also had low interest rates and general expectations of conversion, and it witnessed only a mild overpricing of CA.

More arguments along these lines can be developed (and some are presented in [32]). For example, the proposal for a voluntary conversion by Lowe in 1870 led to a decline in gilts mispricing. Once the prospects of that conversion faded, irrationality in prices returned in an even slightly stronger form. As another example, the supplementary manuscript [32] has data and discussion of the interesting collapse in CA overpricing at the end of 1883. It appears to have been due to investors interpreting a generous and seemingly gratuitous gift by the government to holders of a certain class of gilts as a signal that a conversion of the major gilts was coming soon. As yet another argument, RA and NR did have some differences in redeemability, and also differed in volume, and NR was protected from redemption until late 1874. Yet, from about 1858 until the Goschen conversion of 1888, with the brief exception of the Childers episode in 1884, they were priced in the market
almost identically. So it seems investors did not regard the small differences in the special features of these two gilts, or their varying volumes, as significant.

Thus the overall conclusion is that we can absolve the British government from blame for the gilts mispricing, at least if we assume investor rationality. If, as this paper concludes was likely, the mispricing was the results of mass psychology operating on investors’ minds to persuade them that CA was in some sense a “higher class” security, the situation is different. Then we can blame the government for reinforcing this irrational impression by increasing the fraction of the national debt that was in CA.

9 Liquidity and other possible reasons for gilts mispricings

A variety of possible explanations for the observed mispricings of the major gilts are considered in [32] and are found insufficient. For example, seasonality and the term structure of interest rates produce effects that are an order of magnitude smaller than what we observe in the market. Further, all those potential reasons run up against the phenomenon cited at the end of the previous section, namely the existence of extended periods of rational pricing. If there was some rational cause for the mispricings, why should it have operated in some periods and not others? The dramatic underpricing of NR in the late 1840s, described in Section 3, reinforces such thinking, as it seems very hard to attribute it to any of those potential causes.

In this section we consider in more detail just one of the potential explanations for the mispricing, the one based on liquidity. It is also deficient, for a variety of reasons (including the phenomenon cited above, of extended periods when there was no mispricing), but we discuss it at some length as it was by far the most common excuse (to the practical exclusion of all others) to be cited by contemporaries in the 19th century. Apparently it was the most plausible one they could think of. An excellent illustration is provided by a leader published by the Economist in 1870, in its commentary on the Lowe gilts conversion proposal. (That proposal, and the Economist coverage of it, are discussed, with extended quotes, in [32].) The editor of the Economist at that time was Walter Bagehot, so he may very well have written the leader, and almost surely must have reviewed and approved it. Since Robert Giffen was then the financial editor, he may also have been the author. Whoever was responsible, the argument of that leader can be summarized (almost caricatured) as follows:

- a larger security is in general more valuable than a smaller one, other things being equal, because it provides higher liquidity
- RA is large enough that size should not matter for it, it provides enough liquidity
- the market value of CA is higher than that of RA
- therefore the conclusion that RA is large enough must be wrong, the overpricing of CA must be due to its higher liquidity

Clearly this author felt compelled to come up with a rational explanation of the pricing anomaly, and did not bother to think seriously about the logic of the argument. (It should be said that consols mispricing was not the central theme of the leader, so having a flimsy and irrational rationalization for it is easier to excuse.)
Some of the other reasons that were cited frequently in the 19th century for CA over-pricing were also related to liquidity, although it is hard to be sure, since in most cases, as with the *Economist* leader cited above, comments were tossed off without careful argument or thought. Many observers claimed CA had a higher price because speculators were using it. As an example, Giffen wrote in 1877 that he had been assured the overpricing happened “for this and for no other reason,” although he himself clearly had doubts about the validity of this argument ([13], p. 95). (We should note that two decades later, a decade after the Goschen conversion, Giffen seemed to treat this more seriously as a valid explanation, [14], vol. 2, p. 193.) Some claimed that CA overpricing was due to its being “a large stock” (to cite Goschen in his speech proposing the 1888 conversion, see [32]), without explaining in detail how size would affect price. They may have had liquidity in mind, but we cannot be sure. They may just have had some vague idea that larger securities are more valuable.

Liquidity is also frequently cited as an explanation for various market anomalies today, in cases such as the collapse of Long Term Capital Management, or the mispricings of U.S. government bonds in the wake of the 2008 crisis [28]. At one level it is possible to argue that in many cases “lack of liquidity” is *prima facie* evidence of market inefficiency. For example, when we read about negative interest rates in the overnight “repo market” as a result of a shortage of certain U.S. Treasury five-year notes [38], that could be interpreted as a poor design of the market that does not allow for more flexible substitution of equivalent securities. However, suppose we do accept liquidity as a valid reason for price differentials. It is certainly the case that there is a well-established correlation between liquidity and market values, and interesting studies have exploited this, e.g. [1]. Furthermore, there is every reason to believe that CA enjoyed higher liquidity than RA or NR. That was stated frequently by contemporary observers, and there is some quantitative evidence in [32]. But higher liquidity for CA does not justify the price differentials we observe. In particular, and most important of all, it does not justify the holding onto CA of most investors in that security. We do have fairly detailed information about the distribution of account sizes in the major gilts, and they were very similar for all of CA, RA, and NR, with the bulk of the holdings fairly small [32].

Liquidity is a poorly-defined concept, but generally refers to the ability to buy or sell easily, without affecting the market price. The major gilts appear to have had more than enough liquidity for most investors’ needs. Jobbers (in other markets called specialists or market makers) had to honor their quotes for only £1,000 in gilts. (See [32] for data on this and other technical points cited in this section.) In practice, the evidence we have suggests that normally it took transactions of several hundred thousand pounds to affect prices. Even in turbulent times, when some actors were suspected of having special knowledge, deals for several tens of thousands of pounds generally did not move the market quotes. Since the main major gilts studied here, CA, RA, and NR, had average account sizes around £3,000, so not just the bulk of the accounts, but the bulk of the invested capital, was under this threshold of a few tens of thousands of pounds. So liquidity did not seem to be a problem from this angle. In terms of the jobber “turn” (the bid-ask spread), it was usually at the level of £0.125 for the major gilts, occasionally rising to twice that level, and extremely rarely higher. The data collected for this study does show that the spread
for RA and NR was at the £0.25 level somewhat more frequently than for CA, but not
often. (It was found in about 15% of the Friday closing quotes during 1872–74 for RA, as
opposed to no instances for CA, for example.) So a modest investor dealing in RA or NR
might lose £0.125 a small fraction of the time (with a higher probability of that in times of
turmoil) as compared to dealing in CA. So such investors, had they been acting rationally,
had little to fear from the lower liquidity of RA. The difference was just too small for them.

We should note that liquidity was a more serious issue for other securities, as shown in
the study of foreign bond trading in London in [1]. It surely was also a consideration for
large speculators and some large financial institutions. They did have rational reasons for
preferring CA, and possibly for paying a small premium to hold CA as opposed to RA. But
it does not apply to the bulk of the investors and the bulk of the capital in gilts. Modest
long-term investors (whether private individuals or trusts) were not affected by the small
differences in liquidity that prevailed, and so had strong incentives to migrate from CA to
RA and NR. Even large but long-term investors, such as Greenwich Hospital, could make
such a move without affecting prices by shifting gradually.

10 Contemporary views on gilts mispricing

The project on which this paper is based involved a large search of the British literature
of the 19th century for comments that might explain the observed gilts mispricings. A
substantial number (in the hundreds) were found, and they are described in [32]. This
section provides a brief summary. There are good reasons for considering contemporary
opinions. 19th century observers may not have had our more advanced theory and the
accumulated experience, but they were not dumb, and their reactions can serve as a check
to ensure we are not overlooking some special conditions of that time. They also provide
us with insights into the markets of that day, and the thinking of investors.

It should be emphasized that the overwhelming majority of the citations are from
financial journalists, who generally appear to have shared our modern views on economic
rationality. In many cases they appear to have accepted the standard explanations for
the pricing anomalies (liquidity, use by speculators, ...), but they still recognized that this
represented an opportunity for passive long-term investors to gain by switching from CA
to the underpriced RA and NR.

The 1870 Lowe conversion proposal is especially interesting, in that it produced more
commentary from other groups in society, and so several sections are devoted to it in [32].
Overall, gilts mispricing never became a big issue for the press, and never attracted much
attention other than from financial journalists, which is likely part of the reason it persisted
for as long as it did.

In the early part of the 19th century (before 1830, say), most references described rational
pricing as something to be expected, and as something that markets seldom deviated from. However, a couple of references mentioned gilts mispricings as frequent, possibly based on memory of earlier times. (This study is based on data from 1823 and later. Some non-systematic collections of prices from earlier periods, before 1815, do indicate that mispricings were common then.) The first substantial overpricing of CA, described in Section [4]
led to several news citations (brief ones, inside what was in those days very thin coverage of financial markets), all of which described it as abnormal, and bound to be eliminated soon (as it was, although only for a while). Later, as the mildly and intermittently irrational pricing continued for much of the 1830s and early 1840s, we find some more citations. They include an amusing demonstration of short memories among journalists and of the tendency of people to invent rationalizations for whatever happens in the market. In July 1839, after about a year of rational CA vs. RA pricing, CA overpricing reappeared. The *Spectator* was surprised by the anomaly, as it regarded rational pricing as the norm. But the anomaly persisted. When it vanished in October 1842, this paper was surprised again, as it had gotten used to the irrationality. It argued that since “all the speculative operations” were confined to CA, CA overpricing was normal. Then, when CA became overpriced yet again during the Railway Mania, the *Spectator* was surprised once more in April 1846, as it had again gotten used to rational pricing, and expected the anomaly to be quickly eliminated by arbitrage.

The Railway Mania, usually dated to 1844 through 1849, was associated with substantial gilts mispricings, and these led to considerable press coverage. (To some extent gilts were pushed to the background by the preoccupation with the more speculative railway investments, but this was more than counterbalanced by the large expansion of coverage of financial markets, and greater sophistication in financial analysis.) There were some notable press campaigns, including multi-year ones by the *Illustrated London News* and *Freeman’s Journal*, to persuade their readers to take advantage of the seemingly enticing arbitrage opportunities. Another long campaign against gilts mispricing was carried on by the *Economist* from late 1859 to late 1861.

By the late 1860s, it appears that there were fewer mentions of gilts pricing anomalies. To some extent this may have been due to gilts becoming less important, as the financial markets developed. But it may also reflect resignation, as the mispricing continued. One item, published in 1874, cited the mispricing and noted that it was “a standing Stock Exchange anomaly,” but that it could not “be too often pointed out to intending investors ..., or to those who hold [CA] and who wish to continue to hold [gilts]” as it was to their advantage to switch to RA and NR. But this was not pointed out too often. Financial editors may have decided that there was no point in annoying their readers by citing facts that were obvious to some, and were being ignored by others. (Possibly in a similar vein, modern newspapers don’t devote much space to the harms of smoking.)

11 Heterogeneous views and actions

19th century British gilts pricing anomalies are interesting for a variety of reasons, not least because they demonstrate a wide variety of views on the relative valuations of the major gilts, something that there should not have been any question about. The market produced an equilibrium that diverged from the unambiguously correct value. But we can discern some groups that appear to have had views different from the market consensus, and from the correct views. Unfortunately no opinions have been found so far of the people who held these views, so we do not know what motivated them.
In 1880, Parliament passed a law allowing customers of the Post Office Savings Bank to invest directly in gilts. From the start of operations of this new service on 22 November 1880 through 31 March 1881, customers made the investments shown in Table 2. Data is from the annual report of the Postmaster General[10].

Table 2. Post Office Savings Bank customer investments in gilts, 22 Nov. 1880 to 31 March 1881.

<table>
<thead>
<tr>
<th>gilt</th>
<th>number of investments</th>
<th>aggregate investments</th>
<th>average investment</th>
</tr>
</thead>
<tbody>
<tr>
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<td>£54.07</td>
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<td>RA</td>
<td>481</td>
<td>26,301</td>
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<tr>
<td>NR</td>
<td>3,291</td>
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<td>56.92</td>
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</tbody>
</table>

As was noted in Section [9] the average size of an account in the major gilts was around £3,000. The accounts represented in Table 2 on average were less than 2% of that. So they represented holdings of much poorer strata of the population. It is noteworthy that while the volume of CA was about twice that of NR, these investors put about as much money into the underpriced NR as into the overpriced CA. So in that sense they do show some rationality. But why the preference for NR over RA? It is unreasonable to expect anyone at that time to have been able to predict that Goschen in 1888 would offer holders of RA more than the holders of NR (even if only £0.25 more), but there did not seem to be any reason to regard RA as less desirable than NR. Market transactions and jobber quotes around 1880 were essentially identical for the two. So it seems that there was some popular prejudice against RA that we have not found any documentation on in the literature.

A group of even poorer investors showed even greater rationality. Friendly Societies, essentially mutual-help groups of the poor, had (in a small, but hopefully unbiased sample) 9 accounts containing a total of £3,592 of CA and 15 accounts with £13,883 of NR (and none with RA). (Details are in [32].) So here we again find the same puzzling bias against RA as among Post Office Savings Bank investors, but a greater bias towards the underpriced NR.

The supplementary manuscript [32] discusses the market in British gilts in Dublin in the late 1840s. It consisted primarily of NR and some CA, and there was apparently active arbitrage going on that kept the Dublin and London markets integrated, but not perfectly, since communication was slow. It appears that the Irish market was somewhat more rational than the London one, possibly assisted by the fact that gilts were quoted in Dublin without accrued interest, making comparisons easier.

The manuscript [32] has many sections devoted to gilts investments of a collection of organizations. They show a variety of behaviors, in no case fully rational. This includes the universities of Cambridge and Oxford, and a large life insurance company. Perhaps the
most interesting example is that of the Institution of Civil Engineers (ICE), the world’s oldest professional engineering organization. By the 1880s, it was not only large and professionally influential, but also quite prosperous. Further, its members were among the most sophisticated in financial matters outside those in finance itself, and the annual reports of the ICE were distributed to all members in the main publication of this organization. Those reports show some rationality, and generally what may have been a growth in rationality with time. However, there are also some strange moves (and use of strange language) that might lead one to think that all the major gilts were regarded as equivalent. The overall conclusion from the examples that have been studied is that even the most prestigious and most sophisticated organizations in Victorian Britain, which was then the world’s most advanced economy, were not fully rational in their financial behavior.

12 Causes of gilts mispricings

One voice that is almost completely missing from the opinions about gilts mispricings that have been found is that of economists. Aside from Giffen, none appear to have written about this phenomenon, even though it overlapped the careers of John Stuart Mill, Alfred Marshall, and many other significant thinkers. Were they oblivious to what was happening in the gilts markets, or did they suppress any mention of the anomalies as an inconvenient fact that clashed with their theories? Those might seem the obvious choices. However, a study of 19th century thought shows that the British elite regarded investors as frequently irrational, and markets as often inefficient. So it is more likely that the political economists of that era shared this view, and so regarded gilts mispricings as just one of many market imperfections, not worthy of special notice. But this is a supposition, and it would be valuable to find some solid information.

Giffen in 1877 clearly thought that CA overpricing was irrational ([13], p. 95). He described it in a section on market anomalies, following a passage in which he ascribed what he thought was an excessive price of Bank of England shares to the prestige that ownership of them brought. He was explicit in saying he had asked around. (Until shortly before writing that passage, he had been in a perfect position to inquire, as the financial editor of the Economist.) Several other observers have been found in the 19th century who explicitly attributed gilts mispricing to investor irrationality. The most thoughtful of those was a writer of a piece in the Leeds Mercury in 1876. That person concluded that a likely contributor to CA overpricing was the irrational prestige attached to the word “Consols” [11]. That is a possible contributor. The supplementary manuscript [32] has a discussion of some indications that as the 19th century progressed, Consols was named with increasing frequency, even when any of the major gilts was meant. However, that does not explain what appeared to be frequent CA overpricing episodes before 1823. Nor does it explain the occasional RA overpricings, such as that of mid-1787 that is documented in the tables. It also does not explain the frequent mispricings of the minor gilts. Thus we are left with the prospect that gilts prices were influenced to a substantial extent by various rumors and opinions, diffusing in the strange ways that modern research on social networks, communication dynamics, information diffusion, ..., is beginning to elucidate.
13 Conclusions

Far more work is called for on 19th century gilts pricing. The research documented here has just scratched the surface. Complete price records of gilts (and other securities, for comparative purposes) are needed, both realized prices and quotes, to map the patterns of mispricings. Far more intensive searches should be made of various contemporary sources, printed or not, to find out how various people thought about this phenomenon.

But we can already draw some conclusions, beyond adding to the literature what seem to be the most striking counterexamples known to the Efficient Markets Hypothesis and the Law of One Price. Starting from the most concrete, to the five pitfalls identified by Klovland in his work on the estimation of the yield on CA [20], we can add a sixth, namely that CA is not sufficient to give a complete picture of risk-free long-term interest rates. Other gilts (primarily RA) are in principle just as valid, and produce different answers. The effect is not very large, just a couple of basis points, but it is comparable to some of the adjustments that have been made by Klovland and other investigators in earlier studies.

Next, various studies that assume market rationality in pricing of government bonds (such as [1][20], to cite just two that rely on data about gilts in the 19th century) should be reconsidered. The irrational relative pricing of CA and RA means that we cannot assume the existence of a well-defined term structure of interest rates, for example. More generally, the presence of long-term pricing anomalies among the most important financial instruments of the 19th century adds weight to the findings of modern behavioral finance in suggesting there is far less rationality in the markets than is often assumed. It is easy to dismiss CA overpricing in the 1831–87 period as irrelevant, due to the lack of sophistication of investors during the early formative period of corporate capitalism. But that attitude is questionable. Sophistication is a relative term. It is not clear that modern investors, faced with far more complicated choices (often deliberately obfuscated) than those faced by gilts investors in the 19th century, are making better decisions. Much of what is explained away as result of rational investors operating on imperfect information may well be the result of the whims of crowd psychology.

Notes

1 Figures for GDP come from [25], and are at current market prices. The data for total national debt, and volumes of major gilts are taken from Parliamentary Papers such as 1850 (169) XXXIII.1, and represent the nominal value, not the market value, of each. National debt given is the sum of the funded and unfunded components. The terminology used here is rather loose, in that figures that are cited as describing the British economy and debt actually cover all of the UK, which included all of Ireland in the 19th century.


3 Table on p. 291 of the 5th edition, published in 1855, of [29]. There is a mistake in addition in that table, as the total of the entries comes to £1,295.514 million, not 1,035.514.
See, for example *The Times*, 11 March 1844, p. 5.


No evidence has been found that he said this exactly, although there are some authenticated quotes by Keynes that are similar, see [10].

For example, *Morning Chronicle* of 3 June 1853, p. 7, claimed over two thirds of all property was “of a fiduciary nature.”

Financial (“money market”) column, *Spectator*, 27 July 1839, p. 702; 22 October 1842, p. 1017; 11 April 1846, p. 346. Quotes from those columns about CA overpricing are presented in [32].

*Financier*, 2 June 1874, p. 3, reprinted in an abbreviated form in *Leeds Mercury*, 2 June 1874, p. 4. A fuller quote is in [32].

*Parliamentary Papers* 1881 [C.3006] XXIX.583, p. 27. There were also some liquidations, which are not shown in this table. The next few reports in this series do give the total amount invested by customers in gilts, but without providing separate figures for CA, RA, and NR, so they provide no useful information for us. However, a later report provides circumstantial evidence that the balance of investments did not change until the Goschen conversion. See [32] for details.

*Leeds Mercury*, 26 July 1876, p. 4. That passage is reprinted in [32], which has references to the other quotes with irrationality conclusions.

References


British gilts irrationalities

41. R. W. Wade, *The Stock-holder’s Assistant. Containing a Table Shewing the Proportional Prices Which the Different Funds Should Bear to Each Other, and ...,* H. D. Steel, 1806.