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The Winner's Curse and Bidder Competition in Acquisitions: Evidence from Failed Bank Auctions

S. MICHAEL GILIBERTO and NIKHIL P. VARAIYA*

ABSTRACT

This study examines the effect of bidder competition in acquisitions. We use predictions from auction theory to test whether acquirers of failed banks overpay (the "winner's curse") when bidding in FDIC sealed-bid purchase and assumption (P&A) transactions (auctions). The empirical results indicate that *winning* bids tend to increase as the number of competitors increases, as predicted by theory. We also find that bid levels of *all* bidders increase with increased competition, which is consistent with bidders' failing to adjust for the winner's curse in a common value auction setting. However, additional tests using winning bids only are consistent with both a common value and a private values model, so this result should be interpreted with caution.

THE WINNER'S CURSE HYPOTHESIS states that the winner of a *sealed-bid* auction in which the value of the object being competed for is uncertain tends to be the one who most overestimates the true value of the auctioned object. As a result, auction winners who fail to recognize this possibility are likely to be "cursed" by having paid more for the object than its true worth. This hypothesis has been applied to various situations, including bidding on oil and gas leases (Capen et al. [3]), and corporate takeovers (Roll [16], Varaiya [19]).

Support for the existence of the winner's curse has been reported primarily from laboratory experiments (Bazerman and Samuelson [1], Kagel and Levin [12]). Testing of the "winner's curse hypothesis" with market data is in its early stages. Gilley, Karels, and Leone's [7] study of bidding for oil leases provides mixed suport. Brannman, Klein, and Weiss [2] examine bidding behavior in a variety of auction markets and interpret some of their results as supporting the winner's curse hypothesis. Our study examines the effects of bidder competition and the winner's curse hypothesis within the context of FDIC auctions of failed banks.

Our study may also have relevance for the broader corporate control literature. This literature uniformly indicates that shareholders of acquired firms earn large and positive abnormal returns due primarily to the payment by acquiring firms

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of substantial premiums. By comparison the results for acquiring firms are mixed, with some studies reporting small but (marginally) positive or zero announcement-period returns and others reporting small but significantly negative returns. Not surprisingly, this mixed evidence is consistent with conflicting explanations. Jensen and Ruback [10] conclude that "corporate takeovers generate positive gains, that target firm shareholders benefit, and that bidding firm shareholders do not lose" (p. 47). Roll [16] reinterprets the evidence on bidder returns as supporting the hubris hypothesis, which states that managers infected with hubris try to maximize value but overestimate the magnitude of takeover gains and thus simply pay too much for target firms. He concludes, "Bidders may indicate by their actions a belief in the existence of takeover gains, but systematic studies have provided little to show that such beliefs are well founded" (p. 213).

The hubris hypothesis itself appears to be premised on an improper recognition of the winner's curse phenomenon by bidding firms. Strictly speaking, the usual corporate takeover auction does not conform to the sealed-bid auction framework in which the winner's curse phenomenon can occur. However, FDIC auctions, being sealed-bid auctions, provide unique market data to examine bidder response in acquisition settings in which the winner's curse can occur. Such an examination offers evidence, albeit from a specialized setting, on the unresolved issue of whether bidders pay too much in corporate takeovers.

When an insured commercial bank fails, the Federal Deposit Insurance Corporation (FDIC) has two primary options to protect depositors. First, it may choose to pay off insured depositors and liquidate the bank. Using the second option, called a purchase and assumption (P&A) transaction, the FDIC arranges a takeover of the failed bank by an (existing) financial institution. Under this option the FDIC conducts an auction in which commercial banks bid against one another to purchase some of the failed bank's assets and assume its deposits. Over the time period 1969–1985 the P&A option was utilized in approximately 76% of all failed bank transactions (FDIC [4]).

The effects on the common stock of the acquirer that wins a P&A auction have been examined by Pettway and Trifts [14] and James and Weir [9]. Pettway and Trifts report that average geometric abnormal returns are negative and continue to decline shortly after the acquisition for a sample of eleven P&As over the period 1972–1981. They conclude that winning bidders *overbid* for failed banks. James and Weir report, however, that average announcement-period abnormal returns to winning bidders are positive and significant for a sample of nineteen P&As over the period 1973–1983. Based on this result, along with results of other cross-sectional tests, they conclude that winning bidders in P&A auctions pay *less* than "true" value and thereby gain at the expense of the insurance fund.[1]

The approach used in this paper differs from the above two studies in that we test two sets of predictions: (i) the relationship between the expected *optimal* bid

[1] A comparison between the two studies is rendered difficult since abnormal returns are measured differently and there appear to be differences in the compositions of the samples in each study. Moreover, estimating acquisition gains by abnormal stock returns may be especially problematic in such acquisitions if (i) the winning bidder is much larger than the failed bank, (ii) the winning bidder is (a small) part of a multi-bank holding company with nonbanking businesses, and (iii) announcement dates are difficult to identify since regulation-induced information leakages are more likely than for nonbank acquisitions.

of any bidder and the number of competing bidders as predicted by the winner's curse model and (ii) the relationship between the expected *winning* bid and the number of competing bidders as predicted by alternative auction models. Since very few (acquiring) banks have actively traded common shares, tests based on observed bids (instead of abnormal returns) enable us to work with a sample that approximates the entire population of P&A transactions from 1975 to 1985.

The paper is organized as follows: Section I describes the mechanics of P&A transactions. Section II summarizes the relevant auction theory and provides a statement of its testable predictions. It is followed by a description of the data and empirical methodology in Section III. Section IV contains the empirical results along with their interpretation, and Section V contains the conclusions of this study.

I. P&A Transactions

In almost all failures of federally insured commercial banks, the FDIC is named receiver and is granted authority to dispose of the failed bank. The decision of which method to use to dispose of the bank is based on the cost of the various possible methods to the FDIC along with other considerations such as potential effects of the method chosen on regional or national financial and other markets.[2]

In the case of a P&A transaction, the FDIC invites eligible bidders to an auction in which they bid on a package containing some of the failed bank's assets and all its nonsubordinated liabilities. Bidder eligibility requirements vary by state and depend on factors such as regulations on bank ownership, branching restrictions, restrictions on multibank holding companies (MBHCs), and compliance with the FDIC's capital policy. At the auction,

> a uniform package is offered to bidders. This package consists of deposits and other nonsubordinated liabilities and a like amount of assets, less the amount of the premium bid. In its simplest form the assets consist of bank premises (subject to subsequent appraisal), cash assets, securities valued at market, performing consumer loans and cash furnished by the FDIC to equate acquired assets (less the premium paid) to assumed liabilities. (FDIC [5, p. 88])

A ninety-day "put-back" option is (generally) written into the P&A agreement. This allows banks to return to the FDIC those loans that the acquiring bank believes should have been classified at the time of the acquisition. The acquiring bank, i.e., winning bidder, is determined by a first-price sealed-bid auction generally held within forty-eight hours of (expected) closure of the failed bank. Participating bidders may therefore have only about twenty-four hours to evaluate the specifics of the failed bank and to submit a bid.

The Federal Deposit Insurance Act directs the agency to weigh the benefits to the insurance fund of selecting a particular bidder against possible anticompeti-

[2] Between 1969 and 1985, there were 393 insured commercial bank failures. Of these, eighty-five (22%) were disposed of via deposit payoffs and 297 (76%) were disposed of via P&A transactions. The Federal Deposit Insurance Act explicitly requires the FDIC to choose the approach to handle a bank failure that minimizes the expected cost to the insurance fund.

tive effects or adverse effects on the soundness of the banking system. In the absence of any extenuating circumstances (as determined by the FDIC), the highest bid for the failed bank would be accepted.

Since assets of questionable worth, such as all nonperforming loans, are not part of the package offered to bidders, bidders in essence bid on the failed bank as a going concern, i.e., purchase the charter to operate a reconstituted failed bank. The purchase premium, the dollar bid offered by any bidder, will then depend on the bidder's estimate of the economic value of the charter. The adjustment of the values of acquired assets to market values and the presence of the "put-back" option imply that the differences in individual bids are unlikely to reflect uncertainty about purchased assets. Rather, the differences arise from uncertainty about the economic value of the charter.

The charter's value is the present value of the expected future earnings to be generated from charter ownership. Future earnings will in turn depend on the average difference between the cost at which funds can be obtained and the return at which the procured funds can be invested. Briefly, for a failed bank the cost of funds depends primarily on the composition of the acquired deposits and the bank's access to funds. The return on invested funds in turn depends on both the national and regional economic environment, as well as restrictions on branching and holding company formation and future access to borrowers (Hirschhorn [8]).

II. Auction Theory

P&A auctions are first-price sealed-bid auctions. Two frameworks have been developed in auction theory to study bidding behavior: the independent private values (IPV) and common value (CV) models. In a CV auction, the value of the auctioned object is the same to all bidders. However, this value is unknown at the time bids are placed. In an IPV auction, each bidder knows precisely the value of the auctioned object to himself or herself. However, each bidder does not know the value of the object to the other bidders. (This is the private values assumption.) It may, however, be difficult to determine a priori whether a given "real world" auction can be categorically classified as an IPV or CV auction. Thus, for example, oil lease auctions are generally viewed as CV auctions whereas auctions for oil paintings or antique objects are generally viewed as IPV auctions.

A. Are P&As CV or IPV Auctions?

It could be argued that there is a "true" value to the charter of the reconstituted failed bank (determined, for example, by location, access to depositors, customers, etc.) which is nearly the *same* across bidders, so that the P&A auction may be dominated by elements of the CV model. Moreover, FDIC-imposed bidder eligibility criteria require that bidders must comply with the FDIC's capital policy as well as state and federal laws governing bank acquisitions on MBHCs. These eligibility requirements may thereby serve to restrict the set of bidders to be more or less *equally* capable of exploiting the failed bank's franchise.

On the other hand, value differences among bidders may be due to differences in their abilities to utilize the deposit and customer base of the failed bank. If bidders, for example, are part of large MBHC organizations, they may be better able to utilize the failed bank's charter than non-MBHC bidders. In such situations, IPV elements may dominate the P&A auction. Identifying the appropriate auction model is therefore an empirical issue.

B. Optimal Bidding

In the CV model it is assumed that the auctioned object has some "true" value which is unknown but is the same for all bidders. Bidder value estimates are assumed to be unbiased and modeled as random drawings from a probability distribution having the true value as its mean.

The winner's curse arises when a bidder fails to recognize that if his or her bid is the winning bid it is highly likely that he or she has received the highest estimate of value. If bidders fail to account for this adverse-selection problem, then the winner is likely to pay more than true value. Optimal bidding strategies to avoid the winner's curse have been developed (Wilson [20], Kagel and Levin [12]). These strategies require that the bidder discount his or her value estimate to reflect (i) the number, N, of competing bidders and (ii) the degree of uncertainty, σ, about true value. The optimal bid in the CV model *decreases*, ceteris paribus, with increases in both N and σ.[3]

In the IPV model bidders form *independent* subjective valuations of the auctioned object and know their valuations with *certainty*. There is, therefore, no need to adjust for the winner's curse or adverse-selection problem. Optimal bidding again implies a discount that reflects uncertainty, in this case about the value estimates of other bidders and the number of competing bidders. Ceteris paribus, an increase in the variance of bidder valuations increases the distance between a bidder's valuation and that of the closest competing bidder. As a result, a bidder can lower his or her bid without (materially) affecting the probability of winning the auction. Hence, as in the CV model, an increase in σ, ceteris paribus, results in a decrease in optimal bids. Unlike the CV model, an increase in N, ceteris paribus, *increases* optimal bids, as it is more likely that another bidder's estimate is close to one's own (French and McCormick [6]).

To summarize, the optimal bid, b_i, of any bidder can be characterized as $b_i = b(E, N, \sigma)$, where E denotes the expected value of the auctioned object—$\partial b_i/\partial E > 0$ for both the CV and IPV models; $\partial b_i/\partial N < 0$ for the CV model; $\partial b_i/\partial N > 0$ for the IPV model; and $\partial b_i/\partial \sigma < 0$ for both the CV and IPV models. However, it should be noted that no explicit linear relationship between b_i and E, N, and σ has been derived in the literature.[4]

C. Discriminating between the IPV and CV Models

C.1. IPV Model

Riley and Samuelson [15] show that, when bidders are *risk neutral* and the IPV model is applied to a "high bidder wins" first-price sealed-bid auction, the

[3] See Smith [18] for necessary and sufficient conditions underlying the predicted relationship between the optimal bid and number of competing bidders.

[4] For example, the optimal bid function derived in Kagel and Levin [12] is linear in the value estimate but nonlinear in N, σ.

expected winning bid equals the expected second-order statistic (the expected value of the second highest observation in a random sample) of the underlying distribution of the bidders' subjective valuations. The intuition behind this result is that it is not necessary for a bidder to bid his or her valuation in order to win. For the bidder who values the object most, it is only necessary to bid slightly more than the bidder whose valuation is next highest. As the number of bidders increases, the expected second-order statistic also increases; the expected winning bid lies farther out in the right tail of the distribution.

C.2. CV Model

In the CV model, the predicted relationship between the expected winning bid and the number of competing bidders depends on whether bidders account for the winner's curse phenomenon. If bidders do not adjust for the winner's curse and aggressively bid their estimated values, then the expected winning bid equals the expected maximum-order statistic of the distribution of bidders' value estimates. This increases with an increase in N.

If bidders cognizant of the winner's curse adopt optimal bidding strategies, then the expected winning bid converges asymptotically to the unknown true value as the number of bidders increases. Moreover, the expected winning bid increases in proportion to $1/N$, where N is the number of bidders (Rothkopf [17], Wilson [20]).

To summarize, both IPV and CV models predict that the expected winning bid increases with the number of bidders, but the specific pattern of this increase depends on the type of auction model (and whether bidders adjust for the winner's curse in the CV model). Further,

(i) In the IPV model, the expected winning bid equals the expected second-order statistic of the distribution of valuations (with risk-neutral bidders).
(ii) In the CV model without adjustment for the winner's curse, the expected winning bid equals the expected maximum-order statistic of the distribution of bidder value estimates.
(iii) In the CV model with adjustment for the winner's curse, the expected winning bid increases in proportion to $1/N$, N being the number of competing bidders.

III. Data Description and Empirical Methodology

A. Data Description

To examine the effects of bidder competition and to test whether bidders suffer from the winner's curse in P&A auctions, data on insured commerical bank failures were obtained from the FDIC. There were 322 transactions in the acquired data, covering the majority of failures of insured commercial banks during the period 1965–1985. Out of the initial 322 transactions, we eliminated sixty-seven cases which either were labeled as not being purchase and assumption or lacked information identifying the method the FDIC used to handle the failure. For each failure handled by a P&A, we attempted to determine the dollar amounts of assets to be purchased and liabilities to be assumed, the sizes of the bids submitted, plus pertinent identifying information (date, bank names, etc.). Incomplete data forced the elimination of thirty-six P&As, predominantly in the early part of the period. Our final sample consists of 219 P&A transactions taking place from 1975 through 1985 and comprises 85.8 percent of all P&As over the period 1975–1985. Note that data on bidders who were invited to participate in the auction but who declined to bid were unavailable. Therefore, the sample contains only positive bids. In total, 572 nonzero bids were submitted, for an average of 2.61 bids per auction. Descriptive statistics about the sample's composition are contained in Table I.

Eighty-seven percent of the P&As in the sample occur over the period 1982–1985, mirroring the increasing bank failure rate over this period. Federal Reserve districts 6, 7, and 10–12 account for eighty-three percent of the sample P&As, largely accounted for by failures in the farm belt and oil-producing regions. Table I (Panel E) also indicates a decline in average bid levels and average number of bidders in P&A auctions through time. Panels C and D indicate that the second highest bid approximates sixty-two percent of the highest bid and that the lowest bid approximates forty percent of the highest bid in transactions with more than one bidder. This suggests considerable variance among bidders with respect to the estimated value of the reconstituted failed bank.

B. *Empirical Methodology*

Two sets of testable predictions about the relationship between bids, uncertainty, and the number of competing bidders were described earlier. The first approach utilizes both winning and losing bids, the second approach only the winning bids.

B.1. Tests Based on All Bids

Assume that P&A auctions are CV auctions. Optimal bidding behavior to avoid the winner's curse implies that bids are inversely related to (i) the number of competing bidders[5] and (ii) the variance of the distribution of value estimates, i.e., uncertainty. To test these predictions for P&A transactions, we estimated the following model:

$$\log BID_{ij} = b_0 + b_1 \log TDDA_j + b_2 T_{82} + b_3 T_{83,}$$
$$b_4 T_{84} + b_5 T_{85} + \sum_{k=6}^{12} b_k F_k + c_1 \log N_j + c_2 V_j + u_{ij}, \tag{1}$$

where BID_{ij} is the ith bid submitted for bank j, N_j is the number of positive bids received for bank j (a proxy for the expected number of bidders), and V_j is a measure of the uncertainty about the value of the failed bank.[6] Additional

[5] Note that this does not contradict the prediction that the expected *winning* bid increases with increased competition.

[6] We also estimated a version of (1) using number-of-bidders dummy variables to account for any nonlinearities in the relationship. These results are similar to those presented below and are not reported.

The logarithmic specification is also used by Brannman et al. [2]. We estimated (1) in nonlogarithmic form. The residuals here exhibited a pattern consistent with a nonties functional form and/or heteroscedasticity in the disturbance term. These results are not presented.

Table I

FDIC Purchase and Assumption Auction Bid Statistics (1975–1985)

A. Number of Bidders Participating in Auction[a]

Number Participating	Frequency of Occurrence	Percentage Frequency of Occurrence
1	73	33.3%
2	56	25.6%
3	41	18.7%
4	19	8.7%
5	13	5.9%
6	9	4.1%
7	1	0.5%
8	3	1.4%
9	2	0.9%
10	2	0.9%
Total	219	100.0%

Mean = 2.61
Median = 2

B. Ratio of Highest Bid to Assumed Liabilities

Highest Bid as a Percentage of Assumed Liabilities	Frequency of Occurrence	Percentage Frequency of Occurrence
Less Than 1%	49	22.4%
1%–2%	37	16.9%
2%–3%	35	16.0%
3%–4%	20	9.1%
4%–5%	22	10.0%
5%–6%	20	9.1%
6%–7%	14	6.4%
7%–8%	6	2.7%
8%–9%	4	1.8%
9%–10%	2	0.9%
10%–12%	5	2.3%
12%–14%	3	1.4%
14%–16%	0	0.0%
16%–18%	1	0.5%
18%–20%	0	0.0%
More Than 20%	1	0.5%
Total	219	100.0%

Mean = 3.449%
Median = 2.643%

C. Ratio of Second-Highest to Highest Bid

Ratio of Second-Highest to Highest Bid	Frequency of Occurrence	Percentage Frequency of Occurrence
Less Than 10%	3	2.1%
10%–20%	7	4.8%
20%–30%	7	4.8%
30%–40%	16	10.9%

Table I

continued

C. Ratio of Second-Highest to Highest Bid

Ratio of Second-Highest to Highest Bid	Frequency of Occurrence	Percentage Frequency of Occurrence
40%–50%	15	10.3%
50%–60%	16	11.0%
60%–70%	16	11.0%
70%–80%	22	15.1%
80%–90%	24	16.4%
More Than 90%	20	13.7%
Total	146[b]	100.0%

Mean = 62.239%
Median = 65.803%

D. Ratio of Lowest to Highest Bid

Ratio of Lowest to Highest Bid	Frequency of Occurrence	Percentage Frequency of Occurrence
Less Than 10%	17	11.7%
10%–20%	23	15.7%
20%–30%	21	14.4%
30%–40%	20	13.6%
40%–50%	17	11.6%
50%–60%	12	8.3%
60%–70%	9	6.1%
70%–80%	13	8.9%
80%–90%	7	4.8%
More Than 90%	7	4.8%
Total	146[b]	100.0%

Mean = 40.558%
Median = 35.524%

E. Selected Variables by Year

		High Bid as a Percentage of:		
Year	Number of Auctions	Assumed Liabilities	Demand Deposits	Average Number of Bidders
1975–1981	29	5.97%	19.98%	3.41
1982	20	4.79%	23.69%	3.00
1983	32	2.98%	20.85%	2.28
1984	59	3.48%	21.37%	2.64
1985	79	2.34%	15.28%	2.33
Total	219	Means: 3.44%	19.13%	2.61

[a] Positive bids only.

[b] Total equals 146 because seventy-three cases with only one bidder are excluded.

variables appear in (1) to control for value differences in the expected economic values of failed bank charters across auctions. Bidders could presumably obtain assets similar to those offered at market value in the FDIC package; it is the (core) deposit base and/or deposit-gathering capability of the failed bank that attracts bidders. Thus, the value of the (reconstituted) failed bank's charter is expected to be positively correlated with the volume of core deposits. The log of total demand deposits is used as a proxy for this.[7] The remaining variables are dummy variables for the year of acquisition (T_{82}, T_{83}, T_{84}, T_{85}; $T_{83} = 1$ if the transaction took place in 1982 and $T_{82} = 0$ otherwise, for example) and Federal Reserve district (F_6–F_{12}; $F_{10} = 1$ if the failed bank was in the tenth district and $F_{10} = 0$ otherwise). The reason for including these is to provide proxies for cyclical and regional factors affecting the value of a failed bank's charter. Failures in Federal Reserve districts 1 through 5 account for less than six percent of the sample; any effects associated with these districts are included in the intercept. Any differential effects for failures occurring prior to 1982 (about thirteen percent of the sample) are also part of the intercept; passage of the Depository Institutions Deregulation and Monetary Control Act in 1981 suggests that this is a reasonable point in time at which to allow for the effect of broad changes in the regulatory environment.[8] For V_j we used several alternative measures which are described below.

The expected sign of b_1 is positive; c_2 is expected to be negative. If bidders adjust for the winner's curse, c_1 should also be negative, indicating that the expected optimal bid level declines with increased competition. Therefore, a significant positive value for c_1 is evidence against the hypothesis that bidders recognize the winner's curse.

Our P&A sample contains no data on the number of bidders who chose not to submit bids; hence, the number of zero bids is unknown: the sample is truncated at zero. We used both the OLS and the truncated regression model described in Maddala ([13, pp. 165–70]) to estimate (1). The truncation problem also influences the choice of how to measure value uncertainty (V_j). A natural measure might be the variance of the bids in the jth auction, but this is available only if data are obtained on *all* bids—positive and zero. For V_j, several alternative measures were used: (i) the variance of the positive bids for the jth auction, (ii) the observed bid range for the jth auction, and (iii) an estimate of the variance of the entire distribution computed from the observed bids for the jth auction (Johnson and Kotz [11, p. 85]).

B.2. Tests Based on Winning Bids

The nature of a particular auction, i.e., whether it is IPV, CV with adjustment, or CV without adjustment, may, in principle, be empirically differentiated by examining the relationship between the expected winning bid and the number of bidders. First, we estimated the following general model of the expected winning

[7] The FDIC data also provide an amount for time deposits. We were unable to identify what proportion of this is volatile time deposits and what proportion belongs to core deposits.

[8] We also estimated versions of (1) with full sets of time and Federal Reserve district dummies and with an additional dummy for whether there were restrictions on branch banking within the failed bank's state. The results were not significantly different from those presented below. In particular, the restriction dummy did not appear to be significant. States with branching restrictions are generally "neighbors," so the Federal Reserve district dummies may also pick up the effects of branching restrictions.

bid and its determinants:

$$\log WBID_j = b_0 + b_1 \log TDDA_j + b_2 T_{82} + b_3 T_{83}$$

$$+ b_4 T_{84} + b_5 T_{85} + \sum_{k=6}^{12} b_k F_k + \textstyle\sum_{k=2}^{10} c_k D_k + u_j, \tag{2}$$

where $WBID_j$ is the winning bid for the jth auction, $TDDA_j$ and the time and Federal Reserve district dummies are as previously described, and D_k is a dummy variable for the number of bidders ($D_k = 1$ if there are k bidders and $D_k = 0$ otherwise). The expected value of b_1 is again positive.

In (2) the number-of-bidders coefficients c_k measure the effect of increased competition on the expected winning bid, after controlling for the expected value of the failed bank's franchise. As in Brannman et al. [2], the assumption is made that bidders' estimates of the value of the franchise are drawn from a normal (or lognormal) distribution. Then the different auction models imply the following alternative predictions about the coefficients c_k:

$$\text{IPV:} \qquad c_k = a_0 + a_1 SOS_k, \tag{3a}$$

$$\text{CV unadjusted:} \qquad c_k = a_0' + a_1' MOS_k, \tag{3b}$$

$$\text{CV adjusted:} \qquad c_k = a_0'' + a_1'' N^{-1}, \tag{3c}$$

where SOS_k is the expected second-order statistic for k draws from the standard normal distribution, MOS_k is the expected maximum-order statistic for k draws from the standard normal distribution, and N is the number of bidders.[9] By imposing (3a) through (3c) as alternative restrictions on the c_ks in (2), we can test the hypothesis that P&A auctions are IPV, CV unadjusted, or CV adjusted, respectively. Further, alternative restrictions may be tested against each other.[10]

IV. Results and Their Interpretation

A. Results: All Bids

In Table II, OLS estimates of (1) are presented, where the variance of the bids in each auction is used as a proxy for value uncertainty V_j.[11] The OLS and truncated regression estimates are virtually identical.[12]

As expected, bids increase as the deposit base increases. If, as posited, the value of the franchise is positively correlated with the volume of acquired core

[9] When the value estimates $V_i \sim N(\mu, \sigma^2)$, $V_i = \sigma z + \mu$ where $z \sim N(0, 1)$. Values of MOS and SOS for the standard normal distribution are tabulated in the *CRC Handbook of Probability and Statistics*.

[10] The methodology is similar to that of Brannman et al. [2]. They use a two-stage procedure wherein the OLS estimates of the c_ks are used as dependent variables in a second set of regressions. The second-stage regressions are identical to (3) with the addition of error terms. However, there may be measurement error problems in the two-stage procedure, resulting from the fact that estimates of the c_ks are used rather than the true parameters.

[11] Estimates using the range of bids and an estimate of the variance of the truncated distribution as alternative proxies for value uncertainty are qualitatively similar to those in Table II and are not reported.

[12] These results may be obtained from the authors upon request.

Table II

Estimated Relationship between Expected Bid Level and Number of Bidders[a] FDIC Purchase and Assumption Auctions (1975–1985)

$$\log BID_{ij} = b_0 + b_1 \log TDDA_j + b_2 T_{82} + b_3 T_{83} + b_4 T_{84} + b_5 T_{85} + \sum_{k=6}^{12} b_k F_k + c_1 \log N_j + c_2 \, \mathrm{VARLOG}_j + u_{ij}$$

Parameter	Estimate	t-Value
b_0	0.733	1.063
b_1	0.772	17.016[b]
b_2	0.564	3.234[b]
b_3	0.596	3.578[b]
b_4	0.377	2.694[b]
b_5	0.159	1.104
b_6	−0.153	−0.811
b_7	−0.260	−1.319
b_8	−0.513	−2.060[c]
b_9	−0.124	−0.487
b_{10}	−0.621	−2.944[b]
b_{11}	−0.554	−2.523[c]
b_{12}	−0.967	−4.457[b]
c_1	0.578	7.441[b]
c_2	−0.306	−5.538[b]

Number of observations = 572; adjusted $R^2 = 0.541$.

[a] $\log BID_{ij}$ = log of bid submitted for bank j by bidder i;
$\log TDDA_j$ = log of total demand deposit balances at failed bank j;
T_{nn} = dummy variable equal to one if failure occurred in year nn, zero otherwise;
F_n = dummy variable equal to one if failure occurred in Federal Reserve district n, zero otherwise;
$\log N$ = log of number of bidders submitting positive bids for bank j;
VARLOG_j = variance of logs of bids submitted for bank j.
[b] Significant at the 0.01 level.
[c] Significant at the 0.05 level.

deposits (as proxied by total demand deposits), then the significant demand deposit coefficient implies that high expected franchise values elicit high bids, on average. Seven of the eleven dummy variables for year and Federal Reserve district have significant coefficient estimates.[13] The generally declining time dummy coefficients suggest a decline in charter values due to a worsening economic environment for many banks over the time period 1982–1985. The significant Federal Reserve district dummy coefficients (Federal districts 8, 10,

[13] A regression similar to (1) but without log N or V, the variables used to test the auction theory predictions, was also estimated. The coefficient estimates and significance levels were similar to those in Table II and are not reported; the adjusted R^2 was 0.4821.

11, 12) are primarily associated with the farm belt and oil patch states. They also suggest declining charter values in these regions due to their adverse economic environments. As predicted by the auction models, increased uncertainty about the failed bank's value leads to lower average bid levels ($c_2 < 0$).

According to the estimates in Table II, bidders do not adjust for the winner's curse; the estimate of c_1, the coefficient on the (log of) number of bidders, is significantly positive. This finding—that P&A auction participants do not adjust for the winner's curse—is consistent with the results reported by Gilley et al. [7] for their second set of oil lease bids.[14] However, this interpretation hinges on the maintained assumption that P&A auctions are CV auctions. The observed results are also consistent with a pure IPV setting or with a mixed CV-IPV setting with dominant IPV elements.

B. Results: Winning Bids

Additional tests of bidder competition and the winner's curse hypothesis were conducted using (2). Alternative auction models lead to three alternative restrictions on the number-of-bidders coefficients c_k in (2); these restrictions are given by (3), In principle, we should be able to use (2) to determine whether P&A auctions are indeed CV or IPV. If the results support the CV setting, the interpretation of the evidence obtained from (1) is reinforced.

Table III presents the results of OLS estimation of the unrestricted version of (2). The results indicate that expected winning bids appear to increase as more bidders compete to acquire a failed bank. Although the estimates of the c_ks tend to increase with the number of bidders, the differences between different c_ks are not statistically significant.[15]

To assess more effectively the impact of bidder competition, we estimated a modified version of (2). Using Table I Panel A as a guide, the sample was divided into three groups: (1) auctions with only one bidder (33%), (2) auctions with two or three bidders (44%), and (3) auctions with four or more bidders (23%). The individual number-of-bidders dummies were replaced with D_1 and D_2 ($D_1 = 1$ if two or three bidders, $D_1 = 0$ otherwise; $D_2 = 1$ if four or more bidders, $D_2 = 0$ otherwise). The estimated equation is (t-values in parentheses):

$$\log WBID_j = \underset{(0.27)}{0.298} + \underset{(11.25)}{0.807} \log TDDA_j + \cdots + \underset{(7.81)}{1.23}\, D_1 + \underset{(7.98)}{1.58}\, D_2 + u_j,$$

$$\text{adjusted } R^2 = 0.64. \tag{4}$$

[14] The results of laboratory experiments indicate that inexperienced bidders substantially overbid in common value auctions, but experience moderates this phenomenon (Kagel and Levin [12]). Whether the inability to overcome the adverse effects of the winner's curse in P&A auctions is the result of inexperience on the part of bidders can only be speculated. Out of the winning bidders in our sample over the time period 1975–1985, there were only thirteen winning bidders each of whom was involved in two transactions and only two winning bidders each of whom was involved in three transactions. Thus, it appears that bidders in P&A auctions have not had significant prior bidding experience. This may account for the bidders' apparent neglect of the winner's curse.

[15] The F-value for the null hypothesis $c_2 = c_2 = \cdots = c_{10}$ is 0.888. The 0.05 critical value for $F_{8,197}$ is 1.98.

Table III

Estimated Relationship between Winning Bid and Number of Bidders[a]
FDIC Purchase and Assumption Auctions
(1975–1985)

$$\log WBID_j = b_0 + b_1 \log TDDA_j + b_2T_{82} + b_3T_{83} + b_4T_{84} + b_5T_{85} + \sum_{k=6}^{12} b_kF_k + \sum_{k=2}^{10} c_kD_k + u_j$$

Parameter	Estimate	t-Value
b_0	0.536	0.472
b_1	0.790	10.582[b]
b_2	−0.369	−1.153
b_3	0.206	0.758
b_4	−0.120	−0.477
b_5	−0.569	−2.239[c]
b_6	−0.149	−0.462
b_7	0.182	0.511
b_8	0.179	0.436
b_9	0.091	0.198
b_{10}	−0.496	−1.439
b_{11}	−0.155	−0.409
b_{12}	−0.841	−2.371[c]
c_2	1.224	5.757[b]
c_3	1.268	5.277[b]
c_4	1.564	5.798[b]
c_5	1.484	4.786[b]
c_6	1.488	4.113[b]
c_7	2.897	2.734[b]
c_8	1.444	2.255[c]
c_9	1.988	2.736[b]
c_{10}	2.376	3.256[b]

Number of observations = 219; adjusted $R^2 = 0.633$.

[a] $\log WBID_j$ = log of winning bid submitted for bank j;
$\log TDDA_j$ = log of total demand deposit balances at failed bank j;
T_{nn} = dummy variable equal to one if failure occurred in year nn, zero otherwise;
F_n = dummy variable equal to one if failure occurred in Federal Reserve district n, zero otherwise;
D_k = dummy variable equal to one if there were k bidders for bank j.

[b] Significant at the 0.01 level.

[c] Significant at the 0.05 level.

The suppressed time and Federal Reserve district dummy variable coefficients are similar to those reported in Table III.

The coefficient estimates for D_1 and D_2 are highly significant. Ceteris paribus, there appears to be a significant increase in the winning bid as one moves from an auction with a single active bidder to those with two or three bidders. A further significant increase results when additional bidders participate; the null hypothesis $D_2 = D_1$ (i.e., regression coefficients are equal) was rejected at the 0.05 level in a one-tailed test (F-value = 3.69).

We then used the estimated coefficients of D_1 and D_2 to obtain point estimates of the dollar magnitudes of these increases.[16] The expected winning bid increases by approximately $350,000 as a direct result of having two or three bidders in an auction rather than one. An additional increase of about $207,000 can be attributed to the presence of more than three bidders. To place these values in context, the *total change* in the mean winning bid is about $1,000,000 when there are two or three bidders rather than one. With four or more bidders, the average winning bid increases by close to $1,460,000 over the mean in auctions having two or three bidders. Increased bidder competition, holding all else constant, appears to have substantial economic impact on the magnitude of the winning bid.

Table IV shows the results of imposing the restrictions of the IPV (3a), unadjusted CV (3b), and adjusted CV (3c) models, respectively, on the coefficients c_k. Tests of the alternative auction models offer no statistically significant evidence concerning the presence or absence of a winner's curse in P&A auctions. It does appear that winning bids increase as the number of bidders increases, as predicted by auction theory. However, it is not possible to reject one model in favor of another, although the unadjusted CV model appears to have the best fit with the observed (unrestricted) coefficient pattern. The failure to discriminate between the alternatives was also encountered by Brannman et al. [2], although they reported a few significant differences. The probable cause is that the measures SOS, MOS, and N^{-1} are highly correlated. The correlation is −0.985 between MOS and N^{-1}, 0.996 between MOS and SOS, and −0.996 between SOS and N^{-1}.

In conclusion, our test using average bid levels showed a strong positive relationship between expected bid level and the number of bidders. This supports the hypothesis that bidders failed to adjust for the winner's curse, under the assumption that CV elements predominate in P&A auctions. A second test using winning bids and number of bidders failed to distinguish between the different auction models, although the unadjusted CV model (the winner's curse model) appears to explain marginally more of the pattern in the estimated number-of-bidders coefficients. However, based on the second set of tests, one cannot exclude the possibility that there are significant IPV elements in the auctions. Thus, clear interpretation of the first set of tests is difficult, as the findings are consistent with the unadjusted CV or winner's curse model *and* the IPV model.

[16] The estimates were derived by assuming that the overall population of winning bids is lognormally distributed. Holding all variables in (4) other the D_1 and D_2 constant at their means, the ratio

$$\frac{\text{expected winning bid (two or three bidders)}}{\text{expected winning bid (one bidder)}}$$

equals exp(1.23), or 3.42. Ceteris paribus, the increase in the expected winning bid (two or three bidders) is 2.42 times the expected winning bid (one bidder). From (2), the expected winning bid in single-bidder auctions is nearly $145,000. Multiplying this by 2.42 gives a value of about $350,000. The additional increase as more bidders participate was computed similarly.

Table IV

Winning Bids and Number of Bidders: Tests of Alternative Auction Models[a]
FDIC Purchase and Assumption Auctions (1975–1985)

$$\log BID_j = b_0 + b_1 \log TDDA_j + b_2 T_{82} + b_3 T_{83} + b_4 T_{84} + b_5 T_{85} + \sum_{k=6}^{12} b_k F_k + \sum_{k=2}^{10} c_k D_k + u_j$$

Test 1: independent private value model against unrestricted model[b]
H$_0$: $c_k = a_0 + a_1\ SOS_k$.
Adjusted R^2 under H$_0$: 0.6525; test statistic: 0.35 $\sim F_{7,145}$ (0.05 level critical value 2.07).

Test 2: common value model without winner's curse adjustment against unrestricted model (Table III)
H$_0$: $c_k = a_0' + a_1'\ MOS_k$.
Adjusted R^2 under H$_0$: 0.6403; test statistic: 0.45 $\sim F_{7,197}$ (0.05 level critical value 2.05).

Test 3: common value model with winner's curse adjustment against unrestricted model (Table III)
H$_0$: $c_k = a_0'' + a_0''\ N^{-1}$.
Adjusted R^2 under H$_0$: 0.6393; test statistic: 0.53 $\sim F_{7,197}$ (0.05 level critical value 2.05).

[a] $\log WBID_j$	= log of winning bid submitted for bank j;
$\log TDDA_j$	= log of total demand deposit balances at failed bank j;
T_{nn}	= dummy variable equal to one if failure occurred in year nn, zero otherwise;
F_n	= dummy variable equal to one if failure occurred in Federal Reserve district n, zero otherwise;
SOS_k	= expected second-order statistic for k drawings from the standard normal distribution ($k > 1$);
MOS_k	= expected maximum-order statistic for k drawings from the standard normal distribution;
N	= number of bidders for the failed bank.

[b] Not directly comparable to other tests or to Table III because SOS_k is undefined for auctions with one bidder.

V. Conclusions

P&A auctions provide a unique set of market data to examine the effect of bidder competition in acquisitions. Assuming a common value framework, our results provide support for the presence of a winner's curse. Specifically, (i) observed bids are found to decrease with increases in the degree of uncertainty about the value of the (reconstituted) failed banks, and (ii) observed bids increase with an increase in the number of competing bidders. The first finding has been reported by other studies; bidders clearly respond negatively to increased uncertainty. However, our second finding *contradicts* the critical prediction regarding optimal bidder behavior in common value models. It suggests that bidders pursue aggressive bidding strategies that fail to adjust sufficiently for potential value overestimation; i.e., they overpay.

Caution is warranted in extending this conclusion to typical nonfinancial takeovers. This caution stems from differences in auction structures between P&A auctions and corporate takeover auctions. First, corporate takeovers are not sealed-bid auctions. Second, our results are also consistent with optimal bidder behavior if P&As are IPV auctions. Nonfinancial takeovers may be dominated by IPV elements perhaps due to synergistic complementarities between specific bidder-target combinations, though "· · · knowledge of the source of takeover gains still eludes us" (Jensen and Ruback [10, p. 47]). Nevertheless, our findings suggest that one should not categorically exclude the possibility that some bidders overestimate the value of gains from acquisitions and that some winners may, ex post, be cursed.

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