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**EXPLAINING THE BREADTH  
OF EXPERT ESTIMATE RANGES  
IN AUCTIONS OF RARE BOOKS**

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**Explaining the breadth of expert estimate ranges in  
auctions of rare books<sup>1</sup>**

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## ABSTRACT

This paper uses data from 3144 rare book auctions to study the breadth of auctioneers' estimate ranges. The 'information hypothesis' proposes that wider ranges reflect greater uncertainty. The 'reserve hypothesis' proposes that a narrower range indicates a higher reserve price. The information hypothesis is tested by seeing whether estimate breadths are related to the presence of greater information about likely prices. The reserve hypothesis is tested by seeing whether narrower estimate ranges predict 'no sales'. Evidence is found in support of the information hypothesis but not the reserve hypothesis. The paper identifies differences between the auction houses Christie's and Sotheby's in the estimate strategies they adopt.

## 1.1 INTRODUCTION

In many settings, auction firms engage experts to prepare estimates of prices. The estimates are published before sale events and often comprise an estimate range with an upper and a lower bound. This paper investigates the breadth of such estimate ranges. Two main hypotheses have been proposed with respect to the breadth of the ranges. The 'information hypothesis' proposes that the breadth reflects auctioneers' uncertainty. The 'reserve hypothesis' stresses interaction between the auctioneer and the seller, and the role of the seller's reserve. The information hypothesis is untested, while there is empirical evidence in favour of the reserve hypothesis from auctions of Latin American art in New York.

The paper uses data from 3144 rare book auctions at twenty-one Christie's and Sotheby's sale events between 1984 and 1999 in Australia. Data from book auctions can be used to analyse estimate breadths, and are especially useful for testing the information hypothesis. As well as high and low price estimates, the book auction data contain several measures of the amount of information available to auctioneers that has a bearing on price expectations. Key among these measures are sales of identical and nearly identical copies at other auctions nearby in time, and the presence of multiple copies of particular books at particular auction events. Other measures of the information available to auctioneers can also be extracted from the book auction data. The information hypothesis is tested by seeing whether estimate breadths are related to the presence of greater information about likely prices.

The book auction data can also be used to test the reserve hypothesis because there is information about 'passed-in' items (also called 'no-sales'): books that failed to reach the seller's reserve price and so were not sold. The reserve hypothesis is tested by seeing whether narrower estimate ranges predict passed-in items, and therefore whether they are associated with a higher reserve.

The paper contributes to the empirical literature on auctions by testing the information and reserve hypotheses in tandem and in a new setting. The approach used to test the information hypothesis is novel. The analysis of pre-sale estimates is informative about the strategies of auctioneers. It is also relevant to learning in markets and how institutional features influence the determination of prices.

The paper is structured as follows. Section 1.2 provides some background information about estimate ranges and reviews the previous literature. Section 1.3 describes the dataset and relevant features of the institutional setting of Australian book auctions. Section 1.4 gives a profile of the data. Section 1.5 investigates the information hypothesis, and Section 1.6 investigates the reserve hypothesis. Section 1.7 presents some concluding comments.

## **1.2 BACKGROUND AND LITERATURE SURVEY**

Pre-sale estimates are a feature of auctions of real estate, art, jewellery, antiques, business equipment and many other assets. Numerous researchers have investigated whether the estimates are biased. See for example Ashenfelter (1989), Louargand and McDaniel (1991), and Chanel et al. (1996). However, other aspects of estimates are not much explored. One of these aspects is the breadth of estimate ranges. Estimates are often published as a high and low estimate rather than a point estimate. Two main hypotheses have been proposed to explain the breadth of estimate ranges: the information hypothesis and the reserve hypothesis.

The information hypothesis proposes that estimate range breadth reflects auctioneers' uncertainty, with a narrower range indicating greater confidence in the estimate. If this hypothesis were true, estimate ranges would be narrower when auctioneers had more information about likely prices. This information might include previous prices, appraisals by

other experts and information about the quantity and quality of the assets in circulation. The information hypothesis claims strong intuitive support but has not been tested directly. Beggs and Graddy (1997) regressed the ratio of the price to the estimate range midpoint on the breadth of the estimate range and variables that captured asset characteristics and sale order. The coefficient on breadth was negative and significant. Beggs and Graddy interpreted this as tentative evidence that the estimate range spread was wider for those items where the estimate was less accurate. The main shortcoming of this approach is that it does not explicitly capture the information available to auctioneers.<sup>2</sup>

The reserve hypothesis stresses interaction between the auctioneer and the seller. Ekelund et al. (1998) studied estimate ranges in 6378 New York auctions of paintings by Latin-American artists. Ekelund et al. claimed that in these auctions, the lower bound of the estimate range was the result of a negotiation in which the seller had the final say about the reserve and therefore the lower bound. This is because the auction houses applied a (loose) rule that the reserve was 80 per cent of the low estimate. Ekelund et al. claimed this 'rule' did not always hold, in that the reserve could be less than 80 per cent of the lower bound or non-existent. It was, however, a binding rule in the auctions they studied that the low estimate was not below the reserve price.<sup>3</sup> The expert alone chose the upper bound in the estimate range. This separation of responsibility meant that ranges were narrower when the seller set a 'high' reserve. This can be tested by seeing whether narrower ranges are more likely to be associated with passed-in items. Passed-in items are those that fail to reach the reserve price. A 'high' reserve price is more likely to see an item passed-in.

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<sup>2</sup> Another problem with the approach of Beggs and Graddy (1997) was their definition of estimate range breadth as the difference between the high and low estimates, not the proportional difference. The present paper returns to this issue in Section 1.5.

<sup>3</sup> This second rule is followed elsewhere. In art sales, Christie's London announces that the reserve shall not exceed the low estimate.

To test whether the estimate range was related to items being passed-in, Ekelund et al. defined the breadth of the range as  $(\text{high} - \text{low})/\text{mid point}$  and used a binomial Probit model (1 = passed-in, 0 = sale) with variables that captured the separate effects of auction house (Christie's and Sotheby's), whether the painting was signed, the size of the work (measured by the area in square inches), the year of the sale and the breadth of the estimate range. In support of the negotiation hypothesis, they found that the breadth of the estimate range was negatively and significantly related to the likelihood of an item being passed-in.

It is not clear whether this result is specific to art auctions in New York or whether it is a general feature of art auctions as well as auctions in other settings. It might be that elsewhere there is no relationship between estimate range breadth and passed-in items, or even a positive relationship, as sellers and auctioneers who are especially uncertain about an asset's value might set a wide estimate bound and post a high reserve to exploit the uncertainty or protect against the risk of selling too low. Evidence is needed from another setting. Also, the information and negotiation hypotheses are not mutually exclusive, so there is a need to test these hypotheses together in the same setting. To do so, data are needed on prices realised as well as passed-in items. Ideally, the assets sold would be fairly homogenous. Researchers would need to know what information the auctioneers had at the time of sale.

### **1.3 DATA AND MARKET SETTING**

Data were collected from 3144 rare book auctions held at twenty-one sale events at Christie's Australia and Sotheby's Australia. Book auctions have a number of advantages for studying estimate ranges. Book auctions feature a spread of asset values and a simple sale environment that is similar to those in many other settings. All the book auctions studied were ascending auctions that featured secret reserves. In all the auctions, the books were available for pre-sale

inspection and pre-sale catalogues were issued. The catalogues provided descriptions of the books, including accurate bibliographic information and information about the books' physical condition.

An advantage of studying a set of auctions in Australia is that they provide evidence from outside the standard targets of New York and London art auctions. It is useful to know whether results found in those centres apply elsewhere.

There were several reasons for focusing on auctions at Christie's and Sotheby's. Their catalogues are widely distributed and include pre-sale estimates. In the 1980s and 1990s, Christie's was one of the main auction houses dealing in books in Australia. Sotheby's had a smaller share of the market but in many other respects was similar to Christie's. Like Christie's, it is a subsidiary of a multi-national firm.<sup>4</sup> It services the same 'high end' segment of the book auction circuit. Auctions at Christie's and Sotheby's are very similar in the way they are conducted.<sup>5</sup>

All the data are publicly available. The auction catalogues were sourced from the University of Melbourne Library. The price data were drawn from *Australian Book Auction Records* (see Kells, 2002, for a description). The present author matched the books in *Australian Book Auction Records* with the books in the catalogues and entered the prices and estimates into a database.

The price data in *Australian Book Auction Records* exclude books that are not 'of Australasian interest'.<sup>6</sup> Excluding such books from the analysis had the effect of making the cohort of books

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<sup>4</sup> The same cannot be said of any other book auction firms operating in Australia over the sample period.

<sup>5</sup> There is a growing body of empirical work comparing auction outcomes at sales held by these two firms.

<sup>6</sup> This is defined as books and periodicals written by Australians, or published in Australia, or written about Australia or Australians, or about Antarctica, New Guinea, New Zealand or the South Pacific

more homogenous. Multi-book lots were also excluded.<sup>7</sup> This is also not without implications. Auction houses decide whether to sell books individually or in multiple book lots. Selling books in multiple book lots might exclude amateur or retail buyers, who face higher transaction costs in offloading the unwanted books, and financial constraints in purchasing the multiples in the first place.<sup>8</sup> For some very high value books, an estimate range was not published but was available on application at the auction house.<sup>9</sup> These 'on application' estimates were excluded.

The twenty-one sale events were all significant Australiana sales and were all held between 1984 and 1999. The smallest of the twenty-one sale events had 22 auctions of single-book lots of Australasian interest. The largest had 423 such auctions. Every one of the sale events was held in Sydney or Melbourne. Sales before 1984 are not included because many of those sales did not have estimates, and the price data are less readily available before 1984.<sup>10</sup> All the auctions pre-date the goods and services tax that was introduced in Australia on 1 July 2000 and that applies to books sold at auction. Sotheby's largely withdrew from auctioning Australiana between 1991 and 1999.

#### 1.4 DATA PROFILE

This Section gives a graphical and statistical profile of the book auction data. Following Ekelund et al. (1998), the breadth of the estimate ranges is calculated as (high estimate – low

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<sup>7</sup> Book auctions typically include a combination of single book and multiple book lots. One sale event in the sample, at Christie's in 1994, saw an entire library of books sold as one lot.

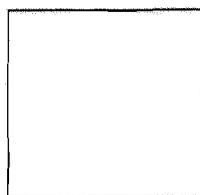
<sup>8</sup> Amateur buyers (private individuals, novices) as opposed to professional buyers (eg. people buying for institutions); retail buyers as opposed to wholesale buyers (eg. booksellers, dealers).

<sup>9</sup> An example was lot 152 (ABAR reference 901486) at Sotheby's, April 1990, which sold for \$110,000 (nominal, including buyer's premium).

<sup>10</sup> The price data before 1984 are incomplete because *Australian Book Auction Records* was not published between 1979 and 1982 inclusive and the 1983 volume covered only a small number of sale events as the data were

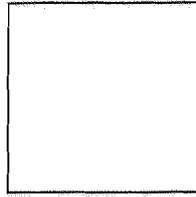
estimate)/midpoint, where the midpoint is the simple average of the high and low estimates. Figure 1.1 shows that the breadths tend to cluster at particular points, for example 40 per cent and 50 per cent. The ten most common breadths are 0.400 (783 instances), 0.286 (451), 0.222 (345), 0.500 (270), 0.182 (245), 0.667 (194), 0.333 (7), 0.250 (106), 0.200 (77) and 0.154 (76). A wide variety of actual estimate ranges are represented by each one of these frequently occurring breadths.

**Figure 1.1: Distribution of breadths, whole sample**

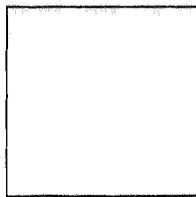


The mean breadth over the whole sample is 33.2 per cent. Figure 1.2 shows that there is a weak negative relationship between estimate range breadth and book value, captured by the midpoint of the estimate range (the gradient of the trendline is  $-1.1346$ ; the R-squared is 0.071). The average breadth for 'high value' books (defined as books with a midpoint estimate above the median midpoint estimate) is 29.4 per cent (1565 observations), compared with 36.8 per cent for low value books (1579 observations). Figure 1.3 gives the distributions of breadths for low value and high value books separately. Narrower breadths are more common for the high value books. Also, the estimates for low value books are relatively concentrated at one point (40 per cent).

**Figure 1.2: Relationship between book value and range breadth, whole sample**



**Figure 1.3: Distribution of breadths of high value books and low value books**

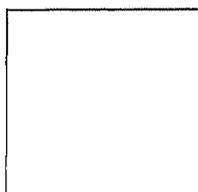


That estimate ranges are narrower for more valuable books makes sense with respect to the information hypothesis, as for those items the auction houses are likely to apply more appraisal effort. The more auction houses seek out information about values, the narrower the estimate ranges would be. Beggs and Graddy (1997) found evidence of a *positive* relationship between value and breadth, but this finding was influenced by their choice of definition of the spread: the difference between the high and low estimates, not the *proportional* difference used by Ekelund et al. (1998) and in this paper. The existence of a statistically significant relationship between estimate range breadth and value in the book auction data is investigated formally in the next Section.

There are differences across the two auction houses in the sample. The average estimate breadth for Christie's is 36.2 per cent, compared with 29.4 per cent for Sotheby's. Figure 4 shows the distribution of the breadths for the two auction firms. The breadths for Sotheby's tend to be

smaller, and they are more evenly spread across different percentages. Thus, in two senses, the Sotheby's estimates are more precise than the Christie's estimates: the Sotheby's estimate ranges are narrower, and they are less concentrated at standard points.

**Figure 1.4: Distribution of breadths for Christie's and for Sotheby's**



There are other differences between Christie's and Sotheby's. In the sample, Christie's had 384 items passed-in, out of 1759 offered for sale, giving a pass-in rate of 21.8 per cent. For Sotheby's, the pass-in rate was 26.4 per cent (1385 offered, 366 passed-in).

Overall, the pass-in rate was 23.9 per cent (so the 'clearance rate' was 76.1 per cent). The average estimate range breadth for passed-in items (34.3 per cent; 750 observations) was higher than the average breadth for items that sold (32.9 per cent; 2394 observations<sup>1</sup>). This is not consistent with the reserve hypothesis. The relationship between estimate range breadths and passed-in items is explored formally in Section 1.6.

## **1.5 INFORMATION AND THE BREADTH OF ESTIMATE RANGES**

This Section explores whether the breadth of expert estimate ranges are narrower when auctioneers have more information about likely prices. The analysis begins with a statistical and graphical analysis. Then the results of a regression analysis are presented.

There are a number of ways to measure how much information auctioneers' have about likely

sale prices. There will be more information for books that are traded more often. This can be measured by counting the number of times copies are auctioned within a year, say, across all auction firms. Another indicator of frequency of sale is the number of copies of a particular book that are offered as separate lots at the same sale event. Books are published in runs, and it is often the case that more than one copy is offered for sale at the same sale event. Such sequential sales of identical and nearly identical assets have been the subject of a great deal of empirical work on how prices and auctioneers behave in multiple object auctions.<sup>11</sup> (Kells, 2001, investigated price paths in sequential auctions of rare books in Australia.) As well as indicating that a book is frequently traded, the presence of more than one copy in a particular sale may lead the auctioneer to apply greater appraisal effort in arriving at the price estimate.

Defects in assets are another indicator of information about likely sale prices. It is reasonable to think that the value of an object is less certain when it is damaged. A defect will affect different people's valuations in different ways, and many different types of major and minor defects can occur.

In forming their valuations, buyers and sellers draw on information in price guides and, in the book market, bibliographies. The information in these sources includes the number of copies that were printed (rarity is key when valuing books) and other details that affect values, such as 'points' that indicate priority in publication. The most well known and authoritative bibliography of rare Australian books is J. A. Ferguson's *Bibliography of Australia* ('Ferguson'). It covers books published between 1784 and 1900 inclusive (not all the books of Australasian interest published in this period are included). It was first published in seven volumes between 1941 and 1963. A facsimile edition, also in seven volumes, was published between 1975 and 1977. An addenda covering 1784 to 1850 was published in 1986.

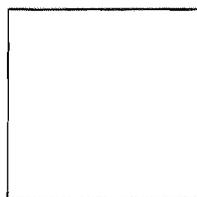
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<sup>11</sup> For example, see Ashenfelter (1989), Chanel et al. (1996), Jones, et al. (1996).

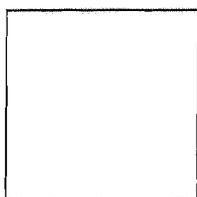
All the information in these four measures was publicly available at the time of sale. This is important. Not only was the information available for auctioneers to use in arriving at their estimates, but it was also available for buyers to form judgements about the accuracy of the estimates and therefore the credibility of the experts. Auction houses care about their credibility because they compete to attract sellers and buyers.

Distributions of breadths were prepared for each of the four information measures. Figure 1.5 gives the distribution of breadths for books that were frequently traded, proxied by whether at least one other copy was sold at auction in Australia in the same calendar year. Figure 1.5 also gives the distribution of breadths for books that were not frequently traded. Figure 1.6 gives the analogous two distributions for books in and not in the *Bibliography of Australia*. Figures 1.5 and 1.6 give tentative support to the hypothesis that frequently traded books and books in Ferguson—that is, books for which more information is available—have narrower estimate bounds. (The average breadth for frequently traded books is 32.0 per cent, compared with 34.3 per cent for the other books. The average breadth for books in Ferguson is 31.8 per cent, compared with 34.2 per cent for those not in Ferguson.)

**Figure 1.5: Distributions of breadths for frequently traded books and infrequently traded books**



**Figure 1.6: Distribution of breadths for books in and not in Ferguson**



For the other information measures—whether a book has a defect, and whether a book was sold as part of a sequence of identical or nearly identical titles—the distributions are not very revealing, and are not shown. The distributions for books with and without defects closely resemble each other. The same is true for the distributions of books in and not in sequences, though the sample of books in sequences is small (467 observations) and so is not very suitable to this kind of graphical analysis. (The average breadth for books with defects is 33.3 per cent, compared with 33.1 per cent for books without defects. The average breadth for books in sequences is 31.7 per cent, compared with 33.5 per cent for books not sold in sequences.)

To explore more formally the relationship between estimate breadths and the four information measures, the following model was estimated using ordinary least squares regression:

$$\text{BREADTH} = f(\text{CONSTANT, MIDPOINT, MULTIPLE, SEQUENCE, FERGUSON, DEFECT, CHRISTIE'S, PASSED-IN}) \quad (\text{Equation 1})$$

BREADTH is defined as  $1000 * (\text{high estimate} - \text{low estimate}) / \text{midpoint}$ .

As in the graphical and statistical analysis, four separate measures of information were used. Trading frequency was captured by the dummy variable MULTIPLE which takes a value of one if at least one other copy of the book was sold (not passed-in) at another auction in Australia in the same calendar year, as documented in *Australian Book Auction Records*. Otherwise, MULTIPLE is zero. The dummy variable SEQUENCE is one when at least one additional copy of the book was offered at the same sale event, and zero otherwise. For the dummy variable SEQUENCE, the other copies offered in the sequence were not necessarily sold: they might have passed-in. The dummy variable FERGUSON is one if the book is in the *Bibliography of Australia* and zero otherwise. The dummy variable DEFECT is one if the book had a defect that was documented in the auction catalogue, and zero otherwise.

Figures 1.2 and 1.3 in the previous Section showed that the breadths of estimate ranges differ across asset values. The variable MIDPOINT was used to capture the likely sale value and is the simple average of the high and low estimates (in 1999 dollars).<sup>12</sup> In the previous Section, it was also shown that Christie's and Sotheby's differ somewhat in the profile of their estimate breadths. A quick look at the data also shows that the two auction firms differ across the four information measures, as shown in Table 1.1.

**Table 1.1: Data shares across auction firms for each information measure**

Information measure	Christie's	Sotheby's
% frequently traded	42.3	40.6
% in sequences	49.6	41.6
% in Ferguson	17.6	11.3
% with defects	57.2	41.4

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<sup>12</sup> The advantage of using the midpoint instead of the price is that midpoint data are available for passed-in items whereas price data are not. The midpoint was converted into 1999 dollars using the Australian consumer price index.

To capture differences between the auction firms, the variable CHRISTIE'S was used. It equals one if the book was offered by Christie's and zero if it was offered by Sotheby's.<sup>13</sup> Finally, the variable PASSED-IN was used to capture whether the breadth of the estimate ranges was different for passed-in items compared with those that sold, controlling for all the other variables. PASSED-IN equals one if the book was passed-in, and zero otherwise.

When Equation 1 was estimated, the auction house dummy CHRISTIE'S was found to be highly significant. Additional regressions were therefore estimated for each of the two auction firms (2A and 3A). The coefficient on PASSED-IN was also significant, and regressions were estimated for books that sold (4A) and books that passed-in (5A). The coefficient on the variable DEFECT was not significant in any of the regressions at the 10 per cent level (this is consistent with the statistical and graphical analysis above). The five regressions were therefore re-estimated with DEFECT excluded.<sup>14</sup>

Table 1.2 gives the results for the five regressions. The figures in brackets are t values. Significance at the 5 per cent level is indicated by two asterisks; significance at the 10 per cent level is indicated by one asterisk.

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<sup>13</sup> Bauwens and Ginsburgh (2000) provide evidence that Sotheby's London follows different estimate strategies for different asset values - specifically that it underestimates for high value assets and overestimates for low value assets, in order to manage the clientele who attend its auctions.

<sup>14</sup> Tests of the joint significance of the coefficients in each of the regressions were conducted and in every case the null hypothesis of insignificance was rejected. There is no reason a priori why heteroskedasticity should be a problem in these regressions, and inspection of the residuals showed no evidence of heteroskedasticity.

**Table 1.2: Regression results using Equation 1**

BREADTH	Constant	Midpoint	Multiple	Sequence	Ferguson	Passed-in	Christie's	F
1A. All n=3144	310.57 (63.87)**	-0.0004 (-1.90)*	-22.68 (-4.36)**	-12.56 (-1.73)*	-21.02 (-4.31)**	13.88 (2.46)**	71.43 (14.84)**	45.17
2A. Christie's n=1759	389.31 (64.66)**	-0.0002 (-0.96)	-38.46 (-5.11)**	-22.21 (-2.24)**	-17.09 (-2.46)**	14.87 (1.79)*		13.32
3A. Sotheby's n=1385	305.62 (56.05)**	-0.0007 (-4.81)**	-1.10 (-0.16)	15.90 (1.47)	-23.92 (-3.57)**	9.83 (1.33)		9.42
4A. All sold n=2394	305.39 (55.89)**	-0.0002 (-1.14)	-13.60 (-2.24)**	-8.98 (-1.07)	-17.30 (-3.12)**		68.45 (12.15)**	32.30
5A. PI only n=750	340.51 (43.28)**	-0.0045 (-4.15)**	-47.90 (-4.75)**	-27.80 (-1.88)*	-17.79 (-1.68)*		73.61 (7.95)**	28.98

The significant and positive coefficient in model 1A ('All') on CHRISTIE'S indicates breadths are on average higher for Christie's auctions, which is consistent with Figure 1.4.

The coefficient on MIDPOINT was negative in all the regressions, and significant in all except model 2A ('Christie's'). Christies and Sotheby's were thus found to differ with respect to the relationship between estimate breadth and asset value. For Sotheby's, BREADTH was negatively related to the midpoint of the estimate range; in other words, estimates were more precise for more expensive books. In the case of Christie's, no relationship between BREADTH and MIDPOINT was found.

The coefficient on the PASSED-IN dummy was significant and positive in model 1A, indicating that estimate range breadths are wider for passed-in items, controlling for the other influences. For the auction house regressions (2A and 3A), the coefficients on PASSED-IN were also positive, though not significant at Sotheby's (the coefficient was significant at the 10 per cent level at Christie's). These results are not consistent with the reserve hypothesis. For Sotheby's they imply there is no relationship between estimate range breadth and whether an item is passed-in. For Christie's (and for the dataset as a whole) the results imply that estimate range breadths are *wider* for passed-in items.

What do the regressions say about the information hypothesis? The coefficients on the information measures MULTIPLE, SEQUENCE and FERGUSON all had the expected signs (they were all negative) with the exception of the coefficient on SEQUENCE in model 3A ('Sotheby's'). The influence of MULTIPLE was significant at the 5 per cent level in all the models except 3A ('Sotheby's'). The influence of SEQUENCE was significant at least at the 10 per cent level in all the models except 3A ('Sotheby's') and 4A ('All sold'). The influence of FERGUSON was significant at the 5 per cent level in all the regressions, except for 5A ('Passed-in only') where it was significant at the 10 per cent level. (Recall that the coefficient on DEFECT was not significant in any of the regressions, so DEFECT was excluded.)

These results are broadly consistent with the graphical and statistical analysis: asset value was found to play a role; DEFECT has no effect; SEQUENCE has a small effect; and the other information measures have a relatively strong effect. Overall, they provide support for the information hypothesis, because they indicate that estimate range breadths are narrower when there is more information available about asset values. As noted above, the results do not provide any support for the reserve hypothesis. The next Section investigates the reserve hypothesis more extensively.

## **1.6 PASSED-IN ITEMS AND THE BREADTH OF ESTIMATE RANGES**

The previous Section found some empirical support for the information hypothesis. The subject of this Section is the reserve hypothesis. The Section begins with an investigation of the relationship between reserve prices and price estimates, and specifically of whether books sell at prices below the low estimate, and how much below. The Section then presents the results of a Probit analysis that was used to explore whether the breadth of estimate ranges is related to the probability of an item being passed-in.

The reserves in the auctions studied were secret, but it is possible to make inferences about the reserves using information about whether books sold, the price at which they sold, and the estimate ranges. If a book sold at a price below the lower bound of the estimate range, for example, it can be inferred that the reserve price was lower than the lower bound.

Table 1.3 shows the proportion of prices that were below the low estimate, the proportion between the low and high estimates, and the proportion above the high estimate. The proportions below 80 per cent of the low estimate and below 50 per cent of the low estimate are also shown.

**Table 1.3: Relationship between prices and estimates**

	% below low estimate	% below 80% of low estimate	% below 50% of low estimate	% between low and high estimate (inclusive)	% above high
All	33.42	15.33	1.80	35.34	31.24
Sotheby's	30.81	11.19	1.77	30.72	38.47
Christie's	35.35	18.40	1.82	38.76	25.89

The table shows that it is not unusual for books to sell below the low estimate; a third of all the books in the sample did so. It is also not unusual for books to sell below 80 per cent of the low estimate; 15.3 per cent of books did so. Thus a substantial number of books broke the loose rule identified by Ekelund et al. (1998) for Latin American art auctions in New York, indicating that no such rule applies in Australian rare book auctions.

The table gives the proportions for Christie's and Sotheby's separately. The data show that Sotheby's tended to underestimate prices (a relatively high share sold above the high estimate) and that Christie's was more accurate (insofar as a higher share of prices fell in the estimate range) but was more likely to overestimate than to underestimate prices.

To analyse the relationship between reserves and estimate breadths more formally, the remainder of this Section presents the results of a Probit analysis. The approach follows Ekelund et al. (1998). A binomial Probit model was estimated using maximum likelihood estimation. The dependent variable took a value of 1 if the lot passed-in, and zero otherwise. The explanatory variables captured the influence of estimate range breadth, asset value and auction house.

$$\text{Prob (PASSED-IN)} = f(\text{constant, BREADTH, MIDPOINT, CHRISTIE'S})$$

(Equation 2)

The variables are the same as those defined in Section 1.5. The model was estimated in three versions: one for the whole sample, one for Christie's only and one for Sotheby's only. The coefficient on the dummy variable MIDPOINT was not significant at the 10 per cent level in all three versions and so was excluded. The models were re-estimated. The results are in Table 1.4. Significance at the 5 per cent level is indicated by two asterisks; significance at the 10 per cent level is indicated by one asterisk.

**Table 1.4: Z statistics from maximum likelihood estimation of Equation 2**

	Constant	Breadth	Christie's	LR $\chi^2$
1B. All n=3144	-12.48**	3.43**	-3.75**	20.72
2B. Christie's n=1759	-11.18**	2.87**		8.22
3B. Sotheby's n=1385	-8.26**	1.90*		3.58

For 1B ('All') and 2B ('Christie's'), breadth was significantly positively related (at the 5 per cent level of significance) to the probability of an item being passed-in. For 3B ('Sotheby's') the relationship was found to be significant at the 10 per cent level. In 1B ('All'), the influence of the dummy variable CHRISTIE'S was highly significant and indicated that the probability of an item passing-in was higher at Sotheby's than at Christie's.

The finding, that higher estimate range breadths are associated with a higher probability of items passing-in, is **not** consistent with the reserve hypothesis; in fact, it is the opposite of the relationship that was identified by Ekelund et al. (1998).

How robust is this result? To explore this question, the remainder of this Section considers how the degree of information available to auction market participants, along with the breadth of the estimate range, is related to the likelihood of an item being passed-in. Underlying this is the possibility that the availability of more information influences how sellers set the reserve price. The approach adopted to test this was to include in the binomial Probit model the information measures described in Section 1.5. The expanded model is as follows:

$$\text{Pr(PASSED-IN)} = f(\text{constant, BREADTH, MIDPOINT, CHRISTIE'S, MULTIPLE, SEQUENCE, DEFECT, FERGUSON}) \quad (\text{Equation 3})$$

The variable definitions are the same as those for the previous two models. As before, three versions of Equation 3 were estimated: one for the whole sample (1C), one for Christie's only (2C) and one for Sotheby's only (3C). The results are in Table 1.5. Again, significance at the 5 per cent level is indicated by two asterisks, and significance at the 10 per cent level is indicated by one asterisk.

**Table 1.5: Z statistics from maximum likelihood estimation of Equation 3**

	Const.	Breadth	Midpoint	Multiple	Sequence	Defect	Ferguson	Christie's	LR $\chi^2$
1C. All n=3144	-8.08**	2.42**	-0.16	-2.43**	-0.50	2.76**	-6.98**	-3.58**	83.14
2C. Christie's n=1759	-7.32**	1.46	-0.80	-1.14	-4.30**	5.44**	-5.81**		85.79
3C. Sotheby's n=1385	-4.85**	1.39	2.16**	-2.51**	4.03**	-1.45	-5.37**		56.99

In model 1C ('All'), the influence of the auction house dummy was found to be significant and

negative, again indicating books at Christie's were less likely to pass-in.

In 2C and 3C, the most important result for this paper is that the influence of BREADTH becomes insignificant when the information measures are included. The effect is still positive but is not significant at the 10 per cent level.

As in Section 1.5, Christie's and Sotheby's were found to differ with respect to the influence of SEQUENCE. For Christie's, there was a significant negative effect for books that were part of sequences; for Sotheby's, there was a significant positive sequence effect. The two auction houses appear to follow quite different strategies with respect to how to set estimate ranges and reserves for books sold in sequences. It appears that Sotheby's and its seller clients tend to set higher reserves for books in sequences.

Table 1.5 shows that the two auction houses also differ with respect to the influence of MULTIPLE, MIDPOINT and DEFECT. Only FERGUSON, BREADTH and the constant term had similar influences at the two auction houses on the probability of items being passed-in. Books in Ferguson were found to be much less likely to pass-in than other books. For Christie's, all the information measures have consistent signs; more information reduces the likelihood of a book being passed-in (only MULTIPLE is not significant at 10 per cent). In the Sotheby's estimation, FERGUSON and MULTIPLE have negative signs, consistent with the results for Christie's. But the DEFECT variable for Sotheby's also has a negative sign, although it is insignificant.

## 1.7 CONCLUSION

This paper investigated two explanations of the breadth of ranges of expert estimates in auctions. Statistical and regression techniques were used to see if estimate ranges were

narrower in the presence of more information about asset values. A Probit analysis was used to see if the breadth of estimate ranges was associated with the probability of assets being passed-in.

The analysis found evidence in support of the information hypothesis: that estimate range breadths are narrower when there is more information about likely prices. The analysis found no evidence in support of the reserve hypothesis: that narrower estimate ranges predict items being passed-in. The relationship identified by Ekelund et al. (1998) between the low estimate and the reserve price is not relevant to rare book auctions in Australia.

The paper identified some differences between Christie's and Sotheby's with respect to the strategies they adopt in rare book auctions in Australia. This is consistent with the evidence from sequential auction studies that the two firms adopt different approaches even though the auctions they conduct are broadly similar. Differences in auctioneers' strategies in this setting warrant further research.

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