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The Learned Hand Unformula for Short-Swing Liability

Andrew Chin

THE LEARNED HAND UNFORMULA
FOR SHORT-SWING LIABILITY

Andrew Chin[*]

Abstract: Section 16(b) of the Securities Exchange Act of 1934 allows for the recovery of short-swing profits realized by certain insiders from trading in a corporation's stock within a period of less than six months. Three generations of corporate law students have been taught the "lowest-in, highest-out" formula that is intended to maximize the disgorgement of short-swing profits under section 16(b). Arnold Jacobs's 1987 treatise presented two hypothetical examples where the formula fell short of the intended maximum, but courts, commentators, and practitioners have largely ignored these theoretical challenges to the formula's validity.

This Article identifies *Gratz v. Claughton* as the first reported real-world example of the formula's failure. Ironically, *Gratz* has been taught and cited for more than sixty years as a leading authority for the formula's use, not least because of its distinguished author, Judge Learned Hand. This Article argues that *Gratz* has been misunderstood and that Hand wisely adjudicated this complex case without prescribing or endorsing the formula in any way. It also shows that the formula has no need of *Gratz*'s endorsement, as long as the formula is correctly interpreted as limited to simpler cases where it is mathematically valid. It formalizes and extends Jacobs's results by showing that the formula may fall short of the maximum by up to fifty percent when misused in more complex cases, and has actually fallen short in another more recent case. Finally, it provides online tools to enable practitioners and judges to calculate short-swing liability correctly in all cases.

INTRODUCTION

Under section 16(b) of the Securities Exchange Act of 1934,[1] certain insiders may be held liable to a corporation for any "short-swing" profits realized from trading in the corporation's stock within a period of less than six months. The corporation is entitled to disgorgement of the maximum possible profit that can be calculated by any matching of the insider's purchases and sales within less than six months, according to Second Circuit case law, which has long been authoritative on the subject.[2]

In *Smolowe v. Delendo Corp.*,[3] the Second Circuit adopted the "lowest-in, highest-out" formula as a simple calculation intended to maximize the disgorgement of short-swing profits under section 16(b).[4] The liability calculation in *Smolowe* involved a relatively simple

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[1] 15 U.S.C. §§ 78a–78pp (2012).

[2] DETLEV F. VAGTS, BASIC CORPORATION LAW 552 (3d ed. 1989) ("Opinions by the Second Circuit in the Section 16 field are generally regarded as authoritative.").

[3] 136 F.2d 231 (2d Cir. 1943).

[4] *See id.* at 239.

sequence of insider transactions, all of which took place within a single six-month period and within the two-year statute of limitations.[5] In a 1987 article, however, Arnold Jacobs presented hypothetical examples showing that the *Smolowe* formula[6] may fall short of maximizing the short-swing profit calculation in situations in which the insider's trades span a period of more than six months or when some trades are not within the statute of limitations.[7] In these situations, the calendar can preclude the recovery of profits from matching some low-priced purchases with higher-priced sales, a complication the *Smolowe* formula was not designed to take into account.[8] Courts, commentators, and practitioners, however, have largely ignored these theoretical challenges to the formula's validity in adopting the *Smolowe* formula for use in all section 16(b) liability calculations.[9]

This Article identifies another early Second Circuit case, *Gratz v. Claughton*,[10] as the first reported real-world example of the *Smolowe* formula's failure to calculate the maximum possible profit. The liability calculation in *Gratz* was too complicated for the formula because it involved a sequence of hundreds of insider transactions spanning more than twenty-one months.[11] Ironically, *Gratz* has been a staple of corporate case law and casebooks for more than sixty years as a leading authority for the formula's use, not least because of its distinguished author, Judge Learned Hand.[12] However, neither the Second Circuit nor the district court performed any calculations in *Gratz*. In district court proceedings before a special master, the defendant proffered a liability

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[5] Smolowe v. Delendo Corp., 46 F. Supp. 758, 761, 766 (S.D.N.Y. 1942) [hereinafter *Smolowe I*].

[6] The formula will be referred to hereinafter as "the *Smolowe* formula" (or simply "the formula" when clear from context). The more common designation "the *Smolowe* rule" will not be used in order to avoid unintended connotations of legal authority in light of the formula's questionable applicability in complex cases.

[7] Arnold S. Jacobs, *An Analysis of Section 16 of the Securities Exchange Act of 1934*, 32 N.Y. L. SCH. L. REV. 209, 532–33 (1987).

[8] *See id.*

[9] *See, e.g.*, Adler v. Klawans, 267 F.2d 840, 847–48 (2d Cir. 1959); LOUIS LOSS & JOEL SELIGMAN, FUNDAMENTALS OF SECURITIES REGULATION 693 (5th ed. 2004); WILLIAM K.S. WANG & MARC I. STEINBERG, INSIDER TRADING 924 n.12 (3d ed. 2010).

[10] 187 F.2d 46 (2d Cir. 1951).

[11] *See* Def.'s Exhibits 5 & P, Gratz v. Claughton, No. 35-410 (S.D.N.Y. 1949) (hereinafter "*Gratz* Master's Report") (listing, inter alia, 276 purchases and 101 sales of common stock and 11 purchases and 20 sales of preferred stock between December 18, 1944 and September 24, 1946).

[12] *See, e.g.*, Gerald Gunther, *Judge Learned Hand: The Man, the Myth, the Biography*, 20 J. SUP. CT. HIST. 47, 47 (1995) (describing Hand's opinions as "familiar to every lawyer and law student").

calculation[13] that fell more than $50,000 short of the short-swing profits that would have been found by the *Smolowe* formula. Perhaps overwhelmed by the prospect of checking the sums, the plaintiff stipulated to the defendant's calculation in the district court and did not challenge it on appeal.[14] Accordingly, Hand adjudicated *Gratz* without performing a liability calculation or even mentioning the formula.[15]

With the benefit of hindsight and subsequent developments in computing, the remainder of this Article elucidates the meaning, wisdom, and continuing significance of Hand's mathematical silence in *Gratz*. Part I of this Article sets the stage for this exposition by introducing the short-swing liability provisions of section 16(b), the *Smolowe* formula and its shortcomings, and the role *Gratz* has played in sustaining the *Smolowe* formula.

Part II of this Article dispels the notion that *Gratz* in any way supports use of the *Smolowe* formula. Section II.A harmonizes the Second Circuit's adjudication of liability in *Smolowe* and *Gratz* and shows that Hand rightly did not read *Smolowe* to require use of the formula in *Gratz*. Section II.B explains that Hand wisely based his affirmance on Gratz's acquiescence in the judgment below and not on the master's putative adoption of the *Smolowe* formula, thereby devising a form of adjudication that might be dubbed "the Learned Hand unformula." Section II.C shows that *Gratz* could not have corroborated the *Smolowe* formula because the formula was probably not used to calculate Claughton's liability and would have fallen short even if it had been so used.

Part III of this Article explains why courts, attorneys, professors, and regulators should stop relying on *Gratz* to justify the *Smolowe* formula's use beyond its valid and intended range. Section III.A proves the *Smolowe* court's assertion that the formula maximizes profit recovery from trades within a single statutory six-month period, obviating six decades of unjustified reliance on *Gratz* for empirical corroboration of the formula. Section III.B extends and formalizes Jacobs's results by showing that the formula may fall short of calculating the maximum short-swing profit by up to fifty percent in the worst case. Section III.C brings Jacobs's hypotheticals into the real world by describing a more recent case where the *Smolowe* formula's fallibility led to a diminished recovery.

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[13] *See* Def.'s Exhibit C to *Gratz* Master's Report, *supra* note 11.

[14] *See Gratz*, 187 F.2d at 52.

[15] *See generally id.*

It will not be easy to disrupt the six decades of case law and legal teaching that have perpetuated overreliance on the *Smolowe* formula. A leading treatise calls the formula "so firmly ingrained in the fabric of Section 16(b) that there is virtually no chance a court will deviate from it in the absence of a statutory or rule change to the contrary."[16] Part IV of this Article describes two potentially disruptive efforts. Section IV.A introduces a free online calculator on the author's website that should facilitate and encourage a more limited reading of *Smolowe* in future short-swing liability proceedings and in law school classrooms. Section IV.B discusses the prospect of legal change through the Securities and Exchange Commission's petition for rulemaking and request for amicus participation processes. The Article concludes by summarizing its central insight about *Gratz.*

I.   PRELIMINARIES

A.   *Short-Swing Liability Under Section 16(b)*

The Securities Exchange Act of 1934[17] aims to "insure the maintenance of fair and honest markets" by, inter alia, regulating transactions by officers, directors, and principal owners.[18] As a deterrent to unfair insider trading,[19] section 16(b) of the Act allows a corporation, or a shareholder suing on the corporation's behalf, to recover any "short-swing" profit realized by an officer, director, or ten percent beneficial owner from any purchase or sale, or sale and purchase, of its stock within any period of less than six months.[20]

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[16] *See* PETER J. ROMEO & ALAN L. DYE, SECTION 16 TREATISE AND REPORTING GUIDE § 11.02, at 11-16 (1994).

[17] 15 U.S.C. §§ 78a–78b. (2012).

[18] 15 U.S.C. § 78b (2012).

[19] *See* H.R. REP. NO. 1383, at 13 (1934) ("Men charged with the administration of other people's money must not use inside information for their own advantage.").

[20] Section 16(b) provides in relevant part:

For the purpose of preventing the unfair use of information which may have been obtained by such [more than ten percent] beneficial owner, director, or officer by reason of his relationship to the issuer, any profit realized by him from any purchase and sale, or any sale and purchase, of any equity security of such issuer (other than an exempted security) or a security-based swap agreement involving any such equity security within any period of less than six months, unless such security or security-based swap agreement was acquired in good faith in connection with a debt previously contracted, shall inure to and be recoverable by the issuer, irrespective of any intention on the part of such beneficial owner, director, or officer in entering into such transaction of holding the security or security-based swap agreement purchased or of not repurchasing the security or security-based swap agreement sold for a period exceeding six months. Suit to recover such profit may be instituted at law or in equity in any court of competent jurisdiction by the issuer, or by the owner of any security of the issuer in the name and in behalf of the issuer if the issuer shall fail or refuse to bring such suit within sixty days

Section 16(b) is a strict liability provision in two respects. First, it "requires insiders to disgorge these 'short-swing' profits 'even if they did not trade on inside information or intend to profit on the basis of such information.'"[21] Second, it allows the corporation to recover the maximum profit calculated from the matching of "any purchase and sale, or any sale and purchase . . . within any period of less than six months,"[22] even if the insider incurred a net loss from other trading during the pertinent period.[23] In effect, section 16(b) demands that the insider "pay the maximum after-the-fact value that inside information concerning [short-term changes in the price of] the stock could have had, given his stock transactions[,]"[24] regardless of whether or how he actually used that information.[25] It thereby encourages insiders to manage their companies "in ways that will cause steady appreciation of stock prices," while "depriv[ing] them of trading opportunities that might lead them to manage corporate affairs in ways that will cause prices to fluctuate or decline."[26]

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after request or shall fail diligently to prosecute the same thereafter; but no such suit shall be brought more than two years after the date such profit was realized.

15 U.S.C. § 78p(b) (2010).

[21] Credit Suisse Securities (USA) LLC v. Simmonds, __ U.S. __, 132 S. Ct. 1414, 1417 (2012) (quoting Gollust v. Mendell, 501 U.S. 115, 122 (1991)).

[22] 15 U.S.C. § 78p(b) (2012); *see* Smolowe v. Delendo Corp, 136 F.2d 231, 237 (2d Cir. 1943) ("The fact that purchases and sales may be thus coupled, regardless of the intent of the insider . . . points to an arbitrary matching to achieve the showing of a maximum profit.").

[23] *See* Adler v. Klawans, 267 F.2d 840, 847 (2d Cir. 1959) ("The argument that losses and profits made by defendant . . . should be matched against each other to determine liability must be answered in the negative . . . ."); *see, e.g.*, Donna Darm, *Short-Swing Profits in Failed Takeover Bids—The Role of Section 16(b)*, 59 WASH. L. REV. 895, 912 (1984) (arguing that section 16(b) punishes unsuccessful takeover bids too harshly); Park McGinty, *Replacing Hostile Takeovers*, 144 U. PA. L. REV. 983, 1061 n.205 (1996) (citation omitted) (referring to *Gratz* as "the most famous example of the draconian character of [section 16(b)]'s 'mechanical' provisions").

[24] *See* Robert L. Davis, Note, *Tax Treatment of Section 16(b) Payments*, 27 STAN. L. REV. 143, 150 (1974).

[25] *See* Kern Cty. Land Co. v. Occidental Petrol. Corp., 411 U.S. 582, 609 (1973) ("You hold the director, irrespective of any intention or expectation to sell the security within 6 months after, because it will be absolutely impossible to prove the existence of such intention or expectation, and you have to have this crude rule of thumb, because you cannot undertake the burden of having to prove that the director intended, at the time he bought, to get out on a short swing.") (quoting *Hearings on Stock Exchange Practices before the Senate Committee on Banking and Currency*, 73d Cong., 2d Sess., pt. 15 at 6557 (1934) (statement of principal drafter Thomas G. Corcoran)).

Section 16(b)'s harshness has long been controversial. Ellen Taylor, *Teaching an Old Law New Tricks: Rethinking Section 16*, 39 ARIZ. L. REV. 1315, 1318 (1997) (arguing that section 16(b) should be repealed because it is ineffective, unfair, and expensive).

[26] Steve Thel, *The Genius of Section 16: Regulating the Management of Publicly Held Companies*, 42 HASTINGS L.J. 391, 411 (1991).

Short-swing profit recoveries can be considerable. For example, during the internet bubble of the late 1990s, InfoSpace, Inc.'s CEO Naveen Jain inflated the company's value to more than $31 billion[27] and cashed out millions of his own shares before the stock price plunged.[28] A shareholder successfully sued Jain on behalf of the company[29] under section 16(b), and Jain was ordered to disgorge more than $247 million in trading profits and prejudgment interest.[30]

B.   *The* Smolowe *Formula and Its Potential Shortcomings*

Given a lengthy sequence of stock transactions, there can be many ways of matching purchases and sales to calculate profits recoverable under section 16(b). Since the Second Circuit's decision in *Smolowe v. Delendo Corp.*,[31] courts have generally used the "lowest price in, highest price out" formula[32] to calculate short-swing profits.[33] This formula consists of iteratively "matching off against each other the shares purchased at the lowest price during the period [of less than six

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[27] *See* David Heath & Sharon Pian Chan, *Dot-Con Job: How InfoSpace Took Its Investors for a Ride*, SEATTLE TIMES (Mar. 6, 2005), http://www.seattletimes.com/business/dot-con-job-how-infospace-took-its-investors-for-a-ride/ [https://perma.cc/FT3T-J6NX].

[28] *See* David Heath & Sharon Pian Chan, *When Times Got Tough, Execs Hid Troubles, Dumped Stock*, SEATTLE TIMES (Mar. 7, 2005), http://www.seattletimes.com/business/when-times-got-tough-execs-hid-troubles-dumped-stock/ (last visited Dec. 7, 2016).

[29] *See* Dreiling *ex rel.* Infospace v. Kellett, 281 F. Supp. 2d 1215, 1217 (W.D. Wash. 2003) (discussing Dreiling's suit against Jain and co-defendants on behalf of InfoSpace).

[30] *See id.* at 1242 (ordering disgorgement of $202,551,696.05 in profits and $44,571,016.92 in prejudgment interest for a total judgment of $247,122,712.97). The company eventually settled with the Jains for approximately $83 million. Press Release, InfoSpace, Inc., Settlement Agreement Reached in InfoSpace Derivative Case, Section 16(b) Case, and Certain Related Cases Brought by the Jains (Dec. 22, 2004), http://www.sec.gov/Archives/edgar/data/1068875/000119312504219392 /dex991.htm [https://perma.cc/628X-66ZD].

[31] *See* 136 F.2d 231 (2d Cir. 1941).

[32] *See id.* at 239 (describing the formula succinctly as "lowest price in, highest price out—within six months—as applied by the district court").

[33] *See, e.g.*, *Dreiling*, 281 F. Supp. 2d at 1239 ("Consistent with the definition of profit and the 'lowest in, highest out' rule, therefore, the Jains' profit is calculated at $202,551,696.05."). The court's calculation was simplified—and arguably inflated—by the fact that it attributed a purchase price of zero to shares of company stock Jain had transferred into his family's brokerage accounts. *See id.* at 1239; Brief of Sec. and Exch. Comm'n as Amicus Curiae at 12–13, Dreiling *ex rel.* Infospace v. Kellett, 281 F. Supp. 2d 1234 (W.D. Wash. 2003) (No. 03-35710) (criticizing the court's characterization of the transfer). Jain was held liable for the entire proceeds of $85,600,000.00, $17,955,000.00, and $98,966,696.05 from three corresponding sales of company stock made within two months of the transfer, for a total liability of $202,551,696.05. *See Dreiling*, 281 F. Supp. 2d at 1237–39.

months] and an equal number of shares sold at the highest price or prices during the [same] period."[34]

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[34] Brief of Sec. and Exch. Comm'n as Amicus Curiae at 3, Smolowe v. Delendo Corp, 136 F.2d 231 (2d Cir. 1943) (No. 191) [hereinafter SEC *Smolowe* Brief]; *see id.* at 4–5 (containing the full original statement of the formula).

In *Smolowe*, the defendant Kaplan purchased 15,800 shares from co-defendant I.J. Seskis on April 4, 1940 for $2.25 per share, or $35,550. *See Smolowe I*, 46 F. Supp. 758, 62 (S.D.N.Y. 1942). Of these, 15,583 were acquired in connection with a prior debt and were therefore exempt from section 16(b) liability. *See id.* at 766. In addition to his purchase from Seskis, Kaplan conducted the following transactions during the period in question:

Date	Transaction	Shares	Amount ($)	Price ($)/Share
12/1/1939	Purchase	5000	7,750.00	1.5500
2/5/1940	Purchase	200	285.00	1.4250
2/15/1940	Sale	200	308.91	1.5446
2/20/1940	Purchase	200	335.00	1.6750
3/25/1940	Purchase	400	924.00	2.3100
3/27/1940	Purchase	1,000	2,560.00	2.5600
4/11/1940	Purchase	300	768.00	2.5600
4/16/1940	Sale	15,800	35,550.00	2.2500
4/19/1940	Sale	500	750.00	1.5000
4/22/1940	Sale	500	1,312.50	2.6250
5/7/1940	Sale	200	525.00	2.6250
5/7/1940	Sale	800	2,000.00	2.5000
5/10/1940	Sale	500	1,040.20	2.0804
5/11/1940	Sale	200	250.00	1.2500
5/13/1940	Sale	2,000	7,779.03	3.8895
5/14/1940	Sale	1,000	3,889.52	3.8895

See id. at 762.

Using the Commission's "lowest-in, highest-out" formula, the district court matched Kaplan's transactions as follows. First, the court identified the 200 shares purchased on February 5, 1940 as the shares purchased at the lowest price per share ($1.4250) during the period. The court matched these shares with 200 of the 1,000 shares sold on May 14, 1940 at the highest price per share ($3.8895) during the period. The matching process continued as shown below, yielding a total profit of $9,161.05:

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
200	2/5/1940	$ 285.00	5/14/1940	777.90	492.90
800	12/1/1939	1,240.00	5/14/1940	3,111.62	1,871.62
2,000	12/1/1939	3,100.00	5/13/1940	7,779.03	4,679.03
500	12/1/1939	775.00	4/22/1940	1,312.50	537.50
200	12/1/1939	310.00	5/7/1940	525.00	215.00
800	12/1/1939	1,240.00	5/7/1940	2,000.00	760.00

The *Smolowe* formula is capable of producing results that fall short of the maximum possible profit. In a 1987 article[35] that would become his section 16 treatise,[36] Jacobs provided hypothetical examples to illustrate that the formula may fail to recover the maximum possible short-swing profit when some trades are not within the statute of limitations[37] and when trades span a period of more than six months.[38] Figure 1 depicts Jacobs's example of the

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
500	12/1/1939	775.00	4/16/1940	1,125.00	350.00
200	12/1/1939	310.00	4/16/1940	450.00	140.00
200	2/20/1940	335.00	4/16/1940	450.00	115.00

See id. at 766 (noting in supplemental opinion that only paired transactions resulting in profit should be included in calculation).

[35] Jacobs, *supra* note 7. Neither Jacobs nor the author is aware of any earlier acknowledgment of the *Smolowe* formula's limitations in the literature, and Jacobs claims credit for discovering them. Personal communication with Arnold S. Jacobs.

[36] ARNOLD S. JACOBS, SECTION 16 OF THE SECURITIES EXCHANGE ACT (2011).

[37] Jacobs's example considers a suit filed in month 28 attacking the following trading sequence:

Month	Shares Purchased	Purchase Price ($) Per Share	Shares Sold	Sale Price ($) Per Share
1	1,000	10		
2	1,000	12		
3			1,000	17
5			1,000	15

The *Smolowe* formula would pair the purchases in months 1 and 2 with the sales in months 3 and 5, respectively; however, the statute of limitations would bar recovery of profits from the former pair of transactions, leaving only the $3,000 proceeds from the latter pair. A higher profit of $5,000 can be calculated by instead pairing the purchases in months 1 and 2 with the sales in month 5 and 3, respectively. *See* Jacobs, *supra* note 7, at 533–34.

[38] Jacobs's example uses the following trading sequence:

Month	Shares Purchased	Purchase Price ($) Per Share	Shares Sold	Sale Price ($) Per Share
1	1,000	10		
5			1,000	12
8	1,000	8	1,000	13
9	1,000	9	1,000	11

The *Smolowe* formula produces a total profit of $8,000 by pairing the purchases in months 8 and 9 with the sales in months 8 and 5, respectively (leaving the transactions in months 1 and 9, which are too far apart to be paired). A higher profit of $9,000 can be calculated by instead pairing the purchases in 1, 8 and 9 with the sales in 5, 8 and 9, respectively. *See id.* at 532–33; Andrew Chin, *Accurate Calculation of Short-Swing Profits Under Section 16(b) of the Securities Exchange Act of 1934*, 22 DEL. J. CORP. L. 587, 596–99 (1997) (providing another example); *supra* Figure 1.

Smolowe formula's failure to maximize recovery from a sequence of trades spanning an eight-month period.

Figure 1:

Hypothetical example of a trading sequence spanning more than six months for which the *Smolowe* formula falls short of calculating the maximum possible short-swing profit to be disgorged to the company. After the *Smolowe* formula (left) respectively matches the two lowest-priced purchases with the two highest-priced sales within less than six months, the remaining transactions are more than six months apart and cannot be matched for a recoverable profit. To achieve the maximum recovery (right), it is necessary to depart from the matching prescribed by the "lowest-in, highest-out" formula.

Even though the *Smolowe* formula cannot be reliably applied to trading sequences spanning more than six months, not every long trading sequence results in a shortfall, as Figure 2 illustrates.

Figure 2:
Trading sequence spanning more than six months for which the *Smolowe* formula correctly calculates the maximum recovery.

Regardless of what formula is used, trades spanning more than one statutory six-month period pose complications for section 16(b) liability calculations that were not before the *Smolowe* court, as Figure 3 illustrates.[39]

Figure 3:

Six-month short-swing trading periods in *Smolowe*'s trading sequence and in a hypothetical trading sequence. All of the trades challenged in *Smolowe* (left) occurred within a single statutory six-month period. Even with fewer trades, the hypothetical sequence (right) presents a more complex section 16(b) liability calculation problem because the transaction dates span a period of more than six months.

Purchase dates in roman type
Sale dates in italic type

Dec. 1, 1939
Feb. 5, 1940
Feb. 15, 1940
Feb. 20, 1940
March 25, 1940
March 27, 1940
April 11, 1940
April 16, 1940
April 19, 1940
April 22, 1940
May 7, 1940
May 10, 1940
May 11, 1940
May 13, 1940
May 14, 1940

Smolowe

January 12
March 18
April 4
June 8
August 20
September 15
December 19

Hypothetical trading sequence
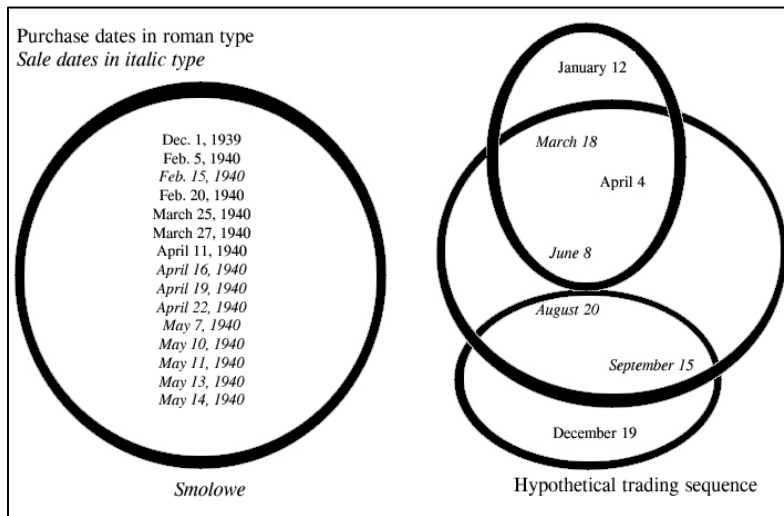
C. The Ubiquity of the Smolowe Formula and the Misreading of Gratz

Despite the *Smolowe* formula's computational complications and discrepancies in trading sequences extending beyond the statute of limitations[40] and spanning more than six months,[41] courts have not hesitated to apply the formula in these potentially problematic situations,[42] and courts[43] and commentators[44] have described the

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[39] *See also* ROMEO & DYE, *supra* note 16, § 10.01[2], at 10-5 (describing possible matchings of transactions in overlapping six-month periods).

[40] *See supra* note 37 and accompanying text.

[41] *See supra* notes 38–39 and accompanying text.

[42] *See, e.g.*, Adler v. Klawans, 267 F.2d 840, 847–48 (2d Cir. 1959) (spanning more than seven months); Donoghue v. Casual Male Retail Group, Inc., 375 F. Supp. 2d 226, 237 (S.D.N.Y. 2005) (spanning more than ten months); Segen v. Westcliff Capital Mgmt., LLC, 299 F. Supp. 2d 262,

Smolowe formula in unqualified terms as a correct method for maximizing recovery in all section 16(b) cases. As one treatise puts it,

265–66, 272 (S.D.N.Y. 2004) (spanning more than ten months); Donoghue v. MIRACOR Diagnostics, Inc., No. 00 Civ. 6696, 2002 WL 233188, at *1–3 (S.D.N.Y. Feb. 11, 2002) (spanning more than thirteen months); Morales v. New Valley Corp., 999 F. Supp. 470, 476 (S.D.N.Y. 1998) (spanning more than six months); Morales v. Mylan Labs., Inc., 443 F. Supp. 778, 780 (W.D. Pa. 1978) (three purchases made more than two years prior to suit); Heli-Coil Corp. v. Webster, 222 F. Supp. 831, 837 (D.N.J. 1963) (spanning more than nine months), *modified*, 352 F.2d 156 (3d Cir. 1965); Ark. La. Gas Co. v. W.R. Stephens Inv. Co., 141 F. Supp. 841, 847–48 (W.D. Ark. 1956) (spanning more than thirteen months); Kogan v. Schulte, 61 F. Supp. 604, 605 (S.D.N.Y. 1945) (spanning fifteen months).

[43] *See, e.g.*, Credit Suisse Secs. LLC v. Simmonds, __ U.S. __, 132 S. Ct. 1414, 1418–21 (2011); Whittaker v. Whittaker Corp., 639 F.2d 516, 532–33 (9th Cir. 1981) ("We believe the *Smolowe* rule is in accord with the absolute and thoroughgoing nature of liability under § 16(b). This statute is intended to be a deterrent to a type of activity which Congress realized was subject to much abuse. In some cases the *Smolowe* rule can be criticized for harshness and artificiality. But other methods would be equally artificial. The *Smolowe* rule assures full recovery of profits for the corporation."); Morales v. Lukens, Inc., 593 F. Supp. 1209, 1213 (S.D.N.Y. 1984) (quoting Blau v. Lehman, 286 F.2d 786, 791 (2d Cir. 1960), *aff'd* 368 U.S. 403 (1962)) ("The purpose of the [lowest-in, highest-out] rule is to 'squeeze every penny of profit' from the defendant."); Roth v. Jennings, No. 03 Civ. 7760(DAB), 2009 WL 1440670, at *5 (S.D.N.Y. May 21, 2009) (citing *Nat. Microsystems Corp.*, 198 F. Supp. 2d at 492 ("[T]he lowest-in, highest-out rule maximizes damages to be assessed against a short-swing trader, rendering potential losses that might otherwise be recognized irrelevant.")); Segen *ex rel.* KFX Inc. v. Westcliff Capital Mgmt., LLC, 299 F. Supp. 2d 262, 272 (S.D.N.Y. 2004) (citing Smolowe v. Delendo Corp., 136 F.2d 231, 239 (2d Cir. 1943)) ("[T]he trades must be matched in a manner that maximizes the disgorgeable amount to [the issuer]. This is accomplished by matching the highest sale prices with the lowest purchase prices within the six month period."); Mayer v. Chesapeake Ins. Co. Ltd., 877 F.2d 1154, 1164 (2nd Cir. 1989) (citing *Smolowe*, 136 F.2d at 239); Synalloy Corp. v. Gray, 816 F. Supp. 963, 971 (D. Del. 1993) (citing *Mayer*, 877 F.2d at 1164); Dreiling *ex rel.* Infospace v. Kellett, 281 F. Supp. 2d 1234, 1238–39 (W.D. Wash. 2003) (citing *Whittaker*, 639 F.2d at 533); *Casual Male Retail Group*, 375 F. Supp. 2d at 237 (citing Donoghue v. Nat. Microsystems Corp., 198 F. Supp. 2d at 492); Huppe v. Special Situations Fund III QP, L.P., 565 F. Supp. 2d 495, 502 (S.D.N.Y. 2008) (citing *Nat. Microsystems Corp.*, 198 F. Supp. 2d 487).

[44] *See, e.g.*, WANG & STEINBERG, *supra* note 9, at 924 n.12 ("The formula established [in *Smolowe*] matches the lowest price in with the highest price out, thus ensuring recovery of all possible profits."); Robert L. Davis, Note, *Tax Treatment of Section 16(b) Payments*, 27 STAN. L. REV. 143, 150 (1974) (citing *Smolowe*, 136 F.2d 231) ("Only by computing the 'profit' in this manner is all potential for trading on inside information within a six-month period removed."); Michael Rosenzweig, Note, *Section 16(b) Liability for Profits Realized from a Cash Purchase and Sale Within Six Months of the Securities of Two Issuers Involved in an Intervening Reorganization*, 75 COLUM. L. REV. 1323, 1326 n.23 (1975) (citing *Smolowe*, 136 F.2d at 239) ("Had another method of calculation been chosen, liability for violation of the section would not be as great."); Steve Thel, *The Genius of Section 16: Regulating the Management of Publicly Held Companies*, 42 HASTINGS L.J. 391, 404 & n.36 (1991) (stating that through *Smolowe*'s "lowest-in, highest-out" formula, "[t]he courts have given section 16(b) teeth by computing profit so as to maximize the forfeiture"); Timothy Tomlinson, *The Application of Section 16(b) to Tax-Qualified Employee Benefit Plans*, 33 STAN. L. REV. 231, 232 n.7 (1981) (citing *Smolowe*, 136 F.2d 231) ("'Profits' are normally calculated so as to recover the maximum amount from trading insiders. Thus, the highest sale price is matched with the lowest purchase price within the 6-month period.").

the *Smolowe* formula "has reigned supreme" among methods for calculating short-swing profits.[45]

One of famed jurist Learned Hand's final decisions as an active judge,[46] *Gratz v. Claughton*, has been instrumental in the *Smolowe* formula's ubiquity. Casebooks have used *Gratz* to introduce three generations of law students to short-swing profit calculation,[47] often in connection with problems or worked examples to illustrate the *Smolowe* formula's operation.[48] Of the many section 16(b) cases that could be used for this purpose, *Gratz* stands out both for its author's illuminating analysis[49] and

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[45] *See* LOSS & SELIGMAN, *supra* note 9, at 693.

[46] Learned Hand retired from active status on May 15, 1951, but continued to serve as a senior judge until his death in 1961. *See* GERALD GUNTHER, LEARNED HAND: THE MAN AND THE JUDGE 504–05, 548–49 (1994). Hand's significance in American jurisprudence is unquestioned. *See* HENRY J. ABRAHAM, JUSTICES, PRESIDENTS, AND SENATORS: A HISTORY OF U.S. SUPREME COURT APPOINTMENTS FROM WASHINGTON TO BUSH II 45 (5th ed. 2008) ("To date, Learned Hand served longer, a total of 52 years, and arguably, perhaps with more distinction, than any other federal jurist in our history."); James A. Thomson, *Learned Hand: Evaluating a Federal Judge*, 22 N. KY. L. REV. 763, 794 (1995) ("Unanimity prevails on one proposition: Hand's influence on American law was wide and deep.").

[47] *See, e.g.*, WILLIAM T. ALLEN ET AL., COMMENTARIES AND CASES ON THE LAW OF BUSINESS ORGANIZATION 627 (3d ed. 2009) (note case); WILLIAM L. CARY & MELVIN ARON EISENBERG, CASES AND MATERIALS ON CORPORATIONS 593–97 (concise 6th ed. 1988) (principal case); JAMES D. COX ET AL., SECURITIES REGULATION: CASES & MATERIALS 894 (4th ed. 2004) (note case); MELVIN ARON EISENBERG & JAMES D. COX, CORPORATIONS & OTHER BUSINESS ORGANIZATIONS: CASES & MATERIALS 1009–12 (10th ed. 2011) (principal case); ALEXANDER H. FREY ET AL., CASES AND MATERIALS ON CORPORATIONS 762–64 (1966) (principal case); ROBERT W. HAMILTON, CASES AND MATERIALS ON CORPORATIONS INCLUDING PARTNERSHIPS AND LIMITED LIABILITY COMPANIES 1001–02 (7th ed. 2001) (note case); THOMAS LEE HAZEN & JERRY W. MARKHAM, CORPORATIONS & OTHER BUSINESS ENTERPRISES 887–90 (standard 3d ed. 2009) (note case); NORMAN D. LATTIN ET AL., CORPORATIONS CASES AND MATERIALS 695–700 (4th ed. 1968) (principal case); VAGTS, *supra* note 2, at 551–53 n.7 (note case); *see generally* Gunther, *supra* note 12, at 47 (describing Hand's opinions as "familiar to every lawyer and law student").

[48] *See, e.g.*, ALLEN, *supra* note 47, at 629 (exercise); CARY & EISENBERG, *supra* note 47, at 598 (example); COX, *supra* note 47, at 894–95 (exercise); EISENBERG & COX, *supra* note 47, at 1013 (examples); HAMILTON, *supra* note 47, at 1000–03; HAZEN & MARKHAM, *supra* note 47, at 889 (exercises); VAGTS, *supra* note 47, at 562 (exercise).

[49] *See* JOHN R. VILE, 1 GREAT AMERICAN JUDGES: AN ENCYCLOPEDIA 319 (2003) (Judge Hand "has been quoted in Supreme Court opinions and scholarly publications more often than any lower court judge in the United States. . . . He could take a mass of cases, unorganized splinters and shards of ideas, and painstakingly fit them into a glittering stained glass window that illuminated an entire field for the rest of the legal world"); THE ART AND CRAFT OF JUDGING: THE DECISIONS OF JUDGE LEARNED HAND 1 (Hershel Shanks ed. 1968) ("[F]requently, a case attained significance because the opinion was written by Learned Hand—because of his ability to fathom the principle on which decision depended and illuminate its meaning. In this way, he created his legacy: a light for the future, to guide lawyers and judges in applying the law to cases yet unborn.").

for its draconian judgment of $300,000 against an insider who had already suffered a net overall loss of $400,000.[50]

Courts have also widely cited *Gratz* in connection with the formula. Along with *Smolowe*, *Gratz* has been cited as one of the two leading authorities for the formula's use in section 16(b) decisions spanning from the 1950s to the present day.[51] Commentators have followed suit.[52]

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[50] *See* Adler v. Klawans, 267 F.2d 840, 847–48, (2d Cir. 1959) (citing Gratz v. Claughton, 187 F.2d 46 (2d Cir. 1951)); COX & HILLMAN, *supra* note 47, at 894 (citing *Gratz*, 187 F.2d at 52–53) ("Under this [lowest-in, highest-out] approach, an insider can be liable for large amounts of profits, even where he lost money on his purchase and sale activity in the aggregate."); EISENBERG & COX, *supra* note 47, at 1014 (noting that the "*Smolowe/Gratz* formula" may impose liability based on the mere "possibility" that a defendant may have profited by limiting his loss through the use of inside information); Park McGinty, *Replacing Hostile Takeovers*, 144 U. PA. L. REV. 983, 1061 n.205 (1996) (citation omitted) (referring to *Gratz* as "the most famous example of the draconian character of [section 16(b)]'s 'mechanical' provisions").

[51] *See, e.g.*, Whittaker v. Whittaker Corp., 639 F.2d 516, 531 (9th Cir. 1981) (citing Smolowe v. Delendo Corp., 136 F.2d 231 (2d Cir. 1943)); Anderson v. Comm'r, 480 F.2d 1304, 1307 (7th Cir. 1973) (same); Adler v. Klawans, 267 F.2d 840, 847–48 (2d Cir. 1959) (same); Falco v. Donner Found., 208 F.2d 600, 602 (2d Cir. 1953) (same); *Gratz*, 187 F.2d 46, *abrogated on other grounds*, Credit Suisse Secs. LLC v. Simmonds, 132 S. Ct. 1414, 1418–21 (2012); Huppe v. Special Situations Fund III, 565 F. Supp. 2d 495, 502–03 (S.D.N.Y. 2008) (citing *Gratz*, 187 F.2d 46); Donoghue v. Casual Male Retail Grp., Inc., 375 F. Supp. 2d 226, 237 (S.D.N.Y. 2005) (same); Donoghue v. MIRACOR Diagnostics, Inc., No. 00 Civ. 6696, 2002 WL 233188, at *1–3 (S.D.N.Y. Feb. 11, 2002) (same); Donoghue v. Nat. Microsystems Corp., 198 F. Supp. 2d 487, 492 (S.D.N.Y. 2002) (same); Tyco Labs., Inc. v. Cutler-Hammer, Inc., 490 F. Supp. 1, 9 n.7 (S.D.N.Y. 1980) (same); Lewis v. Levinson, 77 Civ. 1481, 1978 WL 1087, at *3 (S.D.N.Y. May 8, 1978) (same); Lewis v. Riklis, 446 F. Supp. 582, 584 (S.D.N.Y. 1978) (same); Makofsky v. Ultra Dynamics Corp., 383 F. Supp. 631, 638–39 (S.D.N.Y. 1974) (same); W. Auto Supply Co. v. Gamble-Skogmo, Inc., 231 F. Supp. 456, 460–61 (D. Minn. 1964) (same), *rev'd on other grounds*, 348 F.2d 736 (8th Cir. 1965); Heli-Coil Corp. v. Webster, 222 F. Supp. 831, 837 (D.N.J. 1963) (same); Kornfeld v. Eaton, 217 F. Supp. 671, 673–74 (S.D.N.Y. 1963) (same); Blau v. Lehman, 173 F. Supp. 590, 595 n.3 (S.D.N.Y. 1959) (same); Ark. La. Gas Co. v. W.R. Stephens Inv. Co., 141 F. Supp. 841, 847 (W.D. Ark. 1956) (same). *See generally* EISENBERG & COX, *supra* note 47, at 1013 ("The formula adopted in *Smolowe* and *Gratz* has been generally approved by the courts."); VAGTS, *supra* note 47, at 552 ("Opinions by the Second Circuit in the Section 16 field are generally regarded as authoritative.").

Unlike many of the liability calculations discussed in this Article, the calculation of Jain's liability was trivially simple, *see supra* note 33, and relied on *Gratz* only indirectly. *See* Dreiling *ex rel.* Infospace v. Kellett, 281 F. Supp. 2d 1215, 1238 (W.D. Wash. 2003) (citing *Whittaker*, 639 F.2d at 522, 533); *Whittaker*, 639 F.2d at 531 (citing *Gratz*, 187 F.2d at 50–52).

[52] *See, e.g.*, LOSS & SELIGMAN, *supra* note 9, at 694 ("Eight years later [in *Gratz*] the Second Circuit reasserted the lowest-in, highest-out formula after independent analysis."); ROMEO & DYE, *supra* note 16, at 11-8 (1994) ("The 'lowest-in, highest-out" method was reasserted, with independent analysis, by the Second Circuit in [*Gratz*]."); Donald C. Cook & Myer Feldman, *Insider Trading Under the Securities Exchange Act*, 66 HARV. L. REV. 612, 614 n.151 (1953) (stating that *Gratz* reaffirmed the *Smolowe* formula); Michael H. Dessent, *Weapons to Fight Insider Trading in the 21st Century: A Call for the Repeal of Section 16(b)*, 33 AKRON L. REV. 481, 481 n.3 (2000) ("The [*Gratz*] court followed *Smolowe* . . . , which stated that to give section 16(b) its full effect, the calculation would be the shares with the lowest purchase price, matched against those with the highest sale prices."); Maureen S. Duggan, Annotation, *Proper Measure and Elements of Recovery for Insider Short-Swing Transaction*, 86 A.L.R. FED. 16, § 4 (1988) ("In *Gratz* . . . the

This historically dominant reading of *Gratz* has always been strained at best. Hand did cite *Smolowe*[53] and agreed with its strict approach to fiduciary liability,[54] but he said nothing about the *Smolowe* formula, did not use it, and did not even comment on the calculations in the record on appeal: "the plaintiff has not appealed, so that she is not entitled to any more than she has recovered. On this account *we have not examined the [special] master's computations in detail and are not to be understood to have passed upon them.*"[55] Hand may have been famously fond of algebra,[56] but in *Gratz*, he skipped the math.[57]

As the remainder of this Article will show, recent developments in computer science and technology have brought to light the meaning and wisdom of Hand's mathematical silence in *Gratz*. By "examin[ing] the [special] master's computations in detail," today's computers can determine that the *Smolowe* formula was probably not used to calculate defendant Edward N. Claughton's short-swing profits and would have fallen short of maximizing those profits even if it had been used (section II.C). Modern computer science has also made it possible to characterize the *Smolowe* formula's worst-case errors (section III.B) and to identify a

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court affirmed the adoption of the lowest in-highest out rule for computing short-swing profits when there are multiple purchases and sales . . . ."); Roger J. George, Jr., Comment, *The Application of Section 16(b) to Mergers: A Hidden Hazard*, 47 TEX. L. REV. 1417, 1421 n.34 (1969) (same); Robert W. Hamilton, *Convertible Securities and Section 16(b): The End of an Era*, 44 TEX. L. REV. 1447, 1448 n.7 (1966) (citing *Gratz*, 187 F.2d 46, as authority for the formula); Timothy Tomlinson, *Section 16(b): A Single Analysis of Purchases and Sales—Merging the Objective and Pragmatic Analyses*, 1981 DUKE L.J. 941, 941 n.5 (1981) (same); Rosenzweig, *supra* note 44, at 1326 n.23 (same); Recent Development, *Second Circuit Limits Insider-Partner's 16(b) Liability*, 14 STAN. L. REV. 192, 194 n.10 (1961) (same); *but cf.* ARNOLD S. JACOBS, SECTION 16 OF THE SECURITIES EXCHANGE ACT 531 (2011) (citations omitted) ("[Although it] has been widely cited and followed . . . the lowest price in-highest price out rule is not the real holding of *Smolowe* [or *Gratz*].").

[53] *Gratz*, 187 F.2d at 49 n.4, 50, 52 (citing *Smolowe*, 136 F.2d 231).

[54] *See id.* at 51–52.

[55] *See id.* at 52 (emphasis added).

[56] *See* United States v. Carroll Towing Co., 159 F.2d 169, 173 (2d Cir. 1947) ("[I]f the probability be called P; the injury, L; and the burden, B; liability depends upon whether B is less than L multiplied by P: i.e., whether B [less than] PL."). This algebraic rule is taught to every first-year torts student as the "famous Learned Hand formula." Neal Kumar Katyal, *Criminal Law in Cyberspace*, 149 U. PA. L. REV. 1003, 1080 (2001); *see also* Patrick J. Kelley, *The* Carroll Towing Company *Case and the Teaching of Tort Law*, 45 ST. LOUIS U. L.J. 731, 732 n.4 (2001) (citing casebooks that prominently feature *Carroll Towing*). It is "arguably the most prominent approach used to determine negligence." Arden Rowell & Jessica Bregant, *Numeracy and Legal Decision Making*, 46 ARIZ. ST. L.J. 191, 215 (2014).

[57] Accordingly, there is no basis for referring to the "lowest-in, highest-out" formula as "[t]he formula adopted in *Smolowe* and *Gratz*." *See* EISENBERG & COX, *supra* note 47, at 1013; *supra* notes 51–52 (citing cases and commentaries that attribute the formula to *Gratz*, 187 F.2d 46).

costly error from the formula's use in a recent case (section III.C). Even by 1987, Jacobs had shown that the *Smolowe* formula could not reliably be applied to Claughton's twenty-one month trading sequence.[58] In 1951, however, Hand could not have feasibly calculated the maximum value of Claughton's short-swing profits or assessed the *Smolowe* formula's accuracy (section II.B). Prudently, Hand adhered to *Smolowe*'s strict fiduciary liability doctrine (section II.A) and resolved the issue of Claughton's liability (section II.B) without prescribing the *Smolowe* formula or any other method of liability calculation. Now that the requisite technology is available to calculate and verify an insider's maximum short-swing profits in all cases (section IV.A), there is no longer any reason to rely on *Gratz* (or any other case law) as an authority for the *Smolowe* formula's use (section III.A). It is time for Hand's mathematical silence to be heard (section IV.B).

II.   THE MEANING OF HAND'S MATHEMATICAL SILENCE

A.   Smolowe *and Hand's Silence in* Gratz

It may seem difficult at first to reconcile Hand's silence regarding the "lowest-in, highest-out" formula in *Gratz* with the district court's and Second Circuit's explicit adoption of the "lowest-in, highest-out" formula in *Smolowe*. The two cases, however, presented very different facts. Because *Gratz* involved hundreds of transactions spanning more than twenty-one months,[59] not all pairs of the defendant's low-priced purchases and high-priced sales would yield a recoverable short-swing profit, but only such pairs occurring within six months of each other.[60] *Smolowe* involved a far simpler sequence of six purchases and nine sales between December 1, 1939 and May 14, 1940[61] (i.e., all within a single statutory six-month period).[62] *Smolowe* was therefore more amenable to use of the formula than was *Gratz*,

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[58] *See supra* note 38 and accompanying text.

[59] *See Gratz* Master's Report, *supra* note 11 (listing, inter alia, 276 purchases and 101 sales of common stock and 11 purchases and 20 sales of preferred stock between December 18, 1944 and September 24, 1946).

[60] To be more precise, section 16(b) requires disgorgement of profit "from any purchase and sale, or any sale and purchase . . . within any period of *less than six months*." 15 U.S.C. § 78p(b) (2012) (emphasis added). Neither *Smolowe* nor *Gratz* discussed the fine points of measuring the statutory six-month period or the implications of section 16(b)'s "less than" provision. *See* ROMEO & DYE, *supra* note 16, § 10.01, at 10-2 to 10-4 (surveying case law on measuring the short-swing period).

[61] *Smolowe I*, 46 F. Supp. at 762.

[62] The complaint was filed October 28, 1940, i.e., within the statute of limitations. *See* Smolowe v. Delendo Corp., 36 F. Supp. 790, 791 (S.D.N.Y. 1940).

as Figure 3 suggests, and the adjudication of liability in the two cases confirms this theory.

In *Smolowe*, the Securities and Exchange Commission filed an amicus brief to the district court expressly "confine[d] . . . to a single question—the measure of damages to be applied in cases where, as here, numerous purchases and sales have been made in differing sized lots and at different prices during *the period in respect of which relief is sought*."[63] The Commission proposed the following formula:

> [T]he plaintiff in any case under Section 16(b) is entitled to list in one column all purchases made during *the period in respect of which he seeks relief*, and in another column all sales made within *the same period*. As a measure of the recovery to which he is entitled, he may start by matching off against each other the shares purchased at the lowest price during *the period* and an equal number of shares sold at the highest price or prices during *the period*, the measure of recovery in respect of this "purchase and sale" being the difference between the two prices. Then, the purchase price of the shares purchased at the next lowest price may be similarly matched off against the highest share price of any remaining equal number of shares sold during *the period*. The same process may be continued until all shares purchased have been matched off, so far as possible, against an equal number of shares sold at higher prices. The gross recovery is the sum of the several differentials thus determined.[64]

In this definitive statement of the formula,[65] each of the italicized occurrences of the term "the period" refers to the antecedent term "the period in respect of which he seeks relief," so they are all synonymous. Because it is permissible to match shares purchased and shares sold during "the period" for a recoverable profit only if the transactions occur within six months of each other,[66] "the period" logically must refer to a single statutory six-month

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[63] SEC *Smolowe* Brief, *supra* note 34, at 4.

[64] *Id.* at 4–5 (emphases added).

[65] It bears noting that the "lowest-in, highest-out" formula was first suggested much earlier in two preliminary drafts of the 1934 Act. *See* Smolowe v. Delendo Corp., 136 F.2d 231, 237 n.11 (2d Cir. 1943) ("H.R. 7852 and S. 2693 contained the provision that 'profit shall be calculated on the sale or sales by such person of such security made at the highest price or prices and on the purchase or purchases made by such person of such security at the lowest price or prices during the six months' period . . . .'"). The *Smolowe* court, however, found these drafts to be minimally relevant to the interpretation of the enacted statute, *see id.*, and explicitly affirmed the district court's adoption of the Commission's version of the formula. *See id.* at 239; *Smolowe I*, 46 F. Supp. at 766. Even if the draft language were to be taken as definitive, it still refers to a single "six months' period," so the limited scope of the Commission's formula would apply to the legislative version of the formula with equal force. *See Smolowe*, 136 F.2d at 237 n. 11.

[66] *See* 15 U.S.C. § 78p(b) (2012).

period. The Commission's formula therefore addresses only cases in which "the period in respect of which relief is sought" is a single statutory six-month period, and says nothing regarding the additional complexities of matching transactions that span a longer time frame.[67] In particular, the Commission's formula is facially inapplicable to the twenty-one-month trading sequence challenged in *Gratz*.

In addition to the Commission's formula, the district court also considered defendant Henry C. Kaplan's alternative proposals to allow only the matching of purchases and sales occurring "first in and first out" within the trading sequence or involving identical stock certificates.[68] After finding Kaplan's proposals inconsistent with section 16(b)'s text and purpose, the court immediately proceeded to adopt the Commission's formula without further comment or analysis:

> The subsection [16(b)] carefully states that profits are to be computed from "any" purchase and sale or "any" sale and purchase within the six months. It does not say that any purchase is to be set off against the next sale nor that any rule of "first in and first out" shall be adopted. The purpose of the statute was to make unprofitable short swings by persons in a position to have inside information. If they saw fit to disobey the law, there is no reason why the recovery should be minimized. The rule to be adopted must disregard the identity of the certificates, as I have previously stated. The computation suggested by the Securities & Exchange Commission is, therefore, adopted as fixing the amount of profits recoverable from the defendant Kaplan.[69]

The Second Circuit, in an affirmance authored by Judge Charles Edward Clark, similarly found Kaplan's proposals inconsistent with section 16(b)'s

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[67] *See supra* Figure 3 (illustrating that longer transaction sequences give rise to multiple partially overlapping statutory six-month periods within which pairs of transactions can be matched for a recoverable profit). The following example illustrates the complexity introduced by overlapping short-swing periods:

A plaintiff may match transactions in overlapping six-month periods. Suppose, for example, that an insider makes a purchase of 100 shares of stock on January 1, followed by a sale of 300 shares on May 1 and a purchase of 200 shares on September 30. Both the purchase on January 1 and the purchase on September 30 may be matched with the sale on May 1. The period from January 1 through June 29 may be considered one short-swing period, permitting the January 1 purchase to be matched with the sale of 100 of the shares sold on May 1. Similarly, the period from May 1 through October 30 may be considered a separate short-swing period, permitting the May 1 sale of the remaining 200 shares to be matched with the September 30 purchase. However, if the two purchases exceeded 300 shares (the number of shares sold), only 300 shares would be matched.

ROMEO & DYE, *supra* note 16, § 10.01[2], at 10-5 (citation omitted).

[68] *Smolowe I*, 46 F. Supp. at 766.

[69] *Id.*

"any purchase and sale, or any sale and purchase" provision.[70] Clark drew an even stronger conclusion from the statute's expansive language, finding that "its generality permits and points to . . . . an arbitrary matching to achieve the showing of a *maximum profit*."[71] Clark then proceeded to set forth the "only rule" that would recover the maximum profit attributable to an insider's stock transactions:

> We must suppose that the statute was intended to be thorough-going, to squeeze all possible profits out of stock transactions, and thus to establish a standard so high as to prevent any conflict between the selfish interest of a fiduciary officer, director, or stockholder and the faithful performance of his duty. The only rule whereby all possible profits can be surely recovered is that of lowest price in, highest price out—within six months—as applied by the district court. We affirm it here, defendants having failed to suggest another more reasonable rule.[72]

Clark explicitly identified "[t]he only rule whereby all possible profits can be surely recovered" as the formula "applied by the district court" in *Smolowe*: namely, the formula "suggested by the Securities & Exchange Commission."[73] Accordingly, the instruction "lowest price in, highest price out"[74] was simply an elegantly succinct paraphrase of the Commission's formula for matching off "the shares purchased at the lowest price during the period and an equal number of shares sold at the highest price or prices during the period."[75] The accompanying qualifier "within six months"[76] referred to the statutory six-month period during which all of the challenged transactions occurred, as set forth in the Commission's formula.[77]

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[70] *Smolowe*, 136 F.2d at 237–38.

[71] *Id.* at 237.

[72] *Id.* at 239 (citations omitted).

[73] *Smolowe I*, 46 F. Supp. at 766.

[74] *Smolowe*, 136 F.2d at 239.

[75] *See* SEC *Smolowe* Brief, *supra* note 34, at 4–5.

[76] *Smolowe*, 136 F.2d at 239.

[77] SEC *Smolowe* Brief, *supra* note 34, at 3 (emphasis added). By 1981, the *Smolowe* formula had been employed in enough cases involving longer trading sequences that the Commission reinterpreted the "within six months" provision as referring to each pair of matched transactions, rather than the length of the entire trading sequence. *See* Interpretive Release on Rules Applicable to Insider Reporting and Trading, 46 Fed. Reg. 48147, 48161 n.102 (1981) (citing *Smolowe*, 136 F.2d 231) (stating that "profit is computed by matching the highest sale price with the lowest purchase price within six months, the next highest sale price with the next lowest purchase price within six months, and so on, until all shares have been included in the computation"). As the foregoing discussion has shown, this reinterpretation has no basis in *Smolowe*.

The *Smolowe* formula "lowest price in, highest price out—within six months"[78] therefore amounted to nothing more or less than the Commission's formula,[79] which in turn was designed and proposed for use only in cases involving a single statutory six-month trading period.[80] Thus, despite Clark's sua sponte reference to the formula as "[t]he only rule,"[81] and contrary to the dominant reading of *Smolowe*,[82] the *Smolowe* court did not endorse the formula for application to the twenty-one-month trading sequence challenged in *Gratz*.[83]

Gratz involved a sequence of more than 400 transactions in Missouri-Kansas-Texas Railroad Company stock spanning from December 18, 1944 to September 24, 1946.[84] In district court proceedings before a special master, the plaintiff Stella Gratz had sought liability under the *Smolowe* formula.[85] The defendant Edward N. Claughton had argued for more lenient methods of calculation, including a modification of the *Smolowe* formula involving "matching the highest prices out against the lowest prices in for three months before or three months after each sale."[86] The master rejected Claughton's alternative proposals because they did not "conform to or satisfy the statute as I view it, or the rule of damages in the *Smolowe* case which I find plaintiffs have correctly adopted."[87]

Claughton had also submitted various calculations, including an accounting purporting to show:

> [T]he damages, though not conceding the correctness of the theory of such calculation, which might be awarded to the plaintiffs, in the sum of [$308,417], upon the basis of highest price out and lowest price in during the period of his trading, as to purchases and sales

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[78] *Smolowe*, 136 F.2d at 239.

[79] *See* SEC *Smolowe* Brief, *supra* note 34, at 4–5.

[80] *Id.*

[81] *Smolowe*, 136 F.2d at 239.

[82] *See, e.g.*, Whittaker v. Whittaker Corp., 639 F.2d 516, 533 (9th Cir. 1981), *abrogated on other grounds by* Credit Suisse Secs. LLC v. Simmonds, __ U.S. __, 132 S. Ct. 1414, 1418–21 (2011) (stating without qualification that "[t]he *Smolowe* rule assures full recovery of profits for the corporation"); EISENBERG & COX, *supra* note 47, at 1013 (discussing the predominance of the formula in *Smolowe* and *Gratz* in case law).

[83] For further discussion, *see* section III.A (arguing that the *Smolowe* court's statement of the rule must be read as limited to cases involving a single statutory six-month trading period because otherwise it would be empirically false).

[84] *See Gratz* Master's Report, *supra* note 11.

[85] *Id.* ¶ 16.

[86] *See id.*; Brief of Defendant-Appellant at 15, Gratz v. Claughton, 187 F.2d 46 (2d Cir. 1951) (No. 147 Docket 21660).

[87] *See Gratz* Master's Report, *supra* note 11, ¶ 16.

and sales and purchases . . . within any period less than six months . . . .[88]

A detail from Claughton's accounting is reproduced in Figure 4.

Figure 4:
Detail of Claughton's profit calculation.[89]

Gratz and the master were both content to let Claughton handle the math. Gratz stipulated that Claughton's accounting was correct according to the *Smolowe* formula,[90] and the master entered a finding that "the profits made by Claughton during the less than six months periods have been shown to amount altogether to the sum of [\$308,417], under the [*Smolowe*] rule of damages."[91] The district court adopted the master's report in all respects.[92]

Hand affirmed the district court's judgment in a unanimous decision for the Second Circuit.[93] Hand began his analysis of Claughton's liability by

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[88] *See id.* Various reports of Claughton's calculation exhibited small typographical and/or rounding discrepancies. *Cf. Gratz* Master's Report, *supra* note 11, ¶ 16 (stating the result of Claughton's calculation as \$308,417.50 and as \$308,417.09); Def.'s Exhibits C & N to *Gratz* Master's Report, *supra* note 11 (showing Claughton's calculation of profits totaling \$308,417.05). These errors are negligible, and fractional dollars have been omitted hereinafter where warranted for clarity of exposition.

[89] Def.'s Exhibit N to *Gratz* Master's Report, *supra* note 11, at 1.

[90] *See Gratz* Master's Report, *supra* note 11, ¶ 16.

[91] *See id.*

[92] Order ¶ 2, Gratz v. Claughton (S.D.N.Y. 1949) (No. 35-410).

[93] Gratz v. Claughton, 187 F.2d 46, 52 (2d Cir. 1951).

observing that section 16(b)'s expansive language provided "no principle by which to select any two transactions which are to be matched," thereby forcing a choice between matching trades

> in such a way as to reduce profits to their lowest possible amount, or in such a way as to increase them to the greatest possible amount. The master adopted the second course, following what he supposed to be the doctrine of *Smolowe*. . . . We think that he was right for the following reasons.[94]

Hand reasoned that any uncertainty in the liability calculation must be resolved against the fiduciary, Claughton, in accordance with the traditional common law doctrine of spoliation:

> As we have said, the statute makes all such dealings unlawful, and makes the fiduciary accountable to the corporation. Although it is impossible in the case at bar to compute the defendant's profits, except that they must fall between two limits—the minimum and the maximum—the cause of this uncertainty is the number of transactions within six months: that is, the number of defendant's derelictions. The situation falls within the doctrine which has been law since the days of the "Chimney Sweeper's Jewel Case," that when damages are at some unascertainable amount below an upper limit and when the uncertainty arises from the defendant's wrong, *the upper limit will be taken as the proper amount*.[95]

After rejecting Claughton's alternative calculation method as falling short of this "upper limit,"[96] Hand observed that the plaintiff was free to recover this maximum amount by matching purchases and sales of equal numbers of shares in any way that would produce a short-swing profit:

> If one is seeking an equation of purchase and sale, one may take *any* sale as the minuend and look back for six months for a purchase at less price to match against it. On the other hand, if one is looking for an equation of sale and purchase, one may take the same sale and look forward for six months for *any* purchase at a lower price. Although obviously no transaction can figure in more than one

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[94] *Id.* at 51.

[95] *Id.* at 51–52 (emphasis added); *but see* John E. Munter, *Section 16(b) of the Securities Exchange Act of 1934: An Alternative to "Burning Down the Barn in Order to Kill the Rats,"* 52 CORNELL L. REV. 69, 83 n.64 (1966) ("The validity of the analogy is dubious in cases where the defendant would be able to prove the exact amount of his actual profit if the court gave him a chance, for then the damages would no longer be 'unascertainable.'").

[96] *See Gratz*, 187 F.2d at 52 ("This results in looking for six months both before and after any sale, and not for three months only, as the defendant insists.").

equation, with that exception we can see no escape from what we have just said.[97]

Hand's analysis thus led to precisely two legal conclusions: first, that "the proper amount" of section 16(b) liability is given by "the upper limit" of short-swing profits attributable to the defendant's trading, and second, that a section 16(b) plaintiff is entitled to recover this maximum amount by arbitrarily matching pairs of purchases and sales within six months of each other.[98]

Hand's opinion offered no view as to whether specifically matching pairs of trades according to the "lowest-in, highest-out" formula would yield the maximum amount of profits recoverable from *Gratz*'s twenty-one-month trading sequence.[99] Hand also expressly declined to review Claughton's calculation and affirmed the sufficiency of the judgment below solely on the grounds that the plaintiff had stipulated to it:

> [T]he plaintiff has not appealed, so that she is not entitled to any more than she has recovered. On this account we have not examined the master's computations in detail and are not to be understood to have passed upon them.[100]

Hand's analysis concluded: "[t]herefore, not only will we follow *Smolowe v. Delendo Corporation*, *supra*, as a precedent; but as *res integra* and after independent analysis we reassert its doctrine."[101]

It is notable that in undertaking his "independent analysis" of what he took to be *Smolowe*'s doctrine, Hand saw no need to discuss or even mention the "lowest-in, highest-out" formula.[102] Hand instead focused on and reasserted two other doctrinal aspects of the *Smolowe* decision: the strict character of fiduciary liability[103] and the determination that section 16(b)'s expansive

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[97] *Id.* (emphasis added).

[98] *See supra* text accompanying notes 96–97.

[99] As it turns out, the *Smolowe* formula would not have maximized Claughton's liability. *See infra* app. A, tbls. 1 & 2.

[100] *Gratz*, 187 F.2d at 52.

[101] *Id.*

[102] For more discussion of Hand's view of his Second Circuit colleague Clark's jurisprudence, see, for example, MARVIN SCHICK, LEARNED HAND'S COURT 304 (1970) (quoting Letter from Learned Hand to Charles Edward Clark (Feb. 23, 1950)) ("Of course, we have positive differences; we should not be worth our salt if we did not . . . . Between ourselves we may say, what I think we all believe in secret, that we have a fine court and that each of us contributes to it a part which would make the sum much poorer if it were absent.").

[103] *See* Smolowe v. Delendo Corp., 136 F.2d 231, 239 (2d Cir. 1943) ("We must suppose that the statute was intended to be thorough-going, to squeeze all possible profits out of stock transactions, and thus to establish a standard so high as to prevent any conflict between the selfish interest of a fiduciary officer, director, or stockholder and the faithful performance of his duty.").

language warranted "an arbitrary matching to achieve the showing of a maximum profit."[104]

In the final analysis, the Second Circuit's contrasting adjudications of short-swing liability in *Smolowe* and *Gratz* are easily harmonized. It suffices to observe that the historically dominant interpretation of *Gratz* as an authority in support of the *Smolowe* formula is incorrect. Contrary to popular belief, the formula was *not* among the doctrines from *Smolowe* that Hand "independently examined and adhered to in *Gratz*."[105] *Gratz* may have followed *Smolowe* as a precedent with respect to its other doctrines, but Hand's analysis and conclusions provided no support for the *Smolowe* formula.

B.   *The Judgment Below and Hand's Silence in* Gratz

It should be clear at this point that Hand's decision to "follow *Smolowe* . . . as a precedent" and to "reassert its doctrine"[106] did not involve an endorsement of the *Smolowe* formula. Even so, it might be possible to interpret Hand's affirmance of the judgment below as encompassing the master's characterization of the *Smolowe* formula as "[t]he only rule whereby all profits can be 'squeezed out' of the 10% stock trader [Claughton]."[107]

Such a reading, however, would belie *Gratz*'s historical context. In reviewing an accounting of more than 400 transactions over a twenty-one month period[108] in an era when spreadsheets were calculated by hand[109] and transcribed on a typewriter,[110] Hand could not have confidently based his affirmance of the district court's $308,417 judgment on the proposition that this sum actually represented the

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[104] *Id.* at 237.

[105] Kornfeld v. Eaton, 217 F. Supp. 671, 674 (S.D.N.Y. 1963) ("[The *Smolowe* court] reached an empirical judgment that '[t]he only rule whereby all possible profits can be surely recovered is that of lowest price in, highest price out—within six months . . . .' This doctrine was independently examined and adhered to in *Gratz* . . . ."); *cf.* ROMEO & DYE, *supra* note 16, § 11.02, at 11-8 ("The 'lowest-in, highest-out' method was reasserted, with independent analysis, by the Second Circuit in *Gratz v. Claughton* eight years after its adoption.").

[106] *Gratz*, 187 F.2d at 52.

[107] *See Gratz* Master's Report, *supra* note 11, ¶ 16. For such an interpretation, see Duggan, *supra* note 52, § 4 ("In *Gratz* . . . the court affirmed the adoption of the lowest in-highest out rule for computing short-swing profits when there are multiple purchases and sales . . . .").

[108] *See Gratz* Master's Report, *supra* note 11.

[109] No pun intended. *See supra* Figure 4.

[110] *See* Def.'s Exhibits C & N to *Gratz* Master's Report, *supra* note 11 (providing handwritten and typewritten versions of Claughton's liability calculations).

maximum possible profit that could be "squeezed out" of Claughton's transactions.[111]

Finding a profit-maximizing matching of purchases and sales is an example of what Lon Fuller called a "polycentric task,"[112] a problem whose complexity stems from the fact that each decision point "is a distinct center for distributing tensions."[113] Six years after *Gratz*, in what would become his classic article, *The Forms and Limits of Adjudication*,[114] Fuller illustrated this concept with the example of a probate court's division of an art collection into two equal shares where:

> [T]he disposition of any single painting has implications for the proper disposition of every other painting. If it gets the Renoir, the Gallery may be less eager for the Cezanne but all the more eager for the Bellows, etc. . . . . Any judge assigned to hear such an argument would be tempted to assume the role of mediator or to adopt the classical solution: Let the [Metropolitan] divide the estate into what he regards as equal shares, let the [Gallery] take his pick.[115]

Section 16(b) liability calculation is similarly polycentric, in that any matching of a purchase P_1 with a sale S_1 may affect the profits recoverable from sales that otherwise might have been matched with P_1 and purchases that otherwise might have been matched with S_1. Prefiguring Fuller's probate judge and his "cut and choose" solution, Hand adopted a form of adjudication—giving Gratz the entitlement to choose an arbitrary matching of short-swing trades[116]—that elegantly elided the limits of the court's computational powers.[117] It might aptly be dubbed "the Learned Hand unformula."[118]

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[111] An accurate computational method for calculating the maximum short-swing profit attributable to a sequence of transactions was first published in 1997. *See* Chin, *supra* note 38.

[112] *See* Lon L. Fuller, *The Forms and Limits of Adjudication*, 92 HARV. L. REV. 353, 394 (1978).

[113] *See id.* at 395.

[114] *See id.* at 353 (explaining that the initial version of the article was circulated at Harvard Law School in 1957). As of Nov. 22, 2016, the query "Fuller /p 'The Forms and Limits of Adjudication'" yielded 1,023 hits in Westlaw's secondary sources database.

[115] *See id.* at 394.

[116] *See* Gratz v. Claughton, 187 F.2d 46, 52 (2d Cir. 1951).

[117] This form-of-adjudication approach to the resolution of polycentric disputes has continued to inspire a burgeoning game theory literature on mechanism design. *See, e.g.*, STEVEN J. BRAMS & ALAN D. TAYLOR, FAIR DIVISION: FROM CAKE CUTTING TO DISPUTE RESOLUTION (1996) (surveying applications of mechanism design to dispute resolution); Steven J. Brams & Joshua R. Mitts, *Law and Mechanism Design: Procedures to Induce Honest Bargaining*, 68 N.Y.U. ANN. SURV. AM. L. 729, 773–89 (2013) (applying mechanism design to improve blockholder disclosure under section 13(d) of the Securities Exchange Act of 1934); Lee Ann Fennell, *Revealing Options*, 118 HARV. L. REV. 1399 (2005) (surveying applications of option mechanisms to dispute resolution

Hand understood that Gratz's stipulation to Claughton's calculation made it unnecessary to verify its correctness and maximality.[119] The district court's $308,417 judgment could be affirmed solely on the grounds that Gratz was entitled to an arbitrary matching of purchases and sales within six months of each other,[120] and Gratz had exercised this entitlement by assenting to the matching set forth in Claughton's accounting.[121] Hand therefore had no reason in *Gratz* to rely on or endorse the master's adoption of the *Smolowe* formula, even implicitly. Given *Gratz*'s historical context and Hand's famous adherence to judicial restraint,[122] there is no basis for reading into Hand's opinion an endorsement of the master's characterization and adoption of the *Smolowe* formula.

C.   Gratz*'s Unsuitability for Endorsing the* Smolowe *Formula*

Hand did explicitly endorse a different aspect of the master's analysis: namely, its adherence to *Smolowe*'s doctrine of strict fiduciary liability.[123] Hand also specifically found that the master was right to "adopt[] the . . . course" of matching trades "in such a way as to increase [profits] to the greatest possible amount, . . . following what he supposed to be the doctrine of Smolowe."[124] Hand's independent analysis of the *Smolowe* doctrine confirmed his conclusion that "the proper amount" of section 16(b) liability is given by "the upper limit."[125]

It can now be seen that the calculation of Claughton's liability was unsuitable as a vehicle for endorsing the *Smolowe* formula, because

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and regulation); Eric L. Talley, Note, *Contract Renegotiation, Mechanism Design, and the Liquidated Damages Rule*, 46 STAN. L. REV. 1195 (1994) (using mechanism design to suggest more efficient contract renegotiation procedures).

[118] *Cf. supra* note 56 (describing the Learned Hand formula).

[119] *See Gratz*, 187 F.2d at 52.

[120] *See id.*

[121] *See id.*

[122] *See* GUNTHER, *supra* note 46, at xi (foreword by Ruth Bader Ginsburg) (citation omitted) (describing Hand's approach to judging as "heedful of limitations stemming from the judge's own competence"); Zachary Baron Shemtob, *Following Thayer: The Many Faces of Judicial Restraint*, 21 B.U. PUB. INT. L.J. 61, 71 (2011) ("Few jurists followed judicial restraint as closely as Hand."); Justin Zaremby, *Learned Hand's Two Concepts of (Judicial) Liberty*, 65 RUTGERS L. REV. 787, 790 (2013) ("Hand maintains a reputation as a judge whose jurisprudence epitomizes restraint.").

[123] *See Gratz* Master's Report, *supra* note 11, ¶ 14 (citation omitted) (finding that section 16(b) "was intended 'to be thorough-going, to squeeze all possible profits out of stock transactions . . . and thus to establish a standard so high as to prevent any conflict between the selfish interest of a fiduciary officer, director or stockholder, and the faithful performance of his duty'").

[124] *See Gratz*, 187 F.2d at 51.

[125] *See id.* at 51–52.

Hand could not have endorsed the formula's use without destabilizing *Smolowe*'s strict fiduciary liability doctrine. It suffices to compare a correct calculation of Claughton's liability using the *Smolowe* formula with a linear programming method that actually "squeeze[s] all possible profits out of" a sequence of transactions.[126] Using modern

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[126] The latter method derives from a 1997 article in which I identified the section 16(b) liability calculation problem as a special case of the transportation problem in the field of management science. *See* Chin, *supra* note 38, at 593–99. The transportation problem is, in turn, a special case of the linear programming problem. *See* Alexander Schrijver, *On the History of Combinatorial Optimization*, *in* HANDBOOKS IN OPERATIONS RESEARCH AND MANAGEMENT SCIENCE: DISCRETE OPTIMIZATION 13 (K. Aardal et al. eds. 2005), http://homepages.cwi.nl/~lex/files/histco.pdf [https://perma.cc/97B7-W6FE]. Any trading sequence can therefore be translated into a linear programming problem whose solution represents "the upper limit" of section 16(b) liability.

For example, consider the following sequence of trades:

Date	Transaction	Shares	Amount ($)	Price ($)/Share
Jan. 1	Purchase	1,000	$ 9	$ 9,000
Feb. 15	Sale	400	8	3,200
Mar. 1	Purchase	2,000	8	16,000
May 1	Purchase	800	7	5,600
June 15	Sale	1,200	10	12,000
Sept. 1	Purchase	1,000	6	6,000
Oct. 15	Sale	2,400	9	21,600

For $i=1,2,3,4$ and $j=1,2,3$, let p_{ij} denote the per-share profit recoverable under section 16(b) from pairing the i-th purchase and j-th sale in this table (counting chronologically). For example, pairing the shares purchased on May 1 for $7/share (i.e., the third purchase) with the shares sold on February 15 for $8/share (i.e., the first sale) yields a recoverable profit of $1/share; this fact may be expressed as $p_{31}=1$. On the other hand, the first purchase on January 1 and third sale on October 15 are more than six months apart, so $p_{13}=0$. Thus we form the vector

$P=(p_{11},p_{12},p_{13},p_{21},p_{22},p_{23},p_{31},p_{32},p_{33},p_{41},p_{42},p_{43})=(0,1,0,0,2,0,1,3,2,0,4,3).$

To maximize the total recoverable profit, one must find the number of shares x_{ij} for each pair of purchases and sales for which the total recoverable profit $\sum_{i,j} p_{ij} x_{ij}$ is maximum,

subject to the constraints:

$$\sum_j x_{1j} \leq 1,000 \quad \sum_i x_{i1} \leq 400$$
$$\sum_j x_{2j} \leq 2,000 \quad \sum_i x_{i2} \leq 1,200$$
$$\sum_j x_{3j} \leq 800 \quad \sum_i x_{i3} \leq 2,400$$
$$\sum_j x_{4j} \leq 1,000 \quad \forall i,j : x_{ij} \geq 0$$

This linear programming problem may be solved by standard techniques, such as the simplex method. *See* MOKHTAR S. BAZARAA ET AL., LINEAR PROGRAMMING AND NETWORK FLOWS 91–150 (4th ed. 2010). The solution vector is:

$X=(x_{11},x_{12},x_{13},x_{21},x_{22},x_{23},x_{31},x_{32},x_{33},x_{41},x_{42},x_{43})=(0,0,0,0,1200,0,0,0,800,0,0,1000),$

for a maximum recoverable profit $P \cdot X$ of $ 7,000.

computational tools to apply the *Smolowe* formula to the sequence of Claughton's common stock transactions yields a liability of $337,599.[127] By comparison, the linear programming method applied to the same sequence of transactions produces a liability of $337,800,[128] or $201 more than the result from the *Smolowe* formula.

While this is a small difference, it does demonstrate that Hand could not have endorsed the formula's use while adhering to "the upper limit" of section 16(b) liability.[129] Even if the discrepancy might have gone unrecognized,[130] Hand's opinion would have carried within it a latent irreconcilable tension.[131] Allowing the *Smolowe* formula to trump the plaintiff's entitlement to "an arbitrary matching to achieve the showing of a maximum profit"[132] in *Gratz* would have opened the door to much larger discrepancies in other cases. The formula may fall short of the maximum by up to fifty percent when trades span a period of more than six months, as section III.B will show.[133]

The $337,599 result from the *Smolowe* formula deviates even further from Claughton's accounting, which showed a total liability of only $283,835 from common stock trades.[134] This latter discrepancy casts doubt on the master's finding that Claughton used the formula in his

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While linear programming problems had been formulated by 1939, *see* L.V. Kantorovich, *Mathematical Methods of Organizing and Planning Production* (1939), *cited in* SAUL I. GASS & ARJANG A. ASSAD, AN ANNOTATED TIMELINE OF OPERATIONS RESEARCH: AN INFORMAL HISTORY 50 (2005), and the simplex method was known in 1947, *see* George B. Dantzig, *Maximization of a Linear Function of Variables Subject to Linear Inequalities*, *in* ACTIVITY ANALYSIS OF PRODUCTION AND ALLOCATION 19–32 (Tjalling C. Koopmans ed. 1951), the application of linear programming to section 16(b) liability was not publicly available until fifty years later. *See* Chin, *supra* note 38, at 596–99.

[127] *See infra* app. A, tbl. 1.

[128] *See infra* app. A, tbl. 2.

[129] It also falsifies the master's characterization of the formula as "[t]he only rule whereby all profits can be 'squeezed out' of [Claughton] . . . ." *See Gratz* Master's Report, *supra* note 11, ¶ 16.

[130] *See, e.g.*, Kornfeld v. Eaton, 217 F. Supp. 671, 674 (S.D.N.Y. 1963) (describing *Gratz*'s liability calculation as adhering to both the *Smolowe* formula and *Smolowe*'s strict fiduciary liability doctrine).

[131] *Cf.* Stuart Benjamin, *Stepping Into the Same River Twice: Rapidly Changing Facts and the Appellate Process*, 78 TEX. L. REV. 269, 281 (1999) ("If the facts on which the opinion relied no longer describe the world, then the opinion purports to lay down the current status of the law but in fact misdescribes the world, and thus creates an intolerable tension.").

[132] Smolowe v. Delendo Corp., 136 F.2d 231, 237 (2d. Cir. 1943).

[133] *See supra* text accompanying note 38.

[134] *See* Def.'s Exhibit C to *Gratz* Master's Report, *supra* note 11 (showing recoverable profit of $282,572.91 from matching of purchases and sales prior to April 4, 1946, and $1,261.43 from matching of purchases and sales after April 4, 1946). Claughton also submitted an accounting showing $24,582.71 from preferred stock trades for a total liability of $308,417. *See* Def.'s Exhibit N to *Gratz* Master's Report, *supra* note 11.

liability calculations and strongly suggests that Gratz and the railroad left at least $53,764 on the table by not challenging that finding.

When considered together, these discrepancies reveal a deep incongruity in the notion that Hand used *Gratz* as a vehicle to endorse the *Smolowe* formula, even beyond the demonstrated absence of evidence that he had any reason to do so.[135] It must be remembered that Judge Clark provided no mathematical justification for his assertion in *Smolowe* that the formula was "[t]he only rule whereby all possible profits can be surely recovered";[136] it was, in the words of another court, merely an "empirical judgment."[137] As a factual predicate for Hand's adjudication of *Gratz*, Claughton's accounting was so inaccurate that it probably did not result from the *Smolowe* formula's use, and even a corrected accounting would have fallen $201 short of corroborating Clark's empirical assertion. The dominant reading of *Gratz* as an authority for the *Smolowe* formula's applicability thus proves to be both doctrinally and mathematically unjustifiable.

III. THE WISDOM OF HAND'S MATHEMATICAL SILENCE

A.   The Smolowe *Formula Needs No Corroboration in Simple Cases*

Until now, through case law, casebooks, and commentary,[138] the dominant reading of *Gratz* has played a significant role in ensuring that the *Smolowe* formula has become "firmly ingrained in the fabric of Section 16(b)."[139] This role has largely been necessitated by the tenuous justification for the formula provided by the *Smolowe* case itself. By offering the formula as an "empirical judgment"[140] with no mathematical rationale, Judge Clark put the formula on a path to be corroborated over time through the common law process, rather than proved once and for all as a mathematical proposition. In the dominant reading of section 16(b) case law, *Gratz* has served long and well as *Smolowe*'s vital buttress, putatively carrying the gravitas of Learned Hand's independent

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[135] *See supra* sections II.A and II.B.

[136] *Smolowe*, 136 F.2d at 239.

[137] Kornfeld v. Eaton, 217 F. Supp. 671, 674 (S.D.N.Y. 1963) (citing *Smolowe*, 136 F.2d at 239).

[138] *See supra* section I.C.

[139] *See* ROMEO & DYE, *supra* note 16.

[140] *Kornfeld*, 217 F. Supp. at 674.

analysis[141] and extending the formula's applicability beyond six-month trading sequences.[142]

The findings in Part I have called into question *Gratz*'s role as an auxiliary authority for the *Smolowe* formula's use. As it turns out, however, the *Smolowe* formula no longer has any need of such empirical corroboration. The formula states a mathematical fact, not merely an empirical judgment, as long as *Smolowe*'s "within six months" provision is correctly interpreted as a limit on the formula's range of application.[143] What follows is the first known proof that the "lowest-in, highest-out" formula correctly produces the maximum profit attributable to a sequence of transactions falling within a single statutory six-month period. This provides the *Smolowe* formula with the mathematical justification it has lacked for more than seventy years.

The proof follows a standard technique for software verification known as a loop invariant. Loop invariant methods for software verification have been formally shown to be sound,[144] and various introductory texts provide clear explanations and illustrative examples of loop invariant proofs.[145] For present purposes, it suffices to explain that "[a] loop invariant expresses important relationships among the variables that must be true at the start of every iteration and when the loop terminates."[146] As illustrated in Figure 5, a correctness proof must show,[147] given that the input satisfies the specified precondition, that: the loop invariant (a) is true before executing the loop for the first time[148] and (b) remains true after each iteration.[149] In addition, the proof must show that (c) the loop's exit condition is eventually met,[150] and that (d)

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[141] *See id.* (stating that the *Smolowe* formula was "independently examined and adhered to in *Gratz*").

[142] *See, e.g.*, Adler v. Klawans, 267 F.2d 840, 847–48 (2d Cir. 1959) (spanning more than seven months); Donoghue v. Casual Male Retail Group, Inc., 375 F. Supp. 2d 226, 237 (S.D.N.Y. 2005) (spanning more than ten months).

[143] *See supra* text accompanying notes 78–80.

[144] *See* KRZYSZTOF R. APT & ERNST-RÜDIGER OLDEROG, VERIFICATION OF SEQUENTIAL AND CONCURRENT PROGRAMS 57–66 (David Gries & Fred B. Schneider eds., 2d ed. 1997).

[145] *See, e.g.*, JEFF EDMONDS, HOW TO THINK ABOUT ALGORITHMS 12–26 (2008) (explaining loop invariant proofs and providing examples); DERRICK G. KOURIE & BRUCE W. WATSON, THE CORRECTNESS-BY-CONSTRUCTION APPROACH TO PROGRAMMING 55–93 (2012) (providing examples).

[146] EDMONDS, *supra* note 145, at 8 (emphasis omitted).

[147] *See id.* at 20.

[148] *See id.* at 17–18.

[149] *See id.* at 16–17.

[150] *See id.* at 19.

the required result, or postcondition, is achieved when this occurs and the loop is exited.[151]

Figure 5:

Structure of a correctness proof that uses a loop invariant (LI). Given that input F satisfies the precondition @pre, it is necessary to prove that (a) the loop invariant LI is true initially; (b) LI remains true after each iteration of the algorithm steps S; (c) the predicate P is eventually false; and (d) when P is false, the postcondition @post is true.[152]
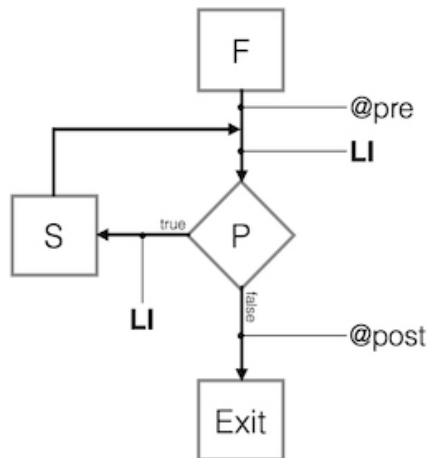
To formalize the result, it is necessary first to provide the following mathematical specification of the "lowest-in, highest-out" algorithm, heavily commented to facilitate comparison with less formal descriptions of the *Smolowe* formula in the legal literature.

1. *Lowest-In, Highest-Out*

 Precondition: Purchases $(p_1, q_1), (p_2, q_2)\ldots,(p_m, q_m)$ and sales $(P_1, Q_1), (P_2, Q_2)\ldots,(P_n, Q_n)$ (listed in nondecreasing and nonincreasing

---

[151] *See id.*

[152] This diagram was taken from the course blog for CS207: Systems Development for Computational Science at Harvard University's School of Engineering and Applied Sciences. *See* Cris Cecka & Ray Jones, *CS207 Systems Development for Computational Science: Loop Invariants*, HARVARD SCH. ENG'G AND APPLIED SCIS. (Oct. 5, 2014), http://iacs-courses.seas.harvard. edu/courses/cs207/blog/index.php [https://perma.cc/XC2D-CJR5].

order of per-share prices, respectively;[153] i.e., $p_1 \le p_2 \le \ldots \le p_m$, $P_1 \ge P_2 \ge \ldots \ge P_n$, $q_i, Q_j > 0$ for all i, j), all of which occurred within the same period of less than six months and within the statute of limitations under section 16(b).

Comment: Recoverable profit M is accumulated by iteratively matching blocks of previously unmatched shares (u_{i_0}, U_{j_0}) at the lowest remaining purchase price and the highest remaining sale price until no further shares can be profitably matched.

Postcondition: M is the maximum possible profit that can be attained from any matching of the given purchases and sales. That is, for all $\vec{q}', \vec{Q}'$ with

$$0 \le q_i' \le q_i \ , \ 0 \le Q_j' \le Q_j \text{ for all } i, j, \text{ such that } \sum_{i=1}^{m} q_i' = \sum_{j=1}^{n} Q_j',$$

$$M \ge \sum_{j=1}^{n} P_j Q_j' - \sum_{i=1}^{m} p_i q_i'.$$

$B, S, M, x \leftarrow 0$

$i_0, j_0 \leftarrow 1$

$\vec{u} \leftarrow \vec{q}$

$\vec{U} \leftarrow \vec{Q}$

$r, x \leftarrow \min\{u_1, U_1\}$

while $\left(\left(P_{j_0} > p_{i_0} \right) \wedge (r > 0) \right)$ *do*

---

[153] In the case where all purchases and sales take place within the same period of less than six months, transaction dates are immaterial to matching, and transactions can be listed in any convenient order.

$$B \leftarrow B + rp_{i_0} \qquad \{\text{update cost of purchases}\}$$
$$S \leftarrow S + rP_{j_0} \qquad \{\text{update proceeds from sales}\}$$
$$M \leftarrow S - B \qquad \{\text{update profits}\}$$
$$u_{i_0} \leftarrow u_{i_0} - r \qquad \{\text{update unmatched shares purchased}\}$$
$$U_{j_0} \leftarrow U_{j_0} - r \qquad \{\text{update unmatched shares sold}\}$$
$$i_0 \leftarrow \min\{i : u_i > 0\} \qquad \{\text{find lowest - price unmatched purchase}\}$$
$$j_0 \leftarrow \min\{j : U_j > 0\} \qquad \{\text{find highest - price unmatched sale}\}$$
$$r \leftarrow \min\{u_{i_0}, U_{j_0}\} \qquad \{\text{determine number of matchable shares}\}$$
$$x \leftarrow x + r \qquad \{\text{update total number of matched shares}\}$$
end while

It is now possible to prove the following.

   Theorem. Algorithm *Lowest-In, Highest-Out* terminates with the specified postcondition.
   Proof. We use the following loop invariant:

$$
\left\{
\begin{array}{l}
\text{For all non - negative real - valued } \vec{q}', \vec{Q}' \text{ such that } \sum_{i=1}^{m} q'_i = \sum_{j=1}^{n} Q'_j = x, \\[4pt]
\text{there exist non - negative integers } k, l \text{ such that} \\[4pt]
\displaystyle\sum_{i=1}^{k} q_i \leq x < \sum_{i=1}^{k+1} q_i, \ \sum_{j=1}^{l} Q_j \leq x < \sum_{j=1}^{l+1} Q_j, \text{ and} \\[4pt]
\displaystyle B = \sum_{i=1}^{k} p_i q_i + p_{k+1}\left(x - \sum_{i=1}^{k} q_i \right) \leq \sum_{i=1}^{m} p_i q'_i \qquad (1) \\[4pt]
\displaystyle S = \sum_{j=1}^{l} P_j Q_j + P_{l+1}\left(x - \sum_{j=1}^{l} Q_j \right) \geq \sum_{j=1}^{n} P_j Q'_j \qquad (2) \\[4pt]
\displaystyle M = S - B \geq \sum_{j=1}^{n} P_j Q'_j - \sum_{i=1}^{m} p_i q'_i \qquad (3)
\end{array}
\right\}
$$

In the above loop invariant, the expression $B = B(x)$ represents the cost of purchasing a total of x shares in nondecreasing order of per-share price. Inequality (1) states that there is no lower-cost list of purchases $\vec{q}'$ totaling x shares. We present a full proof only for the truth of (1).

The proof of (2) is analogous, and (3) follows immediately from (1) and (2).

 (a) *The loop invariant is initially true*: Before the *while* loop $(x = \min\{u_1, U_1\})$, (1) is true because $B = p_1 x \leq p_1 q_1' + p_2(x - q_1') \leq \sum_{i=1}^{m} p_i q_i'$

for any $\vec{q}'$ such that $\sum_{i=1}^{m} q_i' = x$.

 (b) *The truth of the loop invariant is maintained*: Now suppose (1) holds at the beginning of the *while* loop; thus $i_0 = k + 1$. There are two cases, each of which will imply (1) also holds at the end of the *while* loop.

 Case 1: $r = u_{i_0}$. Then $x_{new} \leftarrow x + u_{i_0} = \sum_{i=1}^{k+1} q_i$, and for any $\vec{q}'$ such

that $\sum_{i=1}^{m} q_i' = x_{new}$, we have

$$
\begin{aligned}
B &= \sum_{i=1}^{k+1} p_i q_i \\
&\leq \sum_{i=1}^{k+1} p_i q_i' + p_{k+1}\left(x_{new} - \sum_{i=1}^{k+1} q_i' \right) \\
&= \sum_{i=1}^{k+1} p_i q_i' + p_{k+1} \sum_{i=k+2}^{m} q_i' \\
&\leq \sum_{i=1}^{m} p_i q_i'
\end{aligned}
$$

 Case 2: $r = U_{j_0} < u_{i_0}$. Then $x_{new} \leftarrow x + U_{j_0}$ and

$\sum_{i=1}^{k} q_i \leq x_{new} = x + r < \sum_{i=1}^{k+1} q_i$. For any $\vec{q}'$ such that

$\sum_{i=1}^{m} q_i' = x_{new} = x + r,$ we have

$$B = \sum_{i=1}^{k} p_i q_i + p_{k+1}\left(x + r - \sum_{i=1}^{k} q_i\right)$$

$$\leq \sum_{i=1}^{k} p_i q_i' + p_{k+1}\left(x_{new} - \sum_{i=1}^{k} q_i'\right)$$

$$= \sum_{i=1}^{k} p_i q_i' + p_{k+1} \sum_{i=k+1}^{m} q_i'$$

$$\leq \sum_{i=1}^{m} p_i q_i'$$

The proof of (2) similarly breaks into Case 1, where $r = U_{j_0}$, so that $x_{new} \leftarrow \sum_{j=1}^{l+1} Q_j$; and Case 2, where $r = u_{i_0} < U_{j_0}$, so that $x_{new} \leftarrow x + u_{i_0}$. Each case in the proof of (2) proceeds analogously to its counterpart case in the proof of (1).

(c) The exit condition is eventually met: the loop terminates when the condition $\left((P_{j_0} > p_{i_0}) \wedge (r > 0)\right)$ fails, i.e., when either all remaining unmatched purchases were at a higher per-share price than that of all remaining unmatched sales, or when there are no remaining unmatched purchases or sales. Progress toward termination is guaranteed by the fact that during each iteration, Case 1 of the proof of either (1) or (2) applies, so that the r matched shares must exhaust the remaining unmatched shares of at least one transaction, i.e., the $(k+1)$-st purchase or the $(l+1)$-st sale, respectively. Because there are only $m+n$ transactions to exhaust, the loop must terminate after at most $m+n$ iterations.

(d) The postcondition is met upon exit: the postcondition follows from (3) and the failure of the exit condition. The postcondition is trivially true if all transactions can be matched (eventually $r = 0$) or if none can be matched $(P_1 \leq p_1)$. We show that the postcondition also holds when $(P_{j_0} > p_{i_0})$ fails after it has held at least once.

Let x_T denote the final total number of matched shares, i.e, the value of x at the beginning of the last iteration of the while loop. Let (i_T, j_T) and (i_F, j_F) denote the respective values of (i_0, j_0) when $(P_{j_0} > p_{i_0})$ last holds and fails, respectively; thus $P_{j_T} > p_{i_T}$ and $P_{j_F} \leq p_{i_F}$. Also,

denote $\quad x' = \sum_{i=1}^{m} q_i' = \sum_{j=1}^{n} Q_j' \quad$ and $\quad M' = \sum_{j=1}^{n} P_j Q_j' - \sum_{i=1}^{m} p_i q_i'$. Then (3)

simply states the postcondition in the case $x' = x_T$. For the case $x' < x_T$, (3) implies

$$
\begin{aligned}
M &\ge \sum_{j=1}^{n} P_j Q_j' - \sum_{i=1}^{m} p_i q_i' + (x_T - x')\left(P_{j_T} - p_{i_T}\right) \\
&\ge M'
\end{aligned}
$$

and for the case $x' > x_T$, (3) implies

$$
\begin{aligned}
M' &= \sum_{j=1}^{n} P_j Q_j' - \sum_{i=1}^{m} p_i q_i' \\
&\le M + (x' - x_T)\left(P_{j_F} - p_{i_F}\right) \\
&\le M
\end{aligned}
$$

Thus the postcondition holds in all cases. *Q.E.D.*

This theorem clarifies the *Smolowe* formula's mathematically valid range—"within six months"—and obviates six decades of unjustified reliance on *Gratz* for empirical corroboration of the formula.

B.   *The* Smolowe *Formula's Worst-Case Errors in Complex Cases*

The fact that the *Smolowe* formula is always correct when applied to statutory six-month trading sequences does not, of course, imply that it is always erroneous when applied to longer sequences.[154] The formula's $201 shortfall in *Gratz*[155] does, however, demonstrate its potential for material inaccuracy in complex cases.

The legal community should discontinue the practice of citing *Gratz* to support the *Smolowe* formula's use, not only because it is untenable[156]

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[154] *See supra* Figure 2 (illustrating with a hypothetical example). For cases where the *Smolowe* formula correctly calculated the maximum liability attributable to a trading sequence spanning more than six months, despite questionable authority for the formula's use, see, e.g., Adler v. Klawans, 267 F.2d 840, 847–48 (2d Cir. 1959) (more than seven months); Donoghue v. Casual Male Retail Group, Inc., 375 F. Supp. 2d 226, 237 (S.D.N.Y. 2005) (more than ten months); Segen v. Westcliff Capital Mgmt., LLC, 299 F. Supp. 2d 262, 265–66, 272 (S.D.N.Y. 2004) (more than ten months); Donoghue v. MIRACOR Diagnostics, Inc., No. 00 Civ. 6696, 2002 WL 233188, at *2 (S.D.N.Y. Feb. 11, 2002) (more than thirteen months); Morales v. New Valley Corp., 999 F. Supp. 470, 476 (S.D.N.Y. 1998) (more than six months); Heli-Coil Corp. v. Webster, 222 F. Supp. 831, 837 (D.N.J. 1963) (more than nine months), *modified*, 352 F.2d 156 (3d Cir. 1965); Ark. La. Gas Co. v. W.R. Stephens Inv. Co., 141 F. Supp. 841, 847 (W.D. Ark. 1956) (more than thirteen months); Kogan v. Schulte, 61 F. Supp. 604, 605 (S.D.N.Y. 1945) (fifteen months).

[155] *See supra* text accompanying note 128.

[156] *See supra* section I.C.

and superfluous,[157] but because it could lead to a significant error in the amount of a section 16(b) judgment. While $201 pales in comparison to the $53,764 deficiency in Claughton's calculations,[158] it is worth considering how much larger the *Smolowe* formula's errors might become in the worst case.[159]

As Jacobs pointed out with his hypothetical examples, the *Smolowe* formula may fall short of calculating the maximum possible short-swing profit when some trades are not within the statute of limitations[160] and when trades span a period of more than six months.[161] These two kinds of problematic trading sequences give rise to different worst-case scenarios, which can be illustrated with the following variations on Jacobs's examples.

As a worst-case scenario involving trades outside the statute of limitations, consider a suit filed in month 28 attacking the following trading sequence:

Month	Shares Purchased	Purchase Price ($) Per Share	Shares Sold	Sale Price ($) Per Share
1	1,000	1		
2	1,000	1,000		
3			1,000	1,002
5			1,000	1,001

The *Smolowe* formula would pair the purchases in months 1 and 2 with the sales in months 3 and 5, respectively; however, the statute of limitations would bar recovery of profits from the former pair of transactions, leaving only the $1,000 proceeds from the latter pair. A higher profit of $1,002,000 can be calculated by instead pairing the purchases in months 1 and 2 with the sales in months 5 and 3, respectively. It should be apparent from this example that the formula's

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[157] *See supra* section III.A.

[158] *See supra* text accompanying note 134.

[159] Even though the formula's $202 million short-swing profit calculation in Dreiling v. Jain, 281 F. Supp. 2d 1234 (W.D. Wash. 2003) was accurate, the court's citation to Whittaker v. Whittaker Corp., 639 F.2d 516, 522, 533 (9th Cir. 1981) as primary authority for the formula's use was unsound. The *Whittaker* decision features one of the most comprehensive and unqualified endorsements of the *Smolowe* formula in section 16(b) case law, in which it inaccurately states that the *Gratz* court "considered the profit computation issue and, after an independent analysis, affirmatively reasserted the *Smolowe* [formula]." Whittaker v. Whittaker Corp., 639 F.2d 516, 522, 531 (9th Cir. 1981).

[160] *See* Jacobs, *supra* note 7, at 533.

[161] *See id.* at 532–33.

error in cases where some trades fall outside the statute of limitations may be arbitrarily close to 100 percent.

A worst-case scenario involving a trading sequence spanning more than six months might resemble the following:

Month	Shares Purchased	Purchase Price ($) Per Share	Shares Sold	Sale Price ($) Per Share
1	1,000	1		
2			1,000	1,001
5			1,000	1,002
9	1,000	2		

Here, the *Smolowe* formula would pair the purchase in month 1 with the sale in month 5, yielding a recovery of $1,001,000 (leaving the transactions in months 2 and 9 unpaired as more than six months apart). A higher profit of $2,000,000 can be calculated by instead pairing the purchases in months 1 and 9 with the sales in months 2 and 5, respectively. It should be apparent from this example that the formula's error in cases covering more than six months may be arbitrarily close to fifty percent.

The following theorem shows that fifty percent is also an upper limit on the formula's error in such cases.

Theorem 1. For any sequence of trades within the statute of limitations, the recovery calculated by the *Smolowe* formula is at least half as much as the recovery calculated by any other method.

Proof. Assume to the contrary that there exist trading sequences for which there is a pairing of trades that results in more than twice the amount of profit recovered by the *Smolowe* formula. Among these trading sequences, consider one in which the formula's pairing involves a minimal number of shares (a "*Smolowe*-minimal" trading sequence). Let $G = ((X, Y), E)$ be the bipartite graph corresponding to this *Smolowe*-minimal trading sequence, wherein each vertex $x \in X$ represents one share purchased, each vertex $y \in Y$ represents one share sold, and edge $(x, y) \in E$ is present with weight $w = w(x, y)$ if a pairing of x with y would yield a recoverable profit $w > 0$.[162]

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[162] It may be assumed, without loss of generality, that all of the challenged trades involve whole numbers of shares; if any fractional shares are involved, all share quantities may be multiplied by their lowest common denominator before proceeding with the construction of G without affecting the proof.

Let $S = ((X(S), Y(S)), E(S))$ be the subgraph of G corresponding to the pairing of transactions produced by the *Smolowe* formula, and let $w(S)$ denote the total weight of S. By the assumption, there exists a subgraph $T = ((X(T), Y(T)), E(T))$ of G corresponding to a different pairing of transactions such that $w(T) > 2w(S)$.

Let $(x_1, y_1) \in E(S)$ be an edge of maximal weight in S. Then the share purchased at x_1 and the share sold at y_1 must be part of the first purchase and sale, respectively, paired by the *Smolowe* formula, and (x_1, y_1) must also be an edge of maximal weight in G. Let G_1 denote the subgraph of G induced by $(X \setminus x_1, Y \setminus y_1)$. Because reducing the first purchase and sale by one share each leaves the "lowest-in, highest-out" sequence intact, it follows that $S_1 = ((X(S) \setminus x_1, Y(S) \setminus y_1), E(S) \setminus (x_1, y_1))$ is the subgraph of G_1 corresponding to the pairing of transactions produced by the *Smolowe* formula, and $w(S_1) = w(S) - w(x_1, y_1)$.

From among the edges in $E(T)$ incident to x_1 and y_1, arbitrarily choose representatives (x_1, y') and (x', y_1). (Without loss of generality, these exist and are distinct; otherwise $\left| \{ (x_1, y'), (x', y_1) \} \right| < 2$ and the following inequality holds *a fortiori*.) Then $T_1 = ((X(T) \setminus \{x_1, x'\}, Y(T) \setminus \{y_1, y'\}), E(T) \setminus \{(x_1, y'), (x', y_1)\})$ is a subgraph of G_1 corresponding to a different pairing of transactions such that

$$
\begin{aligned}
w(T_1) &\geq w(T) - \big(w(x_1, y') + w(x', y_1) \big) \\
&\geq w(T) - 2w(x_1, y_1) && (\text{since } w(x_1, y_1) \text{ is maximal in } G) \\
&> 2w(S) - 2w(x_1, y_1) \\
&= 2w(S_1),
\end{aligned}
$$

but $\left| S_1 \right| < \left| S \right|$, contradicting the assumption that G represents a *Smolowe*-minimal trading sequence. *Q.E.D.*

C. *The* Smolowe *Formula's Continuing Fallibility*

Modern technology may have facilitated the accurate calculation[163] and verification[164] of short-swing trading liability, but it still has not eliminated the risk of error when the *Smolowe* formula is used

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[163] *See* Chin, *supra* note 38, and accompanying text.

[164] *See supra* section III.A.

improperly.[165] In *Chechele v. Vicis Capital*,[166] a shareholder of Bond Laboratories, Inc. sued one of the company's former directors, Elorian Landers, over a sequence of 252 purchases and 81 sales of the company's stock between August 2009 and October 2010, a period spanning more than thirteen months.[167] The complaint alleged that Landers had realized short-swing profits of "not less than $30,000" calculated using the *Smolowe* formula.[168] The claim settled before trial, with the company recovering $30,000.[169]

Actual calculations of Landers's short-swing profits using the *Smolowe* formula and, alternatively, using linear programming methods would have yielded $34,967[170] and $35,361,[171] respectively. Interestingly, the *Smolowe* formula's small shortfall of $394 in *Chechele* resembles the formula's small $201 error in *Gratz*. It also appears that Bond Laboratories did not attempt an actual calculation of the defendant's short-swing profits under the *Smolowe* formula and left a significant fraction of the potential recovery on the table, just as Gratz did sixty years earlier.[172]

Even though Claughton's handwritten accounting has given way to Excel spreadsheets, plaintiffs and their attorneys still might not consider careful liability calculations to be worth the effort, because "[r]ecovery runs not to the stockholder, but to the corporation."[173] Maximizing the

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[165] *See supra* section III.B.

[166] Chechele v. Vicis Capital, LLC, No. 11 Civ. 2191, 2012 WL 310943 (S.D.N.Y. 2012).

[167] *See* Complaint ¶¶ 19–20, Chechele v. Vicis Capital, LLC, No. 11 Civ. 2191, 2011 WL 7566992 (S.D.N.Y. Mar. 30, 2011) (listing trades). Chechele also sued an investment fund that had traded in the company's stock. *See id.* ¶¶ 21–25 (stating claim against Vicis Capital Master Fund and Vicis Capital, LLC). The claim against the fund was dismissed without prejudice. *Chechele*, 2012 WL 310943, at *1.

[168] *See* Complaint ¶ 29, *Chehele*, 2011 WL 7566992 ("Under the 'lowest-in, highest-out' method for computing realized profits pursuant to Section 16(b) of the Act, Defendant Landers realized recoverable profits as a result of the transactions described in paragraphs 19–20 above in an aggregate amount not less than $30,000.").

[169] BOND LABORATORIES, INC. ANNUAL REPORT (FORM 10-K) 23 (April 13, 2012), http://www.sec.gov/Archives/edgar/data/1374328/000141588912000538/bnlb10k12312011.htm [https://perma.cc/UU4D-DL3U] (noting that $30,000 of Landers's consulting fees "was setoff against amounts owed to the Company as a result of violations of Section 16(b)").

[170] *See infra* app. B, tbl. 3.

[171] *See infra* app. B, tbl. 4.

[172] *See supra* text accompanying note 134.

[173] Smolowe v. Delendo Corp., 136 F.2d 231, 239 (2d. Cir. 1943). Out of a $18,894.85 recovery in *Smolowe*, the plaintiffs received about three dollars based on their ownership share, and the attorney was awarded $3,000 in fees and $78.98 in expenses. *Id.* at 241; *cf.* Louis Kaplow & Steven Shavell, *Accuracy in the Determination of Liability*, 37 J.L. & ECON. 1 (1994) (suggesting a trade-off between accurate liability calculation and enforcement effort)*;* Louis Kaplow & Steven Shavell,

short-swing recovery from a sequence of 333 transactions over a thirteen-month period is still a polycentric task,[174] and the path from the *Smolowe* formula to a matching that actually "squeeze[s] all possible profits out of [those] stock transactions"[175] is not always direct or intuitive. As Figure 6, below, illustrates by reference to Landers's transactions, the facial differences between a profit-maximizing matching of trades found by the linear programming method and a matching according to the *Smolowe* formula are complex and subtle. It is not readily apparent to a casual observer that the *Smolowe* formula's matching is deficient, let alone how it can be improved. In light of these complexities, the cost-benefit calculus in section 16(b) litigation may not yet support the adoption by plaintiffs of a more accurate alternative to the *Smolowe* formula.

Accuracy in the Assessment of Damages, 39 J.L. & ECON. 191 (1996) (arguing that plaintiffs may inefficiently overinvest in accurately calculating liability when there are potential gains from doing so).

[174] *See* Fuller, *supra* note 112, at 394–95.

[175] *Smolowe*, 136 F.2d at 239.

Figure 6:

Landers's purchases (down-arrows) and sales (up-arrows) of Bond Laboratories stock, matched according to the linear programming method (top graph) and the *Smolowe* formula (bottom graph).
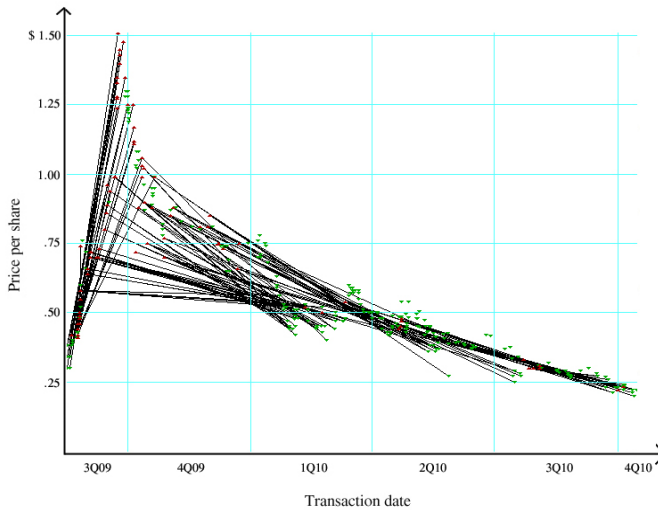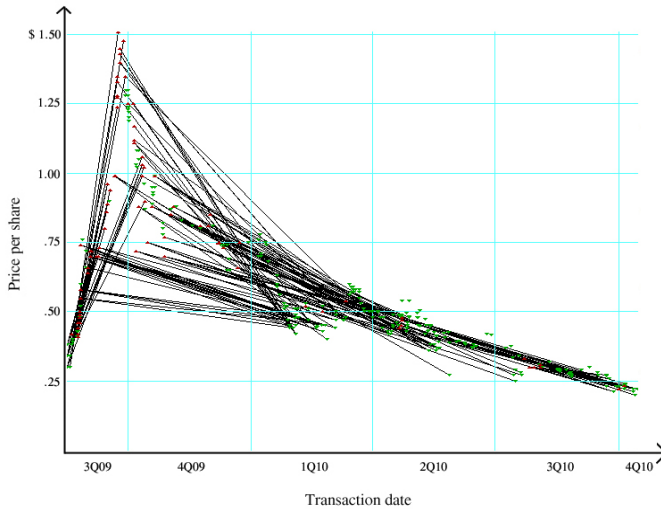
IV. LEARNING FROM HAND'S MATHEMATICAL SILENCE

A.   An Online Solution

This Article's sole normative concern is for mathematical correctness. It does not take sides in the longstanding debate over the statute's harshness.[176] Nor does it address the merits of *Smolowe* and *Gratz*, except to urge a more careful reading of their statements and silences.

Proponents of section 16(b)'s repeal might dismiss the pursuit of accurate liability calculation as akin to fine-tuning a sledgehammer,[177] perfecting a trap for the unwary,[178] or abetting the creation of a

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[176] *See, e.g.*, John C. Coffee, Jr., *The SEC and the Institutional Investor: A Half-Time Report*, 15 CARDOZO L. REV. 837, 895 (1994) (noting that section 16(b) supports the public policy of encouraging a "longer time horizon" on the part of corporate managers and investors); Donna Darm, *Short-Swing Profits in Failed Takeover Bids—The Role of Section 16(b)*, 59 WASH. L. REV. 895, 912 (1984) (arguing that section 16(b) punishes unsuccessful takeover bids too harshly); Dessent, *supra* note 52 (arguing that section 16(b)'s strict liability approach is out of step with other legal standards developed under Rule 10b-5 to address insider trading, warranting repeal); Jesse M. Fried, *Reducing the Profitability of Corporate Insider Trading Through Pretrading Disclosure*, 71 S. CAL. L. REV. 303, 361–65 (1998) (arguing that section 16(b) should be abolished in favor of pretrading disclosure); Kanji Ishizumi, *Insider Trading Regulation: An Examination of Section 16(b) and a Proposal for Japan*, 47 FORDHAM L. REV. 449, 484 (1979) (arguing that "[t]he costs of the section exceed its benefits"); Marleen A. O'Connor, *Toward a More Efficient Deterrence of Insider Trading: The Repeal of Section 16(b)*, 58 FORDHAM L. REV. 309, 323 (1990) (noting that commentators began criticizing the statute as soon as it was enacted); Karl Shumpei Okamoto, *Rereading Section 16(b) of the Securities Exchange Act*, 27 GA. L. REV. 183, 186 (1993) (defending section 16(b) under a reconception of the statute as "a device primarily concerned with price manipulation by insiders through stock trading"); Ellen Taylor, *Teaching an Old Law New Tricks: Rethinking Section 16*, 39 ARIZ. L. REV. 1315, 1318 (1997) (arguing that section 16(b) should be repealed because it is ineffective, unfair, and expensive); Thel, *supra* note 44, at 397–99 (conceding that "Section 16 is ill-tailored for the task of preventing insiders from taking advantage of inside information," but arguing that it is "an extraordinarily precise measure for getting those in charge of publicly held companies to operate them in ways that will benefit the general public").

[177] *See, e.g.*, O'Connor, *supra* note 176, at 372–75 (arguing that section 16(b)'s "sledge hammer" approach is both overinclusive and underinclusive, and therefore inefficient); *cf.* Provident Secs. Co. v. Foremost-McKesson, Inc., 331 F. Supp. 787, 792 (N.D. Cal. 1971) (describing section 16(b) as "an extremely crude rule of a most deformed and misshapen thumb"), *aff'd*, 506 F.2d 601 (9th Cir. 1974), *aff'd*, 423 U.S. 232 (1976).

[178] *See, e.g.*, RICHARD W. JENNINGS & HAROLD MARSH, JR., SECURITIES REGULATION 1402 (David L. Shapiro et al. eds., 6th ed. 1987) ("Judging solely from the facts stated in the opinions in the decided cases, the function of Section 16(b) would appear to be to impose unjust liability upon entirely innocent persons."); O'Connor, *supra* note 176, at 373 ("Section 16(b) . . . does not provide much deterrence because its arbitrary restrictions are easy to evade."); *but see* Merritt B. Fox, *Insider Trading Deterrence Versus Managerial Incentives: A Unified Theory of Section 16(b)*, 92 MICH. L. REV. 2088, 2093 (1994) (arguing that insider trading may be deterred by the six-month waiting period to make a corresponding trade).

monstrosity.[179] Defenders of the statute might concede at least some of these characterizations, yet take a more appreciative view.[180]

One need not take sides on the (probably moot) question of section 16(b)'s repeal, however, to acknowledge the importance of ensuring that "this rule of thumb is no cruder than it needs to be."[181] A matching of trades produced by an erroneous application of the *Smolowe* formula does not correspond to any articulable theory of insider trading deterrence, does not advance anyone's ideal approach to securities regulation, and does not lend itself to coherent jurisprudence. It is problematic for everyone, even proponents of repeal. If sound public policy favors faster traffic, the solution is not to use defective radar guns, but to raise the speed limit.

For any federal judges (especially those in the Second Circuit), members of the section 16(b) plaintiffs' bar, and corporate law professors willing to consider using and teaching a more accurate alternative to the *Smolowe* formula, a free online tool may now shift the cost-benefit calculus in their favor. With the able assistance of undergraduate computer science students enrolled in the Fall 2014 and Spring 2016 software engineering laboratory courses at the University of North Carolina, I have made a "Short-Swing Profit Liability Calculator"

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[179] *See* LOUIS LOSS, SECURITIES REGULATION 1088 n.212 (2d. ed. 1961) (quoting James D. Calderwood, *Section 16(b): Another Noble Experiment Gone Wrong* 32 (address before American Society of Corporate Secretaries, Apr. 21, 1960) ("[T]he SEC has gotten so fascinated with the algebraic formulae which a fertile mind can conceive under Section 16(b) that it has never walked away a hundred paces and taken a good look at the monstrosity which has been created.").

[180] *See, e.g.*, Thel, *supra* note 44, at 414–15 ("Automatic forfeiture of short-swing profits eliminates the incentive to speculate for the short swing, and thus helps to keep corporate managers from being distracted from the business of running publicly held companies."); Byron D. Woodside, *Resumé of the Report of the Special Study of Securities Markets and the Commission's Legislative Proposals*, 19 BUS. LAW. 463, 476 (1964) ("Section 16(b) is about as subtle as a sledge hammer . . . [t]herein, in part, lies its virtue. The clamor for certainty is pretty well satisfied in this section of the law."); *see also* Reliance Elec. Co. v. Emerson Elec. Co., 404 U.S. 418, 422 (1972) (stating that section 16(b) is a "relatively arbitrary rule capable of easy administration.") (quoting Bershad v. McDonough, 428 F.2d 693, 696 (7th Cir. 1970)); Blau v. Lamb, 363 F.2d 507, 515 (2d Cir. 1966) ("It might be said that [in enacting section 16(b)] Congress decided in order to throw out the bathwater that the baby had to go too."); Hearings on Stock Exchange Practices Before the Senate Committee on Banking & Currency, 73d Cong., 2d Sess., 6557–58 (1934) (statement of principal drafter Thomas G. Corcoran) ("You have to have a general rule. In particular transactions it might work a hardship, but those transactions that are a hardship represent the sacrifice to the necessity of having a general rule.").

[181] *See* Fox, *supra* note 178, at 2201–02 (reaching no conclusion as to "whether section 16(b) should be retained" and stating that "section 16(b) is unlikely to be repealed in the foreseeable future" because of popular opposition to insider trading, but concluding "we must be sure that this rule of thumb is no cruder than it needs to be").

publicly available on the web.[182] If this tool succeeds in making it easy to use accurate linear programming methods to calculate short-swing profits and to detect the *Smolowe* formula's errors when they occur, then courts, attorneys, and professors will have less reason to perpetuate the misreading of *Gratz* and the misapplication of the formula. Corporate law professors in particular may find the calculator helpful as a reminder to students that the formula is not the exclusive method for calculating section 16(b) liability.

In addition to accepting manually inputted transaction data, the calculator provides the ability to search the SEC's public EDGAR database for any insider's Form 4 filings to compile a list of trades during any given time period. Figure 7 illustrates how a plaintiff might search for trades by Peter Huntsman, CEO of Huntsman Corporation, that took place between March and September 2009.

Figure 7:
The section 16(b) liability calculator's integrated EDGAR database search engine interface.

The search engine retrieves a sequence of four purchases (three of which were at a price of zero) and three sales of Huntsman Corporation stock.

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[182] Andrew Chin, *Short-Swing Profit Liability Calculator*, UNIV. OF N.C. SCH. OF LAW, http://16b.law.unc.edu.

Figure 8:
The section 16(b) liability calculator's data input interface populated by the result of the EDGAR database search depicted in Figure 7.

By clicking on the adjacent "Link to filing" links, the user can see that the first zero-price purchase was a grant of restricted stock that would not vest until March 2, 2010,[183] and the other two zero-price

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[183] The plaintiff in *Bennigson v. Huntsman*, No. 13 Civ. 452, 2013 WL 5348461 (S.D.N.Y. Sept. 24, 2013), apparently concluded that the grant satisfied the requirements for exemption under Rule 16b-3 and did not refer to it in the complaint. *Benningson*, 2013 WL 5348461, at *4. The requirements for exemption of restricted stock under the rule are quite detailed and beyond the scope of this Article. *See* STANTON P. EIGENBRODT, A PRACTICAL GUIDE TO SECTION 16: REPORTING AND COMPLIANCE, § 11.05[C], at 11-16 (2013).

purchases were withdrawals for the benefit of Huntsman Family Holdings and not Peter Huntsman. All three of these zero-price purchases can be eliminated (using the adjacent "Remove" buttons) as not matchable with any of the listed sales. The resulting trading sequence is shown in Figure 9 The bottom of the input interface shown in Figure 9 provides buttons to launch calculations based on the *Smolowe* formula ("lowest-in, highest-out," or "LIHO") and linear programming ("LP") methods.

Figure 9:
The search result depicted in Figure 8 after deletion of exempt transactions.

This happens to be a case in which the *Smolowe* formula produced the same result as the linear programming method even though the trading period spanned (slightly) more than six months. Using either of the two methods, the calculator produces the result shown in Figure 10.

Figure 10:
The section 16(b) liability calculator's output interface providing
matched trades and recoverable profit from the data in Figure 9.

Input	Output	Upload CSV Data	EDGAR Search

Purchase Date	Per Share Price	Sale Date	Per Share Price	Paired Securities	Profit
3/5/2009	$2.3697	9/3/2009	$7.86	100000	$549030.00
				Total	$549030.00

The result is reflected in the amended complaint in *Bennigson*, which sought a recovery of $549,030.00.[184]

A distinctive feature of the calculator is that it addresses the intricate problem of measuring the statutory six-month period in light of the complications created by months of differing lengths. According to the calendar, the interval that begins on October 30 and ends on April 29 is a "period of less than six months," inasmuch as April 29 precedes the date (i.e., April 30) that falls exactly six calendar months after October 30.[185] While a section 16(b) plaintiff could argue for this "matching date" interpretation, courts have read the statutory period more narrowly.[186]

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[184] *See Bennigson*, 2013 WL 5348461, at *4. The district court dismissed the complaint, finding that the challenged sales were merely "transfer[s] of shares by a Trust of which [the defendant] is simply a trustee, to an independent LLC" and therefore not "sales" within the meaning of section 16(b). *See id.*

[185] *See, e.g.*, Stella v. Graham-Paige Motors Corp., 132 F. Supp. 100 (S.D.N.Y. 1955), *remanded on other grounds*, 232 F.2d 299 (2d Cir. 1956).

[186] *Id.* The court adopted a construction of the term "period of less than six months" to require that the midnight preceding the start date and the midnight following the end date be less than six months apart. *See id.* at 103. Trades on January 1 and June 29 could therefore be paired for short-swing profit recovery, but trades on January 1 and June 30 could not. *See id.* at 103–04. According to a leading treatise, the *Stella* method "has been followed by all courts that have considered the question." ROMEO & DYE, *supra* note 16, § 10.01, at 10-3.

In *Jammies Int'l, Inc. v. Nowinski*, 700 F. Supp. 189 (S.D.N.Y. 1988), the court considered the situation where, due to the varying lengths of months, there was no date six months following and numerically corresponding to the first date in a period. *Jammies*, 700 F. Supp. at 191. The plaintiffs argued for "May 1 as the date most closely corresponding to October 31, because it is one day after the thirtieth day of the month." *Id.* at 192. The court, however, held that in such cases, "the corresponding date for the last day of a month is the last day of the month six months hence." *Id.* The *Jammies* court also regarded *Stella* as controlling precedent. *See id.* Consequently, under *Jammies*, the first permissible trade date in a non-leap year following a transaction on August 29, 30, or 31 is February 27. The *Jammies* rule addresses the measurement of short-swing periods that begin on March 31, May 31, August 29 (in non-leap years), 30, and 31, October 31, and December 31.

The calculator's attention to these calendrical details may seem arcane, but it simply reflects the level of precision that has emerged from six decades of case law on the calculation of section 16(b). This illustrates a final point about the cost-benefit calculus of adopting the calculator. If the courts have taken such pains to address the measurement of short-swing periods that begin on seven exceptional calendar dates,[187] it seems more than worthwhile for the legal community to adopt a freely available alternative calculation method in cases where a formula with a worst-case error of fifty percent cannot be validly used as a rule for calculating maximum short-swing profit.

B.   *Prospects for Change at the SEC*

Rules of law need less and less to rely on computational rules of thumb. As Larry Zelenak has pointed out, tax rules are rarely drafted with simplicity in mind, now that almost ninety percent of federal income tax returns are prepared on computers.[188] Zelenak tells the story of the "Rule of 78's," a simple but inaccurate method of calculating interest on short-term installment notes.[189] The IRS had historically permitted taxpayers to use the rule, but reversed its position in a 1983 revenue ruling, concluding that it could no longer be used "because it fails to reflect the true cost of borrowing."[190] Zelenak notes that the Hewlett-Packard 12C, "the world's first mass-market handheld financial calculator," was introduced in 1982,[191] and writes that "it is unlikely that the appearance of the ruling shortly after the appearance of the calculator was a coincidence."[192]

With the introduction of a free online tool for accurately calculating section 16(b) liability, the time is now ripe for the Securities and

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The calculator provides three options for measurement of the statutory "period of less than six months": (1) the calendar method, applying the *Jammies* plaintiff's rule for differing lengths of months; (2) the *Stella* method, applying the *Jammies* plaintiff's rule; and (3) the *Jammies* method, which incorporates *Stella*. The *Jammies* method is selected by default, as it is apparently the only reported case on the question of varying lengths of months, but plaintiffs in jurisdictions where *Stella* and *Jammies* are not controlling may want to consider the calculation of section 16(b) liability under other rules.

[187]   *See Jammies*, 700 F. Supp. at 192 (regarding the *Jammies* rule, which specifies certain calendar dates that especially affect the calculation of short-swing profits).

[188]   Lawrence Zelenak, *Complex Tax Legislation in the TurboTax Era*, 1 COLUM. J. TAX. L. 91, 95 (2010).

[189]   *See id.*

[190]   *See id.* at 96 & n.16.

[191]   *See id.* at 95–96.

[192]   *See id.* at 96.

Exchange Commission ("Commission") to consider updating its guidance regarding such calculations. Section 16(b) does not give the Commission standing to sue[193] and expressly acknowledges the Commission's rulemaking authority[194] only with respect to rules and regulations exempting transactions from the subsection's coverage.[195] Nevertheless, there is a strong argument for engaging the Commission in the effort to encourage the legal community to adopt more accurate short-swing liability calculation methods.

Importantly, the Commission has used these muscles before.[196] It was the Commission's amicus brief in *Smolowe* that provided the courts with the "lowest-in, highest-out" formula that would bear the case's name.[197] The Commission also filed an amicus brief to the Second Circuit in *Gratz*[198] in which it asserted without mathematical justification that the *Smolowe* formula "was the rule for the calculation of profits applied by the court below"[199] and that "the intention 'to squeeze all possible profits out of stock transactions' can only be accomplished by the adoption of the measure of damages applied in the *Smolowe* case and in the court below."[200] While Hand wisely decided *Gratz* without endorsing either of these dubious assertions,[201] the Commission remains on record as an

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[193] *See* 15 U.S.C. § 78(p)(b) (2012) (granting standing to "the issuer" and "the owner of any security of the issuer").

[194] Section 23(a) of the Securities Exchange Act of 1934 authorizes the Commission "to make such rules and regulations as may be necessary or appropriate to implement the provisions of this chapter for which they are responsible." 15 U.S.C. § 78(w)(a) (2012).

[195] *See* 15 U.S.C. § 78(p)(b) (2012) ("This subsection shall not be construed to cover . . . any transaction or transactions which the Commission by rules and regulations may exempt as not comprehended within the purpose of this subsection.").

[196] In the 1991 comprehensive revision to its section 16 rules, *see Ownership Reports and Trading by Officers, Directors and Principal Security Holders*, Release No. 34-28869, 56 Fed. Reg. 7242 (Feb. 21, 1991), the Commission promulgated Rule 16b-6(c) addressing the calculation of short-swing profits recoverable from transactions involving derivative securities, *see id.* at 7272–73 (promulgating 17 C.F.R. § 240.16b-6(c)). *See generally* Joan MacLeod Heminway, *Rock, Paper, Scissors: Choosing the Right Vehicle for Federal Corporate Governance Incentives*, 10 FORDHAM J. CORP. & FIN. L. 225, 288 (2005) ("Substantive competence is, however, acquired through repeated relevant rulemaking experience over an extended period of time. The SEC has this experience in securities regulation . . . ."); *but cf.* HARRY MARKOPOLOS, NO ONE WOULD LISTEN: A TRUE FINANCIAL THRILLER 63–64 (2010) (arguing that the SEC suffers from an "unbridgeable [quantitative] skills gap" in regulating capital markets and must rely on the intervention of mathematically sophisticated outsiders).

[197] *See* SEC *Smolowe* Brief, *supra* note 34, at 4–5.

[198] Memorandum for the SEC as Amicus Curiae, Gratz v. Claughton, 187 F.2d 46 (2nd Cir. 1951).

[199] *Id.* at 10.

[200] *Id.* at 11.

[201] *See* Gratz v. Claughton, 187 F.2d 46, 52 (2d Cir. 1951); *supra* note 134 and accompanying text (showing that Claughton probably did not use the *Smolowe* formula to produce the calculation

advocate for the use of the *Smolowe* formula beyond its intended and valid scope. The Commission has subsequently issued two interpretive releases describing the application of the *Smolowe* formula to trading sequences spanning multiple six-month short-swing periods,[202] again without mathematical justification[203] and without acknowledging the formula's fallibility when used in this way.[204] It does not seem unreasonable to request that the Commission now set the record straight.

A petition for rulemaking may be a productive avenue for eliciting the Commission's interest and support. The Commission has been singled out for praise among federal agencies for the transparency and efficiency of its petition for rulemaking process.[205] The findings in this Article could provide the principal basis for a petition for rulemaking or interpretive guidance on short-swing liability calculation.[206]

It is also possible to seek the Commission's support by requesting that it participate as an amicus curiae in a pending case involving an important securities law issue. Given the six decades of case law that have incorrectly cited *Gratz* as an authority in support of the

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adopted by the district court); *supra* section II.C (showing that the *Smolowe* formula would not have maximized calculation of Claughton's short-swing profits).

[202] *See* Commission Guidance on the Application of Certain Provisions of the Securities Act of 1933, the Securities Exchange Act of 1934, and Rules Thereunder to Trading in Security Futures Products, Securities Act Release No. 34-46101, 2002 WL 1677437, at *7 & n.40 (June 21, 2002) (stating that under the *Smolowe* formula, "profit is computed by matching the highest sale price with the lowest purchase price within six months, the next highest sale price with the next lowest purchase price within six months, and so on, until all shares have been included in the computation"); Interpretive Release on Rules Applicable to Insider Reporting and Trading, Securities Act Release No. 34-18114, 46 Fed. Reg. 48147, 48161 n.102 (1981) (same).

[203] *See* ROMEO & DYE, *supra* note 16, § 10.01[2], at 10-5 (explaining the complexity added by multiple short-swing periods).

[204] *See supra* section III.B (demonstrating the formula's fallibility and worst-case errors when multiple short-swing periods are involved in the *Smolowe* formula calculation).

[205] As Jason Schwartz and Richard Revesz recently reported to the Administrative Conference of the United States:

> After receiving and initially screening petitions, SEC sends the petitioner an acknowledgment and transmits the petition to the appropriate division of the agency, as well as to its web staff for posting. Stakeholders report this docketing typically happens fairly promptly. The agency then continues to update the docket with all comments it receives from the public on the petition. SEC reports that even with a relatively high volume of petitions, public comments, and other documents to process, its small web team has managed the volume well.

JASON A. SCHWARTZ & RICHARD L. REVESZ, PETITIONS FOR RULEMAKING: FINAL REPORT TO THE ADMINISTRATIVE CONFERENCE OF THE UNITED STATES (Nov. 5, 2014), https://www.acus.gov/sites/default/files/documents/Final%2520Petitions%2520for%2520Rulemaking%2520Report%2520%255B11-5-14%255D.pdf [https://perma.cc/27WU-FNER].

[206] *Cf.* Joan MacLeod Heminway, *Just Do It! Specific Rulemaking on Materiality Guidance in Insider Trading*, 72 LA. L. REV. 999, 1000 (2012) (urging the Commission "to adopt clarifying guidance on materiality—one unclear area of insider trading law").

unwarranted and erroneous use of the *Smolowe* formula,[207] the potential precedential impact of a case addressing the scope of the *Smolowe* formula's applicability would likely be substantial enough to warrant the Commission's participation.[208] The findings in this Article may prove helpful to future parties in making such a request.

CONCLUSION

Gratz has finally reached its teachable moment. The takeaway lesson is that *Gratz* should no longer be read as endorsing the *Smolowe* formula, but as wisely declining to prescribe a formula the court was not yet technologically competent to validate.[209] Given the complexity of the modern regulatory state and the pace of recent technological change, the Learned Hand unformula's silent jurisprudential insights might come to inform the path of the law in this century as pervasively as the Learned Hand formula did in the last.

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[207] *See, e.g.*, Falco v. Donner Found., 208 F.2d 500, 502 (2d Cir. 1953); Huppe v. Special Situations Fund III, 565 F. Supp. 2d 495, 502–03 (S.D.N.Y. 2008).

[208] *See Request for Commission* Amicus *Participation in a Pending Case*, U.S. SECURITIES AND EXCHANGE COMMISSION, https://www.sec.gov/litigation/briefs/amicusrequest.htm [https://perma. cc/AXH6-EVBT] ("In deciding whether to recommend that the Commission file an *amicus* brief, the staff generally considers the following factors: (a) whether the decision in the case is likely to have substantial precedential impact; (b) whether the case raises issues important to the Commission's ability to carry out its statutory objectives or other important securities law issues; (c) whether there is a potential conflict between the securities laws and other federal or state laws involved; and (d) whether the brief might provide an opportunity to convince the court to adopt a narrow or moderate holding, rather than a broad and potentially damaging one.").

[209] Even without *Gratz*'s endorsement, the *Smolowe* formula can still validly be applied to trading sequences falling "within six months," as the *Smolowe* court said. *See supra* section III.A.

APPENDICES

A. *Computation of Short-Swing Profits in* Gratz

Table 1:

Matching of Edward N. Claughton's common stock trades[210] **according to the** *Smolowe* **formula, as performed by the online Short-Swing Profit Liability Calculator.**[211]

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
600	12/20/1944	4.22	2/28/1945	8.29	2,444.88
600	12/20/1944	4.22	2/28/1945	8.16	2,369.88
200	12/21/1944	4.34	6/19/1945	13.01	1,734.32
400	12/21/1944	4.34	6/19/1945	12.89	3,418.76
400	12/21/1944	4.34	6/19/1945	12.76	3,368.88
600	12/18/1944	4.34	2/28/1945	8.16	2,294.88
100	12/22/1944	4.47	6/20/1945	16.38	1,191.30
900	12/22/1944	4.47	6/20/1945	16.34	10,687.41
1200	12/26/1944	4.47	6/20/1945	16.34	14,249.88
1000	12/21/1944	4.47	6/19/1945	12.76	8,297.20
500	12/18/1944	4.47	2/28/1945	8.16	1,849.60
150	12/26/1944	4.59	6/20/1945	16.34	1,762.49
850	12/26/1944	4.59	6/20/1945	16.25	9,913.89
100	12/27/1944	4.59	6/20/1945	16.25	1,166.34
1000	12/21/1944	4.59	6/19/1945	12.76	8,172.20
1500	12/19/1944	4.59	2/28/1945	8.16	5,362.05
600	12/19/1944	4.59	3/1/1945	8.16	2,144.82
1300	12/19/1944	4.59	2/27/1945	7.91	4,322.11
1300	12/19/1944	4.59	2/27/1945	7.79	4,159.61

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[210] *See* Pl.'s Exhibit 5 to *Gratz* Master's Report, *supra* note 11 (listing Claughton's common stock trades between December 18, 1944 and September 9, 1946 in chronological order).

[211] *See* Andrew Chin, *Short-Swing Profit Liability Calculator*, UNIV. OF N.C. SCH. OF LAW, http://unclaw.com/chin/16b [https://perma.cc/Q87G-VVK7]; *supra* section IV.A (describing the calculator). All monetary values have been rounded to the nearest cent. *See supra* note 88. Somewhat anachronistically, but without loss of generality, short-swing periods have been measured according to two subsequent district court decisions that have clarified the matching of trades separated by almost six full months. *See generally* Jammies Int'l Inc. v. Nowinski, 700 F. Supp. 189 (S.D.N.Y. 1988); Stella v. Graham-Paige Motors Corp., 132 F. Supp. 100 (S.D.N.Y. 1955), *remanded on other grounds*, 232 F. 2d 299 (2d Cir. 1956).

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
500	12/19/1944	4.59	3/26/1945	7.79	1,599.55
600	12/19/1944	4.59	4/25/1945	7.68	1,850.94
500	12/19/1944	4.59	3/27/1945	7.67	1,542.35
800	12/19/1944	4.59	4/26/1945	7.67	2,467.76
600	12/19/1944	4.59	3/26/1945	7.67	1,850.22
1500	12/19/1944	4.59	3/31/1945	6.58	2,983.20
300	12/22/1944	4.59	6/20/1945	16.25	3,498.72
1550	12/22/1944	4.72	6/20/1945	16.25	17,884.52
700	12/22/1944	4.72	6/20/1945	16.25	8,076.81
200	12/22/1944	4.72	6/20/1945	16.13	2,282.74
50	12/22/1944	4.72	6/20/1945	16.00	564.45
350	12/26/1944	4.72	6/20/1945	16.00	3,951.15
150	12/26/1944	4.72	6/20/1945	15.88	1,674.65
50	12/27/1944	4.72	6/20/1945	15.88	558.22
250	12/27/1944	4.72	6/20/1945	15.75	2,759.90
400	12/21/1944	4.72	6/19/1945	12.76	3,218.88
2300	12/21/1944	4.72	6/19/1945	12.64	18,221.75
500	12/21/1944	4.72	6/19/1945	12.51	3,898.90
100	12/21/1944	4.72	6/19/1945	12.01	729.92
400	12/19/1944	4.72	3/31/1945	6.58	745.44
500	12/19/1944	4.72	1/30/1945	6.56	922.30
800	12/19/1944	4.72	1/29/1945	6.18	1,175.68
150	12/27/1944	4.84	6/20/1945	15.75	1,637.19
500	12/27/1944	4.84	6/20/1945	15.51	5,332.65
500	12/27/1944	4.84	6/20/1945	15.38	5,270.30
600	12/27/1944	4.84	6/21/1945	15.38	6,324.36
700	12/21/1944	4.84	6/19/1945	12.01	5,021.94
400	12/27/1944	4.84	6/19/1945	11.76	2,769.88
800	12/27/1944	4.84	6/19/1945	10.64	4,642.08
1000	12/29/1944	5.48	6/26/1945	12.50	7,025.00
900	12/29/1944	5.73	6/26/1945	12.50	6,097.50
300	1/23/1945	5.85	7/3/1945	13.64	2,335.50
100	1/8/1945	5.98	7/3/1945	13.64	766.00
100	12/29/1944	5.98	6/26/1945	12.50	652.50
600	1/5/1945	6.11	7/3/1945	13.64	4,515.00
1000	2/19/1945	7.62	8/9/1945	14.00	6,380.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
300	4/26/1945	7.87	10/15/1945	14.76	2,066.16
100	4/27/1945	7.87	10/15/1945	14.76	688.72
100	10/4/1946	7.87	9/19/1946	10.39	252.19
100	10/4/1946	8.00	9/19/1946	10.39	239.69
400	9/24/1946	8.13	9/19/1946	9.77	655.64
100	9/24/1946	8.63	9/19/1946	9.77	113.91
700	9/9/1946	8.88	3/12/1946	14.38	3,852.17
300	9/9/1946	8.88	3/12/1946	14.26	1,613.52
100	6/5/1945	9.01	11/20/1945	15.01	600.15
200	6/5/1945	9.01	11/19/1945	14.88	1,175.38
300	9/9/1946	9.01	3/12/1946	14.26	1,576.02
500	6/5/1945	9.14	11/20/1945	14.88	2,870.90
400	6/5/1945	9.14	11/20/1945	14.76	2,246.88
400	6/5/1945	9.14	11/19/1945	14.76	2,246.28
200	6/5/1945	9.14	11/29/1945	14.76	1,123.14
400	6/5/1945	9.14	9/25/1945	14.63	2,197.00
200	6/5/1945	9.14	10/10/1945	14.63	1,098.50
100	6/5/1945	9.14	9/24/1945	14.51	536.78
800	6/5/1945	9.14	9/25/1945	14.51	4,294.24
400	6/5/1945	9.14	9/21/1945	14.38	2,097.24
200	6/5/1945	9.14	9/24/1945	14.38	1,048.62
100	6/5/1945	9.14	9/25/1945	14.38	524.31
900	6/5/1945	9.14	9/21/1945	14.38	4,718.16
100	6/5/1945	9.14	11/2/1945	14.38	524.24
300	9/8/1946	9.14	3/12/1946	14.26	1,535.52
400	9/8/1946	9.14	3/13/1946	13.26	1,648.36
100	9/8/1946	9.14	3/13/1946	13.01	387.16
900	9/9/1946	9.14	3/13/1946	13.01	3,484.44
900	9/9/1946	9.14	3/13/1946	12.89	3,372.21
200	6/18/1945	9.52	12/11/1945	15.01	1,098.02
800	6/18/1945	9.52	12/11/1945	14.88	4,293.20
200	6/18/1945	9.52	12/12/1945	14.84	1,064.38
200	6/18/1945	9.52	12/11/1945	14.76	1,048.14
600	6/18/1945	9.52	11/2/1945	14.38	2,920.44
100	6/18/1945	9.64	11/2/1945	14.38	474.24
300	6/18/1945	9.64	9/21/1945	14.26	1,385.52

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
100	6/18/1945	9.64	10/22/1945	14.26	461.84
1300	6/18/1945	9.64	10/17/1945	14.26	6,003.27
400	6/18/1945	9.77	10/17/1945	14.26	1,797.16
100	6/18/1945	9.77	9/21/1945	14.26	449.28
200	6/18/1945	9.89	9/21/1945	14.26	873.56
600	6/19/1945	10.15	9/21/1945	14.26	2,464.68
200	7/25/1945	11.15	1/14/1946	15.51	870.56
300	7/25/1945	11.15	1/15/1946	15.26	1,231.02
200	6/19/1945	11.15	9/21/1945	14.26	621.06
100	7/25/1945	11.40	1/15/1946	15.26	385.28
200	7/25/1945	11.40	1/15/1946	15.26	770.40
100	7/27/1945	11.65	1/15/1946	15.26	360.13
100	8/22/1945	11.78	1/15/1946	15.26	347.60
100	8/22/1945	11.78	1/14/1946	15.13	335.21
200	8/22/1945	11.90	1/14/1946	15.13	645.36
100	8/22/1945	12.03	1/14/1946	15.13	310.15
100	8/22/1945	12.03	1/15/1946	15.13	310.15
200	8/21/1945	12.16	1/15/1946	15.13	595.24
200	8/21/1945	12.28	1/16/1946	15.13	570.18
100	8/1/1945	12.41	1/16/1946	15.01	260.10
100	8/3/1945	12.41	1/16/1946	15.01	260.10
400	8/9/1945	12.41	1/16/1946	15.01	1,040.40
200	8/21/1945	12.41	1/16/1946	15.01	520.20
200	8/21/1945	12.53	1/16/1946	15.01	495.14
400	8/23/1945	12.53	1/16/1946	15.01	990.28
200	8/1/1945	12.66	1/14/1946	15.01	470.06
200	8/21/1945	12.66	1/14/1946	15.01	470.06
500	8/23/1945	12.66	1/14/1946	15.01	1,175.15
100	8/1/1945	12.78	1/14/1946	15.01	222.50
100	8/2/1945	12.78	1/14/1946	15.01	222.50
600	8/23/1945	12.78	1/14/1946	15.01	1,335.00
100	8/23/1945	12.78	1/15/1946	15.01	222.50
400	8/2/1945	12.91	1/15/1946	15.01	839.88
200	8/9/1945	12.91	1/15/1946	15.01	419.94
400	8/23/1945	12.91	1/14/1946	14.88	790.00
200	8/9/1945	13.03	1/14/1946	14.88	369.94

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
100	8/21/1945	13.03	1/14/1946	14.88	184.97
100	8/21/1945	13.03	1/15/1946	14.88	184.96
300	7/19/1945	13.16	1/15/1946	14.88	517.29
300	7/19/1945	13.16	1/16/1946	14.88	517.26
300	8/9/1945	13.16	1/16/1946	14.88	517.26
200	8/17/1945	13.16	1/16/1946	14.88	344.84
1000	2/28/1946	13.16	1/16/1946	14.88	1,724.20
200	8/17/1945	13.28	1/16/1946	14.88	319.78
100	8/3/1945	13.41	1/16/1946	14.88	147.36
200	8/17/1945	13.41	1/16/1946	14.88	294.72
100	9/5/1945	13.41	1/16/1946	14.88	147.36
100	8/3/1945	13.53	1/16/1946	14.88	134.83
200	8/17/1945	13.53	1/16/1946	14.88	269.66
100	9/5/1945	13.53	1/16/1946	14.88	134.83
200	8/6/1945	13.66	1/16/1946	14.88	244.58
200	8/14/1945	13.66	1/16/1946	14.88	244.58
400	9/5/1945	13.66	1/16/1946	14.88	487.16
400	8/6/1945	13.78	1/16/1946	14.88	439.04
200	8/14/1945	13.78	1/16/1946	14.88	219.52
400	12/12/1945	13.86	1/16/1946	14.88	410.16
100	7/18/1945	13.91	1/16/1946	14.88	97.23
900	7/18/1945	13.91	1/14/1946	14.76	763.02
100	8/6/1945	13.91	1/14/1946	14.76	84.78
200	8/14/1945	13.91	1/14/1946	14.76	169.56
300	9/5/1945	13.91	1/14/1946	14.76	254.34
500	8/7/1945	13.91	1/14/1946	14.76	423.60
200	7/18/1945	14.03	1/15/1946	14.76	144.50
200	8/14/1945	14.03	1/15/1946	14.76	144.50
900	9/5/1945	14.03	1/15/1946	14.76	650.25
200	7/16/1945	14.03	9/21/1945	14.26	44.62
1500	7/18/1945	14.16	1/16/1946	14.76	895.80
200	8/6/1945	14.16	1/16/1946	14.76	119.44
1000	8/10/1945	14.16	1/16/1946	14.76	597.20
1100	8/14/1945	14.16	1/16/1946	14.76	656.92
200	9/5/1945	14.16	1/16/1946	14.76	119.44
700	9/10/1945	14.16	1/16/1946	14.76	418.04

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
1700	9/11/1945	14.16	1/16/1946	14.76	1,015.24
900	12/6/1945	14.16	1/16/1946	14.76	537.48
100	2/25/1946	14.16	1/16/1946	14.76	59.72
2400	2/27/1946	14.16	1/16/1946	14.76	1,433.28
200	7/13/1945	14.16	9/21/1945	14.26	19.56
100	12/7/1945	14.16	1/16/1946	14.76	59.59
200	9/17/1945	14.29	1/16/1946	14.76	94.38
200	11/26/1945	14.29	1/16/1946	14.76	94.38
500	9/17/1945	14.41	1/16/1946	14.76	173.30
100	9/17/1945	14.41	1/23/1946	14.76	34.66
850	11/26/1945	14.41	1/23/1946	14.76	294.61

Table 2:

Matching of Edward N. Claughton's common stock trades[212] according to the linear programming method,[213] as performed by the online Short-Swing Profit Liability Calculator.[214]

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
100	12/20/1944	4.22	3/27/1945	7.67	345.98
1,100	12/20/1944	4.22	3/31/1945	6.58	2,600.29
150	12/21/1944	4.34	6/19/1945	12.64	1,244.63
350	12/21/1944	4.34	6/19/1945	12.01	2,685.97
500	12/21/1944	4.34	6/19/1945	10.64	3,151.30
100	12/18/1944	4.34	2/28/1945	8.29	394.98
500	12/18/1944	4.34	2/28/1945	8.16	1,912.40
950	12/26/1944	4.47	6/20/1945	16.34	11,281.16
700	12/22/1944	4.47	6/20/1945	16.25	8,251.81
300	12/22/1944	4.47	6/20/1945	16.00	3,461.70
300	12/21/1944	4.47	6/19/1945	12.76	2,489.16
250	12/26/1944	4.47	6/19/1945	12.64	2,043.13
500	12/21/1944	4.47	6/19/1945	12.51	4,023.90
200	12/21/1944	4.47	6/19/1945	11.76	1,459.94
500	12/18/1944	4.47	1/29/1945	6.18	859.65
1,000	12/26/1944	4.59	6/20/1945	16.34	11,749.90

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[212] *See* Pl.'s Exhibit 5 to *Gratz* Master's Report, *supra* note 11.

[213] *See* Schrijver, *supra* note 126.

[214] *See supra* section 0.

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
100	12/27/1944	4.59	6/20/1945	16.00	1,141.40
200	12/21/1944	4.59	6/19/1945	13.01	1,684.32
200	12/21/1944	4.59	6/19/1945	12.89	1,659.38
600	12/21/1944	4.59	6/19/1945	12.76	4,903.32
2,700	12/19/1944	4.59	2/28/1945	8.16	9,651.69
600	12/19/1944	4.59	3/1/1945	8.16	2,144.82
1,300	12/19/1944	4.59	2/27/1945	7.91	4,322.11
1,300	12/19/1944	4.59	2/27/1945	7.79	4,159.61
500	12/19/1944	4.59	3/26/1945	7.79	1,599.55
600	12/19/1944	4.59	4/25/1945	7.68	1,850.94
600	12/19/1944	4.59	3/26/1945	7.67	1,850.22
800	12/19/1944	4.59	3/31/1945	6.58	1,591.04
500	12/19/1944	4.59	1/30/1945	6.56	984.90
300	12/19/1944	4.59	1/29/1945	6.18	478.44
300	12/22/1944	4.59	6/20/1945	16.25	3,498.72
300	12/26/1944	4.72	6/20/1945	16.34	3,487.47
1,850	12/22/1944	4.72	6/20/1945	16.25	21,346.04
200	12/26/1944	4.72	6/20/1945	16.13	2,282.74
200	12/22/1944	4.72	6/19/1945	12.89	1,634.38
1,300	12/21/1944	4.72	6/19/1945	12.76	10,461.36
1,450	12/21/1944	4.72	6/19/1945	12.64	11,487.63
450	12/22/1944	4.72	6/19/1945	12.64	3,565.13
350	12/21/1944	4.72	6/19/1945	12.01	2,554.72
200	12/21/1944	4.72	6/19/1945	11.76	1,409.94
300	12/27/1944	4.72	6/19/1945	10.64	1,778.28
500	12/19/1944	4.72	2/28/1945	8.29	1,787.25
400	12/19/1944	4.72	3/27/1945	7.67	1,183.80
800	12/19/1944	4.72	4/26/1945	7.67	2,367.60
100	12/27/1944	4.84	6/20/1945	16.38	1,153.80
650	12/27/1944	4.84	6/20/1945	16.25	7,418.71
200	12/27/1944	4.84	6/20/1945	15.88	2,207.86
400	12/27/1944	4.84	6/20/1945	15.75	4,365.84
500	12/27/1944	4.84	6/20/1945	15.51	5,332.65
500	12/27/1944	4.84	6/20/1945	15.38	5,270.30
600	12/27/1944	4.84	6/21/1945	15.38	6,324.36
600	12/21/1944	4.84	6/19/1945	12.76	4,753.32
100	12/21/1944	4.84	6/19/1945	12.01	717.42
1,000	12/29/1944	5.48	6/26/1945	12.50	7,025.00
900	12/29/1944	5.73	6/26/1945	12.50	6,097.50
300	1/23/1945	5.85	7/3/1945	13.64	2,335.50
100	1/8/1945	5.98	7/3/1945	13.64	766.00
100	1/3/1945	5.98	6/26/1945	12.50	652.50
600	1/23/1945	6.11	7/3/1945	13.64	4,515.00
1,000	2/19/1945	7.62	8/9/1945	14.00	6,380.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
300	4/26/1945	7.87	10/15/1945	14.76	2,066.16
100	4/27/1945	7.87	9/21/1945	14.38	651.31
100	10/4/1946	7.87	9/19/1946	9.77	189.91
100	10/4/1946	8.00	9/19/1946	9.77	177.41
200	9/24/1946	8.13	9/19/1946	10.39	452.38
200	9/24/1946	8.13	9/19/1946	9.77	327.82
100	9/24/1946	8.63	9/19/1946	9.77	113.91
1,000	9/9/1946	8.88	3/13/1946	13.01	4,131.60
300	6/5/1945	9.01	9/21/1945	14.38	1,613.43
300	9/9/1946	9.01	3/12/1946	14.38	1,613.43
400	6/5/1945	9.14	11/19/1945	14.76	2,246.28
200	6/5/1945	9.14	11/29/1945	14.76	1,123.14
800	6/5/1945	9.14	9/25/1945	14.51	4,294.24
400	9/9/1946	9.14	3/12/1946	14.38	2,097.24
900	6/5/1945	9.14	9/21/1945	14.38	4,718.16
800	6/5/1945	9.14	11/2/1945	14.38	4,193.92
100	6/5/1945	9.14	10/22/1945	14.26	511.84
900	9/9/1946	9.14	3/12/1946	14.26	4,606.56
1,500	6/5/1945	9.14	9/21/1945	14.26	7,676.70
400	9/8/1946	9.14	3/13/1946	13.26	1,648.36
400	9/8/1946	9.14	3/13/1946	12.89	1,498.76
500	9/9/1946	9.14	3/13/1946	12.89	1,873.45
100	6/18/1945	9.52	11/20/1945	15.01	549.15
200	6/18/1945	9.52	12/11/1945	15.01	1,098.02
200	6/18/1945	9.52	11/19/1945	14.88	1,073.38
500	6/18/1945	9.52	11/20/1945	14.88	2,683.40
400	6/18/1945	9.52	12/11/1945	14.88	2,146.60
400	6/18/1945	9.52	11/20/1945	14.76	2,096.88
200	6/18/1945	9.52	12/11/1945	14.76	1,048.14
100	6/18/1945	9.64	12/12/1945	14.84	519.69
1,700	6/18/1945	9.64	10/17/1945	14.26	7,850.43
400	6/18/1945	9.77	12/11/1945	14.88	2,046.60
100	6/18/1945	9.77	12/12/1945	14.84	507.19
200	6/18/1945	9.89	10/10/1945	14.63	948.50
300	6/19/1945	10.15	9/25/1945	14.63	1,344.75
200	6/19/1945	10.15	9/24/1945	14.38	846.62
100	6/19/1945	10.15	9/25/1945	14.38	423.31
500	7/25/1945	11.15	1/16/1946	14.76	1,802.35
100	6/19/1945	11.15	9/24/1945	14.51	335.53
100	6/19/1945	11.15	9/21/1945	14.26	310.59
300	7/25/1945	11.40	1/14/1946	15.01	1,081.05
100	7/27/1945	11.65	1/14/1946	14.88	322.81
200	8/22/1945	11.78	1/14/1946	14.76	595.62
200	8/22/1945	11.90	1/14/1946	15.01	620.44

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
200	8/22/1945	12.03	1/14/1946	15.01	595.38
200	8/21/1945	12.16	1/16/1946	14.76	520.44
200	8/21/1945	12.28	1/15/1946	15.13	570.18
100	8/1/1945	12.41	1/16/1946	14.88	247.61
100	8/3/1945	12.41	1/14/1946	14.76	235.16
400	8/9/1945	12.41	1/14/1946	14.76	940.64
200	8/21/1945	12.41	1/16/1946	14.76	470.32
200	8/21/1945	12.53	1/16/1946	14.76	445.26
400	8/23/1945	12.53	1/16/1946	14.76	890.52
200	8/1/1945	12.66	1/16/1946	14.76	420.18
200	8/21/1945	12.66	1/15/1946	14.76	420.18
500	8/23/1945	12.66	1/16/1946	14.76	1,050.45
100	8/1/1945	12.78	1/15/1946	14.76	197.56
100	8/2/1945	12.78	1/15/1946	14.76	197.56
700	8/23/1945	12.78	1/16/1946	14.76	1,382.92
400	8/2/1945	12.91	1/16/1946	14.76	740.12
200	8/9/1945	12.91	1/16/1946	14.76	370.06
400	8/23/1945	12.91	1/16/1946	14.76	740.12
200	8/9/1945	13.03	1/14/1946	15.01	394.88
200	8/21/1945	13.03	1/14/1946	15.01	394.88
1,000	2/28/1946	13.16	1/16/1946	14.88	1,724.20
600	7/19/1945	13.16	1/16/1946	14.76	959.82
300	8/9/1945	13.16	1/16/1946	14.76	479.91
200	8/17/1945	13.16	1/16/1946	14.76	319.94
200	8/17/1945	13.28	1/14/1946	15.01	344.76
100	8/3/1945	13.41	1/14/1946	14.88	147.38
200	8/17/1945	13.41	1/16/1946	14.76	269.82
100	9/5/1945	13.41	1/15/1946	14.76	134.91
200	8/17/1945	13.53	1/15/1946	15.26	344.34
100	8/3/1945	13.53	1/16/1946	14.76	122.38
100	9/5/1945	13.53	1/14/1946	14.76	122.38
200	8/6/1945	13.66	1/15/1946	15.26	319.26
200	8/14/1945	13.66	1/15/1946	14.76	219.68
400	9/5/1945	13.66	1/16/1946	14.76	437.36
400	8/6/1945	13.78	1/16/1946	14.76	389.24
200	8/14/1945	13.78	1/16/1946	14.76	194.62
400	12/12/1945	13.86	1/16/1946	14.88	410.16
400	7/18/1945	13.91	1/15/1946	14.88	388.96
600	7/18/1945	13.91	1/16/1946	14.88	583.38
100	8/6/1945	13.91	1/16/1946	14.88	97.23
200	8/14/1945	13.91	1/15/1946	14.76	169.56
300	9/5/1945	13.91	1/16/1946	14.76	254.34
500	8/7/1945	13.91	1/14/1946	14.76	423.60
200	7/16/1945	14.03	1/14/1946	15.51	294.12

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
200	7/18/1945	14.03	1/15/1946	15.26	244.24
200	9/5/1945	14.03	1/16/1946	15.13	219.30
200	8/14/1945	14.03	1/15/1946	14.76	144.50
700	9/5/1945	14.03	1/23/1946	14.76	505.75
200	8/14/1945	14.16	1/15/1946	15.26	219.18
100	7/18/1945	14.16	1/15/1946	15.13	97.12
200	8/6/1945	14.16	1/14/1946	15.13	194.24
200	7/17/1945	14.16	1/14/1946	15.01	169.32
1,300	7/18/1945	14.16	1/16/1946	15.01	1,100.58
700	8/14/1945	14.16	1/15/1946	15.01	592.62
50	9/5/1945	14.16	1/16/1946	15.01	42.33
400	7/17/1945	14.16	1/14/1946	14.88	288.76
100	7/18/1945	14.16	1/14/1946	14.88	72.19
100	2/25/1946	14.16	1/16/1946	14.88	72.17
2,400	2/27/1946	14.16	1/16/1946	14.88	1,732.08
100	7/13/1945	14.16	10/15/1945	14.76	59.72
1,000	8/10/1945	14.16	1/16/1946	14.76	597.20
200	8/14/1945	14.16	1/23/1946	14.76	119.44
100	9/5/1945	14.16	1/15/1946	14.76	59.72
50	9/5/1945	14.16	1/23/1946	14.76	29.86
700	9/10/1945	14.16	1/16/1946	14.76	418.04
1,700	9/11/1945	14.16	1/16/1946	14.76	1,015.24
900	12/6/1945	14.16	1/16/1946	14.76	537.48
100	7/13/1945	14.16	9/25/1945	14.63	47.25
200	7/13/1945	14.16	9/21/1945	14.26	19.68
100	12/7/1945	14.16	1/14/1946	14.76	59.59
200	9/17/1945	14.29	1/14/1946	15.13	169.18
200	11/26/1945	14.29	1/14/1946	15.01	144.26
50	11/26/1945	14.41	1/16/1946	15.01	29.80
600	11/26/1945	14.41	1/14/1946	14.76	207.96

B.   *Computation of Short-Swing Profits in* Chechele

Table 3:

Matching of Elorian Landers's trades in Bond Laboratories, Inc. common stock[215] according to the *Smolowe* formula, as performed by the online Short-Swing Profit Liability Calculator.[216]

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
500	10/13/2010	0.20	4/23/2010	0.48	140.00
1,000	9/27/2010	0.21	4/23/2010	0.48	270.00
2,500	9/27/2010	0.21	4/23/2010	0.47	650.00
375	9/27/2010	0.21	4/22/2010	0.45	90.00
400	10/12/2010	0.21	4/22/2010	0.45	96.00
150	10/15/2010	0.22	4/22/2010	0.45	34.50
250	10/12/2010	0.22	4/22/2010	0.45	57.50
550	10/12/2010	0.22	4/22/2010	0.45	126.50
675	10/5/2010	0.22	4/22/2010	0.45	155.25
1,700	10/12/2010	0.22	4/22/2010	0.45	391.00
600	10/15/2010	0.22	4/21/2010	0.44	132.00
275	10/5/2010	0.23	4/21/2010	0.44	57.75
450	10/1/2010	0.23	4/21/2010	0.44	94.50
500	9/29/2010	0.23	4/21/2010	0.44	105.00
575	9/22/2010	0.23	4/21/2010	0.44	120.75
250	10/5/2010	0.23	7/23/2010	0.33	25.00
1,750	10/5/2010	0.23	7/23/2010	0.33	175.00
50	10/6/2010	0.23	8/4/2010	0.31	4.00
450	10/5/2010	0.23	8/4/2010	0.31	36.00
1,000	10/6/2010	0.23	8/4/2010	0.31	80.00
50	10/6/2010	0.23	7/30/2010	0.30	3.50
2,000	10/6/2010	0.23	7/27/2010	0.30	140.00
460	10/6/2010	0.24	7/30/2010	0.30	27.60
1,000	7/16/2010	0.25	3/12/2010	0.54	290.00
500	9/24/2010	0.26	7/30/2010	0.30	20.00
500	5/28/2010	0.27	12/1/2009	0.85	290.00

[215] *See* Complaint ¶¶ 19–20, Chechele v. Vicis Capital, LLC, 2011 WL 7566992 (S.D.N.Y. filed Mar. 30, 2011) (listing purchases between Aug. 17, 2009 and Oct. 15, 2010, and sales between Aug. 20, 2009 and Oct 5, 2010, respectively, in chronological order).

[216] *See supra* section IV.A.

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
500	7/21/2010	0.27	3/12/2010	0.54	135.00
500	7/21/2010	0.27	3/12/2010	0.54	135.00
500	8/27/2010	0.27	3/12/2010	0.54	135.00
1,000	7/15/2010	0.27	3/12/2010	0.54	270.00
990	9/16/2010	0.27	7/30/2010	0.30	29.70
2,000	9/16/2010	0.27	8/4/2010	0.30	60.00
500	8/25/2010	0.28	3/12/2010	0.54	130.00
1,000	7/20/2010	0.28	3/12/2010	0.54	260.00
1,000	7/16/2010	0.29	2/10/2010	0.52	230.00
1,000	8/16/2010	0.29	2/23/2010	0.50	210.00
1,000	8/17/2010	0.29	2/23/2010	0.50	210.00
1,000	8/17/2009	0.30	9/24/2009	1.51	1,210.00
1,000	8/19/2009	0.30	9/28/2009	1.48	1,180.00
1,000	8/17/2009	0.34	9/25/2009	1.45	1,110.00
1,000	8/17/2009	0.34	9/25/2009	1.43	1,090.00
1,000	8/17/2009	0.34	9/25/2009	1.40	1,060.00
1,000	8/17/2009	0.34	9/23/2009	1.35	1,010.00
1,000	8/17/2009	0.34	9/29/2009	1.35	1,010.00
500	8/19/2009	0.34	9/23/2009	1.33	495.00
500	5/13/2010	0.36	12/1/2009	0.85	245.00
500	5/13/2010	0.36	11/24/2009	0.81	225.00
1,000	5/18/2010	0.36	11/30/2009	0.81	450.00
300	5/18/2010	0.36	12/7/2009	0.75	117.00
150	5/21/2010	0.37	12/8/2009	0.75	57.00
250	5/21/2010	0.37	12/23/2009	0.75	95.00
300	5/19/2010	0.37	12/8/2009	0.75	114.00
550	5/19/2010	0.37	12/8/2009	0.75	209.00
700	5/19/2010	0.37	12/7/2009	0.75	266.00
750	6/14/2010	0.37	12/23/2009	0.75	285.00
750	6/14/2010	0.37	12/22/2009	0.66	217.50
500	8/17/2009	0.38	9/23/2009	1.33	475.00
500	8/17/2009	0.38	9/23/2009	1.28	450.00
500	8/17/2009	0.38	9/23/2009	1.28	450.00
500	8/17/2009	0.38	10/1/2009	1.25	435.00
500	8/20/2009	0.38	10/1/2009	1.25	435.00
500	8/20/2009	0.38	10/5/2009	1.25	435.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
400	5/14/2010	0.38	12/11/2009	0.73	140.00
250	5/14/2010	0.38	12/22/2009	0.66	70.00
500	8/21/2009	0.39	10/5/2009	1.25	430.00
1,000	8/21/2009	0.39	9/23/2009	1.24	850.00
1,000	8/21/2009	0.39	10/6/2009	1.17	780.00
1,000	8/21/2009	0.39	10/6/2009	1.12	730.00
500	8/21/2009	0.40	10/6/2009	1.11	355.00
500	8/21/2009	0.40	10/6/2009	1.11	355.00
500	2/26/2010	0.40	10/12/2009	1.06	330.00
500	8/24/2009	0.41	10/12/2009	1.06	325.00
500	8/24/2009	0.41	10/12/2009	1.03	310.00
2,000	2/3/2010	0.42	10/12/2009	1.03	1,220.00
1,000	2/3/2010	0.42	10/13/2009	1.02	600.00
250	4/13/2010	0.42	10/21/2009	0.99	142.50
250	4/14/2010	0.42	10/21/2009	0.99	142.50
1,000	2/3/2010	0.42	9/21/2009	0.99	570.00
1,000	2/3/2010	0.42	9/22/2009	0.99	570.00
500	8/24/2009	0.43	10/21/2009	0.99	280.00
1,000	8/24/2009	0.43	10/12/2009	0.99	560.00
500	8/24/2009	0.43	9/16/2009	0.96	265.00
500	8/25/2009	0.43	9/16/2009	0.96	265.00
250	2/23/2010	0.43	9/18/2009	0.94	127.50
500	8/25/2009	0.43	9/18/2009	0.94	255.00
125	2/23/2010	0.43	10/14/2009	0.90	58.75
300	4/12/2010	0.43	10/14/2009	0.90	141.00
320	4/15/2010	0.43	10/19/2009	0.88	144.00
350	4/26/2010	0.43	11/4/2009	0.88	157.50
575	1/29/2010	0.44	10/14/2009	0.90	264.50
25	1/29/2010	0.44	9/16/2009	0.89	11.25
975	2/1/2010	0.44	9/16/2009	0.89	438.75
25	2/1/2010	0.44	10/9/2009	0.88	11.00
25	2/18/2010	0.44	10/19/2009	0.88	11.00
55	4/26/2010	0.44	11/4/2009	0.88	24.20
250	4/8/2010	0.44	11/4/2009	0.88	110.00
345	3/4/2010	0.44	11/4/2009	0.88	151.80
400	2/1/2010	0.44	10/9/2009	0.88	176.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
575	2/18/2010	0.44	10/9/2009	0.88	253.00
655	3/4/2010	0.44	10/19/2009	0.88	288.20
170	4/26/2010	0.44	11/2/2009	0.85	69.70
225	4/27/2010	0.44	11/2/2009	0.85	92.25
370	1/29/2010	0.45	9/15/2009	0.86	151.70
630	1/29/2010	0.45	9/15/2009	0.86	258.30
130	1/29/2010	0.45	11/2/2009	0.85	52.00
410	2/19/2010	0.45	11/2/2009	0.85	164.00
415	2/3/2010	0.45	11/2/2009	0.85	166.00
10	2/22/2010	0.45	9/14/2009	0.80	3.50
400	2/22/2010	0.45	9/14/2009	0.80	140.00
590	2/19/2010	0.45	9/14/2009	0.80	206.50
60	4/16/2010	0.45	10/28/2009	0.77	19.20
440	2/22/2010	0.45	10/28/2009	0.77	140.80
500	2/25/2010	0.45	10/28/2009	0.77	160.00
220	4/16/2010	0.45	10/28/2009	0.70	55.00
250	4/20/2010	0.45	10/28/2009	0.70	62.50
300	4/20/2010	0.45	10/28/2009	0.70	75.00
200	4/19/2010	0.46	10/28/2009	0.70	48.00
225	1/28/2010	0.47	10/16/2009	0.75	63.00
350	2/12/2010	0.47	10/16/2009	0.75	98.00
425	3/5/2010	0.47	10/16/2009	0.75	119.00
575	3/5/2010	0.47	9/10/2009	0.73	149.50
1,000	3/10/2010	0.47	10/7/2009	0.72	250.00
205	3/11/2010	0.47	10/28/2009	0.70	47.15
500	3/11/2010	0.47	10/28/2009	0.70	115.00
1,000	8/26/2009	0.48	8/27/2009	0.74	260.00
425	8/26/2009	0.48	9/10/2009	0.73	106.25
75	2/5/2010	0.48	9/3/2009	0.72	18.00
325	2/5/2010	0.48	9/4/2009	0.72	78.00
350	2/2/2010	0.48	9/3/2009	0.72	84.00
400	2/5/2010	0.48	9/4/2009	0.72	96.00
575	8/26/2009	0.48	9/3/2009	0.72	138.00
220	2/3/2010	0.49	9/4/2009	0.72	50.60
250	3/5/2010	0.49	9/8/2009	0.70	52.50
1,000	3/5/2010	0.50	9/8/2009	0.70	200.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
55	1/25/2010	0.51	9/4/2009	0.72	11.55
30	2/12/2010	0.51	9/3/2009	0.70	5.70
245	2/2/2010	0.51	9/3/2009	0.70	46.55
280	2/4/2010	0.51	9/3/2009	0.70	53.20
320	2/12/2010	0.51	9/9/2009	0.70	60.80
445	1/25/2010	0.51	9/3/2009	0.70	84.55
180	8/27/2009	0.52	9/9/2009	0.70	32.40
500	8/27/2009	0.52	9/9/2009	0.70	90.00
320	8/27/2009	0.52	9/1/2009	0.66	44.80
680	1/26/2010	0.52	9/1/2009	0.66	95.20
430	1/27/2010	0.52	9/1/2009	0.64	51.60
570	1/26/2010	0.52	9/1/2009	0.64	68.40
20	1/27/2010	0.52	8/27/2009	0.58	1.20
275	2/23/2010	0.52	8/27/2009	0.58	16.50
590	2/10/2010	0.53	8/27/2009	0.58	29.50
600	1/25/2010	0.53	8/27/2009	0.58	30.00
15	1/22/2010	0.56	8/27/2009	0.58	0.30

Table 4:

Matching of Elorian Landers's trades in Bond Laboratories, Inc. common stock[217] according to the linear programming method,[218] as performed by the online Short-Swing Profit Liability Calculator.[219]

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
500	10/13/2010	0.20	7/23/2010	0.33	65.00
375	9/27/2010	0.21	4/21/2010	0.44	86.25
400	10/12/2010	0.21	7/23/2010	0.33	48.00
1,500	9/27/2010	0.21	7/30/2010	0.30	135.00
2,000	9/27/2010	0.21	8/4/2010	0.30	180.00
875	10/12/2010	0.22	4/23/2010	0.48	227.50
765	10/12/2010	0.22	4/23/2010	0.47	191.25
675	10/5/2010	0.22	4/22/2010	0.45	155.25

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[217] *See* Chin, *supra* note 215.

[218] *See* Schrijver, *supra* note 126.

[219] *See supra* section IV.A.

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
610	10/12/2010	0.22	7/23/2010	0.33	67.10
250	10/12/2010	0.22	7/23/2010	0.33	27.50
240	10/15/2010	0.22	7/23/2010	0.33	26.40
510	10/15/2010	0.22	7/27/2010	0.30	40.80
100	10/1/2010	0.23	4/23/2010	0.48	25.00
525	10/5/2010	0.23	4/23/2010	0.48	131.25
1,275	10/6/2010	0.23	4/23/2010	0.47	306.00
575	9/22/2010	0.23	4/22/2010	0.45	126.50
500	9/29/2010	0.23	4/22/2010	0.45	110.00
350	10/1/2010	0.23	4/22/2010	0.45	77.00
2,000	10/5/2010	0.23	4/22/2010	0.45	440.00
200	10/5/2010	0.23	4/21/2010	0.44	42.00
1,000	10/6/2010	0.23	4/21/2010	0.44	210.00
825	10/6/2010	0.23	4/21/2010	0.44	173.25
460	10/6/2010	0.24	4/23/2010	0.47	105.80
1,000	7/16/2010	0.25	2/10/2010	0.52	270.00
500	9/24/2010	0.26	7/27/2010	0.30	20.00
500	5/28/2010	0.27	12/8/2009	0.75	240.00
1,000	7/15/2010	0.27	3/12/2010	0.54	270.00
500	8/27/2010	0.27	3/12/2010	0.54	135.00
1,000	7/21/2010	0.27	3/12/2010	0.54	135.00
1,500	9/16/2010	0.27	8/4/2010	0.31	60.00
500	9/16/2010	0.27	7/30/2010	0.30	15.00
990	9/22/2010	0.27	7/27/2010	0.30	29.70
1,000	7/20/2010	0.28	3/12/2010	0.54	260.00
1,500	8/25/2010	0.28	3/12/2010	0.54	390.00
500	8/26/2010	0.28	3/12/2010	0.54	130.00
500	9/3/2010	0.29	3/12/2010	0.54	125.00
1,000	8/18/2010	0.29	2/23/2010	0.50	210.00
500	8/17/2009	0.30	10/12/2009	1.03	365.00
500	8/17/2009	0.30	9/16/2009	0.89	295.00
1,000	8/19/2009	0.30	8/27/2009	0.55	250.00
1,000	8/17/2009	0.34	9/23/2009	1.24	900.00
2,000	8/17/2009	0.34	10/12/2009	1.03	1,380.00
1,000	8/17/2009	0.34	9/15/2009	0.86	520.00
1,000	8/17/2009	0.34	9/14/2009	0.80	460.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
500	8/19/2009	0.34	9/8/2009	0.70	180.00
500	5/13/2010	0.36	12/1/2009	0.85	245.00
500	5/13/2010	0.36	11/24/2009	0.81	225.00
300	5/18/2010	0.36	11/30/2009	0.81	135.00
1,000	5/18/2010	0.36	12/7/2009	0.75	390.00
500	5/19/2010	0.37	12/1/2009	0.85	240.00
700	5/19/2010	0.37	11/30/2009	0.81	308.00
50	5/19/2010	0.37	12/8/2009	0.75	19.00
250	5/19/2010	0.37	12/23/2009	0.75	95.00
50	5/19/2010	0.37	12/8/2009	0.75	19.00
400	5/21/2010	0.37	12/8/2009	0.75	152.00
750	6/14/2010	0.37	12/23/2009	0.75	285.00
750	6/14/2010	0.37	12/22/2009	0.66	217.50
1,000	8/20/2009	0.38	9/23/2009	1.35	970.00
400	5/17/2010	0.38	12/11/2009	0.73	140.00
580	8/17/2009	0.38	9/9/2009	0.70	185.60
420	8/17/2009	0.38	9/1/2009	0.66	117.60
250	5/14/2010	0.38	12/22/2009	0.66	70.00
1,000	8/17/2009	0.38	8/27/2009	0.55	170.00
1,000	8/21/2009	0.39	9/24/2009	1.51	1,120.00
1,000	8/21/2009	0.39	10/13/2009	1.02	630.00
500	8/21/2009	0.39	9/16/2009	0.96	285.00
1,000	8/21/2009	0.39	10/14/2009	0.90	510.00
500	8/21/2009	0.40	9/16/2009	0.89	245.00
500	2/26/2010	0.40	10/9/2009	0.88	240.00
500	8/21/2009	0.40	9/1/2009	0.66	130.00
750	8/24/2009	0.41	9/18/2009	0.94	397.50
250	8/24/2009	0.41	9/4/2009	0.72	77.50
1,000	2/3/2010	0.42	9/25/2009	1.45	1,030.00
1,000	2/3/2010	0.42	9/23/2009	1.33	910.00
1,000	2/3/2010	0.42	9/23/2009	1.28	860.00
1,000	2/3/2010	0.42	10/5/2009	1.25	830.00
1,000	2/3/2010	0.42	10/6/2009	1.17	750.00
100	4/14/2010	0.42	10/21/2009	0.99	57.00
250	4/13/2010	0.42	10/16/2009	0.75	82.50
150	4/14/2010	0.42	10/16/2009	0.75	49.50

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
1,000	8/24/2009	0.43	9/28/2009	1.48	1,050.00
200	8/24/2009	0.43	10/12/2009	0.99	112.00
320	4/15/2010	0.43	10/19/2009	0.88	144.00
300	4/12/2010	0.43	10/16/2009	0.75	96.00
750	8/24/2009	0.43	9/4/2009	0.72	217.50
100	2/23/2010	0.43	9/3/2009	0.72	29.00
275	2/23/2010	0.43	9/3/2009	0.70	74.25
350	4/26/2010	0.43	10/28/2009	0.70	94.50
1,000	8/25/2009	0.43	9/1/2009	0.64	210.00
50	8/24/2009	0.43	8/27/2009	0.55	6.00
600	1/29/2010	0.44	9/25/2009	1.43	594.00
400	2/1/2010	0.44	9/25/2009	1.43	396.00
400	2/1/2010	0.44	10/6/2009	1.11	268.00
600	2/18/2010	0.44	10/6/2009	1.11	402.00
500	3/4/2010	0.44	10/9/2009	0.88	220.00
250	4/8/2010	0.44	10/19/2009	0.88	110.00
225	4/27/2010	0.44	11/2/2009	0.85	92.25
375	2/1/2010	0.44	9/3/2009	0.70	97.50
500	3/4/2010	0.44	9/8/2009	0.70	130.00
225	4/26/2010	0.44	10/28/2009	0.70	58.50
225	2/1/2010	0.44	8/27/2009	0.55	24.75
650	2/19/2010	0.45	9/21/2009	0.99	351.00
280	4/16/2010	0.45	10/19/2009	0.88	120.40
500	4/27/2010	0.45	11/2/2009	0.85	200.00
500	1/29/2010	0.45	8/27/2009	0.74	145.00
415	2/3/2010	0.45	8/27/2009	0.74	120.35
85	2/22/2010	0.45	8/27/2009	0.74	24.65
215	2/19/2010	0.45	9/10/2009	0.73	60.20
135	2/19/2010	0.45	9/3/2009	0.72	36.45
400	2/22/2010	0.45	9/3/2009	0.72	108.00
365	2/22/2010	0.45	9/3/2009	0.72	98.55
350	2/25/2010	0.45	9/3/2009	0.70	87.50
300	4/20/2010	0.45	10/28/2009	0.70	75.00
250	4/20/2010	0.45	10/28/2009	0.70	62.50
80	2/25/2010	0.45	9/1/2009	0.66	16.80
630	1/29/2010	0.45	8/27/2009	0.58	81.90

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
70	2/25/2010	0.45	8/27/2009	0.58	9.10
200	4/19/2010	0.46	10/21/2009	0.99	106.00
650	4/27/2010	0.46	11/4/2009	0.88	273.00
350	4/27/2010	0.46	11/2/2009	0.85	136.50
350	2/12/2010	0.47	9/25/2009	1.40	325.50
500	3/11/2010	0.47	9/25/2009	1.40	465.00
1,000	3/10/2010	0.47	10/1/2009	1.25	780.00
1,000	3/11/2010	0.47	9/22/2009	0.99	520.00
800	3/5/2010	0.47	10/7/2009	0.72	200.00
200	3/5/2010	0.47	9/9/2009	0.70	46.00
225	1/28/2010	0.47	8/27/2009	0.55	18.00
850	8/26/2009	0.48	9/29/2009	1.35	739.50
150	8/26/2009	0.48	10/12/2009	1.06	87.00
500	8/26/2009	0.48	10/12/2009	1.06	290.00
350	2/2/2010	0.48	10/12/2009	1.06	203.00
350	3/12/2010	0.48	9/21/2009	0.99	178.50
500	8/26/2009	0.48	9/16/2009	0.96	240.00
350	4/7/2010	0.48	11/4/2009	0.88	140.00
275	4/28/2010	0.48	11/2/2009	0.85	101.75
275	4/22/2010	0.48	10/28/2009	0.77	79.75
275	4/23/2010	0.48	10/28/2009	0.77	79.75
300	4/9/2010	0.48	10/16/2009	0.75	81.00
200	4/1/2010	0.48	10/7/2009	0.72	48.00
250	4/23/2010	0.48	10/28/2009	0.70	55.00
400	2/5/2010	0.48	8/27/2009	0.58	40.00
400	2/5/2010	0.48	8/27/2009	0.58	40.00
250	4/16/2010	0.49	10/21/2009	0.99	125.00
225	4/21/2010	0.49	10/28/2009	0.77	63.00
225	4/22/2010	0.49	10/28/2009	0.77	63.00
220	2/3/2010	0.49	9/9/2009	0.70	46.20
250	3/5/2010	0.49	9/8/2009	0.70	52.50
250	4/16/2010	0.49	10/28/2009	0.70	52.50
50	4/21/2010	0.49	10/28/2009	0.70	10.50
150	3/5/2010	0.50	9/25/2009	1.40	135.00
150	3/26/2010	0.50	9/29/2009	1.35	127.50
1,000	4/1/2010	0.50	10/6/2009	1.12	620.00

Shares	Purchase Date	Cost ($)	Sale Date	Proceeds ($)	Profit ($)
450	4/1/2010	0.50	10/21/2009	0.99	220.50
500	4/5/2010	0.50	10/12/2009	0.99	245.00
300	4/5/2010	0.50	10/12/2009	0.99	147.00
150	4/1/2010	0.50	10/19/2009	0.88	57.00
785	3/5/2010	0.50	9/10/2009	0.73	180.55