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An Analysis of Bidding in the Japanese Government Bond Auctions

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ABSTRACT

We examine the bidding patterns and auction profits in the Japanese Government Bond (JGB) auctions and empirically test the predictions of auction theory. We find that the average profit in JGB auctions is not reliably different from zero, and the degree of competition and the level of uncertainty are insignificant in determining auction profits. The winning shares of the U.S. dealers are positively related to auction profits, whereas the winning shares of their Japanese counterparts show a negative association. We also find that the share of winnings of Japanese dealers tends to be correlated with the share of winnings of their compatriot dealers but a similar relation is not found for U.S. dealers.

THE JAPANESE GOVERNMENT BOND (JGB) market is the second largest treasury bond market in the world, with an outstanding volume of $2 trillion (more than two-thirds of the U.S. Treasury market) and annual trading volume of $12 trillion in 1993.[1] The largest sector of JGBs is ten-year bonds, accounting for more than 80 percent of all outstanding JGBs. Until the introduction of an auction in April 1989, however, foreign firms were virtually excluded from participation in the primary market for ten-year JGBs.[2] Before April

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[1] Bond Underwriters Association of Japan (1995).

[2] The efforts to open up the primary market for JGB to foreign competition were not easy due to several legal and political obstacles. The negotiations were conducted at the government level, mostly between Japan and the United States and the United Kingdom. They often involved threats of retaliation in the form of denying license to Japanese financial institutions in the U.S. and U.K. markets. A major stepping stone was laid when an intergovernmental working group known as the U.S.–Japan Yen–Dollar Committee issued its report in May 1984. One

1989, JGBs were sold to investors through a syndicate of underwriters. In syndicated offerings, a designated syndicate of underwriters bought newly issued bonds from the Ministry of Finance at a negotiated price and distributed these bonds to investors. The syndicate consisted of more than 800 banks, securities firms, and insurance companies, with only small shares sold to foreign financial institutions.[3]

In response to strong pressure from the U.S. government, the Ministry of Finance (MOF) eventually decided to issue portions of the ten-year JGBs through an auction process, similar to that used for the U.S. Treasury auction. Under the new system, from April 1989 to September 1990, 40 percent of the new ten-year JGBs were issued through a competitive discriminatory price auction and the remaining 60 percent were sold noncompetitively to the syndicate members at the quantity-weighted average of successful bids. From October 1990, the auction portion was increased to 60 percent. The hybrid nature of combining auction and noncompetitive allocation was a compromise between the U.S. position that the entire underwriting process should be based on an auction system and the Ministry's position that the syndicate underwriting system offers a more stable conduit for distributing JGB issues (see Semkow (1992)).

This paper examines bidding behavior and bidder characteristics in JGB auctions. First, we empirically test some predictions of auction theory regarding the determinants of auction profits. In particular, we examine the association between auction profits and the level of competition in the auctions and the level of uncertainty. There is a growing literature that tests similar predictions of auction theory in the context of U.S. Treasury auctions. For example, Cammack (1991) investigates the Treasury bill (T-bill) auction in the U.S. and finds support for the theory. On the other hand, Jegadeesh (1993) examines the Treasury note and bond auctions and finds only weak support for the theory. Simon (1994) finds some consistent results with the theory for Treasury coupon auctions. Nyborg and Sundaresan (1996) compare the profitability and bidding strategies in discriminatory and uniform price auctions. Away from the U.S. market, however, there is a significant paucity of literature on this subject, with the exception of Umlauf (1993) who examines the Mexican Treasury bill auctions. Our paper makes a contribution to fill this gap.

The next set of tests examines the characteristics of bidders in the primary market for JGBs. We first examine whether there are any discernible differences in the bidding skills of the two major participants in this market, Japanese and U.S. investment banks. If auction bidding skills are country-specific then the fact that the Japanese firms have operated domestically for a long time will provide them with a competitive advantage in JGB auctions.

of the major mandates addressed in the report was the liberalization of access by foreign financial institutions to Japanese financial markets. Several changes followed this report, including the introduction of a competitive auction mechanism to the primary market of JGBs.

[3] For example, in 1985, the foreign share in the syndicate totaled less than 1 percent.

On the other hand, if bidding skills are transferable, then the U.S. firms that have long dominated the U.S. Treasury auctions will also exhibit similar superior bidding skills in JGB auctions. If we find that one group of bidders possesses superior bidding skills that would imply that the bidders in this market are heterogeneous. In such a setting a realistic model of the auction needs to allow for such heterogeneity in bidding skills, whereas most models in the literature assume homogeneity.

Another issue that has been of general interest is whether certain groups of bidders tend to bid in a synchronized manner. In the U.S. Treasury auctions, for example, it is generally believed that the Japanese investment bank bids tend to be synchronized, i.e., the Japanese bidders either all bid aggressively, winning large shares in the auctions, or their bids are all weak. The basis for this belief appears to be casual observation, and no formal evidence is available. If true, however, such bidding practices have important implications for auction bidding strategies and outcomes. For instance, if bidding strategies were synchronized then the auction bids would be more volatile than if all participants bid independently. We empirically test the bid synchronization hypothesis in JGB auctions.

These issues pertaining to bidder characteristics have not been addressed in the extant literature, hence we know very little about the composition of participants in the primary market for government bonds. We are able to address them in the JGB market because we use data on the winning shares of individual bidders that are not available for other countries. We expect that a better understanding of bidder characteristics will provide the basis both for recognizing where extant models may deviate from reality in their underlying assumptions and for modeling government bond auctions more realistically.

The rest of the paper is organized as follows. The next section describes the institutional background and the data. Section II examines the bids in JGB auctions and the distribution of winning bids across different classes of bidders. Section III presents the empirical tests and Section IV concludes the paper.

I. Background and Data

Ten-year JGBs are issued by the Ministry of Finance in discriminatory price auctions. The activity schedule for each auction is as follows. During the last 10 days of every month, MOF announces the coupon and the size of the next JGB issue, which are set after consultation with the syndicate representatives. The issues range from 500 billion yen to 1.2 trillion yen in our sample period. Announcement of the actual size and the bond coupon occurs at 8:30 a.m. on the auction date and bids are received from 11:30 a.m. to 1:30 p.m. Any syndicate member can bid up to 30 percent of the amount offered for auction. Although all members of the syndicate are eligible to submit bids, typically most of the bids are made by large banks and securities houses. The MOF releases the auction results at 2:30 p.m. (4:30 p.m. until April

1993) on the auction date. On the following day, the remaining underwritten portion is allocated to the syndicate according to preset shares at the quantity-weighted average price of successful bids.[4] An underwriting commission of 0.63 yen per 100 yen face value is paid by the government for both auctioned and noncompetitively allocated portions. Because this payment is offset against the price paid by the bidders, we subtract this amount from auction prices in our analysis below.

The actual issue usually occurs on the 20th of the calendar month after the auction and the payment is made on the issue date. There is no when-issued market in the preauction period similar to that in the U.S., but dealers can start trading the bonds on a when-issued basis after the auction date, although there is no formal market for such transactions.

Secondary market trading of JGBs is concentrated on the over-the-counter (OTC) transactions through Nihon Sogo Shoken (Japan Bond Trading Company). Roughly 95 percent of secondary market transactions take place on the OTC market. JGBs are also listed on the Tokyo Stock Exchange on the first trading day in the second month following the issue date, but the Exchange transactions are aimed at small investors. The characteristics of the secondary market are discussed in detail by Campbell and Hamao (1993) and Kikugawa and Singleton (1994).

We obtained data on auction results since auctions were introduced in April 1989 for ten-year JGBs. Our sample period ends November 1995. The database contains average and minimum winning bids (in prices), coverage ratio (total bids tendered divided by the amount sold in auction). Our database also contains the quantity of successful bids by each bidder (domestic and foreign), which is not publicly available for other countries. These data are collected by Sanyo Securities and are published in *Kinyu Facsimile Shinbun* (*Financial Facsimile News*), a newsletter circulated among dealers. We also obtained daily secondary market prices of newly issued bonds, as well as seasoned bonds from Goldman Sachs. We use the last dealer quote of the day in our analysis.

II. JGB Auctions: Winning Bids

Table I presents summary statistics for the ten-year JGB auctions.[5] The auctions are grouped by the Japanese fiscal year which begins in April. Our sample consists of 78 auctions, of which 56 are auctions of new bonds and 22 are reopenings. A total of 67.8 trillion yen was raised with the issue of ten-year JGBs (both through auctions and direct issues to syndicates) during this sample period.

[4] Although the syndicate shares may be revised every year, they are generally fixed and do not directly reflect the results of the previous auctions. The breakup as of April 1994 is shown in the Appendix.

[5] All analyses are conducted for twenty-year JGBs as well. The number of auctions for twenty-year bonds is small, so we do not report the results, which are qualitatively similar to those of ten-year JGBs.

Table I

Ten-Year Japanese Government Bond Auctions: Summary Statistics

This table presents summary information of ten-year Japanese Government Bond (JGB) auctions. The sample period is April 1989 to November 1995. From April 1989 to September 1990, 40 percent of each ten-year JGB issue was sold in the auction and the rest were allocated to syndicate members at the average auction price; from October 1990, 60 percent of each JGB issue was sold in the auction.

Price range is the difference between the weighted average auction price and the lowest accepted bid in the auction. Coverage ratio is the ratio of total bids in an auction to the amount sold in the competitive portion of the auction. Reopens are auctions of bonds with the same coupon and maturity as a previously issued bond.

Fiscal Year (year:month)	Number of Auctions	Amount Issued (trillion yen)	Price Range			Coverage Ratio		
			Min.	Avg.	Max.	Min.	Avg.	Max.
89	11	7.2	0.04	0.16	0.32	2.82	4.05	7.13
90	12	9.0	0.07	0.15	0.26	2.30	4.32	6.00
91	12	9.6	0.03	0.07	0.12	2.43	4.03	6.08
92	12	9.8	0.05	0.11	0.21	2.46	4.82	7.74
93	12	10.8	0.05	0.15	0.38	1.44	4.20	6.88
94	12	13.2	0.04	0.12	0.18	1.81	2.65	3.49
95	7	8.2	0.05	0.07	0.08	2.53	4.26	6.40
All issues								
89:04–90:09	17	11.9	0.04	0.16	0.32	2.35	4.28	7.13
90:10–95:11	61	55.9	0.03	0.11	0.38	1.44	3.96	7.74
89:04–95:11	78	67.8	0.03	0.12	0.38	1.44	4.03	7.74
New issues								
89:04–90:09	12	8.2	0.06	0.17	0.32	2.35	4.10	7.13
90:10–95:11	44	39.3	0.05	0.12	0.38	1.44	3.98	7.74
89:04–95:11	56	47.5	0.05	0.13	0.38	1.44	4.01	7.74
Reopens								
89:04–90:09	5	3.7	0.04	0.13	0.19	3.81	4.71	5.67
90:10–95:11	17	16.6	0.03	0.10	0.33	1.68	3.91	6.56
89:04–95:11	22	20.3	0.03	0.11	0.33	1.68	4.10	6.56

The average coverage ratio is 4.03. This is nearly twice that for the ten-year note auctions in the U.S. where it is 2.16 (see Jegadeesh (1993)). One of the reasons for the strong demand for ten-year JGBs is the fact that this is considered the benchmark bond in the Japanese market and the secondary market for these bonds is very liquid.

The average price range for accepted bids is 0.12 percent. In comparison, the average range of accepted bids for ten-year Treasury notes in the U.S. is 0.24 percent. The significantly lower range of accepted bids in Japan suggests that there is less price uncertainty in the JGB primary market. This is somewhat surprising as there is no preauction when-issued market in Japan and hence, unlike the U.S. market, participants in JGB auctions do not have the benefit of price discovery provided by this market. It appears that any increased price uncertainty due to the absence of a when-issued market was

more than offset by lower interest rate uncertainty in Japan and higher levels of auction participation, as indicated by the higher coverage ratio, resulting in lower dispersion of accepted bids.

Table II presents the average winning bids tendered by major participants in the auctions. Japanese commercial banks tendered 28.01 percent of the winning bids in 1989. Their share declined to 15.16 percent in 1991 and eventually recovered to 29.27 percent in 1995. The U.S. firms started off strong by winning 28.08 percent of the auction in 1989. Their share, however, declined over time and was only 6.67 percent in 1995.

A bulk of the loss in share of Japanese banks and U.S. firms was captured by the Japanese investment banks. Their share grew from 42.44 percent in 1989 to 60.42 percent in 1995. On average, the Big Four investment banks (Daiwa, Nikko, Nomura, and Yamaichi) accounted for 82.82 percent of the share of this group. Foreign firms other than U.S. firms failed to make any significant inroads into the JGB auction market and their combined share hovered around 1 percent over the entire sample period.

It is interesting to compare the percentage winnings in competitive auctions with syndicate allocations set by the MOF. As stated earlier, only 60 percent of the ten-year JGB issues (40 percent until September 1990) are sold through auction; the remaining 40 percent of those issues are allocated to a syndicate at the quantity-weighted auction price. MOF decides on the share of each firm in the syndicate. The combined share of Japanese banks in the syndicate is 65 percent (see footnote 4) but they win on average only 22 percent of the auctioned portion of the issues. On the other hand, the combined share of foreign firms in the syndicate is only 8 percent but they win about 14 percent of the auctions. It appears that the syndicate system in the ten-year JGB issues serves to protect a certain share for Japanese banks that are probably not equipped to compete in the auctions, at the expense of foreign competition.[6]

III. Empirical Tests

We first test predictions of auction theory with JGB auction data. The specifics of the discriminatory price auction designed for JGB auctions include a number of complex features that have not been fully incorporated in any model in the literature. Our tests, therefore, rely on the predictions of first-price common value auctions wherein each bidder submits one bid for one unit of the auctioned good.[7] The predictions of these models, which do not critically depend on auction design, are tested here. The models that form the basis of our tests are those of Milgrom and Weber (1982), Engelbrecht-

[6] It should be noted that Japanese commercial banks participate in the auction mainly as ultimate investors, not as dealers. Banks owned 36 percent of JGBs outstanding as their investment in 1992 (Bond Underwriters Association of Japan, 1995). Banks have also been allowed to sell government bonds to their clients since 1985, but these transactions tend to be retail-oriented and small in volume.

[7] In first-price auctions, the highest bidder gets the auctioned good at the price he or she bids.

Wiggans, Milgrom, and Weber (1983), French and McCormick (1984), and Bikhchandani and Huang (1989).

In these models, two important factors that affect expected profit to the winner are the extent of dispersion of opinion among bidders and the number of bidders. Intuitively, the marginal probability of losing an auction by lowering the bid by a given amount decreases with an increase in the dispersion of bidders' preauction valuations. Therefore, auction theory predicts that higher dispersion of opinion will on average result in lower bids and higher auction profits. The marginal probability of losing an auction by lowering the bid by a given amount increases with increasing levels of competition. Therefore, increased competition on average results in higher bids and lower profits. It should be noted that both these predictions obtain when there are a finite number of bidders. When the number of bidders is large (technically, tending to infinity) then the auction is characterized by perfect competition and the expected auction profit is zero. In this limiting case, all bidders bid their expected values conditional on their winning the auction.

In addition to the above predictions, one aspect of the characteristics of bidders that we examine is their relative bidding skills. In particular, we test for differential bidding skills between U.S. and Japanese investment houses in the JGB auctions. Intuitively, if one class of bidders is better informed than the other class then the expected profit conditional on the informed bidder winning the auction will be higher than the expected profit conditional on the uninformed bidder winning the auction. This intuition is consistent with the predictions of Engelbrecht-Wiggans et al. (1983). That paper considers an auction for a common value good in a setting where one bidder is informed and the other is uninformed and shows that the expected profit for the informed bidder is higher than that for the uninformed bidder.

We measure auction profit δ_t as follows:

$$\delta_t \equiv \Delta P_t^a - \Delta P_t^c, \tag{1}$$

where ΔP_t^a is the percentage price change of the auction bond from the value-weighted average auction price (minus 0.63 yen) to the secondary market (the unofficial when-issued market) bond price at the close of date t, and ΔP_t^c is the average percentage change in the prices of three control bonds from the auction date to date t.[8] The control bonds are bonds with maturities closest to the auction bonds.[9] Because the control bonds are traded in the spot market, we adjust their returns for accrued coupon and carrying cost. The carrying cost is computed at the repo rate. Since trading in the auction

[8] One may also consider ΔP_t^a as a measure of auction profit. This measure, however, contains the expected auction profit component as well as any price change due to unexpected changes in interest rates. Because price changes due to interest rate changes add noise to the profit estimates, we use δ as our measure of profit and control for price changes due to interest rate changes.

[9] The results we report below are qualitatively similar when we use one control bond that has the closest maturity data rather than three bonds.

Table II
Japanese Government Bond Auctions: Distribution of Winning Bids

This table presents the percentage of ten-year Japanese Government Bonds (JGBs) won by each individual or class of bidders. Japanese Banks are Japanese commercial banks, Japanese Investment Banks (Big 4) is the combined winnings of the following Japanese investment banks: Daiwa, Nikko, Nomura, and Yamaichi. Japanese Investment Banks (Total) includes other Japanese investment banks. U.S. Total includes all U.S. firms. Other Foreign means foreign firms other than U.S. firms. Reopens are auctions of bonds with the same coupon and maturity as a previously issued bond.

Fiscal Year (year:month)	Number of Auctions	Japanese Banks	Japanese Inv. Banks (Big 4)	Japanese Inv. Banks (Total)	U.S. Total	Other Foreign
			Panel A: Distribution among Classes of Bidders			
89	11	28.01	32.71	42.44	28.08	1.31
90	12	17.60	56.84	65.96	16.20	1.33
91	12	15.16	55.90	69.16	14.39	1.12
92	12	16.29	73.33	77.60	4.41	0.36
93	12	22.61	61.19	66.12	10.48	0.02
94	12	25.39	43.05	57.45	13.97	1.04
95	7	29.27	33.76	60.42	6.77	0.42
All issues						
89:04–90:09	17	25.38	37.34	47.46	25.90	1.59
90:10–95:11	61	20.43	56.47	67.52	10.32	0.60
89:04–95:11	78	21.51	52.30	63.15	13.72	0.82
New issues						
89:04–90:09	12	25.54	32.40	42.65	30.60	1.33
90:10–95:11	44	21.53	56.76	67.13	9.63	0.59
89:04–95:11	56	22.39	51.54	61.88	14.12	0.75
Reopens						
89:04–90:09	5	25.00	49.20	59.00	14.60	2.20
90:10–95:11	17	17.58	55.74	68.53	12.12	0.63
89:04–95:11	22	19.27	54.25	66.36	12.68	0.99

Fiscal Year (year:month)	Number of Auctions	Japanese Investment Banks				U.S. Investment Banks			
		Daiwa	Nikko	Nomura	Yamaichi	Goldman Sachs	Merrill Lynch	Morgan Stanley	Salomon Brothers
Panel B: Distribution among Individual Bidders									
89	11	9.59	4.34	12.84	5.95	1.53	0.99	2.19	21.25
90	12	14.71	11.60	19.59	10.94	3.31	0.56	1.14	10.32
91	12	11.82	15.88	16.72	11.48	7.95	1.27	0.85	2.98
92	12	18.20	22.50	21.75	10.87	2.32	0.39	1.54	0.00
93	12	10.59	19.14	14.83	16.62	3.99	0.55	1.26	4.20
94	12	10.07	10.35	13.43	9.20	4.07	2.11	1.62	2.65
95	7	9.30	8.72	8.94	6.80	0.00	2.11	0.24	3.63
All issues									
89:04–90:09	17	10.58	5.12	14.90	6.69	2.58	0.94	2.02	18.48
90:10–95:11	61	12.71	15.98	16.17	11.62	3.81	1.12	1.12	3.06
89:04–95:11	78	12.24	13.62	15.89	10.54	3.55	1.08	1.32	6.42
New issues									
89:04–90:09	12	9.99	4.07	12.28	6.06	2.57	0.58	2.45	22.92
90:10–95:11	44	14.43	15.88	16.00	10.45	3.07	1.05	1.11	3.06
89:04–95:11	56	13.48	13.35	15.20	9.51	2.97	0.95	1.39	7.32
Reopens									
89:04–90:09	5	12.00	7.80	21.20	8.20	2.60	1.80	1.00	7.80
90:10–95:11	17	8.26	16.23	16.62	14.63	5.74	1.29	1.16	3.07
89:04–95:11	22	9.11	14.32	17.66	13.17	5.02	1.40	1.12	4.14

Table III

Profits to Winning Bids in Ten-Year Japanese Government Bond Auctions

This table presents the average profits to winning bids in the ten-year JGB auctions. ΔP_t^a is the percentage change in price of the auction bond (expressed in basis points) from the value-weighted average auction price to the secondary market price at the close of t days after the auction. ΔP_t^c is the average percentage change in the secondary market price of three seasoned bonds with maturity closest to the auction bond, adjusted for changes in accrued coupon and carrying costs. t-statistics are reported in parentheses.

Fiscal Year (year:month)	Profit Measure	Number of Bonds	Days after Auction (t)				
			1	2	3	4	5
89	$\Delta P_t^a - \Delta P_t^c$	9	23.42	15.20	21.44	17.10	26.28
			(2.34)	(1.36)	(2.26)	(1.51)	(2.50)
90	$\Delta P_t^a - \Delta P_t^c$	8	1.36	−1.36	0.04	−0.77	1.58
			(0.19)	(−0.21)	(0.00)	(−0.08)	(0.13)
91	$\Delta P_t^a - \Delta P_t^c$	6	6.23	3.47	5.16	4.32	−5.62
			(1.41)	(0.74)	(1.07)	(0.83)	(−0.64)
92	$\Delta P_t^a - \Delta P_t^c$	9	−0.85	−0.28	−2.15	−4.24	−2.86
			(−0.18)	(−0.07)	(−0.45)	(−0.81)	(−0.51)
93	$\Delta P_t^a - \Delta P_t^c$	9	−11.71	−15.29	−16.05	−17.41	−20.00
			(−4.10)	(−4.66)	(−4.22)	(−4.88)	(−4.10)
94	$\Delta P_t^a - \Delta P_t^c$	9	0.54	−0.26	1.38	4.26	4.62
			(0.05)	(−0.03)	(0.12)	(0.37)	(0.40)
95	$\Delta P_t^a - \Delta P_t^c$	6	4.95	2.15	2.23	0.46	1.28
			(1.57)	(0.56)	(0.59)	(0.11)	(0.29)
89:04–90:09	$\Delta P_t^a - \Delta P_t^c$	12	22.05	14.61	21.72	17.04	25.88
			(2.92)	(1.68)	(2.59)	(1.76)	(2.62)
90:10–95:11	$\Delta P_t^a - \Delta P_t^c$	44	−2.13	−3.60	−3.96	−4.19	−5.72
			(−0.76)	(−1.27)	(−1.27)	(−1.31)	(−1.64)
89:04–95:11	$\Delta P_t^a - \Delta P_t^c$	56	2.79	0.31	1.54	0.36	1.05
			(0.92)	(0.10)	(0.46)	(0.10)	(0.27)

bonds is on a forward basis until the issue date (typically about 15 days from the auction date), no adjustments are required for carrying cost or accrued coupons. In essence, δ_t measures the incremental returns a dealer can earn by winning in an auction relative to purchasing a similar bond in the secondary market.

We restrict our analysis to auctions of new issues only. Since issues in reopenings are identical to bonds simultaneously traded in the secondary market, publicly available market prices convey substantially more information to bidders in this market than in the case of new issues. Therefore the nature of information that different bidders use in their bidding strategies is likely to be much different in the case of reopenings compared to that of new auctions.

Table III presents the average auction profits for one to five days after auction. The auction profits for the entire sample are not reliably different from zero. The only year when the average profits were reliably positive was

1989. In comparison, Jegadeesh (1993) and Nyborg and Sundaresan (1996) find statistically significant average profits for ten-year Treasury note auctions in the U.S. There are at least two reasons why the profits in Japan may be lower than in the U.S.—or perhaps even nonexistent. First, the competition, as reflected in higher coverage ratios in Japan, is more intense for JGB auctions. Second, the price uncertainty, as reflected in the narrower price range, is also lower in Japan. Both of these factors diminish auction profits.

We now formally examine the determinants of auction profits. Our tests use coverage ratio (*Ratio*) as the measure of competition. A high coverage ratio indicates intense competition and hence is expected to be associated with low auction profit. We use the difference between the average auction price and the lowest accepted bid (*Range*) as a measure of dispersion of preauction valuation. The variables *Big4Japan* and *Big4US* used in the regression below are the fractions of the auction won by the four major Japanese investment banks (Daiwa, Nikko, Nomura, and Yamaichi) and four major U.S. investment banks (Goldman Sachs, Merrill Lynch, Morgan Stanley, and Salomon Brothers), respectively. If the Japanese firms have superior information, then the profits would on average be larger in auctions where they win a large fraction than in auctions where they win a small fraction.

We fit the following two regressions:

$$\delta = a_0 + a_1 Range + a_2 Ratio + a_3 Big4Japan + e \tag{2}$$

$$\delta = b_0 + b_1 Range + b_2 Ratio + b_3 Big4US + u. \tag{3}$$

Table IV presents the regression estimates and test statistics based on White's (1980) heteroskedasticity-consistent standard errors. Interestingly, the slope coefficients on both *Ratio* and *Range* are not reliably different from zero.[10] This indicates that neither the level of competition nor the level of uncertainty plays a significant role in determining auction profits. These results do not support the predictions of auction theory when there are a finite number of bidders. It suggests, however, that the number of bidders in JGB auctions is sufficiently large so that the auction market is approximated by the limit with infinite bidders. In this case, the theory predicts that ex ante expected profit will be driven down to zero and hence there will be no relation between ex post profits and the variables *Range* and *Ratio*. Our earlier finding that the average auction profit is not different from zero is also consistent with this explanation.

Turning to the slope coefficients on the country variables, we find that the slope coefficient of *Big4Japan* is reliably negative. On the other hand, the slope coefficient on the variable *Big4US* is reliably positive. This indicates that when Japanese investment banks win larger amounts in JGB auctions,

[10] Similar results are found when we use the preauction volatility of ten-year JGB futures prices in place of *Range*. Also, the regression slope coefficients on *Range* and *Ratio* are close to the reported values when the *Big4* variables are excluded from the regression specification.

Table IV

Association of Japanese Government Bond Auction Profits with Price Range, Coverage Ratio, and Winning Shares of Japanese and U.S. Investment Banks: Regression Analysis

This table reports the parameter estimates of the following regressions:

$$\text{Profit} = a_0 + a_1 Range + a_2 Ratio + a_3 Big4Japan + e \quad \text{and}$$

$$\text{Profit} = b_0 + b_1 Range + b_2 Ratio + b_3 Big4US + u,$$

where auction profit is defined as $\Delta P_t^a - \Delta P_t^s$. ΔP_t^a is the percentage change in price of the auction bond (expressed in basis points) from the value-weighted average auction price to the secondary market price at the close of t days after the auction. ΔP_t^s is the average percentage change in the secondary market price of three seasoned bonds with the maturity closest to the auction bond. *Range* is the difference between the weighted average auction price and the lowest accepted bid in the auction. *Ratio* is the ratio of total bids in an auction to the amount sold in the competitive portion of the auction. *Big4Japan* is the fraction of the auction won by the following four Japanese investment banks: Daiwa, Nikko, Nomura, and Yamaichi; *Big4US* is the fraction of the auction won by the following four U.S. investment banks: Goldman Sachs, Merrill Lynch, Morgan Stanley, and Salomon Brothers. t-statistics are reported in parentheses. The sample comprises all (56) new bond auctions in the April 1989 to November 1995 period.

t	Intercept	Range	Ratio	Big 4 Japan	Big 4 US
1	0.1629	−0.1689	0.0178	−0.4413	—
	(1.30)	(0.39)	(0.88)	(−3.59)	—
1	−0.0455	−0.2574	−0.0002	—	0.8243
	(−0.40)	(−0.58)	(−0.01)	—	(3.85)
2	0.2155	0.2634	−0.0128	−0.3778	—
	(1.68)	(0.59)	(−0.62)	(−3.00)	—
2	0.0300	−0.0840	−0.0271	—	0.7291
	(0.26)	(−0.18)	(−1.36)	—	(3.32)
3	0.2615	0.4873	−0.0122	−0.5024	—
	(1.98)	(1.07)	(−0.57)	(−3.88)	—
3	0.0201	0.1051	−0.0311	—	0.8452
	(0.16)	(0.22)	(−1.48)	—	(3.63)
4	0.2765	0.4371	−0.0229	−0.4590	—
	(2.00)	(0.91)	(−1.02)	(−3.37)	—
4	0.0621	0.1815	−0.0401	—	0.6263
	(0.47)	(0.35)	(−1.76)	—	(2.50)
5	0.3202	0.6154	−0.0258	−0.5516	—
	(2.13)	(1.18)	(−1.06)	(−3.73)	—
5	0.0597	0.2648	−0.0465	—	0.8205
	(0.42)	(0.47)	(−1.89)	—	(3.03)

the average auction profits are lower, and the reverse is true for U.S. investment banks. To examine the robustness of this result and to examine whether this result is driven by the first year that the ten-year JGB auctions were conducted in Japan, we also fitted the regressions above excluding the first nine observations pertaining to fiscal year 1989. We find virtually identical results (not reported here).

Table V

Auction Profits and Winning Shares of Japanese and U.S. Investment Banks in Japanese Government Bond Auctions

This table presents the average profits in ten-year JGB auction within three groups sorted by the percentage of auctions won by Big 4 Japan (Daiwa, Nikko, Nomura, and Yamaichi) and also within three groups sorted based on the percentage of auctions won by Big 4 U.S. (Goldman Sachs, Merrill Lynch, Morgan Stanley, and Salomon Brothers). *t*-statistics are reported in parentheses. The sample comprises all (56) new bond auctions in the April 1989 to November 1995 period.

	Percentage Won	Auction Profit (per number of days postauction)				
		1	2	3	4	5
Sort by Big 4 Japan						
Low	24.39	9.93	10.52	15.89	16.00	16.82
		(1.83)	(1.66)	(2.41)	(2.43)	(2.43)
Medium	51.33	10.66	4.11	5.45	1.87	6.87
		(2.24)	(1.04)	(1.54)	(0.42)	(1.39)
High	74.86	−9.37	−11.04	−13.58	−13.53	−18.62
		(−2.31)	(−2.64)	(−2.86)	(−2.82)	(−3.88)
High–Low	50.47	−19.30	−21.57	−29.48	−29.53	−36.44
		(−2.85)	(−2.84)	(−3.63)	(−3.63)	(−4.16)
Sort by Big 4 U.S.						
Low	0.35	−6.17	−8.23	−9.18	−9.54	−13.49
		(−2.13)	(−2.84)	(−2.98)	(−2.96)	(−3.49)
Medium	7.75	−1.25	−2.10	−1.82	0.38	1.20
		(−0.24)	(−0.41)	(−0.30)	(0.06)	(0.16)
High	26.22	11.27	4.95	9.36	4.79	10.73
		(2.06)	(1.04)	(1.83)	(0.82)	(1.69)
High–Low	25.87	17.45	13.17	18.54	14.33	24.22
		(2.82)	(2.37)	(3.11)	(2.15)	(3.26)

To analyze the economic significance of this point, we sort auctions into three groups by the percentage won by the Big 4 Japanese and U.S. investment banks and examine the average auction profits in each of these subsets of auctions. Table V presents the average fraction of auctions won by the Big 4 Japanese and U.S. firms in the respective groups and the average auction profits from one to five days after the auctions. There is substantial variation in the fraction of auctions won by these two groups of bidders in individual auctions. For the Big 4 U.S. firms the percentage of auction won varies from 0.35 percent to 26.22 percent and for the Big 4 Japanese firms the corresponding range is 24.39 percent to 74.86 percent.

When the Japanese Big 4 firms win a low proportion of the auction, the auction profits are positive and are statistically significant. But when they win a high proportion of the auction, the profits are significantly negative. On the contrary, for the U.S. Big 4 firms, the profits are significantly negative (positive) when they win a low (high) percentage of the auctioned bond. The differences between the profits in the "high" and "low" auctions for *Big4US*

and *Big4Japan* are 17.45 and −19.30 basis points respectively. These differences are reliably different from zero, they increase in magnitude from one to five days after auction, and they appear to be economically significant.

The bidding strategies of U.S. investment banks seems to enable them to win relatively more in auctions when the expected profits are high. The Japanese investment banks get a higher share of the auctions that generate losses. This evidence suggests that the U.S. investment banks have better skills in processing information concerning the value of the JGBs sold in the auctions.

It should be noted, however, that this interpretation takes the traditional view in this literature in general, and in the models that form the basis of tests in particular, that auctions such as JGB auctions are best described as auctions for common value goods. It is also possible to deviate from this traditional view and interpret our evidence as being consistent with the view that bidders may have private value associated with purchasing bonds in the auctions that is not readily evident when we consider only the direct profits to winning. For example, the trade publication *Nikkei Koshasai Joho* (*Nikkei Newsletter on Bond and Money*) reports that "aggressive bidding prices by Japanese houses are only justifiable by their ability to sell JGBs to their clients in combination with other attractive products such as new issues of convertible bonds that they underwrite" (April 17, 1989). This suggests that an inventory of JGBs may help Japanese investment houses attract other business and this benefit is not captured by δ, the auction markup.

Investment banks also submit bids on behalf of their clients which are called *Dairi Nyusatsu* (proxy bids). These bids are submitted by investment banks at prices and quantities the clients specify. Although investment banks typically bid for resale, their clients may bid for long term investment purposes and may be willing to pay a higher price in the auctions rather than bear the price impact in large secondary market transactions.

These explanations imply that there may be various sources of private valuations for JGBs that are not captured by direct auction profits that are examined here and in other papers on related topics. A broader definition of profits and relaxation of the common value good assumption may be necessary to get a better understanding of JGB and other government bond auctions, which we leave for future research.

We next test whether there is evidence of bid synchronization, i.e., whether certain groups of bidders either all bid aggressively, winning large shares in the auctions, or whether their bids are all weak. To develop our test of the synchronization hypothesis, consider a setting where there are bidders A, B, and C with winning shares α, β, and γ. Under the hypothesis that all three bidders bid independently, the fraction of the auction won by A should not have any relationship to how the rest of the auction is divided between B and C. On the other hand, if the winnings by A and B are correlated, then a large share for A (α) will be associated with a large share for B (β) as a proportion of $\beta + \gamma$. To illustrate this point, assume that A, B, and C on average each win one-third in the auctions. In a particular auction assume

Table VI

Correlation between Winning Shares of Japanese and U.S. Investment Banks in Ten-Year Japanese Government Bond Auctions

This table presents the correlation between winnings of each of the Big 4 Japanese and U.S. investment banks with the fraction of the remaining portion of the auction won by the rest of their compatriot investment banks. *t*-statistics are reported in parentheses. The sample comprises all (56) new bond auctions in the April 1989 to November 1995 period.

Big 4 Japan		Big 4 U.S.	
Investment Bank	Correlation	Investment Bank	Correlation
Daiwa	0.29	Goldman Sachs	−0.04
	(2.29)		(−0.32)
Nikko	0.59	Merrill Lynch	0.08
	(5.42)		(0.61)
Nomura	0.42	Morgan Stanley	0.08
	(3.42)		(0.58)
Yamaichi	0.44	Salomon Brothers	0.07
	(3.67)		(0.49)

that the fraction won by A is 40 percent. If all bids are independent, then conditioning on the information of A's winnings will not help in predicting how the remaining 60 percent of the auction is split between B and C; on average B and C will each win 50 percent of the *remaining* portion of the auction. But if the bids of A and B are positively correlated, then conditional on the information that A has won higher than his average share of the auction would be the expectation that B will on average win more than 50 percent of the remaining portion of the auction. We measure this conditional correlation between the winnings of A and B by $\text{corr}(\alpha, \beta/(\beta + \gamma))$.[11]

Our tests of the bid synchronization hypothesis examine whether the winning of each Japanese and U.S. investment bank is correlated with combined winnings of their compatriot investment banks. To investigate, for example, whether the winnings of Nikko are correlated with those of the other Japanese investment banks, let α be the percentage winning of Nikko, β be that of the other three Japanese investment banks, and γ be that of all others (including four U.S. investment banks). Under the null hypothesis of uncorrelated winnings, $\text{corr}(\alpha, \beta/(\beta + \gamma)) = 0$.

Table VI presents the correlations between the winnings of each of the four Japanese and U.S. investment banks with the fraction of the remaining portion of the auction won by the rest of their Japanese or U.S. compatriot investment banks. This correlation is significantly positive for all Japanese

[11] The auction winnings of different bidders will typically be negatively correlated because the total should add up to one. Note, however, that in this case we consider the correlation between the fraction of an auction won by A with the fraction of the *remaining* portion of the auction won by B.

investment banks.[12] The correlation coefficients are not reliably different from zero for any of the American investment banks.

These results indicate that when one of the Japanese banks wins a high proportion in an auction, the others tend to win higher than average amounts of the remaining portion of the auction, which is consistent with the synchronization hypothesis. For the U.S. investment banks, however, none of the correlation coefficient estimates is reliably different from zero. Therefore, the null hypothesis of independence of winnings across bidding firms cannot be rejected for the U.S. investment banks.

There are several reasons why the proportion of the auctions won by Japanese investment houses may be correlated. One possibility is that customer demand for JGBs is correlated across investment banks. As we discussed earlier, since these dealers place bids on behalf of their customers, any correlation in customer demands will lead to the investment banks themselves jointly bidding aggressively in certain auctions and not so aggressively in others. It is also possible that the Japanese investment banks observe similar information or apply similar models to analyze information. Investigation of the relative merits of these explanations is likely to be of broad interest but it is beyond the scope of this paper.

Irrespective of the interpretation, our results indicate a specific type of correlation in information across bidders. Broadly, our evidence suggests that there are at least two groups of bidders in this market and the signals received by one group (say group A) are correlated with those of others in that group. The consequences of such heterogeneity for bidding strategies has not been modeled so far and models built with this structure may provide interesting insights. For example, it is possible that even when both groups of bidders receive information with equal precision (or possess equal skill levels), bidders in group A may be at a disadvantage because other bidders in their group have correlated information. This may result in lower expected profits for bidders in group A relative to those for bidders in the other group.

IV. Conclusions

This paper examines auction profits and bidding behavior in the ten-year Japanese Government Bond primary market. We do not find empirical support for predictions based on models of first price auction for common value goods with finite bidders. We find that the average auction profit is not reliably different from zero and we do not find any association between auction profits and measures of competition and dispersion of opinion among bidders.

We further examine the relation between auction profits and winning shares by the Big 4 Japanese and U.S. investment banks. We find the winning shares of the U.S. investment banks are positively related to auction profits.

[12] The standard error of the correlation coefficient is $\sqrt{(1 - \rho^2)/(n - 1)}$ where ρ is the correlation coefficient and n is the number of observations.

whereas the winning shares of their Japanese counterparts show a negative association. We also find that the share of winnings of Japanese investment banks tends to be correlated with winnings of other compatriot investment banks but a similar relation is not found for U.S. investment banks. These findings provide some insights into the heterogeneous characteristics of participants in JGB auctions.

Appendix

Breakup of Syndicate Shares of the Japanese Government Bond Underwriting

Japanese banks	65.08%
Foreign banks	1.25%
Japanese securities	23.11%
Foreign securities	6.25%
Insurance	4.31%
Total	100.00%
Within securities firms (out of total):	
Daiwa	2.37%
Nikko	2.37%
Nomura	5.85%
Yamaichi	2.37%
Japanese Big 4 Total	12.96%
Goldman Sachs	0.60%
Merrill Lynch	0.60%
Morgan Stanley	0.60%
Salomon Brothers	1.51%
U.S. Big 4 Total	3.31%

As of April 1994; source: the Ministry of Finance, Japan.

REFERENCES

Bikhchandani, Sushil, and Chi-Fu Huang, 1989, Auctions with resale markets: An exploratory investigation of Treasury bill markets, *Review of Financial Studies* 2, 311–339.

Bond Underwriters Association of Japan, 1995, *Bond Review* 471, 6–7.

Cammack, Elizabeth, 1991, Evidence of bidding strategies and the information in Treasury bill auctions, *Journal of Political Economy* 99, 100–130.

Campbell, John, and Yasushi Hamao, 1993, The interest rate process and the term structure of interest rates in Japan, in Kenneth Singleton, ed.: *Japanese Monetary Policy* (University of Chicago Press, Chicago, Ill.).

Engelbrecht-Wiggans, Richard, Paul Milgrom, and Robert Weber, 1983, Competitive bidding and proprietary information, *Journal of Mathematical Economics* 11, 161–169.

French, Kenneth, and Robert McCormick, 1984, Sealed bids, sunk costs and the process of competition, *Journal of Business* 57, 417–441.

Jegadeesh, Narasimhan, 1993, Treasury auction bids and the Salomon squeeze, *Journal of Finance* 48, 1403–1419.

Kikugawa, Tadashi, and Kenneth Singleton, 1994, Modeling the term structure of interest rates in Japan, *Journal of Fixed Income* 4-2, 6–16.

Milgrom, Paul, and Robert Weber, 1982, A theory of auctions and competitive bidding, *Econometrica* 50, 1089–1122.

Nyborg, Kjell, and Suresh Sundaresan, 1996, Discriminatory versus uniform Treasury auctions: Evidence from when-issued transactions, *Journal of Financial Economics* 42, 63–104.

Semkow, Brian, 1992, Foreign financial institutions in Japan, *Law and Policy in International Business* 23, 331–413.

Simon, David, 1994, Markups, quantity risk, and bidding strategies at Treasury coupon auctions, *Journal of Financial Economics* 35, 43–62.

Umlauf, Steven, 1993, An empirical study of the Mexican Treasury bill auction, *Journal of Financial Economics* 33, 313–340.

White, Halbert, 1980, A heteroskedasticity-consistent covariance matrix estimator and direct tests for heteroskedasticity, *Econometrica* 48, 817–838.