

# AGGRESSIVE REPORTING UNDER IMPRECISE STANDARDS

## A LABORATORY INVESTIGATION

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### ABSTRACT

We study the market consequences of reporting with imprecise accounting standards, such as those in model-based financial reports. In a laboratory experiment, our participants take advantage of imprecision in standards to report aggressively. Two effects of aggressive reporting are illiquid asset markets and low asset prices, compared with those arising in a regime in which aggressive reporting is prevented and conservative reporting is imposed. Illiquidity occurs because aggressive reports do not provide firms with a credible way to disclose good news about a worst-case scenario, creating a market friction. On the other hand, lower prices occur because aggressive reports convey news about a best-case scenario, protecting investors against paying information rents. We relate our results to empirical studies and to other experiments on reporting with imprecise standards.

**Key Words:** Standard precision, model-based fair value, ambiguity, experiments

**JEL classification:** M41, C92, D44, D82, D83, G01, G12

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## 1. INTRODUCTION

Accounting standards are seldom cut and dried. Seemingly clear language can turn out to admit many interpretations. Standards may be principles-based, or may depend on estimates, or may be based on models, in some situations even requiring internally generated models. Our interest is in the market consequences of imprecision in financial standards. Do firms interpret imprecise standards aggressively, to present their results in the best possible light? How do prices and liquidity differ if regulators and auditors permit firms to use aggressive interpretations, compared with a regime that restricts aggressive reporting?

We address these questions in a laboratory study, similar to experiments on strategic disclosure (some examples are King and Wallin, 1991, Forsythe et al., 1999, Dickhaut et al., 2003, Hobson and Kachelmeier, 2005). A seller can report a possible value of an asset to the market. The seller's report must be consistent with the seller's private information. To keep our focus on aggressive interpretation of standards, rather than on explicit earnings management or fraud, we provide the seller with ambiguous information about the asset's value. The ambiguity provides the seller with a range of justifiable reports, all of which are consistent with non-fraudulent reporting.<sup>1</sup> As in Akerlof (1970), our seller is not forced to sell, but can set a secret reserve price. The difference between the distribution of reserve prices and that of reports gives us a way to measure reporting aggressiveness. By providing a reserve

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<sup>1</sup>King and Wallin (1990, 860) provide the following definition: "An antifraud rule is a mechanism that requires that the disclosure set must include as one of its elements the true (known) quality level. The rule permits vagueness but not lying. The antifraud provisions of the Securities and Exchange Commission Acts of 1933 and 1934 . . . are examples of such rules."

price, each seller acts as his or her own control.

Given that sellers prefer to report aggressively, we are interested in the consequences for the market of permitting or preventing aggressive reporting. An aggressive but non-fraudulent report provides investors with information on a best-case scenario. If an auditor or regulator prevents the seller from reporting aggressively, for example by imposing a conservative valuation method, then the report instead informs investors about a worst-case scenario. This distinction has implications for pricing and for liquidity. Information about a best-case scenario protects investors from paying information rents. This means that, although a higher report is always better news, the price response to an increase in an aggressive report is muted. When sellers are prevented from aggressively reporting, investors do not learn an upper bound, and the market's reaction is more pronounced.

The other side of the coin is the effect on liquidity. If a seller is known to report aggressively and is not forced to sell, then he or she has no means of providing buyers with a pessimistic scenario. By preventing aggressive reporting, an auditor or regulator provides sellers with the ability to commit to provide information about a lower bound. This informs buyers about minimum credible bids, increasing liquidity. To summarize, as we show below, permitting aggressive reporting leads to lower prices and lower trading volume than would be expected under a regime that restricts aggressive reporting.

To test the predicted effects of restricting aggressive reporting, we manipulate the report the buyers receive. As in our discretionary reporting treatment, a seller is

privately informed with ambiguous information about an asset’s value, and is not forced to sell. In our aggressive reporting treatment, the computer informs the buyers of the seller’s best-case scenario. In our conservative reporting treatment, the computer informs the buyers of the seller’s worst-case scenario. We then compare trading volume and prices across treatments, and confirm that prices and volume are both lower under aggressive reporting. To verify the causal mechanism, we compare the distribution of bids across treatments. We find that the bid distribution is shifted to the left under aggressive reporting, generating our results.<sup>2</sup>

The effects we find match with and clarify those in the literature on imprecise accounting standards. A particularly noteworthy example on which our analysis sheds light is reporting with model-based fair value estimates as specified in Statement of Financial Accounting (SFAS) 157, which provides guidance for the use of fair value in the absence of a liquid market.<sup>3</sup> Several authors have noted that the imprecision

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<sup>2</sup>For discussion of a setting in which higher prices and greater liquidity arise through a different channel, see Diamond and Verrecchia (1991), who study a market in which adverse selection decreases as disclosure quality improves. See also Bloomfield and Wilks (2000), who find that demand increases as disclosures improve. In their setting, the effect is weakened when liquidity is lower, whereas in the market we study, the effects of disclosure on liquidity are endogenous.

<sup>3</sup>Although SFAS 157 did not explicitly expand the use of model-based fair values, it resulted in such estimates becoming much more widespread. This appears to have been the FASB’s intention: it issued SFAS 157 at roughly the same time as SFAS 159. The latter gives an irrevocable option to use fair value for financial instruments that were not previously recorded at fair value, for the stated purpose of expanding the use of fair value accounting (see <http://www.fasb.org/st/summary/stsum159.shtml>). These new standards sharply affected the financial reporting of the debt-backed securities that were central to the crisis. The 2007 Lehman Brothers annual report cites these standards as its reason for using fair value for “financial instruments not previously recorded at fair value” (39–40), and shows in Note 4 to the balance sheet (97) that 99.7% of its mortgage- and asset-backed securities had fair values determined by marking to model. Compared with 2006, Lehman’s reported values of derivatives based on market prices increased by 3.2% in 2007, or \$100 million. In the same time, its value of derivatives reported using fair values based on internally generated models increased by 111.8%, or \$21.8 billion. Similarly, Bear Stearns, in its report for the quarter ended August 31, 2007, reported 97.9% of its derivative

in model-based fair value reports leads to the market discounting the reported values (Song et al., 2010, Kadous et al., 2012, Goh et al., 2015, Magnan et al., 2015); relatedly, Riedl and Serafeim (2011) argue that the market associates model-based fair values with higher information risk. If a firm using model-based fair values is prevented from reporting aggressively, the market attaches more weight to the reports (Kolev, 2013, Bens et al., 2016).

Our results are consistent with these findings, and in addition highlight a subtle tradeoff. When regulators and auditors permit firms to report aggressively, within the letter of the standard, the benefit to investors is protection against paying information rents (as in the model of Shin, 1994). This observation offers a new perspective on the negative market reaction to the news indicating more likely fair value adoption, which Bowen and Khan (2014) document. To the extent that fair value reports include model-based estimates, the consequence would be lower firm values, holding all else equal. The downside for investors is the lack of information about a lower bound on the firm's value, harming liquidity (particularly of those assets valued with market-based fair values). Both these effects would make investors less responsive to model-based, hence potentially aggressive, fair value reports.

The results in this paper also suggest an interpretation of the empirical finding that liquidity is lower for firms with more analyst forecast dispersion (for example, Sadka and Scherbina, 2007, Kerr et al., 2015). As the reporting standards affecting a firm become more imprecise, we would expect liquidity to fall, unless auditors or

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trading inventory using mark-to-model fair value reports, along with 77.7% of its non-derivative trading inventory (15).

regulators attempt to restrict aggressive reporting. This interpretation may inform future empirical work on information and liquidity.

In sum, our experiments suggest that firms report aggressively when facing imprecise standards, and that the desirability of preventing or permitting aggressive reporting depends on whether information rents or illiquidity are a greater concern.

The rest of this paper is organized as follows: Section 2 provides enough theoretical background for our hypothesis development. Some of the theory is novel, arising because the market we study involves ambiguity. We keep the theoretical background in Section 2 to a minimum, and defer the full development to an appendix. Section 3 provides our hypotheses and the design of our experiment. Section 4 gives our results. Section 5 concludes. We follow with two appendices. Appendix A provides a full exposition of the theory used to develop the hypotheses. Appendix B shows the instructions we gave to our participants.

## **2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT**

This section provides the theoretical underpinnings of our hypotheses. We focus on financial reporting under ambiguity, as a common finding in the auditing literature is that ambiguity creates discretion in reporting (for example Schmidt, 2009, Bratten et al., 2013). We show below that, under weak assumptions, a seller (firm's manager) will use this discretion to report aggressively. This result has empirical support in several contexts, such as accounting for goodwill (Beatty and Weber, 2006), recognition of gains from asset securitizations (Dechow et al., 2010), and employee stock

option valuations (Blacconiere et al., 2011).

We illustrate with a model of a seller reporting on the value of a single indivisible asset. We restrict attention here to the main ideas from the model. A full exposition is in Appendix A.

A seller, who is endowed with a single indivisible unit of an asset, reports a value of the asset to potential buyers. The asset's value, which we denote by  $\tilde{v}$ , is ambiguous. That is, the buyers and the seller lack a unique prior distribution over  $\tilde{v}$ , as in the private value auction experiments of Chen et al. (2007) and the common value auction of Dickhaut et al. (2011).<sup>4</sup> Despite the lack of a unique prior, all parties know a lower bound  $\underline{a}$  and an upper bound  $\bar{b}$  on the asset's value. That is, the seller and all potential buyers know that  $\tilde{v} \in [\underline{a}, \bar{b}]$ .

The seller receives private information about the asset's value, in the form of a refinement of the possible values of the asset. We write  $a'$  for the seller's private lower bound and  $b'$  for the seller's private upper bound, so that the seller's private information is that  $\tilde{v} \in [a', b'] \subset [\underline{a}, \bar{b}]$ .

After receiving the private information, the seller issues a report  $\hat{v} \in [a', b']$ . Because the expectation of  $\hat{v}$  is indeterminate, an antifraud rule does not specify what the seller must report, other than restricting the report to be no higher than  $b'$  and no lower than  $a'$ .

In Appendix A, we give the technical axioms on preferences that are necessary and sufficient for the following theorem to hold. The theorem states that the seller always

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<sup>4</sup>For more on auctions under ambiguity, see Kaplan and Zamir (2015).

reports the private upper bound if given discretion:

**Theorem 2.1** (Aggressive Reporting). *If the seller's private information is  $[a', b']$ , then the uniquely optimal report is  $\hat{v} = b'$ .*

The intuition behind Theorem 2.1 is as follows: the seller's report informs the market about both the lower bound  $a'$  and the upper bound  $b'$ . The higher the report, the greater the maximum possible value of  $a'$ , and the greater the minimum possible value of  $b'$ . That is, the report  $\hat{v}$  is a ceiling on the lower bound and a floor on the upper bound. An increase in  $\hat{v}$  is good news about both the lower bound and the upper bound. As long as the seller and all buyers prefer more wealth to less, a higher report is always better news. This means that the only information the seller can credibly report is the upper bound  $b'$ .

Next, we turn to the consequences of permitting or preventing aggressive reporting. To do so, we place the reporting decision in the context of a specific trading environment. We focus on a first-price sealed bid (FPSB) auction, similar to those that King and Wallin (1990), Salo and Weber (1995), and Hobson and Kachelmeier (2005) study. As in those prior studies, we restrict attention to a single trading period. This enables us to eliminate a potential confound of inefficiencies arising from laboratory bubbles or panics, as observed in Lei et al. (2001).

In our FPSB auction, the sequence of events is as follows. After the seller learns the ex post lower bound  $a'$  and the ex post upper bound  $b'$ , he or she reports a value  $\hat{v} \in [a', b']$ . Then the seller sets a private reserve price,<sup>5</sup> and the buyers privately

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<sup>5</sup>We make the reserve price secret because it is known that public reserve prices alone can create liquidity frictions (Choi et al., 2015). Our interest is in illiquidity, and we want to avoid the

submit their bids on the asset. If the highest bid is greater than the seller's reserve price, the buyer making the highest bid receives the asset and the seller receives the amount of the bid (with ties resolved randomly). Otherwise, no trade occurs and the seller keeps the asset. At the end of the trading period, the asset value  $\tilde{v}$  is realized and paid to its owner, and then the game ends. See Figure 1.



Figure 1: Timeline.

We now illustrate how permitting aggressive reporting leads to lower bids and less trading volume than would occur if the seller were prevented from reporting aggressively. First, observe that the seller's reserve price, given wealth maximization, must be in  $[a', b']$ . If aggressive reporting is permissible, then the seller optimally reports  $\hat{v} = b'$ . This provides buyers with no information about  $a'$ , so that after receiving the report, buyers know that  $\tilde{v} \in [\underline{a}, b']$ . The report prevents the buyers from paying an information rent, as the upper bound is revealed. However, they have no way of learning that bids between  $\underline{a}$  and  $a'$  cannot exceed the seller's reserve price. See Figure 2.

Suppose instead that aggressive reporting is prevented, and that the seller must provide a conservative report  $\hat{v} = a'$ . This reveals the ex post lower bound to the buyers, avoiding the liquidity friction that arises with aggressive reporting. However,

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confound of illiquidity arising through another channel.

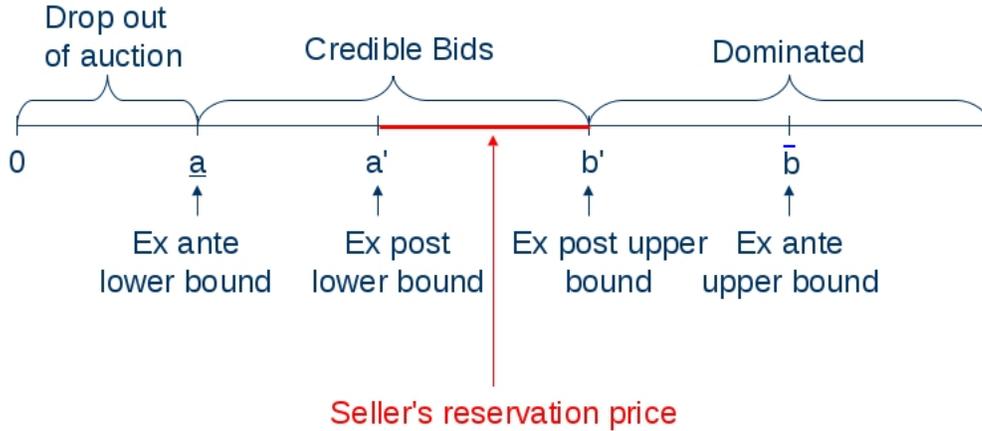


Figure 2: Bids and reserve prices under aggressive reporting. The seller optimally chooses a reserve price in  $[a', b']$ . The seller optimally discloses  $b'$ , so no buyer bids above  $b'$ . The buyers do not know  $a'$ , and therefore any buyers wishing to make a credible bid must choose a value in  $[\underline{a}, b']$ .

buyers cannot learn anything about the ex post upper bound  $b'$ . This means that bids in  $[b', \bar{b}]$  are rationalizable values from the buyer's viewpoint, but will end up giving the seller an information rent. The result is greater liquidity and higher prices when aggressive reporting is prevented. It should be noted, however, that only the increase in liquidity represents reduction in trading frictions. The higher prices are instead a reflection of the introduction of a friction. See Figure 3.

### 3. DESCRIPTION OF THE EXPERIMENT AND HYPOTHESES

We recruited from a university participant pool in the mid-Atlantic, using an online recruiting program. We coded the experiment in z-Tree (Fischbacher, 2007). At the beginning of each session, we read the instructions aloud, gave the participants a

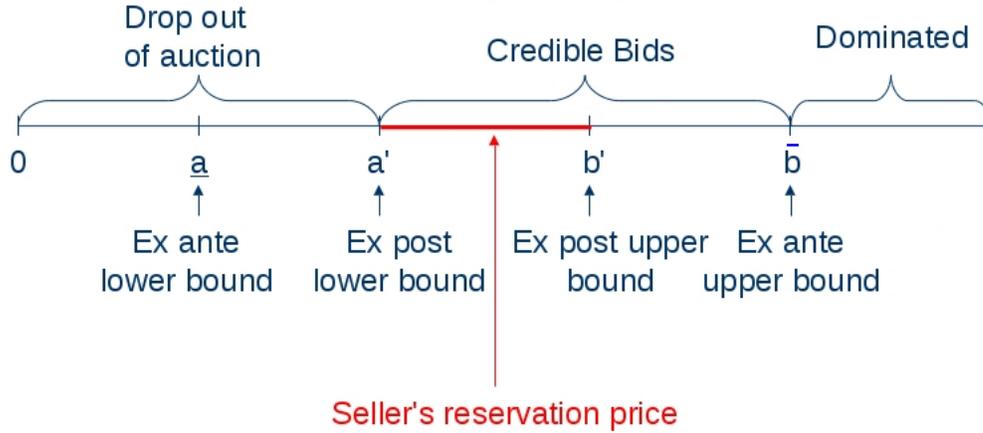


Figure 3: Bids and reserve prices under conservative reporting. The seller's reserve price is in  $[a', b']$ . The buyers do not know  $b'$ , and therefore any buyers wishing to make a credible bid must choose a value in  $[a', \bar{b}]$ .

quiz, and then reviewed the answers privately with each participant.

Participants interacted in groups of 5 for 16 rounds. We assigned each group to one of three treatments: discretionary, aggressive, or conservative reporting. The discretionary reporting treatment allows the seller to disclose any value that is no lower than the ex post lower bound and no higher than the ex post upper bound. This treatment tests whether, given reporting discretion, sellers of a financial asset report aggressively. The conservative reporting treatment informs buyers of ex post lower bound, and the aggressive reporting treatment informs buyers of the ex post upper bound. The manipulation of aggressive versus conservative reporting enables us to test whether preventing aggressive reporting increases liquidity and prices.

In each treatment, the computer privately and randomly selected one participant in each round as the seller for that round. The other four participants in the group

were the buyers for that round. All five participants in a group were equally likely to be the seller in any given round. The instructions explained the method of selecting the seller to the participants.<sup>6</sup>

As we describe above in Section 2, the setting of the experiment was a first-price sealed bid auction, in which the privately informed seller enters a secret reserve price (see Figure 1). We set the ex ante lower bound  $\underline{a}$  to \$0.50 and the ex ante upper bound  $\bar{b}$  to \$1.50. Thus, sellers were endowed in each round with an asset worth between \$0.50 and \$1.50. We endowed the buyers in each round with \$1.50, which they could use only in the current round.

After the seller submitted the reserve price and all the buyers submitted their bids in a given round, the computer revealed the asset's value to all the participants, along with an indication of whether trade occurred and, if so, at what price. The computer deposited all the money that a participant held at the end of a given round into the participant's bank account, which determine the participant's earnings but was unavailable for trading in any subsequent round.

To generate the values for  $(a', v, b')$  in each of the 16 rounds, we used the ambiguity generator of Stecher et al. (2011). The procedure draws numbers from a nonstationary, nonergodic process, giving realizations for which each draw comes from a new distribution, and for which the way the distribution changes between draws is

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<sup>6</sup>Keeping the participants grouped together enables us to rule out participant heterogeneity as the sole source of differences in behavior across treatments. However, having fixed groups may make order effects more likely, because participants can learn about the members of their groups and can attempt to build reputations. We ran several tests (available from the authors on request), and found no evidence of any order effects.

unknowable. We partitioned the realizations into triples and sorted, making the ex post lower bound  $a'$  the lowest realization in the triple, the actual value  $v$  the median realization, and the ex post upper bound  $b'$  the highest.

In total, we generated five blocks of 16 realized triples  $(a', v, b')$ , and used the same sample realizations across treatments. In particular, we ran two sessions of the discretionary treatment using two blocks of the realized triples, and ran five sessions each of the conservative and aggressive treatments using all five blocks of realizations. This enabled us to hold the information that sellers received constant across treatments, so that we could isolate the effect of the reporting regime.

Our hypotheses, stated in alternative format, are as follow:

$\mathbf{H}_A^1$ : In the discretionary treatment, the distribution of reports first-order stochastically dominates the distribution of reserve prices.

$\mathbf{H}_A^2$ : The bid distribution in the conservative treatment first-order stochastically dominates the bid distribution in the aggressive treatment.

$\mathbf{H}_A^3$ : The maximum bid under conservative reporting is higher than the maximum bid under aggressive reporting.

$\mathbf{H}_A^4$ : Aggressive reporting reduces liquidity. That is,  $\Pr[\text{trade} \mid \text{Aggressive}] < \Pr[\text{trade} \mid \text{Conservative}]$ .

The first hypothesis is based on Theorem 2.1. If sellers report aggressively, then we would observe reported values that are systematically larger than reserve prices. The second and third hypotheses are related to demand and prices, or, if there is no trade,

to the latent price.  $H_A^2$  states that the overall level of demand shifts leftward under the aggressive treatment, compared with the conservative treatment.  $H_A^3$  states that the leftward shift affects the highest bids, and hence is pronounced enough to affect prices. The last hypothesis states that aggressive reporting reduces liquidity.<sup>7</sup>

#### 4. RESULTS

We recruited 60 participants for a total of twelve sessions. The median participant age was 24.5 years, with an interquartile range of 21–29 years. Roughly 40% were female.

For the discretionary treatment, there were two groups of participants, giving 32 rounds of discretionary report and reserve price observations. For the conservative and aggressive treatments, there were five groups each, with each conservative group matched to a fair value group. In total, we had 80 matched pairs of rounds, with 640 bid observations.

Among the 80 matched pairs of conservative and aggressive reporting rounds, in 59 (74%), all participants in both groups made decisions that were consistent with wealth maximization. In the remaining 21 rounds, at least one participant either

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<sup>7</sup>Because our data come from an experiment, we are able to observe latent prices, in the form of highest bids. Outside of the laboratory, an empiricist would be restricted to analyzing prices when trade occurs, possibly adding a selection equation. For this reason, we also tested hypothesis  $H_A^3$  restricting attention to rounds in which trade occurred. We found no differences between focusing on prices or on latent prices. We choose to focus on latent prices here, in order to include all observations that address our hypotheses. As an additional robustness check, we tested whether the behavior of prices and liquidity could be due to seller behavior, rather than being the result of the demand shifts our theoretical analysis predicts. We found no evidence of differences in seller reserve prices across treatments. Details are available from the authors on request.

made a bid that was guaranteed to lose money or chose a reserve price that was a dominated strategy. Among these violations of wealth maximization, 13 decisions were made by a single participant, who repeatedly bid above the commonly known upper bound on the asset’s value. Our analysis focuses on the rounds in which behavior was consistent with wealth maximization.<sup>8</sup> This left us with 472 bid observations.

Each session took approximately 45 minutes, including time to seat participants, read and quiz the participants on the instructions, and pay the participants at the end of the session. Earnings ranged from \$19.60 to \$24.02.

#### 4.1. Result: discretion leads to aggressive reporting

In the sessions with discretionary reporting, sellers provided both a private reserve price and a report to the market. Because the private lower bound  $a'$  and the private upper bound  $b'$  varied across rounds, we calculate a normalized value  $\frac{\hat{v}-a'}{b'-a'}$ , representing how far the report  $\hat{v}$  is along the line segment from  $a'$  to  $b'$ . We use a similar normalization to scale the seller’s private reserve price  $v^*$ . It is a weakly dominant strategy for the seller to truthfully report  $v^*$ .<sup>9</sup> If the distribution of  $\hat{v}$  first-order stochastically dominates the distribution of  $v^*$ , then there is evidence that the sellers report aggressively from their own viewpoint. This comparison allows us to distinguish between aggressive reports and high reports arising from optimistic

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<sup>8</sup>The results are robust to inclusion of the rounds with non-maximizing behavior.

<sup>9</sup>If the seller’s preferences are incomplete, as is commonly assumed in models with ambiguity (e.g., Bewley, 2002), then  $v^*$  is optimally chosen at a value at which the seller does not strictly prefer not selling (see Appendix A).

beliefs.

Figure 4 shows the cumulative empirical distributions of seller reserve prices and reported values. The  $x$ -axis gives the normalized distance along the line segment from  $a'$  to  $b'$ . The  $y$ -axis shows the cumulative proportion of observations at or below a given level on the  $x$ -axis. The distribution of reports is shifted to the right of the distribution of reserve prices. The difference between the cumulative distributions is significant at the 0.05 level under a Kolmogorov-Smirnov test.<sup>10</sup> We therefore reject the null of no difference in favor of the alternative  $\mathbf{H}_A^1$  that report distribution under discretionary reporting first-order stochastically dominates the reserve price distribution. That is, we find significant evidence that sellers report aggressively when given discretion.

In terms of magnitude, the median report was at  $7/8$  of the distance from the ex post lower bound  $a'$  to the ex post upper bound  $b'$ . By contrast, the median reserve price was at only  $3/8$  of this distance. The upper quartile of the report distribution was 97% of the distance from the  $a'$  to  $b'$ , essentially at the upper bound  $b'$ . As is apparent from the figure, the upper quartile of reserve price distribution is considerably lower, at 82% of the distance from  $a'$  to  $b'$ .

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<sup>10</sup>As a robustness check, we performed three other nonparametric tests for differences in distributions: the Anderson-Darling, Cramér-von Mises, and Mann-Whitney tests. The difference between the distributions was significant under all these alternative tests at the 0.01 level. In subsequent analyses, we report only the Kolmogorov-Smirnov test, which we view as the most familiar. None of our significance results changes if we substitute any of these other tests.

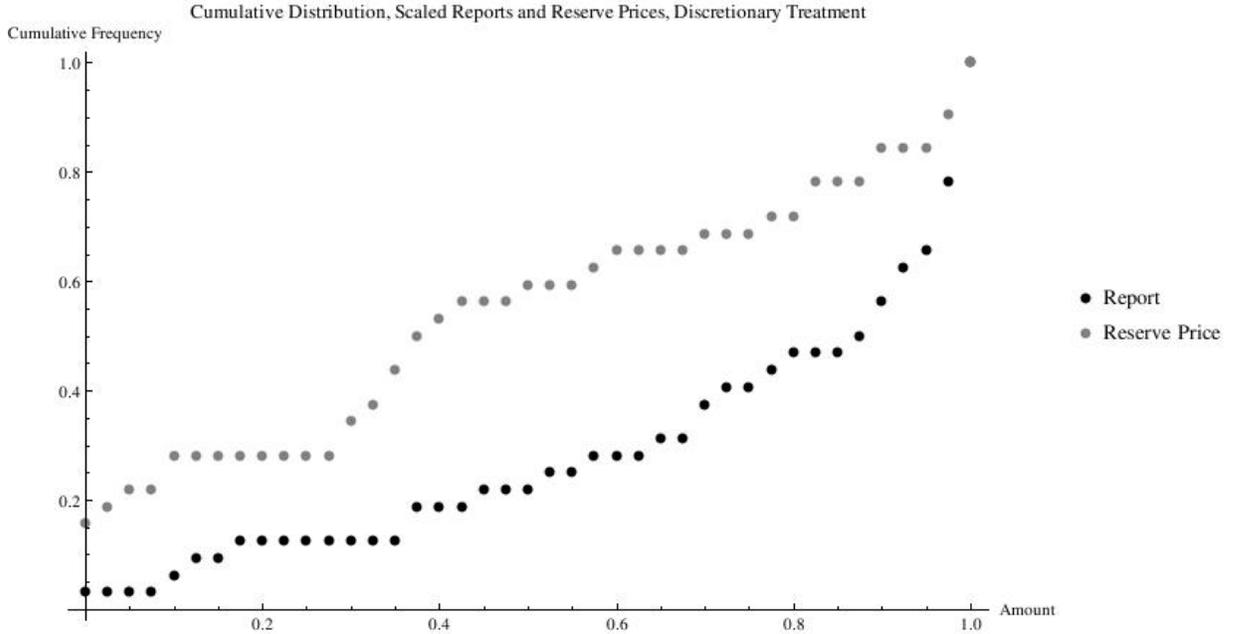


Figure 4: Cumulative distributions of scaled reported values (dark) and reserve prices (light) in the discretionary treatment.

#### 4.2. Results: bids and latent prices are lower under fair value

Given that sellers use discretion to report aggressively, we now address whether permitting aggressive reporting causes a leftward shift in demand, compared with conservative reporting.

Figure 5 shows the cumulative empirical histograms of bids in the conservative and aggressive treatments. We do not scale the values for the bid distributions to values between 0 and 1. The reason is that participants in the aggressive reporting treatment know the ex ante lower bound  $a$  and the ex post upper bound  $b'$ , whereas participants in the conservative reporting treatment know the ex post lower bound  $a'$  and the ex ante upper bound  $b$ . The raw bid amounts are comparable, and the participants are

matched across sessions, so unscaled data are more directly comparable. By contrast, the data in Figure 4 come from the sellers, who always know both  $a'$  and  $b'$ , and in any case face the same information when choosing their reserve prices and their reports.

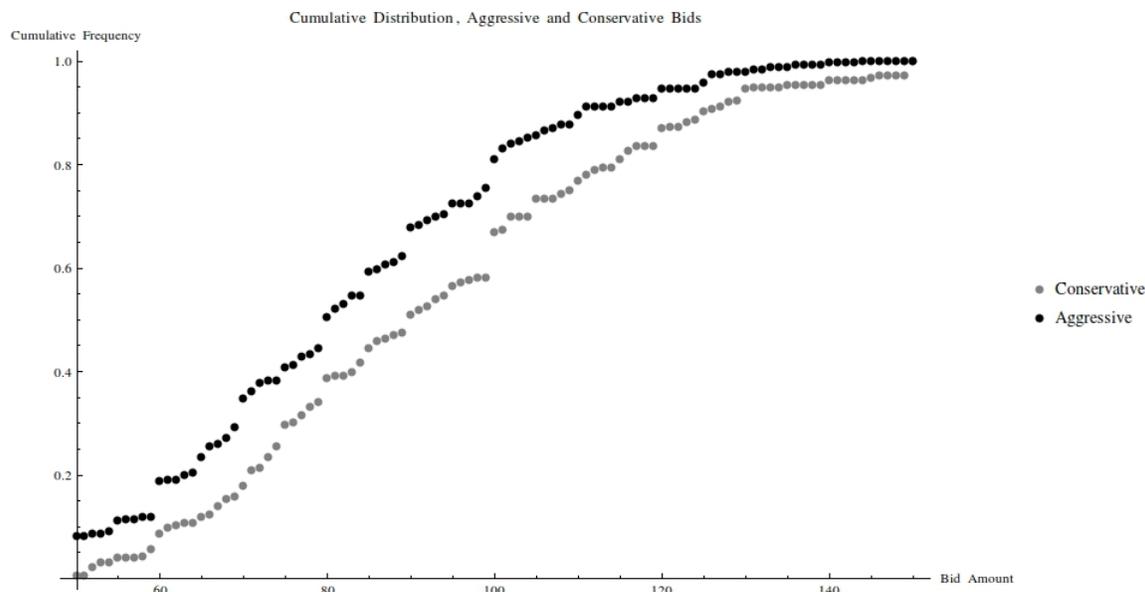


Figure 5: CDFs of bids under the conservative (light) and aggressive (dark) reporting treatments.

Figure 5 shows that the bid distribution under conservative reporting is to the right of the distribution under aggressive reporting. The difference between the two empirical cumulative distributions is significant at the 0.001 level under a Kolmogorov-Smirnov test. We therefore strongly reject the null of no difference in favor of the alternative hypothesis  $H_A^2$  that fair value reporting lowers the amount buyers are willing to pay and thus weakens demand.<sup>11</sup>

<sup>11</sup>To rule out an alternative story, in which prices fall under aggressive reporting due to changes in seller behavior, we tested whether reserve prices differed across treatments. We found no

Having established that bids are lower under aggressive reporting than under conservative reporting, we now address whether this difference is large in a practical sense. Our third hypothesis  $\mathbf{H}_A^3$  addresses the fact that the highest bid determines prices and liquidity. Table 1 compares the average values of the maximum bids across treatments, and shows the maximum bid was lower under aggressive reporting. Under a Wilcoxon signed-rank test, the difference in the maximum bids was significant with a  $p$ -value of 0.002. We therefore strongly reject the null of no difference in favor of the alternative hypothesis  $\mathbf{H}_A^3$  that bids are lower under aggressive reporting than under conservative reporting.

Conservative	Aggressive
110.1¢	99.4¢

Table 1: Average value of highest bid across treatments. Prices, or latent prices if there was no trade, were 10.8% higher under conservative reporting, compared with aggressive reporting. This difference was highly significant ( $p = 0.002$ ).

### 4.3. Result: fair value reduces liquidity

To test whether aggressive reporting causes illiquidity, we compare the frequency of trade across each treatment. See Table 2.

We use a variation on the McNemar test, which compares the off-diagonal entries with a binomial distribution with a success probability of 1/2. The idea behind the test is as follows: under the null, the treatment does not affect the probability of trade. This

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significant differences in the reserve price distributions across treatments. We therefore limit our focus to drops in prices arising from changes in the bid distribution.

Conservative \ Aggressive	Trade Agg	No Trade Agg
Trade C	30.5%	<b>42.4%</b>
No Trade C	<b>15.3%</b>	11.9%

Table 2: Frequency of trade, cross tabulated across treatments. In 42.4% of the rounds, there was trade under the conservative reporting treatment but no trade under the aggressive reporting treatment. By comparison, in 15.3% of the rounds, there was trade under the aggressive reporting treatment but no trade under the conservative treatment.

implies that the probability a given round leads to trade under conservative reporting and no trade under aggressive reporting is equal to that of a round ending in trade under aggressive reporting and no trade under conservative reporting. That is, the null predicts that the frequencies in the top-right and bottom-left cells of Table 2 should be equal. The classical McNemar test compares these observed frequencies with equal frequencies.

Our variation on the McNemar test adjusts for the repeated measures inherent in our design. The same participant would make 16 decisions, one in each round, and these decisions are unlikely to be completely independent.

To control for repeated measures, we use the two-step procedure from the medical statistics literature, due to Eliasziw and Donner (1991). The first step estimates the correlation among the discordant pairs (the off-diagonal elements in Table 2). The second step calculates an approximate McNemar test statistic, adjusted for the estimated correlation.

Our first step finds a correlation among discordant pairs of 0.048, suggesting that the role of repeated measures is low. In the second step, we find that the difference

between the frequencies of discordant pairs in Table 2 is highly significant, with a  $p$ -value of 0.009.

In practical terms, the difference in trade frequency across treatments is quite large. From Table 2, we see that in 42.4% of the rounds, trade occurred under the conservative treatment and did not occur under the aggressive treatment. We observe the opposite pattern, with trade under aggressive reporting but not under conservative reporting, in only 15.3% of the rounds. Conditional on trade occurring under one treatment but not the other, trade was 2.77 times more likely under the conservative treatment. Overall, trade occurred in roughly 3/4 of the rounds under conservative reporting but just under half the rounds under aggressive reporting. Based on these results, we reject the null of no liquidity friction under aggressive reporting in favor of the alternative  $\mathbf{H}_A^4$  that aggressive reporting reduces liquidity.

## 5. DISCUSSION AND CONCLUSION

Our experiment demonstrates that imprecise standards are, de facto, aggressive reporting standards. Given an imprecise standard, a seller (firm managers) chooses an aggressive interpretation. We show that the consequences of permitting aggressive reporting are lower market prices and less liquidity than would be observed when aggressive reporting is prevented, for example by requiring a conservative interpretation of vague standards.

The key piece of the story is market liquidity. Aggressive reporting creates a market friction, not because it reveals an optimistic scenario, but because it makes it im-

possible for market participants to learn a pessimistic scenario. Sellers cannot limit the downside value of an asset, and this will make assets difficult to sell. Perversely, the better the seller's news on the pessimistic scenario, the more illiquid the market becomes. A seller whose worst-case scenario is very close to the best-case scenario cannot credibly distinguish himself or herself from someone with the same upside but with a far worse downside, as in standard adverse selection settings.

This insight has implications for future empirical work. Researchers studying imprecise standards, such as model-based fair value reports, will need to focus on trading volume, rather than on prices. If firms have leeway to report aggressively and if trade occurs, prices are efficient. The friction affects latent trades, not observed ones.

Our work relates to Dye (2002), whose model illustrates the difference between a classification standard as written and the reporting behavior the standard de facto implements. Dye's focus is more on manipulations, whereas we study compliance with an imprecise standard.

Our argument rests on imprecision of accounting resulting from underlying ambiguity.<sup>12</sup> The external validity of our study therefore depends on whether ambiguity is present in financial reporting contexts. Additionally, we assume that it is possible to prompt auditors or regulators to restrict aggressive reporting given that a standard is imprecise, and that auditors would tolerate aggressive reporting if not prompted to impose conservative assumptions. We now address each of these points.

Several authors have remarked on the relationship between complexity and ambigu-

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<sup>12</sup>For other causes of imprecise standards, see for example Kanodia et al. (2005) or Penno (2008).

ity. Coval et al. (2009) and Meder et al. (2011) show that the values of derivatives such as tranching mortgage-backed securities are extremely sensitive to the covariance structure among the underlying assets, which itself is likely to vary with conditions in the housing market. Embrechts et al. (2013) show that calculating bounds on the values of such instruments is straightforward; however, Al-Najjar (2009) and Brunnermeier (2009) show that estimating the exact distribution is extremely difficult even with an arbitrarily large sample size. Investors do not appear to have the precision of knowledge that would make estimating the exact distribution feasible, as Eyster and Weizsäcker (2011) document. Williams (2015) provides empirical evidence that investors react to earnings news as if it is ambiguous. Like us, Williams finds a connection between reporting under ambiguity and abnormally low trading volume.

Studies of auditor behavior consistently find that auditors are willing to permit aggressive reporting (Hackenbrack and Nelson, 1996), and will be more inclined to do so if the standard is vague (Kadous et al., 2003, Backof et al., 2016) or when the standard involves a highly complex estimation procedure (Griffith et al., 2015a). These results are robust to changes in the participant population and task. For instance, Kadous and Mercer (2016) find that mock jurors in a negligence lawsuit task become more lenient in their response to aggressive reports if the standards are imprecise. However, if auditors are prompted to be deliberative (Griffith et al., 2015b) or to consider both reasons to support and to oppose a manager's assertions (Cohen et al., 2016), they become more inclined to restrict aggressive reporting.

We conclude with some remarks about the broader significance of our results. The

macroeconomics literature has demonstrated multiplier effects of liquidity frictions (Bernanke et al., 1996, Hall, 2010), particularly if liquidity frictions occur in credit markets. Vague reporting standards for financial instruments would therefore be of great concern, at least if the standards are not designed to elicit conservative estimates.

### A. AXIOMS AND FULL THEORETICAL DEVELOPMENT

The central tenet of our argument is that discretion in vague accounting standards under ambiguity leads to aggressive reporting. In this appendix, we elaborate on necessary and sufficient axioms on preferences for aggressive reporting to be the seller's unique optimal reporting strategy. Because the market of interest to us is characterized by ambiguity, as discussed in Section 1, we allow preferences to be incomplete.<sup>13</sup>

We require that all agents prefer an asset that is guaranteed to have a higher value to one that is guaranteed to be lower. This is the interval order axiom of Fishburn (1985). Letting

$$X = \{[a, b] \mid \underline{a} \leq a \leq b \leq \bar{b}\},$$

we have the following:

**Axiom 1** (Interval Order). *All agents have preferences that are monotone in the*

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<sup>13</sup>For details on incomplete preference models, see Aumann (1962), Bewley (2002), Dubra et al. (2004), and, in a social choice context, Stecher (2008).

range of values: if asset  $x$  has value in  $[a, b]$  and asset  $y$  has value in  $[c, d]$ , then

$$b \leq c \Rightarrow x \succsim y,$$

and if there is at least one strict inequality among  $a \leq b \leq c \leq d$ , then  $x \succ y$ .

For convenience, we will write preferences as if directly on  $X$ . Thus, we will henceforth write  $[a, b] \succsim [c, d]$  instead of writing  $x \succsim y$  for asset  $x$  with values in  $[a, b]$  and asset  $y$  with values in  $[c, d]$ .

Violations of Axiom 1 lead to counterexamples to the unique optimality of always reporting the private upper bound. If buyers have a bliss point, then there is nothing to be gained by reporting that a value above the bliss point is feasible. Note that 1 implies a full support condition.

Because a report  $\hat{v}$  is feasible if and only if  $a' \leq \hat{v} \leq b'$ , buyers learn from the seller's report that  $a' \in [\underline{a}, \hat{v}]$  and  $b' \in [\hat{v}, \bar{b}]$ . We therefore extend preferences to *rectangular* subsets of  $X$  ("rectangles"), which are sets of the form

$$R(w, x, y, z) := \{[a, b] \in X \mid w \leq a \leq x \leq y \leq b \leq z\}.$$

In this notation, the report  $\hat{v}$  is feasible if and only if  $[a', b']$  is in the rectangle  $R(\underline{a}, \hat{v}, \hat{v}, \bar{b})$ .

Our next axiom is monotonicity with rectangular sets.

**Axiom 2** (Witnessed Strict Dominance). *Let  $S, T$  be nonempty rectangular subsets*

of  $X$ . Suppose that

$$(\forall [a', b'] \in S)(\exists [a'', b''] \in T) \quad [a', b'] \prec [a'', b'']$$

and

$$(\forall [c'', d''] \in T)(\forall [c', d'] \in S) \quad \neg([c'', d''] \succ [c', d']).$$

Then  $S \prec T$ .

Axiom 2 is weaker than strict dominance. It says that, if every element of  $S$  is strictly dominated by something in  $T$ , and nothing in  $T$  is strictly dominated by anything in  $S$ , then  $S \prec T$ . That is, given a possible range of values in  $S$ , there must be a witness in  $T$  willing to testify that  $T$  offers something better. If this condition holds, then the agent must prefer  $T$  to  $S$ .

We illustrate Axiom 2 graphically in Figure 6.

The figure represents the seller's private information as a point in the square, with the  $x$ -axis giving possible values of the private lower bound  $a'$  and the  $y$ -axis giving possible values of the private upper bound  $b'$ . Because  $b' \geq a'$ , the seller's private information is some point above the  $45^\circ$  line, represented by the gray triangle.

In terms of Figure 6, Axiom 2 requires that the horizontally striped region, excluding the left boundary, is strictly better than the vertically striped region, excluding the top boundary. If this does not hold, and our next axiom does, then the seller could be better off issuing a lower report than an higher report.

Axiom 2 compares regions that are feasible under one report and infeasible under

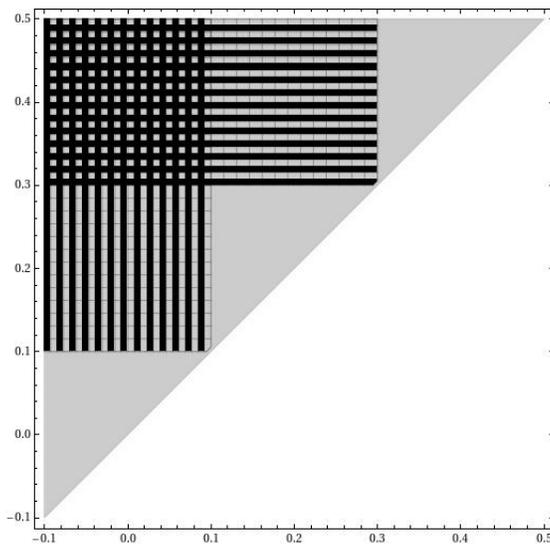


Figure 6: The  $x$ -axis represents the ex post lower bound  $a'$  on the asset's value. The  $y$ -axis represents the ex post upper bound  $b'$ . The seller's private information is represented as a point in the gray triangle. The horizontally striped region, including the checked region, is the set of possible values of  $(a', b')$  given a low report (in this case, 0.1). The vertically striped region, including the checked region, is the set of possible values of  $(a', b')$  given a higher report (in this case, 0.3).

another. That is, 2 addresses the symmetric difference of feasible regions for distinct reports. The next axiom, which we call *disjoint union betweenness*, compares the intersection of feasible regions.

**Axiom 3** (Disjoint Union Betweenness). *Let  $S, T, U$  be nonempty rectangular subsets of  $X$ . Suppose  $S \prec T$ ,  $\neg(U \prec S)$ , and  $\neg(T \prec U)$ . Then*

$$U \cup S \prec U \cup T.$$

It is important to restrict attention to rectangles that are no worse than a preferred rectangle and no better than the dominated rectangle. To see why, assume  $S \prec T$  and  $U, S$ , and  $T$  are pairwise disjoint. Suppose  $U \prec S$ , and that  $T$  is a small region, say a single identified point  $[v, v]$ . Suppose  $U$  is a larger region than  $T$ , but a much smaller region than  $S$ . Then  $U \cup T$  is almost identical to  $U$ , and  $U \cup S$  is almost identical to  $S$ . The restriction of Axiom 3 to regions  $U$  that are not worse than  $S$  or better than  $T$  avoids this difficulty.

Under Axioms 1–3, aggressive reporting is optimal but not necessarily uniquely. The reason is that none of Axioms 1–3 assures that the checked region in Figure 6 is neither better than the horizontally striped region nor worse than the vertically striped region. The additional axiom we need is a closure condition. We first define a notion of distance.

**Definition A.1.** Let  $[a, b], [a', b'] \in X$ , and let  $U \subseteq X$ . Define

$$d([a, b], [a', b']) := \|(a, b) - (a', b')\|$$

$$d([a, b], U) := \inf_{[a'', b''] \in U} d([a, b], [a'', b''])$$

If  $U = \emptyset$ , then set  $d([a, b], U) := -\infty$ .

Definition A.1 says the following: associate the interval  $[a, b] \in X$  with the point  $(a, b) \in \mathbb{R}^2$ , as in Figure 6. Define the distance between two intervals as the Euclidean distance between the associated points in  $\mathbb{R}^2$ , and let the distance from an interval  $[a, b] \in X$  to a set  $U \subseteq X$  be the distance from  $[a, b]$  to the closest point in  $X$ .

**Axiom 4 (Closure).** *Let  $S, T$  be rectangular subsets of  $X$ , with  $S \prec T$ . Then for all*

$[a, b], [a', b'] \in X$ , if  $d([a, b], S) = d([a', b'], T) = 0$ ,  $\{[a, b]\} \preceq \{[a', b']\}$ .

Lastly, we impose a consistency condition.

**Axiom 5** (Consistency). *Let  $S, T \subseteq X$ . Suppose  $(\forall [a, b] \in S)(\forall [c, d] \in T)$ , we have  $[a, b] \preceq [c, d]$ . Then  $S \preceq T$ .*

**Lemma A.1.** *Let  $\underline{a} < v' < v'' < \bar{b}$ . Define the rectangles*

$$\begin{aligned} S &= R(\underline{a}, v', v', v'') \setminus \{[a, b] \in X \mid \underline{a} \leq a \leq v' \text{ and } b = v''\} \\ T &= R(v', v'', v'', \bar{b}) \setminus \{[a, b] \in X \mid a = v' \text{ and } v'' \leq b \leq \bar{b}\} \\ U &= R(\underline{a}, v', v'', \bar{b}) \end{aligned}$$

Then  $\neg(U \prec S)$  and  $\neg(T \prec U)$ .

*Remark A.1.* In Lemma A.1, the regions  $S, T$ , and  $U$  correspond to the vertically striped, horizontally striped, and checked regions in Figure 6.

*Proof.* First, note that, for every  $[a_0, b_0] \in S$  with  $a_0 < v'$ , the points  $\{[a, b] \in X \mid a = v' \text{ and } v'' \leq b \leq \bar{b}\} \subset U$  strictly dominate  $[a_0, b_0]$ . On the other hand, no point in  $S$  strictly dominates any point in  $U$ . So by witnessed strict dominance,  $S \setminus \{[a, b] \in S \mid a = v'\} \prec U$ .

Next, observe that for any  $[v', b] \in S$  and any  $[c, d] \in U$ , we have  $d([v', b], S) = d([c, d], U) = 0$ . So by the closure axiom 4,  $[v', b] \preceq [c, d]$ . We therefore have, for all  $[a, b] \in S$  and for all  $[c, d] \in U$ ,  $[a, b] \preceq [c, d]$ , and hence by the consistency axiom 5,  $S \preceq U$ .

An analogous argument shows that  $U \preceq T$ . □

We can now prove Theorem 2.1.

*Proof of Theorem 2.1.* Let  $S, T, U$  be as in the proof of Lemma A.1. We will show that  $S \cup U \prec T \cup U$ . Since  $S \cup U$  is the information the buyer receives from report  $v'$  and  $T \cup U$  is the information the buyers receives from report  $v'' > v'$ , it then follows that a higher report is always better news. Consequently, the seller's uniquely optimal strategy is to choose the highest admissible report,  $\hat{v} = b'$ .

Observe that  $S \prec T$ ; this is an immediate consequence of the interval order axiom 1 and the witnessed strict dominance axiom 2. Lemma A.1 then guarantees that  $S \succsim U$  and  $U \succsim T$ . By the disjoint union betweenness axiom 3, the result follows.  $\square$

## B. INSTRUCTIONS

We provide the instructions and the review questions for the conservative treatment. The instructions for other treatments are shown in brackets.

### **Instructions**

This is an experiment in the economics of decision-making. This experiment will last approximately one hour. Do not talk to others at any time during the experiment. If you have any questions during the experiment, please raise your hand.

To make a profit, you will trade a financial asset. At the end of the experiment, we will pay you a show-up fee of \$5 plus any profits you will have made.

The experiment will last for 16 rounds. In each round, the computer will randomly

select one person as the seller. The other four participants will be buyers for that round. Everyone has an equal chance of being the seller in any given round. The computer will tell you whether you are a seller or a buyer. The computer will not tell the buyers who the seller is.

At the beginning of each round, the seller will receive an asset, and the buyers will receive 150 cents. The computer will determine the asset's value at the end of the round.

**Your Information** [*Discretionary treatment: Your Information and the Seller's Report*]

If you are the seller, the computer will tell you a minimum and maximum value of the asset for that round. The minimum will be at least 50 cents, and the maximum will be at most 150 cents. The asset's value will be between the minimum and maximum. [*Discretionary treatment: The computer will ask you to enter a possible value of the asset, which must be between the minimum and the maximum.*] If you are a buyer, the computer will tell you the minimum, and will remind you that maximum is at most 150 cents. [*Aggressive treatment: If you are a buyer, the computer will tell you the maximum, and will remind you that minimum is at least 50 cents.*] [*Discretionary treatment: If you are a buyer, the computer will tell you the possible value the seller entered.*]

### **The Auction**

If you are a seller, the computer will ask you to enter the lowest price for which you

are willing to sell the asset. None of the buyers will see the minimum price you enter.

If you are a buyer, the computer will ask you to enter the amount you are willing to pay for the asset. We call this amount your bid. You may enter any amount from 0 to your 150 cents. None of the other participants will see your bid.

If the highest bid is at least the minimum price the seller is willing to accept, then the computer will sell the asset to the buyer who made the highest bid. The price will be the amount of the highest bid. If two or more buyers tie for the highest bid, then the computer will randomly select one of these buyers and sell the asset to the selected buyer. The computer will then determine the asset's value. If trade does not occur, the seller will receive the asset's value. If trade occurs, the buyer who bought the asset will receive the asset's value. After the computer determines the asset's value, your money for the current round will be deposited into your account.

At the end of the experiment, we will pay you the balance in your account. If your account balance is negative, we will still pay you the full \$5 show-up fee.

*If you have any questions, please raise your hand now.*

## **Review Questions**

Please answer the following questions. Your answers will not affect your payment.

1. The computer tells the seller that the asset is at least 59 cents and at most 120 cents. The computer will also tell the buyer that the asset is worth at most 120 cents. [*Discretionary Treatment*: The computer tells the seller that the asset is worth at least 59 cents and at most 120 cents. The computer will also tell

the buyers the possible value the seller enters.]

**True**                      **False**

2. The computer tells the seller that the asset is at least 59 cents and at most 120 cents. The computer will also tell the buyer that the asset is worth at least 59 cents. [*Discretionary treatment:* The computer tells the seller that the asset is worth at least 59 cents and at most 120 cents. The seller may enter a possible value of 125 cents.]

**True**                      **False**

3. The lowest price for which the seller is willing to sell the asset is 76 cents. The highest bid is 87 cents. Trade will occur.

**True**                      **False**

4. The lowest price for which the seller is willing to sell the asset is 87 cents. The highest bid is 76 cents. Trade will occur.

**True**                      **False**

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