Bidding and Information:

Evidence from Gilt-Edged Auctions

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Abstract

Many studies have shown that government debt auctions underprice debt compared with the secondary market. This paper corroborates this for certain forms of gilt auction by comparing the price received at auction with an almost identical parent stock in the secondary market. Although the sample is small, the parent/tranche price comparison gives a cleaner measure than used in other studies. The paper also compares non-fungible auctions (where the tranche differs slightly from the parent at auction and merges subsequently) with fully-fungible ones (where they are identical throughout). Significant underpricing only occurs in non-fungible auctions.

I. Introduction

The empirical study of auctions provides researchers with a good opportunity to test the predictions of economic theory in an environment that is relatively uncontaminated by external influences. Research on government debt auctions can also usefully inform practical decisions on the design of improved auction rules. For example, the US Treasury has experimented with alternative auction techniques (Reinhart (1992), Malvey, Archibald and Flynn (1995)). These two factors have made using the results of government debt auctions to test the predictions of auction theory an important area for study. Most of these studies - Cammack (1991), Umlauf (1993), for example - have found that the predictions of auction theory appear to be borne out in results from debt auctions.

However, one puzzle which has arisen from the growing body of empirical evidence on government debt auctions is the existence of predictable auction effects (particularly underpricing of the auction security relative to the secondary market), even when the degree of price discovery in the auction itself may appear to be small. In particular, it seems difficult to rationalise downward-biasing in the auction price due to information effects if there is already an active secondary market for the security in question or if a when-issued market has been in operation prior to the auction.

This paper investigates pricing at UK gilt auctions in the light of the behaviour of both the when-issued market and a comparable secondary market security. It is organised as follows. Section II describes institutional aspects of the primary market for UK government debt. Section III outlines some theoretical interpretations of underpricing, section IV presents a selection of empirical definitions, and section V presents measures of underpricing for UK gilts and tests for their statistical significance. Section VI investigates the determinants of underpricing and section VII concludes.

II. The primary market for gilt-edged securities

Taps, tenders and auctions

The Bank of England uses a range of methods to sell gilt-edged securities.[1] Selling methods are of two broad types, tap sales and public offers. Tap issues occur when the Bank of England makes relatively small amounts of gilts available for sale direct to Gilt-Edged Market Makers (GEMMs). Taps have been of two forms: small "tranchettes" typically up to £500 million which are fully fungible immediately with an existing stock in the secondary market, or, more rarely, larger "tranches" of stock which may not be fully fungible until the first dividend date owing to part payments or differences in accrued interest.[2]

Public offers are made either by tender or, more commonly, by auction. At a "tender" (last used in 1991) the Bank invites bids and if these are sufficient to sell the stock above a stated minimum price the Bank issues stock to all successful bidders at the lowest accepted bid price (the "allotment" price). This is a form of single-price auction.[3] "Gilt-edged auctions" were held for the first time, and on an experimental basis, in 1987 and 1988 as a result of structural reforms which "had created a more favourable climate for auctions by increasing the number and capitalisation of firms at the centre of the gilt market".[4] Thereafter one further auction was held, in August 1988, before the Bank began a series of reverse

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[1] See Chapter 5 of *British Government Securities*, Bank of England, 1993 for full details.

[2] Taps are described in more detail in Matthews (1995).

[3] See Feldman and Mehra (1993) for a comprehensive overview of the principal auction formats.

[4] See "The experimental series of gilt-edged auctions", *Bank of England Quarterly Bulletin*, May, 1988.

auctions, buying in stocks from the market, during the period of government financial surplus. The government returned to net funding in April 1991 when the current series of auctions began.

Gilt-edged auctions, which are now the primary means of gilt sales, are bid-price auctions with no minimum price (though the *Report of the Debt Management Review* has indicated the possibility of experimental common-price auctions being held in future[5]). Applicants may make either competitive or non-competitive sealed bids for a £500,000 minimum or maximum respectively. Competitive bids (made in multiples of £100,000) are allocated from the top down at the price bid until supply is exhausted. Non-competitive bids are allotted at the weighted average price of successful competitive bids.

Chronology of a gilt-edged auction

For the auctions analysed in this paper the chronology of an auction was as follows (these auctions occurred prior to the introduction of a maturity schedule in 1995/96). A general indication of funding plans was given in a Bank Press Notice each March.[6] This outlined the general principles underlying funding policy in the coming financial year and gave some details on the operation of auctions and taps. More specifically in 1993/94 and 1994/95 it indicated auctions would be held at broadly monthly intervals - usually on the last Wednesday of the month - and would be for £2 billion to £4 billion of stock. Details of each auction were announced only a few days in advance. The first announcement, which was usually not less than 10 calendar days before the auction, gave the date of the auction and an

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[5]See HM Treasury and the Bank of England, *Report of the Debt Management Review*, July 1995.

[6] See "Gilt-edged funding operations in 1994/95", Bank of England Press Notice, 17 March 1994.

indication of the maturity range of the stock to be offered.[7] The second announcement was made not less than 7 days before the auction and gave full details including the coupon, the amount of stock on offer and the exact maturity. When-issued (WI) trading, for delivery of the auction stock on the first business day after the auction, began immediately after the second announcement and ended at close of business ("cob") on auction day. Thereafter, secondary market trading began in the auction stock.

Our sample is made up of all conventional auctions between May 1987 and February 1995 (ie it excludes convertible and floating rate gilts). Of this sample, 12 were new issues (ie issues of a new gilt) and 19 were further tranches of an existing stock. This study concentrates on the auctions of further tranches as these offer a simple comparison of primary and secondary market prices. Before April 1994, the stock being auctioned (the tranche) differed from the existing gilt (the parent) for one or both of two reasons. First, the size of the first dividend differed to allow for the shorter period of existence of the tranche. Second, the tranche was often issued partly paid, so that successful bidders did not pay the full price of the stock on auction day but in a number of instalments. In the latter part of our sample, between April 1994 and February 1995 further tranches of existing stock were issued in fully fungible form (ie identical to the parent in all respects) following technical changes which made this possible. These differences are described in more detail in section IV. The evolution of trading in the auction stock - through when-issued, primary and secondary markets - is summarised in Chart 1.

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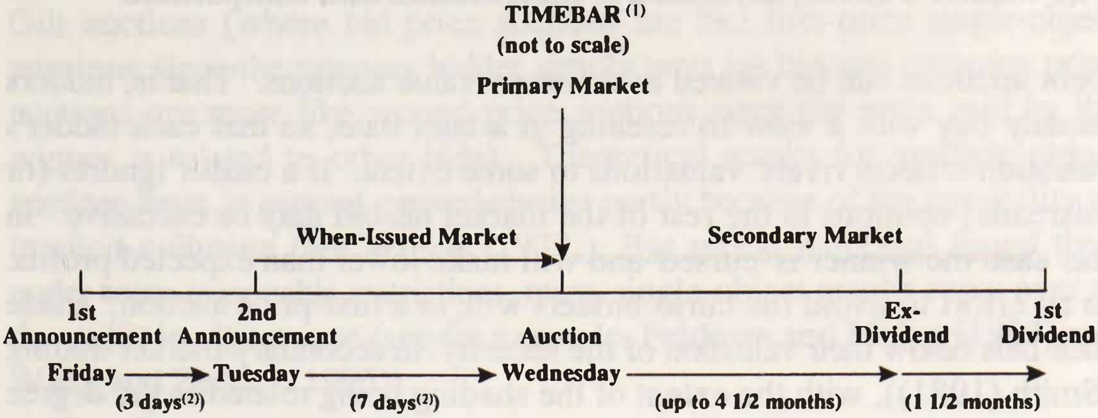
[7] The timing of the first announcement has changed a number of times. Before March 1991 it was at least a month before the auction (though it was less informative) while between March 1991 and March 1993 it was a full week before the second announcement.

Chart 1:

Chronology of a gilt-edged auction



(1) All timings are approximate.
(2) Business days.

Bids for the auction can be submitted to the Bank as soon as the full auction details have been announced, but the majority of competitive bids arrive between 9.45 am and 10 am on the auction day itself. Over that quarter-hour period competitive bidders can submit up to 6 bids each. Bids are not accepted after 10 am and the result of the auction is usually announced about 45 minutes later. The when-issued market continues trading right up to cob on the day of the auction since stock is not due for delivery until the next trading day.

III. Determinants of pricing

This section examines the factors which may determine the relation between primary and secondary market prices.

The winner's curse, asymmetric information and competition

Debt auctions can be viewed as common-value auctions. That is, bidders usually buy with a view to reselling at a later date, so that each bidder's valuation reflects rivals' valuations to some extent. If a bidder ignores (or misreads) opinions in the rest of the market his bid may be excessive. In this case the winner is 'cursed' and will make lower than expected profits. In an effort to avoid the curse bidders will, in a first-price auction,[8] shade their bids below their valuation of the security in secondary market trading (Smith (1981)), with the extent of the shading being related to the degree of information asymmetry amongst bidders. Thus, in a single-object auction, the expected profit from winning an auction, Π_1, depends on the expected value of the object, $\tilde{v}$, less the awarded price, b_1, conditional on winning the auction. That is, bidder 1's objective is to maximise:

$$\Pi_1 = E\left[\tilde{v} - b_1 \middle| b_1 > b_i \forall i\right] \quad \textbf{(1)}$$

by choosing b_1 (where i is an index defining the other bidders). In a first-price auction, a high bid lowers the profit from victory, but raises the probability of winning. The strategic bidder faces a trade off between the two: for example he may reduce the bid relative to $\tilde{v}$, in order to profit

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[8] A first price auction is one where the price paid by the winning bidder is simply the highest bid he is prepared to make. A second-price auction is one where the winning bid need only be as high as the valuation of the second highest bidder (since the auction stops when there is only one bidder left). A standard ascending price English auction is a second-price auction since the winning bidder need only bid enough to beat the second highest bidder.

more from winning but accept a lower probability of winning (Reinhart (1992)). As the degree of information asymmetry rises, bids will become increasingly biased downwards relative to the bidders' valuation (Reece (1978), Milgrom and Weber (1982)). It should be noted that most results in the literature apply to single object auctions not multiple object cases like Gilt auctions (where bid price auctions are like first-price single-object auctions since the winning bidder simply pays his bid and common price auctions are more like second-price auctions since the price paid by the winner is related to other bids). Theoretical results for multiple object auctions have, in general, proved elusive partly because of the possibility of implicit collusion (see Wilson (1977)). But recent work has found that, under some reasonable restrictions, many single-object results carry over to the multiple-object case (see for example, Feldman and Mehra (1993) and Wang and Zender (1995)).

However, in the case of UK government debt auctions, the assumption of information asymmetry is questionable. There are two relevant sources of information that should mean that bidders enter the auction with a good, if not complete, knowledge of the market value of the security. The first indicator of value is the secondary market price of the outstanding issue. The auction stock is often a further tranche of an existing stock allowing a direct comparison of the two (after making the adjustments outlined below). The second indicator is the price of the auction stock in the when-issued market which allows an even more direct comparison (see Nyborg and Sundaresan (1995) for US evidence on the role of the when-issued market). But Cammack (1991) argues that even the existence of a secondary market for the auction security may not reveal all the information relevant to pricing. She argues that there is imperfect information in the secondary market (following the argument of Grossman and Stiglitz (1980)) and so bidders may wait to reveal new information in the auction because of the higher returns to information at that time. This leads to information asymmetries at the auction and so a potential winner's curse.

Liquidity, inventory and risk

Although information effects are the most commonly cited reason for downward biasing of the auction price there are a number of other possible explanations that do not rely on these. One possibility is liquidity effects. For example, Amihud and Mendelson (1991) show that the price of US Treasury Bills and Notes rises with increases in their liquidity. The usual distinction made in the US is between on-the-run and off-the-run vintages of bills, the latter being much more thinly traded than the former. A possible analogy in the UK can be found in stocks with benchmark maturities (eg five and ten years) which may trade at a higher price than similar non-benchmark stocks. Such an effect may cause an auction to appear to underprice a security simply because the non-fungible auction stock is less liquid than the comparable secondary market issue until they merge.

A number of additional price effects can be traced to inventories. Risk-averse bidders may cut their bids relative to their true valuation simply to restrain inventory growth (Spindt and Hoffmeister (1988)) or may in fact bid more aggressively due to the possibility of a short squeeze (Nyborg and Sundaresan (1995)). Spindt and Stolz (1992) suggest underpricing relative to the secondary market can be characterised in terms of bidder profits: in short, bidders provide services to retail and wholesale investors and can reasonably expect to be compensated for the risk involved. GEMMs will typically enter the auction with a short position acquired through when-issued trading and face the risk that they may be unable to acquire the stock they require to cover their position. They also face the risk that the market price may move against them in the 45 minutes between the time they bid and the time the stock allocation is known. These short positions may represent a material proportion of their allocated capital.

IV. Empirical definitions of pricing relative to secondary market prices

Although there have been well over 30 gilt auctions since May 1987 this section focuses on pricing of two subsets; the 13 non-experimental, non-fungible and 4 fully fungible auctions that were a further tranche of an existing gilt. This allows a direct comparison of successful bids at auction with comparable secondary market prices.

Adjustments to the auction price

As noted in section II, the price of the auction stock and the parent stock were not directly comparable before April 1994 for two reasons:

1) Auction stocks were generally issued partly paid. A partly-paid issue means that the purchaser pays only a proportion of the value of the auction stock on settlement day with further calls for payment at later dates.

2) Auction stocks tended to have different dividend characteristics. As dividends are paid biannually, an auction less than six months before the next dividend will reduce the total accrued interest on the tranche, as will part payments (since initially interest accrues on a smaller principal).

To adjust for these effects, it is necessary to allow for the discounted value of the calls for payment and for the effect the calls have on the value of the first dividend. The formula used to adjust for auction stocks that are partly paid and pay their first coupon on the same day as the parent stock is:

$$P_t = P_t^T + (div^P v_t^P - div^T v_t^T) + \sum_{i=1}^{k} C^i v_t^i + (ai_t^T - ai_t^P) \tag{2}$$

P_t = Adjusted tranche price (comparable with clean price of parent) on day t.
P_t^T = Clean price of tranche (trading price net of accrued interest).
div^P = Biannual dividend on parent; v_t^P is its discount rate.[9]
div^T = First dividend on tranche; v_t^T is its discount rate.
C^i = Value of ith call; v_t^i is its discount rate.
ai_t^P = Accrued interest on parent.
ai_t^T = Accrued interest on tranche.

Where a stock was issued within 100 calendar days of a dividend date for the parent stock, no dividend was normally paid on that date, the amount was instead carried over to the next dividend date. In this case the discounted value of this extra dividend was also included in the adjustment:

$$P_t = eqn(1) + div^{P'} v_t^{P'} \qquad \textbf{(3)}$$

$div^{P'}$ = Next dividend on parent (usually standard biannual dividend); $v_t^{P'}$ its discount rate.

Using the adjustments in either equations **(2)** or **(3)** it is possible to compare the price of the auction stock and the parent stock directly, even for auction stocks that are not fully fungible.

V. Results

In our sample, WI trading began eight calendar days before the auction around cob on the second announcement day (Tuesday) and continued until cob on auction day. Chart 2 compares cob secondary market prices of an adjusted parent stock with cob WI prices in trading averaged over the 13

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[9] In all cases the discount rate (v) is LIBID with linear interpolations between observed rates. We also experimented with LIBOR which made no noticeable difference to the results (Treasury Bill rates would not be appropriate given their eligibility premium. See Schnadt (1994)) .

non-fungible auctions (August 1988 to February 1994 inclusive[10]). Initially, the tranche trades at a premium to the secondary market, which peaks on average at 5.4p per £100 at cob on the second day of WI trading. But subsequently the premium becomes a discount as the tranche is marked down relative to the parent in growing anticipation of the auction. The discount in the when-issued market reaches 10.6p per £100 at 10 am on auction day, close to the discount of 12.8p at the Highest accepted bid at auction (see "HAP" in Chart 2). The average accepted bid (AVP) is then 23.9p below the parent. This gives a measure of the difference between seller revenue in the primary market and the prevailing secondary market price. The lowest accepted bid (LAP) is 34.7p below the parent. Chart 2 suggests the pattern of the average parent/tranche price differential is fairly systematic. There is some cross-section variation around this average differential. On auction day, for example, the data suggest the differential at individual auctions could be up to three ticks either side of the average differential at non-fungible auctions (one tick is 1/32 of a £). At other times, for example the day details of the auction stock are announced, the dispersion around the average differential can be larger (possibly up to 4 or 5 ticks either side of the average).

After the auction, the difference between parent and tranche prices persists for some time, declining gradually as the ex-dividend date approaches when the two stocks merge (Chart 3). Since the tranche prices have been adjusted for part payments, differences in dividends etc, it is not clear what might explain a difference between parent and tranche prices after auction. Some difference between the stocks is retained in the eyes of market participants, perhaps relating to their relative liquidity or tax effects (part payment may influence the coupon/capital gain split of returns and thus slightly alter the tax properties of the gilt).

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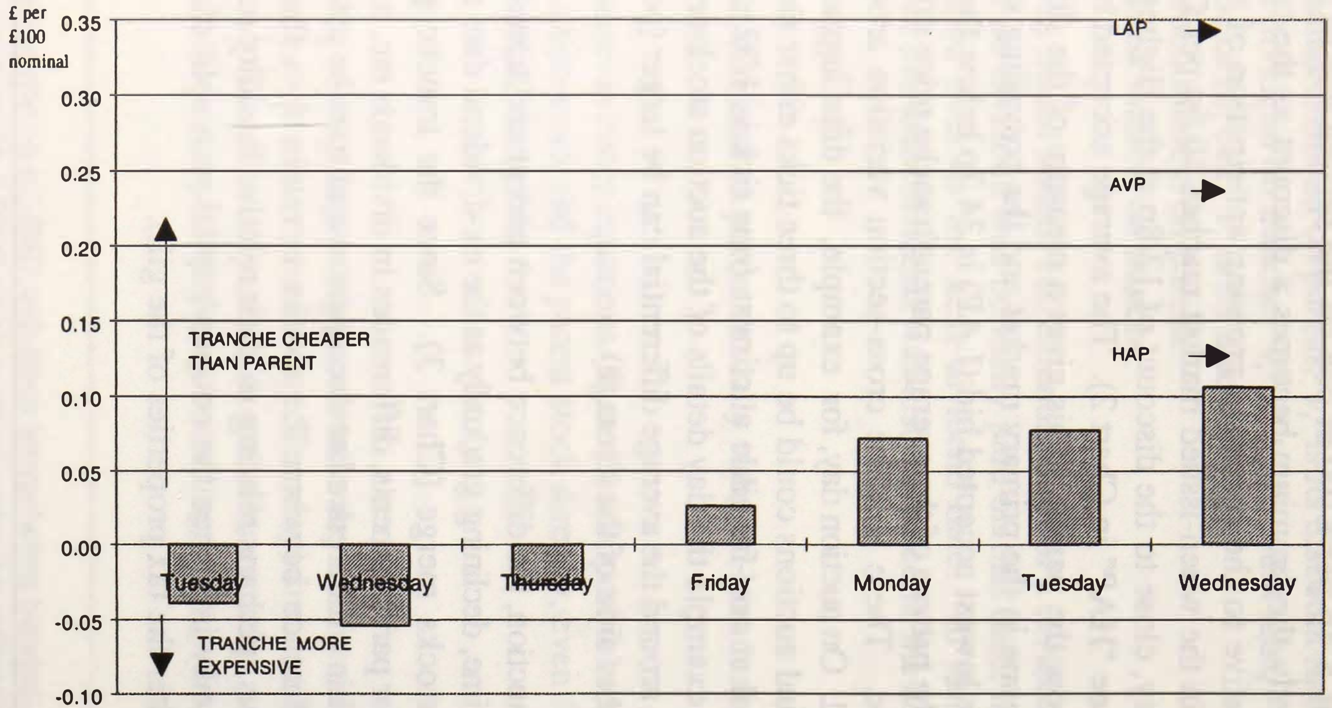
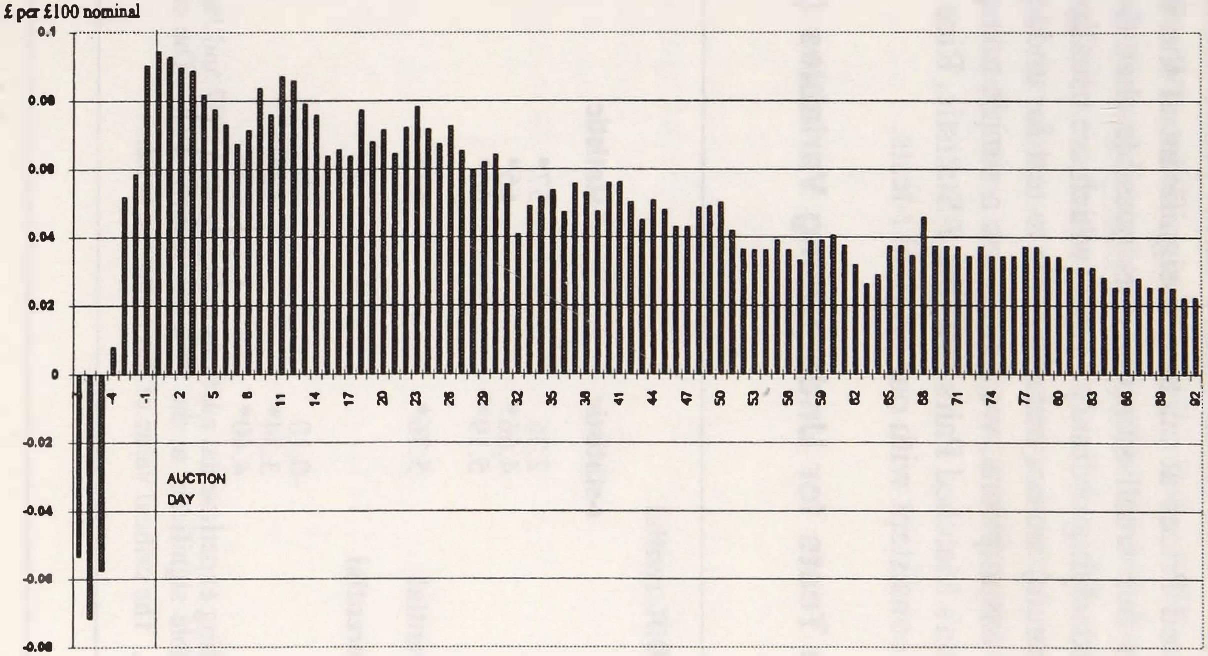
[10] The experimental auctions in September 1987 and January 1988 have been excluded to remove outlying observations. The resulting "average" auction is typical of the individual auctions.

Chart 2:Parent/tranche comparison. WI period and auction: non-fungible stocks



Notes: 1) Columns indicate average parent price minus average tranche price at cob (10am on auction day).
2) Arrows indicate average parent price at 10am auction day minus lowest, average and highest accepted bid at auction.

Chart 3: Parent/tranche price differential pre- and post-auction (non-fungible auctions)



Notes: 1) Positive figures indicate tranche cheaper than parent.
2) Pre-auction tranche prices = cob WI prices, post auction tranche prices = cob secondary market prices.

Table 1 presents the results of significance tests for each definition of the price differential at the Highest, Average and Lowest accepted auction prices and at 10 am in the WI market. It is clear from the *t*-statistics that the difference between 10 am secondary market prices and the Average and Lowest Accepted Prices at auction is significant at the 95% probability level.[11] Given our small sample, it is possible that the distributional assumptions underlying ordinary *t*-tests (which are usually justified by the central limit theorem) are not met. In order to test for underpricing without implying these assumptions, we undertook a simple non-parametric test, namely Wilcoxon's Matched Pairs test (the *J*-Statistic, Rice (1988)).[12] The *J*-statistics are consistent with our original *t*-tests.

Table 1
Significance Tests for Underpricing Variables (non-fungible auctions)

	t-statistic	*J*-statistic
Parent Tranche Differential		
HAP	2.36	57*
AVP	4.66*	66*
LAP	5.19*	66*
Parent WI differential	5.76*	67*
WI Tranche differential		
HAP	-0.10	40
AVP	3.34*	62*
LAP	4.40*	66*

Notes: (1) Excluding experimental auctions in September 1987 and January 1988
* denotes a variable significant at the 95% probability level: The critical value of the *t*-statistic is 2.634. The critical value of the *J*-statistic is 52.

[11] The differential at the Highest Accepted Price is statistically significant at the 90% level.

[12] The test simply requires that the pairs are independent of one another. We have tested for this and can find no evidence of dependence.

Chart 4 shows a similar WI and auction comparison for the four fully-fungible auctions (between April 1994 and February 1995). These results are in sharp contrast to those for the earlier auctions. The WI price hardly deviates from the comparable parent price and the bids themselves are much closer to both the WI and the parent (LAP = 9.4p, AVP = 0.02p and HAP = -11.7p).[13] What is surprising however, is that the bid dispersion for fully-fungible auctions (21p) is similar to that of non-fungible ones (21.9p). One might expect that the existence of a completely identical parent stock would mean that bids would come in at or very near to that price.

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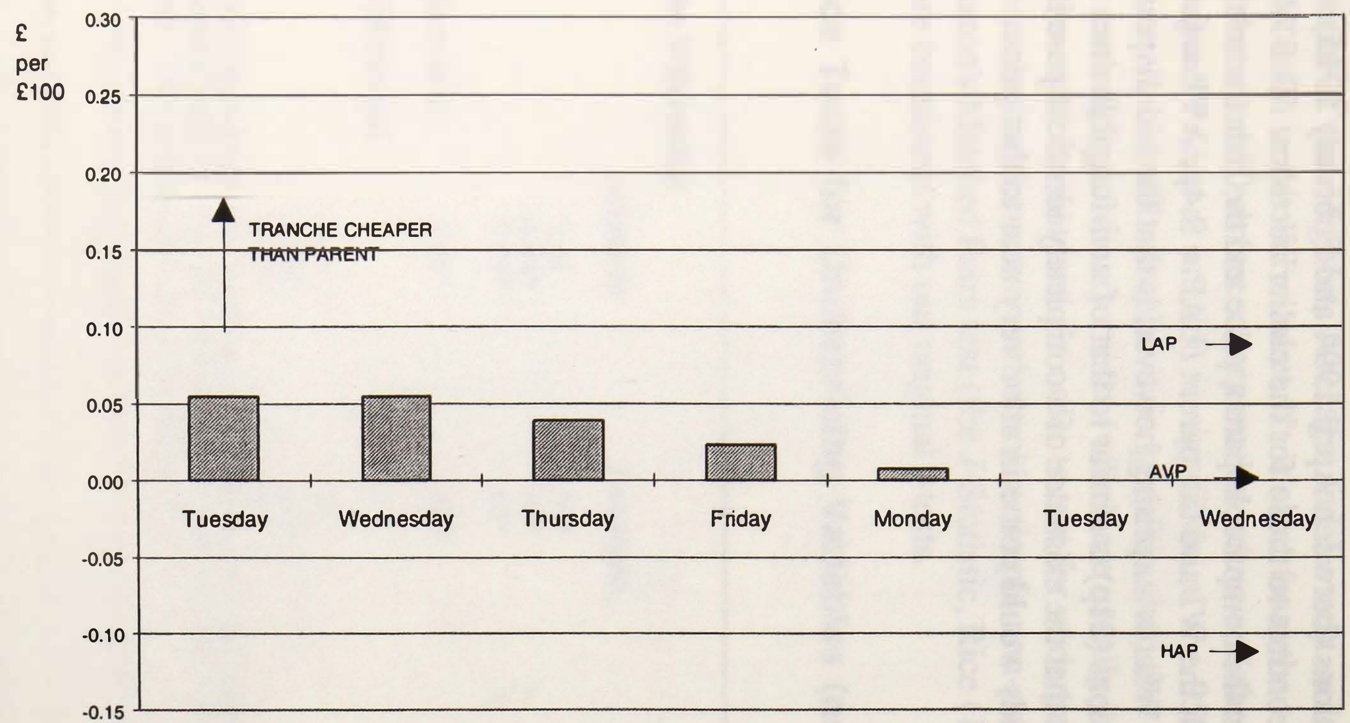
[13] The fact that the WI-bid comparison also changes substantially suggests that the change in parent-WI results are not simply due to errors in our parent adjustment for earlier auctions.

Chart 4: Parent/tranche price comparison for fully-fungible stocks



Notes 1) Positive values indicate tranche cheaper than parent.
2) Columns indicate cob WI prices, arrows indicate lowest, average and highest accepted bid at auction.

Given the results of Table 1 above, it follows that fully-fungible auctions give significantly different results from the previous auction format since they have either resulted in no underpricing relative to the average accepted bid (on two occasions) or only a very small degree of divergence.

VI. The determinants of pricing in non-fungible auctions

The comparison shows a material difference between fully-fungible and non-fungible auctions, but what aspect of this difference is responsible for the difference in bidder behaviour? In order to establish what factors may have played a role in the underpricing of non-fungible auctions we examined a selection of variables that may proxy some of the effects described in section III and tested if they were significantly correlated with the extent of underpricing. These factors can loosely be classified as measures of information dispersion or risk and liquidity (both of the parent and of the tranche). Using these measures we tested for statistically significant correlations with the parent/tranche differential and the parent/WI differential for 13 auctions and the WI/tranche differential for 25 auctions.[14]

It should be noted the sample size used in the tests below is relatively small and so the results are suggestive rather than definitive; for this reason, only simple correlations were used rather than a full model. [15] Also, some of the data are proxies for unobservable variables. The tail for example is a proxy for the distribution of information. It does not literally measure this, and so, even in a larger sample, the tests could only be illustrative.

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[14] The experimental auctions in September 1987 and January 1988 have been excluded.

[15] Spindt and Stolz (1992) analysed the secondary/primary market spread for US T bills between 1982 and 1988. They found that cover, tail, inventories, commitments from WI trading and the cost of carry were significant determinants of this spread.

Table 2
Correlation Coefficients for the Pricing Differential[1]

Parent Tranche Differential

(excludes fully-fungible and experimental auctions)

Price differential	Parent/HAP	Parent/AVP	Parent/LAP	Parent/WI	WI/AVP[2]
Information Dispersion/Risk					
TAIL	0.16	0.23	0.73*	0.29	0.20
VOLGT	-0.22	0.09	0.13	0.02	0.02
TURN	0.88*	0.79*	0.57*	0.80*	0.28
VOLST	0.28	0.09	0.31	0.23	0.26
Liquidity of Parent					
DEL	0.07	0.06	0.13	-0.23	0.35
BENCH	-0.79*	-0.81*	-0.62*	-0.58*	-0.33
STOCK	0.13	0.08	0.36	0.45	-0.46
Liquidity of Tranche					
QUANTITY	0.18	-0.06	0.21	0.37	-0.32
Other					
COVER	0.14	0.02	-0.27	-0.18	0.23
MATUR	-0.47	-0.42	-0.35	-0.40	-0.23

* denotes a statistically significant correlation at the 95% probability level.

(1)Parent/ HAP/ AVP/ LAP/10am WI = the price differential between the secondary market price of an identical parent stock and the highest/average/lowest accepted prices at auction/the 10am price in the when-issued market.
(2) Estimated using larger sample, (ie includes auctions with no parent stock).
TAIL = average accepted price less lowest accepted auction price.
VOLGT = implied volatility from the at-the-money option on the long-gilt futures contract.

Table 2 continued overleaf

Table 2 continued

TURN[16] = number of purchases plus sales (turnover) in a maturity band which includes the auction tranche on auction day. The maturity bands are: (1) up to 5 years; (2) 6-10 years; (3) 10+ years.
VOLST = implied volatility from the at-the-money option on the short-sterling futures contract.
DEL = a 0,1 dummy variable indicating whether auction tranche is deliverable (at auction time) into the short/medium/long gilt futures contract.
BENCH = a 0,1 dummy variable indicating whether the auction tranche will begin trading as a benchmark.
STOCK = nominal amount (£mns) of parent stock outstanding on auction day.
QUANTITY = size of auction tranche in £bns.
COVER = ratio of value of bids to amount of stock on offer at auction.
MATUR = maturity of the auction tranche in years.

Because both information dispersion and liquidity are unobservable the results cannot be conclusive. Subject to that, Table 2 suggests that measures of information dispersion show the strongest link with auction underpricing. This is consistent with auction theory, but could equally well be due to other factors such as risk aversion (higher dispersion may increase risk). Of the measures of liquidity, only benchmark status has a strong effect. This effect, however, is not consistent with a liquidity premium effect since this would predict that a highly liquid parent should trade at a greater premium to the tranche. The benchmark effect is more in line with Cammack's (1991) version of the auction theory approach, since a highly liquid parent stock reduces the possibility of new information being 'saved up' for the auction. Other results, not reported, indicate that the size of the parent relative to the tranche and the time until the two stocks merge were not significant determinants of the pricing differential. Overall, these results suggest that liquidity is not an important factor.

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[16] A number of studies have shown a strong link between measures of turnover and asset price volatility/information arrival (see for example Karpoff(1987)) and since this measure is based on turnover within a maturity band it is unlikely to be related to the liquidity of the auction stock.

Many studies of bond auctions look at yield comparisons rather than price. In this study we have used price mainly because the bids in the auction are submitted in price terms. Given the range of maturities looked at in the study, however, the choice between yield or price can be important, so as an additional check we looked at the correlation between maturity and the price differential. As Table 2 shows, the maturity correlation is insignificant although it is consistent with the predicted effect.

As a way of getting some feel for the interaction of the variables analysed in Table 2, we ran simple regressions including maturity and the variables that had significant correlations (TAIL, TURN and BENCH) on the parent/AVP differential (13 observations) and the WI/AVP differential (25 observations). Results of these two regressions are reported in Table 3.

Table 3
Regressions for the Pricing Differential (*t*-statistics in brackets)

Parent Tranche Differential

	Dependent Variable			
Independent Variable	**Parent/AVP**		**WI/AVP**	
Constant	0.46	(5.1)*	0.09	(1.8)
TAIL	0.17	(0.8)	0.15	(1.0)
TURN	-	(0.3)	0.03	(1.0)
BENCH	-	(-3.9)*	-	(-1.5)
MATUR	-0.0	(-1.2)	-0.0	(-0.5)

* Significant at the 5% level

Clearly, the usefulness of these regressions are severely restricted by the limited degrees of freedom. However, given that qualification, the Parent/AVP regression indicates that Benchmark status is the most important and appears to dominate turnover. The significant constant confirms the finding of significant underpricing. Although the WI/AVP regression (based on a larger sample which includes issues without a parent stock) seems to indicate that all the variables in the regression have similar - low - explantory power.

Post Auction Effects

Table 2 suggests that measures of information dispersion show the strongest link with auction underpricing. This is consistent with underpricing in non-fungible auctions being due to asymmetric information but could equally well be due to other factors such as risk aversion being important. An alternative test of the asymmetric information hypothesis is to study the effect of auction results on the secondary market price. For asymmetric information to be important new information must be revealed in the auction that is not contained in the secondary market price of the parent. This implies that the secondary market price may react to the auction result. Table 4 shows the correlation between selected auction variables and the change in the secondary market price of the parent stock between 10am auction day and cob auction day (based only on non-fungible auctions - unfortunately the sample of fungible auctions is currently too small to undertake a similar test). This may give some indication of the effect of the auction on the secondary market, though it relies on the market having no prior view as to the likely outcome of the auction (ie that deviations from average auction results are unanticipated).

Table 4: Post Auction Effect of auction results for non-fungible auctions

Correlation coefficient for change in secondary market price between 10am and cob auction day and selected auction variables (excluding experimental auctions)

	Correlation Coefficient	Regression Coefficient (t-statistics in brackets)
COVER	-0.16	0.17 (0.7)
TAIL	0.02	0.23 (0.2)
Parent/AVP differential	0.21	2.77 (2.4)
WI/AVP differential	0.26	-2.89 (-1.4)

Table 4 shows that the results for the two published auction variables, cover and tail, do not accord with the information asymmetry hypothesis (one would expect a positive correlation with cover and a negative correlation with tail). The two underpricing variables do have quite a strong (though not significant) correlation, though the results of the regression indicate that it is the Parent/WI differential that seems to influence price post auction (given equal and opposite coefficients on the two differentials used). This is surprising not only because it suggests that a large differential leads to a price increase but also because the evolution of the Parent/WI differential is not directly related to the auction result.[17]

Another, less direct test of the asymmetric information hypothesis is to examine the relative size of price movements over auction periods relative to other periods. If more information is revealed in the auction period one might expect price changes to be larger over that period compared with others. This second test is weaker than the direct comparison in Table 4, but allows for the possibility that unobserved information is passed to the secondary market from the auction (again we focused on non-fungible auctions because the sample of fungible auctions was too small).

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[17] It should also be noted that none of these variables is correlated with price movements prior to the auction.

Table 5: Average absolute price changes for non-fungible auctions

	inc. experimental	exc. experimental
15 day period before auction	0.24	0.25
WI period	0.27	0.29
Auction Day	0.27	0.35
Week after auction	0.32	0.36
50 day period after auction	0.31	0.35

The results in Table 5 are not consistent with the view that information revealed at the auction induces greater price volatility on the auction day. But it is possible that the choice of auction date is made such as to coincide with what is generally a period of limited public information arrival[18] so that reduced total volatility is consistent with increased private information release. The dramatic increase in price volatility after the auction may be consistent with this view.

[18] However, regular official UK data releases are mainly in the third week of the month, shortly before the auction.

VII. Conclusion

UK government debt auctions appear to provide one of the best means of testing hypotheses concerning auctions. This is because the existence of a parent stock in many auctions gives a better measure of "true" value than most other measures. In particular, the use of when-issued prices common in US studies may lead to incorrect inference because of the interaction between the WI market and the auction. (Nyborg and Sundaresan (1995) find evidence of such interaction and suggest some ways to combat the problem.) However, our results for UK auctions seem to raise as many questions as they answer.

For non-fungible auctions (auctions where the tranche trades on a slightly different basis from the parent for a period after the auction) we get the standard result found in other studies with the auction stock being underpriced relative both to the parent and the when-issued price and there being some evidence that the extent of that underpricing is related to measures of information dispersion. However, other results for non-fungible auctions seem puzzling; first, when-issued prices can deviate substantially from the parent (starting off above the parent but then falling significantly below as auction day approaches). Second, the parent and tranche continue to trade at significantly different prices after the auction. Third, there seems to be little information revealed in the auction itself, and price volatility is higher after the auction than both before auction day and on auction day itself.

The Bank introduced fully-fungible auctions (where the parent and the tranche are identical on auction day) in early 1994. In these cases, no significant underpricing occurs and the when-issued trades very close to the parent throughout. The puzzle here is that the dispersion of bids at the auctions is similar to that observed for the non-fungible auctions indicating that information dispersion has not been eliminated.

Overall, these results leave us unable to explain the behaviour of fungible and non-fungible auctions using any of the standard theories described in section III (since, as well as information and risk, measures of liquidity considered seem not to explain underpricing). They do, however, have a practical conclusion: that fungible auctions appear to have produced a better price for the seller than non-fungible ones. Of course, the small sample of auctions analysed in this study means that any such conclusion can only be tentative.

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