

ACCURATE CALCULATION OF SHORT-SWING PROFITS
UNDER SECTION 16(b) OF THE SECURITIES EXCHANGE ACT
OF 1934

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I. INTRODUCTION

Section 16(b) of the Securities Exchange Act of 1934¹ requires ten percent owners, directors and officers of a company to disgorge "any profit realized . . . from any purchase and sale, or any sale and purchase, of any equity security" of the company within a six-month period. If this indirect prohibition against the taking by insiders of short-swing profits is, as many have argued, merely a "trap for the unwary,"² then its

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¹Section 16(b) states in relevant part:

For the purpose of preventing the unfair use of information which may have been obtained by such 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) within any period of less than six months, unless such security 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 purchased or of not repurchasing the security sold for a period exceeding six months.

15 U.S.C. § 78p(b) (1995).

²Barry W. Lee & Andrew L. Dudnick, *Directors' and Officers' Liability Insurance: Policy Exclusions*, in *DIRECTORS' AND OFFICERS' LIABILITY INSURANCE 1988*, at 487, 499 (PLI Com. Law & Practice Course Handbook Series No. A4-4223, 1988). See also Dan L. Goldwasser, *Scope of Coverage of Directors' and Officers' Liability Policies*, in *DIRECTORS' AND OFFICERS' LIABILITY INSURANCE AND SELF INSURANCE 173*, 188 (PLI Com. Law & Practice Course Handbook Series No. A4-4144, 1986) ("[L]iabilities can easily be avoided by appropriate corporate planning . . ."); RICHARD W. JENNINGS ET AL., *SECURITIES REGULATION: CASES AND MATERIALS 1364* (7th ed. 1992) ("[A]ny moderately bright manipulator should be able in many cases to string out his activities over a period of more than six months and thus escape any penalty under [§ 16(b)]."); PETER J. ROMEO & ALAN L. DYE, *SECTION 16 TREATISE AND REPORTING GUIDE § 8.01[3][b]*, at 8-8 (1994) ("Congress recognized from the outset that Section 16(b) might impose liability on some innocent insiders whose violations were wholly inadvertent."); Marleen A. O'Connor, *Toward a More Efficient Deterrence of Insider Trading: The Repeal of Section 16(b)*, 58 *FORDHAM L. REV.* 309, 373 (1989) ("Section 16(b) . . . does not provide much deterrence because its arbitrary restrictions are easy to evade.").

continuing prominence in securities litigation is troubling.³ Despite computerized monitoring of insiders' transactions⁴ and recent streamlining of Securities and Exchange Commission interpretations,⁵ section 16(b) compliance remains a complex problem for corporate counsel, especially given the continuing popularity of derivative⁶ and convertible debt⁷ securities in executive compensation plans.

The purpose of this article is to remove one fundamental impediment to section 16(b) compliance efforts: the absence of a general method for accurately calculating short-swing profits.⁸ As sections II and III of this article show, the "lowest-in, highest-out" algorithm, widely cited in casebooks and case law, originated from an erroneous 1943 analysis that cannot be defended in today's complex, computerized environment. Sections IV and V present a correct method for short-swing profit calculation. This method is based on the well-known transportation algorithm which is widely taught in business and public administration schools and is available in public domain software.

³Section 16(b) was the eighth most frequent cause of action in reported securities cases between 1987 and 1992. Merritt B. Fox, *Insider Trading Deterrence Versus Managerial Incentives: A Unified Theory of Section 16(b)*, 92 MICH. L. REV. 2088, 2091 (1994).

⁴See Peter G. Samuels, *Liability for Short-Swing Profits and Reporting Obligations Under Section 16 of the Securities and Exchange Act of 1934*, in SECURITIES FILINGS 1995, at 481, 511 (PLI Com. Law & Practice Course Handbook Series No. A4-4493, 1995).

⁵The most recent revisions to the SEC's Rule 16, which became effective August 15, 1996, recognized and sought to remove these traps by streamlining the application of § 16(b) to complex transaction patterns. "The proposals were designed to facilitate the operation of employee benefit plans; broaden exemptions from section 16(b) short-swing profit recovery where consistent with statutory purposes; and codify several staff interpretive positions." 61 Fed. Reg. 30,376 (1996) (to be codified at 17 C.F.R. § 240.16(a)-(b)). A detailed discussion of the Rule 16 revisions is beyond the scope of this article.

⁶See Donald W. Glazer & Keith F. Higgins, *Section 16 Rules: Seven Easy Fixes to the New Section 16 Rules*, INSIGHTS, June 1992, at 8, 17 (illustrating the complexity of reporting derivative securities); John F. Olson et al., *The New Section 16 Rules: Background, Compliance and Disclosure*, in DIRECTORS' AND OFFICERS' LIABILITY: A SATELLITE PROGRAM 143, 223 (PLI Com. Law & Practice Course Handbook Series No. A4-4383, 1992) ("One of the most difficult issues under section 16 is the treatment of options and other derivative securities . . .").

⁷See Daniel B. Bogart, Note, *Mismatching Convertible Debentures and Common Stock Under Section 16(b)*, 1985 DUKE L.J. 1057, 1069 (1985) (noting that transactions involving convertible debentures often provide no opportunity for abuse of inside information).

⁸The extensive economic literature on § 16(b) is part of a wider study of management incentive structure in agency theory. For a review of this literature, see Fox, *supra* note 3, at 2097-107. The treatment in leading casebooks of short-swing profit calculation under § 16(b) is reviewed in section III.

II. AN ACCURATE INTERPRETATION OF SECTION 16(b)

This short-swing profit calculation error arises from a common misreading of *Smolowe v. Delendo Corp.*,⁹ the leading case regarding the construction of section 16(b) liability. In *Smolowe*, the Second Circuit rejected the defendants' contention that the preamble of section 16(b) limited liability to profits created by the unfair use of inside information.¹⁰ Instead, the court articulated a doctrine of strict liability for short-swing profits.¹¹ Noting the statute's "failure to specify a method of computation"¹² and the lack of any express limitation on the terms "purchase" and "sale," the court concluded that section 16(b) "points to an arbitrary matching to achieve the showing of a maximum profit."¹³ After a discussion and rejection of alternate methods of profit calculation, the court held:

The statute is broadly remedial. Recovery runs not to the stockholder, but to the corporation. We must suppose that the statute was intended to be thoroughgoing, *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.¹⁴

In the next sentence, the *Smolowe* court suggested a specific algorithm which could match transactions to produce the maximum possible profit: "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."¹⁵ While this "lowest-in, highest-out" algorithm¹⁶ did produce the maximum possible profit in *Smolowe*,¹⁷ it is easy to construct fact patterns for which the algorithm

⁹136 F.2d 231 (2d Cir.), *cert. denied*, 320 U.S. 751 (1943).

¹⁰*Id.* at 235.

¹¹*Id.* at 235-36.

¹²*Id.* at 237.

¹³*Smolowe*, 136 F.2d at 237.

¹⁴*Id.* at 239 (citations omitted) (emphasis added).

¹⁵*Id.*

¹⁶This "lowest-in, highest-out" algorithm successively matches, share for share, purchases at the lowest prices with sales at the highest prices, until no share purchased can be matched with a share sold at a higher price. For an illustration of this algorithm, see *infra* note 17 (providing details of damages calculation in *Smolowe*).

¹⁷Defendant I.J. Seskis purchased 14,920 shares on January 19, 1940 for \$24,245, and 584 shares on February 28, 1940 for \$905.20, for a total of \$25,150.20. See *Smolowe v.*

fails to recover the maximum possible profit.¹⁸ Thus, Arnold Jacobs, in

Delendo Corp., 46 F. Supp. 758, 762 (S.D.N.Y. 1942). He sold 15,800 shares to co-defendant Henry C. Kaplan on April 4, 1940 for \$35,550. *Id.*

In addition to his purchase from Seskis, Kaplan conducted the following transactions during the period in question:

Purchases

| | | |
|-------------------|-----------------|---------------|
| December 1, 1939 | 5,000 shares at | \$ 7,750.00 |
| February 5, 1940 | 200 " " | 285.00 |
| February 20, 1940 | 200 " " | 335.00 |
| March 25, 1940 | 400 " " | 924.00 |
| March 27, 1940 | 1,000 " " | 2,560.00 |
| April 11, 1940 | <u>300</u> " " | <u>768.00</u> |
| | 7,100 | \$12,622.00 |

Sales

| | | |
|-------------------|------------------|-----------------|
| February 15, 1940 | 200 shares at | \$ 308.91 |
| April 19, 1940 | 500 " " | 750.00 |
| April 22, 1940 | 500 " " | 1,312.50 |
| May 7, 1940 | 200 " " | 525.00 |
| May 7, 1940 | 800 " " | 2,000.00 |
| May 10, 1940 | 500 " " | 1,040.20 |
| May 11, 1940 | 200 " " | 250.00 |
| May 13, 1940 | 2,000 " " | 7,779.03 |
| May 14, 1940 | <u>1,000</u> " " | <u>3,889.52</u> |
| | 5,900 | \$17,855.16 |

Id.

In a decision affirmed by the Second Circuit, the district court matched all of Seskis's transactions for a profit of \$9,733.80. *Id.* at 766. Kaplan's transactions were matched by successively pairing the lowest per-share purchase prices with the highest per-share sale prices, as shown below, yielding a profit of \$9,161.05.

| Date | Bought | | Sold | | Profit |
|---------|------------|---------------|---------|---------------|---------------|
| | No. Shares | Amount | Date | Amount | |
| 2/5/40 | 200 | \$ 285.00 | 5/14/40 | \$ 777.90 | \$ 492.90 |
| 12/1/39 | 800 | 1,240.00 | " | 3,111.62 | 1,871.62 |
| " | 2,000 | 3,100.00 | 5/13/40 | 7,779.03 | 4,679.03 |
| " | 500 | 775.00 | 4/22/40 | 1,312.50 | 537.50 |
| " | 200 | 310.00 | 5/7/40 | 525.00 | 215.00 |
| " | 800 | 1,240.00 | " | 2,000.00 | 760.00 |
| " | 500 | 775.00 | 4/16/40 | 1,125.00 | 350.00 |
| " | 200 | 310.00 | " | 450.00 | 140.00 |
| 2/20/40 | <u>200</u> | <u>335.00</u> | " | <u>450.00</u> | <u>115.00</u> |
| | 5,400 | \$8,370.00 | | \$17,531.05 | \$9,161.05 |

Id. (noting in the supplemental opinion that only paired transactions resulting in profit should be included in the calculation).

¹⁸For example, when the transactions take place over more than six months, or some

his leading treatise article on section 16, correctly concluded that "the lowest price in-highest price out rule is not the real holding of *Smolowe*."¹⁹

In *Gratz v. Claughton*,²⁰ a Second Circuit case of the same period, the court emphatically underlined *Smolowe*'s "maximum possible profit" reading of section 16(b). In *Gratz*, Judge Learned Hand affirmed the judgment of a master who interpreted *Smolowe* to require the matching of transactions "in such a way as to increase [profits] to the greatest possible amount."²¹ Maximum liability was appropriate, according to Hand, because "the statute makes the fiduciary a constructive trustee for any profits he may make."²² Noting also that any uncertainty in the short-swing profit calculation arose from the defendant's actions during the six-month trading period, Hand concluded that all uncertainty must be resolved against the defendant and that "the upper limit" should be taken as the amount of damages.²³

Because *Gratz* is still good law, *Smolowe* should be read as holding that in short-swing profit calculations under section 16(b), transactions should be matched to produce the maximum possible profit.

III. THE CONFUSED LEGACY OF *SMOLOWE*

The "maximum possible profit" reading of *Smolowe* has been widely followed.²⁴ Nevertheless, many courts have also continued to cite *Smolowe* for the incorrect proposition that short-swing profits should be calculated using the "lowest-in, highest-out" algorithm.²⁵

trades are immunized by the statute of limitations, the "lowest-in, highest-out" algorithm may not result in the correct matching of purchases and sales. See Arnold S. Jacobs, *An Analysis of Section 16 of the Securities Exchange Act of 1934*, 32 N.Y.L. SCH. L. REV. 209, 532 (1987). The method presented in this article will be applied to a fact pattern taking place over eight months, in which the "lowest-in, highest-out" algorithm fails. See *infra* part V.

¹⁹Jacobs, *supra* note 18, at 531.

²⁰187 F.2d 46 (2d Cir.), *cert. denied*, 341 U.S. 920 (1951).

²¹*Id.* at 51.

²²*Id.*

²³*Id.* at 51-52.

²⁴See, e.g., *Allis-Chalmers Mfg. Co. v. Gulf & W. Indus., Inc.*, 527 F.2d 335, 355 (7th Cir. 1975) (affirming *Smolowe* because no one has "suggest[ed] another more reasonable rule"), *cert. denied*, 423 U.S. 1078 (1976); *Feder v. Martin Marietta Corp.*, 406 F.2d 260, 269 (2d Cir. 1969) (citing *Smolowe* as the "well-established rule" for matching purchases and sales to maximize profits), *cert. denied*, 396 U.S. 1036 (1970); *Western Auto Supply Co. v. Gamble-Skogmo, Inc.*, 348 F.2d 736, 743 (8th Cir. 1965) (recognizing *Smolowe* as the origin of the current matching method), *cert. denied*, 382 U.S. 987 (1966); *Lewis v. Riklis*, 446 F. Supp. 582, 584 (S.D.N.Y.) (same), *aff'd per curiam*, 575 F.2d 416 (2d Cir. 1978).

²⁵See, e.g., *Gund v. First Fla. Banks, Inc.*, 726 F.2d 682, 688 (11th Cir. 1984) ("Under

Similarly, most leading casebooks that offer a method for calculating short-swing profits teach *Smolowe's* erroneous "lowest-in, highest out" algorithm.²⁶ Other casebooks suggest the *Smolowe/Gratz* "maximum possible profit" rule, but provide neither a general method for calculating short-swing profits under the rule nor examples demonstrating the potential inaccuracy of the "lowest-in, highest-out" algorithm.²⁷

Even Jacobs's treatise article, which provided the most thorough argument for the "maximum possible profit" rule, did not supply an algorithm for calculating short-swing profits. In his exposition, Jacobs presented two examples of fact patterns for which the "lowest-in, highest-out" algorithm failed to produce the maximum profit.²⁸ For each example, he first matched transactions using the "lowest-in, highest-out" approach and then presented an alternative matching calculation that achieved a higher profit.²⁹ He asserted in each case that the latter calculation was performed using the maximum profit approach, but made no attempt to demonstrate that the result attained was in fact the maximum profit possible.³⁰ Furthermore, he did not suggest any general procedure that could be used either to calculate the maximum possible profit or to duplicate his results.³¹

In the forty-four years since *Smolowe*, the literature on section 16(b) has failed to describe a general procedure for accurately calculating short-swing profits. While the use of an incorrect algorithm may have

the *Smolowe* rule, the highest sales price is matched with the lowest purchase price in any given six-month period in order to calculate the recoverable profit."); *Whittaker v. Whittaker Corp.*, 639 F.2d 516, 530-31 (9th Cir.) (holding that *Smolowe's* "lowest purchase price, highest sale price" method is the "nearly unanimous" computation method), *cert. denied*, 454 U.S. 1031 (1981); *Chemical Fund, Inc. v. Xerox Corp.*, 377 F.2d 107, 109 & n.3 (2d Cir. 1967) (citing *Smolowe* for the "lowest-in, highest-out" formula); *Western Auto Supply*, 348 F.2d at 742-43 (same); *Adler v. Klawans*, 267 F.2d 840, 847 (2d Cir. 1959) (same); *Morales v. Lukens, Inc.*, 593 F. Supp. 1209, 1213 (S.D.N.Y. 1984) (same).

²⁶See, e.g., WILLIAM L. CARY & MELVIN ARON EISENBERG, *CASES AND MATERIALS ON CORPORATIONS* 961-62 (7th ed. 1995) (using practice problems to exhibit the "lowest-in, highest-out" calculation method); JESSE H. CHOPER ET AL., *CASES AND MATERIALS ON CORPORATIONS* 515-16 (3d ed. 1989) (same); ROBERT W. HAMILTON, *CASES AND MATERIALS ON CORPORATIONS* 1055-56 (5th ed. 1994) (same). Cary and Eisenberg also err in attributing the "lowest-in, highest-out" rule to both *Smolowe* and *Gratz*. CARY & EISENBERG, *supra*, at 961-62.

²⁷See ALFRED F. CONARD, *ENTERPRISE ORGANIZATION* 1004 & n.2 (3d ed. 1982) ("[T]he law has been construed to apply not to the net effect of all transactions, but to the excess of any sale price over any purchase price.") (citing *Gratz v. Claughton*, 187 F.2d 46 (2d Cir. 1951)).

²⁸See Jacobs, *supra* note 18, at 532-34.

²⁹See *id.*

³⁰See *id.*

³¹See *id.*

been harmless in litigated cases to date,³² given the high stakes and complex transactions involved in modern section 16(b) enforcement, it is likely that the lack of an accurate algorithm has frequently created unnecessary confusion for corporate counsel, plaintiffs' attorneys, and Securities and Exchange Commission staff.³³ The remainder of this article will fill this gap by presenting such an algorithm.

IV. THE TRANSPORTATION ALGORITHM

The transportation algorithm, a well-known problem-solving technique from management science, should be employed to create an accurate calculation of short-swing profits. The transportation algorithm is a standard topic in modern business schools and public administration schools, and most MBA and MPA students today are taught to solve transportation problems with pencil and paper. Thus, the algorithm could reasonably be introduced in the law school curriculum, possibly in advanced courses on securities regulation. Alternatively, public domain software packages are currently available which implement the transportation algorithm and produce an optimal solution.³⁴

The details of the transportation algorithm require a chapter of exposition in most management science texts³⁵ that reach beyond the scope of this article. This section will simply define the transportation problem and its tableau representation. Section V will show how a short-

³²See *supra* notes 24-25 (listing cases where the "lowest-in, highest-out" rule worked effectively).

³³Section 16(a) of the Securities Exchange Act requires insiders to make monthly filings of any purchases or sales of their companies' equity securities. 15 U.S.C. § 78p(a) (1994). Section 16(b)'s scrutiny of insiders' transactions has "spawned a small industry of plaintiffs' lawyers. . . . [and] probably plays a larger day-to-day role in constraining the behavior of America's corporate executives than rule 10b-5's headline-grabbing, judge-made strictures against insider trading." Fox, *supra* note 3, at 2091-92.

To the extent that insiders must make rational decisions based on the calculation of liability under § 16(b), the unavailability of an accurate method for analyzing complex transaction patterns creates uncertainty, and may result in increased liability and litigation.

As Professor Fox has noted, "The number of reported cases in fact probably understates the impact of § 16(b) on the behavior of insiders because, over a wide range of possible situations, its applicability can be determined mechanically." Fox, *supra* note 3, at 2091 n.8. By presenting a general method for short-swing profit calculation, this article expands the range of possible situations for which § 16(b) liability can be determined with certainty.

³⁴One software package is available by sending electronic mail to "ftp-request@theory.stanford.edu" with the phrase "send csmin.tar" as the subject.

³⁵See, e.g., DAVID G. DANNENBRING & MARTIN K. STARR, *MANAGEMENT SCIENCE: AN INTRODUCTION* 309-56 (1981) (describing the transportation method algorithm).

swing profit calculation can be represented as a transportation problem and solved using the standard transportation algorithm.

Consider the problem of moving commodities from some set of sources (e.g., factories) to some set of destinations (e.g., warehouses). The following data are available: the quantity produced at each source, the quantity demanded at each destination, and the unit cost of transport from each source to each destination. The transportation problem consists of determining the quantity to be shipped from each source to each destination so as to minimize the total cost.

For example, consider an oven manufacturer who will have 175 ovens available for shipment next week: 75 produced at Atlanta, 60 at Boston, and 40 at Chicago. These ovens have been allocated to four warehouses as follows: 30 to Kansas City, 65 to Los Angeles, 55 to Memphis, and 25 to New Orleans. The cost of shipping an oven from each source to each destination is as shown in the table below.³⁶

| Factory location | Warehouse Location | | | |
|------------------|--------------------|-------------|---------|-------------|
| | Kansas City | Los Angeles | Memphis | New Orleans |
| Atlanta | 11 | 22 | 6 | 5 |
| Boston | 16 | 31 | 14 | 15 |
| Chicago | 5 | 21 | 4 | 9 |

Next, the transportation problem data is arranged for solution in a tableau representation with each row corresponding to a source and each column corresponding to a destination. The quantities produced at each source appear in the column furthest to the right, and the quantities demanded by each destination appear in the bottom row. The body of the tableau is made up of cells. Each cell contains the unit transportation cost from a source to a destination in its upper right corner and any quantity to be shipped along that route in its remaining area.

³⁶This example is taken from DANNENBRING & STARR for the convenience of readers who wish to follow the details of the transportation algorithm. *Id.* at 310-11.

| Factory Location | Warehouse Location | | | | Supply |
|------------------|--------------------|-------------|---------|-------------|--------|
| | Kansas City | Los Angeles | Memphis | New Orleans | |
| Atlanta | 11 | 22 | 6 | 5 | 75 |
| | | 50 | | 25 | |
| Boston | 16 | 31 | 14 | 15 | 60 |
| | | 15 | 45 | | |
| Chicago | 5 | 21 | 4 | 9 | 40 |
| | 30 | | 10 | | |
| Demand | 30 | 65 | 55 | 25 | |

The transportation algorithm functions within this tableau by successively reallocating quantities among the cells in order to reduce the overall transportation cost. The quantities in the tableau shown above represent the final output of the transportation algorithm for the oven example, i.e., the minimum-cost shipment plan.³⁷ Reading from the tableau, we find that demands will be met and transportation costs will be minimized if the Atlanta factory ships 50 ovens to Los Angeles and 25 ovens to New Orleans; the Boston factory ships 15 ovens to Los Angeles and 45 ovens to Memphis; and the Chicago factory ships 30 ovens to Kansas City and 10 ovens to Memphis.

The transportation problem arises in a wide variety of settings, including location analysis, media scheduling for advertising, traffic routing, and the assignment of jobs to workers.³⁸ As a previous law review article observed, a special case of this last application is the assignment of judges to cases.³⁹

³⁷See *id.* at 331-32.

³⁸*Id.* at 346.

³⁹Stuart S. Nagel & Miriam K. Mills, *Using Management Science to Assign Judges to Casetypes*, 40 U. MIAMI L. REV. 1317 (1986).

V. TRANSFORMING SHORT-SWING PROFIT CALCULATION
INTO A TRANSPORTATION PROBLEM

This section shows how a given short-swing profit calculation can be transformed into a transportation problem, so that the matching of transactions produced in the transportation algorithm's final tableau results in the maximum total profit.

Given a fact pattern consisting of a sequence of equity securities transactions, the first step is to identify purchases, sales,⁴⁰ and all pairs of matching transactions that would result in a recoverable profit on a per-share basis. The second step, if necessary, is to introduce a "dummy purchase" at a high price or a "dummy sale" at a low price which equalizes the total number of shares purchased and sold, but leaves the recoverable profit unaffected. The corresponding transportation problem is created by reinterpreting each purchase as a source, each sale as a destination, and the unit cost of transportation as the negative value of the recoverable profit per share.⁴¹

For example, consider the following pattern of trades:

| Date | Shares Purchased | Purchase Price Per Share | Shares Sold | Sale Price Per Share |
|-------|------------------|--------------------------|-------------|----------------------|
| 1/1 | 1000 | \$9 | | |
| 2/15 | | | 400 | \$8 |
| 3/1 | 2000 | \$8 | | |
| 5/1 | 800 | \$7 | | |
| 6/15 | | | 1200 | \$10 |
| 9/1 | 1000 | \$6 | | |
| 10/15 | | | 2400 | \$9 |

⁴⁰The terms "purchase" and "sale" are intended here to include all non-exempt transactions that are interpreted by the SEC as equivalent to purchases and sales of equity securities for Rule 16-b purposes. See Securities and Exchange Commission Rule 16-b, 17 C.F.R. § 240.16 (1996).

⁴¹The negative value is taken because whereas the objective of the calculation is to maximize profit, the objective of the transportation problem is to minimize cost.

To determine the maximum possible profit, the corresponding transportation problem is formulated as follows. There are four purchases and three sales in the trading pattern; thus, the transportation problem will have four sources and three destinations. The quantities supplied at the sources are 1000, 2000, 800, and 1000, respectively, which correspond to the four purchases. Similarly, the quantities demanded at the three destinations are 400, 1200, and 2400, respectively. Since a total of 4800 shares have been purchased and 4000 shares have been sold, a dummy sale of 800 shares at \$0/share on 1/1⁴² is added to the fact pattern. Consequently, a fourth destination is introduced with a demand of 800.

The cost imputed to moving each unit from a source to a destination is calculated as the negative of the difference between the purchase price per share and the sale price per share, if the corresponding transactions can be paired under section 16(b). All remaining pairs of purchases and sales are assigned a cost of zero.

Applying the six-month rule to this example, the 1/1 purchase can be paired with the 6/15 sale, the 3/1 purchase can be paired with the 6/15 sale, the 5/1 purchase can be paired with the 2/15, 6/15 and 10/15 sales, and the 9/1 purchase can be paired with the 6/15 and 10/15 sales. The recoverable profit per share for each of these possible matchings is indicated in the table below:

| Purchase Date | Sale Date | | | |
|---------------|-------------|------|------|-------|
| | 1/1 (dummy) | 2/15 | 6/15 | 10/15 |
| 1/1 | 0 | 0 | \$1 | 0 |
| 3/1 | 0 | 0 | \$2 | 0 |
| 5/1 | 0 | \$1 | \$3 | \$2 |
| 9/1 | 0 | 0 | \$4 | \$3 |

The data is now ready to be converted into tableau form for the transportation algorithm. The tableau, including the final output from the transportation algorithm, is shown below:

⁴²Since no profit will be recoverable in a matching with the dummy sale, the date of the transaction is immaterial.

| Source | Destination | | | | Quantity Supplied |
|-------------------|----------------|------|------|-------|-------------------|
| | 1/1 (dummy) | 2/15 | 6/15 | 10/15 | |
| 1/1 | 0 | 0 | -1 | 0 | 1000 |
| | | 400 | | 600 | |
| 3/1 | 0 | 0 | -2 | 0 | 2000 |
| | 800 | 0 | 1200 | 0 | |
| 5/1 | 0 | -1 | -3 | -2 | 800 |
| | 0 | 0 | 0 | 800 | |
| 9/1 | 0 | 0 | -4 | -3 | 1000 |
| | 0 | 0 | 0 | 1000 | |
| Quantity Demanded | 800 | 400 | 1200 | 2400 | |

Reading from the tableau and omitting allocations to cells with zero recoverable profit, the maximum possible profit may be calculated by matching the indicated transactions as follows:

| Bought | | | Sold | | |
|-------------|-------------------|-----------------|-------------|-----------------|-----------------|
| <u>Date</u> | <u>No. Shares</u> | <u>Amount</u> | <u>Date</u> | <u>Amount</u> | <u>Profit</u> |
| 3/1 | 1200 | \$ 9,600.00 | 6/15 | \$12,000.00 | \$2,400.00 |
| 5/1 | 800 | 5,600.00 | 10/15 | 7,200.00 | 1,600.00 |
| 9/1 | <u>1000</u> | <u>6,000.00</u> | 10/15 | <u>9,000.00</u> | <u>3,000.00</u> |
| | 3000 | \$21,200.00 | | \$28,200.00 | \$7,000.00 |

As a result, the section 16(b) liability for this sequence of transactions should be \$7,000 on trades involving a total of 3000 of the 4800 shares. The transportation algorithm ensures that the profit produced is in fact a maximum.

It becomes immediately apparent that using the "lowest-in, highest-out" algorithm does not yield the maximum possible profit. The algorithm would initially require that the purchase of 1000 shares at \$6/share on 9/1 be matched with the sale of 1000 shares at \$10/share on 6/15 for a profit of \$4,000. Next, the purchase of 800 shares at \$7/share on 5/1 would be matched with the sale of the remaining 200 shares at \$10/share on 6/15 and the sale of 600 shares at \$9/share on 10/15 for a total profit of \$1,800. No more matching of purchases is possible, because the remaining sales are either at too low a price (\$8/share on 2/15) or occur more than six months after the remaining purchases (\$9/share on 10/15). Thus, the "lowest-in, highest-out" algorithm yields a profit of \$5,800, or \$1,200 less than the profit obtained using the transportation algorithm.

VI. CONCLUSION

To ensure the accurate calculation of short-swing profits under section 16(b), the method described in this article, not the "lowest-in, highest-out" algorithm, should be used. In many factual scenarios the "lowest-in, highest-out" algorithm does not produce the maximum possible profit required by the holding of *Smolowe*. Moreover, because the transportation algorithm has been proven to produce the lowest-cost solution to the transportation problem, the new calculation method can provide certainty for even the most complex transaction sequences.

As securities transactions become increasingly automated, a reliable, accurate procedure for calculating short-swing profits warrants a place not only in the literature, but also in the law school curriculum on securities regulation. The transportation algorithm's widespread inclusion in other professional school curricula suggests that it could be added comfortably to an advanced course on securities regulation. More generally, this article further illustrates the robustness of management science techniques in the analysis of legal rules and public institutions — already recognized by schools of public administration — and supports the growing case for including courses in management science in the law school curriculum.

