Did Adoption of Forward-Looking Valuation Methods Improve Valuation Accuracy in Shareholder Litigation?

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Before 1984, Delaware judges relied exclusively on the Delaware Block method—an appraisal formula based on trailing earnings and liquidation value—to price shares in shareholder litigation. In 1984, the Delaware Supreme Court changed the law to permit its judges to use any valuation method they deem appropriate. As a result, judges and litigants began switching from the Block method and adopting forward-looking valuation techniques based on cash flow and earnings forecasts. While the use of forward-looking methods potentially improves valuation accuracy by incorporating forecast information, the use of forecasts allows more room for subjective manipulation. Did the adoption of forward-looking methods improve or reduce valuation accuracy in shareholder litigation? We address this question using a comprehensive hand-collected sample of all Delaware corporate "appraisal-remedy" cases published between 1966 and 2002 in Lexis-Nexis. The sample identifies, on a case-by-case basis, the plaintiff's, the defendant's, and the judge's valuation methods and resulting valuation estimates. We show that the adoption of forward-looking valuation methods improves litigants' valuation accuracy on average.

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We thank Joseph Aharony, Thomas Lau, Yong Gyu Lee, Steven Orpurt, an anonymous referee, and our colleagues at Columbia Business School. We also thank Peter Easton for an account of his first-hand experiences as a Delaware valuation expert. Participants of the Columbia Business School Burton Workshop, the 6th APJAE Symposium, the Center for Corporate Reporting and Governance at Cal State Fullerton; the 13th Pacific Basin Finance, Economics, and Accounting Conference at Rutgers University; and seminar participants at Columbia University, Korea University, and Singapore Management University contributed useful feedback. Kenton Yee acknowledges the Eugene Lang Faculty Fellowship for financial support and Sharon Park and Joshua Schwartz (Columbia Law School students during 2002–05 during this research) for their able research assistance. Yong Keun Yoo was supported by the Korea Research Foundation Grant funded by the Korean Government (KRF-2006-332-B00200).

Keywords: *equity valuation, earnings forecasts, Delaware, shareholder litigation*

JEL Classification: *G12, G34, K00, M41*

1. Introduction

Financial statement analysis courses and textbooks (e.g., White, Sondhi, & Fried [2002]; Penman [2003]) spend considerable time discussing valuation methods and techniques. Accounting researchers have spent considerable effort investigating both traditional and new valuation methods (e.g., Ohlson [1995]; Lee, Myers, & Swaminathan [1999]; Dechow, Hutton, & Sloan [1999]; Easton, Taylor, Shroff, & Sougiannis [2002]). Hence, the extent to which the evolution of methodology and thinking has an impact on the practice of valuation in the financial community is of interest. Moreover, how valuation method choice affects valuation accuracy is a fundamentally important issue in its own right.

Despite the importance of this issue, few studies directly examine the link between valuation method choice and valuation accuracy. While several empirical studies do use or characterize the use of valuation methods (e.g., Kaplan & Ruback [1995]; Lee, Myers, & Swaminathan [1999]; Dechow, Hutton, & Sloan [1999]; Easton, Taylor, Shroff, & Sougiannis [2002]; Liu, Nissim, & Thomas [2002]), these studies do not show—and do not seek to show—that investors actually rely on any particular valuation methods to assess what they are willing to pay for shares. To directly link a valuation method to a valuation outcome, one needs concrete information about an investor's valuation method and the valuation estimate resulting from the application of that method. Without such information, it is not possible to draw a causal link between valuation method choice and valuation accuracy.

In existing literature, accounting researchers have finessed this issue by testing how well the estimates produced by exogenously imposed valuation models agree with stock prices. The problem is that the exogenously imposed valuation models, even if reasonable, are not the same as the actual models used by the agents to produce the valuation estimates. As a result, these empirical studies cannot demonstrate a direct causal link between the actual valuation method used by the agents and the agents' reported valuation estimates. Rather, these studies can document only how well the researchers' imposed valuation model produces estimates that agree with stock prices.

This article differs from the existing literature by directly linking valuation methods to valuation estimates based on hand-collected data from shareholder litigation. Our data contain detailed information about each judge's, plaintiff's, and defendant's valuation methods as well as their proposed valuation estimates. In this regard, our data set contains more explicit methodology-related information

than any existing study we are aware of, including the seminal studies of appraisal techniques used in tax courts (LeClair [1990]; Beatty, Riffe, & Thompson [1999]). Our new contribution is to draw a direct link between valuation method choice and valuation outcomes when the valuation method choice is specified endogenously by actual data rather than imposed exogenously by researchers.

Judges are frequently faced with assessing equity value in bankruptcy, mergers, and acquisitions lawsuits, insider trading, tax, and other litigation (LeClair [1990]; Francis, Philbrick, & Schipper [1994]; Griffin [1996]; Beatty, Riffe, & Thompson [1999]; Evans & Sridhar [2002]). The judicial system is unique in that a judge may promulgate an *official* opinion to summarize the trial and describe specifically how she, the plaintiff, and the defendant each arrive at his or her own valuation estimate. In Delaware, widely regarded as the most influential corporate law jurisdiction in the United States, appraisal hearings are tried in the Court of Chancery, Delaware's trial court system. Accordingly, Delaware Chancery judges tend to be experienced corporate lawyers who, while not finance specialists, are much more financially sophisticated than the average judge. Because judicial opinions tend to be thorough, carefully crafted, and unbiased, they offer first-hand accounts, not only of how experienced practitioners perform valuation, but also of what financial variables they deem most reliable.

Our data set is also interesting because valuation in the courts inevitably reflects the practices of the broader financial community. Parties in an appraisal hearing usually solicit leading appraisal experts to testify on their behalf, so judges typically hear testimony from competing appraisal experts before they decide on an appraisal. Infrequently, judges sometimes appoint a special master or expert, whose job is to provide the judge with an independent valuation assessment.[1] Given that the appraisal process is lengthy and thorough, judges' and parties' valuations inevitably reflect the prevailing views of the practitioner community. A reading of judicial opinions also suggests that a judge's choices of valuation methodology and technique are significantly influenced by the financial experts testifying for the litigants.

The first half of this article documents how judicial language as well as valuation methods in court have shifted away from trailing information in the mid-1980s and have since become decidedly more forward-looking. First, we describe the judicial appraisal procedure in Delaware. Then, by using hand-collected data from Lexis-Nexis, we present the shift toward more forward-looking valuation methods, such as discounted cash flows (DCF) and excess earnings method, in American, Australian, Canadian, and United Kingdom judicial opinions. Consistent with this shift in terminology, valuation methodology in Delaware courts

1. In *In re Shell Oil Co.*, Del. Supr., 607 A.2d 1213 (1992), the Delaware Supreme Court recognized that the trial court is often forced to pick and choose from a limited record without the benefit of objective analysis and opinion. To compensate for this handicap, it allowed the Court of Chancery to consider appointing its own expert witnesses in these cases.

has shifted away from the Delaware Block method (a method of comparables approach based on trailing benchmarks) to forecasts-based methods like DCF and excess earnings. While legally attributable to the landmark 1983 Delaware Supreme Court decision opening the courtroom door to modern valuation techniques, we believe these trends also reflect the evolution of practice in the broader financial community.

Is the adoption of forward-looking methods good public policy? There are at least two schools of thought on the effects of forward-looking methods on valuation accuracy (e.g., Lambert [1999]; Healy & Palepu [2001]; Yee [2004a]). According to the ''informativeness hypothesis,'' forecasted cash flows or earnings contain more information. Thus, the use of forward-looking valuation methods potentially improves valuation accuracy by incorporating more information into valuation estimates. The informativeness hypothesis is supported by evidence that valuation models incorporating earnings forecasts tend to explain cross-sectional share-price variations better than valuation models that rely only on trailing earnings (e.g., Lee, Myers, & Swaminathan [1999]; Dechow, Hutton, & Sloan [1999]; Easton, Taylor, Shroff, & Sougiannis [2002]; Liu, Nissim, & Thomas [2002]). Conversely, the ''manipulation hypothesis'' warns that the use of forecast information invites subjective manipulation of the forecasts by the (self-interested) forecaster. A plaintiff seeking a higher appraisal for his or her shares can exaggerate an earnings forecast to inflate the valuation estimate. Thus, the use of earnings forecasts in court gives litigants another ''knob'' to fiddle with in the valuation game.

Does informativeness dominate manipulation or *vice versa*? If the informativeness hypothesis dominates, then adoption of forward-looking methods improves valuation accuracy. Conversely, if manipulation dominates, then adoption of forward-looking methods enables litigants to propose more biased valuation estimates that, in turn, cause judges to face more valuation uncertainty and make more mistakes.

Lurking in the background is a third alternative hypothesis, ''perfect rationality.'' The perfect rationality hypothesis suggests that valuation methods do not matter at all; no matter which method is used, judges[2] rationally adjust out any systematic bias provided by the litigants to obtain the most accurate valuation estimate based on a rational interpretation of all available information. In summary, whether the switch to forward-looking methods improves, reduces, or does not affect valuation accuracy is an open empirical question.

The latter half of this article examines the tension between the informativeness hypothesis and the manipulation hypothesis based on a comprehensive hand-collected sample of all Delaware appraisal remedy cases during 1966–2002. Unfortunately, even though our sample is comprehensive, the size of the sample

2. We do not try to apply the rationality hypothesis to litigants because rational litigants pursue strategic behavior, which may superficially appear irrational even if it is rational.

is small and the conclusions drawn from the statistical analysis should be regarded as exploratory rather than conclusive.

Employing a technique attributable to Lee, Myers, and Swaminathan (1999), we decompose the valuations errors of each party (judge, plaintiff, and defendant) into a systematic "bias" component and an unpredictable "random" component. We find that adoption of forward-looking valuation methods by plaintiffs and defendants does *not* increase their systematic bias component. Moreover, we find that the plaintiffs' and defendants' overall valuation errors are significantly reduced when they use forward-looking valuation methods compared with when they use valuation methods that rely on trailing accounting information. Furthermore, the adoption of forward-looking methods did not significantly change the average size of judicial valuation errors. Thus, we argue that the adoption of forward-looking valuation methods improves the valuation estimates of plaintiffs and defendants without causing them to be more biased on average. Overall, our main results are consistent with the "informativeness hypothesis."

This article is organized as follows. Section 2 provides institutional background about judicial appraisal in Delaware. Section 3 documents how valuation methods have shifted over time to be more forward-looking. Section 4 presents a valuation model that is the framework of the empirical tests of the informativeness and manipulation hypotheses. Sections 5 and 6 describe results of the empirical tests. Section 7 summarizes and discusses the limitations of our small sample study.

2. The Appraisal Remedy

After a major corporate restructuring, dissenting minority stockholders have the right to cash out at a price determined by court appraisal (Seligman [1984]; Thompson [1995]). Although the circumstances triggering appraisal vary from state to state, appraisal actions most commonly occur after the merger or management buyout of a closely held corporation. According to section 13.02 of the Model Business Corporations Act of 1999, all states grant appraisal rights in some merger situations. Forty-six states provide appraisal rights for mergers requiring shareholder authorization. In some of these states and in the remaining four, appraisal rights are available in other merger situations as well. However, only a tiny fraction of mergers ultimately result in appraisal hearings. Seligman's 1984 survey found that, of 16,479 mergers of U.S. companies during 1972–81, only 20 resulted in judicial appraisal hearings nationwide. This is because dissenting shareholders customarily settle with the company out of court. Appraisal acts largely as a shadow remedy—an option lurking in the shadows to provide incentives for the parties to bargain toward fair value.

Delaware is the most popular and important jurisdiction of incorporation for American corporations (Greenfield [2004]). Nearly half of New York Stock Exchange (NYSE) firms are Delaware corporations, even though most of them have home offices and major plants outside of that state. In particular,

49.6 percent of all NYSE and American Stock Exchange (AMEX) target firms during 1975–91 covered by state appraisal statutes were incorporated in Delaware, 9.2 percent were incorporated in New York, and 4.7 percent were incorporated in California (Mahoney & Weinstein [1999]). Delaware has a special court, the Court of Chancery, which has jurisdiction over all corporate governance matters. The six Chancery Court judges (called ''chancellors'') are all experienced corporate lawyers. Appeals of Chancery Court decisions go directly to the Delaware Supreme Court.

As encapsulated in Delaware General Corporations Law (DGCL), section 262, the purpose of the appraisal statute is twofold: (1) to give dissenting shareholders an option to withdraw from the company at a fair exit valuation, and (2) to guarantee that appraisal is always available for cash-out mergers. Accordingly, the prototypical Delaware appraisal case occurs after a cash-out merger when dissenting shareholders refuse to tender their shares for the cash-out valuation. Delaware case law defines fair value as ''that which has been taken from [the shareholder], viz., his proportionate interest in a going concern.''[3] The corporation is to be evaluated as an ongoing business occupying a particular market position in the light of future prospects. A fundamental premise is that the fair value of equity shares in a corporation is not necessarily the same as the market value of those shares (Coates [1999]; Yee [2005]). This premise traces back to an influential Court of Chancery opinion written, not surprisingly, during the Great Depression. The chancellor explained, ''Markets are known to gyrate in a single day. The numerous causes ... from joy to grief need not be reviewed.''[4]

Appraisal in Delaware is adversarial and not inquisitorial. This means that, except in highly unusual circumstances in which they appoint a special master to do an independent investigation and analysis, judges rely solely on information provided by the litigants to make the final appraisal. Litigants in an appraisal hearing usually hire leading investment bankers and financial academics to testify on their behalf. In this light, the trends of valuation in court should be of interest to researchers because they reflect how and to what extent the financial community uses accounting information for valuation.

The appraisal process is lengthy and thorough. As an extreme example, proceedings to appraise Technicolor, Inc. began with the original merger transactions in 1982 and have dragged on for the last twenty years. The Delaware Supreme Court invalidated the original appraisal because it did not take into account the merger-enhancing strategies Technicolor implemented before the offending merger. Chancellor Chandler, the highly respected Delaware trial judge handling the new trial, describes the situation literally:[5]

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3. *Tri-Continental Corp. v. Battye*, Del. Supr., 31 Del. Ch. 523, 74 A.2d 71, 72 (1950).

4. *Chicago Corp. v. Munds*, 20 Del. Ch. 142, 172 A. 452 (1934).

5. A recent court memorandum is *Cede v. Technicolor*, Court of Chancery, C.A. No. 7129, decided on May 7, 2001.

> The long history of the dispute between these parties is well known, not only to the parties, but also to all those who are familiar with Delaware corporate law.... As these parties launch their final campaign, the conflict between them not only appears to sustain both combatants, but has in part come to define them.

3. Rise of Forward-Looking Language

Between the Great Depression and 1984, virtually all states followed a valuation framework that has evolved into what is now called the Delaware Block method. The key feature of the Block method is that it is not forward-looking; it arrives at a valuation estimate based on a weighted average over capitalized trailing earnings, book value, and the contemporaneous liquidation and market value of assets. It uses neither cash flow nor earnings forecasts. The Delaware Block method is summarized in Yee (2004b).

The precursor of the Institutional Brokers Estimate System (now part of Thomson Financial) began publishing monthly consensus earnings estimates in July 1972. In the latter 1970s, these estimates evolved from a simple reference service to an important investment tool (Brown [2000]). Financial analysis became more forecast oriented in the 1980s due to the rise of modern finance theory and the advent of computer database technology. One of the most important early studies, ''Expectations and Share Prices'' (Elton, Gruber, & Gültekin [1981]), helped spawn an explosion of new research, especially since Institutional Brokers Estimate System (I/B/E/S) current and historical data became widely available in electronic format at about the same time. In the early 1980s, use of I/B/E/S consensus expectations data grew rapidly among both academic researchers and practitioners.

With the rise of modern finance and the advent of computer spreadsheet technology, appraisal experts hired to testify in appraisal hearings began to rely more and more on DCF and other valuation methods. However, since the Delaware Block method had been the law, Delaware courts steadfastly rejected these valuation techniques until 1983. Finally, in a landmark 1983 decision, *Weinberger v. UOP*,[6] the Delaware Supreme Court overturned exclusive reliance on the Block method with the following justification:[7]

> The standard ''Delaware block'' or weighted average method of valuation, formerly employed in appraisal and other stock valuation cases, shall no longer exclusively control such proceedings. We believe that a more liberal approach must include proof of value by any techniques or methods that are generally considered acceptable in the financial community and otherwise admissible in court.... Fair price obviously requires consideration of all

6. *Weinberger v. UOP, Inc*., Del. Supr., 457 A.2d 701 (1983).
7. Ibid., note 32.

> relevant factors.... This is not only in accord with the realities of present day affairs, but it is thoroughly consonant with the purpose and intent of our statutory law.

Accordingly, the Court ordered that to the extent that the Block method "excludes other generally accepted techniques used in the financial community and ... [other] courts, it is now clearly outmoded. It is time we recognize this in appraisal and other stock valuation proceedings and bring our law current to the subject."

The Delaware Supreme Court's decision in *Weinberger* opened up the possibility of using DCF and other new valuation methods in the courts. But, as exemplified by the final outcome of *Weinberger*, in which the trial judge ultimately disregarded DCF, judicial valuation is case- and fact-based. With this in mind, it is not ironic that *Weinberger,* which has been given credit for opening the floodgates to the use of modern methods in judicial valuation, was ultimately decided in favor of a valuation based on the Delaware Block method.

Did opening the courts to non-Block method techniques change the thinking of judges during this period? To investigate, we search all U.S. court documents in "Corporate Law (Federal and State cases)" of the U.S. Lexis-Nexis database during 1976–2001.[8] We identify all judicial mentions of the relevant phrases, tabulating the number of documents that refer to each phrase.[9] For example, if the chancellor refers to DCF more than once in the same document, it is counted only as a single judicial mention. Because our intention is to capture overall judicial awareness of these valuation concepts, we did not attempt to restrict counting to only appraisal opinions.

Figure 1 traces the evolution of judicial mentions of DCF and of the Block method factors (i.e., "market value and net asset value and earnings value") in the United States courts. To control for variations in the amount of court activity over time, the raw counts are deflated by the contemporaneous judicial mentions of "fair value" in the same U.S. courts.

As shown in Figure 1, the popularity of DCF rose after the *Weinberger* decision to displace the Block method in U.S. courts.

Looking ahead to the present and future, we have not found much evidence to suggest that judicial valuation methods have evolved beyond the DCF framework. One prominent alternative method is the "Treasury Method," otherwise known as the "capitalized excess earnings method." The idea of this method is similar to residual income valuation (Ohlson [2005]): the value of intangible (off

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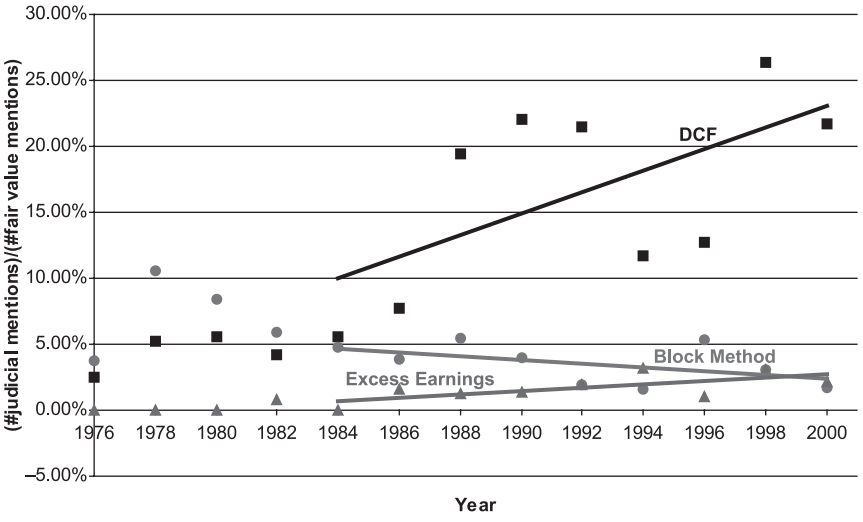
8. Lexis-Nexis is one of two major commercial databases that law firms and courts rely on for their legal literature searches. Lexis-Nexis contains a comprehensive list of every published judicial opinion. In addition to officially published judicial opinions, the database also includes any supporting memos or court documents that judges voluntarily submit to Lexis-Nexis. In the second half of this study, we hand-collect all official judicial opinions published during 1966–2002 from Lexis-Nexis by distinguishing the official judicial opinions from the other documents on a document-by-document basis.

9. One caveat applies: judicial mentions tend to give more weight to prior cases that generated numerous judicial opinions than to those that speedily resolve or settle out of court.

FIGURE 1

Rise of DCF and Excess Earnings, U.S. Courts



Regressions of Judicial Mentions on the Intercept and Trend Variables

	Intercept	Pre-1984 Trend	Post-1984 Trend	Adjusted R^2
DCF/FV	0.036	0.003	0.008	0.61
(*t*-statistic)	(1.03)	(0.27)	(3.67)***	
BLK/FV	0.063	0.003	−0.002	0.42
(*t*-statistic)	(4.77)***	(0.69)	(−2.01)*	
EE/FV	−0.002	0.001	0.001	0.63
(*t*-statistic)	(−0.45)	(1.01)	(4.19)***	

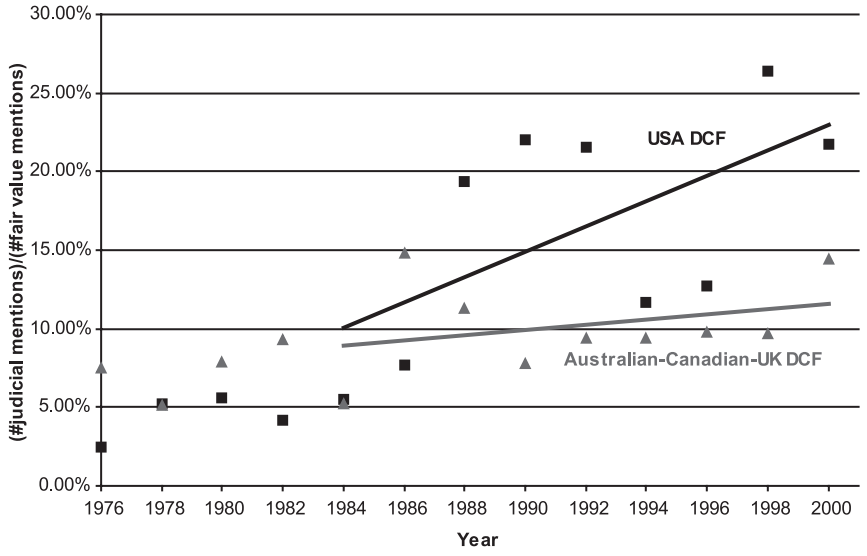
* and *** indicate, respectively, the significance level at the 10 percent and 1 percent level or better.

Note: This figure presents the frequency of judicial mentions of DCF, Block method, and excess earnings, relative to fair value mentions over 1976–2001 for all U.S. courts. The relative frequencies are calculated every two years. Trend lines are also plotted between 1984 and 2001. DCF/FV is the frequency of judicial mentions of DCF, scaled by the mentions of fair value. BLK/FV is the frequency of judicial mentions of Block method, scaled by the mentions of fair value. EE/FV is the frequency of judicial mentions of excess earnings, scaled by the mentions of fair value. In the regression tests, Pre-1984 Trend is defined as *Year* less 1976 if *Year* is before 1984, and 0 otherwise; Post-1984 Trend is defined as *Year* less 1976 if *Year* is at and after 1984, and 0 otherwise.

balance sheet) assets is the value of excess earnings they generate. As depicted in Figure 1, the excess earnings method seems to be almost as popular in U.S. courts today as the Block method. However, it has a long way to go to catch up with DCF in shareholder litigation. Both DCF and excess earnings became popular in judicial mentions after the 1980s, but the Block method has become less

FIGURE 2

Rise of DCF, U.S., and Australian-Canadian-UK Courts



Regressions of Judicial Mentions on the Intercept and Trend Variables

	Intercept	Pre-1984 Trend	Post-1984 Trend	Adjusted R^2
USA DCF/FV	0.036	0.003	0.008	0.61
(*t*-statistic)	(1.03)	(0.27)	(3.67)***	
Australian-Canadian-UK DCF/FV	0.067***	0.003	0.002	0.15
(*t*-statistic)	(3.76)	(0.59)	(1.88)*	

* and *** indicate, respectively, the significance level at the 10 percent and 1 percent level or better.

Note: This figure presents the frequency and trend lines of judicial mentions of DCF relative to fair value mentions over 1976–2001 for all U.S. courts and courts of Australia, Canada, and United Kingdom. The relative frequencies are calculated every two years. Trend lines are also plotted between 1984 and 2001. USA DCF/FV is the frequency of judicial mentions of DCF, scaled by the mentions of fair value, for U.S. courts. Australian-Canadian-UK DCF/FV is the frequency of judicial mentions of DCF, scaled by the mentions of fair value, for Australian, Canadian, and U.K. courts. In the regression tests, Pre-1984 Trend is defined as *Year* less 1976 if *Year* is before 1984, and 0 otherwise; Post-1984 Trend is defined as *Year* less 1976 if *Year* is at and after 1984, and 0 otherwise.

popular. Today, DCF appears to be the judicial valuation method of choice, even though Block method factors maintain a steady following and the excess earnings method is making slight inroads.

As depicted in Figure 2, the frequency of judicial references to DCF has risen markedly internationally in Australian, Canadian, and United Kingdom

courts since 1984. In addition to DCF references, the use of other forecasts and growth language reflect on the degree to which judges are forward-looking. We have done additional studies, not reported here, and find that judicial mentions of "earnings growth" and "future cash flow" have also grown markedly in U.S. courts since 1984.

To summarize, we document how judicial language regarding valuation methods has shifted away from trailing information in the mid-1980s and have since become decidedly more forward-looking. Specifically, we present hand-collected data from Lexis-Nexis indicating that in the last twenty-five years U.S. judges have begun referring more to the forward-looking valuation methods, like DCF and excess earnings method, and commensurately less to backward-looking valuation methods, like the Block method. While procedurally attributable to the landmark 1983 Delaware Supreme Court decision opening the courtroom door to modern valuation techniques, we believe these trends also reflect the evolution of practice in the general financial community.

4. A Valuation Model and Hypothesis Development

Have the changes in valuation methods in court affected valuation outcomes by judges, plaintiffs, and defendants? Did the introduction of forward-looking valuation methods into court affect valuation accuracy in shareholder litigation?

We motivate our statistical tests in the following sections with a simple valuation model in shareholder litigation. Suppose that JV is the judicial valuation outcome and that PV (DV) is the valuation estimate by the plaintiff (defendant), while FV is the unobservable fair value of the underlying firm. Valuation estimates by judges, plaintiffs, and defendants are considered to be noisy measures of the fair values of underlying firms. Further suppose that overall valuation errors consist of two components. The first component is a systematic valuation bias, denoted by β, and the other one is a random valuation error, denoted by ε. One expects a plaintiff (defendant) to argue for the highest (lowest) valuation estimate possible, because a plaintiff wants the highest valuation of his minority shares whereas the defendant will have to pay the plaintiff based on the judge's final valuation. Let β_{JV}, β_{PV}, and β_{DV} reflect, respectively, the judge's, the plaintiff's, and the defendant's systematic bias in a particular valuation estimate. Let ε_{JV}, ε_{PV}, and ε_{DV} reflect, respectively, the random valuation errors after controlling for the systematic valuation bias. Let FV denote the unbiased fair value of the shares (unobservable), and let JV, PV, and DV denote, respectively, the judge's, a plaintiff's, and a defendant's valuation estimate of FV. Specifically, we assume that

$$JV = FV \times \exp(\beta_{JV} + \varepsilon_{JV}) \tag{1}$$

$$PV = FV \times \exp(\beta_{PV} + \varepsilon_{PV}) \tag{2}$$

$$DV = FV \times \exp(\beta_{DV} + \varepsilon_{DV}) \tag{3}$$

We assume that judicial valuation outcome is not systematically biased from the fair value (that is, β_{JV} is zero). While this is an assumption, it is reasonable because there is no known reason for Delaware chancellors to favor a systematically high or low valuation; they derive career benefit from developing a reputation for being capable and unbiased. Thus, we assume that judges estimate *FV* with only random valuation errors.

Following Lee, Myers, and Swaminathan (1999), we apply the log transformation to prepare these equations for empirical work. We assume that the systematic valuation biases in the log-transformed equation have a normal distribution. In addition, we assume that the random valuation error in the log-transformed equation have a normal distribution with zero mean. We also assume that these errors are not mutually correlated. Thus, the system of equations becomes:

$$\log(JV) = \log(FV) + \varepsilon_{JV}, \quad \text{where } \varepsilon_{JV} \sim N(0, \delta^2_{\varepsilon JV}) \tag{4}$$

$$\log(PV) = \log(FV) + \beta_{PV} + \varepsilon_{PV}, \quad \text{where } \beta_{PV} \sim N(b_{PV}, \delta^2_{\beta PV}), \; \varepsilon_{PV} \sim N(0, \delta^2_{\varepsilon PV}) \tag{5}$$

$$\log(DV) = \log(FV) + \beta_{DV} + \varepsilon_{DV}, \quad \text{where } \beta_{DV} \sim N(b_{DV}, \delta^2_{\beta DV}), \; \varepsilon_{DV} \sim N(0, \delta^2_{\varepsilon DV}) \tag{6}$$

Following Kaplan and Ruback (1995), we estimate the size of "overall valuation errors" as the mean of the squared log of the ratio of the valuation estimates by judge (or plaintiff, or defendant) to the fair value.[10] Specifically, the overall valuation errors by judge, plaintiff, and defendant are inferred from the following equations:

$$E\left[\left(\log\left(\frac{JV}{FV}\right)\right)^2\right] = E\left[\varepsilon^2_{JV}\right] = \delta^2_{\varepsilon JV} \tag{7}$$

$$E\left[\left(\log\left(\frac{PV}{FV}\right)\right)^2\right] = E\left[\left(\beta_{PV} + \varepsilon_{PV}\right)^2\right] = b^2_{PV} + \delta^2_{\beta PV} + \delta^2_{\varepsilon PV} \tag{8}$$

$$E\left[\left(\log\left(\frac{DV}{FV}\right)\right)^2\right] = E\left[\left(\beta_{DV} + \varepsilon_{DV}\right)^2\right] = b^2_{DV} + \delta^2_{\beta DV} + \delta^2_{\varepsilon DV} \tag{9}$$

As indicated above, mean squared valuation errors consist of the squared average systematic valuation bias, the variances of the systematic valuation bias, and the variances of the random valuation errors. Thus, by examining the magnitudes of sum of these three components, we can determine whether the adoption of forward-looking valuation methods enhances valuation accuracy in court.

10. Kaplan and Ruback (1995) use the log ratio because it is symmetric with respect to overvaluation and undervaluation.

Because fair value is unobservable, we cannot calculate mean-squared valuation errors directly from eqs. (7) through (9). To address this problem, we take the differences of eqs. (4) through (6), which cancels out the unobservable fair values to yield

$$\log (PV/JV) = \beta_{PV} + \varepsilon_{PV} - \varepsilon_{JV} \tag{10}$$

$$\log (DV/JV) = \beta_{DV} + \varepsilon_{DV} - \varepsilon_{JV} \tag{11}$$

$$\log (PV/DV) = \beta_{PV} - \beta_{DV} + \varepsilon_{PV} - \varepsilon_{DV}. \tag{12}$$

From eqs. (10) through (12), we get

$$E\,[\log (PV/JV)] = b_{PV} \tag{13}$$

$$E\,[\log (DV/JV)] = b_{DV} \tag{14}$$

$$VAR\,[\log (PV/JV)] = \delta^2_{\beta PV} + \delta^2_{\varepsilon PV} + \delta^2_{\varepsilon JV} \tag{15}$$

$$VAR\,[\log (DV/JV)] = \delta^2_{\beta DV} + \delta^2_{\varepsilon DV} + \delta^2_{\varepsilon JV} \tag{16}$$

$$VAR\,[\log (PV/DV)] = \delta^2_{\beta PV} + \delta^2_{\varepsilon PV} + \delta^2_{\beta DV} + \delta^2_{\varepsilon DV} \tag{17}$$

Manipulating eqs. (7) through (9) and (13) through (17), we estimate the overall valuation errors by judge, plaintiff, and defendant based on the following observable measures:

$$E\left[\left(\log\left(\frac{JV}{FV}\right)\right)^2\right] = E\left[\varepsilon^2_{JV}\right] = \delta^2_{\varepsilon JV}$$

$$= \frac{\left[\,VAR\left[\log(PV/JV)\right] + VAR\left[\log(DV/JV)\right] - VAR\left[\log(PV/DV)\right]\right]}{2} \tag{18}$$

$$E\left[\left(\log\left(\frac{PV}{FV}\right)\right)^2\right] = E\left[\,(\beta_{PV} + \varepsilon_{PV})^2\right] = b^2_{PV} + \delta^2_{\beta PV} + \delta^2_{\varepsilon PV} = \left(E\left[\log(PV/JV)\right]\right)^2$$

$$+ \frac{\left[\,VAR\left[\log(PV/JV)\right] - VAR\left[\log(DV/JV)\right] + VAR\left[\log(PV/DV)\right]\right]}{2} \tag{19}$$

$$E\left[\left(\log\left(\frac{DV}{FV}\right)\right)^2\right] = E\left[\,(\beta_{DV} + \varepsilon_{DV})^2\right] = b^2_{DV} + \delta^2_{\beta DV} + \delta^2_{\varepsilon DV} = \left(E\left[\log(DV/JV)\right]\right)^2$$

$$+ \frac{\left[-VAR\left[\log(PV/JV)\right] + VAR\left[\log(DV/JV)\right] + VAR\left[\log(PV/DV)\right]\right]}{2} \tag{20}$$

Using eqs. (13) and (14), we test whether the introduction of forward-looking valuation methods into court allows plaintiffs (or defendants) to manipulate

the valuation estimates more. Our first null hypothesis, regarding the systematic valuation bias of plaintiff (or defendant), is as follows:

H_1: Adoption of forward-looking valuation methods doesn't affect the average systematic bias of plaintiffs' or defendants' valuation estimates.

Specifically, in Section 6, we test whether the sample mean of log (PV/JV) or log (DV/JV) is different across the cases under forward-looking valuation methods and the cases under historical valuation methods.

Next, using eqs. (18) through (20), we measure the estimated overall valuation errors of the valuation estimates by judge (or plaintiff, or defendant) relative to the fair values. By applying bootstrap analysis on these measures, we test whether the introduction of forward-looking valuation methods into court mitigates the overall valuation errors of each of judge's, plaintiff's, and defendant's valuation estimates, in an individual manner. Our second null hypothesis is as follows.

H_2: Adoption of forward-looking valuation methods doesn't affect the average sizes of judges', plaintiffs', or defendants' valuation errors.

As implemented by Liu, Nissim, and Thomas (2002), for example, bootstrap analysis constructs subsamples with the same number of observations as the full sample by randomly drawing (with replacement) observations with the same judicial or litigant valuation method as in the full sample. For each subsample thus constructed, we compute the valuation errors of judges, plaintiffs, and defendants separately using the subsample means and subsample variances on the basis of eqs. (18) through (20) across valuation method choices. This process is repeated one hundred times to obtain a distribution for differences of valuation errors across valuation method choices. Then, t-statistics (z-statistics of Wilcoxon rank score) for the differences of the valuation errors across valuation method choices are calculated.

If the forward-looking valuation methods allow judges, plaintiffs, and defendants to overcome the practical limitations of historical valuation methods in reflecting value-relevant information, we expect the valuation errors of judges and litigants to decrease. On the other hand, if litigants take advantage of forward-looking valuation methods to strategically manipulate their valuation estimates more, we expect the systematic bias component and the average valuation errors of plaintiffs' and of defendants' valuation estimates to rise. If the "perfect rationality" hypothesis applies to judges, however, there would be no effect of valuation method choice on valuation errors.

5. Descriptive Statistics: Delaware Appraisal Cases

The second half of this paper empirically tests our three hypotheses in a comprehensive hand-collected sample of all 1966–2002 Delaware "appraisal remedy" judicial opinions published in the Lexis-Nexis database. We identified

all Delaware appraisal cases published during 1966–2002 in the Lexis-Nexis database.[11] There are ten cases in the 1966–83 period and thirty-one cases in the 1984–2002 period. After identifying these cases, a law school graduate read all the cases and (with assistance from a research assistant who had been a practicing mergers and acquisition attorney before joining the master's of business administration program) hand coded all the data used to make Tables 1 through 5.

Table 1 presents some basic information about these Delaware cases, including the title, year, and type of entity (public or private); merger type and industry classification; valuation methods used by judge, plaintiff, defendant; and presiding judge's last name. In each of the cases, the judge's, plaintiff's, and defendant's valuation methods were initially identified as either DCF, the Block method, the liquidation value method, the comparables method, or a combination of DCF and the other methods. Then, we classify these valuation methods into two broader groups—DCF and a combination of DCF and other methods—as the method that is forward-looking in nature (denoted by FLM), and the remaining three methods as the method that contains historical accounting information only (denoted by HM). In subsequent analyses, we delete a few cases from the initial sample, because the key information in those cases was not well specified. The final sample results in thirty-five firms between 1968 and 2002.

Table 2 describes the frequencies of the valuation method choices made by judges, plaintiffs, and defendants before and since 1984. Looking at Table 2, we find that judges use forward-looking methods for 63 percent of twenty-seven cases that occurred since 1984. This increasing popularity of forward-looking methods also can be observed in the valuation method choices of both plaintiffs (70 percent since 1984) and defendants (59 percent since 1984). In addition, plaintiffs and defendants choose different valuation methods in nine of thirty-five cases.[12] Table 2 indicates that in six cases judges follow the plaintiffs' methods, and for another three cases judges choose the defendants' methods.

Because judges did not utilize forward-looking methods at all before 1984, we plot judicial choice of valuation methods in Delaware courts since 1984. Figure 3 presents cumulative plots of both forward-looking methods and historical methods used by Delaware judges. The plots also indicate that forward-looking methods have been used more often as the years progress. However, historical methods have not disappeared from the landscape.

Table 3, Panel A, presents the descriptive statistics of the log differences between the judicial and plaintiffs' (defendants') valuation outcomes, and between the opposing parties' valuation estimates. Note that in the coding process, we already omitted minority discounts or control premiums. The mean (median) of log (*PV*/*JV*) is 0.72 (0.51), indicating that the plaintiffs' valuation

11. The first Delaware case in our sample starts at 1968 because we found no cases in 1966 and 1967.

12. When both plaintiffs and defendants choose the same valuation methods, judges follow litigants' choices in twenty-five of twenty-six cases.

TABLE 1

Delaware Appraisal Cases Published in the Lexis-Nexis Database, 1966–2002

Title	Year	Public/ Private	Merger Type	Industry Classification	Plaintiff's Method	Defendant's Method	Judge's Method	Presiding Judge
In re Olivetti Underwood Corporation	1968	public	cash out	Office Equipment	HM	HM	HM	Duffy
Poole v. N.V. Deli Maatschappij	1968	public	cash out	Tobacco	HM	HM	HM	Short
E.F. Gibbons v. Schenley Industries, Inc.	1975	public	cash out	Whiskey Producer	HM	HM	HM	Marvel
Francis I DuPont & Co. v. Universal City Studios, Inc.	1975	public	cash out	Entertainment	HM	HM	HM	Quillen
*In re Creole Petroleum Corp.**	1978	public	cash out	Oil	HM	HM	HM	Hartnett
*Lynch v. Vickers Energy Corporation**	1979	private	cash out	Oil	HM	HM	HM	Marvel
Tannetics Inc. v. AJ Industries, Inc.	1979	private	cash out	Mental Manufacturer	HM	HM	HM	Marvel
Edith K. Bell v. Kirby Lumber Corporation	1980	public	cash out	Wood Products Manufacturer	HM	HM	HM	Brown
Lebman v. National Union Electric Corporation	1980	public	cash out	Electronics Manufacturer	HM	HM	HM	Marvel
Steinhart v. Southwest Realty & Development Co.	1982	public	stock merger	Real Estate	HM	HM	HM	Hartnett
Eliot Charlip, et. al. v. Lear Siegler, Inc.	1984	public	cash out	Computing Service	FLM	HM	FLM	Brown
Robbins & Co. v. A. C. Israel Enterprises	1985	private	cash out	Holding Company	HM	HM	HM	Berger
Weinberger v. UOP	1985	public	cash out	Diversified, Oil	FLM	HM	HM	Brown
Wacht v. Continental Hosts Ltd.	1986	public	cash out	Catering	FLM	FLM	FLM	Chandler
Campbell v. Caravel Academy, Inc.	1988	private	cash out	Private School	HM	HM	HM	Hartnett
Cavalier Oil (Part II)	1988	private	cash out	Real Estate	FLM	FLM	FLM	Jacobs
Cavalier Oil Corp. v. Harnett	1988	private	cash out	Real Estate	FLM	FLM	FLM	Jacobs
Pinson v. Campbell-Taggart, Inc.	1989	private	cash out	Bakery	HM	FLM	HM	Jacobs
In re Shell Oil Co.	1990	public	cash out	Oil	HM	FLM	FLM	Hartnett
Neal v. Alabama By-Products Corp.	1990	public	cash out	Mining & Forestry	FLM	FLM	FLM	Chandler
In re Radiology Assoc., Inc.	1991	private	cash out	Service	FLM	HM	FLM	Chandler

Kahn v. Household Acquisition Corp.	1991	public	cash out	Airline	HM	HM	HM	Berger
Harris v. Rapid-American Corp.	1992	public	cash out	Retail	HM	HM	HM	Chandler
Hodas v. Spectrum Technology, Inc.	1992	private	cash out	Service	FLM	HM	HM	Berger
Salomon Bros., Inc. v. Interstate Bakeries Corp.	1992	public	cash out	Bakery	FLM	FLM	FLM	Berger
Cooper v. Pabst Brewing Co.	1993	public	cash out	Brewery	FLM	HM	FLM	Hartnett
TV58 Ltd. Partnership v. Weigel Broadcasting Co.	1993	private	cash out	Media	FLM	HM	FLM	Chandler
*In re Vision Hardware Group**	1995	private	dissolution	Retail Hardware	FLM	FLM	FLM	Allen
Kleinwort Benson Ltd. v. Silgan Corp.	1995	public	cash out	Manufacturer	FLM	FLM	FLM	Chandler
Ryan v. Tad's Enters.	1996	public	cash out	Diversified, Restaurant	FLM	FLM	FLM	Jacobs
Grimes v. Vitalink Communs. Corp.	1997	public	cash out	Telecom	FLM	FLM	FLM	Chandler
Le Beau v. M. G. Bancorporation	1998	private	cash out	Bank	FLM	FLM	HM	Jacobs
Borruso v. Communications Telesystems Int'l	1999	private	cash out	Telecommunications	HM	HM	HM	Lamb
*Boyer v. Wilmington Materials, Inc.**	1999	private	dissolution	Construction	HM	HM	HM	Lamb
M.P.M. Enterprises v. Gilbert	1999	private	cash out	Manufacturer	FLM	FLM	FLM	Steele
*Odyssey Partners L.P. v. Fleming Cos.**	1999	private	dissolution	Grocery Chain	Unspecified	HM	HM	Lamb
ONTI Inc. v. Integra Bank	1999	private	cash out	Service	FLM	FLM	FLM	Chandler
*Cole v. Kershaw**	2000	private	buy out	Real Estate	FLM	HM	HM	Jacobs
Hintmann v. Fred Weber, Inc.	2000	private	cash out	Construction	FLM	FLM	FLM	Steele
Agranoff v. Miller	2001	private	shareholder dispute	Courier	HM	FLM	HM	Strine
Gray v. Cytokine Pharmasciences, Inc.	2002	private	stock merger	Pharmaceutical	FLM	FLM	FLM	Lamb

*We drop these six cases from the subsequent main analyses because of following reasons: in one case, judge's, plaintiff's, and defendant's valuations were contaminated with extra damages; in two other cases, the plaintiffs' merger valuations were unspecified; and in the remaining three cases, the valuation outcomes by plaintiffs, or defendants, or judges were zero.

Note: This table lists all forty-one Delaware appraisal cases during 1966–2002 that are published in the Lexis-Nexis database. We classify valuation methods used by plaintiffs, defendants, and judges into two ways: (1) the valuation methods that involve forecasting (denoted by FLM), and (2) the valuation methods that involve no forecasting (denoted by HM).

TABLE 2

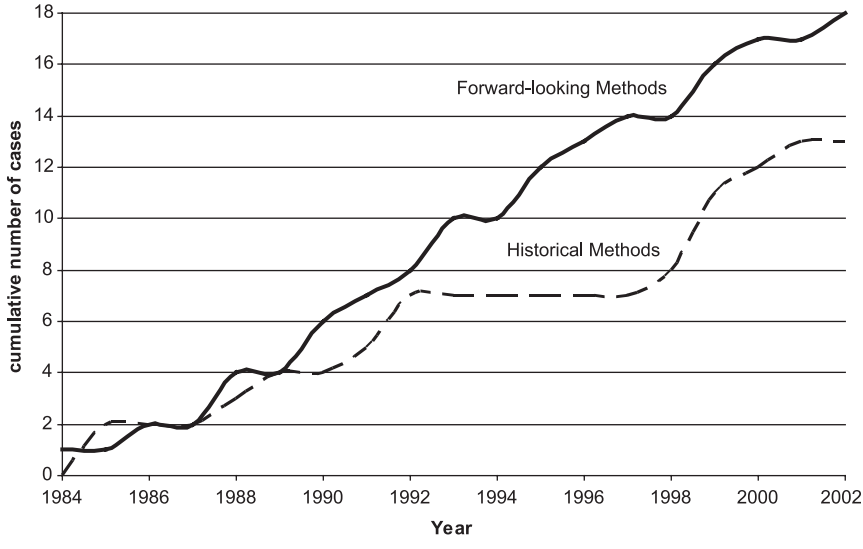
Frequencies of the Valuation Method Choices

Classification	1966–1983			1984–2002		
	Judge's Method = FLM	Judge's Method = HM	Subtotal	Judge's Method = FLM	Judge's Method = HM	Subtotal
Plaintiff's Method & Defendant's Method = HM	0	8	8	0	5	5
Plaintiff's Method = FLM & Defendant's Method = HM	0	0	0	4	2	6
Plaintiff's Method = HM & Defendant's Method = FLM	0	0	0	1	2	3
Plaintiff's Method & Defendant's Method = FLM	0	0	0	12	1	13
Subtotal	0	8	8	17	10	27

Note: This table presents the frequencies of the valuation method choices by plaintiffs, defendants, and judges from thirty-five Delaware appraisal cases occurring during 1966–2002. We drop six cases from the subsequent main analyses for the reasons listed in the asterisked note to Table 1. We classify valuation methods used by plaintiffs, defendants, and judges into two ways: (1) the valuation methods that involve forecasting (denoted by FLM), and (2) the valuation methods that involve no forecasting (denoted by HM).

FIGURE 3

Rise of Forward-Looking Valuation Methods, Delaware Courts



Note: This figure presents the cumulative plots of forward-looking valuation methods and historical methods adopted by Delaware judges for appraisal cases between 1984 and 2002.

TABLE 3

Descriptive Statistics of the Valuation Outcomes by Judges, Plaintiffs, and Defendants

Panel A: Distribution of the valuation outcomes

Variables	Mean	Median	Standard Deviation	1%	5%	10%	25%	50%	75%	90%	95%	99%
Log (*PV*/*JV*)	0.72	0.51	0.68	0.00	0.00	0.15	0.24	0.51	0.92	1.90	2.44	2.93
Log (*DV*/*JV*)	−0.84	−0.64	0.96	−3.77	−3.46	−1.83	−0.99	−0.64	−0.20	0.00	0.03	0.07
Log (*PV*/*DV*)	1.57	1.11	1.31	0.31	0.37	0.44	0.80	1.11	1.98	3.46	3.99	6.70

Panel B: Tests of the differences of the valuation outcomes

	Log (*PV*/*JV*)	Log (*DV*/*JV*)	Log (*PV*/*DV*)
t-statistics of Mean Differences From Zero	6.29***	−5.19***	7.08***
z-statistics of Wilcoxon Rank Score Differences From Zero	7.07***	−6.27***	7.68***

*** indicates the significance level at the 1 percent level or better.

Note: Panel A presents the distributions of logarithmic ratios among plaintiffs', defendants', and judicial valuation outcomes. Panel B presents both the *t*-test results and the Wilcoxon rank score test results for the differences of log (*PV*/*JV*), log (*DV*/*JV*) and log (*PV*/*DV*) from zero. The *z*-statistics of the Wilcoxon rank scores differences are derived from the nonparametric test as described in footnote 13.

estimates are positively biased on average relative to the judicial valuation outcomes. On the other hand, the mean (median) of log (*DV*/*JV*) is −0.84 (−0.64), which suggests that the defendants' valuation estimates are negatively biased on average relative to the judicial valuation outcomes. The mean (median) of log (*PV*/*DV*) is 1.57 (1.11), confirming that plaintiffs are more aggressive on average than defendants in valuation.

Table 3, Panel B, presents the results of the tests of whether the positive (negative) average bias of the plaintiff's (defendant's) valuation outcomes is statistically significant. Following Beatty, Riffe, and Thompson (1999), who analyzed a small sample from tax court with skewed distributions, we examine the *z*-statistics of the Wilcoxon rank score differences[13] as well as the conventional *t*-statistics of the mean differences. Both statistics confirm that plaintiffs' valuations are significantly higher than the judicial valuation outcomes, while defendants' valuations are statistically lower than the judicial valuation outcomes. In other words, β_{PV} in eq. (2) is significantly positive, on average, while β_{DV} in eq. (3) is significantly negative on average.

In summary, the descriptive statistics indicate that the plaintiffs' (defendants') valuation estimates are systematically biased upward (downward) than the judicial valuation outcomes. This result is consistent with the prior literature reporting the systematic valuation bias of the plaintiffs or defendants due to their incentives (as in Beatty, Riffe, & Thompson [1999]).

6. Rise of DCF and Valuation Accuracy

In this section, we examine whether the shift toward forward-looking methods enhances the accuracy of judicial, plaintiffs', and defendants' valuation outcomes. We test the two empirical hypotheses developed in Section 4.

Table 4 presents the results for the Hypothesis 1. Specifically, in Panel A, we classify the sample into two groups: (1) plaintiffs who apply forward-looking valuation methods, and (2) plaintiffs who use historical methods. The mean of log (*PV*/*JV*) is 0.72 when plaintiffs employ forward-looking methods in their valuation, while it is 0.73 when they use historical methods. The *t*-statistic for the mean difference (the *z*-statistic of Wilcoxon rank score difference) between such two subsamples is 0.06 (−0.38), which is statistically insignificant. Likewise, the mean of log (*DV*/*JV*) in Panel B is −0.61 for the group of defendants with forward-looking methods, while it is −1.04 for the other group of defendants with historical methods. The *t*-statistic for the mean difference (the *z*-statistic of Wilcoxon rank score difference) between the two subsamples, standing at −1.41 (−0.48), is statistically insignificant. The above results indicate that the adoption

13. The nonparametric Wilcoxon test applies to small-sample studies whether the underlying distributions are normal or not (Wackerly, Mendenall, & Scheaffer [2001]). Furthermore, we use the rank scores of the valuation outcomes as the inputs for the Wilcoxon test. Thus, our *z*-statistics are robust to the effects of both outliers and possible deviations from normality.

TABLE 4

The Rise of DCF and Changes in the Systematic Valuation Bias

Panel A: Differences of systematic valuation bias by plaintiffs across valuation methods

Log (*PV*/*JV*)	Plaintiff's Method = HM	Plaintiff's Method = FLM	*t*-statistics of Mean Differences	*z*-statistics of Wilcoxon Rank Score Differences
Mean	0.73	0.72	0.06	−0.38
Sample Size	16	19	–	–

Panel B: Differences of systematic valuation bias by defendants across valuation methods

Log (*DV*/*JV*)	Defendant's Method = HM	Defendant's Method = FLM	*t*-statistics of Mean Differences	*z*-statistics of Wilcoxon Rank Score Differences
Mean	−1.04	−0.61	−1.41	−0.48
Sample Size	19	16	–	–

Note: Panel A (B) presents the differences of mean of the logarithmic ratio of valuations by plaintiffs (defendants) to the judicial valuation outcomes for two groups: (1) plaintiffs (defendants) using forward-looking methods (denoted by FLM), and (2) plaintiffs (defendants) using historical methods (denoted by HM). The *z*-statistics of the Wilcoxon rank score differences are derived from the nonparametric test as described in footnote 13.

of forward-looking methods does not increase the systematic biases of plaintiffs' and defendants' valuation estimates, which is contradictory to the "manipulation" hypothesis. Thus, we cannot reject Hypothesis 1.[14]

To test Hypothesis 2, we compare the overall valuation errors between two subsamples with historical methods and with forward-looking methods separately for judges, plaintiffs, and defendants. For the statistical tests on the differences of the overall valuation errors between two subsamples, we run bootstrap analyses as described in Section 4.

Table 5 presents the averages of overall valuation errors from one hundred trials under bootstrap analyses when judges, plaintiffs and defendants choose historical and forward-looking methods. When judges use historical methods, the mean of overall valuation errors is 0.101; when judges choose forward-looking methods, the mean of overall errors is slightly lower, at 0.087. The overall valuation errors by judges are not statistically different across the two subsamples. Although this particular result is more consistent with the "perfect rationality" hypothesis, we find strongly significant effects of valuation method choice on the accuracy of plaintiffs' and defendants' estimates, as follows. The overall valuation errors by both plaintiffs and defendants have decreased with the

14. Because plaintiffs' (defendants') valuation estimates are positively (negatively) biased from the judicial valuation outcomes for most individual cases (i.e., individual β_{PV} [β_{DV}] is consistently positive [negative]), the comparison of mean of log ratios and the comparison of mean of squared log ratios are equivalent to each other. The *t*-tests of mean differences of squared log ratios show similar results as the *t*-tests of mean differences of log ratios.

TABLE 5

The Rise of DCF and Changes in Overall Valuation Accuracy

	Valuation Method=HM	Valuation Method=FLM	*t*-statistics of Mean Differences	*z*-statistics of Wilcoxon Rank Score Differences
Overall Valuation Errors of Judicial Valuation Outcomes	0.101	0.087	1.53	1.28
Overall Valuation Errors of Plaintiff's Valuation Outcomes	1.671	0.872	7.47***	5.41***
Overall Valuation Errors of Defendant's Valuation Outcomes	2.940	0.600	17.52***	11.58***

*** indicates the significance level at the 1 percent level or better.

Note: This table presents the average of overall valuation errors of judicial (plaintiff's or defendant's) valuation outcomes from one hundred trials under bootstrap analyses for two groups: (1) judges (plaintiffs or defendants) using forward-looking methods (denoted by FLM), and (2) judges (plaintiffs or defendants) using historical methods (denoted by HM). In this table, the *t*-statistic of mean differences and *z*-statistics of the Wilcoxon rank score differences are computed from bootstrapping. When applying bootstrap analysis, we delete the observations with negative overall valuation errors.

introduction of forward-looking methods. Take plaintiffs as an example. The mean of overall valuation errors by plaintiffs is 1.671 when plaintiffs use historical methods, while it is 0.872 when plaintiffs choose forward-looking methods. The *t*-statistic for the mean difference (the *z*-statistic of Wilcoxon rank score difference) between the two subsamples, standing at 7.47 (5.41), is statistically significant at 1 percent. Defendants experience similar improvement in valuation accuracy across two valuation methods. Thus, while our result pertaining to judges' valuation outcomes fails to reject Hypothesis 2, the results related to litigants strongly reject Hypothesis 2.

To ensure the robustness of our results, we run a battery of sensitivity analyses. First, we use the raw ratios of valuation estimates instead of their logarithmic values for the statistical tests. Second, we restrict samples to the post-1984 cases to control for the general improvement of valuation technique beyond the forward-looking versus historical methods. The sensitivity analyses render qualitatively similar results as reported.

In summary, utilizing all published Delaware shareholder litigation cases during 1966–2002, we report that the shift toward more forward-looking valuation methods on average does not make plaintiffs and defendants more manipulative of valuations in a systematic way. On the contrary, the adoption of forward-looking valuation methods mitigates the overall errors of plaintiffs' and defendants' valuation estimates. Taken as a whole, these results indicate that the

adoption of forward-looking valuation methods has enhanced valuation accuracy in shareholder litigation.

7. Limitations of our Exploratory Study

This section first summarizes our results. It then discusses the limitations of our study (mainly stemming from the small sample issue) and suggests how future research might try to correct these limitations.

Before 1984, American courts relied heavily on the Delaware Block method. By searching judicial documents in Lexis-Nexis, we show that—

- Forecasting-based methods (mainly DCF in its different guises) have been displacing the Block method in the U.S. and Australian-Canadian-UK courts since 1984.
- While judges, plaintiffs, and defendants in Delaware courts did not utilize forward-looking methods at all before 1984, they have adopted forward-looking methods significantly since 1984.

Has the shift of methods affected valuation accuracy in court? The second half of our paper uses a hand-collected comprehensive sample of all published 1966–2002 Delaware "appraisal remedy" cases published in Lexis-Nexis. Based on statistical analysis, we find that—

- Contrary to the "manipulation hypothesis," the adoption of forward-looking valuation methods does *not* increase the systematic valuation bias by plaintiffs and defendants.
- Consistent with the "informativeness hypothesis," the adoption of forward-looking valuation methods *does* reduce the size of plaintiffs' and defendants' valuation errors.
- Consistent with the "perfect rationality" hypothesis, the adoption of forward-looking valuation methods *does not* significantly affect the size of judicial valuation errors. This suggests that judges adjust out any systematic bias imposed by valuation methodology.

If one takes these results at face value (see caveats below), one must conclude that valuation methods matter but only to a limited extent. The adoption of forward-looking methods in the Delaware courts has improved the valuation estimates proposed by the litigants without introducing the additional systematic bias that might arise if the parties systematically manipulated forecast information to their own advantage.

We view our results as being exploratory or documentary rather than conclusive. Our sample is comprehensive in that it consists of all judicial opinions arising out of Delaware corporate "appraisal remedy" cases published between 1966 and 2002 in Lexis-Nexis. Hence, it documents comprehensively the use and impact of valuation methods in Delaware appraisal litigation between 1966 and

2002. However, the sample size is small in number (and endogenously selected), which means one must refrain from using it to draw broad inferences about the use and impact of valuation methodology outside of Delaware appraisal litigation. Our sample size is small despite Delaware being, arguably, the most important jurisdiction for corporate law litigation in the United States because many potential litigation cases are settled out of court and judges do not publish their opinions in every court case.[15] One way future researchers may mitigate the sample size problem is to hand collect all appraisal opinions in all U.S. federal and state courts (not just Delaware courts). To the best of our knowledge, at present, such a data set is not readily available even though the raw data (the published judicial opinions) are publicly available in searchable electronic databases such as Lexis-Nexis. Additionally, it would be interesting to extend the scope of investigation beyond shareholder litigation to include bankruptcy procedures, tax and other regulatory enforcement actions, and other settings involving court appraisal. It would be interesting to look at valuation methods used in cases that settle out of court, if one can obtain relevant data.

An issue that potentially plagues all such studies (including this one) is the endogeneity problem arising from the fact that we observe ex post valuation accuracy rather than ex ante valuation accuracy.[16] Ex ante valuation accuracy is what a judge or litigant believes is the prospective accuracy of a particular valuation method applied to a particular firm in a particular information environment. In contrast, ex post valuation accuracy is what is the observed accuracy conditional on the fact a particular valuation method was chosen. Ex post valuation accuracy differs from ex ante valuation accuracy because the former suffers from the fact that a judge or litigant would only choose a method after taking into account the accuracy of that method in that particular situation. Hence, ex post valuation accuracy does not reflect the valuation accuracy of methods that were not chosen. If parties seek to maximize valuation accuracy, then a method's ex post accuracy would be smaller than its ex ante accuracy.

In a large-sample study, one can try to control for the endogeneity problem and, hence, have a measure of ex ante valuation accuracy. One possible control is to conduct a matched-pair comparison by matching valuation method pairs applied to firms that are matched to valuation-relevant characteristics such as industry membership and size. Because our sample is too small to implement such a control, our proxy for accuracy reflects only ex post accuracy and our results must be interpreted with this in mind.

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15. A Delaware trial judge has discretion whether to publish an opinion or not. Such a judge generally chooses to publish only those opinions that she considers to be of significance or public interest. It is probably safe to say that opinions arising out of all "important" and hotly contested cases are published. Private communications with Lexis-Nexis as well as attorneys with direct Delaware experience suggest that a substantial fraction, if not majority, of Delaware opinions may *not* be published. Since unpublished opinions are seldom cited or read by other judges or lawyers, however, they are selectively unimportant by definition.

16. We thank an anonymous referee for emphasizing this issue to us.

This exploratory study opens new avenues for studying how valuation methods matter in institutional settings. Although the small sample evidence examined here suggests that valuation methods change over time and do matter to a limited extent, it also raises the following question: When, why, and how much do valuation methods matter? We pose this question for future research.

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