THE CLASS CERTIFICATION OF EXCHANGE-LISTED OPTIONS IN SECURITIES CLASS-ACTION LITIGATION

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ABSTRACT

Class-action litigation for fraud on the market typically focuses on purchasers and sellers of stock. Yet those that bought and sold options on the shares can likewise be harmed. Drawing from experience in *In re Apple, Inc. Securities Litigation* (N.D. Cal. 2022), the authors describe the issues related to including options traders in a certified class. This article explains how to overcome the obstacles to certifying an investor class that includes buyers and sellers of options

I. INTRODUCTION

In 1989, in the seminal case *Basic v. Levinson*,[1] the U.S. Supreme Court endorsed the "fraud-on-the-market" doctrine, which establishes a presumption of reliance by public purchasers and sellers of securities on market prices for purposes of Section 10(b) of the Securities Exchange Act of 1934 (the "Exchange Act") and Rule 10b-5 thereunder.[2] The same year *Basic* was decided, the Supreme Court denied certiorari in *Deutschman v. Beneficial Corporation*,[3] a Third Circuit case holding that purchasers and writers of options have a private right of action under Rule 10b-5 for false or misleading statements that affect the price of the option's reference stock. Together, these cases opened the door for options traders to seek class-wide relief alongside purchasers and sellers of stock for prices tainted

1. Basic Inc. v. Levinson, 485 U.S. 224, 246 (1988).
2. 15 U.S.C. § 78k(b); 17 C.F.R. § 240.10b-5.
3. Deutschman v. Beneficial Corp., 841 F.2d 502 (3d Cir. 1988), *cert. denied*, 490 U.S. 1114 (1989).

by materially false or misleading statements.[4] In the ensuing years, however, courts have not always consistently applied the logic of *Basic* and *Deutschman* in deciding the scope of investor class certification with respect to including buyers and sellers of options.[5]

In part, this may reflect longstanding judicial uncertainty as to how to gauge the informational efficiency of securities markets for purposes of invoking the fraud-on-the-market doctrine. For nearly four decades, federal district and circuit courts have grappled with the evidentiary conundrum of "proving" market efficiency at the class certification stage.[6] Concerns over the prevalence of strike suits, moreover, led both Congress and the courts to impose additional—and perhaps redundant—procedural burdens on class actions,[7] especially in the specific context of securities litigation.[8] These considerations have occasionally led courts to question whether to include options traders in securities class actions, particularly to the extent that the methodologies courts commonly employ to gauge market efficiency and calculate damages do not map neatly to options markets.[9]

The Supreme Court's 2014 decision in *Halliburton Co. v. Erica P. John Fund, Inc.* nevertheless reaffirmed the fraud-on-the-market doctrine and clarified that plaintiff's burden at class certification should train on whether new information affects market prices.[10] District courts have duly

4. *See, e.g.*, Fry v. UAL Corp., 84 F.3d 936, 938 (7th Cir. 1996) ("Option traders play an important role in maintaining the efficiency of the securities markets, . . . so they have a claim to protection against being defrauded."); Donald C. Langevoort, *Insider Trading and the Fiduciary Principle: A Post* Chiarella *Restatement*, 70 CALIF. L. REV. 1, 42 (1982) (finding no reason to distinguish between option traders and shareholders for purposes of disclosure).

5. *See infra* Part III.A (discussing courts' willingness to take judicial notice of options market efficiency at class certification); *see also infra* Part V (discussing additional considerations regarding certification of a class including options traders).

6. *See, e.g.*, Donald C. Langevoort, Basic *at Twenty: Rethinking Fraud on the Market*, 2009 WIS. L. REV. 151; *Basic Inc.*, 485 U.S. at 263 (White, J., concurring in part and dissenting in part) (expressing skepticism about conditioning a legal presumption on economic theory).

7. *See, e.g.*, Comcast Corp. v. Behrend, 569 U.S. 27, 34 (2013) (common damages methodology); Byrd v. Aaron's Inc., 784 F.3d 154, 166 (3d Cir. 2015) (administrative feasibility); Class Action Fairness Act of 2005, Pub. L. No. 109-2, 119 Stat. 4-14 (2005).

8. Private Securities Litigation Reform Act of 1995, Pub. L. No. 104-67, 109 Stat. 737 (codified in part at 78 U.S.C. § 78u-4); Margaret V. Sachs, *Superstar Judges as Entrepreneurs: The Untold Story of Fraud-on-the-Market*, 48 U.C. DAVIS L. REV. 1207, 1213 (2015) (describing the roles of Judges Posner and Easterbrook in shaping Rule 23 class certification jurisprudence).

9. *See infra* Part III.B (discussing the *Crammer-Krogman* factors) and Part IV (discussing the requirement of a common damages methodology).

10. Halliburton Co. v. Erica P. John Fund, Inc., 573 U.S. 258 (2014). In a prior grant of certiorari in the same case, the Court held that plaintiffs were not required to "show loss

refocused class certification decisions on proof of the relationship between new information and stock prices generally, rather than exacting proof of fundamental price efficiency, loss causation, or specific evidence of price impact.[11] To the extent that generally accepted option pricing models accurately describe the relationship between stock prices and observed option prices, the transitive impact of new information on option prices should embolden courts to include options traders among the plaintiffs entitled to relief and to quantify their damages.

This article sets forth an approach, based on the recent experience of two of the co-authors as expert witnesses, for invoking the presumption of reliance in fraud-on-the-market cases for options traders and performing the common damages calculation on their behalf. In *In re Apple, Inc. Securities Litigation*, plaintiff alleged that the price of Apple shares was inflated by misleading statements released by Apple CEO Tim Cook in early November 2018.[12] The plaintiff sought class certification not only for purchasers of Apple stock, but also for options traders who bought Apple call options or sold Apple put options during the class period.

In June 2024, the district court approved a preliminary settlement, under the terms of which the defendants would pay $490 million into a common settlement fund.[13] Under the proposed settlement plan, purchasers

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causation as a condition of obtaining class certification." Erica P. John Fund, Inc. v. Halliburton Co., 563 U.S. 804, 813 (2011).

11. *See, e.g.*, Waggoner v. Barclays PLC, 875 F.3d 79, 97 (2d Cir. 2017) (noting that "the burden required to establish market efficiency 'is not an onerous one'" (quoting *In re* Petrobras Sec. Litig., 862 F.3d 250, 278 (2d Cir. 2017))); Angley v. UTi Worldwide Inc., 311 F. Supp. 3d 1117, 1127 (C.D. Cal. 2018); Carpenters Pension Tr. Fund of St. Louis v. Barclays PLC, 310 F.R.D. 69, 94 (S.D.N.Y. 2015); *In re* Groupon, Inc. Sec. Litig., No. 12 C 2450, 2015 WL 1043321, at *11 (N.D. Ill. Mar. 5, 2015).

12. In this case, plaintiffs filed a class action against Apple, Inc. ("Apple") for a statement made by CEO Tim Cook in November 2018, which the market allegedly understood to mean that China was not among the countries in which Apple was facing local demand problems. Plaintiffs engaged the services of co-author Dr. Steven Feinstein of Babson College and Crowninshield Financial Research, who submitted a report addressing the efficiency of the Apple stock and options. In February 2022, the court certified a class comprising purchasers of Apple shares from November 2, 2018 through January 2, 2019, but requested further evidence on plaintiffs' petition to certify a class comprising option investors. *See In re* Apple, Inc. Sec. Litig., No. 19-cv-2033, 2022 WL 354785 (N.D. Cal. Feb. 4, 2022) (class certification order). Plaintiffs then engaged co-author Dr. Don Chance, an options expert, to provide evidence on the efficiency of options markets. Based on the expert testimony of Drs. Chance and Feinstein, the court modified its class certification order in March 2023 to include purchasers of call options and writers of put options during the same period. *See In re* Apple, Inc. Sec. Litig., No. 19-cv-2033, 2023 WL 2763952 (N.D. Cal. Mar. 28, 2023) (order modifying class). Professor Dombalagian is not involved in the Apple litigation.

13. *In re* Apple, Inc. Sec. Litig., No. 19-cv-2033, 2024 WL 3297079, at *27 (N.D. Cal.

of Apple call options and sellers of Apple put options would participate in the net settlement fund alongside purchasers of Apple stock based on the amount of their respective "[r]ecognized loss amount" as calculated pursuant to a stipulated formula.[14]

This article discusses the legal and evidentiary issues the co-authors were asked to address in *Apple* and how they successfully persuaded the district court to certify a class comprising options traders along with stock investors. The article proceeds as follows. Part II fleshes out the legal and practical issues options traders face in establishing market efficiency and calculating class-wide damages under Rule 10b-5 and the Federal Rules of Civil Procedure. Part III then discusses how experts should relate the traditional factors used to assess the informational efficiency of the market for an individual stock to the informational efficiency of its option chain. Part IV describes a common methodology for calculating damages suffered by options traders using generally accepted option pricing models. Part V discusses extensions and other issues that have arisen in class action litigation involving options trading. Part VI offers concluding thoughts. For readers unfamiliar with the mechanics of options, an Appendix follows.

II. LEGAL BACKGROUND AND ISSUES

In 2022, there were 201 class action securities lawsuits filed against publicly traded corporations in the United States, up slightly from the average of 192 per year since 1997.[15] Most of these cases were filed in U.S. federal district court pursuant to Section 10(b) of the Exchange Act and Rule 10b-5 promulgated thereunder. Rule 10b-5 makes it unlawful for any person to use U.S. jurisdictional means, inter alia, to make a materially false or misleading statement, with scienter, in connection with the purchase or sale of a security.[16] In a private right of action for damages under Rule 10b-5, plaintiffs must further show that they purchased or sold the security in reliance upon the false or misleading statement, and that the statement caused economic loss.[17]

Prior to the Third Circuit's seminal decision in *Deutschman*, several

June 3, 2024) (granting preliminary approval of settlement and setting deadlines for notice, objection, exclusion, and final fairness hearing).

14. *Apple*, 2024 WL 3297079, at *35–37.

15. CORNERSTONE RSCH., SECURITIES CLASS ACTION FILINGS: 2022 YEAR IN REVIEW 1 (2023), https://www.cornerstone.com/wp-content/uploads/2023/05/Securities-Class-Action-Filings-2022-Year-in-Review.pdf [https://perma.cc/49Y3-SPR6].

16. 17 C.F.R. § 240.10b-5.

17. Halliburton Co. v. Erica P. John Fund, Inc., 573 U.S. 258, 267 (2014).

courts questioned whether options traders had standing to bring an action under Rule 10b-5 absent a fiduciary relationship with the issuer.[18] In *Deutschman*, the Third Circuit held that plaintiffs in a Rule 10b-5 action predicated on false or misleading statements affecting public markets are not required to demonstrate the existence of a fiduciary relationship between the defendants and the victims of the fraud.[19] As long as corporate pronouncements are "disseminated to the public in a medium upon which a reasonable investor would rely," plaintiffs do not have to show that the statement was directed at or intended to influence a specific investor.[20] *Deutschman* further clarified that purchasers and sellers of options were no less entitled to relief under federal securities law consistent with the "policy considerations" in *Blue Chip Stamps*.[21] Subsequent cases have affirmed that short sellers,[22] purchasers of corporate debt, and parties to other derivative contracts likewise have standing to sue.[23]

Deutschman also affirmed that options traders may participate in securities class actions.[24] Because the harm suffered by individual investors

18. *See, e.g.*, Laventhall v. Gen. Dynamics Corp., 704 F.2d 407 (8th Cir.), *cert. denied,* 464 U.S. 846 (1983); Bianco v. Tex. Instruments, 627 F. Supp. 154 (N.D. Ill. 1985). Other pre-*Deutschman* cases recognized a cause of action for options traders, including *In re* Digit. Equip. Corp. Sec. Litig., 601 F. Supp. 311 (D. Mass. 1984); Lloyd v. Indus. Bio-Test Laboratories, 454 F. Supp. 807 (S.D.N.Y. 1978); *see generally* Daniel T. White, *Options Traders, Rule 10b-5, and Standing: Making Sense of It All*, 67 N.C. L. REV. 1123, 1134–37 (1989) (summarizing pre-*Deutschman* options cases).

19. Deutschman v. Beneficial Corp., 841 F.2d 502, 506 (3d Cir. 1988).

20. Semerenko v. Cendant Corp., 223 F.3d 165, 176 (3d Cir. 2000); *see also In re* Carter-Wallace Sec. Litig., 150 F.3d 153 (2d Cir. 1998). Options traders may not have standing in cases involving nondisclosure in breach of a relationship of trust and confidence, such as insider trading cases under Rule 10b5-1. *See, e.g.*, Peter J. Henning, *Between* Chiarella *and Congress: A Guide to the Private Cause of Action for Insider Trading under the Federal Securities Laws*, 39 U. KAN. L. REV. 1, 37–38 (1990). Even here, however, contemporaneous options traders have a statutory right of action at least as against insiders who trade options. *See* 15 U.S.C. §§ 78t(d) (liability rule for insider trading in options), 78t-1 (liability of contemporaneous traders).

21. *See Deutschman*, 841 F.2d at 507 (citing Blue Chip Stamps v. Manor Drug Stores, 421 U.S. 723 (1975)); *see also* Fry v. UAL Corp., 895 F. Supp. 1018, 1035 (N.D. Ill. 1995), *aff'd*, 84 F.3d 936 (7th Cir. 1996) ("Our recognition of the useful functions of options and the options market bolsters our conclusion that option traders are entitled to standing to assert a Rule 10b-5 claim.").

22. Zlotnick v. TIE Commc'ns, 836 F.2d 818, 821 (3d Cir. 1988); *cf.* United States v. Russo, 74 F.3d 1383, 1392 (2d Cir. 1996).

23. *See, e.g.*, *In re* Enron Corp. Sec., 529 F. Supp. 2d 644, 755 (S.D. Tex. 2006); *see also* Michael Hartzmark et al., *Fraud on the Market: Analysis of the Efficiency of the Corporate Bond Market*, 2011 COLUM. BUS. L. REV. 654, 660 (2011); Henning, *supra* note 20, at 48.

24. *Deutschman*, 841 F.2d at 507.

is relatively small, securities fraud cases are typically pursued as class actions. Certification of an investor class is an important step in securities fraud litigation.[25] It not only reduces the cost of the litigation, but a significant percentage of securities fraud cases settle in the wake of class certification.[26] Under Rule 23(a) of the Federal Rules of Civil Procedure, a class action may be certified if the class satisfies baseline requirements of numerosity, commonality, typicality, and adequacy of representation.[27] In securities class actions, Rule 23(b)(3) additionally requires that plaintiffs establish that "questions of law or fact common to class members predominate over any questions affecting only individual members" (the "predominance" requirement), and that "a class action is superior to other available methods for fairly and efficiently adjudicating the controversy" (the "superiority" requirement).[28]

In a garden-variety securities fraud case, plaintiffs allege that a corporation made a false or misleading statement or omission regarding a material aspect of its financial condition or performance, typically with a view to artificially inflating the price of its stock.[29] All individuals who purchase the stock while the price is artificially inflated are harmed to the extent that a subsequent disclosure correcting the misleading statement or omission results in a decline in the stock price, thereby causing plaintiffs' loss.[30] Individual questions of law and fact nevertheless relate to each class member's reliance and economic loss.[31] As discussed below, to satisfy the

25. *See* Amgen Inc. v. Conn. Ret. Plans & Tr. Funds, 568 U.S. 455, 474 (2013) (acknowledging this fact).

26. *See* CORNERSTONE RSCH., SECURITIES CLASS ACTION SETTLEMENTS: 2022 REVIEW AND ANALYSIS 14 (2023), https://www.cornerstone.com/wp-content/uploads/2023/03/Securities-Class-Action-Settlements-2022-Review-and-Analysis.pdf [https://perma.cc/4JFX-SM8U] (finding that "the median issuer defendant total assets for 2022 [securities class action] cases that settled after the ruling on a motion for class certification was over four times the median for cases that settled prior to such a motion being ruled on").

27. FED. R. CIV. P. 23(a).

28. FED. R. CIV. P. 23(b)(3). The Private Securities Litigation Reform Act of 1995 imposed additional procedural requirements on securities class actions, including, as discussed below, various constraints on how losses are measured and calculated. *See, e.g.*, 15 U.S.C. § 78u-4.

29. In some cases, as in *Basic Inc.*, the false or misleading statement may artificially deflate the price of the stock. *See* Basic Inc. v. Levinson, 485 U.S. 224, 227 (1988) (challenging three public statements made by defendant denying that it was engaged in merger negotiations).

30. *See, e.g.*, *In re* Vivendi, S.A. Sec. Litig., 838 F.3d 223, 261–62 (2d Cir. 2016) (noting that whether "the truth comes out by way of a corrective disclosure describing the precise fraud inherent in the alleged misstatements, or through events constructively disclosing the fraud, does not alter the basic loss-causation calculus").

31. *Compare Basic Inc.*, 485 U.S. at 242 (holding that without the presumption of

predominance requirement for class certification, private litigants must allege class-wide reliance on the misrepresentations and omissions and also establish that damages can be calculated with a common methodology for all class members. Given the presumption that all investors rely on the integrity of the market price, common reliance can be established by proving that the subject security traded in an efficient market, one in which the subject security price reflects all public information and misinformation.

Several courts since *Deutschman* have certified classes including options traders on the grounds that it is "logical and appropriate to apply the same presumption of reliance" for options traders and stock traders.[32] The number of cases contesting the inclusion or exclusion of option investors in a securities class action nevertheless appears to be relatively small in relation to the total number of class actions filed. This may of course reflect the fact that some publicly traded shares do not have an associated option chain, or that the administrative or clerical costs of including options traders may not be justified by the expected recovery on their behalf. Our experience in *Apple* nevertheless suggests that, when potential liability to options traders may be significant, courts may require further reassurance that options trade in an efficient market and that damages can be computed using a common methodology before certifying a class including options traders.

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reliance, "individual issues then would have overwhelmed the common ones"), *with* Amgen Inc. v. Conn. Ret. Plans & Tr. Funds, 568 U.S. 455, 475 (2013) (holding that materiality, loss causation, and the falsity of defendant's statements "are common questions that need not be adjudicated before a class is certified").

32. *In re* Merck & Co., Inc. Sec., Derivative & ERISA Litig., No. 05-CV-1151, 2013 WL 396117, at *12 (D.N.J. Jan. 30, 2013) (applying "the same presumption of reliance to class members who exercised options . . . whose value depended on the value of the Merck stock"); *see also* Turocy v. El Pollo Loco Holdings, Inc., No. 15-CV-1343, 2018 WL 3343493, at *17 (C.D. Cal. July 3, 2018); Marcus v. J.C. Penney Co. No. 13-CV-736, 2016 WL 8604331, at *9 (E.D. Tex. Aug. 29, 2016); *In re* Countrywide Fin. Corp. Sec. Litig., 273 F.R.D. 586, 609 n.74 (C.D. Cal. 2009) (asserting that "efficiency is very nearly a nonissue for Countrywide common stock and options"); Rougier v. Applied Optoelectronics, Inc., No. 17-CV-2399, 2019 WL 6111303, at *14–19 (S.D. Tex. Nov. 13, 2019); Levie v. Sears, Roebuck & Co., 496 F. Supp. 2d 944, 949 (N.D. Ill. 2007); *In re* Sci.–Atlanta, Inc. Sec. Litig., 571 F. Supp. 2d 1315, 1330 (N.D. Ga. 2007); *In re* Enron Corp. Sec., 529 F. Supp. 2d 644, 754 (S.D. Tex. 2006); *In re* Priceline.com Sec. Litig., 236 F.R.D. 89, 99 (D. Conn. 2006); *In re* Adobe Sys., Inc. Sec. Litig., 139 F.R.D. 150, 155 (N.D. Cal. 1991); *In re* Oxford Health Plans, Inc. Sec. Litig., 199 F.R.D. 119, 123–24 (S.D.N.Y. 2001); Weikel v. Tower Semiconductor Ltd., 183 F.R.D. 377, 391 (D.N.J. 1998); Moskowitz v. Lopp, 128 F.R.D. 624, 631 (E.D. Pa. 1989); Tolan v. Computervision Corp., 696 F. Supp. 771, 779 (D. Mass. 1988).

A. Proving Market Efficiency at Class Certification

To prevail in a Rule 10b-5 lawsuit alleging fraudulent misrepresentations, a plaintiff must prove "reliance"—i.e., that there is a "proper connection between a defendant's misrepresentation and a plaintiff's injury."[33] The *Basic* Court endorsed the broad proposition that "where materially misleading statements have been disseminated into an impersonal, well-developed market for securities, the reliance of individual plaintiffs on the integrity of the market price may be presumed."[34] Under *Basic*, plaintiffs bear the burden of establishing market efficiency to a reasonable degree of certainty in order to invoke the fraud-on-the-market principle at class certification.[35] Defendants meanwhile can defeat class certification by "sever[ing] the link between the alleged misrepresentation and either the price received (or paid) by the plaintiff, or his decision to trade at a fair market price."[36]

Following *Basic*, federal courts grappled with the evidentiary burden necessary to prove or disprove market efficiency for this purpose. Academic debates about market efficiency spilled over into the legal arena, as vying testifying finance experts sought to prove subject securities either efficient or not efficient pursuant to particular definitions.[37] In *Cammer v. Bloom*, a federal district court identified five indicators that it found probative of market efficiency for common stock.[38] Virtually all federal courts that have tried class action securities fraud cases since have referenced the *Cammer* factors.[39] Numerous courts have adopted three additional factors recognized by the Fifth Circuit Court of Appeals in *Unger v. Amedisys*[40] and the district court in *Krogman v. Sterritt*[41] as

33. Amgen Inc. v. Conn. Ret. Plans & Tr. Funds, 568 U.S. 455, 461 (2013) (citing Erica P. John Fund, Inc. v. Halliburton Co., 563 U.S. 804, 810 (2011)).

34. *Basic Inc.*, 485 U.S. at 247.

35. Halliburton Co. v. Erica P. John Fund, Inc., 573 U.S. 258, 276 (2014) (noting that "[t]he burden of proving those prerequisites still rests with plaintiffs and (with the exception of materiality) must be satisfied before class certification").

36. *Basic Inc.*, 485 U.S. at 248.

37. For a discussion on these academic debates, see Langevoort, *supra* note 6, at 177–78.

38. Cammer v. Bloom, 711 F. Supp. 1264, 1286–87 (D.N.J. 1989). The *Cammer* factors are enumerated and discussed in Part III.B, *infra*.

39. *See, e.g.*, Bradford Cornell & John Haut, *How Efficient Is Sufficient: Applying the Concept of Market Efficiency in Litigation*, 74 BUS. LAW. 417, 420–25 (2019) (discussing the prevalence of the *Cammer* and *Krogman* factors in securities class action litigation). As discussed in note 68 below, some courts have acknowledged, but declined to apply or require application of, the *Cammer* factors.

40. Unger v. Amedisys, Inc., 401 F.3d 316 (5th Cir. 2005).

indicators of market efficiency.

Even as courts apply these factors in weighing the efficiency of the market for an individual stock, they also recognize that these factors may not be applicable in the same way for testing the efficiency of other types of securities. For example, in the *Enron* and *DVI* securities cases, the respective courts made accommodations for structural differences between stock and bond markets when applying the *Cammer* and *Krogman* factors.[42] Bonds tend to trade less frequently than stocks, but with larger order sizes. Citing *Enron*, the *DVI* court observed that the "factors and standards applicable to common stock, however, are admittedly not well-suited for the analysis of debt securities" and therefore decided to "take the same general approach for determining the market-efficiency of DVI's Senior Notes as with DVI common stock, bearing in mind these structural differences."[43]

After decades of handwringing within the judiciary and the academy over the wisdom of the *Basic* decision, the Supreme Court reaffirmed the validity of the fraud-on-the-market presumption in its 2014 decision in *Halliburton II*.[44] More importantly, *Halliburton II* clarified the nature of the evidentiary showing required to demonstrate market efficiency at class certification. In his opinion, Justice Roberts noted that "[d]ebates about the precise *degree* to which stock prices accurately reflect public information are . . . largely beside the point. 'That the . . . price [of a stock] may be inaccurate does not detract from the fact that false statements affect it, and cause loss,' which is 'all that *Basic* requires.'"[45] He thus distilled the teaching of *Basic* as follows:

> To recognize the presumption of reliance, the [*Basic*] Court explained, was not "conclusively to adopt any particular theory

41. Krogman v. Sterritt, 202 F.R.D. 467 (N.D. Tex. 2001). The *Krogman* factors are 1) sizable market capitalization, 2) sizable float, and 3) a narrow bid-ask spread. *Id.*; *see infra* Part III.B.

42. *In re* Enron Corp. Sec., 529 F. Supp. 2d 644, 749 (S.D. Tex. 2006) (concluding "that factors affecting debt securities must also be examined analytically . . . with a view to their distinctive nature and to the kinds of news that would move their market price in contrast to the kind of information that might affect the more volatile stock market, as well as the manner in which that movement would occur"); *In re* DVI Inc. Sec. Litig., 249 F.R.D. 196, 214 (E.D. Pa. 2008).

43. *In re* DVI Inc. Securities Litig., 249 F.R.D. at 214.

44. *Halliburton II* enumerated the elements required to invoke the presumption of reliance as follows: "(1) that the alleged misrepresentations were publicly known, (2) that they were material, (3) that the stock traded in an efficient market, and (4) that the plaintiff traded the stock between the time the misrepresentations were made and when the truth was revealed." Halliburton Co. v. Erica P. John Fund, Inc., 573 U.S. 258, 268 (2014).

45. *Id.* at 272 (emphasis in original and internal citations omitted).

> of how quickly and completely publicly available information is reflected in market price." The Court instead based the presumption on the fairly modest premise that "market professionals generally consider most publicly announced material statements about companies, thereby affecting stock market prices."[46]

The *Halliburton II* Court specifically stated that it was not necessary to establish that a market price conformed to any particular valuation model, or that the speed of adjustment to new information had to surpass any particular standard. What needed to be established was a link between price and public information. Therefore, for purposes of proving market efficiency, plaintiffs need not prove the correctness of the market price, but rather that the market price generally absorbs and reflects new public information, including publicly disseminated misinformation.[47]

Due to the unique characteristics of options and the markets in which they trade, we explain that the *Cammer* and *Krogman* factors may not be the appropriate framework for assessing the efficiency of a market for options. As *Halliburton II* teaches, the focus of the class certification inquiry is whether option prices react to new information about the underlying stock. We believe that state-of-the-art option pricing theory, which comprises the generally accepted fact that an option price is a function of the underlying stock price, together with easily administered empirical tests of this relationship, provide sufficient proof of efficiency to invoke the fraud-on-the-market principle for options when the underlying stock trades in an efficient market. The challenge of proving an options market to be efficient need not be an overwhelming obstacle.

B. Calculating Class-wide Damages

A second challenge to including options in a certified class stems from the calculation of damages. Damages in Rule 10b-5 actions are generally limited to the plaintiff's "out-of-pocket" losses caused by the alleged false or misleading statements.[48] In cases involving public statements, plaintiffs allege that defendants' material misrepresentations or misleading omissions

46. *Id.* at 271–72 (internal citations omitted).

47. The Court acknowledged, however, that defendants "may seek to defeat the *Basic* presumption at [the class certification] stage through direct as well as indirect price impact evidence." *Id.* at 283.

48. Randall v. Loftsgaarden, 478 U.S. 647, 662 (1986) (observing that courts have generally applied the "'out-of-pocket' measure of damages in § 10(b) cases" (citing Harris v. Am. Inv. Co., 523 F.2d 220, 225 (8th Cir. 1975)).

artificially inflated the price of the stock; plaintiffs' loss is caused when the security price declines following a corrective disclosure or when the truth becomes more generally known.[49] Damages are thus limited to the amount the security price was artificially inflated at the time of its purchase, minus any artificial inflation remaining in the security price at the time the security was later sold (or after the final corrective disclosure). Various statutory limitations also apply.[50]

To satisfy the predominance requirement of Rule 23(b)(3), plaintiffs must establish a common class-wide methodology for calculating investors' damages that is consistent with plaintiffs' theory of liability.[51] The common damages methodology requirement has received greater attention since the U.S. Supreme Court's 2013 decision denying class certification in *Comcast Corp. v. Behrend*.[52] To satisfy the requirement, plaintiffs' experts may propose that an event study will estimate how much artificial inflation was triggered when the misinformation was disseminated and/or dissipated when disclosures ultimately corrected the misinformation in the market; they may alternatively propose valuation analyses to estimate what the stock price would have been "but for" the alleged misstatement or omission.[53]

The out-of-pocket damages methodology is appropriate for measuring damages suffered by option investors and, therefore, is an appropriate and common methodology for stock and option investors alike. The implementation of the methodology, however, is somewhat more complex

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49. Dura Pharms., Inc. v. Broudo, 544 U.S. 336, 346–47 (2005) (requiring plaintiffs to prove both economic loss and loss causation). Artificial inflation is measured as the difference between the observed market price of the security and what the security price would have been but for the alleged fraud. *See, e.g.*, *In re* Vivendi, S.A. Sec. Litig., 838 F.3d 223, 253–60 (2d Cir. 2016).

50. *See, e.g.*, 15 U.S.C. § 78u-4(b)(4) (requiring proof of loss causation); *id.* § 78u-4(e) (limiting damages established by reference to the market price of a security using the 90-day mean trading price after correction).

51. *See, e.g.*, Comcast Corp. v. Behrend, 569 U.S. 27, 34 (2013). Some federal circuits additionally require that it be "administratively feasible [to] determin[e] whether putative class members fall within the class definition." Byrd v. Aaron's Inc., 784 F.3d 154, 163 (3d Cir. 2015). *But see In re* Petrobras Sec., 862 F.3d 250, 264, 267–68 (2d Cir. 2017) (rejecting this requirement).

52. *Comcast Corp.*, 569 U.S. at 38; *see, e.g.*, *In re* BP p.l.c. Sec. Litig., No. 10-MD-2185, 2013 WL 6388408 at *18 (S.D. Tex. Dec. 6, 2013) ("Plaintiffs have failed to discharge their burden to establish that damages in this case can be measured on a class-wide basis consistent with their theories of liability.").

53. *See, e.g.*, Angley v. UTi Worldwide Inc., 311 F. Supp. 3d 1117, 1129 (C.D. Cal. 2018); Howard v. Liquidity Servs. Inc., 322 F.R.D. 103, 139 (D.D.C. 2017); *see also* Jill E. Fisch et al., *The Logic and Limits of Event Studies in Securities Fraud Litigation*, 96 TEX. L. REV. 553, 563–40 (2018).

for options, due to how changes in time and volatility affect option prices concomitant with the corrective disclosures. Changes in time and volatility would impact the actual observed option prices and also the but-for prices that would have prevailed without fraud. In this article, we show that, nonetheless, the out-of-pocket damages methodology is feasible for computing damages commonly for all call option purchasers and put option writers who sustained losses on account of corporate misrepresentations and omissions. The common damages methodology requirement is not an insurmountable hurdle.

III. CERTIFYING OPTIONS: THE QUESTION OF MARKET EFFICIENCY

As noted in Section II, certification of a class that includes options requires that two conditions be met. It must be shown that the asset trades in an efficient market, and that a common methodology exists to calculate damages. In this section we address the efficiency question, and in Section IV, we take up the common damages methodology issue.

A. The Sufficient Degree of Efficiency

Economists define an efficient market as one that reflects all relevant public information.[54] Hence, in an efficient market, any piece of public information that is relevant to the price should affect the market price. Conversely, if the market is not efficient, relevant information may not affect the market price.[55] This notion of market efficiency, however, has two important elements. The first, *informational efficiency*, is the idea that market prices merely reflect new information. Informational efficiency does not, however, address the question of how much the market price must move in response to newly disseminated information or whether the

54. This is the definition of the semi-strong form of market efficiency. The strong form of market efficiency means that even private information is reflected in the market price. The weak form means that at least past price and volume data is reflected in the price. The semi-strong form of efficiency is most relevant to securities litigation insofar as the weak and strong forms are incompatible with the fraud-on-the-market doctrine. *See* Jonathan R. Macey, *Good Finance, Bad Economics: An Analysis of the Fraud-on-the-Market Theory*, 42 STAN. L. REV. 1059, 1077 (1990); *see also* Baruch Lev & Meiring de Villiers, *Stock Price Crashes and 10b-5 Damages: A Legal, Economic, and Policy Analysis*, 47 STAN. L. REV. 7, 21 (1994).

55. Relevance is related to the legal concept of materiality, a separate element in Rule 10b-5 class actions, which must be alleged but not proven at the class certification stage. *See* Amgen Inc. v. Conn. Ret. Plans & Tr. Funds, 568 U.S. 455, 459 (2013).

amount the market price moved was the correct amount pursuant to a fundamental valuation formula. The notion that the market price is always a correct price—correct pursuant to a particular valuation model given publicly available information—is known as *price efficiency* or *fundamental efficiency*.

Informational efficiency is a much lighter standard to establish, since it requires only that prices respond to information, not proof that the magnitude of the response was correct.[56] For price efficiency, we would require a theoretical model to determine how much the price of a security should move given the information.[57] To invoke the fraud-on-the-market principle, *Halliburton II* requires only that informational efficiency be established. The notion is that a piece of new material information should impact the market price.[58] Otherwise, a fraudulent statement would not necessarily have had any effect, and the market price would not necessarily have been different if the truth had been told.

In considering whether or not options markets are efficient for this legal purpose, one must recognize that a stock option is *designed* to move in response to a change in the underlying stock price, and the option's value is a function of the underlying stock's price by design. Options do not necessarily respond directly to the release of information by a company, but they are designed to move indirectly. Options are structurally

56. *In re* PolyMedica Corp. Sec. Litig., 432 F.3d 1, 16 (1st Cir. 2005) ("[W]e do not suggest that stock price must accurately reflect the fundamental value of the stock. . . . Our focus on whether a particular market has absorbed all available information (and misinformation)—such that an ordinary investor cannot beat the market by taking advantage of unexploited profit opportunities—is not a fundamental value inquiry.").

57. Professor Fama described this joint hypothesis problem—that testing for fundamental price efficiency is necessarily a test of a pricing model, such as the Capital Asset Pricing Model, in addition to testing that a security price reacts appropriately to information. *See* Eugene F. Fama, *Efficient Capital Markets: A Review of Theory and Empirical Work*, 25 J. FIN. 383, 383–417 (1970). Accordingly, tests gauging the fundamental price efficiency of securities relative to financial data are subject to greater debate than the questions of whether or not securities are informationally efficient (react to information) or whether or not option prices are a function of the underlying stock price. For additional perspective, see Ronald J. Gilson & Reinier Kraakman, *The Mechanisms of Market Efficiency Twenty Years Later: The Hindsight Bias*, 28 J. CORP. L. 715, 742 n.4 (2003) (expressing skepticism of "the analytical foundations of the distinction" between fundamental and informational efficiency in the context of individual stocks, to the extent that a "stock price is efficient with respect to a particular information set").

58. Nevertheless, important information may not change the market price if it is consistent with the market's prior expectations. Moreover, information can have price impact without causing price movement. This may occur when the information serves to keep the security price from moving or when the effect of the information is countervailed by simultaneously released offsetting information. *See* Fisch et al., *supra* note 53, at 564.

designed to take what information is in the underlying stock price and convert that information into the price of the option.[59] Some studies have shown that notwithstanding this indirect mechanism, option prices could move earlier than the stock price in anticipation of the stock price reacting to the new information.[60]

For this reason, several courts have simply taken judicial notice that claims of "options-holders and stockholders are in most cases sufficiently similar that they should be consolidated 'in form and in fact.'"[61] Other courts, however, may require litigants to establish the efficiency of options markets independently of the underlying stock market before extending the presumption of reliance to options traders.[62] For example, in *Apple*, the

59. For example, the listing standards of the U.S. options exchanges and clearing eligibility standards of the Options Clearing Corporation—which formally issues standardized exchange-listed options—generally require that the stocks underlying listed options be National Market System ("NMS") securities. *See* CBOE Rule 4.3(a)(1) [hereinafter NMS security]; Plan for the Purpose of Developing and Implementing Procedures Designed to Facilitate the Listing and Trading of Standardized Options, 89 Fed. Reg. 64005 (July 31, 2024) [hereinafter Options Listing Procedures Plan]. This ensures that consolidated transaction and quotation data feeds in the underlying security are continually available from industry plans. *See* 15 U.S.C. § 78k-1; 17 C.F.R. § 242.600 *et seq.* [hereinafter Regulation NMS].

60. Options may react more quickly to new information than the underlying stock to the extent that traders on options exchanges may be able to execute trades more cheaply or quickly than on stock exchanges and because options require less capital to open a position than stock. Moreover, short sales of stock may be subject to a "locate" requirement. *See, e.g.*, Steven Manaster & Richard J. Rendleman, Jr., *Option Prices as Predictors of Equilibrium Stock Prices*, 37 J. FIN. 1043, 1044 (1982) (finding that options incorporate information more quickly than do stock prices); Joseph H. Anthony, *The Interrelation of Stock and Option Trading Volume Data*, 43. J. FIN. 949, 949 (1988) (finding that trading in call options leads trading in the underlying stock). Other studies, however, arrive at contrary or mixed findings regarding which security reacts most quickly. *See, e.g.*, Staffan Hentze & Michael J. Seiler, *An Examination of the Lead/Lag Relationship Between the Option Market and the Stock Market: Where Do We Stand?*, 39 Q.J. BUS. & ECON. 35, 35–37 (2000) (surveying literature).

61. *In re* MicroStrategy Inc. Sec. Litig., 110 F. Supp. 2d 427, 440 (E.D. Va. 2000) (quoting *In re* Orbital Scis. Corp. Sec. Litig., 188 F.R.D. 237, 240 (E.D. Va. 1999)); *see also In re* Sci.-Atlanta, Inc. Sec. Litig., 571 F. Supp. 2d 1315, 1329 (N.D. Ga. 2007) ("The relevant question is not whether Vigilant has established that the market for SA put options was itself efficient. Rather, the question is whether a seller of put options is entitled to rely on the stock market to accurately reflect the value of the underlying stock upon which the put option is sold.").

62. *See, e.g.*, Industriens Pensionsforsikring A/S v. Becton, Dickinson & Co., No. 20-CV-2155, 2023 WL 4981716, at *6 n.3 (D.N.J. Aug. 3, 2023) (distinguishing "the statement that the inference of options market efficiency flows automatically from a determination of efficiency in the market for a particular common stock—which [plaintiff's expert] did not make—, and the statement [plaintiff's expert] made, that his analyses of the *Cammer* factors . . . supported inferences about the efficiency of both the market for BD common

district court asked plaintiffs and their experts to explain how the *Cammer-Krogman* factors discussed in Section II related to options trading.[63] In the following subsection, we discuss in more detail why the application of the *Cammer-Krogman* factors to options is inappropriate.

B. The Cammer-Krogman Factors

As mentioned in Section II, courts typically use the *Cammer-Krogman* factors as guidance for determining if a market for a stock is efficient. In *Cammer v. Bloom*, the district court identified five factors that can be used to establish efficiency during the class period.[64] These factors are (1) average trading volume, (2) the number of securities analysts that followed and provided reports on the stock, (3) the number of market makers and arbitrageurs that traded in the stock, (4) the company's eligibility to register a securities transaction on Form S-3, and (5) empirical evidence of a cause-and-effect relationship between the release of new information and movement in the stock price.[65] In *Krogman v. Sterritt*, the district court considered three additional factors: (1) the market capitalization of the company, (2) the bid-ask spread of the stock, and (3) the public float, or amount of stock not held by insiders.[66]

Though the *Cammer-Krogman* factors are all measurable[67] and indicative, courts have set no firm minimum or maximum thresholds for any given factor to qualify as evidence of efficiency. Instead, the courts

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stock and the market for BD options on that stock"); *In re* FibroGen Sec. Litig., No. 21-CV-02623, 2024 WL 1064665, at *17 (N.D. Cal. Mar. 11, 2024) (observing that "[p]laintiffs cite no in-circuit precedent for the assertion that an efficient market for options can be presumed solely from a finding of an efficient market for common stock" (citing *In re* Apple Inc. Sec. Litig., No. 19-CV-2033, 2022 WL 354785, at *13 n.11 (N.D. Cal. Feb. 4, 2022))).

63. In its February 2022 class certification order in *Apple*, the Court ruled without prejudice that the standard for class certification had been met for purchasers of Apple stock but not for options traders. In particular, the Court stated:

> [T]he parties did not fully address whether the factors outlined in *Cammer v. Bloom*, 711 F. Supp. 1264, 1286–87 (D.N.J. 1989), and *Krogman v. Sterritt*, 202 F.R.D. 467, 478 (N.D. Tx. 2001), typically used to evaluate market efficiency of common stock, are even applicable to the determination of market efficiency of stock options.

In re Apple, Inc. Sec. Litig., No. 19-CV-2033, 2022 WL 354785 (N.D. Cal. Feb. 4, 2022) (class certification order).

64. Cammer v. Bloom, 711 F. Supp. 1264, 1286–87 (D.N.J. 1989).

65. *Id.*

66. Krogman v. Sterritt, 202 F.R.D. 467, 478 (N.D. Tex. 2001).

67. Measurability means that each factor can be quantified. Even eligibility for S-3 registration can be quantified as a binary: 0 (not eligible) or 1 (eligible).

generally view the *Cammer-Krogman* factors as "an analytical tool, not a checklist" of factors that must be weighed to meet the burden of proving efficiency.[68] "Some courts have suggested that 'the fifth *Cammer* factor is not necessary' in order to find market efficiency, at least as long as the other factors do support a finding."[69] On the other hand, there have been challenges levied by some authors and experts as to whether or not the factors are dispositive with regard to the efficiency of the market for any given security.[70] In this paper, we are not taking a position on this question one way or the other.

In *Apple*, it was apparent that the Court had some doubts as to whether the *Cammer-Krogman* factors could be applied in a straightforward manner to options. We submit that in cases involving options, these factors may not be apposite, but other analysis, presented herein, is better suited and dispositive.

Trading Volume (Cammer Factor 1): According to the *Cammer* court, "the existence of an actively traded market, as evidenced by a large weekly volume of stock trades, suggests there is an efficient market . . . because it implies significant investor interest in the company."[71] Option trading volume is usually considerably less than stock trading volume, which immediately raises the question of what is an adequate level of volume to support a determination of efficiency for options. As discussed below, because option prices are bound to stock prices structurally, and the relationship is enforced by arbitrage, options do not need high trading volume to trade efficiently.

Moreover, the trading volume of options on a particular stock is dispersed across a large range of diverse option series, each series being a different combination of strike price and expiration.[72] Because most option

68. Vinh Nguyen v. Radient Pharm. Corp., 287 F.R.D. 563, 574 (C.D. Cal. 2012) (quoting Teamsters Loc. 445 Freight Div. Pension Fund v. Bombardier, Inc., No. 05-CV-1898, 2006 WL 2161887, at *5 (S.D.N.Y. Aug. 1, 2006), *aff'd*, 546 F.3d 196 (2d Cir. 2008); *see also* Waggoner v. Barclays PLC, 875 F.3d 79, 99 (2d Cir. 2017); Local 703, Int'l Bro. of Teamsters Grocery & Food Emps. Welfare Fund v. Regions Fin. Corp., 762 F.3d 1248, 1255–56 (11th Cir. 2014) ("[W]e do not think it wise to require District Courts to analyze market efficiency in terms of the *Cammer* factors in every case. . . . District Courts have a good idea of what they should be looking for in determining market efficiency, as well as the flexibility to do that analysis in the most sensible way given the circumstances.").

69. Bond v. Clover Health Invs., Corp., No. 21-CV-96, 2023 WL 1999859, at *11 (M.D. Tenn. Feb. 14, 2023) (quoting Cosby v. KPMG, LLP, No. 16-CV-121, 2021 WL 1828114, at *4 (E.D. Tenn. May 7, 2021)); *Waggoner*, 875 F.3d at 99.

70. *See, e.g.*, Fisch et al., *supra* note 53, at 560; Allen Ferrell & Andrew Roper, *Price Impact, Materiality, and* Halliburton II, 93 WASH. U. L. REV. 553, 558 n.18 (2015).

71. Cammer v. Bloom, 711 F. Supp. 1264, 1286 (D.N.J. 1989).

72. The strike price, also known as the exercise price, is the price specified in the option

volume occurs in the shorter-term, near-the-money options, there is little to no trading volume in many option series.[73] The *Apple* defendants attempted to exploit this fact by dividing total option volume by the number of option series, thereby presenting diluted volume figures to make it appear as if all Apple options were thinly traded. In his expert testimony, Chance explained that low volume on certain option series is not indicative of inefficiency of the entire market for options on a given stock, or even for any particular option series, a point we elaborate on in Section IV.C.2.

Analyst Coverage (*Cammer* Factor 2): The *Cammer* court observed that the existence of a "significant number of securities analysts" would imply that an issuer's reports were "closely reviewed by investment professionals, who would in turn make buy/sell recommendations to client investors."[74] In the equity arena, there is a well-defined cohort of analysts working for different firms that follow a stock and who produce periodic reports with recommendations.[75] These reports are based on the analysts' assessments of fundamental information of the company, such as sales, R&D, management quality, cash flow, growth prospects, etc. These factors typically do not change overnight, and, consequently, the published reports have a reasonable half-life. That is, published equity analyst reports can be used to evaluate the target stock over a reasonable horizon, certainly more than an instant.

Options, on the other hand, are valued and therefore analyzed only in relation to the stock price. There are no analyst reports dedicated solely to a particular company's options, as such reports would be immediately outdated as the underlying stock price changes. Options are analyzed on an instantaneous basis as their valuations are a function of the current underlying stock price. While there are thousands of people who specialize in options, these market participants are not an identifiable cohort of analysts, and they do not publish reports and recommendations focused solely on a single company's options. Thus, while the number of securities analysts following a stock is relevant to the efficiency of the underlying stock and the options on the stock, the number of securities analysts publishing reports dedicated to a company's options is not a valid indicator,

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contract to be paid for the underlying security in the transaction triggered by option exercise. *See infra* Appendix §B.

73. *See* Torben Andersen et al., *A Descriptive Study of High-Frequency Trade and Quote Options Data*, 19 J. FIN. ECONOMETRICS 128, 153, 154–55 (2021) (noting the concentration of trading in ultra short-term contracts across options classes sampled and that the "vast majority of the option trading is in close-to-the-money options").

74. *Cammer*, 711 F. Supp. at 1286.

75. A recommendation is typically to buy, if not already owned, sell, if already owned, or hold, meaning to hold on to it if an investor already owns the stock.

as the metric would usually be zero.

Exchange Listing and Market Maker Coverage (*Cammer* Factor 3): The *Cammer* court observed that market makers and arbitrageurs "ensure completion of the market mechanism" of informational efficiency insofar as they "react swiftly to company news and reported financial results by buying or selling stock and driving it to a changed price level."[76] As such, courts consider a listing on an established exchange to be an indicator of market efficiency and have deemed the number of competing market makers and presence of arbitrageurs to be an indicator of market efficiency for stocks.[77]

Exchange-traded options are of course listed on a national securities exchange and thereby satisfy this factor. While options markets do use competitive market makers, the number is mostly unknown.[78] Data sources that provide the number of market makers for a stock do not provide this same information for options. Moreover, with respect to the efficiency of an options market, the number of market makers is largely irrelevant, as we show in Section IV.C.4. Options reflect company information by reacting to the underlying stock price, and the link to the stock price is enforced via arbitrage, which does not require a large number of market makers.[79]

Form S-3 Eligibility (*Cammer* Factor 4): Form S-3 under the Securities Act of 1933 streamlines registration of eligible securities offerings by permitting certain seasoned corporate issuers to incorporate information from their Exchange Act disclosures into the registration statement by reference.[80] In addition to requiring a minimum public float for certain offerings,[81] Form S-3 addresses the registrant's history and experience with filing periodic disclosures under the Exchange Act and

76. *Cammer*, 711 F. Supp. at 1287.

77. *See, e.g.*, *In re* PolyMedica Corp. Sec. Litig., 453 F. Supp. 2d 260, 267 (D. Mass. 2006) (collecting cases).

78. Listing exchanges may designate a primary market maker with respect to each class of listed options, but any number of off-exchange market makers may assist in "consolidating" order flow for execution. *See* U.S. SEC. & EXCH. COMM'N, STAFF REPORT ON EQUITY AND OPTIONS MARKET STRUCTURE CONDITIONS IN EARLY 2021, at 11 (2021) [hereinafter 2021 MARKET STRUCTURE REPORT], https://www.sec.gov/files/staff-report-equity-options-market-struction-conditions-early-2021.pdf [https://perma.cc/C6X3-CLY3].

79. *See, e.g.*, ZVI BODIE, ALEX KANE & ALAN J. MARCUS, INVESTMENTS 311 (12th ed. 2021) ("[W]hen arbitrage opportunities exist, each investor wants to take as large a position as possible; hence, it will not take many investors to bring about the price pressures necessary to restore equilibrium.").

80. 17 C.F.R. § 239.13(d).

81. *Id.* § 239.13(b)(1) (requiring "that the aggregate market value of the voting and non-voting common equity held by non-affiliates of the registrant is $75 million or more" to register a primary or secondary offering of common equity).

therefore the attention such information presumably receives from market participants.[82] As such, Form S-3 eligibility is relevant to the efficiency of stocks.

Standardized options are, of course, exempt from registration under the Securities Act of 1933.[83] Form S-3 registration eligibility has no direct relevance to the efficiency of the option, because an option responds to and reflects company information indirectly, as its price depends on the price of the underlying stock. Moreover, while a company may avail itself of S-3 registration when offering securities to the public, the decision to offer an option for investment and public trading is made by an options exchange, not the company.[84] The SEC's rules for stock issuance do not apply to the exchange's decision to offer options linked to a particular stock. Thus, Form S-3 registration eligibility has no direct relevance to options market efficiency.

Cause-and-Effect Relationship (*Cammer* Factor 5): The fifth factor is empirical evidence of a cause-and-effect relationship between the release of information and stock price movement. It may be satisfied by event studies and other statistical tests demonstrating the stock's movement following information release.[85] This factor has relevance for options but must be dealt with carefully. As noted above, options are not designed to react directly to public information. They react to (or anticipate) movement in the underlying stock, which may be elicited by public information. In this day and age, options may react quickly with the rapid dissemination of information,[86] but the reaction need not be instantaneous for the market to be deemed efficient. The proper pricing of an option is linked to the pricing

82. *Id.* § 239.13(a).

83. *Id.* § 230.238 (exempting options issued by a registered clearing agency and traded on a registered securities exchange from the Securities Act of 1933). The Securities and Exchange Commission exempted standardized options from registration, among other reasons, because they are issued by a registered clearing agency, rather than the issuer of the underlying stock. Exemption for Standardized Options, Securities Act Release No. 8171, Exchange Act Release No. 47082, 68 Fed. Reg. 188, 189 (Jan. 2, 2003).

84. Options exchanges have broad latitude to select the stocks on which options are offered, as well as to decide which exercise prices and expirations will be available for trading. *See* Options Listing Procedures Plan, *supra* note 59; *cf.* Golden Nugget, Inc. v. Am. Stock Exch., Inc., 828 F.2d 586, 589 (9th Cir. 1987) (issuer may not prohibit listing of option on its stock). Furthermore, the options exchanges may limit listing of standardized stock options to contracts on "National Market System" securities. NMS security, *supra* note 59.

85. *See, e.g.*, Fisch et al., *supra* note 53, at 569.

86. Some options exchanges may offer members "auto-quote prices" or other tools to refresh continuous quotations generated by processing real-time data from spot markets and using standard mathematical models. Competitive Developments in the Options Markets, Exchange Act Release No. 100622, 69 Fed. Reg. 6124, 6125 n.3 (Feb. 9, 2004).

of the underlying stock. So, while the reaction of option prices to information may be informative in assessing market efficiency, the efficiency of the underlying stock and the option's link to the pricing of the stock is more informative. We shall take up this point in Section IV.C.5 and make the connection more specific.

Market Capitalization (*Krogman* Factor 1): Market capitalization is the total market value of all of a company's outstanding stock. This measures the size of the market for the company's stock. It is possible to create an analogous measure for the market value of all options on the stock, or the market value of the outstanding options times the exercise price, but these measures are distinct from market capitalization. The size of an options market can be measured numerous ways, so the total value of outstanding options is less informative for an options market than the total value of outstanding stock is for a stock market.

Additionally, options are inherently leveraged instruments, which allow investors to trade sizable exposures with less invested money than would be required by a stock investment. Consequently, the total value of outstanding options will almost always be less than the market capitalization of the underlying stock, by design.[87] Nonetheless, an options market may be efficient with or without a large aggregate outstanding value because option prices are driven to their correct valuations via arbitrage, which can be conducted on a small number of contracts with little trading. This further erodes the relevance of this factor for options markets. A single option contract, continually priced correctly in relation to its underlying stock, can be deemed to be trading in an efficient market.

Bid-Ask Spread (*Krogman* Factor 2): The bid-ask spread is the difference between the price at which a market maker is asking to sell a security and the price at which it is willing to buy the security. Courts have observed that narrower bid-ask spreads reflect lower transaction costs and are thus considered consistent with efficiency.[88] This measure can have

87. In theory, it is possible that there is so much speculative activity in relation to a stock that the total notional value of outstanding options may escalate significantly. For example, in January 2021, the SEC found that short interest exceeded the market average for several meme stocks, including GameStop. 2021 MARKET STRUCTURE REPORT, *supra* note 78, at 16–17. Moreover, the SEC staff found that "[GameStop] options trading volume from individual customers increased substantially, from only $58.5 million on January 21 to $563.4 million on January 22 until peaking at $2.4 billion on January 27." *Id.* at 29. Of course, during the same period, GameStop's market capitalization soared from approximately $1.3 billion on January 12 to approximately $22.6 billion on January 27. *Id.*

88. *See, e.g.*, Junge v. Geron Corp., No. C 20-00547, 2022 WL 1002446, at *4 (N.D. Cal. Apr. 2, 2022) (asserting that the "bid-ask spread [] represent[s] the cost to transact and indicate[s] greater efficiency when the spread [is] 'narrow'"); Rougier v. Applied

some relevance generally, but with options, the connection with efficiency is problematic. Option bid-ask spreads are always greater on a percentage basis than those of stocks because, by design, options are priced much lower than the underlying stock. Consequently, comparison of option bid-ask spreads with acceptable bid-ask spreads of stocks from prior cases is not instructive. Moreover, wide bid-ask spreads in options can be consistent with efficiency as we show in Section IV.C.4.

Public Float (*Krogman* Factor 3): Public float, or the percentage of shares held by non-insiders, is relevant only to a stock and not to an option. The listing rules of the Chicago Board Options Exchange, for example, generally require that the stock underlying an equity option maintain a minimum public float.[89] There is no analogous distinction between insider and non-insider trading in the options market because company insiders rarely buy or sell exchange-traded options on their company's stock and may be restricted from doing so.[90]

In sum, the *Cammer-Krogman* factors were not designed to evaluate the efficiency of options markets. Though some of them have connections to options market efficiency, the court in *Apple* was perceptive in wondering whether and to what extent these factors mattered for certification of a class including options investors. We argue that a different approach can and should be taken.

C. Demonstrating the Efficiency of an Options Market

Demonstrating the efficiency of options markets can be done in a number of ways, with varying degrees of complexity.

Optoelectronics, Inc., No. 17-CV-2399, 2019 WL 6111303, at *13 (S.D. Tex. Nov. 13, 2019) (asserting that a "narrow bid-ask spread is indicative of higher trading volume" and considered by courts as a "factor for determining market efficiency"). Technically, there are other costs to trade, including commissions and taxes.

89. *See* CBOE Rule 4.3.01(a)–(b) (establishing, among other requirements, that the equity security underlying a listed option be an NMS security and satisfy certain minimum numerosity, public float, and trading volume requirements).

90. *See, e.g.*, David M. Schizer, *Executives and Hedging: The Fragile Legal Foundation of Incentive Compatibility*, 100 COLUM. L. REV. 440, 460 (2000) (discussing contractual constraints on the use of options to hedge executive compensation); Alan J. Berkeley, *Corporate Policy on Insider Trading*, *in* PRACTICAL LAW: CORPORATE & SECURITIES ¶ 4 (Thomson Reuters ed., 2022) (including model provision prohibiting a company's covered persons from buying or selling puts or calls on the company's securities). Section 16 insiders must of course promptly report such transactions to the SEC. *See* 17 C.F.R. § 240.16a-3(g).

1. The Academic Literature on Efficiency

As a preliminary matter, academic debates over the exactitude of options pricing models should be irrelevant to whether options prices are informationally efficient under *Halliburton*. The seminal articles on option pricing were published in 1973 by Fischer Black, Myron Scholes, and Robert Merton. These authors presented what has come to be known as the Black-Scholes-Merton (BSM) model.[91] Almost immediately, other researchers set out to test the BSM model empirically, and findings were mixed as to whether the model held, or alternatively, indicated inefficient mispricing of options.[92]

Articles that suggested inefficiency, however, were focused not on whether or not options reacted appropriately to information or changes in the underlying stock price, but rather on whether or not the BSM pricing model precisely fit the data.[93] Importantly, over time, the academic community accepted as a general principle that with certain modifications, the BSM approach does explain observed option prices, option prices are indeed a function of their underlying stock prices, and option prices move appropriately in response to changes in the underlying stock price.[94] Consequently, research on options market efficiency, which started in the mid-1970s, waned by the mid-1990s on account of the generally accepted conclusion that option market efficiency was well-established.[95]

It bears emphasis, however, that the literature on options market efficiency addresses the more stringent fundamental or price efficiency, rather than the standard of informational efficiency required by courts for option class certification. As noted above, the law requires only informational efficiency (i.e., reactivity to information) and not price efficiency (i.e., whether the reaction and resulting price conform precisely

91. Fischer Black & Myron Scholes, *Pricing of Options and Corporate Liabilities*, 81 J. POL. ECON. 637 (1973); R.C. Merton, *Theory of Rational Option Pricing*, 4 BELL J. ECON. & MGMT. SCI. 141 (1973).

92. *See* Robert A. Jarrow, *In Honor of the Nobel Laureates Robert C. Merton and Myron S. Scholes: A Partial Differential Equation That Changed the World*, 13 J. ECON. PERSPS. 229, 239–40 (1999) (recounting that the "empirical validation of the [BSM] formula and its generalizations has become a significant research endeavor over the past 25 years"). This literature is summarized in Dr. Chance's expert report. *See* Expert Report of Don Chance, *In re* Apple Inc. Sec. Litig., No. 19-CV-2033 (N.D. Cal. Apr. 15, 2022).

93. *See, e.g.*, Stephen Figlewski, *Options Arbitrage in Imperfect Markets*, 44 J. FIN. 1289, 1289–92 (1989) (exploring the "disparity between options arbitrage in theory [under the BSM model] and in practice").

94. *See* Jarrow, *supra* note 92, at 238–40 (discussing academic studies seeking to relax the assumptions of the BSM model).

95. Expert Report of Don Chance, *supra* note 92, at 4.

to the theoretical valuation model). Conformance with theories that specify how much an option price must change is not required by the law.

So, when price efficiency is not found, does that mean informational efficiency does not hold? The answer is plainly no. An option price can respond to a stock price change, but perhaps not as much or too much to conform to a theoretical pricing model.[96] This price would be informationally efficient while not necessarily price efficient.

The options market literature does not directly address the informational efficiency of options. There have been no academic studies or portions of studies focused on testing whether options move when their underlying stock prices move. This absence of research is not due to neglect to address an open question. The reason is that the answer is considered far too obvious and is a matter of settled science. For an options researcher to investigate this matter would be akin to a physicist investigating the existence of gravity. The very purpose of options is to take the price of a stock and convert it into something different from the stock. That the value of an option is a function of the underlying stock price is the raison d'être of the option. The academic community considers the question already answered. Option prices do reflect the prices of their underlyings, and they move in response to changes in the prices of their underlyings.[97]

Defendants may try to assert options market efficiency by citing studies that show pockets of inefficiency. But those are pockets of price (or fundamental) inefficiency, not informational efficiency. Defendants may claim that there are limits to arbitrage, but, again, these are limits to price (fundamental) efficiency, not informational efficiency.[98] Defendants may show that not all researchers agree that all options are efficient all the time. But again, these issues relate to price (fundamental) efficiency. No reasonable researcher would ever testify that options simply do not move when stock prices move. Options exist to capture the information in the stock price and convert it into an instrument that pays out the way an option does as a function of the underlying stock price, with a very limited loss and large potential gain. If they did not do this, they would have no

96. *See, e.g.*, Figlewski, *supra* note 93, at 1310 (contending that "while empirical research has shown that option valuation theory plays a very important role in determining prices in real options markets, ... the standard arbitrage cited in the literature . . . becomes a weak force to drive actual option prices toward their theoretical values").

97. The term "underlying" refers to the stock or other asset or economic variable to which the option is linked. *See infra* Appendix §A.

98. *See, e.g.*, Figlewski, *supra* note 93, at 1289–92 (discussing transaction costs that impose "arbitrage bounds on options prices").

reason to exist. Indeed, scholars widely acknowledge that the BSM model works very well in practice and is used by "[v]irtually all market participants."[99] There remains considerable disagreement over what other factors drive option prices,[100] but the question of whether options react to stock prices is settled science.

Notwithstanding this general consensus about option efficiency and the cause-and-effect relationship between stock and option prices, defendants may force debate about the literature. Indeed, it is quite likely that the gap in the literature of directly testing such a truism generates hope on the part of defendants that a court can be convinced that the link between option and stock prices is not settled. However, considering generally accepted principles and how research accepted for publication addresses unanswered questions, such a representation or argument would be disingenuous.

2. Option Series and the Role of Volume in Assessing Efficiency

There are many different series of options on a given stock. Series differ by expiration and exercise price. The option exchanges typically offer a wide range of options spanning maturities of up to a couple of years and exercise prices that may be considerably higher or lower than the current stock price.[101] The listing of a particular option has very little cost to the exchange, and, thus, it could list any option specification that it believes anyone could conceivably have an interest in trading.[102] Even if

99. *See, e.g.*, Jarrow, *supra* note 92, at 234 (noting that the BSM pricing argument "has been central to the development of derivatives markets" and that the "growth in . . . option markets was enabled by the [BSM] option pricing technology"); Figlewski, *supra* note 93, at 1289 (acknowledging that "[v]irtually all market participants are aware of the model and use it in their decision making" and that academics "typically conclude that, while not every feature is accounted for, the model works very well in explaining observed option prices").

100. *See, e.g.*, Xintong Zhan, Bing Han & Qing Tong Cao, *Option Return Predictability*, 35 REV. FIN. STUD. 1394, 1395 (Mar. 2022) (investigating "option return predictability beyond those simply inherited from the underlying stock return predictability"); Mobina Shafaati, Don M. Chance & Robert Brooks, *The Cross-Section of Individual Equity Option Returns* (2022), https://ssrn.com/abstract=3927410 (analyzing option- and stock-level characteristics "to evaluate their contribution to the cross-sectional variation in expected returns of delta-hedged option portfolios," which by construction are hedged against price movements in the underlying stock).

101. For example, as of August 26, 2024, Alphabet Inc. Class C stock (symbol GOOG), selling for about $167.97, has options available up to December 2026 and strikes as low as $45 and as high as $270. *GOOG - Quotes Dashboard*, CBOE, https://www.cboe.com/delayed_quotes/goog/quote_table [https://perma.cc/DJ2S-CSGQ] (last visited Aug. 26, 2024).

102. *See, e.g.*, Options Listing Procedures Plan, *supra* note 59, § 3 (describing

there is no volume, these option series are made available by the exchanges on the off chance that someone would want to trade them. Over time, as the options have progressively shorter maturities, and as the stock price fluctuates, the option series that were previously only lightly traded could begin to gather trading volume.

In the *Apple* case, defendants asserted that dividing total volume among all option series by the total number of option series available for trading showed a low average level of volume per option series.[103] The computation misrepresents option market volume by diluting a large number until it appears small. In the case of the Apple options, defendants argued that Apple, the most actively traded options for the last ten years, may have traded in an inefficient market simply because many of the individual option series had light trading.[104] This argument falters, as the average per series metric it relies on distorts reality, and it also incorrectly assumes option efficiency requires high volume.[105]

Diluting total volume by exploiting the fact that the options exchanges offer a wide range of products, and then claiming the diluted figure is evidence of inefficiency, also punishes the exchanges for their efforts to meet investors' needs. It is certainly in an exchange's interests to be an efficient market. Why would an exchange take an efficient market and turn it into an inefficient one by adding option series that might have low trading volume? It is clear that low trading volume on some option series does not turn an efficient market into an inefficient one.

Suppose counterfactually that low average volume per option series were indeed a marker of inefficiency. Now consider an exchange that offers heavily traded options, all presumably efficient, as is evident by their high volume. Near-the-money options with expirations of a month or less tend to have the highest volume, so the exchange might initially offer only those option series. Would broadening the array of offered option series to include less popular option series make the original option series suddenly inefficient? The answer is, of course, no, but doing so would lower the

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notification process for listing a new series within an existing option class).

103. *See* Expert Report of Steven Grenadier at 41–45, *In re* Apple Sec. Litig., No. 19-CV-2033 (N.D. Cal. June 24, 2022).

104. *See id.*

105. An analogy illustrates how volume per option class, where the averaging includes the lightly traded classes, is an uninformative, if not nonsensical, metric. Consider a basketball game in which Team A defeated Team B by a wide margin, 80–62. Team A played all 12 players on the team, while Team B played only 8 of its 12 players. The average points scored by a player on Team A was 6.7, while the average points scored by a player on Team B was 7.8. Thus, the average player on Team B outscored the average player on Team A, even though Team A scored far more points and won by a wide margin.

volume per option series metric.

Moreover, the tight link between option prices and the price of the underlying stock is enforced by arbitrage, which does not require high volume. Even if option trading is light, if an option price should fail to appropriately react to a change in the underlying stock price, a single arbitrageur can exploit the mispricing and thereby force the option price to respond. Clearly, lightly traded options are not inefficient, suggesting that volume, and particularly volume diluted over all option series available, does not suggest inefficiency.

And there are further ways to show efficiency.

3. The Concept of Option Delta and Its Implication for Efficiency

One of the most important concepts used by options traders is the "delta." An option's delta is formally defined as the change in the option price for a given change in the underlying stock price. All option pricing models recognize that options move with their underlying stocks and quantify not only the price of the option, but also the option's delta. That is, pricing models recognize and incorporate the cause-and-effect relationship and indicate how much the call option price should move for a given unit change in the underlying stock price.

Call option deltas range from 0 to 1, while put option deltas run from –1 to 0. For example, the interpretation of a delta of say 0.55 for a call is that for each $1 change in the stock price, the call will move 55% of the move in the stock, or $0.55. A put delta of –0.42 means that a put will move 42% of the move in the stock price but in the opposite direction.[106] With a delta of –0.42, a $1 increase in the underlying stock price would elicit a –$0.42 change in the price of the put option.

These acceptable ranges of deltas are not artificial. Call option deltas are less than one because a call cannot rationally move more than the stock price, given that exercising the option only results in a long position in the stock. A call can never have a delta of less than 0, as there are no circumstances in which it will move inversely to the stock. In a similar manner, a put delta can never be positive, as it can never move in the same direction as the stock. A put delta can never be less than –1, as all it can ever ultimately do is produce a short position in the stock. Theoretical pricing models such as BSM and the binomial model produce deltas that

106. In the vernacular of the options business, deltas are not referred to as decimals or percentages. A call delta of 0.55 is called a "55 delta call." A put delta is never referred to as a negative. Thus, a put delta of –0.42 is called a "42 delta put." The inverse relationship for puts leading to a negative delta is simply understood.

conform to the rational ranges given above.

Deltas are ubiquitous in the world of options. They are covered in textbooks and studied by traders.[107] The Chicago Board Options Exchange website displays real-time prices, alongside the deltas and other items of contemporaneous information on the listed options.[108]

Dealers use delta to hedge their risk.[109] For example, when a dealer sells a call to a member of the public, the dealer has a short position and is exposed to upward moves in the stock. The dealer could hedge by buying the stock or another option on the stock in such quantity as to offset the risk. For example, if the delta is 0.5, then the dealer can buy 1,000 shares of stock to offset a position in 2,000 options. Since the options move half the move in the stock, twice as many options as shares of stock will provide an offset. This action is known as delta hedging. The widespread use of option deltas for hedging purposes evinces the general acceptance of the quantifiable cause-and-effect relationship between stock and option prices.

As noted, both call and put deltas can be near zero, meaning that their prices would not be expected to change much as the stock price changes. These situations occur when the call or put is deep out of the money.[110] Defendants may jump on such a condition and point to options with very low deltas as indicative of inefficiency, but this argument is specious. For

107. *See, e.g.*, DON M. CHANCE & ROBERT BROOKS, AN INTRODUCTION TO DERIVATIVES AND RISK MANAGEMENT 160–62 (10th ed. 2016); Zhan, Han & Cao, *supra* note 100, at 1395 (observing that "[o]ption traders and market makers frequently use delta-hedging to reduce the total risk of an option position").

108. For example, CBOE provides information about traded options on Microsoft (MSFT): Last (last trade price), Net (change in price on last trade), Bid (best bid price quoted by any dealer), Ask (best ask price quoted by any dealer), Vol (volume of 100-unit contracts traded that day), IV (the implied volatility, which is the volatility that if inserted into the binomial option pricing model would produce the most recent price), Delta (as explained in this section), Gamma (another risk measure, reflecting the sensitivity of delta to a stock price change), and Int (open interest). *MSFT - Quotes Dashboard*, CBOE, https://www.cboe.com/delayed_quotes/msft/quote_table [https://perma.cc/CH5V-R6GR] (last visited Aug. 26, 2024).

109. For an examination of delta hedging in the context of a Rule 10b-5 action involving over-the-counter options on individual stock, see Caiola v. Citibank, N.A., 295 F.3d 312, 329 (2d Cir. 2002) (finding that defendant materially misled plaintiff in violation of Rule 10b-5 "as it abandoned delta hedging and bought and sold exchange-traded stock and options on his behalf without disclosing these activities to him").

110. A call option is out of the money (OTM) when the underlying stock price is below the option strike, such that exercise at that time would not be profitable or rational. A put option is OTM when the underlying stock price is above the option strike. Alternatively, a call (put) is in the money (ITM) when the stock price is above (below) the strike price. A put or a call is at the money (ATM) if the stock price equals the strike price. *See infra* Appendix §B.

deep OTM options, the delta might be quantifiably low, but the relationship is still strong. The magnitude of the delta is indicative of the likelihood of the option expiring either ITM or OTM. When a call expires ITM, it converts into a position in the stock, which has a delta of 1, meaning that it simply moves one-for-one with itself, the underlying stock. When a put expires ITM, it turns into a short position in the stock, which has delta of –1, meaning that it moves opposite the stock price one-for-one. When either option expires OTM, it pays nothing and ceases to exist, and, hence, the delta is zero at expiration. Before expiration, the deltas move toward 1 for calls and –1 for puts as these options move toward expiring ITM. The deltas for both calls and puts move toward zero as the likelihood of expiring OTM increases. Delta is closely related to the probability that an option will expire ITM.

A deep OTM option has little likelihood of expiring ITM. Hence, its delta is near zero, and it will not move much when the stock price changes. An increase in the stock price will not significantly increase the likelihood that a deep OTM call will expire ITM, so that call's price will not increase much, if at all. But this degree of insensitivity of a deep OTM option to the stock price is not inefficiency. Rather, it reflects the appropriate degree of sensitivity. Such a condition is analogous to a basketball game in which one team is very far behind but then scores a basket. The likelihood of that team winning has not increased appreciably.[111] Hence, if a deep OTM option did not move significantly in response to a stock price change, it would not be evidence of inefficiency.

The very existence and critical nature of the concept of delta is proof that the options market is informationally efficient when the underlying stock trades efficiently. If the underlying stock moves in reaction to information, then the question of informational efficiency for the option is the question of whether the option moves when the stock moves. The generally accepted metric of delta measures that option movement. If options did not move with stocks, all deltas would be zero. Hence, the mere existence, general acceptance, and widespread use of the delta metric are proof that an options market is informationally efficient when the market for its underlying stock is efficient.

111. It should be apparent that deltas will not likely be zero if there is a considerable amount of time remaining. When options begin to run out of time and are deep OTM, then the deltas will be near zero. This is much like the sporting analogy. A team far behind just part of the way through the game is not in a hopeless situation, but if that team is far behind and running out of time, the outcome may indeed be more or less a foregone conclusion.

4. The Role of Bid and Ask Prices in Determining Efficiency

Let us use a numerical example drawn from trading in Apple stock and associated options to illustrate how bid-ask spreads differ for stocks and options.[112] At the end of the trading day on June 26, 2023, Apple stock was at $186.11 bid and $186.12 ask, a spread of $0.01 per share. Bid-ask spreads are often expressed as a percentage of the midpoint of the spread. Hence, the percentage bid-ask spread was 0.00537% (= $0.01 divided by $186.115). At the same time, an approximately one-month call option with a $190 strike price had a $2.71 bid and a $2.76 ask, which is a spread of $0.05. In percentage terms, the option bid-ask spread was 1.82% (equal to the $0.05 spread divided by the $2.735 midpoint). The call bid-ask spread in percentage terms was more than 340 times larger than the stock's percentage bid-ask spread.

This characteristic that the option had a much larger percentage bid-ask spread than did the stock is shared by all options and is explainable and not inconsistent with market efficiency. At the time of the quote, more than 8,000 contracts had traded that day and there were more than 47,000 contracts of that option outstanding. It was one of the most active Apple options. The much higher option bid-ask spread percentage was due to the much lower price of the option relative to the stock.[113]

Simply comparing option bid-ask spreads to the standards applied to stocks is highly misleading. Option prices are lower than stock prices, and option volume is lower than stock volume, and yet market making must pay a reasonable return.[114] Hence, spreads must be higher.

Moreover, the existence of and movements in bid and ask prices for every option provides strong evidence of efficiency. The market infrastructure and tools used by market makers rely on there being a close relationship between option prices and the price of the underlying stock.

112. Contemporaneous bid and ask quotations for Apple stock and associated options can be accessed by clicking on "Options" for delayed options data on the CBOE's website. *AAPL – Quotes Dashboard*, CBOE, https://www.cboe.com/delayed_quotes/aapl [https://perma.cc/MX25-KZW4] (last visited Nov. 10, 2024).

113. As another example, the deep OTM one-month call option struck at $235 had a bid of $0.01 and an ask of $0.03. Its bid-ask spread was thus $0.02, or 100% of the midpoint. This option had traded 53 contracts at that time during that day, which is a somewhat large total for a bet that Apple would rise more than 26% in one month. The large percentage bid-ask spread, however, was not an indication that it traded inefficiently. The very purpose of this option's existence was to be a vehicle to tailor exposure to the underlying stock, and thus its valuation was a function of the underlying stock price.

114. For more information on the SEC's oversight of bid-ask spreads on options exchanges, see Competitive Developments in the Options Markets, Exchange Act Release No. 100622, 69 Fed. Reg. 6124, 6134–37 (Feb. 9, 2004).

Option exchanges guarantee market makers will be there to take either side of a transaction. Bid-ask quotes are generated by software that converts the six determinants of option prices into the price of the option.[115] It is absolutely necessary to use software because at any time there are hundreds of options on a given stock and thousands of options available for trading in the entire market. As a result of market-making being largely automated, the response of an option price to new information is quite rapid. For example, one study found that Apple option bid and ask prices update over 9,000 times per second.[116]

Of course, not all options trade as actively as Apple, but all exchange-listed options are priced by market makers using software that converts the six determinant factors into actual option prices. The algorithms and software used by market makers to determine the bid-ask spread take the relationship between option prices and the underlying stock price as a given. Thus, all option bid and ask prices respond instantly to new information, and how they do so supports the efficient relationship between option prices and the underlying stock.

5. Empirical Evidence to Demonstrate Efficiency

Based on generally accepted theoretical principles and prior empirical research, courts should accept that all markets for options are efficient to the degree required for certification in class action litigation if their respective underlying stocks are proved efficient. Some courts may nonetheless require further evidence. Such evidence is easy to obtain.

In *Apple*, to establish that Apple stock traded in an efficient market, plaintiffs' expert Feinstein conducted an event study, a standard and widely accepted methodology for extracting the price response to new information specific to a company. The event study focused on the four Apple earnings announcements over a year.[117] Feinstein used this approach to demonstrate that Apple stock responded to Apple's earnings announcements. Defendants did not challenge, and the Court accepted Feinstein's evidence and conclusion that Apple stock traded in an efficient market.[118]

115. These six determinants are the stock price, the exercise price, the risk-free rate, the time to expiration, the volatility of the stock, and the expected dividends on the stock over the life of the option. *See infra* Appendix §D.

116. *See* Andersen et al., *supra* note 73, at 142 tbl.3.

117. *See* Expert Report on Market Efficiency of Steven Feinstein, *In re* Apple Sec. Litig., No. 19-CV-2033 (N.D. Cal. Apr. 15, 2022).

118. *In re* Apple Inc. Sec. Litig., No. 19-CV-2033, 2022 WL 354785 (N.D. Cal. Feb. 4, 2022) (order granting in part and denying in part a motion for class certification re: Dkt. Nos. 165, 206).

Feinstein then extended the methodology to Apple's options. He calculated a synthetic stock price using European put-call parity, a pricing relationship whereby a stock price is implied by the price of the call minus the price of the put plus the present value of the option exercise price.[119] This synthetic stock price was then evaluated for its response to the earnings announcements, likewise using the event study approach. Feinstein reasoned that if the stock price implied by option prices reacted significantly to Apple's earnings announcements, it followed that the option prices themselves must have been reacting to Apple's earnings announcements.[120]

This is a powerful but difficult test to pass, because not all earnings announcements generate a significant stock price reaction. Stock price reactions on earnings announcement days are determined by whether the announced earnings, and other corporate information simultaneously released, surprised investors and financial analysts who follow the stock. Feinstein found that the synthetic stock price reacted significantly three out of four times in the 2018 sample year, which is quite compelling evidence of the efficiency of the Apple options.

Defendants countered that the put-call parity formula being used was for European options and that the Apple options were American-style.[121] This response is unavailing for several reasons. Omitting the early exercise premium in the call price biases the implied synthetic stock price in one direction, but the omission in the put price biases the implied synthetic stock price in the other, at least partially offsetting. Moreover, the early exercise premium would not change notably over the single day of the earnings announcement. Since the synthetic stock price return is a percentage change in response to the earnings announcement, the effect of disregarding the American option early exercise premium should be immaterial.

Defendants further pointed out that the put-call parity test covered

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119. To understand the concept of the present value of the option strike, consider a one-year option in which the strike is $100, and the risk-free rate of interest is 5%. The present value of the strike is $100/1.05 = $95.24. This means that $95.24 invested at 5% for one year grows to $100. To obtain the synthetic stock price implied by the call and put option prices, consider a call priced at $7.25 and a put priced at $4.89. Then the implied stock price is $7.25 – $4.90 + $95.24 = $97.59. This number should be very close to the actual stock price. European put-call parity was used with these American options, as American put-call parity is stated only as inequalities and cannot produce a unique implied stock price.

120. *See* Expert Report on Market Efficiency of Steven Feinstein, *supra* note 117, at 40–49.

121. *See* Expert Report of Steven Grenadier at 71–79, *In re* Apple Sec. Litig., No. 19-CV-2033 (N.D. Cal. July 9, 2021).

only four days out of the year.[122] This argument, too, falters, as the four earnings announcement days were compared to the control sample of all other trading days, such that all days were considered in the test, not just the four earnings announcement days. Moreover, focusing the event study on a small set of high information flow days is the generally accepted methodology for a market efficiency event study applied to a stock in a securities case. If the test design is valid for the analysis of stocks, it should also be appropriate for the analysis of options. Nonetheless, the Court initially denied certification of the Apple options without prejudice and requested more analysis and evidence.[123]

Dr. Don Chance examined Feinstein's synthetic stock price test and found that over the sample period the synthetic stock price implied by the Apple options had a more than 0.99 correlation with the actual stock price.[124] This correlation is a powerful indicator of informational efficiency of the options, as it shows that whatever information was affecting the stock price on a day-to-day basis was captured by the synthetic stock price, which means that the information moving the stock was also captured by the options. The synthetic stock price was completely determined by the option prices. Hence, a high positive correlation when the stock has already been deemed efficient is dispositive of the efficiency of the options.

Additional empirical evidence of the link between option prices and the underlying stock can be found in an examination of the option bid and ask prices. Detailed options data can be obtained from any provider of daily options data, such as OptionMetrics or iVolatility. These services provide the closing bid and ask prices; the last sale, volume, and open interest; and various other data items for all options. With this data, one can directly examine whether the bid and ask prices responded to stock price changes.

The bid and ask prices should adjust with changes in the stock price. Specifically, if the stock price increases, the bid and ask prices for calls should also increase; conversely, if the stock price decreases, the bid and ask prices should decrease. With the Apple options data, Chance measured the midpoint of the bid and ask prices for more than 152,000 calls and a similar number of puts. He examined whether these price quotes changed in the correct direction when the Apple stock price changed. The correct change occurred more than 80% of the time for calls and more than 79% of

122. *Id.* at 81–82.

123. *See* text accompanying *supra* note 63.

124. *See* Reply Report of Dr. Don Chance at 15, *In re* Apple Inc. Sec. Litig., No. 19-CV-2033 (N.D. Cal. Aug. 26, 2022). It is a basic principle of statistics that the correlation coefficient is a number that ranges between -1.00 and 1.00. A correlation of 0.99, therefore, is near the maximum highest level.

the time for puts.[125]

One might ask why the correct change did not occur 100% of the time. As noted earlier, no scientific test is ever perfect, and a particular result, even if it is the general rule, is rarely obtained 100% of the time. Several factors can explain why in this case the options did not move every single time in the direction that would be seemingly correct given only the stock price change:

- One reason is that, in addition to the effect of the underlying stock price change, option prices are also impacted by expected stock *volatility* as perceived by traders in the market. If volatility changes, the option price could be pulled in what seems to be the incorrect direction considering only the stock price change. Moreover, in the examined data, some stock price changes were small, which would elicit only a very small option price change that could be overwhelmed by the volatility effect. Also, deep OTM options with very low deltas would appropriately move little in response to a stock price change, so that in those cases the stock price effect could be overwhelmed by the volatility effect, which can move the option price in the direction opposite to the stock price effect.

- Option prices also change with the lapse of *time*. This effect is called *time value decay*. One day of time value decay is not a lot, but it does put a drag on the option price, potentially pulling the option price downward. Thus, for some options, the stock price change would be exerting an upward impact while the observed price change could be a decline due to time value decay.

- Changing *interest rates* also have an effect on option prices, but the effect is small, and interest rate changes over the course of a single day are typically minute.

Notwithstanding all of these potentially confounding effects, in the Apple data analyzed by Chance, the options changed in the correct direction corresponding to the stock price change approximately 80% of the time. This finding was a statistically significant outcome that is highly improbable to occur randomly if there was no link between the option prices and the underlying stock price.

125. *Id.* at 16.

Another similar test can prove definitively that options move in reaction to a stock price change and do so in the correct direction. Deep ITM calls are those that have a high likelihood of being exercised and turning into the stock, while deep ITM puts have a high likelihood of being exercised and turning into a short position in the stock. Hence, the bid and ask prices of deep ITM call options should behave very much like the underlying stock price, with calls moving up (down) when the stock moves up (down). Bid and ask prices of deep ITM puts should move in the opposite direction, that is, up (down) when the stock moves down (up). For deep ITM options, the stock price effect will almost always outweigh any countervailing effect of the other relevant variables.

Chance defined deep ITM for calls to be when the stock price was at least 50% above the exercise price, and for puts to be when the stock price was at least 50% below.[126] For the Apple options data, this definition produced a sample of more than 43,000 calls and about 1,200 puts.[127] The results were that more than 97% of the time for calls and more than 98% of the time for puts, the midpoint of the bid-ask spread moved in the correct direction given the stock price change. Chance also computed the empirical delta, a measure of the actual call price change divided by the stock price change. For deep ITM options, this figure should be close to 1 for calls and –1 for puts. The empirical delta was 0.960 for calls and –0.939 for puts.[128] These numbers are clearly very close to what they should be according to theoretical option valuation principles. Thus, this examination showed that the options did move as the stock price changed; they moved in the correct direction and by the theoretically correct amounts.

These results are all the more notable in that deep ITM options are very low volume options, accounting for less than 2% of all trading volume in this sample. These tests demonstrate that movement in the option bid and ask prices can be compelling proof of option efficiency, and low volume does not indicate inefficiency.

126. *Id*. at 17–18.

127. *Id*. at 17. The small number of puts resulted from the fact that to obtain a large number of deep OTM puts would have required that the Apple stock perform poorly over the sample period. It did not. Moreover, call moneyness is unlimited, as the stock price has no upper limit, whereas the stock price is limited on the downside to zero, thereby limiting put deep-in-the-moneyness.

128. *Id.*

IV. A COMMON METHODOLOGY FOR CALCULATING OPTION DAMAGES

As discussed in Part II.B, courts require that for a class to be certified, there must exist a methodology for calculating damages that is common for all proposed class members. In *Apple*, defendants contended that the options were so diverse, spanning such a wide range of expirations and moneyness, as to make the use of a common damages methodology impossible.[129] This argument is naïve and invalid. It belies understanding of option valuation. The damages methodology compares the actual option prices that existed on account of the fraud, with the option prices that would have prevailed in the but-for scenario if there was no fraud. The same common option valuation model can value options in the actual and but-for scenarios for all option series. Thus, the same out-of-pocket damages methodology can be applied to compute damages for all option series.

While the parameter values to be inserted into the common option valuation model may differ from one option series to another, the valuation formula and the damages methodology do not differ among the option series. Let us now take a look at how to use the option valuation model to compute damages.

A. How Option Buyers and Sellers are Damaged by Fraud on the Market

Before addressing this point with regard to options, we illustrate the concept of a common methodology in a hypothetical case involving mortgages. Suppose a mortgage lender is accused of charging a higher interest rate to compute the mortgage payment than the rate stated in the mortgage note. A proposed class may comprise borrowers with diverse mortgage terms, having in common only that they were all allegedly overcharged for interest. Their loans may have had different principal amounts and different term lengths. Some may be standard thirty-year loans, some may be fifteen-year loans, and some may be for other periods. Even the stated contractual interest rates may vary among the contracts. The common allegation, however, is that regardless of the mortgage terms and stated interest rates, the lender charged a higher interest rate when

129. *Id*. at 19–22. The term *moneyness factor* or just *moneyness* is the ratio of stock price to exercise price. It measures how far ITM or OTM an option is given the current underlying price.

computing the monthly mortgage payments.

For this hypothetical plaintiff class, even though contract details and the magnitude of damages will vary from one borrower to the next, a common damage computation formula can be applied for all borrowers. It is a simple matter to use a mortgage rate calculator to recompute what the payment amount should have been had the appropriate interest rate been charged. The broad range of diverse mortgages is not an obstacle to computing damages commonly for all borrowers using a common damages methodology.

Option buyers and sellers similarly choose which options they will purchase and sell. They select the underlying stock, the expiration, and the exercise price from among the array of series specifications offered by the exchange. That is, exchanges offer options on certain underlyings, with certain expirations, and certain exercise prices. The buyer and seller negotiate the option price, both presumably aware of the Law of One Price, assuring that the transaction price will be fair and correct relative to the stock price.[130]

If a stock trades in an efficient market, its price reflects all public information. The price of every option on the underlying stock reflects the stock price, and thus it too reflects all public information. The option any party chooses to buy or sell will have a certain degree of "moneyness" that represents how far ITM or OTM the option is. Moneyness represents the relation of the stock price to the exercise price. If the stock price is inflated due to fraud on the market, the investor pays for an option with a certain perceived degree of moneyness, but actually acquires a position in an option with a different degree of moneyness. If the stock price is artificially inflated, a call option buyer will have overpaid for the option they received, and a put option writer will have been underpaid for the option they sold.

For example, suppose the stock price is $200 and the strike of the call option in which the buyer is interested is also $200, making this an ATM option. The buyer will pay a price that reflects the option being ATM. But suppose there is fraudulent inflation in the stock price in the amount of $20. This means the stock price ought to be $180, meaning that the option is really OTM by $20. The investor paid for an ATM option but received one that was $20 OTM. For calls, the higher the stock price in relation to the strike, the more the call option will cost and so the more the buyer will pay. Given that the stock price is perceived to be $200, though should really be $180, the buyer will pay more than the option is worth. This is essentially

130. The Law of One Price states that equivalent assets or combinations of assets must sell for the same price. *See infra* Appendix §D.

the same as buying a "lemon." The option was of considerably poorer quality than the buyer believed and for which it paid.

Likewise, the seller of the put is hurt by fraudulent inflation in the stock price. Consider that same strike but make the option a put. The seller will receive a price based on the perception that the put is ATM. But if there is $20 of fraudulent inflation in the stock price, the put is really $20 ITM. An ITM put option is worth more. Hence, the seller of the put will receive too little for the put option.

B. Applying an Option Valuation Model to Compute Option Damages

In a case where fraudulent misrepresentations or omissions are alleged to have misled investors and altered market prices, plaintiffs' proposed model for calculating damages "must measure only those damages attributable to that theory."[131] For stocks, as we mentioned, the event study methodology can do this. An event study—coupled with other valuation analysis if necessary—can quantify how much the alleged misrepresentations and omissions artificially inflated the stock price by measuring how much artificial inflation a corrective disclosure dissipated. The level of artificial inflation in the stock price at time of purchase, minus any remaining artificial inflation in the stock price at time of sale, measures an investor's loss caused by the alleged misrepresentations and omissions.

In a straightforward and common manner, one can use the results of the same stock price event study, in combination with an option valuation model, to assess option damages caused by the misrepresentations or omissions. For example, consider a stock priced at $200 in which the expert determines that $20 of the stock price was fraud-induced artificial inflation. From there, with the aid of an option pricing model, we can estimate the effect of $20 of stock price inflation on option prices and, thus, in turn compute the damages to options investors.

Call buyers and put sellers are harmed by an inflated stock price.[132] Artificial inflation in a stock introduces artificial inflation in a call price and artificial depression in a put price. Therefore, call buyers overpay when

131. Comcast Corp. v. Behrend, 569 U.S. 27, 35 (2013).

132. Conversely, call sellers and put buyers are harmed by an artificially deflated stock price. *See, e.g.*, Pampena v. Musk, No. 22-CV-5937, 2024 WL 4331811, at *7 (N.D. Cal. Sept. 27, 2024). Technically it is possible for *sellers* of calls and *buyers* of puts to be hurt by price inflation under certain rare circumstances, notably volatility changes and time value decay. We do not take up these pathologies here because we expect that courts would not consider these traders' claims as "typical" of the class for purposes of Rule 23(a)(3). Such traders could nevertheless proceed individually for relief.

the stock is artificially inflated, and put sellers are underpaid.

To calculate option damages, we need to reprice the option when the position was opened, eliminating the effect of the fraudulent inflation in the stock price, and also reprice the option when the position is closed, eliminating the effect of any remaining fraudulent inflation at that time. The change in the effects of artificial stock price inflation on the option price over the holding period measures the loss sustained by the option investor that is attributable to the fraud. For a call option buyer, this methodology would measure how much the investor overpaid when the option was bought and nets out how much of the overpayment was recouped when the option position was later closed, either by resale of the call option, exercise, or expiration. For a put option seller, this methodology measures how much the seller was underpaid when the option was initially sold and nets out how much of this underpayment was recouped when the short put position was closed, either by repurchase, exercise, or expiration.

While this would be the proper way to find the true financial loss, as discussed below, statutes and case law impose various constraints on recoverable damages.[133] For example, Section 21D of the Securities Exchange Act of 1934 restricts recovery to be no greater than the amount of money the investor actually lost.[134] Thus, the damages to the call buyer are the lesser of the decline in the call price over the call buyer's holding period (the investment loss), or the decrease in the artificial inflation. For put sellers, the damages are the lesser of the increase in the put price over the holding period, or the decrease in the artificial depression in the put price.

C. Implementing the American Binomial Option Pricing Model

We can use an option pricing model to compute artificial inflation in calls, artificial depression in puts, and thus compute damages to call buyers and put sellers.[135] The binomial model is a generally accepted and state-of-the-art option valuation model that provides a convenient and easy-to-use means of estimating damages for American-style options, such as those that trade on U.S. exchanges.[136] While the binomial model allows the stock to

133. *See infra* Part IV.E (discussing the U.S. Supreme Court's opinion in *Dura Pharmaceuticals* and paragraph (e) of Section 21D of the Exchange Act).

134. *See* 15 U.S.C. § 78u-4(b)(4).

135. For a review of generally accepted option pricing principles, see *infra* Appendix §D.

136. *See infra* Appendix §D; *see also* John C. Cox, Stephen A. Ross & Mark Rubinstein,

make only two moves in a particular short period, up or down, it can nonetheless be made to approximate reality.

Consider a one-month option, which is relatively short-term. Application of the binomial model would involve dividing that one-month life into a large number of time units, say 1,000, which are referred to as time steps. With about 30 days in a month, 1,000 time steps in the month would imply about 33 time steps per day, or a little more than one per hour. The factors that determine how much the stock can move up or down per time step as well as the risk-free interest rate are adjusted accordingly.[137]

The binomial model requires as inputs the six factors that determine an option value: stock price, exercise price, risk-free interest rate, time to expiration, volatility of the stock, and dividends on the stock over the life of the option.[138] One simply inserts all of the parameters and the but-for stock price into the binomial model to obtain what the option price would have been had the underlying stock not been artificially inflated. There are some technical factors that must be addressed, however, and we cover them here with an illustrative example.

D. Technical Considerations and an Illustrative Example

Consider the case where an investor paid $4.34 to buy a one-month call option with strike price of $100 on an underlying stock whose price was $100 at the time of purchase. As the option's strike price equaled the underlying stock's market price, the option was ATM at the time of purchase. Suppose additionally that the stock was set to pay a dividend of $0.75 in 10 days. While the purchased call option was ATM, suppose there was an array of available options on the same stock that had exercise prices ranging between $70 and $130, in increments of $5. With a risk-free rate of

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Option Pricing: A Simplified Approach, 7 J. FIN. ECON. 229 (1979). Some may be tempted to use the BSM model, *see* text accompanying *supra* note 91, but the BSM model is not designed to handle the early exercise feature of American-style options, and modifications to the BSM model for this purpose produce less precise valuations than does the binomial model. At one time, the speed of computers was such that the BSM model was much faster than the American binomial model. The BSM model is still faster than the American binomial model, but the difference in speed has shrunk considerably. In many cases, the differences in computed values are small. The American binomial model, however, is easy to use, and there is simply no reason to sacrifice precision for speed.

137. For example, an annual interest rate of 3% must be adjusted downward if each time step is not a year—here, a little more than an hour. The adjustment is simple and well-known to all options experts. There are well-known formulas for obtaining the binomial parameters that model up and down moves such that the model reflects the actual volatility and price dynamics of the stock.

138. For a discussion of these factors, see *infra* Appendix §D.

3%, according to the binomial option pricing model, the $4.34 market price implies that market participants believed that the appropriate volatility parameter for valuing that ATM call option was 40%.[139]

Now, suppose the expert economist determines that when the option was purchased, there was fraud-induced artificial inflation in the stock price in the amount of $12.48 per share. This means that but for the alleged fraud, the stock price would have been $87.52 (= $100 – $12.48). So, the investor bought what was thought to be an ATM option, paying what seemed to be a fair price of $4.34, but what the investor actually got was an option that was OTM by $12.48, and thus was significantly overpriced due to the alleged fraud. Using the binomial option pricing formula, we can determine what the investor should have paid for this artificially inflated OTM call option.

The term *moneyness factor*, or just *moneyness*, is the ratio of stock price to exercise price. It measures how much an option is ITM or OTM. But for the fraud, the option purchased would have had a moneyness factor of 0.8752 (equal to the $87.52 but-for stock price divided by the call option's $100 strike price). We can reprice the call option with the but-for stock price of $87.52. But to do so, we need the appropriate volatility input for an option with moneyness of 0.8752. Ideally, one would look to an option that did have a moneyness of 0.8752 and determine what volatility level was implied by the observed market price of that particular option. But when the stock price was at $100, to obtain moneyness of 0.8752 would require a strike of $100/0.8752 = $114.26. But the available options had strike increments of $5, so there were options with strikes of $110 and $115 but not $114.26. Nonetheless, we can interpolate and use the information of the $110 and $115 strike options to obtain a good estimate of the implied volatility appropriate for an option with a strike of $114.26.[140]

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139. We are ignoring differences in bid and ask prices. Implied volatilities exist for both the bid and ask prices. For a call buyer, we would be dealing with the ask price. For a put seller, we would be dealing with the bid price. For this example, assume the transaction price is an ask price.

140. Interpolation is widely used in the financial world. In bond markets, accrued interest is the total amount of interest that has been accumulated since the last payment day. It is always calculated by linear interpolation even though interest does not accrue linearly. Also, in bond markets, there are benchmark interest rates, such as the yield on a ten-year U.S. Treasury bond. It is rare, however, that a precisely ten-year Treasury bond exists, so benchmark yields are interpolated from the rates on maturities that surround ten years. In option markets, implied volatility is graphed against moneyness, and the value of implied volatility for hypothetical strikes between those that trade is determined by interpolation. Nonlinear interpolation can be used for greater precision, but linear interpolation is likely to provide very close results.

The $110 strike option traded at a price of $1.45 and an implied volatility of 42.0%. The $115 strike option traded at a price of $0.89 and an implied volatility of 44.5%. Thus, we know that the implied volatility of a hypothetical option struck at $114.26 is between 42.0% and 44.5%, though much closer to 44.5%. Using linear interpolation gives an implied volatility of 44.1%. This is a good estimate of the volatility input appropriate for the hypothetical option that has moneyness of 0.8752.

We can now reprice to find what would have been the market price of the $100 strike call option if the stock price had been the uninflated $87.52 per share. We use the same time to expiration, same risk-free rate, and same dividend information, but we use a volatility input of 44.1%. Plugging these parameter values into the binomial option pricing model, we obtain a but-for value of $0.82. Since the actual purchase price of the option was $4.34, but should have been $0.82, the initial price of the option was artificially inflated by $3.52 ($4.34 – $0.82 = $3.52). This artificial inflation is the amount by which the investor overpaid for the option on account of the alleged fraudulent misrepresentations and omissions.

Suppose this investor held the option to expiration, but in the interim the fraud was revealed, dissipating all artificial inflation from the stock price, and in turn dissipating all artificial inflation from the call option price too. The investor would have bought the option when it was artificially inflated by $3.52 and closed out the position when there was no artificial inflation. Thus, the change in artificial inflation in the call price would be the entire $3.52 of original artificial inflation. The compensable damages are this $3.52 decline in artificial inflation, or the total decline in the option price over the investor's holding period, whichever is less. If the call option expired out of the money, such that the terminal option price was $0, the change in the option price over the investor's holding period, representing the investment loss, would be $4.34 (the $4.34 purchase price minus the terminal $0 value). Damages would be $3.52 per option, as the $3.52 decline in artificial inflation is less than the $4.34 investment loss.

Put sellers also would have been harmed by the fraud. Here the put seller who sold the $100 strike put was ostensibly selling an ATM put, but in reality was selling a put that was $12.48 ITM. Therefore, once again, we would need information from a put struck at $114.26 to reprice the sold put option. Put and call implied volatilities are typically different, so one must be careful to use the put implied volatility. The procedure, nonetheless, is the same and would reveal that the put seller received too little. Supposing the artificial depression in the put price was $3.00 when the put seller sold the put and was $0 when the put seller closed out its position. The change in artificial depression would be $3.00. Compensable damages would be

the lesser of this $3.00 change in artificial put price depression and the total increase in the put price over the holding period.

E. Computing Damages Limited to Losses Precipitated by Corrective Disclosures

The Supreme Court's decision in *Dura Pharmaceuticals* has been interpreted by some damage experts to prescribe that recoverable damages can be no greater than the amount by which artificial inflation in the security dissipated specifically as a result of corrective disclosures.[141] The restriction on damages pursuant to this interpretation of the *Dura* case decision is known as the "Dura cap."[142]

Over an investor's entire holding period, artificial inflation in a call option can decline either because of corrective disclosures that reduce the underlying stock price or due to time value decay that reduces how much option inflation is produced by a given level of stock inflation. To restrict measured damages to include only the inflation dissipated by corrective disclosures, one can apply the methodology illustrated above to a window surrounding each corrective disclosure rather than use the methodology to measure the change in inflation over the investor's entire holding period.[143] That is, one can compute how much artificial inflation dissipated from a call option (or artificial depression from a put option) on each corrective disclosure date on account of the corrective disclosure. Damages would comprise the sum of such local changes in artificial inflation. Damages would still be limited to the lesser of this sum and the total investment loss sustained over the investor's entire holding period.

For example, consider a corrective disclosure that dissipates artificial inflation from a stock on a particular day. To measure how much artificial inflation that corrective disclosure dissipated from a call option, one can observe the stock price and call price after the corrective disclosure and then reprice the call option using the binomial model, inputting the stock price with the artificial inflation added back.[144] The difference between the

141. *See* Allen Ferrell & Atanu Saha, *The Loss Causation Requirement for Rule 10b-5 Causes of Action: The Implications of* Dura Pharmaceuticals, Inc. v. Broudo, 63 BUS. LAW. 163, 175–78 (2007) (interpreting Dura Pharms., Inc. v. Broudo, 544 U.S. 336 (2005)).

142. DAVID TABAK, INFLATION AND DAMAGES IN A POST-*DURA* WORLD 10 (2007), https://dx.doi.org/10.2139/ssrn.1017334. Note that this "cap" is different from the statutory cap on damages imposed by § 21D(e) of the Exchange Act. *See* 15 U.S.C. § 78u-4(e) (limiting damages to the average trading price of the security in the 90-day period following the corrective disclosure). Ferrell & Saha, *supra* note 141, at 175.

143. *Cf.* Fisch et al., *supra* note 53, at 600–01 (discussing this approach).

144. As described earlier, the amount of stock inflation dissipated by the corrective

actual call price observed after the corrective disclosure, which is deflated, and the hypothetical reinflated call price computed by the model is the amount of artificial inflation that was dissipated from the call option price specifically by the corrective disclosure.

An analogous local approach to measuring damages can be implemented for put option sellers. One can reprice put options just after a corrective disclosure using the hypothetically reinflated stock price and compare the resulting hypothetical put price to the actual put price observed at that time. The difference equals the change in artificial price depression eliminated specifically by the corrective disclosure.

As the sum of local changes in option inflation precipitated by corrective disclosures will generally be less than the entire change in artificial inflation over an investor's entire holding period, this methodology produces a more conservative measure of damages. This local inflation change methodology, just like the holding period inflation change methodology, would be common for all prospective option class members.

F. Damage Methodology Conclusion

The damages methodology illustrated above can be used in a straightforward manner to compute the damages sustained by any call option buyer or put option seller on account of fraudulent misrepresentations and omissions. It is a common methodology for all call option buyers and put option sellers so injured. Consequently, this methodology for measuring option damages satisfies the common damages methodology requirement for including options in a class action securities fraud class.

V. EXTENSIONS AND OTHER CONSIDERATIONS

While this article explains that market efficiency and a common damages methodology should be relatively easy requirements to satisfy for option class certification, the parties may raise other legal issues in class certification proceedings involving options that may nonetheless need to be considered by counsel, their experts, and the courts. Before closing, we review some of these additional issues.

First, *Halliburton II* generally limits the class of plaintiffs who are

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disclosure can be determined using an event study, supplemented by financial analysis if necessary to exclude the effects of confounding non-fraud factors. *See supra* text accompanying notes 52–53.

entitled to seek class certification to those who traded the security "between the time the misrepresentations were made and when the truth was revealed."[145] Only options traders that open a position after the false or misleading statement is made and close it after the fraud is revealed suffer damages for purposes of Rule 10b-5. Transactions preceding the fraud are executed at undistorted prices.[146] Closing a position before the fraud is revealed produces performance consistent with what the performance would have been had the misrepresentations been true. Consequently, the class must be limited to call buyers or put sellers who open their position after a misstatement is made and close it—either by an opposite trade, exercise, or expiration—only after the fraud is revealed.

Courts may differ as to whether options traders should be included in the same class as purchasers or sellers of common stock. Several courts have held that a purchaser or seller of common stock can serve as an adequate class representative for options traders, and vice versa.[147] Others have certified separate subclasses for purchasers and sellers of common stock and options traders when their interests and incentives do not appear to be fully aligned.[148] Still others have refused to allow options traders to serve as class representatives.[149] Whether to seek certification of a separate class of options traders in such cases will, of course, turn on practical considerations, such as whether a critical mass of traders can be identified

145. Halliburton Co. v. Erica P. John Fund, Inc., 573 U.S. 258, 268 (2014).

146. *Dura Pharms., Inc.*, 544 U.S. at 342 (noting that if "the purchaser sells the shares quickly before the relevant truth begins to leak out, the misrepresentation will not have led to any loss").

147. *See, e.g.*, *In re* Merck & Co. Sec., Derivative & ERISA Litig., No. 05-CV-1151, 2013 WL 396117, at *5 (D.N.J. Jan. 30, 2013) (discerning "no significant difference in the nature of the securities transactions that would destroy typicality or otherwise cause Lead Plaintiffs not to be similarly situated to purchasers of call options or sellers of put options"); *In re* MicroStrategy Inc. Sec. Litig., 110 F. Supp. 2d 427, 440 (E.D. Va. 2000) (quoting *In re* Orbital Sciences Corp. Sec. Litig., 188 F.R.D. 237, 240 (E.D. Va. 1999)); Strong v. AthroCare Corp., No. A-08-CA-574, 2008 WL 11334942, at *8 (W.D. Tex. Dec. 10, 2008); Hall v. Medicis Pharm. Corp., No. 08-CV-1821, 2009 WL 648626, at *5 (D. Ariz. Mar. 11, 2009).

148. *See, e.g.*, Hoexter v. Simmons, 140 F.R.D. 416, 421 (D. Ariz. 1991) (refusing to "exclude option traders from the Class at this time even though they may require separate treatment as a subclass at some point in the litigation"); Margolis v. Caterpillar, Inc., 815 F. Supp. 1150, 1156 (C.D. Ill. 1991) ("[S]ince Kas's claim as an option holder is not typical of a stock purchaser's claim, this Court finds that Kas can only represent a class of option holders, not stockholders.").

149. *See, e.g.*, McNichols v. Loeb Rhoades & Co., 97 F.R.D. 331, 344 (N.D. Ill. 1982) (considering whether "the issues of both reliance and materiality would be different for a market maker" for the purpose of determining whether it can adequately represent the interests of a class).

who bought or wrote options during the class period and held them through the corrective disclosures.[150]

Defendants may also raise broader policy arguments to limit damages awarded to options traders. Some courts have entertained the argument that recognizing a class of options traders creates a risk of overdeterrence, insofar as it is difficult "to gauge [a corporation's] potential liability for a securities fraud if options traders are within the protected class."[151] To be sure, courts have rejected the idea that options traders are "gamblers" who are "fair game for affirmative misrepresentation,"[152] but it is nevertheless conceivable that a court might balk at imposing outsized liability on corporations and their current shareholders for harms suffered by class period options traders.[153] To the extent that the methodologies outlined above focus on domestic exchange-traded options—for which open interest and volume statistics are readily available—such arguments are of limited merit at the class certification stage and in our view should be rejected.

Halliburton II leaves open the door for defendants to defeat class certification for any security by "sever[ing] the link between [a] misrepresentation and . . . the price . . . paid[.]"[154] Based on our analysis herein, it is thus unlikely that an options class would ever be certified if the underlying stock cannot be certified. But courts may grapple with the

150. The magnitude of open interest on the date of corrective disclosure may inform the range of series eligible for relief and the expected costs and benefits of seeking class certification.

151. Fry v. UAL Corp., 84 F.3d 936, 938 (7th Cir. 1996) ("[W]e have to worry about the danger of overdeterrence because, while securities fraud is nominally a species of deliberate wrongdoing, the doctrines of securities law and particularly the application of those doctrines to particular factual situations are so difficult, complex, and uncertain that there is a serious danger of erroneous impositions of liability.").

152. Deutschman v. Beneficial Corp., 841 F.2d 502, 507 (3d Cir. 1988); *see also* Fry v. UAL Corp., 895 F. Supp. 1018, 1035 (N.D. Ill. 1995), *aff'd*, 84 F.3d 936 (7th Cir. 1996) ("[O]ur recognition of the useful functions of options and the options market bolsters our conclusion that option traders are entitled to standing to assert a Rule 10b-5 claim."); *see also* Tolan v. Computervision Corp., 696 F. Supp. 771, 774–76 (D. Mass. 1988) (rejecting defendants' argument that options traders lack standing because their trades "do not represent contributions of capital to the corporation"); Henning, *supra* note 20 (discussing standing of options traders in cases involving misstatements).

153. *See, e.g.*, *In re* Veritas Software Corp. Sec. Litig., 496 F.3d 962, 967 (9th Cir. 2007) (reviewing proposed settlement that capped funds allocated to options traders). Because the issuer itself is typically a co-defendant in securities class actions, "the cost of a great expansion of liability to option holders and concomitant larger judgments against corporations will ultimately be borne by the shareholders of public corporations." Starkman v. Warner Commc'ns, Inc., 671 F. Supp. 297, 307 (S.D.N.Y. 1987).

154. Halliburton Co. v. Erica P. John Fund, Inc., 573 U.S. 258, 269 (2014) (quoting Basic Inc. v. Levinson, 485 U.S. 224, 248 (1988)).

question of whether options traders who employ hedging or arbitrage strategies to eliminate or limit market risk present typical claims for purposes of class certification.[155]

Finally, the available case law suggests that, since option strategies are often used in conjunction with investments in the underlying stock, gains and losses from different portfolio constituents should be netted.[156] Complex or high-volume strategies could complicate the computation of an investor's net damages even if each position's damages can be determined through a common damages methodology.[157] Nonetheless, whether or not netting is necessary is an open legal question, and netting an option trader's profits against losses is always mathematically possible. Furthermore, as long as each plaintiff's trading activity during the class period was "founded upon the integrity of the price of the underlying shares," "'the link between the . . . misrepresentation and [the plaintiff's trading] decision' remains intact."[158] Accordingly, it should be "of no consequence" that options traders "devised different investment strategies as a

155. *See, e.g.*, *In re* LDK Solar Sec. Litig., 255 F.R.D. 519, 533 (N.D. Cal. 2009) (approving class representative who "only *partially* hedged the risk of decline in the price of the shares that he owned" (emphasis in original)); Crossen v. CV Therapeutics, No. C 03-03709 SI, 2005 WL 1910928, at *5 (N.D. Cal. Aug. 10, 2005) (finding lead plaintiff adequate who "sought to profit from his investment in CVT stock but to manage the risk of his investment by also participating in call option transactions"); White, *supra* note 18, at 1150 (discussing losses due to covering a position in response to a misstatement affecting the market price).

156. *See, e.g.*, *In re* Enron Corp. Sec., Derivative & "ERISA" Litig., No. 01-CV-3624, 2008 WL 4178151, at *10 (S.D. Tex. Sept. 8, 2008) (approving settlement plan providing that "gains and losses on both the stock and options will be combined and thereafter netted against each other"); Spicer v. Chi. Bd. Options Exch., Inc., No. 88 C 2139, 1990 WL 16983, at *10 (N.D. Ill. Jan. 31, 1990) (holding that "so long as each class representative claims a net loss, he is adequate notwithstanding some gains due to the wrongs of which he complains"); Etshokin v. Texasgulf, Inc., 612 F. Supp. 1220, 1234 (N.D. Ill. 1985) (considering trader's profit or loss "as measured by the market value of [trader's] net position" during the relevant period for purposes of determining his "compensable damages"); *see also* White, *supra* note 18, at 1151 (endorsing the approach of "net[ting] all losses and gains from all transactions that follow from the misstatement to assure that plaintiffs recover for only actual economic injury in the aggregate").

157. *See, e.g.*, *In re* Veritas, 496 F.3d at 967 (9th Cir. 2007) (reviewing proposed settlement that capped funds allocated to options traders and did not allocate funds to "in-and-out" options traders because of the "cost and difficulty of calculating economic losses for options and the small amount of damages suffered by in-and-out options traders").

158. *In re* Priceline.com Inc. Sec. Litig., 236 F.R.D. 89, 100 (D. Conn. 2006) (quoting *Basic*, 485 U.S. at 248) (finding writer of put options to be adequate class representative); *see also In re* Sci.-Atlanta Inc. Sec. Litig., 571 F. Supp. 2d 1315, 1330 (N.D. Ga. 2007) (A put seller who bets that the stock price "will maintain or increase . . . generally relies—in like fashion to a stock purchaser—on the integrity of the price of the underlying stock.").

consequence of their reliance."[159]

VI. SUMMARY AND CONCLUSIONS

In this article, we present an approach to analyzing the efficiency of options markets for purposes of invoking the fraud-on-the-market presumption under *Basic* and *Halliburton II*. We also present a common damages methodology for options traders that satisfies the predominance requirement of FRCP Rule 23. We hope the analysis and methodologies outlined in this article will be of use to courts and litigants in making class certification determinations involving options traders.

APPENDIX: FUNDAMENTALS OF OPTIONS

In order to appreciate how parties that trade options can be damaged when there are fraudulent misrepresentations or omissions, it is necessary to understand the basics of options. In this section, we provide a treatment of the fundamental concepts, definitions, and characteristics of options and their markets. We must start, however, with the broader concept of derivatives.[160]

A. Derivative Instruments and Markets

Let us begin by placing options in the proper context, as one type of financial instrument in a family of financial instruments that are collectively referred to as *derivatives*. A derivative is a financial instrument representing a contract between two parties, a buyer and a seller, that has a finite life and results in the payment of money from one party to another either during that life or at the end of the life based on the price or performance of a specified underlying asset.[161]

The underlying asset, often called the *underlying*, is typically a stock, stock index, bond, currency, or commodity, but it can also be a financial

159. Tolan v. Computervision Corp., 696 F. Supp. 771, 780 (D. Mass. 1988).

160. For a more in-depth treatment of the fundamentals of derivatives and specifically options, see DON M. CHANCE & ROBERT BROOKS, AN INTRODUCTION TO DERIVATIVES AND RISK MANAGEMENT (10th ed. 2016). Italicized terms used throughout are defined in the Glossary. *Id.* at G-1 to G-14. *See also Characteristics and Risks of Standardized Options*, THE OPTIONS CLEARING CORP. (June 3, 2024), https://www.theocc.com/Company-Information/Documents-and-Archives/Options-Disclosure-Document [https://perma.cc/CP4D-HES3].

161. CHANCE & BROOKS, *supra* note 160, at 26–27.

variable such as an interest rate.[162] The underlying in a derivative contract is always a value that fluctuates, and there would normally be some party that is hurt and some party that is helped by the ultimate outcome.

The class of instruments known as derivatives comprises options, forwards, futures, and swaps.[163] Futures on individual stocks may be analogized to positions in the underlying stock for purposes of securities fraud and insider trading.[164] Although forwards and swaps could theoretically be affected by a corporation's fraudulent misstatements or omissions, these instruments do not typically have individual stocks as their underlying,[165] so we will not discuss them here.[166]

Derivatives are created and traded in either an exchange-traded market or an over-the-counter ("OTC") market. An OTC market is one in which parties contract privately with each other and negotiate all of the terms of the contract. This stands in contrast to an exchange-traded market, where almost all of the terms of derivative contracts are standardized by the exchange, and the market equilibrates the demand from buyers and the supply from sellers to arrive at a market price. To our knowledge, no fraud-on-the-market litigation has occurred in OTC options,[167] so this article

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162. Technically, an interest rate is not an asset, which explains why the word "underlying," normally a participle, is used in this industry as a noun. In addition, there are some other underlyings that have been used in derivatives that are not assets, such as freight rates, measures of weather such as temperature and precipitation, and electricity prices. None of these are assets but all exhibit the characteristic that their prices fluctuate and affect the economic performance or profitability of consumers and businesses. *Id.* at 5–6.

163. *Id.* at 26–31. There are also hybrid derivatives that combine more than one derivative. For example, there are options where the underlying is a future or a swap, to name a couple of the more widely used hybrids.

164. *See, e.g.*, Frank Partnoy, *Multinational Regulatory Competition and Single-Stock Futures*, 21 NW. J. INT'L L. & BUS. 641, 652 (2001).

165. Forwards and swaps are generally based on underlying instruments such as broad-based stock indices or interest rates and are thus subject to the exclusive jurisdiction of the Commodity Futures Trading Commission. *See* 7 U.S.C. § 2(a)(1)(A); *see also id.* § 1a(47) (defining "swap" broadly to include a range of derivative transactions). Over-the-counter options on individual stocks and "security-based swaps" nevertheless remain subject to federal securities laws. *See* 15 U.S.C. § 78c(a)(10).

166. The potential for fraud in the price of an individual stock to affect a broad-based index is not insignificant. Mega-cap stocks such as Apple and Amazon exert a strong pull on the value of many broad-based indexes. To date, however, this matter has not, to our knowledge, been a subject of litigation.

167. Some cases involving OTC equity options or security-based swaps have been brought under the antifraud provisions of federal securities law. *See, e.g.*, Caiola v. Citibank, N.A. 295 F.3d 312 (2d Cir. 2002) (cash-settled options on Phillip Morris stock); SEC v. Banc de Binary Ltd., 964 F. Supp. 2d 1229, 1237 (D. Nev. 2013) (off-exchange binary options); Parkcentral Glob. Hub Ltd. v. Porsche Auto. Holdings SE, 763 F.3d 198, 207 (2d Cir. 2014) (swaps on Volkswagen stock); *see also* CSX Corp. v. Children's Inv. Fund

focuses exclusively on exchange-traded options.[168]

An exchange-traded market is one in which a formal exchange entity provides the facility and rules for trading. This facility can be either physical or electronic. A physical facility for trading derivatives is often executed on a trading floor that consists of areas called pits in which traders gather to buy and sell derivatives. Physical trading is executed with traders making bids to buy and offers to sell the derivatives.[169] Thus, trading is carried out in a face-to-face manner. Electronic trading is an alternative process in which market participants sit in front of computer screens that display information on who is buying and who is selling and what are their bids and offers. If a trader wants to make a trade, the trader simply clicks the appropriate selection. The two participants to a trade are called *parties* or sometimes *counterparties*. In recent years, many exchanges have transitioned from in-person physical pit trading to electronic trading.

Exchange-traded derivatives are characterized by having standardized terms. That is, all characteristics of the contract except its price are fixed by the exchange, which offers a diverse slate of such instruments. Market participants can choose from among the available contracts.[170] In the United States, standardized options trade in units of one hundred. That is, one option contract is actually one hundred options and, thus, covers one hundred shares. In this article, when we specify a quantity of options, say five hundred, we do not mean five hundred contracts of one hundred options. We mean five hundred options, the equivalent of five contracts.

Mgmt. (UK) LLP, 654 F.3d 276, 278 (2d Cir. 2011) (alleging violation of disclosure requirements of section 13(d) of the Exchange Act, 15 U.S.C. § 78m(d)). While such over-the-counter derivatives are generally subject to securities antifraud rules, *see* 17 C.F.R. § 240.9j-1, they tend to be bilaterally negotiated and therefore unlikely to be the subject of class action litigation. *See* Security-Based Swap Execution and Registration and Regulation of Security-Based Swap Execution Facilities, Exchange Act Release No. 98845, 88 Fed. Reg. 87156, 87246–48 (Dec. 15, 2023); *cf*. Basile v. Valeant Pharm. Int'l, Inc., No. SACV 14-2004, 2015 WL 7352005, at *9 (C.D. Cal. Nov. 9, 2015) (finding that defendant's OTC options "should be considered part of the 'same class' as common stock" for purposes of certifying plaintiff class in contemporaneous insider trading litigation).

168. Of note, futures exist only on exchange-traded markets, while forwards and swaps trade only on OTC markets. Options trade on both, though options on individual stocks are almost exclusively exchange-traded. All of that said, developments in the OTC markets have made the distinction between them and exchange-traded markets a little less clear. *See* THOMAS LEE HAZEN, TREATISE ON THE LAW OF SECURITIES REGULATION § 22:39 (6th ed. 2009) (discussing the allocation of regulatory jurisdiction over derivatives after the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010).

169. These bids and offers are done orally and using hand signals in pit trading.

170. If market participants want to trade a contract with terms that are not offered by the exchange, they can conduct the trade on the over-the-counter market, which we previously covered.

The market participants buying or selling options include individuals and institutions that either have memberships, called seats, on the exchange and thus have direct access to trading, or they are external to the exchange. Members of the exchange are typically brokers or dealers. A broker is an entity that executes trades for others. That is, a broker is a member of the exchange and, as such, can execute trades on the exchange for entities that are not members.

The other type of exchange member is a dealer, sometimes called a *market maker*. This is a party that has been authorized by the exchange to create a market—that is, stand ready to buy or sell the security to fill the orders of those who wish to trade the security. A dealer quotes a *bid* price, which is the price they are willing to pay for the instrument, and an *ask* price, which is the price at which they are willing to sell. The dealer stands ready to take either side of the transaction. In this manner, dealers "make" the market. This function, undertaken by dealers, provides liquidity to the marketplace, meaning that customers who wish to buy or sell derivatives are almost always able to do so, and with reasonably low transaction costs.

When a dealer either buys or sells, they do not take or hold that position to speculate on a price change. They *hedge* the position by doing other transactions, either on the same market or on a different market. The dealer has the ability and the connections to hedge at a more favorable cost than the price at which they bought or sold the derivative. As such, the dealer profits off of the difference between the bid or ask price and the cost of laying off the position with a hedge. Dealers typically hold little inventory, thereby rendering themselves largely immune to price fluctuations. Dealers exist on both exchange and OTC markets.

Parties that are external to the exchange, and thus do not have direct access to trading, include individuals and institutions. They enter the market through brokers. Their trades are usually executed with a dealer as the counterparty. As such, an external participant buys at the dealer's ask price and sells at the dealer's bid price.

The difference between the bid and ask prices (ask price minus bid price) is called the *bid-ask spread*. The bid-ask spread can be measured as the absolute difference in dollar terms or as a percentage of the midpoint between the bid and ask prices. If an individual bought a derivative, realized this was a mistake, and then immediately sold the derivative, they would incur a loss equal to the dollar bid-ask spread. This spread is considered a good measure of the degree of liquidity and the cost of trading. Very active (inactive) markets with many (few) competing

participants tend to have low (high) bid-ask spreads.[171]

All exchange-traded derivative transactions go through a process called *clearing*, in which the exchange, through an entity called the *clearinghouse*, inserts itself between the two parties to each contract. The clearinghouse guarantees to each party the contractual performance of the derivative instrument. If one party owes money to the other pursuant to the terms of the derivative instrument, the clearinghouse guarantees the payment of that money. That is, if one party cannot pay the other what it owes, the clearinghouse will step in and make the payment. In this manner, all derivatives contracts are insured against a counterparty defaulting. In the roughly one-hundred-year history of clearinghouses, there have been defaults but no party has ever lost money due to a counterparty defaulting. The clearinghouse makes this guarantee by holding all or a portion of the money each party has paid, collecting additional funds if the market moves against a party, and then not paying the obligatory payments to the recipient counterparty until the contract is terminated. In the case of options, one party is the buyer, and its obligation is only to pay money when making the purchase. Thus, the buyer cannot default on the seller. The seller, however, must meet its obligation when and if the buyer chooses to exercise the option. Thus, the seller can default on the buyer, but, as noted, this default is insured by the clearinghouse.[172]

When parties enter into a derivative contract, they have the opportunity to either hold that position until the contract expires or to exit that position with a trade in the market. What happens when the position is held until expiration depends on whether the contract is an option or a futures contract. Most parties do not, however, hold their positions until expiration. Instead, a party will generally return to the market and execute an offsetting trade before expiration. That is, if a party buys a derivative, it often subsequently goes into the market and sells that derivative before expiration. Ultimately, on account of the large number of offsets, only a small number of contracts, relative to the total number of contracts that have previously traded, remain open on the expiration day.

The number of contracts traded is referred to as the *volume*. The number of outstanding contracts is called the *open interest*.[173] Trading volume can increase or decrease open interest, or leave it unchanged. As an

171. Stock, bond, currency, and commodity markets also have dealers quoting bid and ask prices and operating in a similar manner.

172. The other major type of derivatives exchange, a futures exchange, does have the potential for default by buyer or seller. Likewise, it operates a clearinghouse to insure both parties that if the counterparty defaults, the clearinghouse will step in and pay.

173. CHANCE & BROOKS, *supra* note 160, at 43–44.

example, assume no contracts have been traded. If party A buys ten contracts from party B, volume is incremented by ten. These ten new contracts become the open interest. Suppose at a later date, party A sells seven of these contracts it originally bought. Suppose the counterparty, or purchaser of these seven contracts, is a new party entering the market to establish a long position, not the original seller. Then volume is seven, but open interest is still ten, because party A still has three long contracts, party B still has ten short contracts, and party C has seven long contracts. There are ten long contracts matched with ten short contracts. Now, let us say that the next transaction is that party A sells its three contracts to party B. This time, volume is three contracts, but open interest falls to seven contracts because Party A has no contracts outstanding, party B has seven short contracts, and party C has seven long contracts.

B. Characteristics of Options

An option is a derivative contract in which one party, the buyer (or *long*), pays a sum of money, called the price or premium, to the seller (or *short*) and acquires either the right to buy or the right to sell the underlying at a fixed price either at or before a specific point in time.[174]

An option that grants the right to buy the underlying is referred to as a *call* or *call option*, while the right to sell the underlying is a *put* or *put option*. An option is either a call or a put, chosen at the discretion of the two parties when the contract is initiated. After buying an option, the buyer or long then becomes the owner or holder of the option. The holder of a call has the right to exercise it, thereby paying the fixed price to the call seller and receiving the underlying from the seller. The holder of a put has the right to exercise it, thereby tendering the underlying to the put seller and receiving the fixed sum of money. Exercising a call is equivalent to assuming a long position in the underlying, but the underlying can be immediately sold. The exercise of a put creates a short position in the underlying, but that short position can then be offset by buying the stock in the market.

This fixed sum of money specified in the contract for the buy or sale transaction executed upon exercise is called the *strike*, *strike price*, or *exercise price*. An option with an exercise price of, say, $30 is said to be "struck at 30."[175] The time at which an option can be exercised depends on the style of the option. An *American-style* option can be exercised at any

174. The seller is also sometimes referred to as "the writer."
175. *Id.* at 26–27.

time during business hours prior to or at expiration, while a *European-style* option can be exercised only at the expiration.[176]

Exercise can be done via physical delivery or cash settlement, depending on what the contract specifies. Physical delivery, which characterizes options on individual stocks, involves the exchange of the exercise price for the actual stock. For example, if a physical delivery call option on a stock is exercised, the long party pays the strike price to the short party, and the short party delivers the stock to the long party. Cash settlement, on the other hand, which is commonly associated with options on stock indexes, involves the transfer of a net amount of cash equal to the difference between the current market price of the underlying and the strike price. For example, with cash settlement, if a call with a strike of $100 is exercised and the underlying is valued at $102, the seller would simply pay the holder $2 (the stock price minus the option's strike price).

C. Option Payoffs and Profits

We start with a simple call transaction. Suppose the buyer pays $7 to acquire an American call that expires in twenty-one days and has an exercise price of $100. Let the underlying be selling for $98. This contract grants the buyer the right to pay $100 any time in the next twenty-one days to acquire the underlying. For this right, the buyer paid $7 to the seller.

As the option is an American call, the holder has the right to exercise it before expiration, but in most cases, it is not exercised until expiration, if at all.[177] While the example that follows could be positioned prior to

176. These two types of options are usually just referred to as "American" and "European options." These terms have nothing to do with where they are traded, as both types of options trade in the U.S. and in Europe. These terms do have historical context, however, in that more than 100 years ago, American options traded exclusively in the U.S. and European options traded exclusively in Europe. According to one theory, Americans were viewed as being less intelligent than Europeans and, therefore, in need of a simpler option. Robert Jarrow & Philip Protter, *A Short History of Stochastic Integration and Mathematical Finance: The Early Years, 1880–1970*, 45 INST. MATHEMATICAL STAT. LECTURE NOTES 75, 81 n.17 (2004), https://wwwf.imperial.ac.uk/~ajacquie/IC_AMDP/IC_AMDP_Docs/Literature/Jarrow_Protter_History_Stochastic_Integration.pdf [https://perma.cc/37HB-FG8D] (recounting how economist Paul Samuelson came to coin these names). Ironically, American options are actually far more complex than European options.

177. The reason for the holder not ordinarily exercising before expiration is that the sale price of an option is usually greater than its exercise value. If exercised before expiration, the holder discards the additional value that represents the potential payoff if the option stays alive until the expiration. Exercising an option early is somewhat akin to deciding earlier than you have to. The payment of a dividend on a stock can, however, induce early exercise, but this is an advanced topic that is not necessary to cover for this article.

expiration, we shall focus on the exercise decision at expiration. Suppose the stock is at $105 at expiration, which is $5 greater than the $100 strike price. This condition is said to be in-the-money (ITM), meaning that the underlying price exceeds the call option's exercise price. Because we are at expiration, the call will be exercised, meaning that the holder will pay the $100 strike and receive the stock, which is worth $105. At that point, the option is said to have a payoff of $5. That does not mean the buyer made a profit on net. Indeed, they did not, as they originally paid $7 for the option. By exercising the option, however, the holder cuts their loss from $7 to $2. Obviously, the underlying price must rise above $107 for the call option purchase to have been profitable.

Now suppose that instead the call option expires out-of-the-money (OTM), meaning that the underlying price is below the $100 strike at expiration. Then the payoff is $0, and the holder incurred a loss of $7, which is the full amount paid for the option.

The notion that an option is in or out of the money describes the concept of an option's *moneyness*. For a call option, when the underlying price exceeds the exercise price, the call is in the money (ITM). When the underlying price is less than the exercise price, the call is out of the money (OTM). In addition, the call can be at the money (ATM), whereby the underlying price equals the exercise price. In this article we use the letters ITM, OTM, and ATM to denote in-the-money, out-of-the-money, and at-the-money, respectively.

Now we look at the situation from the point of view of the option seller. The seller's gain or loss is the mirror image of the buyer's gain or loss. That is, the buyer's gains (losses) are the seller's losses (gains). In the first outcome, the seller made $2, corresponding to the holder's loss of $2. If the buyer had made a gain, that amount would be the seller's loss. In the second outcome, the buyer lost the full price paid, $7, which is the seller's gain.

Now consider an American put option to sell the underlying for $100. Suppose there are ninety-one days until expiration, the underlying is at $98, and at that time someone buys the put for $9. As with calls, we shall assume this put option is not exercised early. At expiration, suppose the stock is at $92. In that case, the put is ITM. It allows the holder to sell the stock for $100. So, the holder can buy the stock in the market for $92 and, by exercising the put, thereby sell the stock for $100. This produces a payoff of $8. Of course, the put originally cost $9, so there is still a net loss stemming from the put option purchase (a loss of $1, equal to the $9 put purchase price minus the $8 put payoff). The stock would have to fall below $91 to generate a net profit for the put option buyer.

In an alternative outcome, suppose the stock is at $103 at expiration. In that case, the put expires OTM. The holder would not exercise it (so as not to realize a negative payoff), and they would lose the entire premium paid of $9. Of course, the buyer's gains (losses) are the seller's losses (gains).

For puts, ITM means that the underlying price is below the exercise price. OTM means that the underlying price is above the exercise price. Of course, ATM means that the underlying price equals the exercise price.

Option transactions are a form of leveraged investing, meaning that for a small initial investment, one can amplify returns. Of course, this can also be done by borrowing money to buy stock, but there the downside risk is quite high. When buying options, the downside risk is limited to the price paid for the option. This is one of the attractions of buying options: the potential for a large gain at the risk of a small loss.

Recall the example of the call earlier in this section. The person bought a $100 strike call for $7 when the stock was at $98. The stock must get past $100 to exercise and past $107 to generate a payoff of more than the amount paid. This is not likely to occur in twenty-one days, so calls will often generate losses. In fact, if the underlying does not get above $100 at expiration, the entire price of $7 is lost. That said, suppose the stock makes it just past the strike plus $7, say to $108. This would generate a payoff of $8, producing a profit of $1 ($8 payoff minus the original $7 purchase price), which is a return of 14.3%, a very nice return for a twenty-one-day trade. This is the leverage effect. A similar effect occurs for puts. For puts and calls, losses will be incurred most of the time, but when gains are made, the percentage return tends to be quite high.

A single option position is often combined with other transactions. For example, sellers of calls often hold the underlying. The call serves to cushion any loss on the downside. Puts are often purchased with a long position in the underlying, thereby serving to provide insurance against a loss in value of the underlying. Calls (puts) are sometimes combined with other calls (puts) on the same underlying to amplify or attenuate the risk. Options are also sometimes combined with other derivatives. The various option strategies offer an immense array of profit possibilities and tailored risk exposures that are not attainable with just the underlying.

D. Valuation of Options

Valuation is the determination of what an asset is worth. An understanding of option valuation is critical for understanding options. Derivative instruments are valued using the concept of *arbitrage* and the

principle that the fair and correct value of a derivative must be the price that precludes arbitrage.[178] Arbitrage is any investment strategy that produces abnormally high, risk-free returns. Arbitrage arises when two assets or combinations of instruments that perform identically are selling for two different prices. Arbitrage involves engaging in transactions that exploit that condition to produce abnormally high returns risk free. Those who engage in such transactions are called *arbitrageurs* and sometimes *arbs*. Conditions that allow for arbitrage cannot persist indefinitely because the very trading that exploits arbitrage brings the prices of the two divergently priced assets or combinations of instruments together. The equilibrium price of a derivative cannot be a valuation that allows for arbitrage, but rather must be the specific price under which arbitrage is impossible.

The exploitation of an arbitrage opportunity by arbitrageurs leads to a convergence of derivative prices to their fair fundamental values. For example, suppose a combination of assets called A produces equivalent results to another combination of assets called B. Let us say that A sells for a lower cost than B. In that case, arbitrage will result in the buying of A and selling of B. This generates a gain equal to the difference in the prices of A and B, and the two offsetting long and short positions eliminate any risk. In addition, no funds are required since the sale of B produces enough cash to more than cover the purchase of A.

Because there is an opportunity to make a riskless profit without investing any money, the execution of these trades is arbitrage. However, the arbitrage opportunity will not persist because the buying of A and selling of B forces their prices to converge until they are equal. That is, A and B must sell for the same price, a principle known as "The Law of One Price." In short, the Law of One Price, which is the foundation of option valuation, essentially holds that equivalent assets or combinations of assets must sell for the same price.[179]

Let us now consider an instructive example that illuminates how the Law of One Price determines the valuation of options. Let a stock be priced at $50. Assume it can either go up to $60, a 20% gain, or down to $40, a 20% loss. Now consider an asset that is referred to as a risk-free bill. This asset provides an absolute guaranteed rate of return called the risk-free rate. Suppose that rate is 3% for a particular period. If we put $20 into this risk-free bill for the duration of the period, it would pay off $20 x 1.03 = $20.60. Assume we can borrow or lend any amount at this rate.

178. CHANCE & BROOKS, *supra* note 160, at 12–13.
179. *Id.*

Now consider a call option struck at $50 that expires at the end of the period when the stock is either at $60 or $40. If the stock goes to $60, the call expires with a payoff of $10 (the stock price of $60 minus the exercise price of $50). If the stock goes to $40, the call expires with zero value. The key question is "What would someone pay for that option?"

The valuation of the option is determined by considering a combination of assets that perfectly mimics the performance of the option. Suppose we buy fifty shares of the stock, financing it partially by borrowing $1,942, which we promise to pay back at 3% interest. The amount we will owe is $1,942 x 1.03 = $2,000, subject to a modest bit of rounding. Now look at what happens one period later. If the stock goes to $60, we shall have $3,000 worth of stock (fifty shares at $60 per share), but must pay back $2,000 on the loan, leaving us with a net value of $1,000. If the stock goes to $40, we shall have $2,000 worth of stock (fifty shares at $40 per share), but owe $2,000 on the loan, leaving us with a net value of $0. These two payoffs of $1,000 and $0 are the same exact payoffs as a long position in one hundred calls with a strike of $50. That is, each call would also pay off $10 or $0 in the two outcomes, respectively. Thus, the stock and loan strategy produce precisely the same result as that of one hundred calls struck at $50. Hence, the cost we would pay for the stock and loan strategy must equal the cost of one hundred calls.

The price we would pay for the stock and loan strategy is $50 per share times fifty shares, minus the $1,942 borrowed, which will cover part of the stock cost. That net difference is $558 ($2,500 – $1,942). Since the stock and loan strategy costs $558, that means the call option strategy, which entails the purchase of one hundred calls, must also cost $558. Therefore, each call must cost $5.58 (which is $558/100). The option value must equal the price of the combination of assets that exactly replicates or mimics it.

What we have just illustrated is a simple version of what is called the *binomial model*. An option can be replicated with a position in the underlying stock and borrowed funds. The value of the option must equal the value of the replicating portfolio. The flexibility to apply the binomial model to cover a large number of outcomes, each spanning a very small period of time, makes the model quite efficient and accurate. The renowned Black-Scholes-Merton (BSM) model is an alternative option pricing model, which is completely consistent with the binomial model but assumes that asset prices fluctuate to an infinite number of values over microscopically small periods of time. Indeed, the binomial model can be structured to produce the same value as the BSM model. The binomial model is said to be a *discrete-time model* because it incorporates a discrete process for

underlying stock price movements, while the BSM model is called a *continuous-time model* because it presumes a continuous process for stock prices.

Both the BSM and binomial models are highly practical, relatively easy to use, and widely employed in industry. While the BSM model is recognized as the original solution to the option pricing problem, and is still widely used for many applications, the binomial model has gained prominence and offers several clear advantages over the BSM model. First and foremost, it can incorporate the early exercise feature whereas the BSM model cannot handle this characteristic that defines American options. The details of how this is done are technical and omitted here, but the binomial model does properly value the right to exercise early.

There are six factors that affect the price of an option: the stock price, the exercise price, the risk-free rate, the time to expiration, the volatility of the underlying stock, and any dividends on the underlying stock. It was easy to see in the binomial example that we directly incorporated the stock price, the exercise price, and the risk-free rate. We could have incorporated the time to expiration by adding additional periods to the life of the option. We also could have incorporated the dividends by letting the stock drop by any amount paid as a dividend. We did not directly incorporate the volatility of the stock, but it is easy to see that the spread between how high the stock can go up versus how low it can go down is reflective of the volatility.

In sum, as explicated herein,[180] the key to option pricing is the fact that an option can be replicated by a position in the underlying stock and a position in a risk-free bill. The value of any option must be the value of its replicating portfolio. As the replicating portfolio comprises a position in the underlying stock, it is clear why the price of an option is tied to the price of the underlying stock, and why changes in the underlying stock price cause changes in the option price. Accordingly, if a stock is so informationally efficient that it reflects available public information, so too will be options written on that stock.

180. *See supra* Part III.C.