capstract:2610.00010v1 [q-fin.GN] 29 Oct 2026

Verification and the debt capacity of consumable collateral

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October 29, 2026

Abstract

Verification can reduce the value of a pledged asset when producing a conclusive observation uses up part of the asset. We derive a cash-flow benchmark for debt secured by a finite stock of individually redeemable units and test it in a posted-price experiment with 384 participants. An eight-unit inspection raises mean reservation prices by 0.53 credits when it preserves the collateral, compared with 0.06 credits when it consumes the units inspected. The paired difference is 0.47 credits (95% confidence interval 0.38 to 0.56). At 24 units the difference reaches 1.43 credits. The isolated effect of reducing the available stock accounts for most of the difference in the eight-location comparison. A separate liquidation exercise records the dispersion of bids when buyers receive the physical asset in place of a fixed credit payment. The results distinguish the value of certifying a reserve from the value of the reserve available after certification.

Keywords: secured debt, costly state verification, collateral, experimental finance, liquidation

1 Introduction

In a secured loan the object described in the collateral schedule is ordinarily expected to survive the procedures used to establish its quality. That expectation is appropriate for many assets. A routine inspection of a building establishes something about the probability of recovery while leaving the building where it was. An inventory sample can differ. Where the premium on the asset attaches to an unexercised use, exercising that use to demonstrate quality extinguishes the premium on the sample. The lender receives a report about a stock of which part has already ceased to exist.

One case can be studied at the scale of a single pledge. A sheet of air-cell packaging carries a set of individually exercisable claims on sealed cells. A buyer interested in rupturing them distinguishes cells that produce an audible rupture from cells that merely look raised; a used sheet offers little of the former distinction. The condition of a cell can be confirmed by rupturing it. A conclusive report reading “eight of eight intact” therefore certifies eight cells that the buyer will be unable to rupture. Earlier studies of reusable packing inventory reported condition on receipt and again after the decision to resell (Bruk and Neven, 2021; Messa and Petruven, 2022). We take the sequence of those records literally when determining which cells secure a note.

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Preprint

This paper compares prices elicited for claims on the same inventory when identical information is delivered with and without a reduction in the stock. Audit intensity can be assigned independently of initial quality. The amount due on successful repayment is fixed and observable. This design removes a channel that would otherwise be difficult to distinguish from loss of stock: an expensive inspection might reveal bad news about the borrower. Here its cost can arise even after favorable information. The issuer is a rule in the software and defaults on a public lottery.

The theory of collateral emphasizes what can be transferred on default (Hart and Moore, 1994; Kiyotaki and Moore, 1997), including its value to an outside buyer in circumstances where productive use elsewhere is limited (Shleifer and Vishny, 1992). In models of costly state verification the act of observing the state is itself a resource cost (Townsend, 1979; Gale and Hellwig, 1985). Monitoring costs can in turn determine who gathers information and for whom (Diamond, 1984). Our setting isolates a particular incidence of the cost. Inspection removes precisely the units to which the debt has recourse, with the effect concentrated in the default state. We do not charge the prospective buyer an inspection fee.

Information about quality can cause thin trade or reprice an issue even with no change in resources (Akerlof, 1970; Myers and Majluf, 1984). Debt may also be valuable because some information about collateral is irrelevant to its payoff (Gorton and Pennacchi, 1990). We retain only the part of the payoff that can be identified from the report and the liquidation schedule. Section 2 derives the expected payment. Section 3 describes the inspection and bidding rules. Section 4 separates the information and stock effects. Section 5 examines the use of the asset after repossession.

2 Collateral and valuation

2.1 Delivery state and reserve state

A pledge begins with 48 numbered locations in a single sheet. There are two equally probable types, with $K = 30$ or $K = 42$ redeemable cells. Remaining locations contain cells made nonredeemable before the sheet is assigned. The appearance of these cells is held constant behind the inspection screen. An examiner draws m locations without replacement and announces s, the number of redeemable cells among those locations. The arm of the experiment determines whether the examiner samples the actual sheet or reads a sealed preparation record at those locations. Under the first rule the s cells are ruptured during inspection. Under the second rule they remain available. The examiner tests every assigned location in the first arm, including locations at which a rupture cannot be obtained. A failure cannot consume a right to a future payment because none existed at that location.

Let D indicate destructive inspection and R denote the number of redeemable cells remaining in the pledge. The schedule pays $c = 0.20$ credits per cell on liquidation, and the note has face value $F = 10$ credits. The public probability of default is $q = 0.40$. The two lottery draws, balance-sheet state and repayment, are independent. On default the liquidation desk takes the sheet and pays the cash proceeds to the buyer of the note. Full payment by the issuer releases the sheet to the desk for its own account. Buyer receipts in either state are therefore

$$R = K - Ds, \qquad X = (1 - B)F + B\min\{F, cR\}, \quad \Pr(B = 1) = q. \tag{1}$$

The reserve schedule leaves the debt exposed to every remaining cell. Even the better uninspected sheet is worth 8.40 credits, below face. A capped note with face less than 6 would behave differ-

ently. Some units would then be spent during verification without crossing the overcollateralization threshold. Sampled successes are a subset of redeemable cells, so s cannot exceed K.

2.2 Information before and after the draw

The public posterior for $K = k$, given the reported count, has weights proportional to $\binom{k}{s}\binom{48-k}{m-s}$. Each likelihood is zero outside the familiar sampling support. Neither the prior nor the posterior depends on D. It follows from Eq. (1) that the posterior expected payment of the note is

$$V_D(s, m) = (1 - q)F + qc\big(\mathrm{E}[K \mid s, m] - Ds\big). \tag{2}$$

Conditional on a count s, the difference in expected payments between arms is qcs. The difference grows with the favorable part of the report. In the destructive arm a positive report carries both evidence that the pledge was better before inspection and evidence of more units removed. Those two effects can have different ranks at nearby counts. If the report already rules out the low type, an extra successful inspection within that region can lower the expected recovery even though it adds an intact cell to the certificate. A certificate that cannot change the posterior is detrimental to the note whenever it consumes a positive number of cells.

Before the draw, the two contracts differ by $qc\,m\mathrm{E}[K]/48 = 0.06m$ credits. Expected information value to a risk-neutral buyer committing to transact at a common fixed price is zero by iterated expectations. The same buyer can decline a posted price after seeing the report, and that option introduces a different quantity. The bid schedule can also reflect risk attitudes, misperception of the mixture, or the trouble of evaluating a report. We compare magnitudes with Eq. (2). The causal estimand is a difference in elicited reservation prices. An estimate close to the cash-flow loss does not demonstrate that the bidder uses the posterior.

The full-information limit makes the difference between the two kinds of examination concrete. When all 48 locations are inspected with preservation, the note still has average expected payment 8.88. Inspection of all 48 by rupture produces an expected payment of 6.00. It also leaves the researcher with an exact record of the inventory that would have supported the loan. We stop at 24 so that the high and low types both retain positive expected liquidation proceeds.

3 Experimental design

3.1 Recruitment and assignment

We ran 32 sessions of 12 participants at three laboratories. Eight sessions were held in Utrecht, 12 in Addis Ababa and 12 in Valparaíso. Each subject completed all seven note decisions: no examination, and both examination rules at sizes 8, 16 and 24. Two supplementary bidding decisions held the written count fixed and cross-checked the price of a known change in recovery. The physical exercise excluded prior note bidders. The laboratory committees approved the procedures and subjects gave written consent.

The laboratory randomized the order of the seven decisions separately for each subject and assigned three independently drawn reports, one per sample size. A report was reused across the two arms within a subject and size. The two offers were presented as contracts on independent replica sheets with the exact same initial type and inspected count. Neither subject nor examiner had a choice over which report was drawn. Query positions were also held constant across paired decisions. We used split panels to display the report and the inventory schedule. The inventory schedule described disposition of the cells, including the cases where there was no paid recovery.

Reports recorded nonredeemable locations explicitly, so a statement about an 8-cell sample with one failure could be traced to a total of seven ruptures in the destructive arm.

The design and available observations are in Table 1. All 384 assigned subjects committed bids on all seven primary screens. Starting characteristics and practice decisions remained in the analysis file even if subject comments indicated disbelief in the instrument. These comments could have been affected by order and were collected after the bidding decisions.

Table 1: Session and observation counts. Note decisions include the seven main contracts only. Liquidation bidders took part in a separate exercise with four bids each.

Site	Note sessions	Note bidders	Note decisions	Liquidation bidders	Liquidation bids
Utrecht	8	96	672	24	96
Addis Ababa	12	144	1,008	36	144
Valparaíso	12	144	1,008	36	144
Total	32	384	2,688	96	384

3.2 Bidding, settlement and masking

One of the nine decisions was selected by the computer after all nine had been entered. It drew a posted price independently from a discrete uniform distribution on 0 to 10 credits at intervals of 0.05. A bid at or above the drawn price triggered a purchase at the posted price from an experimental endowment of 10 credits. A lower bid left the endowment untouched. The subject never paid their own bid. Report displays were populated before the posted-price draw and locked against revision after exit. A pilot changed the display to put repayment explicitly in the buyer’s account (Veldsen and Bekaro, 2023). Elicitation follows the random-price principle in (Becker et al., 1964). This pricing rule is used for its separation of bid amount from payment and shares the distinction made in auction theory between a valuation and the amount surrendered on acceptance (Vickrey, 1961). We use a fixed posted-price distribution across contracts.

Only one purchase could enter the terminal budget. This reduces the scope for hedging the better sheet against the worse one. Under expected utility and the usual reduction of compound lotteries, a single decision has a reservation price with the other decisions held fixed. Violation of that reduction is one reason to interpret the observations as bids under these rules. Experimental work emphasizes that cash arrangements can induce the payoffs of interest while allowing incidental motives to remain (Smith, 1962). Views of actual collateral were restricted to the demonstration before bidding and the relevant sheet at settlement. Issuer repayment had the same chance on every screen. All credits were converted at a common purchasing-power schedule within each site after draws and any actual recovery.

The preparation team held the occupancy schedule. A second team administered sessions. The bidding code supplied neither team with access to the other side of the ledger until settlement. Participants had to know whether a contract depleted the asset, and data from comments show that they often recognized the material. There is no claim of blinding to whether the note was secured by a sheet that could still be used. The protocol compares two known contracts. Written schedules and slips were translated separately by site, with reversal into the working script to check whether “tested” implied “still available.” The local name for the packaging material was permitted. This procedure follows the reporting rules for count-based inventories described in (Séguin and Satoya, 2020).

3.3 Outcomes and inferential procedure

The primary contrast is the preserving less the destructive bid at eight locations. We subtract paired bids for each individual, average over individuals and resample the 32 sessions within site with replacement to form a percentile interval from 9,999 draws. Equal original session sizes make this average equal to the mean of the original session means. At each of 16 and 24 locations the procedure is the same. The intervals at those sizes and in the plots are pointwise. We report them as secondary contrasts to describe the slope of depletion. Grouping by session retains dependence from the demo and from conversation in the payment area. Numerical calculations treat bids as point values on the 0.05 grid.

4 Reservation prices

4.1 Value of the report and available reserve

At eight locations bids averaged 8.84 credits with preservation and 8.37 with depletion. The within-person difference is 0.47 credits with a 95% interval of 0.38 to 0.56. Relative to the common no-inspection bid of 8.31, the preserving offer gains 0.53 credits and the destructive offer gains 0.06 (−0.04 to 0.16). Under depletion, the estimated increment is positive from zero to eight locations and negative from eight to 16. The raw bids supporting these statements and the cash-flow predictions are reported in Table 2.

Table 2: Main bids and pre-report expected payments, in credits. Observed means are over 384 subjects per available arm. Differences are preserving less destructive; intervals are from session resampling. The uninspected bid is common to both arms.

Locations	Preserving bid	Destructive bid	Bid difference (95% CI)	Predicted difference
0	8.31	8.31	common	0.00
8	8.84	8.37	0.47 (0.38 to 0.56)	0.48
16	8.87	7.91	0.96 (0.85 to 1.07)	0.96
24	8.88	7.45	1.43 (1.29 to 1.57)	1.44

Figure 1 shows the profile. Beyond eight locations the preserving bid is nearly flat and within four hundredths of the unconditional expected payment of 8.88. Preservation lets the bidder attach the report to the sheet without adjusting the count available on default. Even an approximate evaluation of the report can move bids closer to expected payments. We have no independent valuation of the risk in the uninspected contract and cannot assign the entire 0.53-credit increase to learning. The uninspected contract carries quality risk for a buyer who pays the same posted price in either quality state. It may also be difficult to price a case where the number of cells present has been described but never displayed in a report.

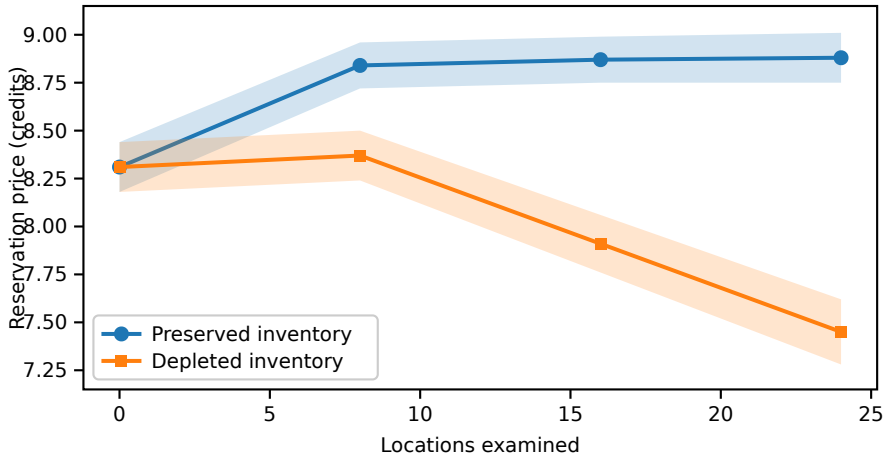


Figure 1: Mean reservation price by number of locations examined. Bands give pointwise 95% session bootstrap intervals. The two series share their zero-inspection estimate.

We computed the paired expected-payoff difference on the reports that subjects saw. These means were 0.48, 0.96 and 1.44 credits after rounding. Each differed by less than 0.01 credits from the benchmark shown in Figure 2. The comparison uses the default weight once, after multiplying the 0.20 credit payment by the number of ruptures. Applying the default weight to the bid difference again would count the default lottery twice. Individual bid gaps are substantially more dispersed than this schedule. At 24 locations, 43 people bid less than half of their report-specific cash-flow difference. Twenty-nine bid more than twice that difference. Both types appear in each site, and the two counts do not define types that can be tracked reliably across individual decisions.

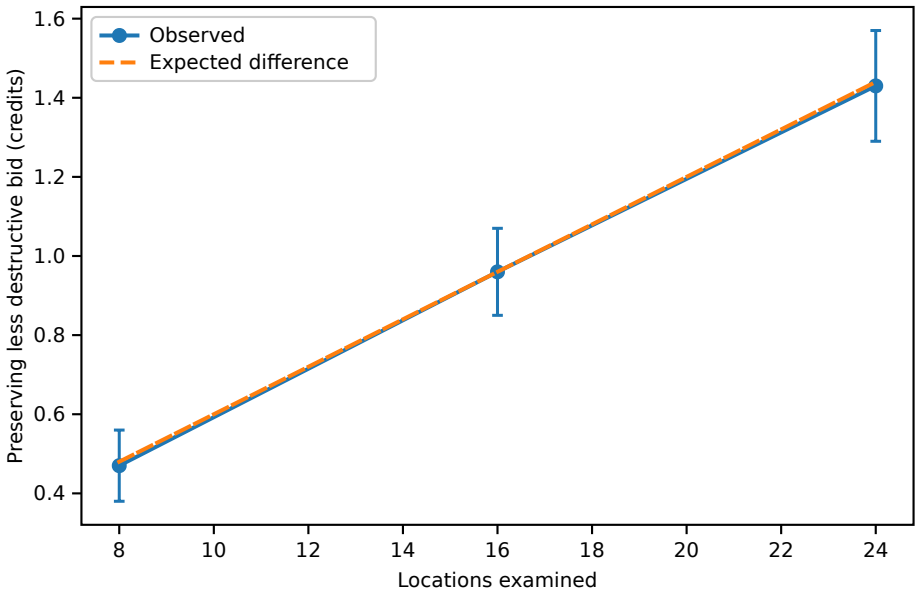


Figure 2: Mean paired differences at the three positive examination sizes. Bars are pointwise 95% session bootstrap intervals. The dashed line is the expected value of consumed cells in the default state.

4.2 Comparison with direct depletion

In the supplementary decisions everyone saw the result of a nondepleting eight-location examination. On one screen the examiner removed s additional redeemable cells after reporting the result. The desk marked the cells as released before the note was offered. No further information about the starting type was released: the software guaranteed that these were known intact locations outside the report sample and showed only how many were taken. There are always enough intact cells outside an eight-location sample for this comparison under both quality states. The other screen preserved the reserve and the two offers were block randomized in order.

The direct reduction in the pledge lowered bids by 0.44 credits (0.33 to 0.55), compared with the 0.47 total contrast at the same report size. We find a difference of 0.03 credits (−0.10 to 0.16) between the two contrasts by resampling the same participants together. The release comparison changes which intact cells disappear. Payment uses only the count, so participants should value both configurations equally under Eq. (1). If a buyer attended disproportionately to the locations explicitly verified, loss of those locations might have cost more. The interval still allows a modest location premium. In actual repossession the material will have a pattern of unrecoverable cells; Section 5 makes that pattern visible to buyers.

The number of reported successes supplied a second descriptive check. In Figure 3, we show pre-specified broad bins of s/m at positive inspection sizes using the mean paired difference within a bin. Paired observations enter both arms under the same report. The dispersion of the price gap among high-success reports at 24 locations reflects, in part, variation in total cells used up. The figure is descriptive because success is associated with starting type. Treating better reports as randomly assigned evidence would confuse location sampling with assignment of initial condition.

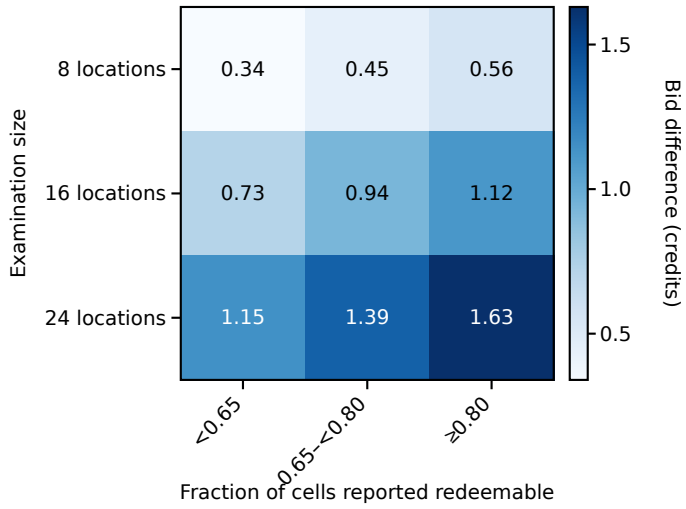


Figure 3: Mean preserving less destructive bid, in credits, by report composition. Bin limits include the lower endpoint except for the first bin, which ends below 0.65. Averages condition on reported successes.

5 Physical liquidation

The main experiment prespecified a cash payment at repossession. A market liquidator might instead have to find parties willing to receive the packaging itself. Some buyers value it as packaging and some buy it for rupture. The latter demand supports a distinction between surface area and available cells. A sheet with the same outline after inspection can remain useful for separating items while making considerably less sound in subsequent use. Messa and Petruven (2022) made this distinction in secondary transactions where the market for partial rolls remained thin. In (Manero and Melunza, 2024), lots sold for packing and lots sold for individual-cell use had different count discounts even after homogenizing dimensions. Neither setting supplies the price of an asset seized at our laboratory terms.

We recruited 96 new bidders, with 24 in Utrecht and 36 in each of the other sites. Each saw four benchmark sheets with known counts of 48, 36, 24 or 12 remaining cells. We built seven patterns per count from the same stock and assigned the pattern uniformly at random per bidder and count. These counts are for the separate liquidation exercise; 48 was never a high type in the note experiment. Buyers could turn a sheet to view its outline but surrendered it if they exercised a cell during inspection of the example lot. None chose to do so. The four examples were left visibly present throughout. The researcher displayed exact certified counts and accepted bids in credits under the random posted-price rule. The selected sheet, on purchase, was handed over in place of a redemption payment.

Table 3: Bids for physical sheets in the liquidation exercise, $n = 96$ per row. The central 50% interval runs from the 25th to the 75th percentile of bidder valuations. No bid was imputed for a failed purchase. The desk benchmark shows what the main experiment would pay at the same remaining count before any cap.

Cells left	Mean bid (credits)	Central 50% (credits)	Desk benchmark (credits)
48	6.19	3.45 to 8.75	9.60
36	4.86	2.60 to 6.65	7.20
24	3.46	1.60 to 4.85	4.80
12	2.03	0.75 to 3.15	2.40

Mean resale bids in Table 3 decline with the count on the sheet. They are below the fixed desk payments, and the differences in mean bids per cell are not constant. The incremental price of adding the last 12 cells to a 36-cell sheet is 1.33 credits, compared with 1.43 credits from 12 to 24. The implied estimates are too close to distinguish at these sample sizes. A fixed value of 0.20 credits per marginal cell would predict 2.40 credits for each of those increments. Buyers can use the sheet as a unit and may pay for the remnant even where there are too few cells to make the exercise attractive. No zero-count sheet was offered, so an intercept corresponding to demand entirely for the substrate remains unidentified.

A participant who purchased a sheet could use it in the waiting area or take it away. We counted 40 purchases at settlement. The receipt recorded 18 sheets used in the waiting area, operationally defined as at least one rupture within view of the cashier, and 22 removed with no observed rupture. This post-transaction behavior provided the study’s only direct observation of demand for rupture. Rates conditional on purchase are selected, and we do not infer the share of

people who value rupture over packaging from them. Ohren (2022) describes a similar problem in cataloguing use at a resale counter when take-away use is unobservable.

6 Discussion

The inventory schedule at origination can refer to the pre-examination stock, the part of that stock the examiner touches, or what remains for repossession. Keeping these accounts separate explains why a certificate can look better while the associated recovery gets worse. At high report counts, a further success changes current availability even in regions where it reveals no new information about initial quality. A senior claimant would be especially insulated from this deterioration under overcollateralization. Subordinated recovery would begin falling earlier. In a model that prices debt relative to the value of supporting assets (Black and Scholes, 1973), it matters which party receives the proceeds associated with an inspection. Here the inspector never transfers the consumption benefit to the creditor.

The properties of the sampling device are part of the contract. We can preserve inventory using the preparation record because condition is assigned and tracked by the experimenter. In a field market, an examiner cannot in general read that record with certainty. If imaging could detect intact cells without release, a noisy image-based certificate might preserve more expected money than an exact test. Purchase and verification could also be bundled if the auditor were a natural final buyer. The observed forgone receipts in this paper load entirely on the default leg; in an actual transaction a lender could ask for compensation by reducing advance size. A borrower with an alternative source of collateral could then substitute out of the pledge. Neither of these behavioral margins is represented by fixed contract menus. Our subjects price claims conditional on receiving an option to buy, whereas a debt offer in the field might be refused by the issuer before any buyer sees it.

A fractional loss of this magnitude in liquidation cannot be translated into a firm-wide change in leverage. In a setting with substantial collateral buffers the same practice might leave most note prices unchanged. Conversely, an issuer that certifies several claims with the same stock has to reconcile the count between each certification. A second examiner can correctly report fewer successes if some of the original locations have become empty through verification for the first creditor. Axelvik and Avelar (2021) discusses separate verification records for assets rehypothecated across contracts. That distinction is observable in the reverse order here: the later creditor gets to see that the cell was intact on the earlier certificate, and encounters a flat cell at settlement. Assigning both entries the same value would include a right to make the same sound twice.

Data availability

The de-identified bid panel, randomization manifest and session summaries are available from the corresponding author with site identifiers limited to the three laboratories listed in Table 1. Individual settlement records contain take-away observations and remain with the site coordinators. The report packet includes the four benchmark counts and settlement rules.

A Estimation and additional offers

Let $P_{i,d,m}$ denote the entered bid of individual i at rule d and size m. We code $d = 1$ for depletion. The experimental average difference is

$$\widehat{\Delta}_{m} = \frac{1}{384}\sum_{i=1}^{384}\left(P_{i,0,m} - P_{i,1,m}\right). \tag{3}$$

For a bootstrap draw we retain the multiplicity of each session sampled and all paired bids in that session. This preserves the no-inspection bid and the supplementary decisions for any subject included in the draw. We make no adjustment for the marginal distribution of counts beyond matching by report through the design. The estimate of the isolated removal contrast replaces the two bid entries in Eq. (3) with the bids for the retaining and releasing offers, both described in the same terms as the eight-location preserving contract.

Under destructive inspection, the certificate records strikes across locations as well as successful ruptures. Losses are in units of successes. As a check on transcription, paper records were rejected for review if the count of struck locations differed from the assigned m, or if the count on the reserve slip plus the number of successful ruptures differed from the preparation count. No record entered the panel before those equalities were reconciled. The preserving sheets were sometimes removed from the holder to check their serial identifiers. This movement was recorded separately from the occupancy report and occasioned no reclassification in the valuation data.

B Payoff comparisons with a cap

For a face below the largest possible recovery, the pointwise advantage of a preserving report changes. The difference between the two default payoffs becomes $\min(F, cK) - \min(F, c(K - s))$. If $c(K - s) \geq F$, the difference is zero; if $cK \leq F$, the difference is cs. Between the two regions it is $F - c(K - s)$, which lies strictly between zero and cs. The posterior mixture of these regions is evaluated with the same hypergeometric weights used for Eq. (2). A certificate can be predominantly about the chance that recovery crosses face rather than the number of intact cells per sheet.

Acknowledgments

We thank the three laboratory coordinators for reconciling the preparation and settlement slips. The Avenroe experimental finance fund paid participant expenses.

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