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Appraisal Arbitrage and Shareholder Value

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ABSTRACT

Post-merger appraisal rights have been the focus of heated controversy within mergers and acquisitions circles in recent years. Traditionally perceived as an arcane and cabalistic proceeding, the appraisal action has recently come to occupy center stage through the ascendancy of *appraisal arbitrage*—whereby investors purchase target-company shares shortly after an announcement principally to pursue appraisal. Such strategies became more feasible and profitable a decade ago, on the heels of two seemingly technocratic reforms in Delaware: (i) the statutory codification of pre-judgment interest, pegging a presumptive rate at five percent above the federal discount rate; and (ii) the *Transkaryotic* opinion, which effectively sanctified appraisal claims trading. Several commentators have decried appraisal arbitrage as visiting unnecessary risks and costs on deal certainty and pricing, advancing the position that it reduces/destroys target shareholder value. This paper interrogates such claims both theoretically and empirically, testing the predictions of an auction-design model that delivers testable implications about appraisal's price and welfare implications. We find—consistent with the comparative statics of our model—that the appraisal-liberalizing events of 2007 were associated with *a significant increase in deal premia*, as the enhanced credibility of appraisal had the effect of raising the *de facto* "reserve price" associated with M&A auctions. We further find little evidence that liberalized appraisal rights stifled the incidence of appraisal eligible deals. Moreover, when interpreted through the lens of our auction-design model, our findings suggest that target-company shareholders of all stripes likely benefited *ex ante* from liberalized appraisal.

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1 Introduction

In mergers and acquisitions (M&A) law, the outcome of deal litigation often hinges critically on the content and discharge of the fiduciary duties owed by target-company officers, directors and dominant shareholders. This obsession is no doubt warranted: Fiduciary conflicts can prove to be *most* consequential at the Rubicon of a sale—often the endgame for target-company shareholders. Accordingly, for the good part of the last half-century, Delaware courts have singled out such circumstances for special attention in developing the state's fiduciary common law, imposing heightened scrutiny on decision making in the M&A context, and spotlighting "the omnipresent specter that a board may be acting primarily in its own interests, rather than those of the corporation and its shareholders." (*Unocal v. Mesa (1985); Revlon v. MacAndrews* and *Forbes (1986)*). The topic is easily one of the most celebrated and written-about areas of company law.

Far from the limelight of fiduciary duties, a vestigial fossil from a bygone M&A era has reclusively lurked, awaiting its Norma Desmond close-up[1]: The statutory appraisal right. The appraisal proceeding affords target-company shareholders the option of eschewing the terms of an acquisition in favor of receiving a judicially determined cash valuation for their shares. All states have long provided this statutory option in some form or another for many—but not all—transactions. Its roots trace to the mid-19th century, and it first became available in Delaware in its modern form in the early part of the 20th century (Eisenberg, 1976).

In appraisal-eligible cases,[2] dissenting shareholders hold a potentially powerful tool to counter deal terms they believe to be inadequate or undercompensatory. When sought by an eligible shareholder, appraisal obliges a court to "determine the fair value of the shares" of the target corporation, "tak[ing] into account all relevant factors" and with no explicit assignment of the burden of proof. 8 Del. C. §262(h). Beginning in the early 1980s, this task of fair valuation in appraisal began increasingly to be based on modern tools of financial valuation, including discounted cash flow (DCF) analysis and comparable company benchmarking. Modern appraisal cases invariably entail prolix valuation reports by competing experts whose fair value estimates can

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[1] *Sunset Boulevard*, Closing Scene E-47 (1950) (https://youtu.be/jMTT0LW0M_Y).

[2] Eligible public-target transactions under the Delaware statute are generally limited to statutory mergers that involve either a mandatory cash component or a squeeze out of minority shareholders. In addition, shareholders seeking the remedy must "perfect" their eligibility in several ways (including not voting their shares in favor of the transaction). *See* 8 Del. C. §262(h).

differ multifold. By most accounts, non-financially-trained judges find such procedures challenging at best (Talley, 2017; Choi and Talley, 2017).

It was not until 2007, however, that appraisal rights finally received their *Desmondian* due, courtesy of two significant legal events that afforded the statutory proceeding a spotlight of its own. First, in August of 2007, §262(h) of the Delaware code was amended to award presumptive pre-judgment interest in appraisal proceedings pegged at the Federal Reserve discount rate plus five percent (5%), compounded quarterly. (Although the statute allows the court to impose a different rate in exercising its equitable discretion, the overwhelming practice since the amendment has been simply to award the statutory spread.) Coming in an era of notable narrowing in spreads and reduced opportunity cost of capital, the statutory pre-judgment rate typically rendered an investment in a post-closing appraisal action against a credit-worthy acquirer to be among the highest yielding investments available (Jetly and Ji, 2016).

Second, in May of 2007 an important Delaware case substantially liberalized eligibility of a shareholder both to aggregate claims through share purchases and to perfect a right to appraisal. In *In re: Appraisal of Transkaryotic Therapies, Inc.* (2007), Chancellor William Chandler held that a beneficial owner of stock in a public target who buys after the "record date" of merger (a) remains eligible to assert appraisal rights; and (b) need not prove continued eligibility by tracing how the votes that were associated with her newly acquired shares were cast in the shareholder proxy election.[3] In effect, *Transkaryotic* sanctified and legitimized a potential market for claims trading and aggregation in appraisal actions.

Although both the statutory amendment to §262 and the *Transkaryotic* opinion were motivated almost solely by pragmatic considerations, they (perhaps unwittingly) opened the door to an arbitrage opportunity for outside hedge funds: For it now became possible to accumulate shares in the target company after an announced merger, perfect appraisal rights, and put forward a sophisticated expert to challenge the merger consideration, possibly obtaining an award in excess of the merger consideration. And, even if the award fell short of the merger consideration, it would accrue interest at the statutory compounded rate, often far outpacing the risk-adjusted return on the deal consideration itself.

The growth in "appraisal arbitrage" that ensued in the years since has attracted much attention, and contending with appraisal risk has (purportedly) become a critical consideration in designing, pricing, and even pursuing an otherwise eligible transaction. The rationale usually advanced by critics is that appraisal risk hurts target shareholders by depressing deal prices and frequencies, and that reintroducing (pre-2007-like) limits on the appraisal right

[3]Under the formal rules of the statute (8 Del. C. §262(h)), if a share were voted in favor of a proposed deal, that share would lose eligibility to seek post-closing appraisal rights.

would ultimately inure to shareholders' *ex ante* benefit. (*See* Hamermesh and Wachter, 2017, reviewing literature). Resistance to appraisal arbitrage has also attracted judicial attention, culminating in two recent Delaware Supreme Court opinions that have substantially undercut the value of seeking appraisal by inducing trial courts to place greater emphasis on the deal price and pre-deal market price (and less relative emphasis on DCF) when valuing shares. (*Dell v. Magnetar* (2017); *DFC Global Corporation v. Muirfield Value Partners* (2017)).

This paper considers the question of whether the 2007 reforms had the negative repercussions that critics lament, both from theoretical and empirical perspectives. Theoretically, we extend the auction-design framework developed in Choi and Talley (2017) to derive a series of comparative statics related to observable factors concerning M&A transactions and target shareholder welfare. Using this model, we demonstrate that a credible threat of an appraisal action can sometimes constitute a valuable vehicle for augmenting shareholder value, whereby the specter of later appraisal value acts as a credible type of "reserve price" in a company auction. So long as the anticipated appraisal value remains (weakly) below the expected-revenue-maximizing reserve price in a company auction (and the appraisal statute all but compels it to do so), appraisal always weakly benefits shareholders in the aggregate. At the same time, the gains from appraisal need not be distributed evenly, and there may exist equilibria where appraisal's benefits inure solely to shareholders who dissent strategically from otherwise good deals in order to seek additional consideration through appraisal (giving the shorter end of the stick to shareholders who must carry the vote and cannot seek appraisal). And, irrespective of distributional concerns, if the anticipated appraisal right grows "too large" it can reduce aggregate target shareholder welfare (by imposing a prohibitive reserve price on an auction, stifling value-enhancing bids). More significantly, our model delivers testable empirical predictions relating to how "shocks" to the appraisal remedy affect expected shareholder value. In particular, we show that under plausible assumptions as to the *status quo ante*, a liberalizing shock to appraisal will lead to enhanced target shareholder welfare if it is accompanied by an *increase* in expected merger premia for appraisal eligible deals.[4]

We then test this (and related) predictions empirically using the 2007 reforms as an appraisal-liberalizing shock. First, we demonstrate (consistent with our model) that deal premia are discernibly higher in appraisal eligible transactions (even when one accounts for the tax status of the deal). Second, we use a difference-in-differences specification to consider the combined effects of the 2007 shocks (*Transkaryotic* and the amendment of DGCL 262(h)) on deal premia for appraisal-eligible acquisition (using appraisal-*in*eligible deals as

[4]Formally, this condition also requires the assumption that under the *status quo ante*, courts faithfully execute their statutory mandate (even *approximately*) to award fair value exclusive of deal synergies. See Corollary 4, *infra*.

a control). We find consistent evidence that the liberalizing 2007 shocks were followed by significant increases in premia associated with appraisal eligible deals relative to the control group. Third, we do a number of tests to confirm the robustness of these results. Specifically, we confirm that are results are not affected by: a trend in the difference between appraisal eligible transactions and non-appraisal eligible transactions before the event date (i.e., parallel trend violations), alternative plausible event dates in 2007, and controls for the tax status of the deal. And finally, we show that the 2007 shocks were associated with a statistically insignificant effect on the incidence of appraisal-eligible deals relative to the control group. All told, our empirical results suggest that the 2007 reforms (and the appraisal arbitrage they ushered in) were beneficial to target shareholder value.

Our contribution fits into a small but growing literature on appraisal remedies and their effects on the takeover market. As noted above, Choi and Talley (2017) develop a theoretical auction model (which we extend here), combining managerial agency costs, shareholder voting, and the appraisal remedy to study how and when appraisal contributes to expected shareholder welfare. They find that it does contribute under a variety of plausible conditions, and thus that current calls for courts simply to use the "merger price" in appraisal actions should be embraced only in special situations (and with considerable caution). Their analysis does not, however, attend to the comparative statics we derive and test below. Mahoney and Weinstein (1999) compare merger premia in appraisal-eligible and appraisal-ineligible cases, finding little evidence that appraisal eligibility predicts different premia – a finding that is inconsistent with our (but predates many of the dynamics explored here). Jiang *et al.* (2016) investigate the appraisal remedy and show that appraisal is more likely to be exercised when there is a perception of conflicts-of-interest and when the premium offered is low, a result that is consistent with our theoretical findings.

Our paper is perhaps most closely related to contemporaneous work by Boone *et al.* (2017) ("BBM") who also explore the effects of the 2007 shocks (along with other smaller events) on appraisal premia. Their paper generates results that appear fully consistent with ours, albeit with a different empirical strategy. A few differences worthy of highlighting between our approach and theirs are as follows: First, our analysis motivates the empirical analysis through a theoretical auction-design framework, deriving comparative statics that we then subject to testing. BBM's conceptual approach is more informal/inductive (though they do root some of their analysis in the insights from Choi and Talley (2017)). Second, while we use *appraisal ineligible* deals as a control within Delaware-target transactions, BBM treat all Delaware public targets as the treatment group and all non-Delaware targets as the control (regardless of appraisal eligibility). Relatedly, our approach requires us to confirmed by hand whether the deal qualifies for appraisal or not under Delaware law, whereas BBM does not engage with appraisal eligibility. Fourth,

while BBM focuses on gross unadjusted premia and abnormal announcement returns, we focus on *logged gross premia*, a design decision we justify in light of the skewed nature of the data. Finally, unlike BBM, we conduct robustness checks on our results related to the tax status of a deal, since most appraisal-eligible deals are taxable (and that taxable deals tend to garner higher deal premia). All that said, we view the two papers to be highly complementary and ultimately symbiotic robustness checks against one another.

Two caveats to our analysis bear emphasis before proceeding. First, the finding that appraisal liberalization appears to have enhanced bid premia satisfies an important diagnostic condition for the 2007 shocks to have enhanced shareholder welfare as well. Standing alone, however, it is not *sufficient*. For example, if appraisal remedies were already "too generous" (in a manner to be formalized below), further liberalization of appraisal could well (i) cause premia to increase; but (ii) unambiguously *harm* incumbent shareholder value by chilling too many deals. We address this issue both conceptually and empirically. Conceptually, we note that the Delaware appraisal statute specifically requires courts to focus on going-concern value, excluding synergies realized solely from the merger. If courts faithfully discharged this mandate (even approximately), we show that an increase in premia induced by liberalization of appraisal rights would then be *sufficient* to conclude shareholder welfare also increased. Empirically, we conduct an additional robustness test on whether deal intensity of appraisal-eligible deals declined after the 2007 shocks relative to the control group, finding no economically or statistically significant differences—consistent with modest chilling effects.

The second caveat relates to our identification strategy. By using appraisal ineligible cases as a control, we implicitly require that it is difficult for a deal structure to cross the eligibility boundary endogenously. In some cases, that presumption is easily warranted when first order concerns dictate deal structure. (For example, a going-private acquisition of a public firm with non-assignable assets virtually requires that the transaction be eligible for appraisal.) In contrast, a strategic stock-for-stock acquisition by another public company makes it relatively easy to avoid appraisal (and most do). That said, we acknowledge that there can be some slippage between eligible and ineligible deals, and that deals that might have weathered the risk of appraisal prior to 2007 would choose a non-eligible structure afterwards (or vice versa). Although we conjecture that this slippage would principally act to *attenuate* our results (thus working in our favor), we cannot rule out other potential effects of endogeneity bias either.

Our analysis proceeds as follows. Section II develops a theoretical model extending the analysis of Choi and Talley (2017) to derive comparative statics plausibly associated with the 2007 shocks. Section III explains how we created our sample and describes our data and variables. Our empirical tests and results are reported in Section IV. Section V briefly concludes.

2 Model

This section develops a set of theoretical hypotheses about the plausible effects the 2007 appraisal liberalization on merger prices and shareholder welfare. Our analysis builds on the appraisal-auction design framework developed elsewhere Choi and Talley (2017). We extend that framework here to develop several comparative statics predictions that we take to the data in the next section.

Consider a potential sale of a corporate entity ("target") involving three groups of strategic, risk-neutral players:

- Incumbent target shareholders of the target;
- An agent (or "manager") of the firm; and
- A group of potential buyers.

There are four relevant periods ($t \in \{0, 1, 2, 3\}$) and no time discounting. At $t = 0$, corporate governance and dissenters' rights are fixed, and the agent establishes a sale process. At $t = 1$, bidders privately observe their respective valuations of the target and bid on the company in pursuant to the established auction protocol. At $t = 2$, incumbent shareholders vote whether to accept the winning bid. Should a sufficient majority vote in favor, the transaction closes, all shareholders (including dissenters) relinquish their shares, with assenting shareholders receive pro rata shares of the winning bid as consideration.[5] At $t = 3$, dissenting shareholders choose between (a) accepting the merger consideration, and (b) receiving a judicially determined "fair value" through an appraisal proceeding. We flesh out each of these details below.

Consider first the target. We assume the target has a single class of fully-distributed voting stock, held by a countably large, diffuse group of $2T + 1$ incumbent shareholders (with $T \in \mathcal{N}$ and $T \gg 0$), each owning a single share of the company. For expositional convenience, and following Choi and Talley (2017), we invoke the notation of a limiting case where shareholder population converges to a continuum with mass 1, each holding a $d\gamma \approx \frac{1}{2T+1}$ fractional ownership share of the company. Each shareholder places a differential valuation on the firm as a going concern, indexed through her type $\gamma \in [\underline{v}, \bar{v}] \subseteq [0, \infty)$, representing the shareholder's willingness to accept. Differential willingness to accept among shareholders is common, and may be due to myriad factors (such as distinct tax bases, portfolio positions, liquidity preferences, non-convergent beliefs, differential time horizons and so forth). Shareholder type γ values her fractional ownership stake at $\gamma \cdot d\gamma$, and thus implicitly values the entire firm at γ. Shareholder types are

[5] Since—unlike tender offers—dissenters *must* relinquish their shares, holdouts (a la Grossman & Hart 1980) are not as problematic in our model. We assume a single-step transaction for cash, but both assumptions are easily relaxed.

distributed according to a commonly-known cumulative distribution function $H(\gamma) : [\underline{v}, \bar{v}] \rightarrow [0, 1]$, with a continuously differentiable density function $h(\gamma) > 0 \; \forall \, \gamma \in [\underline{v}, \bar{v}]$.[6]

Shareholders' differential willingness to accept naturally causes disagreement about the relative attractiveness of a takeover bid. To appreciate the effects of this disagreement in what follows, it will help to distinguish between three distinct shareholder types. First, consider the *marginal* shareholder, whose willingness to accept is lowest among all existing shareholders ($\gamma = \underline{v}$) and is thus the most willing to sell. The marginal shareholder is also functionally the pre-deal market price maker, since her value reflects the market clearing asking price for shares in the absence of a material prospect of a merger.[7]

Second, consider the *representative* shareholder, which we define as the one whose valuation of the firm is equal to the mean across all target shareholders. Aggregating thusly on $[\underline{v}, \bar{v}]$, the representative/mean shareholder's willingness to accept is:

$$\mu = E(\gamma) \equiv \int_{\underline{v}}^{\bar{v}} \gamma h(\gamma) \, d\gamma \in (\underline{v}, \bar{v}) \tag{1}$$

Note that the value of μ is also a focal point for the appraisal remedy, since most appraisal statutes (Delaware's included) direct the court to deliver an assessment calibrated to the target shareholders' overall "going concern" value of the target, one that *excludes* any additional synergies associated with the merger itself. A natural interpretation of this mandate is that fair value should be pegged to the representative shareholder's willingness to accept. (For now, however, we will consider a more general case below, where the expected appraisal value is given by $\phi > 0$, which may or may not be equal to μ).[8]

Third, let $\rho \in (\underline{v}, \bar{v})$ denote the *pivotal shareholder*, who provides the swing vote in approving a merger. The pivotal shareholder's identity turns on the threshold mandate needed by law/doctrine to approve the merger, which we will denote by the parameter $\alpha \in [1/2, 1)$. In many cases, the required mandate will map directly onto shareholders' valuations: conditional on an offered price b, for example, all shareholders with $\gamma \leq b$ would support selling at that price

[6] A special case of this framework involves identically-valuing shareholders, so that $\underline{v} = \bar{v}$. The assumption of differential shareholder valuations is intuitive and familiar. See, e.g., Stulz (1988) (tax basis differences among shareholders generating different reservation values); and Brunnermeier *et al.* (2014) (players holding divergent beliefs that are common knowledge but do not converge).

[7] This is true since if the market price were higher than any shareholder's reservation value, that shareholder would have sold her shares to the market rather than remaining as a shareholder.

[8] It is important to note that setting appraisal equal to the representative shareholder's value need not coincide with—and tends to diverge from—an *optimal* value for fair market appraisal. While not addressed here, the task of calibrating an optimal appraisal value is taken up at length in Choi and Talley (2017).

while shareholders with $\gamma > b$ oppose the sale. So long as shareholders cast their votes non-strategically (a condition we interrogate below), obtaining shareholder approval requires offering a sufficiently high price b such that $H(b) \geq \alpha$. Consequently, under sincere voting the shareholder with valuation ρ satisfying the condition $\alpha = H(\rho)$ is the unique pivotal shareholder.[9] Our framework allows the approval threshold α to be set at any level, but it is no doubt most natural to highlight the 50% point coinciding with a bare majority and the median shareholder ($\alpha = 1/2$).[10] Shareholder heterogeneity implies that the marginal, representative, and pivotal shareholders are generally distinct (except for special distributional cases), and that both the representative and pivotal shareholder values lie strictly above that of the marginal shareholders.

Our model bundles together a variety of individual actors into the "manager" role, including not only corporate officers and directors, but also a host of other professionals who work with them to design the auction at $t = 0$—such as financial and legal advisers. We assume that the manager's key role here is to set a "reserve price" for the auction ($r_m \geq 0$), which establishes the price below which the manager will refuse to sell the company.[11] The manager's behavior may stray from shareholders' interests in two critical respects. First, manager has limited independent ability to commit to a reserve price. In particular, should bidding prove tepid—so that the highest bid falls below the reserve price—the manager cannot credibly commit to walk away from the high bid if it increases her own private payoff relative to the status quo. Second, irrespective of commitment, the manager's objectives may diverge from those of target shareholders. And, given the amalgamated composition of the "manager" player, this divergence can go in multiple directions. Consistent with standard agency cost intuitions, the manager may be *too reluctant* to sell the company (such as when she enjoys private benefits of control from the status quo). Alternatively, however, the manager may be *too eager* to sell (such as when she requires liquidity, or is unduly influenced by outside advisers angling to close a sale[12]). We capture these incentive problems by assuming that the manager seeks to maximize the sum of (a) expected aggregate shareholder value, and (b) a private payoff of $M \in \mathcal{R}$ realized in the event of a successful sale. The manager's objective function is thus given by $\Pi_m = \Pi_s + Pr(sale) \cdot M$, where

[9] The assumptions on $h(.)$ guarantee that the relationship mapping from α and ρ is unique. That said, the pivotal voter need not always be unique with insincere voting.

[10] Corporate law typically fixes a default at $\alpha = 0.5$. See, e.g., DGCL §251(c).

[11] There may be other auction-related tasks for the agent, such as recruiting bidders to participate.

[12] See, e.g., RBC Capital Markets v. Jervis ("Rural-Metro") (2015) (financial advisor manipulated board into accepting a proposed deal for which it had buy-side financing prospects); Smith v. Van Gorkom (1985) (retiring CEO sold the target too cheaply and with inadequate diligence).

Π_s denotes the expected payoff of shareholders.[13] When $M > 0$, the manager receives a private benefit from sale and is thus "too eager" to sell. When $M < 0$, by contrast, the manager enjoys a net private benefit from the status quo, and is thus "too reluctant." In the special case of $M = 0$, the manager's incentives are perfectly aligned with shareholders' interests.[14] We assume that M is commonly known by all players.

Finally, we suppose that $N \geq 1$ outside bidders participate in the auction. We assume N to be exogenous at this stage (reserving for an extension the possibility of recruiting bidders). Each bidder $i \in \{1, \ldots, N\}$ costlessly observes its private valuation of the target, denoted by v_i. We consider an independent private values (IPV) auction, where v_i is independently and identically distributed on support $[0, \infty)$ according to a commonly-known cumulative distribution function $F(v)$, with continuously differentiable density function of $f(v) > 0 \ \forall v \in [0, \infty)$. We also make a standard regularity assumption that the hazard rate $\frac{1-F(v)}{f(v)}$ is monotone non-increasing in v.

Because this is an extensive form game with privately informed players (the buyers and the shareholders), Perfect Bayesian Equilibrium (PBE) is an appropriate solution concept, and we employ it throughout in what follows (calling it simply an "equilibrium"). The equilibrium and the optimal strategies for a generic auction of this type are well known in the literature: for each buyer, the dominant strategy is to stay in the auction until the bid surpasses his valuation v_i.[15] The probability of a sale for $N \geq 1$ number of bidders and reserve price $r \geq 0$, therefore, is given by $\Pr\{Sale \,|\, N, r\} = 1 - F(r)^N$. An issue animating much of our discussion concerns the "optimal" reserve price $r^* \in [\underline{v}, \bar{v}]$, which we define as that which maximizes the shareholders' expected payoff. A well-known result from the literature on generic IPV auctions is that when the seller's valuation is equal to μ the optimal reserve price is independent of N and is given by:

$$r^* = \mu + \frac{1 - F(r^*)}{f(r^*)} \tag{2}$$

[13] To avoid circularity, we omit from Π_s any components of shareholder payoff due to appraisal remedies. At the cost of additional notation, this framework can easily be generalized to $\Pi_m = \beta \cdot \Pi_s + Pr(sale) \cdot M$ where $\beta \in (0, 1)$. Qualitative results of the paper will not change.

[14] Although it is often intuitive to assume managers categorically have net private benefits of control under the *status quo* (so that $M < 0$), the opposite can easily hold in our framework too. For example, a variety of golden-parachute can skew directors' and officers' incentives towards sale. More significantly, because our definition of "manager" amalgamates the interests of officers, directors, financial advisers, legal advisers, providers of finance, etc. under a single banner, a pro-sale skew becomes particularly unsurprising. In any event, we demonstrate below that commitment constraints alone can generate our main result, even when the manager enjoys moderate private benefits of control under the *status quo*.

[15] See Myerson (1981), Milgrom and Weber (1982), and Ausubel and Cramton (2004).

Note that $r^* \in (\mu, \bar{v})$ so that shareholders would optimally set a reserve price exceeding their average valuation.[16] If shareholders could choose (and commit to) their own reserve price, then r^* would be a logical choice.

However, at least three factors cause this framework to deviate from the standard auction model, and most of them are functionally related to reserve pricing. First, the requirement of a shareholder vote to approve a deal tends to provide an implicit floor to bidding, at a level that is closely related to the pivotal voter's willingness to accept ($\gamma = \rho$). Bids that fail to exceed this threshold generally are not approved in equilibrium (assuming one refines the set of equilibria to "weakly undominated" voting outcomes[17]).

Second, the appraisal remedy itself may also provide pricing pressure akin to a reserve price by providing dissenters with an outside option to seek appraised value (at ϕ, as discussed above) rather than accepting the winning bid. The attractiveness of that option turns on its relative value to other parameters and the ease of seeking appraisal.

Finally, target management can play a role in setting a reserve price directly in bargaining, the nature of which turns on the manager's credibility and incentives. As to credibility, we suppose that the manager cannot credibly refuse to approve any winning bid that will—if accepted—cause the manager's expected payoff to increase above the status quo, and thus she may not be able to hold out for an aggressive reserve without some external constraint (see above). Consequently, garnering managerial agreement to the terms of the merger (subject to the manager's limited ability to commit) implies that the agent will privately hold out for a reserve price of:

$$r_m^* \equiv max\left\{\mu - M,\, 0\right\} \tag{3}$$

It is easily confirmed that so long as the manager does not derive benefits that are "too large" from the status quo ($M > -\frac{1-F(r^*)}{f(r^*)}$), the manager's reserve price falls short of the optimal reserve ($r_m^* < r^*$). And, whenever the managerial team receives a *net benefit* from a sale relative to the status quo ($M \geq 0$), the manager's reserve price is even less aggressive than the going-concern value of the firm (as reflected by the representative shareholder's value of μ).

Choi and Talley (2017) characterize the equilibria of a target auction conducted in the shadow of (i) shareholder voting, (ii) dissenters' appraisal rights, and (iii) management's optimal renegotiation-proof bargaining strategy. These equilibria can deviate from a standard auction set up in several ways –

[16]The condition above is closely related to the monopoly pricing problem, where the seller sets price by balancing the chance of no sale against the hope of a higher winning bid (Bulow and Klemperer, 1996).

[17]This refinement disallows any posited equilibrium strategy $\hat{\sigma}_\gamma$ for any player γ if there exists an alternative strategy $\tilde{\sigma}_\gamma \neq \hat{\sigma}_\gamma$ that fares at least as well for player γ across every possible permutation of opponents' strategy profiles $\boldsymbol{\sigma}_{-\gamma} \in \boldsymbol{\Sigma}^{-\gamma}$, and does strictly better for player γ in at least one such permutation. See Choi and Talley (2017) for details.

but in particular, bidding need not coincide with truthful revelation (even in an ascending/Vickrey auction). Rather, the equilibrium in this case depends on the relative values of the governance and valuation parameters, in a way encapsulated by the following result:

Proposition 1. *The following constitute the pure strategy equilibria of the target auction given pivotal shareholder type ρ, a managerial reserve price r_m^*, and an expected appraisal value ϕ:*

1. *When $\phi < max\{r_m^*, \rho\}$, all weakly undominated equilibria are revenue equivalent to that of an ascending auction with a reserve price equal to $\hat{r} = max\{r_m^*, \rho\}$ Bidders drop out when the prevailing bid equals their private valuations (v_i). The winning bid is always at least $max\{r_m^*, \rho\}$ and is approved without dissent. No shareholders seek appraisal.*

2. *When $\phi \geq max\{r_m^*, \rho\}$ there are two classes of weakly undominated equilibria:*

   (a) *In the first, all equilibria are revenue equivalent to an ascending auction with a reserve price equal to $\hat{r} = \phi$. Bidders drop out when the prevailing bid equals their private valuations (v_i). The winning bid is always at least ϕ and is approved without dissent. No shareholders seek appraisal.*

   (b) *In the second, all equilibria are revenue equivalent to an auction with reserve price equal to $max\{\alpha\rho + (1-\alpha)\phi,\ r_m^*\}$. Bidders drop out before the prevailing bid reaches their private valuations (v_i). If the winning bid exceeds ϕ it is approved without dissent and no shareholders seek appraisal. Otherwise, the winning bid is approved by a bare α-fraction of target shareholders, and the remaining $(1-\alpha)$ seek appraisal.*

Proof. See Choi and Talley (2017) (Proposition 6).[18] □

The gravamen of Proposition 1 is that the outside threat of appraisal (with expected value of ϕ) "matters" for bidding outcomes only if it is not eclipsed by alternative forms of price protection, namely shareholder voting (through ρ) and credible managerial bargaining (through r_m^*). When $\phi < max\{r_m^*, \rho\}$ (Part 1A of the Proposition), the appraisal option is insufficiently potent to move the pricing needle, since management's threat point and/or the required vote on the deal already ensure that no winning below the larger of r_m^* and ρ can pass through the sluice gates. The bid-disciplining effect of appraisal is

[18] For purposes of this paper, we confine our analysis to pure strategy equilibria. We note, however, that Choi and Talley (2017) also demonstrate that when shareholder types are truly differentiated across shareholders, mixed strategy equilibria generally do not exist.

thus overshadowed by other factors, and incremental "shocks" to appraisal's availability have no effect on prices or shareholder welfare.

When the anticipated appraisal award exceeds the alternative sources of price protection, however (so that $\phi \geq max\{r_m^*, \rho\}$), equilibrium behavior changes significantly. In particular, two types of pre-strategy equilibria emerge. In the first "non-coordinated" equilibrium (Part 1B(1)), shareholders' are unable to coordinate their actions, so that all will vote against the transaction unless the winning bid is at least ϕ causing ϕ to become the effective reserve price for the auction. In the second "coordinated" equilibrium (Part 1B(2)), shareholders coordinate their voting behavior: Those seeking appraisal must rely on sufficiently many affirmative voters to approve the deal and make appraisal possible, and all shareholders voting to approve the merger effectively become pivotal. Consequently, bidders expect to pay a two-part price consisting of the winning bid's "announcement" price (paid to all shareholders) and an additional appraisal supplement (to the $1-\alpha$ fraction of shareholders who oppose the deal). This expectation, in turn, induces bidders to drop out before the going bid reaches their private valuations, since they must capitalize the value of the anticipated supplement through appraisal. Consequently, in this equilibrium, the winning bid reflects a type of "hold back" of some of the consideration in order to satisfy appraisal claimants. The end result of this strategic posturing is that the coordinated equilibrium replicates the *aggregate* expected revenues of an ascending auction with *de facto* reserve price equal to $max\{\alpha\rho + (1-\alpha)\,\phi,\ r_m^*\}$, though such revenues are no longer split *pro rata* between dissenting shareholders and supporters of the deal.

Choi and Talley (2017) also demonstrate that so long as the alternative sources of reserve pricing fall short of the revenue-maximizing reserve price for the auction—so that $max\{r_m^*, \rho\} < r^*$—there always exists a binding shareholder-welfare maximizing appraisal value that is unique conditional on the equilibrium that emerges. (See Choi and Talley, 2017, Proposition 7). When the uncoordinated equilibrium obtains, this optimal appraisal value is simply $r^* \equiv \mu + \frac{1-F(r^*)}{f(r^*)}$, the familiar optimal reserve price in an independent values auction. When the coordinated equilibrium obtains, in contrast—where the winning bid "holds back" some of his payment for future appraisal actions—the optimal appraisal value is even larger, and is equal to $r^{**} \equiv \left(\frac{r^*-\alpha\rho}{1-\alpha}\right) > r^*$. Though seemingly counter-intuitive, this result makes sense since the optimal reserve price must set a floor for the buyer's total *expected* payment for the target; and thus, when bidders rationally shave their nominal bids downward, an optimal appraisal policy compensates by pushing the appraisal component of total consideration even higher.

Our central focus in this paper concerns not the design of an optimal appraisal rule *per se*. Rather we seek to generate testable predictions about how a "shock" to appraisal policy plausibly distorts deal pricing, and what

implications such distortions hold for shareholder welfare. Note further that in light of the possibility of distributionally non-neutral equilibria (as in the "coordinated" equilibria in Proposition 1(b)(2)), one might be interested in two potential vantage points for measuring shareholder value: (1) Aggregate expected shareholder value, which simply integrates over the payoffs among shareholders without regard to distribution; or (2) "Maximin" shareholder value, which focuses on the expected payoffs realized by those shareholders who receive the lowest payoff from a sale (the "have-nots" in the coordinated equilibrium above). We will keep track of both measures of welfare in the discussion below. Several corollaries to Proposition 1 follow immediately from analysis and comparative statics associated with the equilibria of the auction game. We list several of them formally below[19]:

Corollary 1. *When $\phi < max\{r_m^*, \rho\}$, expected announcement price and all measures of expected shareholder welfare are invariant in ϕ.*

Corollary 2. *When $max\{r_m^*, \rho\} \leq \phi$ and the non-coordinated equilibrium emerges, expected announcement price and all measures of expected shareholder welfare are strictly increasing in ϕ so long as $\phi \leq r^*$. If $\phi > r^*$ however, expected announcement price is strictly increasing in ϕ, but all measures of expected shareholder welfare are strictly decreasing in ϕ.*

Corollary 3. *When $max\{r_m^*, \rho\} \leq \phi$ and the coordinated equilibrium emerges, expected announcement price may be increasing or decreasing in ϕ. When $\phi \leq r^{**}$ the maximin measure of expected shareholder welfare is strictly increasing in ϕ if and only if expected acquisition price is also increasing; the aggregate measure of expected shareholder welfare is weakly increasing if and only if $\phi \leq r^{**}$. When $\phi > r^{**}$, aggregate shareholder value is weakly decreasing in ϕ and maximin shareholder value is increasing only if announcement price is also increasing.*

The most intuitive way understand how Corollaries 1– 3 fit together is through a graphical representation per Figure 1. The left panel of the Figure depicts the comparative statics of the model within the "non-coordinated" equilibrium, while the right panel does the same for the "coordinated" equilibrium. In each panel, the vertical axis depicts the expected appraisal value (ϕ), while the horizontal axis depicts $max\{r_m^*, \rho\}$—effectively the maximal reserve price stemming from managerial bargaining combined with shareholder voting. Note from both figures that in the lower right triangular region (where $\phi < max\{r_m^*, \rho\}$), appraisal has no equilibrium effect on behavior; consequently, expected pricing and shareholder welfare are invariant to changes in ϕ.

In the upper left triangular region (where $\phi \geq max\{r_m^*, \rho\}$), changes in ϕ generally *do* affect both pricing and target shareholder welfare—but not always

[19]The proofs of all Corollaries are provided in the Appendix.

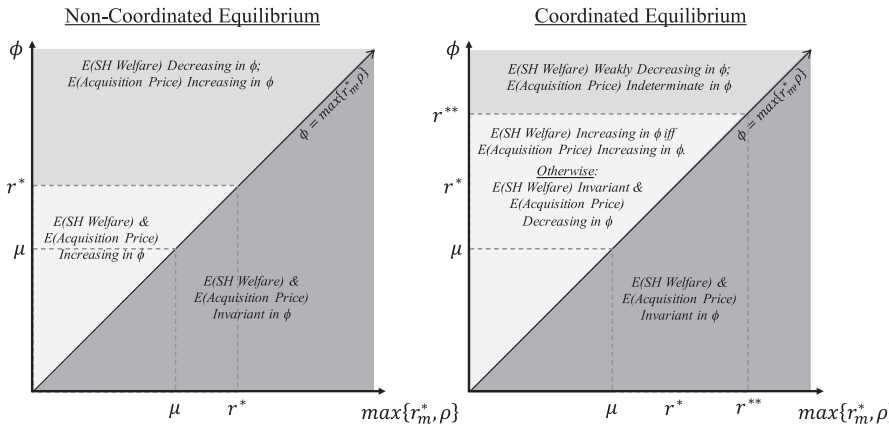

Figure 1: Equilibrium Regions and Comparative Statics on Price and Shareholder Welfare

in a uniform way. In the non-coordinated equilibrium (left panel), expected acquisition prices always increase as ϕ increases; a result that is unsurprising given that this equilibrium is the functional equivalent to a second-price auction with reserve price of ϕ However, expected shareholder welfare is not monotonic in ϕ and it is increasing only so long as $\phi < r^*$. In the coordinated equilibrium (right panel), several other factors may be in play, depending on the ordering of r_m^* and ρ. What is clear, however, is that so long as $\phi \leq r^{**}$ increasing ϕ always weakly improves *aggregate* shareholder welfare (even if its effect on price is ambiguous). Once $\phi > r^{**}$ however, the reverse is true, and expected target shareholder welfare weakly decreases in ϕ with indeterminate effects on equilibrium pricing. A somewhat more complicated picture characterizes the maximin measure of shareholder welfare, since it is possible that an increase in appraisal rights may confer benefits on the "haves" in this equilibrium while making the "have nots" worse off. What is clear is that a necessary condition for increasing the welfare of the have-nots is if expected announcement price also increases upon an upward shock to ϕ.

The heterogeneous comparative statics contained in Corollaries 1–3 and Figure 1 present a complication to our empirical design for purposes of extracting a "clean" comparative static robust across all equilibria. However, if one consolidates the observations made above, then one clean prediction does emerge from the analysis above, at least when one constrains the appraisal rights under the status quo such that $\phi \leq r^*$. Combining Corollaries 1 through 3, we have the following central Corollary:

Corollary 4. *So long as $\phi \leq r^*$ both measures of expected shareholder welfare are increasing in ϕ if expected announcement price is also increasing in ϕ.*

Corollary 4 relates shareholder welfare to a readily testable comparative static on ϕ (so long as one can be sufficiently confident that its underlying assumption holds). If we see acquisition prices in appraisal-eligible deals increase after an upward shock ϕ it signifies that shareholder welfare must be increasing as well.

But what of Corollary 4's predicate assumption that $\phi \leq r^*$? How assuredly does this hold? Recall from the analysis above that $r^* \equiv \mu + \frac{1-F(r^*)}{f(r^*)}$ represents the familiar, revenue-maximizing reserve in a private-values auction. Is there any reason to believe that, prior to the 2007 shocks, courts arrived at fair value appraisals strictly less than this amount? We contend that there is a *good* reason to believe so: The statute itself. Recall that DGCL §262 requires the court to peg appraisal value equal to the going-concern value of the firm under the *status quo ante*, without any buyer-side synergies. In our framework, this value is equal to μ by construction, and it is clear that $\mu = r^* - \frac{1-F(r^*)}{f(r^*)} < r^*$. Thus, so long as courts tend—in expectation—to comply even approximately with their statutory mandate under appraisal law, then the condition for Corollary 4 must hold. More formally, so long as expected appraisal values under the status quo are within the approximate neighborhood of the representative shareholder's going-concern value (or if $\phi \approx \mu$), then a finding that deal premia increase in ϕ is equivalent to shareholder welfare also increasing the status quo are within the approximatethe status quo are within the approximate in ϕ.

The intuitions contained in Corollaries 1–4 are directly relevant to the next section, which studies two important and roughly contemporaneous upward shocks to fair value appraisals.

1. **August 2007:** Amendment of §262(h) of the DGCL. Under the amendment, Delaware code began granting presumptive pre-judgment interest in all appraisal actions pegged (absent an override by the Court) a quarterly compounded quarterly rate of the Federal Reserve discount rate plus 5%. (DGCL §262(h); Effective August 2007). While pegged to another section of the Delaware code on pre- and post-judgment interest, most commentators agree that this statutory reform effectively decoupled and made the pre-judgment interest return more predictable, creating nearly instantaneous arbitrage rents.

2. **May 2007:** *In Re Appraisal of Transkaryotic Therapies, Inc.* In Transkaryotic, Chancellor Chandler held that a beneficial owner of stock who buys after the record date of merger may still assert appraisal right for those newly purchased shares, and need not prove how such shares were actually voted pursuant to the direction of the prior beneficial owner. The impact of this opinion was significant, since it made it much easier for

hedge funds to engage in appraisal arbitrage, purchasing a large number of target shares after announcement for their appraisal value—effectively allowing the arbitrageur to spread the costs of appraisal litigation across the shares purchased.

The combined effects of the amendment to DGCL §262 and *Transkaryotic* are both fairly interpretable as an upward "shock" to anticipated fair value appraisal (or ϕ in our model). Consider first the effect of the statutory interest reform, under which successful claimants would now be able to earn a return on the financial value of their claims that typically exceeded the risk-adjusted returns in the market for similar investments. Effectively, the pre-judgment interest statute gave petitioners a statutory return r_s that exceeded the risk adjusted return in the underlying target/acquirer, $E(r_A)$, compounded over "T" quarters (where T is usually between 8 and 12 quarters for a standard appraisal case). Thus, the present value of the of a gross appraisal claim of ϕ was shocked upwards by the statutory interest change effectively inducing a post-interest claim with present value of $\phi' = \phi \cdot \left(\frac{1+r_s}{1+E(r_A)}\right)^T > \phi$, effectively representing an upward shock to ϕ.

The *Transkaryotic* case can be interpreted as visiting a subtler—but conceptually analogous—upward shock in ϕ, this time due to the economies of scale in aggregating appraisal claims through market trading. To see this point, consider a slight extension to our framework in which the net benefit of appraisal value to the petitioner is equal to $\phi - c$ (where c proxies for the petitioner's litigation costs). Here, a stockholder's aggregate holding ($d\gamma$) plays an important role in whether she will seek appraisal, since her benefit of appraisal over accepting the bid price b is $(\phi - b) \cdot d\gamma$ and her cost is c; without claims trading, the only litigants who would seek appraisal are those for whom $d\gamma > \frac{c}{\phi - b}$, which would rarely (if ever) happen when the shares are widely held (so that $d\gamma$ is infinitesimally small). After *Transkaryotic,* however, claims trading could potentially place all the appraisal shares in the hands of a single party, who exists so long as there is a SH valuing more than the largest bid price. Absent an appraisal-out or supermajority provision, then, appraisal could be aggregated across the entire fraction $(1-\alpha)$ of dissenters, who stand to gain up to $(\phi - b) \cdot (1 - \alpha)$ through the action. The now-aggregated shareholder will seek appraisal whenever $(1 - \alpha) > \frac{c}{\phi - b}$. By effectively introducing scale economies in appraisal, *Transkaryotic* functionally induced an upward shock in the credibly expected realization of ϕ within the baseline model.

Together, then, it is fair to conclude that the 2007 reforms visited a combined upward shock on ϕ within our model, allowing us to perform a direct empirical test of Corollary 4's condition linking price increases to shareholder welfare. It is to that empirical enterprise that we now turn.

3 Sample Creation and Data Description

3.1 Sample Creation

To construct our sample, we begin by collecting data on all domestic merger deals from Thompson Reuters Securities Data Company (SDC) database. We select all completed deals with effective dates between January 2003 and December 2016, resulting in 19,547 observations. We then only include deals with publicly traded targets that are incorporated in the state of Delaware. Furthermore, consistent with Hsieh and Walkling (2005) and Jiang *et al.* (2016), we exclude all deals classified as recapitalizations, repurchases, spinoffs, and divestures, as they are not generally considered as merger activity and would not be eligible in any circumstances for appraisal rights. Finally, we drop all duplicate observations, and any observations missing deal premium data from the SDC database. Our final sample consists of 2,083 unique deals.

3.2 Definition and Sources of Variables

Our principal dependent variable of interest is gross deal premiums ($gross\_prem$), defined as the bid price bid price divided by the target's closing stock price one week prior to deal announcement. The top panel of Figure 2 shows that deal premiums are highly skewed. Accordingly, we winsorize the variable at the 1% and 99% level, and—as in Roll (1988) and Dari-Mattiacci and Talley (2016)—take the natural logarithm of the gross premium ($\ln(gross\_prem)$). We call this variable $\ln(gross\_prem)$. The bottom panel of Figure 2 shows that the right-tail skewness is visibly reduced.

The SDC database also provides us with deal characteristic information such as announcement date, effective date, deal size, and form of consideration (percentage of payment to target shareholders in stock, cash, other and/or unknown). SDC additionally provides data on target and acquirer firm characteristics at the time of the merger such as total assets, total debt, net income, and industry SIC codes. The three target firm control variables we use are: *ln(Assets)*, which is the natural logarithm of the target firm's total assets as of the date of the most current financial statement prior to deal announcement; *Leverage*, which is the target firm's book value of debt divided by total assets; and *ROA*, the ratio of the target firm's most recent 12-month net income divided by its total assets. All three variables are taken from the target firm's most recent financial statement prior to the date of the merger announcement. In addition, we define a dummy variable, *Private*, which is set to unity if SDC has flagged the deal as a "going private" transaction, and zero otherwise.

In order to control for industry effects, we use the SIC codes to construct ten industry dummy variables according to the Fama-French industry classifications. We also create a dummy variable for related deals: If both the target

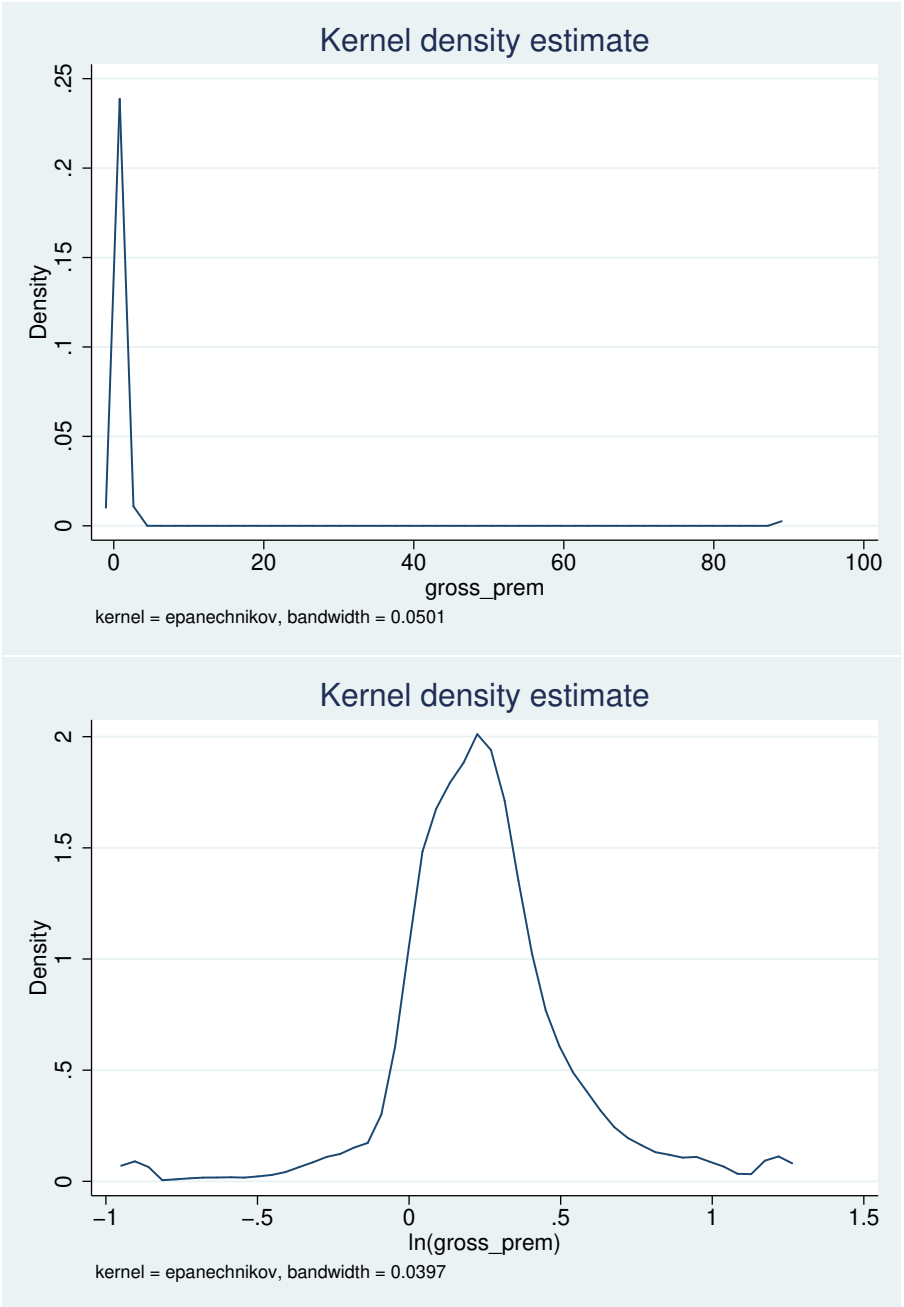

Figure 2: Kernel Density Plots of Gross Premiums and Log Gross Premiums

and acquiring firm are in the same industry and share the same three-digit SIC code we set the variable *related* to unity, and set it to zero otherwise.

We supplement our observations with economic data from the St. Louis Federal Reserve Economic Data (FRED) to include information on interest rates, unemployment, GDP growth, and inflation at the time of each merger deal. We create an opportunity cost variable, *op_ cost*, that is defined as the difference between the high quality 10-year corporate bond yield and the one-month federal funds rate during the month of each observation. The monthly federal funds rate, not seasonally adjusted, is used to construct the variable *Fed_ funds*. Quarterly GDP growth from the quarter one-year ago, seasonally adjusted, is used for the variable *GDP*. Monthly civilian unemployment rates and urban consumer price index growth rates are used to construct *UNEMP* and *CPI*, respectively. Finally, the daily CBOE Volatility Index value is used to construct *VIX*. A summary of the variables used is listed in Table 1.

3.3 Determination of Appraisal Eligibility

To determine whether a deal is eligible for appraisal we start by analyzing the form of consideration data from SDC. Because the DGCL 262(b) restores appraisal rights for deals that require target shareholders to accept cash consideration, we exclude all deals involving a 100% stock consideration from our treatment group. (We tested a random sample of 100 deals that SDC has labeled as "100% stock" by checking their merger agreements to verify that SDC's classification is accurate; all were classified correctly.)

Due to the existence of some 'exceptions-to-the-cash' rules in Delaware law concerning cash payments and the fact that SDC classifications of "unknown" and "other" are too vague to determine appraisal eligibility, we manually examined merger agreements and 8-K filings from the SEC EDGAR database for all remaining (i.e., non-100% stock) deals. The first exception-to-the-cash rule is the occurrence of an apparently all-stock deal which offers the payment of a special dividend immediately prior to the merger that is contingent on shareholder approval. The Delaware Chancery Court deemed that shareholders in such cases are entitled to appraisal rights.[20] SDC includes these special cash dividends as "other" in combination with a portion of the consideration classified as "stock." These cases were identified and included in the treatment group. The second exception-to-the-cash rule occurs when shareholders are given the option to elect whether they receive a cash or stock consideration. In such cases, the Chancery Court has ruled that appraisal rights are not available to target shareholders, as appraisal rights are only awarded when accepting cash consideration is mandatory.[21] To account for these cases, merger agreement forms for all deals classified by SDC as having any portion of consideration

[20] *Louisiana Municipal Police Employees' Retirement System v. Crawford* (2007)
[21] *Krieger v. Wesco Financial Corp.* (2011).

Table 1: Definitions and Sources of Variables

Variable	Description [Source]
ln(Gross_prem)	Natural logarithm of one plus the premium of offer price to target closing stock price one-week prior to the original announcement date. [SDC]
ln(assets)	Natural logarithm of the target firm's total assets as of the date of the most current financial information prior to the announcement of the transaction ($mil). [SDC]
Leverage	Target's book value of debt as of the date of the most current financial information available prior to the announcement of the transaction) divided by target's total assets. [SDC]
ROA	Ratio of the target firm's most recent 12-month net income divided by its total assets. [SDC]
Private	Dummy variable set to unity if the merger is a going private deal, and zero otherwise. [SDC]
Related	Indicator if the target firm and the acquirer firm are in the same industry. Dummy variable set to unity if both firms share the same 3-digit SIC code, and zero otherwise. [SDC]
Op_cost	10-year high quality corporate bond par yield (AAA, AA, and A rated), monthly, not seasonally adjusted minus the effective federal funds rate, monthly, not seasonally adjusted. [FRED]
Fed_funds	Effective federal funds rate, monthly, not seasonally adjusted. [FRED]
GDP	Growth in real gross domestic product, % change from quarter one-year ago, quarterly, seasonally adjusted. [FRED]
UNEMP	civilian unemployment rate, monthly, seasonally adjusted. [FRED]
CPI	consumer price index for all urban consumers: all items, index 1982–1984 = 100, monthly, seasonally adjusted. [FRED]
VIX	The daily CBOE Volatility Index measurement of the market's expectation of 30-day volatility based on the S&P 500 index option prices

paid in cash were manually collected and examined for appraisal rights terms and conditions. The above procedure results in 1,465 appraisal-eligible deals out of our total sample of 2,083 unique deals.

3.4 Descriptive Statistics

We begin by examining the descriptive statistics of our variables in Table 2. We observe that the average deal premium for our full sample is a 34% increase in the bid price over the target firm's stock price one-week prior to deal announcement. In Panel B, we separate our observations into two subsections according to whether the deal terms allow for appraisal rights or not. We observe that those deals that are eligible for appraisal rights on average have slightly higher deal premiums (35%) than those deals that are not appraisal eligible (24%). Furthermore, appraisal eligible deals tend to have targets with lower levels of debt (23.7%, compared with 50.5% for non-eligible deals). Not surprisingly, appraisal-eligible deals also had a higher probability of being a "going private" deals, with about 32% of the sample deals being classified as going private, compared with only 8% of the non-eligible sample. Deals where the target and acquiring firm are both in the same industry also had a slightly greater incidence of appraisal-eligible deals than in non-eligible deals, with 45% and 31% of deals, respectively, occurring between firms in related industries.

In Panel C, we investigate shifting trends in our variables over time by dividing our data observations into three time periods: the period prior to the *Transkaryotic* opinion (January 1, 2003 to May 1, 2007); the time between *Transkaryotic* and the effective date of the pre-judgment interest amendment (May 2, 2007 to July 31, 2007); and after the pre-judgement interest amendment (August 1, 2007 to December 31, 2016). We observe that bid premiums increased to an average of 32% after the pre-judgment interest reform compared to an average premium of 28% before the *Transkaryotic* court ruling. In addition, there was a slightly larger representation of "going private" transactions before *Transkaryotic* (21% of deals) versus after the pre-judgement statute (19%). The proportion of deals between firms in related industries increased from 38% before *Transkaryotic* to 41% after the pre-judgement statute.

4 Empirical Tests and Results

4.1 Effect of Appraisal Eligibility on Bid Premiums

In Table 3 we present the results of our regression analysis of the effects of appraisal eligibility on announced premia. We consider all 2,083 observations over the entire period of our study (2003–2016). Our dependent variable,

Table 2: Descriptive Statistics

Panel A: Full Sample

Variable	Mean	Median	s.d.
Gross_prem	0.336	0.257	0.428
ln(Gross_prem)	0.247	0.228	0.289
ln(assets)	5.939	5.907	2.368
Leverage	0.377	0.204	1.674
ROA	−0.314	0.001	2.51
Private	0.188	0	0.391
Related	0.375	0	0.484

Panel B: Appraisal Eligibility

	Appraisal Eligible			Non-Appraisal Eligible		
Variable	Mean	Median	s.d.	Mean	Median	s.d.
Gross_prem	0.348	0.298	0.418	0.237	0.147	0.432
ln(Gross_prem)	0.288	0.261	0.265	0.161	0.137	0.317
ln(assets)	5.918	5.82	1.885	5.957	6.008	2.739
Leverage	0.237	0.135	0.371	0.505	0.282	2.286
ROA	−0.092	0.016	0.885	−0.517	−0.028	3.362
Private	0.319	0	0.466	0.078	0	0.268
Related	0.452	0	0.498	0.311	0	0.463

Panel C: Three Time Periods

	Before Transkaryotic (05/02/04–05/01/07)			Between TT and Pre-judgment (05/02/07–07/31/07)			After Pre-judgement (08/01/07–08/01/10)		
Variable	Mean	Median	s.d.	Mean	Median	s.d.	Mean	Median	s.d.
Gross_prem	0.278	0.230	0.337	0.228	0.230	0.212	0.319	0.240	0.471
ln(Gross_prem)	0.214	0.207	0.247	0.192	0.206	0.161	0.221	0.215	0.334
ln(assets)	5.584	5.522	2.187	6.000	5.973	2.568	6.469	6.601	1.976
Leverage	0.280	0.177	0.145	0.446	0.203	2.349	0.369	0.263	0.525
ROA	−0.161	0.007	0.653	−0.467	0.000	3.523	−0.176	−0.006	0.389
Private	0.205	0	0.404	0.177	0	0.382	0.186	0	0.389
Related	0.382	0	0.486	0.359	0	0.48	0.408	0	0.492

ln(gross_prem), is regressed over ten different specifications to evaluate the significance of our variable of interest, *Appr. Eligible*. In column [1], we use a simple OLS regression of the appraisal eligibility dummy on log gross premiums, without any control variables. Columns [2] and [3] include a set of control variables for deal characteristics and macroeconomic effects, respectively. Deal characteristic controls include *Target ROA, Target Leverage*, and dummies for *Going Private, and Related*. Macroeconomic controls include our measure of opportunity cost, *op_cost*, as well as the quarterly Fed Funds rate, GDP growth, unemployment rate, inflation rate, and the 30-day market's expectations of S&P 500 volatility.

In columns [4] through [6] we include industry dummy variables based on the ten Fama-French industry classifications to control for industry fixed-effects. Columns [7] and [8] include quarterly dummies to control for time fixed-effects and columns [9] and [10] include both industry and quarterly

Table 3: Prediction of Appraisal Eligibility on Bid Premiums. In this table, we provide the results of ten ordinary least squares models in which the dependent variable is *Ln(gross_prem)*, which is the natural logarithm of the one-week merger deal premium. The regression includes all deals from the full time range of our sample, 1/1/2003–12/31/2016. The coefficient of interest is the variable *Appr. Eligible*, which captures the difference in premiums of those deals which are eligible for appraisal rights from those in our control sample. Columns [4], [5], [6], [9], and [10] all control for industry fixed effects using the ten SIC-based Fama-French industry classifications. We use robust standard errors and the t-statistics are in parentheses. We follow the following indicators of statistical significance: ***indicates $p < 0.01$, **indicates $p < 0.05$, and *indicates $p < 0.10$.

$y = ln(gross\_prem)$	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Appr. Eligible	0.127^{***}	0.135^{***}	0.135^{***}	0.111^{***}	0.122^{***}	0.121^{***}	0.124^{***}	0.131^{***}	0.108^{***}	0.118^{***}
	(9.02)	(9.14)	(8.98)	(7.62)	(7.97)	(7.77)	(8.51)	(8.71)	(7.17)	(7.58)
ln(assets)		-0.018^{***}	-0.018^{***}		-0.013^{***}	-0.013^{***}		-0.017^{***}		-0.013^{***}
		(−4.89)	(−4.93)		(−3.56)	(−3.46)		(−4.70)		(−3.37)
ROA		0.004	0.006		0.011	0.012		0.008		0.013
		(0.23)	(0.33)		(0.60)	(0.71)		(0.47)		(0.88)
Leverage		−0.003	−0.002		−0.001	−0.001		−0.003		−0.002
		(−0.43)	(−0.41)		(−0.26)	(−0.22)		(−0.52)		(−0.36)
Private		−0.018	−0.017		−0.010	−0.009		−0.016		−0.010
		(−1.07)	(−1.00)		(−0.59)	(−0.54)		(−0.97)		(−0.59)
Related		0.011	0.011		−0.001	−0.001		0.011		0.001
		(0.85)	(0.83)		(−0.08)	(−0.08)		(0.86)		(−0.05)
Op_cost			-0.037^{***}			-0.038^{***}				
			(−3.43)			(−3.52)				
Fed_funds			-0.032^{***}			-0.033^{***}				
			(−3.49)			(−3.60)				
GDP			−0.007			−0.007				
			(−1.19)			(−1.21)				
UNEMP			−0.001			0.0001				
			(−0.10)			(0.02)				
CPI			−0.0001			−0.0002				
			(−0.13)			(−0.32)				
VIX			0.003^{**}			$.003^{**}$				
			(2.10)			(2.09)				
Constant	0.161^{***}	0.260^{***}	0.445^{**}	0.133^{***}	0.211^{***}	0.415^{***}	0.150^{***}	0.296^{***}	0.131^{***}	0.252^{***}
	(13.22)	(9.11)	(2.72)	(8.74)	(6.74)	(2.58)	(3.21)	(3.95)	(2.67)	(3.35)
Quarterly dummies	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes
n	2,083	2,037	2,037	2,083	2,037	2,037	2,083	2,037	2,083	2,037
Adjusted R^2	0.0424	0.0678	0.0815	0.0651	0.0837	0.0974	0.0816	0.1053	0.1013	0.1197
p-value that industry effects = 0				0.0001^{***}	0.0003^{***}	0.0001^{***}			0.0000^{***}	0.0003^{***}
p-value that macro effects = 0			0.0001^{***}			0.0000^{***}				

fixed-effects. Specifications that include both quarterly fixed-effects dummies and macroeconomic variables were excluded due to the collinearity of the two sets of controls.

Across all specifications, we find our variable of interest, *Appr. Eligible*, is statistically significant at the 1% level. This provides strong evidence that a deal being eligible for appraisal predicts higher premia for target shareholders, with average one-week deal premiums increasing anywhere between 11.4%–14.4%,[22] depending on which specification we consider. We interpret our results to provide evidence that appraisal rights petitions are not nuisance suits, but instead offer a benefit to all target shareholders. It is consistent with the notion that the credible threat of appraisal litigation may be deterrent effect for an acquiring firm to increase its bid, therefore benefiting all target shareholders, and not just those filing the lawsuits. (Although other factors contribute to this premium as well—such as the greater likelihood that taxable deals are appraisal eligible—we show below that this premium is not fully explained by the taxability of the deal.)

4.2 Effects of the 2007 Shocks on Deal Premiums

We turn next to an analysis of the effect that the 2007 "shocks" to appraisal had on merger deal premiums. As noted by Myers and Korsmo (2014), the *Transkaryotic* opinion is broadly thought to have catalyzed a surge in appraisal petition activity and created a large change in the use of appraisal in Delaware. In addition, appraisal arbitrage incentives were further fed by an amendment to the Delaware appraisal statute regarding pre-judgement interest rates that occurred six days after the *Transkaryotic* opinion was released. As noted above, under this proposed amendment (which became effective August 1, 2007), appraisal petitioners would be presumptively entitled to pre-judgment interest pegged at 5% over the Federal Reserve discount rate, compounded quarterly, up to the date of the judgment. Due to the potential combined shock of the two events, we deem the (excluded) "event window" to be the period between *Transkaryotic* (May 2, 2007) and the effective date of the statutory amendment (August 1, 2007). We use a difference-in-differences model to test the effect of this event. We restrict our sample of observations to three years before and three years after our event date, (though all results hold when we use a time period of two years before and after the event window as well).

We estimate the following difference-in-differences model:

$$ln\left(1 + Premium_i\right) = f\left(Z_i; \alpha_i\right) + \beta_0 * Appr\ Eligible_i + \beta_1 * Post_{Event\,i} + \beta_2 * Appr\ Eligible_i \times Post\_Event_i + \varepsilon_i \quad (4)$$

[22] Marginal effects of the *Appr. Eligible* coefficients are derived from the regression coefficients by using the functional transformation $e^{\beta} - 1$. The reported range is taken from the lowest and highest coefficient values of the *Appr. Eligible* variable reported in Table 3.

where:

$f(Z_i, \alpha_i)$ = set of control variables Z_i and estimated coefficients α_i

$Appr.\ Eligible_i = 1 \Leftrightarrow$ Transaction was eligible for appraisal rights

$Post\_Event_i = 1 \Leftrightarrow$ Date of announcement is after excluded event window

We define our treatment group as all deals that are appraisal eligible and the control group as all deals that are not appraisal eligible. Our set of control variables and ten different model specifications remain consistent with the previous section and Table 3. As noted above, we use the log of one-week gross deals premiums as our dependent variable, and pay interest to the β_2 coefficient, which identifies the differential effect of appraisal rights on merger premiums after the 2007 shocks.

Table 4 reports the results of our difference-in-differences model. We find across all ten model specifications a significantly positive effect on our treatment group after the event date. This suggests that 2007 shocks had the effect of increasing bid premiums for those deals eligible for appraisal rights, above that of our control sample. Depending on the specification, the economic impact of the 2007 shocks to a range of 9.7%–17.2% increase in gross premiums for appraisal eligible deals.[23]

Additionally, in all of the models that included deal characteristic controls (columns [2], [3], [5], [6], [8], and [10]), *Target ROA* is associated with a higher deal premium. Target firm size, as measured by total assets, also has a statistically significant in four of the six specifications that it is included in (columns [2], [3], [5], and [8]). Our results indicate that target size is negatively associated with deal premiums.

The positive significance of deal premiums for appraisal-eligible deals after the 2007 shocks is consistent with a beneficial effect that the appraisal-liberalizing 2007 shocks had for all target shareholders. Recall from Corollary 4 above that so long as the status quo appraisal value is below the optimal reserve price (as the appraisal statute seems to require), shareholder welfare improves if and only if acquisition prices also increase after the shock. The results above demonstrate the latter, facilitating a fair inference of the former. We thus interpret the results to be consistent with the argument that appraisal arbitrage opportunities after the 2007 shocks have had an overall effect of inducing higher bid premiums and higher overall target shareholder value. Consistent with our model, this effect would beneficial for all target shareholders, not just the petitioners of these lawsuits (notwithstanding the possibility that petitioners gained even more).

[23] In unreported regressions (available from authors), we include several other notable post-2007 cases as candidate shocks (such as the *Ancestry.com* and *Huff v. CKx* opinions, finding no economically or statistically notable effects.

Table 4: Difference-in-Differences (three years before TT, three years after pre-judgment). In this table, we provide the results of ten ordinary least squares models in which the dependent variable is *ln(gross_prem)*, which is the natural logarithm of the one-week merger deal premium. The regressions include all deals from the 3 years before the Transkaryotic court ruling (5/2/2007) and the 3 years following the pre-judgement interest ruling (8/1/2007). The coefficient of interest is the variable *After Interest * Appr. Eligible*, which captures the effect in the post-event treatment group from those in our control sample. Columns [4], [5], [6], [9], and [10] all control for industry fixed effects using the ten SIC-based Fama-French industry classifications. We use robust standard errors and the t-statistics are in parentheses. We follow the following indicators of statistical significance: ***indicates $p < 0.01$, **indicates $p < 0.05$, and *indicates $p < 0.10$.

$y = ln(gross\_prem)$	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Appr. Eligible	0.064^{**}	0.071^{***}	0.071^{***}	0.058^{**}	0.063^{**}	0.058^{**}	0.062^{**}	0.067^{***}	0.055^{**}	0.060^{**}
	(2.47)	(2.71)	(2.72)	(2.26)	(2.50)	(2.03)	(2.39)	(2.66)	(2.17)	(2.42)
Post_Event	-0.057	-0.041	-0.136^{**}	-0.050	-0.036	-0.082				
	(-1.66)	(-1.26)	(-2.56)	(-1.48)	(-1.14)	(-1.40)				
Post_Event *Appr. Eligible	0.121^{***}	0.105^{***}	0.113^{***}	0.106^{***}	0.093^{**}	0.159^{**}	0.132^{***}	0.116^{***}	0.117^{***}	0.104^{***}
	(3.03)	(2.69)	(2.73)	(2.67)	(2.45)	(2.47)	(3.19)	(2.90)	(2.84)	(2.63)
ln(assets)		-0.018^{***}	-0.016^{***}		-0.012^{**}	-0.009		-0.016^{***}		-0.010^{*}
		(-3.61)	(-3.27)		(-2.32)	(-1.34)		(-3.20)		(-1.93)
ROA		0.021^{**}	0.020^{**}		0.025^{***}	0.024^{***}		0.021^{**}		0.024^{***}
		(2.03)	(2.10)		(2.58)	(2.62)		(2.38)		(2.90)
Leverage		0.002	0.002		0.002	0.003		0.001		0.001
		(0.54)	(0.54)		(0.81)	(1.03)		(0.20)		(0.43)
Private		-0.002	0.000		0.012	0.022		0.005		0.018
		(-0.09)	(0.00)		(0.49)	(0.78)		(0.23)		(0.76)
Related		0.035^{*}	0.034^{*}		0.024	0.038		0.034		0.023
		(1.86)	(1.86)		(1.24)	(1.38)		(1.79)		(1.19)
Op_cost			-0.029			-0.012				
			(-1.31)			(-0.23)				
Fed_funds			-0.036			-0.001				
			(-1.20)			(-0.02)				
GDP			-0.009			-0.023^{*}				
			(-0.98)			(-1.75)				
UNEMP			-0.009			0.025				
			(-0.51)			(0.81)				
CPI			-0.005			-0.003				
			(1.64)			(-0.55)				
VIX			0.001			-0.005				
			(0.47)			(-0.81)				
Constant	0.171^{***}	0.255^{***}	-0.424	0.134^{***}	0.191^{***}	0.907	0.165^{***}	0.254^{***}	0.142^{**}	0.197^{***}
	(7.44)	(6.46)	(-0.91)	(5.14)	(4.23)	(0.91)	(2.61)	(3.62)	(2.23)	(2.64)
Quarterly dummies	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes
n	987	971	971	987	971	971	987	971	987	971
Adjusted R^2	0.054	0.087	0.096	0.077	0.103	0.111	0.085	0.113	0.104	0.128
p-value that industry effects = 0				0.002^{***}	0.0305^{**}	0.067^{*}			0.005^{***}	0.048^{**}
p-value that macro effects = 0			0.153			0.126				

Table 5: Appraisal Eligible Deal Count. In column [1] of this table, we provide the results a Negative Binomial model in which the dependent variable is the number of appraisal eligible deals completed per quarter. Column [2] provides the results a tobit regression model in which the dependent variable is the number of appraisal eligible deals completed divided by the total number of deals completed per quarter. The regression includes merger deals from 1/1/2003–12/31/2016. The coefficient of interest is the variable *Post_ TT*, which captures the effect of the Transkayotic court ruling on the total number of deals (proportion of deals) eligible for appraisal rights. We use robust standard errors. *T*-statistics are provided below correlation coefficients in parenthesis. We follow the following indicators of statistical significance: ***indicates p $<$ 0.01, **indicates $p < 0.05$, and *indicates $p < 0.10$.

	[1] y = appraisal eligible deal eligible deal count per quarter	[2] y = proportion of appraisal eligible deals to total deals per quarter
Total deals	0.010***	
	(5.18)	
Post_Event	−0.692	−0.034
	(−1.03)	(−1.11)
Constant	2.689***	0.488***
	(22.59)	(23.22)
Obs	56	56
Adjusted R^2	0.0574	0.0149

4.3 Effects of the 2007 Shocks on Takeover Rates

Our findings that deal premiums increased after the 2007 shocks catalyzed appraisal arbitrage is fully consistent with our model's prediction of enhanced shareholder value. However, we reiterate that the inference on shareholder welfare requires an assumption that appraisal valuations tend to comply with the statutory mandate of awarding going concern value (or in μ our model). While we believe this to be a reasonable assumption, one might further interrogate it by investigating whether the 2007 shocks had a measurable chilling impact on takeover rates in appraisal-eligible deals. That is, the inference that shareholder welfare also improves (along with deal premia) might appear questionable if the 2007 reforms caused acquiring firms to shift dramatically away from deal terms and conditions that allow for appraisal rights.

To investigate this question, we run two regression models for deal completion rates. Results are reported in Table 5. First, we run a Negative Binomial regression model to determine the effect of the 2007 shocks on the number of appraisal eligible deals. The dependent variable, *eligibledeals*, is a count of

the number of merger deals completed per quarter that had appraisal rights available to shareholders. The Post-Event coefficient is insignificant, indicating that the court decisions had no significant impact on deal terms that would shift towards a decrease in the availability of appraisal rights. Next, we run a Tobit regression to determine the effect of the court decisions on the proportion of appraisal eligible deals to total deals available per quarter. The Post-Event coefficient is again insignificant, indicating that the court decision had no significant impact on the structuring of deal terms that allow for appraisal rights petitions.

In summary, the above results show that appraisal eligible deals earn higher deal premiums than non-appraisal eligible deals and this difference increases after the 2007 shocks. We also find no statistically meaningful impact of appraisal eligibility and the 2007 shocks on takeover rates. In the next section, we examine the robustness of the deal premium results.

4.4 Robustness Tests

4.4.1 Parallel Trend Assumption

The first robustness check examines the key identifying assumption of the difference-in-differences design—that the treatment group and the control group both follow parallel trends prior to the event date and that there was no indication of any systematic pre-trend during the time leading up to the *Transkaryotic* decision. That is to say, that in the absence *Transkaryotic*, any difference in merger bid premiums would remain similar between appraisal eligible deals and non-eligible deals over time.

Figure 3 illustrates a leads and lags plot of the difference in average bid premia for appraisal eligible deals versus non-eligible deals for the eight quarters before and after our event date (where the event date is the period between the 5/2/2007 *Transkaryotic* ruling and the 8/1/2007 interest amendment declaration). The regression coefficient of interest is of the *Appr. Eligible* indicator variable, wherein *ln(gross_prem)* is regressed on *Appr. Eligible* and firm and deal characteristics. Each regression coefficient and its error band at the 95% confidence interval is plotted for the sixteen quarters around the event date. A fitted line of the eight regression coefficients before the event date, and the fitted line of the eight regression coefficients after the event date, is used to illustrate any trends. Prior to the event date there a slight downward trend (if any significant trend at all) in higher deal premiums for appraisal eligible deals as the coefficients approach the event date. After the event date, however, we observe a noticeable increasing trend in appraisal eligible deal premiums over those for non-eligible deals.

Figure 4 shows a parallel trends plot of the average *ln(gross_prem)*, sorted into treatment and control groups for 12 quarters before and after the event

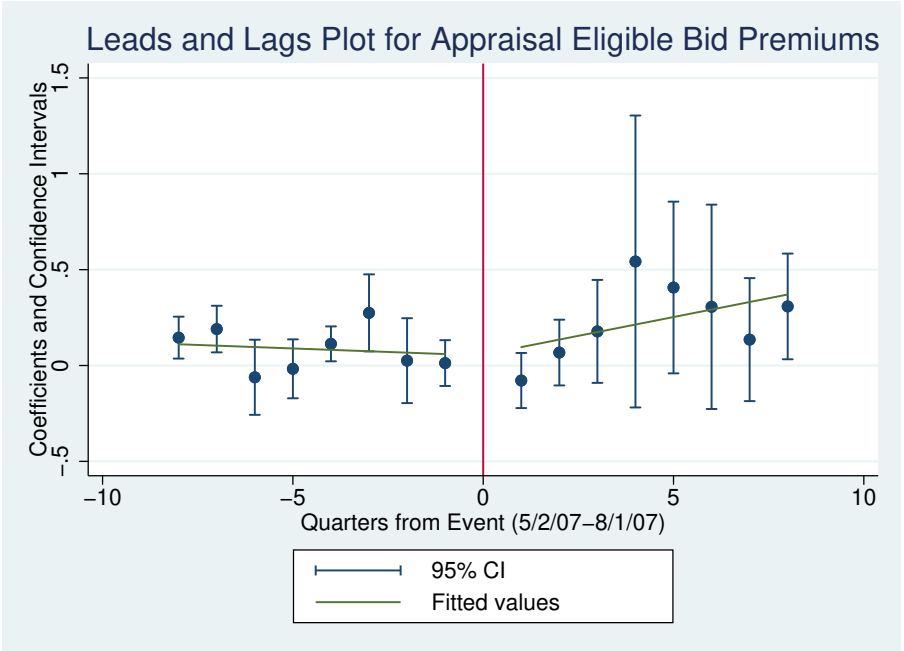

Figure 3: Leads and Lags: This Figure plots pre- and post-time trends bid premia for the treatment and control groups. The x-axis is the number of quarters between the Transkaryotic/interest pre-judgement court rulings. Coefficients are from the *Appraisal Eligible* indicator variable on the OLS model on *ln(1wkprem)* including deal/firm characteristic and industry control variables. 95% confidence intervals of the coefficients are shown.

date. Residuals are from the OLS model predicting *ln(gross_prem)* with control variables for economic, industry, deal, and firm characteristics. As visible from the plot, trends in bid premiums over time for our treatment and control groups have no apparent trend prior to the event date. It is not until after the event that we observe that our treatment group shifts towards higher bid premiums when compared to the control group.

Following the methodology of Angrist and Pischke (2009) and Bishop *et al.* (2017), we perform a "balance test" using regressions to test whether there was any significant pre-trend between our control and treatment groups in the two years before the Transkaryotic ruling.[24] We use the following specification:

$$ln(1 + Premium_i) = \beta_0 * Appr.\ Eligible_i + \beta_1 * \tau_{i,t} + \beta_2 * (Appr.\ Eligible_i \times \tau_{i,t}) + \varepsilon_{i,t} \quad (5)$$

[24]This methodology was also used by Bishop *et al.* (2017). *Activist Directors and Information Leakage* (Doctoral dissertation, Columbia Law School).

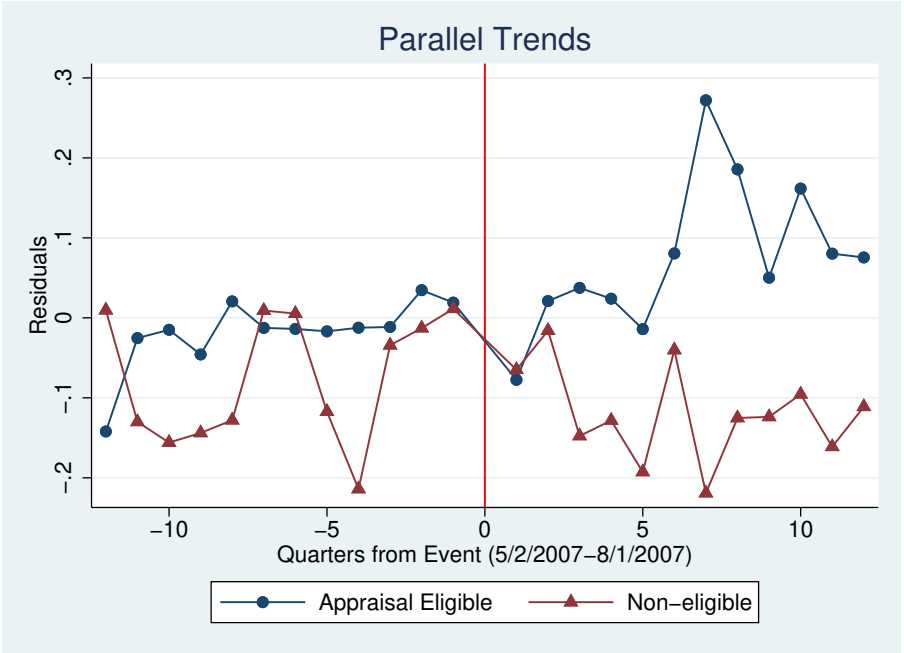

Figure 4: Parallel Trends: This Figure plots pre- and post-time trends for the residuals of bid premia for the treatment and control groups. The x-axis is the number of quarters between the Transkaryotic/interest pre-judgement court rulings. We average the log premia by treatment and control group for each quarter. The treatment group, appraisal eligible deals, is plotted in blue, while the control group, non-eligible deals, is plotted in red, in the Figure below.

where $Appr.\ Eligible_i$ is a dummy variable equal to 1 if a deal is appraisal eligible; $\tau_{i,t}$ is the number of quarters before the Transkaryotic ruling; and $\varepsilon_{i,t}$ is a random error term. The difference-in-differences coefficient of interest is β_2, which indicates the difference in the quarterly time trend between the treatment and control groups after the 2007 reforms. Results are shown in Table 6. We find that β_2 is not statistically different from zero, suggesting that there was no significant systematic pre-trend between the two groups before the event dates.

4.4.2 Change in Event Dates

Tables 7 and 8 provide additional robustness tests to show that our decision to use the time window between the *Transkaryotic* ruling and the interest pre-judgement is appropriate. We run our difference-in-differences model as we did in Section 4.2 adjusting our event date to different specifications. Table 7

Table 6: Robustness Test 1—Balance Test (Parallel Trends Analysis)

2 years prior to Transkaryotic *Ln(GrossPrem)*	coeff.	*t*-stat.
Appr. Eligible	0.0712	1.31
TTqtr	−0.0008	−0.09
TTqtr * Appr. Eligible	0.0038	0.34
const	0.1946	4.15

provides results from using only the May 2, 2007 Transkaryotic case ruling as the event date. The sample includes all observations three years before and three years after the court ruling. Our variable of interest, the interaction variable *After TT * Appr. Eligible*, remains statistically significant across all specifications, with the exceptions of columns [5] and [6] in which case statistical significance decreases from the 1% level to the 5% level. Table 8 provides results for when only the August 1, 2007 interest payment pre-judgement amendment date is used. Results remain significant across all specifications, and all coefficients of interest remain in the range of the results obtained from the original event date specification.

4.4.3 Tax Considerations

To make sure that the increase in merger premiums is not traceable to tax considerations when cash is the medium of exchange in the transaction, we manually code the tax status of each deal under prevailing IRS rules. Table 9 provides results of our regression analysis of the effects of appraisal eligibility on shareholder wealth when only non-taxable deals are considered. In the table, we reduce our sample to only deals that are classified as non-taxable by the Delaware corporate law code. This reduces our sample size to 203 non-taxable deals over the entire sample period of 2003–2016. Our dependent variable, *ln(GrossPrem)*, still shows a significant increase in deal premiums in the range of 6.6%–9.4% for appraisal eligible deals above those premiums for deals not eligible for appraisal rights. These results are consistent when we apply the full models with our control variables and economic controls, as well as our full model with control variables and quarterly fixed effects.

5 Conclusion

This paper has developed, analyzed, and tested an auction-design framework in the mergers and acquisitions context to explore the plausible effects of a

Table 7: Robustness Test 2—Change of Event Date to Transkaryotic Ruling. In this table, we provide the results of ten ordinary least squares models in which the dependent variable is *ln(gross_prem)*, which is the natural logarithm of the one-week merger deal premium. The regressions include all deals from the 3 years before and after the Transkaryotic court ruling (5/2/2007). The coefficient of interest is the variable *After TT * Appr. Eligible*, which captures the effect in the post-event treatment group from those in our control sample. Columns [4], [5], [6], [9], and [10] all control for industry fixed effects using the ten SIC-based Fama-French industry classifications. We use robust standard errors and the t-statistics are in parentheses. We follow the following indicators of statistical significance: ***indicates $p < 0.01$, **indicates $p < 0.05$, and *indicates $p < 0.10$.

$y = ln(gross\_prem)$	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Appr. Eligible	0.069**	0.074***	0.072***	0.060**	0.066**	0.064**	0.064**	0.069*** 0.056**	0.060**	
	(2.51)	(2.71)	(2.74)	(2.28)	(2.50)	(2.52)	(2.44)	(2.67)	(2.16)	(2.37)
After TT	−0.059	−0.045	−0.130***	−0.054	−0.041	−0.121**				
	(−1.59)	(−1.26)	(−2.69)	(−1.50)	(−1.20)	(−2.54)				
After TT * Appr. Eligible	0.104**	0.090**	0.093**	0.091**	0.079**	0.083**	0.119***	0.107***	0.106***	0.096**
	(2.47)	(2.17)	(2.28)	(2.20)	(1.97)	(2.09)	(2.86)	(2.65)	(2.58)	(2.42)
ln(assets)		−0.018***	−0.016***		−0.012**	−0.010**		−0.016***		−0.010*
		(−3.34)	(−3.27)		(−2.07)	(−2.00)		(−2.88)		(−1.66)
ROA		0.021**	0.021**		0.026***	0.025***		0.021**		0.025***
		(1.97)	(2.05)		(2.66)	(2.73)		(2.43)		(3.11)
Leverage		0.002	0.001		0.002	0.002		0.001		0.001
		(0.47)	(0.44)		(0.81)	(0.79)		(0.19)		(0.49)
Private		−0.002	−0.001		0.012	0.011		0.003		0.015
		(−0.08)	(−0.06)		(0.48)	(0.45)		(0.12)		(0.63)
Related		0.028	0.027		0.019	0.018		0.027		0.017
		(1.48)	(1.49)		(0.96)	(0.99)		(1.38)		(0.88)
Op_cost			−0.037			−0.029				
			(−1.32)			(−1.29)				
Fed_funds			−0.035			−0.032				
			(−1.25)			(−1.11)				
GDP			−0.008			−0.007				
			(−0.73)			(−0.59)				
UNEMP			−0.009			−0.003				
			(−0.46)			(−0.15)				
CPI			0.005*			0.005*				
			(1.87)			(1.67)				
VIX			0.001			0.001				
			(0.39)			(0.46)				
Constant	0.166***	0.254***	−0.360	0.131***	0.187***	−0.507	0.176***	0.211***	0.141**	0.139***
	(6.86)	(5.89)	(−1.06)	(4.83)	(3.86)	(−1.09)	(3.23)	(4.76)	(2.35)	(2.73)
Quarterly dummies	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes
n	1,012	996	996	1,012	996	996	1,012	996	1,012	996
Adjusted R^2	0.045	0.073	0.083	0.068	0.090	0.084	0.079	0.101	0.099	0.118
p-value that industry effects = 0				0.006***	0.012**	0.015**			0.002***	0.016**
p-value that macro effects = 0			0.073*			0.070*				

Table 8: Robustness Test 2—Change of Event Date to Interest Pre-judgment. In this table, we provide the results of ten ordinary least squares models in which the dependent variable is *ln(gross_prem)*, which is the natural logarithm of the one-week merger deal premium. The regressions include all deals from the 3 years before and after the pre-judgement interest ruling (8/1/2007). The coefficient of interest is the variable *After Interest * Appr. Eligible*, which captures the effect in the post-event treatment group from those in our control sample. Columns [4], [5], [6], [9], and [10] all control for industry fixed effects using the ten SIC-based Fama-French industry classifications. We use robust standard errors and the t-statistics are given in parentheses. We follow the following indicators of statistical significance: ***indicates $p < 0.01$, **indicates $p < 0.05$, and *indicates $p < 0.10$.

$y = ln(gross\_prem)$	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Appr. Eligible	0.059**	0.066**	0.061**	0.052*	0.057**	0.054**	0.067***	0.073***	0.060**	0.064**
	(2.13)	(2.35)	(2.30)	(1.90)	(2.10)	(2.10)	(2.61)	(2.78)	(2.31)	(2.48)
After Interest Amendment	− 0.077**	− 0.063*	− 0.114**	− 0.071*	− 0.058	− 0.109**				
	(− 2.01)	(− 1.67)	(− 2.30)	(− 1.88)	(− 1.59)	(− 2.24)				
After Interest * Appr.	0.142***	0.127***	0.122***	0.128***	0.115***	0.110***	0.129***	0.118***	0.118***	0.107***
Eligible	(3.24)	(2.95)	(2.95)	(2.94)	(2.72)	(2.71)	(3.21)	(3.02)	(2.98)	(2.81)
ln(assets)		− 0.018***	− 0.016***		− 0.012**	− 0.010*		− 0.017***		− 0.010
		(− 3.33)	(− 3.26)		(− 2.06)	(− 1.93)		(− 2.88)		(− 1.61)
ROA		0.022**	0.021**		0.027***	0.026***		0.022***		0.027***
		(2.35)	(2.25)		(3.31)	(3.16)		(2.77)		(3.75)
Leverage		0.002	0.002		0.003	0.003		0.001		0.002
		(0.71)	(0.59)		(1.18)	(1.04)		(0.32)		(0.73)
Private		− 0.001	0.001		0.015	0.015		0.001		0.016
		(− 0.05)	(0.07)		(0.60)	(0.65)		(0.04)		(0.69)
Related		0.022	0.032*		0.019	0.020		0.029		0.016
		(1.57)	(1.71)		(0.92)	(1.06)		(1.42)		(0.79)
Op_cost			− 0.026			− 0.026				
			(− 1.13)			(− 1.16)				
Fed_funds			− 0.032			− 0.029				
			(− 1.10)			(− 0.98)				
GDP			− 0.006			− 0.006				
			(− 0.74)			(− 0.67)				
UNEMP			− 0.005			− 0.001				
			(− 0.32)			(− 0.04)				
CPI			0.003			0.003				
			(1.16)			(1.11)				
VIX			0.001			0.001				
			(0.34)			(0.42)				
Constant	0.173***	0.263***	− 0.168	0.135***	0.193***	− 0.249	0.161	0.254***	0.134**	0.186
	(6.85)	(5.98)	(− 0.37)	(4.62)	(3.82)	(− 0.55)	(2.54)	(3.53)	(2.06)	(2.41)
Quarterly dummies	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes
n	996	981	981	996	981	981	996	981	996	981
Adjusted R^2	0.054	0.084	0.093	0.079	0.103	0.114	0.084	0.109	0.108	0.129
p-value that industry effects = 0				0.001***	0.003***	0.002***			0.000***	0.002***
p-value that macro effects = 0			0.325			0.237				

Table 9: Tax-Free Deals Only – Effect of Appraisal Eligibility on Bid Premiums. In this table, we two ordinary least squares models in which the dependent variable is *Ln(gross_prem)*, which is the natural logarithm of the one-week merger deal premium. The regression includes tax-free deals from 1/1/2003–12/31/2016. The coefficient of interest is the variable *Appr. Eligible*, which captures the effect in the post-event treatment group from those in our control sample We use robust standard errors and the t-statistics are in parentheses. We follow the following indicators of statistical significance: ***indicates $p < 0.01$, **indicates $p < 0.05$, and *indicates $p < 0.10$.

$y = ln(gross\_prem)$	[1]	[2]	[3]	[4]	[5]
Appr. Eligible	0.082**	0.077**	0.075**	0.090**	0.064*
	(2.39)	(9.14)	(2.45)	(2.56)	(1.85)
ln(assets)		−0.032***	−0.026***		−0.034***
		(−2.78)	(−3.06)		(−3.11)
ROA		−0.208***	−0.225***		−0.215***
		(−3.82)	(−4.32)		(−3.11)
Leverage		0.021	0.011		0.069
		(0.33)	(0.18)		(0.89)
Private		−0.062	−0.064		−0.094
		(−0.52)	(−0.54)		(−0.56)
Related		0.008	0.007		−0.015
		(0.24)	(0.20)		(−0.40)
Op_cost			−0.049*		
			(−1.72)		
Fed_funds			−0.030		
			(−1.13)		
GDP			−0.021		
			(−1.14)		
UNEMP			0.027**		
			(2.30)		
CPI			−0.001		
			(−0.62)		
VIX			−0.003		
			(−0.68)		
Constant	0.192***	0.433***	0.765	0.305***	0.498**
	(9.46)	(4.85)	(1.35)	(8.64)	(2.48)
Quarterly dummies	No	No	No	Yes	Yes
n	203	198	198	203	198
Adjusted R^2	0.029	0.144	0.196	0.367	0.456
p-value that macro effects = 0			0.149		

significant liberalization in shareholder appraisal remedies that occurred in 2007. We have found, consistent with our model's predictions, that the credible threat of appraisal can act as an effective "reserve price" in a target company auction, and that the 2007 liberalization of appraisal appears to have moved this *de facto* reserve price higher. Our results, which appear to be robust and are contemporaneously corroborated consistent results from others in the field (e.g., Boone *et al.*, 2017), suggest that the reserve-price rationale for appraisal actions appears to be substantial. Moreover, we although we cannot test directly for shareholder welfare effects of the 2007 shocks our results (when combined with the insights from our theoretical framework) are strongly suggestive: both the nature of the appraisal statute and the insignificant effects

on deal activity appear strongly consistent with the claim that the reforms also enhanced target-company welfare. It is notable, therefore, that recent judicial opinions in Delaware have acted substantially to undercut the credible threat (and risk) of post-merger appraisal. Future work would do well to revisit the current jurisprudential and legislative skepticism of appraisal, treating it as representing an *appraisal-winnowing* shock, and inquiring whether the shock is associated with the reversal of the effects we have illustrated above.

A Proofs of Corollaries

Corollary A.1. *When $\phi < max\{r_m^*, \rho\}$, the expected acquisition price and all measures of expected shareholder welfare are invariant in ϕ.*

Proof. Suppose $\phi < max\{r_m^*, \rho\}$. By construction, for any successful bid, it must be the case that $b \geq r_m^*$, or the directors will not allow a shareholder vote. Similarly, for any successful bid it must also be the case that $b \geq \rho$, or the shareholders would (under the weak dominance assumption) reject the bid. Consequently, it must be the case that for all winning bids, $b > \phi$. Conditional on a positive vote, then, no shareholder would seek appraisal since it would strictly reduce her expected payoff. Now consider an infinitesimal local shock $d\phi$ to expected appraisal value, increasing ϕ to $\phi^{'} = (\phi + d\phi)$. Because it remains true that $b > \phi'$, appraisal remains irrelevant and equilibrium bids and approval decisions remain the same. Consequently, shareholder welfare does not change either. □

Corollary A.2. *When $max\{r_m^*, \rho\} \leq \phi$ and the non-coordinated equilibrium emerges, expected acquisition price and all measures of expected shareholder welfare are strictly increasing in ϕ so long as $\phi \leq r^*$. If $\phi > r^*$ however, expected acquisition price is strictly increasing in ϕ, but all measures of expected shareholder welfare are strictly decreasing in ϕ.*

Proof. Assume $\phi \geq max\{r_m^*, \rho\}$ and that $\phi < r^*$. In the uncoordinated equilibrium, ϕ is the sharpest lower bound on acceptable bids, and thus is isomorphic to a reserve price for the auction, and thus all shareholders seek appraisal unless $b \geq \phi$. Only buyers with valuations exceeding ϕ will enter the auction, and thus, conditional on sale, the expected winning bid is given by $E\left[max\{\phi, v^{(N-1)}\}|v^{(N)} \geq \phi\right]$, where $v^{(N)}$ and $v^{(N-1)}$ represent the first and second order statistics (respectively) of the population of N buyers. Characterizing this value requires using a variety of identities in order statistics. It is straightforward to confirm that the maximum order statistic, $v^{(N)}$, has cumulative distribution $F^{(N)}(v) = F(v)^N$ with associated density function of $f^{(N)}(v) = Nf(v)F(v)^{N-1}$. The second-highest order statistic, $v^{(N-1)}$ has cumulative distribution $F^{(N-1)}(v) = N \cdot F(v)^{N-1}(1 - F(v))$. Moreover,

conditional on $v^{(N)} = x$, then the remaining *(N-1)* values remain conditionally independent but bounded above by x, so that each has a conditional distribution function of $\frac{F(v)}{F(x)^N}$. The distribution of $v^{(N-1)}$ conditional on $v^{(N)} \geq \phi$ is therefore (after some simplification):

$$F^{(N-1)}\left(v|v^{(N)} \geq \phi\right) = F^{(N-1)}(v) \cdot \left[\ln(F(\phi)^{-N})\right] \tag{A.1}$$

Under the uncoordinated equilibrium, the winning bid (if there is one) is equal to $\max \phi v^{(2)}|v^{(1)} \geq \phi$, and thus in expectation the winning bid is (after simplification):

$$\mathrm{E}\left(\max\{\phi, v^{(2)}|v^{(1)} \geq \phi\}\right) = \ln\left(F(\phi)^{-N}\right) \times \left[\phi \cdot F^{(N-1)}(\phi) + \int_{\phi}^{\bar{v}} v dF^{(N-1)}(v)\right] \tag{A.2}$$

where recall that $F^{(N-1)}(v)$ is the unconditional cumulative distribution function on the second-highest valuation among the N bidders. The term on the outside of the square brackets is clearly increasing in ϕ, and differentiating the term inside the brackets respect to ϕ yields:

$$F^{(N-1)}(\phi) + \phi \cdot f^{(N-1)}(\phi) - \phi \cdot f^{(N-1)}(\phi) = F^{(N-1)}(\phi) > 0 \tag{A.3}$$

Thus, the expected price is always strictly increasing within the uncoordinated equilibrium. As to expected shareholder welfare, note first that in the uncoordinated equilibrium all shareholders receive the same price. Finally, note that by construction of r^*, shareholders' expected payoff is strictly increasing in ϕ for all $\phi < r^*$ and strictly decreasing for all $\phi > r^*$ (See Choi and Talley, 2017 for details). □

Corollary A.3. *When* $\max\{r_m^*, \rho\} \leq \phi$ *and the coordinated equilibrium emerges, expected acquisition price may be increasing or decreasing in* ϕ*. When* $\phi \leq r^{**}$ *the maximin measure of expected shareholder welfare is strictly increasing in* ϕ *if and only if expected acquisition price is also increasing; the aggregate measure of expected shareholder welfare is weakly increasing. When* $\phi > r^{**}$*, aggregate shareholder value is weakly decreasing in* ϕ *and maximin shareholder value is increasing only if announcement price is also increasing.*

Proof. Now consider the coordinated equilibrium which occurs only when the following condition is satisfied at winning bid b : $max\{r_m^*, \rho\} < b < \phi$. Let us first assume that $r_m^* \leq \rho$ so that r_m^* plays no role in the auction (as ρ is a sharper bound). Within this setting, a successful bid b will pay a "headline" price of b to a fraction α of shareholders and will pay the expected appraisal price ϕ to the remaining shareholders (who vote against and seek

appraisal). Consequently, the winning bidder will expect to pay a price of: $\alpha b + (1-\alpha)\phi$. An incentive compatible, efficient auction can be implemented through a revelation mechanism in which each bidder reports its type and the highest report wins, paying a headline "announcement" price equal to b, where:

$$b(v^{(2)}) = \begin{cases} \rho & \text{if } v^{(2)} < \alpha\rho + (1-\alpha)\phi \\ \frac{1}{\alpha}\left(v^{(2)} - (1-\alpha)\phi\right) & \text{if } v^{(2)} \in [\alpha\rho + (1-\alpha)\phi, \phi] \\ v^{(2)} & \text{if } v^{(2)} > \phi \end{cases} \tag{A.4}$$

Factoring in appraisal seekers, of course, the "aggregate" price paid by the winning bidder will be:

$$\hat{b}(v^{(2)}) = \begin{cases} \alpha\rho + (1-\alpha)\phi & \text{if } v^{(2)} < \alpha\rho + (1-\alpha)\phi \\ v^{(2)} & \text{if } v^{(2)} \in [\alpha\rho + (1-\alpha)\phi, \phi] \\ v^{(2)} & \text{if } v^{(2)} > \phi \end{cases} \tag{A.5}$$

Thus, the expected announcement price will be given by:

$$\begin{aligned} E\left\{b(v^{(2)})\right\} = &\int_{\underline{v}}^{\hat{\phi}} \rho dF^{(N-1)}\left(v|v^{(N)} \geq \hat{\phi}\right) \\ &+ \int_{\hat{\phi}}^{\frac{\hat{\phi}-\alpha\rho}{(1-\alpha)}} \left(\frac{v-\hat{\phi}}{\alpha} + \rho\right) dF^{(N-1)}\left(v|v^{(N)} \geq \hat{\phi}\right) \\ &+ \int_{\frac{\hat{\phi}-\alpha\rho}{(1-\alpha)}}^{\bar{v}} v dF^{(N-1)}\left(v|v^{(N)} \geq \hat{\phi}\right), \end{aligned} \tag{A.6}$$

where we have utilized the substitution $\hat{\phi} \equiv \alpha\rho + (1-\alpha)\phi$ so that $\phi = \frac{\hat{\phi}-\alpha\rho}{(1-\alpha)}$. Note that $\hat{\phi}$ is strictly increasing in ϕ, so we can do qualitative comparative statics on ϕ by doing comparative statics on $\hat{\phi}$. Differentiating the above. Substituting for $F^{(N-1)}\left(v|v^{(N)} \geq \hat{\phi}\right)$, this expression becomes:

$$\begin{aligned} \left\{b(v^{(2)})\right\} = \left[\ln(F(\hat{\phi})^{-N})\right] \cdot \Bigg(&\rho F^{(N-1)}(\hat{\phi}) + \int_{\hat{\phi}}^{\frac{\hat{\phi}-\alpha\rho}{(1-\alpha)}} \left(\frac{v-\hat{\phi}}{\alpha} + \rho\right) dF^{(N-1)}(v) \\ &+ \int_{\frac{\hat{\phi}-\alpha\rho}{(1-\alpha)}}^{\bar{v}} v dF^{(N-1)}(v)\Bigg) \end{aligned} \tag{A.7}$$

Without additional assumptions, it is not possible to sign unambiguously the derivative of the expected announcement price as a function of ϕ. Because the maximin welfare of shareholders increases if and only if the announcement price

increases, the ambiguity follows here as well. As to aggregated shareholder welfare, however, we know that so long as $\phi < r^{**}$ shareholder welfare is strictly increasing in ϕ, and strictly decreasing thereafter.

Now suppose that $r_m^* \in (\rho, \phi]$ so that the manager sets a higher reserve payoff than the pivotal shareholder. There are two relevant cases: (a) $r_m^* \in (\rho, \alpha\rho + (1-\alpha)\,\phi]$ and (b) $r_m^* \in (\alpha\rho + (1-\alpha)\,\phi, \phi]$. In case (a), the manager's reserve price is still not binding, since the minimally acceptable bid under appraisal is the winner's total costs, which can never be lower than $\alpha\rho + (1-\alpha)\,\phi$ under this equilibrium. Here, then, the same equilibrium as above holds. In case (b), the manager has additional slack to achieve his reserve price and will (credibly) announce a reserve price $\hat{r}_m^*$ so that the total consideration paid achieves r_m^* Thus, the manager will set

$$r_m^* = \alpha\hat{r}_m^* + (1-\alpha)\,\phi \Longleftrightarrow \hat{r}_m^* = \frac{1}{\alpha}(r_m^* - (1-\alpha)\,\phi) \tag{A.8}$$

Here, when ϕ increases, the manager will simply reduce her headline reserve price to compensate, so that the aggregate reserve price remains as a mean-preserving spread. It is easily confirmed here that aggregate shareholder welfare does not change, but both price and maximin shareholder welfare decrease because of the slackened announcement reserve. This establishes that the in case (b), the aggregate measure of shareholder welfare may remain constant even though $\phi < r^{**}$ This establishes the Corollary. □

Corollary A.4. *So long as $\phi \leq r^*$ expected shareholder welfare is increasing in ϕ if expected announcement price is also increasing in ϕ*

Proof. Within the connected components of the coordinated and non-coordinated equilibria, the claim in the Corollary follows directly from Corollaries 1–3 and Figure 1. One last consideration, however, concerns what happens when a shock to ϕ causes the equilibrium to "jump" from one class to the other.

Suppose first that there is a jump from the non-coordinated equilibrium to the coordinated one as ϕ is increased by infinitesimal $d\phi$, and consider the case where $r_m^* \leq \alpha\rho + (1-\alpha)\phi$ In this case, the announcement price immediately falls from to $E\left[min\left\{\rho, \frac{1}{\alpha}\left(v^{(N-1)} - (1-\alpha)\phi\right)\right\}\right] < \phi < \phi + d\phi$, and the auction migrates from one with a de facto reserve price of ϕ to one with a de facto reserve price of $\alpha\rho + (1-\alpha)\phi$. Consequently, because $\phi \leq r^*$ we also know that expected aggregate revenue declines as well. Finally, in the coordinated equilibrium, the have-not shareholders must be worse off than under the status quo ante, since now they receive the lower, non-pro-rata share of a winning bid in an auction whose de facto reserve is further away from optimal than it was initially. The case where $r_m^* > \alpha\rho + (1-\alpha)\phi$ under the coordinated equilibrium differs only in the respect that the manager may set a reserve higher than ρ and reduce it to with the shock to ϕ in order to preserve

an α-weighted mean spread. Prices still decline, as does maximin welfare, though aggregate shareholder welfare remains unchanged.

The identical reasoning (in reverse) applies when the shock to ϕ induces a jump from the coordinated equilibrium to the non-coordinated one. So long as $\phi \leq r^*$, such a jump will result in both an upward price shock and an upward jump in both measures of shareholder welfare. This completes the proof. □

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