UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

NATCHITOCHES PARISH HOSPITAL SERVICE DISTRICT and J.M. SMITH CORP. d/b/a SMITH DRUG COMPANY, on behalf of themselves and all others similarly situated, Plaintiffs, vs. TYCO INTERNATIONAL, ltd.; and TYCO INTERNATIONAL (U.S.), INC.; TYCO HEALTHCARE GROUP, L.P. THE KENDALL HEALTHCARE PRODUCTS COMPANY, Defendants.	)	Civil Action No. 05-12024 EXPERT REPORT OF DR. HAL SINGER

Introduction and Summary of Results

INTRODUCTION AND SUMMARY OF RESULTS

1. I have been asked by counsel for plaintiffs and the class to estimate the overcharge damages paid by direct purchasers of sharps containers from Tyco from October 4, 2001 to the present ("Class Period") as a result of Tyco's alleged anticompetitive conduct. The methodology that I use to estimate damages presumes that the anticompetitive harm caused by Tyco manifests itself in terms of higher seller concentration ratios relative to the but-for world—that is, that Tyco's alleged conduct prevented rivals from capturing larger market shares. Thus, the primary focus of my inquiry is to estimate the but-for market shares of Tyco's rivals and then use a model that relates that change in rivals' market shares to a change in prices.

2. Plaintiffs allege that Tyco entered into contracts with both group purchasing organizations (GPOs) and hospitals that foreclosed sharps container rivals from a significant share of the market.[1] Specifically, plaintiffs allege (1) that Tyco's sole-source contracts with GPOs have foreclosed its sharps container rivals from accessing GPO brokerage services,[2] which are the most efficient method of selling medical products such as sharps containers; and (2) that

1. Class Action Complaint, Natchitoches Parish Hosp. Serv. Dist., v. Tyco Int'l, Ltd. et al. (D. Mass. 2005) (Case 1:05-cv-12024-PBS) ¶¶ 41, 42.

2. [redacted]

Tyco's contracts with the hospitals, which are often but not always brokered through GPOs, penalize hospitals that do not commit to making a certain percentage of their sharps container purchases from Tyco ("commitment contracts").[3] Plaintiffs allege that these practices have foreclosed Tyco's rivals from a significant share of the relevant market and the most efficient distribution channel to access that market, which they allege has had the effect of increasing the market prices of sharps containers relative to some but-for world. For purposes of this report on damages, I assume that Tyco's practices have caused a decrease in rivals' market share or an increase in rivals' costs or both. As discussed below, I have not had sufficient time with accurate cost data to perform the raising-rivals'-cost analysis.

3. My estimate of damages depends on the nature of Tyco's conduct. Damages associated with foreclosure due to Tyco's commitment contracts with hospitals are estimated at approximately $183 million. Damages associated with foreclosure due to Tyco's sole-source contracts with GPOs are estimated at approximately $123 million. Because there is overlap in the foreclosed segments associated with each type of conduct, damages from the two types of foreclosure are not strictly additive. In my aggregate damages estimate, which encompasses both possible forms of foreclosure, I calculate that, but for Tyco's conduct, sharps container prices would have been between 17 percent and 31 percent less than extant prices during the Class Period, depending on the year in question. These pricing estimates yield an aggregate damages estimate of approximately $191 million for the Class Period.

3. [redacted]

4. My factual inquiry is continuing, and I reserve the right to modify or supplement this report as further information warrants.

5. I submitted my qualifications in my initial class certification report. An updated curriculum vitae is provided in Appendix 1, which contains (1) a list of cases in which I have testified at trial or depositions in the last four years, and (2) a list of publications I have authored in the last ten years. Criterion Economics is being compensated at a rate of $495 per hour for my work in this matter.

I. ANALYSIS OF THE SHARPS CONTAINERS INDUSTRY

6. In this section, I provide a brief background on the sharps containers industry. I discuss the relevant industry participants, and I provide a simple taxonomy of sharps containers. I analyze the extent to which sharps containers differ within and across manufacturers. I conclude that the differences in container types within a given manufacturer are small. I also conclude that, for a given type of container, the differences across manufacturers are not economically significant.

A. Industry Background

7. Sharps containers consist of all containers used by clinicians to dispose of sharps devices.[4] A sharps device is any device with a sharp edge that can pierce the skin, including needles, syringes, tubing with attached needles, scalpels, blades, razors, and glass slides.[5] Sharps containers are ubiquitous in the healthcare industry.[6] A sharps container is designed to manage biohazardous waste and prevent accidental needlestick or other sharps injuries.[7]

4. FROST AND SULLIVAN MARKET REPORT A455-54: U.S. SAFETY DEVICES AND CONTAINERS MARKETS, 2003 TYN0398449-538, at 524[hereinafter FROST & SULLIVAN].
5. *Id.*
6. FY 2005 Sharps Disposal Marketing Plan, TYN0080225-250 at 230 ("Sharps containers are used in every healthcare setting.").
7. FROST & SULLIVAN, *supra* note 4, at 398524.

8. The demand for sharps containers is driven in part from the high cost of needlestick injuries. According to Frost and Sullivan, a single needlestick injury costs healthcare providers between $540 and $3,800.[8] Federal and state regulation requires hospitals to use sharps containers that meet certain requirements. In November 2000, Congress passed the Needlestick Safety and Prevention Act.[9] In January 2001, the Occupational Safety and Health Administration (OSHA) issued new regulations, compliance directives, and guidance to avoid needlestick injuries.[10] In addition to OSHA standards, there are 25 states whose occupational safety and health standards are at least as stringent as OSHA's.[11]

B. Significant Participants

9. In this section, I provide a brief background on the significant participants in the sharps container industry. I review manufacturers of both disposable and reusable containers. Reusable container manufacturers provide a service—namely, collection of filled containers, processing, and sterilization—alongside the container, whereas disposable makers generally sell a product without accompanying service.

10. Kendall is the largest producer of sharps containers in the United States. Kendall is a subsidiary of Covidien, formerly known as Tyco Healthcare.[12] Covidien's market capitalization as of November 23, 2007 was approximately $19.8 billion.[13] The name change from Tyco Healthcare to Covidien corresponded with the 2007 spin off of Tyco Healthcare by

8. *Id.* at 398468.

9. Needlestick Safety and Prevention Act of 2000, H.R. 5178, 106th Cong. (2000), available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=106_cong_public_laws&docid=f:publ430.106.

10. Occupational Safety and Health Administration; Needlestick and Other Sharps Injuries; Final Rule, 29 CFR Part 1910 [Dkt. No. H370A], Jan. 18, 2001, available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=16265.

11. FROST & SULLIVAN, *supra* note 4, at 398470.

12. Covidien Press Release, *Tyco Healthcare Announces Investor Meeting for Covidien Debut on New York Stock Exchange*, Jun. 14, 2007, available at http://investor.covidien.com/phoenix.zhtml?c=207592&p=irol-newsArticle&ID=1015883&highlight= [hereinafter Covidien Announcement].

13. Yahoo Finance, Covidien, Ltd, available at http://finance.yahoo.com/q?s=COV (last accessed Dec. 3, 2007).

Tyco International.[14] For simplicity, I refer to Kendall as Tyco for the remainder of my report. Tyco added to its sharps container business through several acquisitions, including its purchase of Graphic Controls and Sherwood.[15] Tyco became the U.S. market leader in 1999 with its purchase of the sharps container product line from Sage Products.[16] Tyco had sharps container sales (net of rebates) of approximately [redacted] million in 2006.[17] In addition to sharps containers, Tyco manufactures and distributes needles, syringes, wound care, vascular therapy, urological care, incontinence care, and nursing care products, in addition to other products.[18]

11. Becton, Dickinson and Company (BD) is a global medical technology company. BD's market capitalization as of November 23, 2007 was approximately $20.2 billion.[19] BD is divided into three business units: BD Medical, BD Diagnostics, and BD Biosciences. BD sells sharps containers through its Medical division.[20] In 2006, BD had sharps container sales of approximately $41 million.[21]

12. Daniels International (Daniels) began providing sharps management to Australian hospitals and healthcare facilities in 1986.[22] Although Daniels officially began U.S. operations in

14. Covidien Announcement, *supra* note 12. On June 29, 2007, Tyco Healthcare became an independent publicly traded company and subsequently changing its name to Covidien.

15. [redacted]

16. FROST & SULLIVAN, *supra* note 4, at 398529 ("In 1999 Kendall bought out Sage Products' Sharps disposal containers business, which included the leading sharps containers in the market during that time.").

17. Tyco Sales Data.

18. FROST & SULLIVAN, *supra* note 4, at 398529.

19. Yahoo Finance, Becton Dickinson & Co., available at http://finance.yahoo.com/q?s=BDX (last accessed at Dec. 3, 2007).

20. BECTON, DICKINSON & CO., ANNUAL REPORT (SEC FORM 10-K), at 1 (May 11, 2007).

21. BD sales data. I adjusted BD's sales ending October 1, 2006 (the last available date of data) by multiplying by 4/3 to estimate an annual figure.

22. Daniels International Website: About Daniels Australia, available at http://www.danielsinternational.com/au/index.cfm?section=3&category=3 ("Daniels was founded in Melbourne and has its head office in Dandenong (pictured). Daniels has been providing safer sharps management to Australian hospitals and healthcare facilities since 1986.").

2003 (according to its website),[23] [redacted].[24] Daniels is not a publicly traded firm, and therefore has no market capitalization. [redacted][25] Daniels markets itself as an environmentally conscious firm with unique safety features. Daniels containers are reusable, rather than disposable.[26] Daniels also explains the safety benefits of its containers in its marketing materials.[27] As of 2007, the Daniels Sharpsmart system was available in approximately 200 health care facilities throughout the United States.[28] In addition to serving the United States, Daniels sells sharps containers in Canada, the United Kingdom, South Africa, Australia, and New Zealand.[29]

13. Stericycle serves as both a reseller of several other brands of sharps containers and as a full service operator of reusable sharps containers. As a reseller, Stericycle sells Tyco, BD, and Bemis disposal sharps containers.[30] As a full-service reusable container provider, Stericycle operates under the BioSystems brand name, which it acquired in 2003 for $26 million.[31] In 1999, Stericycle purchased Browning-Ferris's medical waste management

23. Daniels International Website: About Daniels USA, available at http://www.danielsinternational.com/us/index.cfm?section=3&category=3 ("Daniels began its operations in California in 2003 and its spread across America has grown rapidly as hospitals and healthcare workers recognize the tremendous safety benefits of the Daniels Sharpsmart system.").

24. [redacted]

25. [redacted]

26. Daniels International Website: Daniels History, available at http://www.danielsinternational.com/us/index.cfm?section=3&category=15.

27. *Id.* (citing a *British Journal of Hospital Infection* study showing that Daniels' sharps containers reduce sharps injuries by an average of 33 percent over other brands.)

28. Daniels International Website: About Daniels USA, available at http://www.danielsinternational.com/us/index.cfm?section=3&Category=3.

29. Daniels International Website: Daniels History, available at http://www.danielsinternational.com/us/index.cfm?section=3&category=15.

30. Stericycle Website: 2005 Catalogue, at 3, available at http://www.stericycle.com/pdf/catalog_summer2005.pdf

31. Stericycle Press Release: Stericycle, Inc. Completes Acquisition of Scherer Healthcare, Inc., Jan. 9, 2003 ("Stericycle, Inc. today announced that it had completed its acquisition of Scherer Healthcare, Inc. for $41.5 million in cash, pursuant to a merger agreement approved by Scherer's stockholders at a special meeting on January 7, 2003.

business.[32] Stericycle's marketing material claims that hospitals switching to Stericycle have enjoyed lower prices. For example, Stericycle highlights a study showing that its full-service sharps disposal system saved a hospital with 1,300 sharps containers $30,000 a year.[33]

14. Medical Action Industries (MAI) manufactures and distributes a diversified portfolio of disposable medical products. MAI has acquired several smaller companies over the relevant class period. In October 2002, MAI acquired the BioSafety Division of Maxxim Medical, Inc., which sold sharps containment systems primarily for the alternative care segment.[34]

15. Bemis Health Care (Bemis) is a division of Bemis Manufacturing Company.[35] Bemis entered the sharps container industry in 1983.[36] Bemis offers a variety of sharps disposal units, including patient room, phlebotomy, multi-use, large, and chemotherapy containers.[37] In November 2003, Bemis introduced the SharpSentinel Wall Cabinet system for use in patient and exam rooms.[38]

16. Sure-Way Systems is a reusable sharps container company that has operated since 1990.[39] Sure-Way has approximately 1,600 customers.[40] Based in Montana, Sure-Way has processing plants in Florida, New York, Montana, North Dakota, Utah, Minnesota, Arizona,

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The net purchase price was $26.0 million, after adjusting for Scherer's cash."), available at http://phx.corporate-ir.net/phoenix.zhtml?c=119334&p=irol-newsArticle&ID=369304&highlight=.

32. Leone T. Young, *Stericycle, Inc. Initiating Coverage*, CITIGROUP SMITH BARNEY EQUITY RESEARCH, Feb. 10, 2004, at 3 [hereinafter SMITH BARNEY].

33. Andi Atwater, *Waste Contract Could Save Wesley $30,000*, WICHITA EAGLE, Aug. 3, 2006.

34. MEDICAL ACTION INDUSTRIES INC., ANNUAL REPORT (SEC FORM 10-K), at 3 (May 11, 2007).

35. Bemis Healthcare Website: About Us, available at http://www.bemishealthcare.com/about.php.

36. *Id.*

37. Bemis Healthcare Website: Sharpsentinel Sharps Disposal System, available at http://www.bemishealthcare.com/products/sharpsentinel.php.

38. Bemis Manufacturing Press Release, *Bemis Health Care Introduces SharpSentinel Wall Cabinet System*, available at http://www.bemismfg.com/pressreleases/release_20031101_01.php.

39. Sure-Way Systems, Inc. Website: About Us, available at http://www.sure-way-systems.com/about_us htm (last accessed Nov. 11, 2007).

40. *Id*.

Kansas, Alabama, Alaska, Hawaii, Georgia and Canada.[41] Sure-Way claims that its reusable containers can reduce costs by 20 to 40 percent relative to disposable sharps container programs.[42] In addition, Sure-Way claims that its technology can reduce a hospital's medical waste stream by 25 percent.[43] Sure-Way offers five container sizes with four interchangeable lids.[44]

C. Taxonomy of Sharps Containers

17. Sharps containers are generally categorized by the suppliers according to type of use.[45] Based on my review of their promotional materials, I have mapped each product for each supplier into one of six product types: (1) patient room, (2) multi-use, (3) large, (4) chemotherapy, (5) phlebotomy, and (6) pharmaceutical.[46] Patient-room sharps containers are appropriately sized for use within a patient's room and equipped to prevent tampering.[47] Multi-use containers are general sharps containers that can be used in a variety of scenarios. Large containers are sharps disposal containers that are either intended for large volumes of sharps or intended for larger sharps that cannot be accommodated in smaller containers. Chemotherapy containers are designed with a large opening to accommodate larger chemotherapy waste and to offer increased leak protection. In addition, chemotherapy containers are uniformly yellow to signify their type. Phlebotomy containers are those designed for use with blood collection and

41. Sure-Way Systems, Inc. Website: Contact Us, available http://www.sure-way-systems.com/contact_us htm (last accessed Nov. 11, 2007).

42. Sure-Way Systems, Inc. Website: About Us, available at http://www.sure-way-systems.com/about_us htm (last accessed Nov. 11, 2007).

43. Barbara Rattle, *Medical Waste Disposal Firm to Establish Facility in Salt Lake Area,* ENTERPRISE, Sep. 29, 2003, at 1.

44. Sure-Way Systems, Inc. Website: About Us, available at http://www.sure-way-systems.com/containers htm (last accessed Nov. 11, 2007).

45. *See, e.g.* ECRI Report, TYN0059350-60055 at 59630 (discussing different types of sharps containers, including large volume, chemotherapy, and phlebotomy).

46. Five of these categories (in-room, ancillary or multi-use, large volume, phlebotomy, and chemotherapy) are specifically laid out in a contract between Tyco and Novation. *See, e.g.,* TYN0000986-1088 at 1087. Pharmaceutical containers were included as a separate category because of their prominence in the marketing materials of several sharps container suppliers.

47. BD Sharps Collectors Selection Guide, available at http://www.bd.com/sharps/pdfs/full_line.pdf.

are smaller and made to be portable. Pharmaceutical sharps containers are made for the disposal of unused, expired, or waste pharmaceuticals and sharps.

18. Although sharps container makers market their product along these product lines, the actual differences across these categories are slight, except possibly in the case of chemotherapy containers. Frost and Sullivan notes few differences between the sharps containers products offered by different companies: "In the sharps, containers, and suction canisters market, there are few significant distinguishing characteristics between companies and their products."[48] All container types appear to be configured based on subtle size and characteristic differences. For example, the only difference between multi-use and large containers appears to be size.[49] Even the difference between chemotherapy and other sharps containers appears to be small. For example, BD's chemotherapy containers say they "are designed to offer increased leak resistance."[50] This seems to differ very little from their other sharps containers that offer leak protection; BD's chemotherapy containers merely offer leak resistance as a standardized feature. Table 1 shows the product name of any sharps containers mapped into a category and the range of sizes offered within each category.

48. FROST & SULLIVAN, *supra* note 4, at TYN0398471.

49. *See, e.g.*, BD Sharps Selection Guide, available at http://www.bd.com/sharps/pdfs/full_line.pdf, and Healthcare Website, available at http://www kendallhealthcare.com/kendallhealthcare/pageBuilder.aspx ?topicID=81045&breadcrumbs=0:121623, both showing the similar designs between different type sharps containers.

50. BD Sharps Selection Guide, at 6, available at http://www.bd.com/sharps/pdfs/full_line.pdf.

TABLE 1: PRODUCT NAME AND AVAILABLE SIZES BY MANUFACTURER AND PRODUCT TYPE

	Tyco[1]	BD[2]	Daniels[3]	Medical Action[4]	Bemis[5]	Sure-Way[6]	Stericycle[7]
Patient Room	IN-ROOM System, Sharpstar, Gatorguard, Renewables (2qt - 4g)	Patient/Exam Room Sharps Collectors (5.4qt - 3g)	Regular Sharpsmart (2g - 8.5g)	Sharps Containers (1qt - 3g)	Sharp Sentinel, Wall Safe (5qt)	Sure-Way Containers (1g - 4g)	Sharps Container (2g – 3g)
Multi-Use	Sharps-A-Gator, Monoject, Renewables (.5g - 14qt)	Multi-Use Sharps Collectors (3.2 qt - 6g)	Access Plus Sharpsmart (2g - 8.5g)	Sharps Containers (1g - 8g)	Sharps Container (2g - 3g)	Sure-Way Containers (1g – 10g)	Sharps Container (2g – 8g)
Large	Sharps-A-Gator Renewables (5g - 30g)	Extra Large Sharps Collectors (9g - 19g)	Regular, Access Plus, Pharma (8.5g)	Sharps Containers (8g - 16g)	Large Volume Sharps Container (8g - 11g)	Sure-Way Containers (10g – 17g)	Sharps Container (8g – 17g)
Chemo.	Chemosafety, Chemo-O-Gator, Renewables (2g - 19g)	Chemotherapy Sharps Collectors (3g - 19g)	--	Chemo Waste Container (1.7qt - 16g)	Chemotherapy Disposal (2g - 11g)	--	--
Phlebotomy	AUTODROP Renewables (1qt - 8qt)	Phlebotomy Sharps Collectors (1qt – 1.5qt)	--	Sharps Containers (.7qt - 1.7qt)	Phlebotomy Container (1qt - 3g)	Sure-Way Containers (1g – 2g)	--
Pharma.	Pharmasafety (2g - 18g)	Pharmaceutical Sharps Collectors (3g - 9g)	Pharma Sharpsmart (2g - 8.5g)	--	--	--	--

Sources: 1. Kendall Healthcare Website, available at http://www.kendallhealthcare.com/kendallhealthcare/pageBuilder.aspx?topicID=81045&breadcrumbs= 0:121623; 2. BD Sharps Selection Guide, available at http://www.bd.com/sharps/pdfs/full_line.pdf; 3. Daniels International Webpage: Sharpsmart Collectors, available at http://www.daniels international.com /us/index.cfm?section=2&category=9., 4. Medical Action Industries Website, available at http://www medicalaction.com/catalog/ businessline.asp?id=2, 5. Bemis Healthcare Website, available at http://www.bemishealthcare.com/products/sharpsentinel.php; 7. Stericycle/Biosystems response to 2003 Novation Invitation to Bid, Sharps Containers, for contract period 8/1/05 - 7/31/08.

As Table 1 shows, two of the major suppliers, Tyco and BD, offered the complete array of sharps containers. Another two, Medical Action and Bemis, offered all but one type (pharmaceutical). All but three suppliers (Daniels, Sure-Way, Stericycle) market chemotherapy containers. Even without marketing chemotherapy containers, Daniels still produces a container that is deemed a competitive threat to Tyco's chemotherapy container.[51] In addition, a report from ECRI suggests that all smaller containers are substitutes for phlebotomy containers, which would include those made by Daniels and Stericycle.[52]

19. Based on my examination of the variety of sharps containers, I conclude that (1) sharps containers do not vary significantly across usage categories for a given manufacturer and (2) conditional on choosing a particular type of sharps container (for example, chemotherapy), sharps containers are effectively homogeneous across all major suppliers. With very few exceptions, each sharps container manufacturer offers the full array of containers with similar product features, sizes, and characteristics. This conclusion is confirmed by industry analysts. Thus, sharps containers are sufficiently homogeneous that the basic damage models used in my report are appropriate. Even if one assumes counterfactually that sharps containers are highly differentiated, the basic models I employ here could be easily adapted.[53]

II. THEORY OF HARM

20. In his initial class certification report, Professor Elhauge outlines several methods for assessing market foreclosure.[54] Professor Elhauge explains that anticompetitive effects are created when a firm with market or monopoly power engages in conduct that has the effect of

51. [redacted]

52. ECRI Report, Jul. 2003, TYN0059350 – 60055 at 59630 (stating that phlebotomy and other sharps containers are part of the same grouping).

53. *See, e.g.*, K. Sudhir, *Competitive Pricing Behavior in the Auto Market: A Structural Analysis*, 20 MARKETING SCIENCE 42, 46 (2001) (showing examples of basic NEIO models when product variety is small and other NEIO models when product variety is large).

54. Elhauge Initial Declaration, ¶¶28-39.

significantly foreclosing the market to rivals. The harmful effects of this foreclosure manifest themselves as lack of or limited access to the most efficient sources of inputs or distribution, and barriers to entry and expansion for smaller rivals, the result of which is to reduce the pricing constraint imposed by rivals on the incumbent.[55] Professor Elhauge also describes why depriving rival firms of sales will be anticompetitive even absent impairing economies of scale, as long as rivals do not have infinite elasticity of supply.[56]

21. In the instant case, Professor Elhauge described two coexistent theories of foreclosure. The first theory relates to Tyco's contracts with end-users that require share-based commitments, which foreclose a substantial share of the sharps container market to Tyco's rivals.[57] The second theory of harm is that the existence of sole-source contracts prevents rival firms from gaining access to GPOs, which are the most efficient distribution channel for the sale of medical devices.[58] Under the first theory, rivals are deprived of sales to end-users, who are bound to purchase from Tyco. Under the second theory, rivals are deprived of sales through exclusion from the most efficient means of distribution. Under both theories, rival firms' ability to constrain Tyco's pricing was diminished, and purchasers therefore paid a price above the competitive level. Professor Elhauge has noted that these foreclosure theories are independent and that either type of foreclosure could exist separately, or they could exist in tandem.[59] Under both theories, denying rivals the ability to achieve economies of scale plays a role in increasing prices. But as Professor Elhauge has emphasized, depriving rival firms of market share is anticompetitive even when economies of scale are not present.[60]

55. *Id.* ¶29
56. *Id.* ¶¶30-32.
57. *Id.* ¶36
58. *Id.* ¶35
59. *Id.* ¶17.
60. *Id.* ¶31.

22. In the following sections, I tailor my damages analysis to these two theories of harm. In particular, I provide an estimate of damages that relates to (1) the share-based commitments with hospitals, (2) the sole-source contracts with GPOs, and (3) the combination of both types of foreclosure (equal to less than the sum of the two components).

III. DAMAGES

23. Total damages to the class can be calculated by multiplying (1) the aggregate quantity of sharps containers purchased by the class from Tyco by (2) the difference between the average actual market price and the average but-for market price for sharps containers.[61] In my earlier report, I presented two possible models for estimating but-for average market prices: (1) the new empirical industrial organization (NEIO) model, and (2) the raising-rivals-cost model. The NEIO model produces but-for average market prices under a theory that foreclosure reduces rivals' market shares. In his initial class certification expert declaration, Professor Elhauge describes why simply depriving firms of market share will have anticompetitive effects.[62] Thus, the NEIO model is appropriate here because the theory of liability posits that Tyco's rivals were foreclosed from large segments of the sharps containers industry, thereby reducing their market share.

24. When estimating damages according to the NEIO model, it bears emphasis that I conservatively assume that any increase in rival market share in the but-for world takes place only in that portion of the market that was directly affected by foreclosure in the actual world. In other words, I ignore the possibility of spillover effects between the foreclosed and non-foreclosed segments of the market. Such effects would be substantial in the presence of significant scale economies, because allowing a rival to increase its scale in the foreclosed

61. Singer Initial Declaration, ¶¶14-15.
62. Elhauge Initial Declaration, ¶31.

segment would also permit it to serve the non-foreclosed segment more efficiently. Moreover, in my analysis, I conservatively assume that in the but-for world, the percentage decrease in Tyco's prices (relative to Tyco's actual price) is equal to the percentage decrease in average market prices, despite the possibility that Tyco's prices could decline by a greater percentage than the market average in the but-for world.

25. The raising-rivals'-cost model produces but-for average market prices under a theory that foreclosure increases rivals' costs, which is also consistent with the theory of harm in this case. As I explain in more detail below, to estimate damages using the raising-rivals'-cost model, I would need to incorporate additional information on the costs Tyco's rivals.[63]

A. NEIO Model

26. The NEIO model dates back to the work of former Department of Justice chief economist Dr. Timothy Bresnahan, who used the NEIO approach to study the effects of industry concentration on the aluminum industry.[64] He described the NEIO approach in the widely used *Handbook of Industrial Organization*.[65] The NEIO model lends itself to several applications in antitrust litigation. These include measuring selling power and estimating damages.

27. The NEIO model shows the relationship between several market characteristics, including: (1) market demand elasticity,[66] (2) seller concentration indices,[67] (3) producer price-

63. I received BD's cost data on November 28, 2007. Stericycle produced cost data on November 29, and December 14, 2007. Bemis produced some cost data on Dec. 17, 2007. Due to the recent production of cost data and the time constraints involved in completing this report, I have not had the opportunity to review and incorporate this information into my analysis and to estimate damages using the raising-rivals'-cost method.

64. Timothy F. Bresnahan & Valerie Y. Suslow, *Oligopoly Pricing with Capacity Constraints*, 15/16 ANNALES D'ECONOMIE ET DE STATISTIQUE 267-89 (1989).

65. Timothy F. Bresnahan, *Empirical Methods of Industries with Market Power*, in 2 HANDBOOK OF INDUSTRIAL ORGANIZATION (Richard Schmalen*see* & Robert Willig eds., North Holland 1989).

66. The market demand elasticity for a product is the percentage change in quantity demanded for that product given a one percent increase in the price of that product. A product with an elasticity of demand greater than one (in absolute terms) is said to be "price elastic," whereas a product with an elasticity of demand less than one (in absolute terms) is said to be "price inelastic." *See, e.g.*, GEORGE J. STIGLER, THE THEORY OF PRICE 334 (MacMillan 3rd ed. 1966).

cost margins,[68] and (4) the extent to which manufacturers act competitively.[69] Thus by knowing any three of these terms, it is possible to estimate the fourth. The relationship between these terms is represented in equation 1.

[1] $$\frac{P-C}{P} = -\frac{HHI*(1+\theta)}{E}$$

Where $(P - C)/P$ is the price cost margin, *HHI* is the Herfindahl-Hirschman Index of industry concentration, E is the industry elasticity of demand, and θ is the extent to which firms behave competitively, known as the "conduct parameter."[70]

28. Note that equation [1] implies that larger values of the conduct parameter lead to higher markups of price over cost, and thus reflect a lower degree of competition. In contrast, if the conduct parameter is sufficiently small—in particular, if it is equal to –1—then implied markups are zero, and pricing is perfectly competitive. In addition, note that, all else equal, markups are higher when E, the industry elasticity of demand, is smaller in absolute value. E itself is defined as the percentage decrease in quantity demanded associated with a one percent

67. The most common seller concentration measure in industrial organization is the Herfindahl-Hirschman Index (HHI). The HHI is computed as the sum of the squared market shares of each firm in the industry. An industry that is perfectly monopolized has an HHI of 10,000 (equal to 100 squared). See, e.g., DENNIS W. CARLTON & JEFFREY M. PERLOFF, MODERN INDUSTRIAL ORGANIZATION 255 (Pearson Addison Wesley 4th ed. 2005).

68. The price-cost margin or "Lerner Index" is typically measured as the difference between the price and the marginal cost divided by the price. The price-cost margin for a profit-maximizing firm equals the inverse of the own-price elasticity of demand faced by that firm. A firm in a perfectly competitive industry sets price equal to marginal cost. *Id*. at 254. Deviation from this perfectly competitive price-cost margin can be used to measure a firm's market power.

69. The conduct parameter can be written as the product of the Lerner Index and the elasticity of demand. *Id*. at 284. Under certain assumptions, the conduct parameter can be decomposed into the product of the HHI and 1 plus the conjectural variation term. For an application of the NEIO method in the long-distance telephone industry, see PAUL W. MACAVOY, THE FAILURE OF ANTITRUST AND REGULATION TO ESTABLISH COMPETITION IN LONGDISTANCE TELEPHONE SERVICE 102-103 (MIT Press 1996). For an application of this method in the airline industry, see J.A. Brander & A. Zhang, Market Conduct in the Airline Industry: An Empirical Investigation, 21 RAND J. ECON. 569 (1990).

70. PAUL W. MACAVOY, THE FAILURE OF ANTITRUST AND REGULATION TO ESTABLISH COMPETITION IN LONG-DISTANCE TELEPHONE SERVICE 102-103 (MIT Press 1996).

increase in price. In other words, *E* captures demand responsiveness. Hence, under the NEIO model, for any given level of competitive conduct, it is possible to sustain higher margins in equilibrium when demand is less responsive to price.

B. Raising-Rivals'-Cost Model

29. The raising-rival's-cost model shows how buyers can be harmed by higher prices despite possessing a but-for market share equal to a real world market share. Even if Tyco's anticompetitive strategy does not manifest itself in the form of higher seller concentrations, the alleged anticompetitive conduct can still translate into higher but-for prices. With higher marginal costs, Tyco's rivals would not be able to impose the same degree of pricing discipline on Tyco as they could in a but-for world. The result would be higher prices. Stated differently, even if Tyco's exclusionary practices did not induce exit, impede entry, or retard rival expansion, its behavior could still increase sharps containers prices.

30. Professors Steven Salop and David Scheffman demonstrate that a sufficient condition for a raising-rivals'-cost strategy to be profitable is that the exclusionary conduct shifts up the dominant firm's residual demand curve (equal to the market demand curve less the supply of the dominant firm's rivals) by more than it shifts up the dominant firm's average cost curve at the original output.[71] In my initial report, I detail the equilibrium pricing condition for the dominant firm that flows from the raising-rival's-cost model. The equation is

[2] $$S_a / (D_p - S_p) = C_a / x,$$

Where S_a is the change in the fringe's supply given a change in the exclusionary conduct, D_p is the change in the market demand given a change in the dominant firm's price, S_p is the change in the fringe's supply given a change in the dominant firm's price, C_a is the change in the dominant

71. Steven C. Salop & David T. Scheffman, *Raising Rivals' Costs*, 73 AMERICAN ECONOMIC REVIEW 267, 270 (1983).

firm's total cost given a change in the exclusionary conduct, and x is the output of the dominant firm. The left hand side of the equation 2 represents the vertical shift in the residual demand curve facing the dominant firm. Therefore, the critical inputs of the raising-rivals-cost model are (1) the industry elasticity of demand, (2) the elasticity of the fringe supply curve, and (3) the increase in the marginal cost of the fringe.

IV. THE FIRST APPROACH TO DAMAGES: NEIO MODEL

31. I obtained sufficient data far enough in advance to estimate damages using the NEIO model, but not the raising-rival's-costs model. In the following section, I explain how I implemented the NEIO approach.

A. Introduction and Data Overview

32. The NEIO model yields a relationship between the producer price-cost margins (known as the Lerner Index), the Herfindahl-Hirschman Index (HHI), and the elasticity of demand, while allowing the researcher to remain agnostic with respect to the precise form of competitive interaction among firms in the industry. The form of competitive interaction is summarized by the "conduct parameter," which is estimated using the data at hand, instead of being imposed through assumptions. When estimating damages, I conservatively assume that the conduct parameter is held fixed in the but-for world. As equation [1] (above) demonstrates, if the conduct parameter were allowed to decrease in the but-for world (under the theory that competition would have been more vigorous, but for Tyco's conduct), then but-for prices would be lower than what I currently estimate. In Appendix 2, I relax this and other conservative assumptions in a sensitivity analysis.

33. Consistent with Professor Elhauge's market definition, I implement the NEIO model at the level of all sales of sharps containers. As shown in equation 1, the left hand side of the equation governing the NEIO model, and the simplest input of the model to calculate, is

given by the price-cost margin, or the Lerner Index. In this context, the Lerner Index is the measure of the degree to which market prices (across all suppliers) exceed marginal production costs. To calculate this input, I rely on transactional sales data and on product-level production cost data obtained from Tyco [redacted]

34. Tyco's transactional sales data provide, for each transaction, units sold and the revenues associated with those units.[72] Tyco's transactional data contain information on revenues from shipments, rebates, and credits.[73] Table 2 shows the key sales data from 2000 to 2007.

TABLE 2: [redacted]

35. [redacted]

72. The Tyco transactional data begin in October of 2000 and end in May 2007. I first examined the data and removed any transactions which clearly did not involve sharps containers. In addition, inspection of the transactional data revealed that the number of units given in the database actually represent the number of cases sold. Each case contains multiple sharps containers, and the number of sharps containers per case often varies from one item to the next. Therefore, I generated a unit of measurement (UOM) variable indicating, for each transaction, the number of sharps containers per unit. The UOM variable was then multiplied by the number of units per case to obtain a variable reflecting the actual quantity of sharps containers purchased in each transaction.

73 . Only entries classified as shipments reflect positive revenues; rebates and credits constitute negative revenues. In addition, "tracing" observations in the dataset are included for tracking purposes. Each positive tracing observation had a negative counterpart somewhere in the database. Thus, when the data are aggregated, tracing observations obviously cancel each other.

[redacted]

36. [redacted][74]

[redacted][75]

[redacted]

1. Price, Cost, and Margin Data

37. Tyco's per-container prices were obtained by aggregating revenues and units sold by year, and then dividing yearly aggregate revenues by yearly aggregate quantity of sharps containers sold (which is equivalent to computing volume-weighted average prices). For the purposes of the average pricing computations, I aggregated (positive) revenue from shipments and (negative) revenue from rebates and credits, such that the average prices presented reflect

74. *See* McKinsey & Company Information Request, TYN0057183-57545, at 57208.

75. As noted previously, because Tyco's fiscal year runs from October through September, the time periods reflected annual data in Table 2 do not correspond exactly to those in the discovery documents cited here. *See* McKinsey & Company Information Request, *supra*.

average revenues net of rebates and credits. The resulting average annual prices for Tyco's products are presented in Table 3.

TABLE 3: [redacted]

38. Tyco's product-level data also contain product-level manufacturing cost information that varies annually. Inspection of the cost data reveals that the information (like Tyco's transactional quantity data) reflects the cost per case, rather than cost per container.[76] Therefore, the cost variable was divided by a previously generated UOM variable (reflecting the number of units per case). This procedure yields a variable measuring the cost per sharps container. I then computed average annual cost per container as follows: First, to arrive at a measure of total cost per transaction, I multiplied the quantity of sharps containers sold by the cost per sharps container. Next, I aggregated this total cost variable across all transactions for each year, to arrive at a measure of total annual cost. Finally, to obtain average annual cost per container, I divided total annual cost by total annual quantity (which is equivalent to computing volume-weighted average cost).

39. [redacted]

76. [redacted]

[redacted]

[redacted].[77]

TABLE 4: [redacted]

2. Estimation of the Elasticity of Demand

40. I now turn to estimating another input required for the NEIO model, the industry elasticity of demand. The industry elasticity of demand measures the percentage decrease in industry-wide quantity demanded in response to a one percent industry-wide increase in price. [redacted]

41. [redacted]

77. [redacted]

[redacted]

42. [redacted]

43. I estimate the demand elasticity using standard econometric techniques, which require that I specify a functional form for the demand curve. I determined that log-linear specifications fit the transactional data best.[78] In Model A, shown in equation 3, the log of quantity demanded is modeled as a linear function of the log of price, in addition to demand shifters—that is, variables that shift the demand curve in the space of price and quantity. Here, q is natural log of the quantity of sharps containers demanded, p is natural log of the price per container, and X are variables that shift the demand curve. These additional right-hand side variables in the regression control for year-specific fixed effects: They allow for the possibility of year-to-year shifts in the demand for sharps containers, which could be driven by multiple factors, such as variations in overall healthcare expenditures and safety regulations. Finally, ε is a random error term.

78. I experimented with alternative (linear) specifications of demand, but found that these specifications fit the data quite poorly. See Appendix 3.

44. The elasticity of demand, E, is given by the equation $E = \beta_1$. For this reason, such log-linear models are sometimes referred to as constant elasticity demand systems, as is the case in Model A below:[79]

[3] $$q_{it} = \beta_0 + \beta_1 p_{it} + \sum_{j=1}^{n} \delta_j X_{ijt} + \varepsilon_{it}$$

45. Table 5 displays the results of an ordinary least squares (OLS) regression based on Model A. The regression results indicate a negative and statistically significant relationship between price and quantity demanded.[80] The coefficient on log of price ("lnp") is statistically significant at the 1 percent level (t-stat equal to -72.69). In addition, the regression results indicate an estimated price elasticity of about -1.18—that is, a one percent increase in price is associated with a 1.18 percent decrease in quantity demanded. Hence, these regression results indicate that the demand for sharps containers is elastic over the relevant range. In addition, the R-squared statistic indicates that the right-hand side variables explain approximately 29 percent of the variation in quantity. This figure is reasonably high, considering that most of the variation in the dataset is cross-sectional—that is, variation across individual products at a given point in time.[81]

79. In Model A (and all subsequent Models), the *i* subscript denotes different products, the *t* subscript denotes time, and the *j* subscript simply assigns a number to each demand shifter. I include six such demand shifters in my specifications; hence, *n* is equal to six.

80. Note that not all demand shifters in Model A (and in subsequent models) are individually statistically significant, based on their respective t- values. However, an F-test of all demand shifters reveals that these variables are collectively significant in explaining the variation in the dependent variable.

81. *See, e.g.,* WILLIAM H. GREENE, ECONOMETRIC ANALYSIS 37 (Prentice Hall 5th ed. 2003).

TABLE 5: REGRESSION RESULTS, MODEL A: CONSTANT ELASTICITY DEMAND

Source	SS	df	MS	Number of Obs	13388
				F(7, 13380)	762.84
Model	16226.0346	7	2318.00494	Prob > F	0.0000
Residual	40657.3234	13380	3.03866393	R-squared	0.2853
				Adj R-squared	0.2849
Total	56883.358	13387	4.24914902	Root MSE	1.7432

lnq	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnp	-1.184563	.0162958	-72.69	0.000	-1.216505	-1.15262
Y00	-.1579445	.0879869	-1.80	0.073	-.3304113	.0145223
Y01	-.1201089	.0557059	-2.16	0.031	-.2293003	-.010918
Y02	-.2055905	.0548994	-3.74	0.000	-.3132011	-.09798
Y03	-.361312	.0547217	-6.60	0.000	-.4685742	-.25405
Y04	-.0359112	.0550578	-0.65	0.514	-.1438322	.0720098
Y05	-.0223719	.0550559	-0.41	0.684	-.1302892	.0855454
cons	10.35666	.0477262	217.00	0.000	10.26311	10.45021

46. A potential source of bias in estimating the elasticity of demand, known to econometricians as simultaneity bias, arises when price, *P*, is endogenous to the demand system.[82] Shifts in demand are likely to be correlated with changes in price, if only because they may result in movements up or down the supply curve. Due to the potential for correlation between *P* and the error term, ε, endogeneity can lead to biased estimates of the elasticity of demand. The standard method used to control for simultaneity bias is known as the "instrumental variables" technique. In the context of demand estimation, implementation of instrumental variable techniques requires that the econometrician make use of a variable which, although correlated with *P*, is uncorrelated with the error term, ε.

47. [redacted],[83] [redacted] Cost shifters are typically excellent candidates for use as instrumental variables in demand information, because, although correlated with price, they are plausibly exogenous to the demand system. Table 6 reports the results of a "first stage"

82. *Id.* at 396.

83. [redacted]

regression, which demonstrates that the (log of) cost per container explains approximately 84 percent of the variation in the (log of) sharps container prices. As expected, an increase in cost is positively and significantly associated with an increase in prices. Hence, I conclude that cost is a suitable instrumental variable for price in demand estimation, given the data at hand.

TABLE 6: FIRST-STAGE REGRESSION RESULTS

Source	SS	df	MS	Number of Obs	13388
				F(7, 13386)	68181.04
Model	9582.86791	1	9582.86791	Prob > F	0.0000
Residual	1881.40667	13386	.140550326	R-squared	0.8359
				Adj R-squared	0.8359
Total	11464.2746	13387	.856373689	Root MSE	.3749

lnp	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnc	.992495	.003801	261.12	0.000	.9850446	.9999455
cons	.698011	.0044092	158.31	0.000	.6893684	.7066536

48. Because the potential for simultaneity bias exists in Model A (Table 5), in Model B I apply the instrumental variables technique to the constant elasticity specification; the results of a two-stage least squares regression are displayed in Table 7. As in the ordinary least squares regression, the instrumental variable regression results continue to display a negative and statistically significant relationship between price and quantity demanded. The coefficient on log of price ("lnp") is statistically significant at the 1 percent level (t-stat equal to -75.80). The results also indicate that demand is revealed to be more elastic after controlling for simultaneity bias. In particular, a one percent increase in price is associated with a 1.35 percent decline in quantity demanded. The explanatory variables are also collectively significant. Finally, the overall fit of the regression indicates that about 28 percent of the variation in quantity demanded is explained by the right-hand side variables.[84]

84. In each of the instrumental variable regressions presented here, I performed a Hausman test to justify the use of the instrumental variables technique. In each case, I was able to reject the null hypothesis at the one percent significance level, providing statistical evidence of systematic differences between the OLS coefficient estimates

TABLE 7: REGRESSION RESULTS, MODEL B: INSTRUMENTAL VARIABLES (2SLS) REGRESSION

Source	SS	df	MS	Number of Obs	13388
				F(7, 13380)	828.75
Model	15903.7447	7	2271.96354	Prob > F	0.0000
Residual	40979.6132	13380	3.06275136	R-squared	0.2796
				Adj R-squared	0.2792
Total	56883.358	13387	4.24914902	Root MSE	1.7501

lnq	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnp	-1.352388	.0178411	-75.80	0.000	-1.387359	-1.31742
Y00	-.1825622	.0883412	-2.07	0.039	-.3557233	-.009401
Y01	-.1379285	.0559313	-2.47	0.014	-.2475619	-.028295
Y02	-.2166761	.0551186	-3.93	0.000	-.3247163	-.108636
Y03	-.3700077	.0549394	-6.73	0.000	-.4776967	-.262319
Y04	-.0407808	.055276	-0.74	0.461	-.1491295	.0675679
Y05	-.0235759	.0552737	-0.43	0.670	-.1319201	.0847683
cons	10.61291	.0491318	216.01	0.000	10.51661	10.70922

49. In the next set of regressions, I employ specifications based on alternative, volume-based measures of the regression variables. Different varieties of sharps containers have varying levels of storage capacity. In addition to considering prices and costs on a per-container basis, it can be useful to think of the demand for sharps containers as the demand for sharps storage volume.

50. As noted previously, given information in the transactional data, I was able to compute, for each transaction, the volume of sharps container capacity purchased. Given this information, I obtain the price per unit of volume. This allowed for estimation of the specification given by Model C, in which demand for capacity is a log-linear function of the price per unit of capacity.

[4] $$q_{cit} = \beta_0 + \beta_1 p_{cit} + \sum_{j=1}^{n} \delta_j X_{ijt} + \varepsilon_{it}$$

and the coefficient estimates produced by the instrumental variables technique. The results of the Hausman test therefore support the use of the instrumental variables technique.

51. In Model C, shown in equation 4, the log of the volume demanded is modeled as a linear function of the log of price-per-unit volume, in addition to the usual demand shifters. Here, q_c is natural log of the volume of sharps containers demanded (measured in quarts), p_c is the natural log of the price per quart, and X are variables that shift the volume-based demand curve. As always, ε is a random error term. In the context of Model C, the elasticity of demand, E, is constant, and is equal to β_1.

52. Table 8 contains the estimates resulting from an OLS regression based on Model C. As expected, the coefficient estimates show a negative and statistically significant relationship between price-per-unit volume and the amount of sharps container volume demanded. The coefficient on log of price per unit of capacity ("lnp_cap") is statistically significant at the 1 percent level (t-stat equal to -79.90). The estimated price elasticity is about -1.63, indicating that a one percent increase in price is associated with a 1.63 percent decrease in quantity demanded. Finally, the R-squared statistic indicates that the explanatory variables account for about 34 percent of the variation in volume demanded.

TABLE 8: REGRESSION RESULTS, MODEL C: VOLUME-BASED

Source	**SS**	**df**	**MS**	**Number of Obs**	12836
				F(7, 12828)	926.61
Model	18499.4494	7	2642.77849	**Prob > F**	0.0000
Residual	36586.6164	12828	2.85209046	**R-squared**	0.3358
				Adj R-squared	0.3355
Total	55086.0658	12835	4.29186333	**Root MSE**	1.6888

lnq_cap	**Coef.**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
lnp_cap	-1.634923	.0204614	-79.90	0.000	-1.67503	-1.59482
Y00	-.190187	.0869666	-2.19	0.029	-.3606545	-.01972
Y01	-.1795477	.0550981	-3.26	0.001	-.2875481	-.071547
Y02	-.2601028	.0543123	-4.79	0.000	-.366563	-.153643
Y03	-.350691	.0541062	-6.48	0.000	-.4567472	-.244635
Y04	-.0218355	.0544089	-0.40	0.688	-.128485	.084814
Y05	-.0489637	.0543789	-0.90	0.368	-.1555544	.057627
cons	9.55936	.0443287	215.65	0.000	9.472469	9.646251

53. As I did in refining Model A, to control for simultaneity bias, in Model D I apply the instrumental variable technique to the volume-based demand specification; the results of a two-stage least squares regression are displayed in Table 9. The instrumental variable regression results display a negative and statistically significant relationship between price per unit volume and volume demanded. The coefficient on log of price per unit of capacity ("lnp_cap") is statistically significant at the 1 percent level (t-stat equal to -80.64). In addition, demand is even more elastic than the value implied by the ordinary least squares regression. In fact, Model D yields the highest estimate yet of demand responsiveness, indicating that a one percent increase in price per unit volume decreases volume demanded by about 1.86 percent. Approximately 33 percent of the variation in quantity demanded is explained by price per unit volume and the other right-hand side variables, as indicated by the R-squared statistic.

TABLE 9: REGRESSION RESULTS, MODEL D: INSTRUMENTAL VARIABLES (2SLS) REGRESSION

Source	SS	df	MS	Number of Obs	12836
				F(7, 12828)	943.39
Model	18146.3325	7	2592.33321	Prob > F	0.0000
Residual	36939.7334	12828	2.87961751	R-squared	0.3294
				Adj R-squared	0.3291
Total	55086.0658	12835	4.29186333	Root MSE	1.6969

lnq_cap	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnp_cap	-1.862596	.0230975	-80.64	0.000	-1.907871	-1.81732
Y00	-.1720121	.0873893	-1.97	0.049	-.3433082	-.000716
Y01	-.1684327	.0553657	-3.04	0.002	-.2769577	-.059908
Y02	-.2542454	.0545745	-4.66	0.000	-.3612195	-.147271
Y03	-.3426796	.054368	-6.30	0.000	-.4492489	-.236110
Y04	-.0178405	.0546711	-0.33	0.744	-.125004	.089323
Y05	-.0476033	.0546407	-0.87	0.384	-.1547072	.0595006
cons	9.352276	.0455593	205.28	0.000	9.262973	9.44158

54. Based on the econometric analysis above, I conclude that the elasticity of demand for sharps containers is significantly negative and elastic: A one percent increase in price, holding other factors fixed, would be expected to decrease quantity demanded by more than one percent. Based on my point estimates from instrumental variables regressions employing

constant elasticity specifications, I estimate that the industry elasticity of demand is likely between -1.35 and -1.86.

B. Detailed Example of Damage Estimation: Share-Based Commitments

55. In this section, I provide a relatively detailed explanation of the damage estimation process using foreclosure estimates derived from share-based commitment contracts. In subsequent sections, I provide a more succinct summary of my damage estimation results using various alternative estimates of foreclosure.

1. The Actual HHI and the But-For HHI

56. To obtain damage estimates due to foreclosure from share-based commitments, I estimate the but-for HHI that would have prevailed in the absence of this particular form of foreclosure. Before the but-for HHI can be determined, it is necessary to calculate the actual HHI. [redacted] The actual HHI, shown in the final column of the table, is given by the sum of the squares of each of the market shares, multiplied by 10,000.

TABLE 10: [redacted]

57. To estimate the but-for HHI, I rely on comparisons of rival market shares in foreclosed and non-foreclosed portions of the market. In particular, I first obtain an estimate of

the market share that Tyco's rivals would have obtained in the but-for world, assuming that a given type of foreclosure had not occurred. This figure is computed from estimates obtained from Professor Elhauge. In particular, as shown in the first column of Table 11, I understand that Professor Elhauge estimates that between 32 and 39 percent of the sharps container market was foreclosed by Tyco's share-based commitment contracts between 2001 and 2007, depending on the year in question. This figure is obtained by multiplying Tyco's market share (obtained from Table 10) by Professor Elhauge's estimate of the share of Tyco's sales going to buyers foreclosed by Tyco's share-based commitment contracts. The second column of Table 11 displays the increase in market share that rivals enjoyed in non-foreclosed portions of the market relative to foreclosed portions, according to the estimates of Professor Elhauge. For example, in 2003, rivals' penetration was 50 percentage points higher in non-foreclosed portions of the market when compared with foreclosed portions. [85]

58. My estimate of the increase in market share that rivals would have obtained in the but-for world is displayed in the final column of Table 11. This estimate is obtained by multiplying the first column by the second. That is, I multiply the increase in rival penetration from the foreclosed to the non-foreclosed market by the overall foreclosure estimate.

85. [redacted]

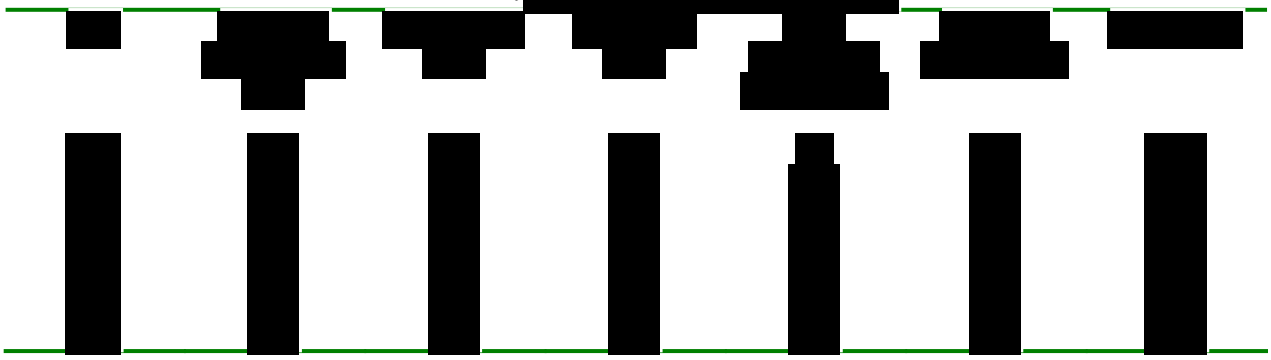
TABLE 11: [redacted]

59. It bears emphasis that this calculation conservatively assumes that any increase in rival market share in the but-for world takes place only in that portion of the market that was foreclosed in the actual world. In other words, this calculation does not account for the possibility of spillover effects between the foreclosed and non-foreclosed segments of the market. Such effects would be substantial in the presence of significant scale economies, because allowing a rival to increase its scale in the foreclosed segment would also permit it to serve the non-foreclosed segment more efficiently.

60. [redacted][86].

86. [redacted]

TABLE 12: [redacted]



2. The Conduct Parameter

61. Given the inputs already computed, I now have sufficient information to summarize competitive interaction in the industry through the conduct parameter. I calculate the conduct parameter for each year of the analysis. Recall that the Lerner Index, L, is given by $(P - C)/P$. Rearranging Equation 1 reveals that the conduct parameter (or, presented here for ease in exposition, the conduct parameter plus one) can be computed from the (actual) HHI, the (actual) Lerner Index, and the elasticity of demand:

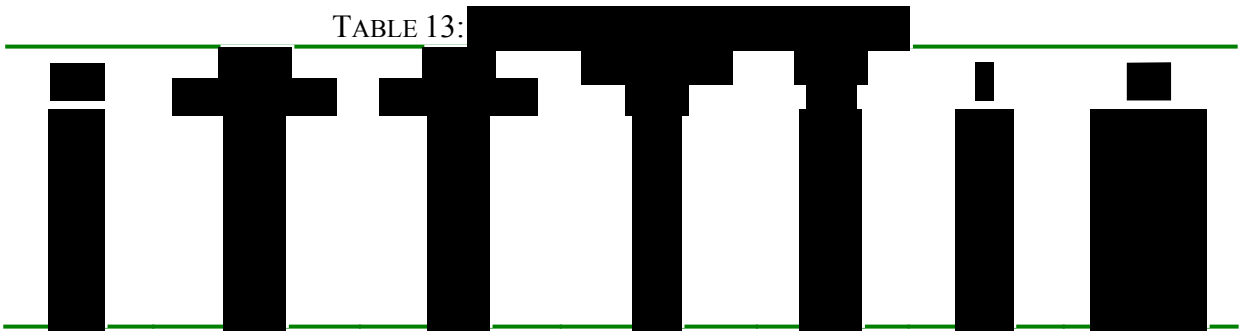
[5] $$-L\frac{E}{HHI} = \theta + 1$$

62. Table 13 presents the resulting estimates of the conduct parameter by year. To calculate the Lerner Index, I used an industry-wide estimate of the average price per container (shown in the first column), based on available industry-wide data on sales and containers sold. [redacted] Finally, the demand

[redacted]

elasticity employed is -1.61, which corresponds to the midpoint of the previously established range of possible values, based on the econometric estimates.

TABLE 13:



63. The conduct parameter estimates contain information on the form of competition in the market for sharps containers. For example, if $(1 + \theta)$ is equal to the inverse of the HHI, then the Lerner Index is equal to the inverse of the industry elasticity of demand. In this case, prices in the marketplace are being set according to a standard monopoly pricing rule. The average of the inverse of the HHIs from Table 10 is approximately 0.00023610. This figure is similar to the conduct values that I estimate in Table 13, although my estimated values are smaller in all years. Thus, according to my estimates of the conduct parameter, competitive interaction in the sharps container market is similar, although not identical, to what would be expected if the industry were monopolized. Given the concentrated nature of the sharps container industry, this result suggests that the NEIO model captures key aspects of competitive interaction in the industry rather well. For example, the results would have been less intuitive if I had obtained a value of the conduct parameter indicating that pricing in the industry is perfectly competitive.

3. Resulting Damage Estimates

64. Given yearly estimates of the conduct parameter, I can obtain estimates of the but-for Lerner Index. In particular, if I denote the but-for HHI as $HHI_{bf,}$ the but-for Lerner Index as L_{bf}, and the but-for price as P_{bf}, then it follows that:

[6] $$L_{bf} = -(\theta + 1)\frac{HHI_{bf}}{E}$$

[7] $$P_{bf} = \frac{C}{1 - L_{bf}}$$

65. Using equations 6 and 7, I can compute the but-for Lerner Index and the but-for price in each year. The results of these computations are shown in Table 14. The actual values for price and the Lerner Index are also shown for comparative purposes.

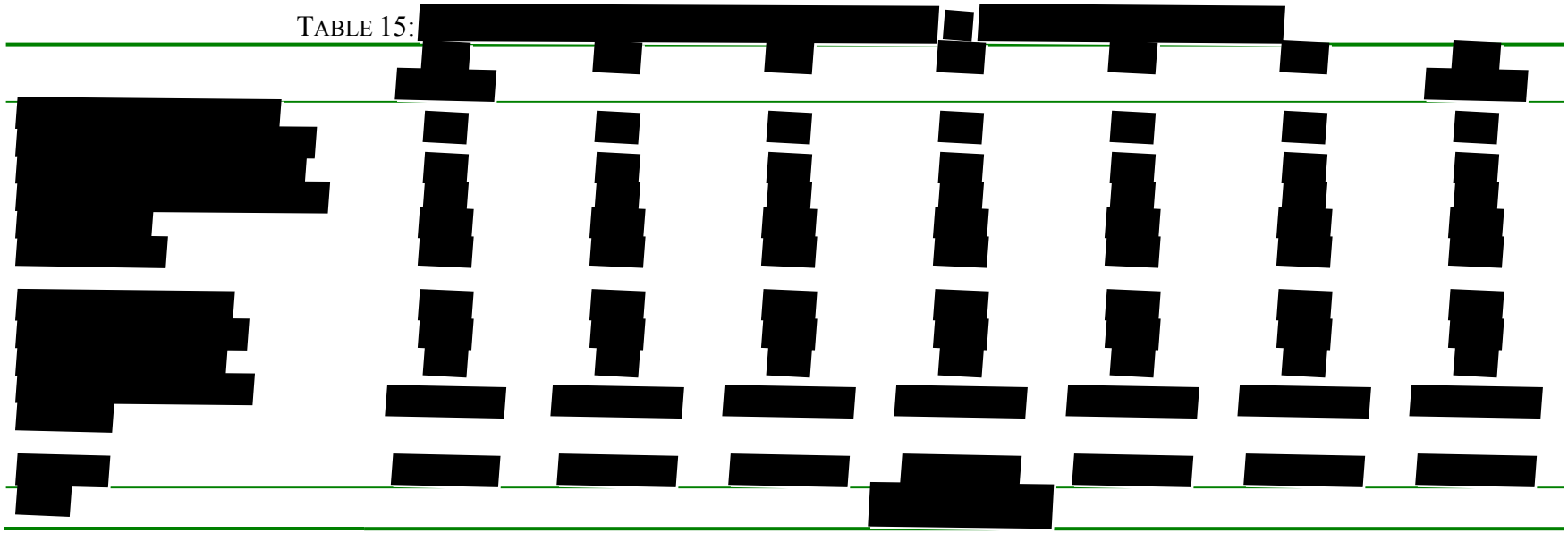
TABLE 14: [redacted]

66. I am now able to compute class-wide damages. Here, damages are denoted D_{cw}, actual average prices are denoted P_a, and but-for average prices are denoted $P_{bf.}$ Finally, Tyco's actual revenues are written $TR_{T.}$

[8] $$D_{cw} = \frac{(P_a - P_{bf})}{P_a} * TR_T$$

67. Note below in Table 15 that 2001 revenues and damages reflect only transactions taking place after the beginning of the Class Period (transactions on or after October 4, 2001). In addition, note that Tyco's transactional data end May 1, 2007. Hence, to estimate damages through the end of November 2007, I multiplied Tyco's 2007 revenues by the ratio (11/4). The results of the aggregate yearly damage computation are shown in Table 15, which shows the damages incurred by Tyco purchasers alone.

TABLE 15: [redacted]



As Table 15 shows, depending on the year in question, prices are estimated to be between 18 percent and 27 percent lower in the but-for world. In addition, the damages associated with foreclosure due to commitment contracts are estimated at approximately $183 million.

C. Foreclosure in the GPO Brokerage Market

68. Tyco's sole-source GPO contracts have the effect of foreclosing rivals from the GPO brokerage market. Table 16 presents damage estimates arising from this foreclosure scenario. To obtain an estimate of the extent of total sharps container sales directly affected by GPO foreclosure, I relied on estimates from Professor Elhauge of the share of Tyco's sales going to buyers foreclosed by Tyco's sole-source GPO contracts. These estimates were then multiplied by Tyco's market share (obtained from Table 10). The result of this computation is an estimate of the share of total sharps container sales directly affected by GPO foreclosure.

69. Next, I obtained the change in rival penetration and the remaining inputs into damage estimation in a manner analogous to that described in detail in section IV.B. As in the previous case, I allocated the increase in rival penetration on a pro-rata basis. It bears emphasis that this approach is conservative: Given BD's unique access to GPO brokerage services in the actual world, it is likely that, in the but-for world, smaller rivals would have benefited disproportionately in the absence of Tyco's alleged anticompetitive conduct. (For example, Daniels experienced a substantial increase in market share upon gaining access to Novation).[87] If this were the case in the but-for world, we would expect but-for HHIs (and but-for prices) to be lower than those implied by a pro-rata allocation.

87. [redacted]

70. As seen in Table 16 below, I estimate damages due to this form of foreclosure at approximately $123 million. In addition, I estimate that but-for prices would have been between 7 and 22 percent lower in the but-for world, depending on the year in question. However, note that there is overlap between this form of foreclosure and foreclosure arising from commitment contracts. Hence, the two estimates in Tables 15 and 16 are not strictly additive, as shown in Table 17 below.

TABLE 16:

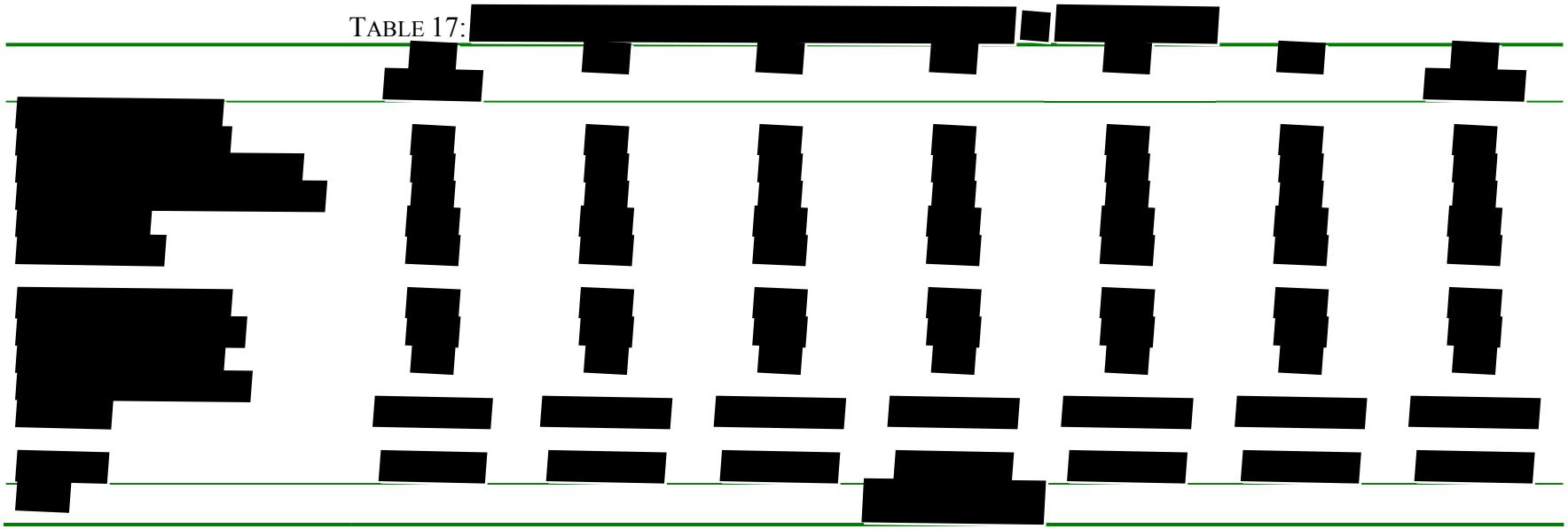
D. Aggregate Damage Estimate, Incorporating Both Forms of Foreclosure

71. Table 17 presents damage estimates which aggregate the effects of commitment-based contracts and GPO sole-source contracts. For this calculation, I obtained from Professor Elhauge a conservative estimate of the aggregate impact of these two forms of foreclosure. In particular, a buyer is considered to be directly affected by foreclosure in Professor Elhauge's estimates if it was affected by *either* type of contracting practice. Thus, the calculation accounts for (1) sales foreclosed through share-based commitments only; (2) sales directly affected by foreclosure in the GPO brokerage market only; and (3) sales affected by both (1) and (2).

72. But-for prices are estimated to be between 17 percent and 31 percent lower than extant prices in the aggregate, depending on the year in question. Aggregate damages for the entire Class Period are estimated at approximately $191 million.

73. These damage estimates are conservative for at least four reasons. First, spillover between the non-foreclosed and the foreclosed portions of the market is assumed to be zero. Thus, any increase in rivals' market share in the but-for world is restricted to the foreclosed segment. Second, my pro-rata allocation of the rivals' increase in market share does not account for the fact that reusables makers and smaller disposable makers would have been deprived of more scale economies than BD as a result of Tyco's foreclosure, and also discounts BD's unique access to the GPO brokerage market in the actual world. Third, the conduct parameter is assumed not to decrease in the but-for world. Finally, I assume that there is no interaction between the two types of foreclosure. In other words, I assume that foreclosure through share-based commitments does not reinforce, and is not reinforced by, foreclosure in the GPO brokerage market.

TABLE 17: [redacted]



V. THE SECOND APPROACH TO DAMAGES: RAISING-RIVALS'-COST MODEL

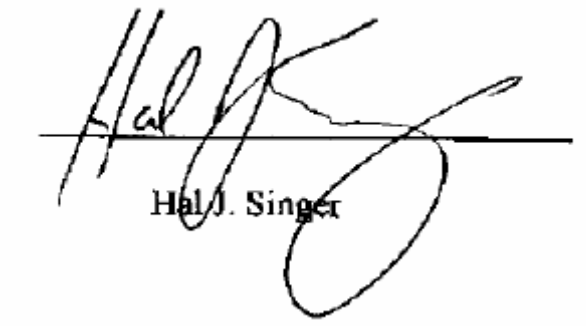
74. The inputs required by the raising-rivals'-cost model include the elasticity of the fringe supply curve, the increase in the marginal cost of the fringe, and the elasticity of Tyco's residual demand curve. Of these three required inputs, at present I have only the last (obtained through estimation of Tyco's own-firm elasticity). To implement the raising-rivals'-cost model, I would need to incorporate additional information on the cost structure of Tyco's rivals. Due to the recent production of cost data and the time constraints involved in completing this report, I have not had the opportunity to estimate damages using the raising-rivals'-cost method. As my factual inquiry continues, and as more data and documents are obtained, estimation of damages using this model may be feasible.

CONCLUSION

75. Based on the NEIO model, I estimate damages attributable to Tyco's commitment contracts with end-users to be $183 million. I estimate damages attributable to Tyco's sole-source contracts with GPOs to be $123 million. I estimate the cumulative effect of Tyco's two forms of allegedly anticompetitive conduct to be $191 million. My analysis is ongoing. I reserve the right to modify or supplement this report as further information warrants. Such information may include, but is not limited to, damage estimates derived from the raising-rivals'-cost model.

***

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.



Executed on December 18, 2007.

APPENDIX 1: CURRICULUM VITAE

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EDUCATION

THE JOHNS HOPKINS UNIVERSITY, Ph.D., 1999; M.A. (Economics), 1996.

TULANE UNIVERSITY, B.S. *magna cum laude* (Economics), 1994. Dean's Honor Scholar (full academic scholarship). Senior Scholar Prize in Economics, 1994.

CURRENT EMPLOYMENT

CRITERION ECONOMICS, L.L.C., Washington, D.C.: President, 2004-present. Senior Vice President, 1999-2004.

EMPLOYMENT HISTORY

LECG, INC., WASHINGTON, D.C.: Senior Economist, 1998-99.

U.S. SECURITIES AND EXCHANGE COMMISSION, OFFICE OF ECONOMIC ANALYSIS, WASHINGTON, D.C.: Staff Economist, 1997-98.

THE JOHNS HOPKINS UNIVERSITY, ECONOMICS DEPARTMENT, BALTIMORE: Teaching Assistant, 1996-98.

AUTHORED BOOKS AND BOOK CHAPTERS

An Antitrust Analysis of the World Trade Organization's Decision in the U.S.-Mexico Arbitration on Telecommunications Services, co-authored with J. Gregory Sidak, in HANDBOOK OF TRANS-ATLANTIC ANTITRUST (Philip Marsden, ed. Edward Elgar 2006).

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2. *The Effect of Incumbent Bidding in Set-Aside Auctions: An Analysis of Prices in the Closed and Open Segments of FCC Auction 35*, __ TELECOMMUNICATIONS POLICY JOURNAL (forthcoming 2007), co-authored with Peter Cramton and Allan Ingraham.

3. *A Real-Option Approach to Analyzing the ACLI's Excise Tax Proposal on Life Settlement Transactions,* __ JOURNAL OF FINANCIAL TRANSFORMATION (forthcoming 2007), co-authored with Joseph R. Mason.

4. *The Economics of Wireless Net Neutrality,* 3 JOURNAL OF COMPETITION LAW AND ECONOMICS 399 (2007), co-authored with Robert W. Hahn and Robert E Litan.

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15. *The Benefits of a Secondary Market for Life Insurance*, 38 REAL PROPERTY, PROBATE AND TRUST JOURNAL 449 (2003), co-authored with Neil A. Doherty.

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18. *Vertical Foreclosure in Broadband Access*, 49 JOURNAL OF INDUSTRIAL ECONOMICS (2001) 299, co-authored with Daniel L. Rubinfeld.

19. *Open Access to Broadband Networks: A Case Study of the AOL/Time Warner Merger*, 16 BERKELEY TECHNOLOGY LAW JOURNAL 640 (2001), co-authored with Daniel L. Rubinfeld.

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22. *Determining the Source of Inter-License Synergies in Two-Way Paging Networks*, 18 JOURNAL OF REGULATORY ECONOMICS 59 (2000).

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EXPERT TESTIMONY

1. Reply Declaration of Hal J. Singer on behalf of PacifiCare Health System, Inc., *In Re* Tricor Indirect Purchaser Antitrust Litigation, C.A. No. 05-360 (KAJ) (D. Del 2006) (Sept. 28, 2007).

2. Reply Declaration of Hal J. Singer on behalf of Direct Purchasers in Natchitoches Parish Hosp. Serv. Dist. v. Tyco Int'l, Ltd. et al. (D. Mass. 2005) (Feb. 9, 2007).

3. Declaration of Hal J. Singer on behalf of Direct Purchasers in Natchitoches Parish Hosp. Serv. Dist. v. Tyco Int'l, Ltd. et al. (D. Mass. 2005) (Dec. 15, 2006).

4. Declaration of Hal J. Singer on behalf of PacifiCare Health System, Inc., *In Re* Tricor Indirect Purchaser Antitrust Litigation, C.A. No. 05-360 (KAJ) (D. Del 2006) (Dec. 15, 2006).

5. Reply Declaration of J. Gregory Sidak and Hal J. Singer on behalf of Mid-Atlantic Sports Network, In the Matter of Comcast Corp., Time Warner Cable, Inc. and Adelphia Communications Corp., Applications for Consent to the Assignment and/or Transfer of Control of Licenses, MB Dkt. No. 05-192 (Nov. 15, 2005).

6. Declaration of J. Gregory Sidak and Hal J. Singer on behalf of the Power Mobility Coalition, In the Power Mobility Coalition v. Michael O. Leavitt, Secretary, U.S. Department of Health and Human Services, and Mark B. McClellan, Administrator, Centers for Medicare and Medicaid (D.D.C. 2005) (Oct. 13, 2005).

7. Comments of Robert W. Crandall and Hal J. Singer on behalf of TELUS Communications Inc., In the Matter of Telecommunications Policy Review, Canadian Radio-television and Telecommunications Commission (Aug. 15, 2005).

8. Declaration of J. Gregory Sidak and Hal J. Singer on behalf of Mid-Atlantic Sports Network, In the Matter of Comcast Corp., Time Warner Cable, Inc. and Adelphia Communications Corp., Applications for Consent to the Assignment and/or Transfer of Control of Licenses, MB Dkt. No. 05-192 (July 22, 2005).

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10. Declaration of Robert W. Crandall and Hal J. Singer on behalf of Verizon Communications Inc. and MCI, Inc., In the Matter of Verizon Communications Inc. and MCI, Inc. Applications for Approval of Transfer of Control, WC Dkt. No. 05-75 (Mar. 10, 2005).

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12. Reply Declaration of Robert W. Crandall and Hal J. Singer on behalf of SBC Communications Inc., In the Matter of EarthLink Inc. v. SBC Communications, Inc., No. EB-04-MD-006 (Dec. 10, 2004).

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17. Declaration of Hal J. Singer on behalf of the Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, In Burlington Northern and Santa Fe Railway Company v. Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation (D. Mont. 2003) (No. CV-01-34-BLG).

18. Declaration of Hal J. Singer on behalf of Tomas H. Miguens, In Q International Courier v. Tomas H. Miguens (S.D.N.Y. 2003) (No. 02 Civ. 5278-JSM).

19. Declaration of Robert W. Crandall and Hal J. Singer on behalf of Bell Canada Enterprises, In the Matter of Hearings before the Standing Committee On Industry, Science And Technology of the House of Commons of Canada Pursuant to Standing Order 108(2), Consideration of Foreign Investment Restrictions Applicable to Telecommunications Common Carriers (Feb. 20. 2003).

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1. Is Greater Price Transparency Needed in The Medical Device Industry? (prepared for Advanced Medical Technology Association), co-authored with Robert W. Hahn (Nov. 30, 2007).

2. Should the FCC Depart from More than a Decade of Market-Oriented Spectrum Policy? Reply to Skrzypacz and Wilson (prepared for CTIA), co-authored with Gerald Faulhaber and Robert W. Hahn (Jun. 18, 2007).

3. Does Retransmission Consent Contribute To Rising Cable Rates? (prepared for the National Association of Broadcasters), co-authored with Jeffrey A. Eisenach and James C. Miller III (Mar. 9, 2007).

4. Does Public Safety Need More Spectrum? (prepared for Verizon Wireless), co-authored with Peter Cramton, Thomas S. Dombrowsky, Jr., Jeffrey A. Eisenach and Allan Ingraham (Nov. 9, 2006).

5. The Budgetary Impact of Eliminating the GPOs' Safe Harbor Exemption from the Anti-Kickback Statute of the Social Security Act (prepared for the Medical Device Manufacturers Association) (Dec. 20, 2005).

6. Reply to "The Life Settlements Market: An Actuarial Perspective on Consumer Economic Value" (prepared for Coventry First), co-authored with Eric Stallard (Nov. 15, 2005).

7. The Competitive Effects of Telephone Entry into Video Markets (prepared for the Internet Innovation Alliance), co-authored with Robert W. Crandall and J. Gregory Sidak (Nov. 9, 2005).

8. How Do Consumers and the Auto Industry Respond to Changes in Exhaust Emission and Fuel Economy Standards? A Critique of Burke, Abeles, and Chen (prepared for General Motors Corp.), co-authored with Robert W. Crandall and Allan T. Ingraham (Sept. 21, 2004).

9. Inter-City Competition for Retail Trade in North Texas: Can a TIF Generate Incremental Tax Receipts for the City of Dallas? (prepared for Harvest Partners), co-authored with Thomas G. Thibodeau and Allan T. Ingraham (July 16, 2004).

10. An Accurate Scorecard of the Telecommunications Act of 1996: Rejoinder to the Phoenix Center Study No. 7 (prepared for BellSouth), co-authored with Robert Crandall (Jan. 6, 2004).

11. Competition in Broadband Provision and Implications for Regulatory Policy (prepared for the Alcatel, British Telecom, Deutsche Telekom, Ericsson, France Telecom, Siemens, Telefónica de España, and Telecom Italia), co-authored with Dan Maldoom, Richard Marsden, and Gregory Sidak (Oct. 15, 2003).

12. The Effect of Ubiquitous Broadband Adoption on Investment, Jobs, and the U.S. Economy (prepared for Verizon), co-authored with Robert W. Crandall (Sept. 17, 2003).

13. The Deleterious Effect of Extending the Unbundling Regime on Telecommunications Investment (prepared for BellSouth), co-authored with Robert W. Crandall (July 10, 2003).

14. Letter Concerning Spectrum Auction 35 to the Honorable Michael K. Powell, Chairman, Federal Communications Commission, from Peter C. Cramton, Robert W. Crandall, Robert W. Hahn, Robert G. Harris, Jerry A. Hausman, Thomas W. Hazlett, Douglas G. Lichtman, Paul W. MacAvoy, Paul R. Milgrom, Richard Schmalensee, J. Gregory Sidak, Hal J. Singer, Vernon L. Smith, William Taylor, and David J. Teece (Aug. 16, 2002).

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1. *Irrational Expectation: Can a Regulator Credibly Commit to Removing an Unbundling Obligation?*, AEI-Brookings Joint Center Related Publication, No. 07-28, co-authored with Jeffrey A. Eisenach (Dec. 2007).

2. *An Antitrust Analysis of Google's Proposed Acquisition of DoubleClick*, AEI-Brookings Joint Center Related Publication No. 07-24, co-authored with Robert W. Hahn (Sept. 2007).

3. *Inter-City Competition for Retail Trade in North Texas: Can a TIF Generate Incremental Tax Receipts for the City of Dallas?*, co-authored with Thomas G. Thibodeau and Allan T. Ingraham (revise and resubmit to JOURNAL OF REAL ESTATE RESEARCH) (July 16, 2004).

4. *An Economic Assessment of the Weight-Based CAFE Standard Proposed by the National Highway Traffic Safety Administration*, co-authored with Robert W. Crandall and Allan T. Ingraham (Apr. 2004).

5. *How Common Are "Conflicts of Interests" in the Investment Banking Industry?*, co-authored with Charles W. Calomiris (Dec. 2003).

6. *Does Clustering by Incumbent MSOs Deter Entry by Overbuilders?* (July 2002).

SPEAKING ENGAGEMENTS

1. *Telecommunications Symposium*, U.S. DEPARTMENT OF JUSTICE ANTITRUST DIVISION, Washington, D.C., Nov. 29, 2007.

2. *Wireless Practice Luncheon*, FEDERAL COMMUNICATIONS BAR ASSOCIATION, Washington, D.C., Nov. 29, 2007.

3. *Association for Computing Machinery's Net Neutrality Symposium*, GEORGE WASHINGTON UNIVERSITY, Washington, D.C., Nov. 12, 2007.

4. *Regulators' AdvanceComm Summit*, NEW YORK LAW SCHOOL, New York, N.Y., Oct. 14, 2007.

5. *Annual Conference*, CAPACITY USA 2007, New York, N.Y., Jun. 26, 2007.

6. *William Pitt Debating Union*, UNIVERSITY OF PITTSBURGH, SCHOOL OF ARTS & SCIENCES, Pittsburgh, PA., Feb. 23, 2007.

7. *Annual Conference*, WIRELESS COMMUNICATIONS ASSOCIATION INTERNATIONAL, Washington, D.C., June 27, 2006.

8. *Annual Conference*, MEDICAL DEVICE MANUFACTURERS ASSOCIATION, Washington, D.C., June 14, 2006.

9. *Annual Conference*, ASSOCIATION FOR ADVANCED LIFE UNDERWRITING, Washington, D.C., May 1, 2006.

10. *Entrepreneur Lecture Series*, LAFAYETTE COLLEGE, Easton, PA., Nov. 14, 2005.

EDITORIALS AND MAGAZINE ARTICLES

1. *Foxes in the Henhouse: FCC Regulation through Merger Review*, MILKEN INSTITUTE REVIEW (forthcoming 2007), co-authored with J. Gregory Sidak.

2. *Don't Drink the CAFE Kool-Aid*, WALL STREET JOURNAL, Sept. 6, 2007, at A17, co-authored with Robert W. Crandall.

3. *The Knee-Jerk Reaction: Misunderstanding the XM/Sirius Merger*, WASHINGTON TIMES, Aug. 24, 2007, at A19, co-authored with J. Gregory Sidak.

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December 18, 2007

APPENDIX 2: EFFECT ON DAMAGE ESTIMATES OF RELAXING VARIOUS CONSERVATIVE ASSUMPTIONS: A SENSITIVITY ANALYSIS

76. Implicit in my damage estimates are several conservative assumptions, which have the effect of decreasing my aggregate damage estimates. Here, I explore the sensitivity of my damage estimates by examining the extent to which estimated damages increase when various assumptions are relaxed. It is important to note that, even in this Appendix, I do not relax all of the conservative assumptions inherent in the analysis. For instance, the analysis continues to assume that any increase in rivals' but-for shares is restricted to the foreclosed segment. In addition, I continue to assume that foreclosure through share-based commitments does not reinforce, and is not reinforced by, foreclosure in the GPO brokerage market.

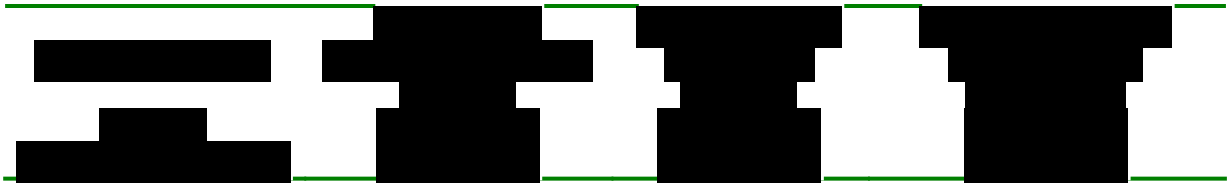
77. First, I relax the imposition of a pro-rata allocation of rivals' increase in market share. As noted previously, reusables makers and smaller disposable makers potentially suffered more than BD as a result of Tyco's foreclosure, because smaller rivals would have been deprived of economies of scale to a greater extent. Thus, smaller rivals would be expected to enjoy disproportionately large increases in market share in the but-for world.

78. In particular, in deviating from a pro-rata allocation, I allow the change in rivals' market share to be redistributed in a manner inversely proportional to rivals' actual market shares. In this way, smaller rivals are permitted to benefit disproportionately. For example, suppose that rivals' market share is estimated to increase by a total of 10 percentage points in the but-for world in a given year. Furthermore, suppose that BD's actual market share is 20 percent, and that the actual market shares for other disposables and reusables are 10 and 5 percent,

respectively. Under these circumstances, BD's market share would increase by 1.4 percentage points[88] in the but-for world. In addition, market shares for other disposables and reusables would increase by 2.9 percentage points[89] and 5.7 percentage points,[90] respectively.

79. Table A1 displays the resulting damage estimates when the inverse proportionality rule is applied to allocate increases in rivals' market share. For comparison, the damage estimates for a pro-rata allocation are also shown. As expected, the damage estimates increase substantially when smaller rivals are allowed to benefit disproportionately.

TABLE A1: DAMAGE ESTIMATES AS A FUNCTION OF INVERSE PROPORTIONALITY



80. Next, I relax the assumption that the conduct parameter remains fixed in the but-for world. It is reasonable to presume that, but for Tyco's conduct, competitive conduct in the industry would have been more intense. If this is the case, then the conduct parameter would decrease in the but-for world, implying lower but-for prices.

81. In particular, I allow the conduct parameter plus one, $(1+\theta)$, to vary between its current value and the value implied by Cournot competition. Under Cournot competition, industry margins are equal to the ratio of the HHI to the elasticity of demand:[91]

$$\frac{P-C}{P} = -\frac{HHI}{E}$$

88. Equal to [(1/20)/(1/20 + 1/10 + 1/5)]*10 percent
89. Equal to [(1/10)/(1/20 + 1/10 + 1/5)]*10 percent
90. Equal to [(1/5)/(1/20 + 1/10 + 1/5)]*10 percent
91. Note that here the HHI is defined as the sum of squares of market shares, and is therefore always less than or equal to one. In other contexts, for convenience the HHI may be scaled up by a factor of 10,000.

82. For ease in exposition, I allow (1+ θ) to vary according to a new variable that I define, labeled δ_1, which can vary freely between zero and one. When δ_1 is set equal to zero, the value of (1+ θ) remains the same in the but-for world, consistent with my prior conservative assumptions. Hence, but-for margins and but-for prices are unchanged from those calculated previously. When is δ_1 is set equal to one, the but-for value of (1+ θ) is chosen such that margins are set equal to those implied by Cournot competition. Therefore, as δ_1 increases from zero to one, the but-for conduct parameter decreases, but-for competitiveness increases, and but-for prices decrease.

83. Table A2 displays the resulting damage estimates when various values of δ_1 are applied to the model. As expected, the damage estimates increase as δ_1 increases. For example, if is δ_1 chosen to equal 0.5, but-for margins lie halfway between their previous values and the values implied by Cournot competition. Under these circumstances, aggregate damages increase from approximately $191 million to approximately $271 million.

TABLE A2: DAMAGE ESTIMATES AS A FUNCTION OF δ_1

[redacted]

APPENDIX 3: ECONOMETRIC RESULTS WITH LINEAR SPECIFICATIONS

84. To identify the specification that fit the data best, I experimented with several alternative models of demand. Here, I display the results of linear specifications. Under a linear specification, the demand elasticity is not constant, and varies with movements along the demand

curve. These specifications proved to fit the data poorly, which ultimately led me to adopt a constant elasticity specification in estimating damages.

85. Here, Q is the quantity of sharps containers demanded, P is the price per container, and X are variables that shift the demand curve. Finally, ε is a random error term.

$$Q_{it} = \beta_0 + \beta_1 P_{it} + \sum_{j=1}^{n} \delta_j X_{ijt} + \varepsilon_{it}$$

86. Table A3 displays the results of an ordinary least squares regression based on the model above. The regression results exhibit a negative and statistically significant relationship between price and quantity demanded. The additional right-hand side variables in the regression control for year-specific fixed effects. As usual, these variables allow for the possibility of year-to-year shifts in the demand for sharps containers. Although the explanatory variables are collectively significant, the fit of the regression is poor: The R-squared statistic indicates that the right-hand side variables explain less than two percent of the variation in quantity.

TABLE A3: ORDINARY LEAST SQUARES REGRESSION RESULTS

Source	SS	df	MS	Number of Obs	13388
				F(7, 13380)	35.40
Model	3.3424e+11	7	4.7749e+10	Prob > F	0.0000
Residual	1.8048e+13	13380	1.3488e+09	R-squared	0.0182
				Adj R-squared	0.0177
Total	1.8382e+13	13387	1.3731e+09	Root MSE	36727

Q	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-333.7137	21.68824	-15.39	0.000	-376.2257	-291.202
Y00	-3195.984	1853.215	-1.72	0.085	-6828.546	436.579
Y01	-2345.996	1173.271	-2.00	0.046	-4645.772	-46.2198
Y02	-1839.068	1156.52	-1.59	0.112	-4106.01	427.8738
Y03	-1000.817	1152.815	-0.87	0.385	-3260.497	1258.863
Y04	715.7499	1159.965	0.62	0.537	-1557.945	2989.444
Y05	-124.316	1159.994	-0.11	0.915	-2398.067	2149.435
cons	21764.05	875.5651	24.86	0.000	20047.82	23480.28

87. To correct for possible simultaneity bias in the linear model, I apply the instrumental variable technique to the linear demand specification; the results are displayed in Table A4. The regression results continue to display a negative and statistically significant relationship between price and quantity demanded. However, the overall fit of the regression remains low: The R-squared statistic indicates that the right-hand side variables continue to explain less than two percent of the variation in quantity.

TABLE A4: INSTRUMENTAL VARIABLES (2SLS) REGRESSION

Source	SS	df	MS	Number of Obs	13388
				F(7, 13380)	30.69
Model	3.3417e+11	7	4.7739e+10	Prob > F	0.0000
Residual	1.8048e+13	13380	1.3489e+09	R-squared	0.0182
				Adj R-squared	0.0177
Total	1.8382e+13	13387	1.3731e+09	Root MSE	36727

Q	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-338.6852	23.72534	-14.28	0.000	-385.1902	-292.180
Y00	-3200.771	1853.241	-1.73	0.084	-6833.386	431.8439
Y01	-2350.702	1173.308	-2.00	0.045	-4650.552	-50.8525
Y02	-1842.106	1156.537	-1.59	0.111	-4109.082	424.8697
Y03	-1002.749	1152.823	-0.87	0.384	-3262.446	1256.947
Y04	714.9987	1159.968	0.62	0.538	-1558.702	2988.699
Y05	-126.3405	1160.002	-0.11	0.913	-2400.109	2147.428
cons	21803.98	878.9681	24.81	0.000	20081.08	23526.88

Based on these results, I conclude that linear specifications fit the data poorly, and are dominated by constant-elasticity models.

APPENDIX 4: MATERIALS RELIED UPON

Case Materials

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