IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF NEW YORK

IN RE: VITAMIN C ANTITRUST LITIGATION	MDL. No. 1738 CLASS ACTION

EXPERT REPORT OF B. DOUGLAS BERNHEIM, Ph.D.

November 14, 2008

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I. Introduction

I.1. Summary of qualifications and experience

(1) I am the Edward Ames Edmunds Professor of Economics at Stanford University. I am also Co-Director of the Tax and Budget Policy Program at the Stanford Institute for Economic Policy Research (SIEPR), a Senior Fellow of SIEPR, and a Partner with Bates White, LLC.

(2) I received my Ph.D. in Economics from the Massachusetts Institute of Technology in September 1982 and my A.B. from Harvard University, summa cum laude, in June 1979. My previous academic appointments include an endowed chair in Economics and Business Policy at Princeton University, where I was also Co-Director of the Center for Economic Policy Studies, and an endowed chair in Insurance and Risk Management at Northwestern University's J.L. Kellogg Graduate School of Management, Department of Finance. I have also served as the Director of the Stanford Institute for Theoretical Economics.

(3) I have taught courses in Microeconomic Theory (Ph.D. level and undergraduate level), Game Theory (Ph.D. level), Public Finance and Public Economics (Ph.D. level and undergraduate level), Industrial Organization (Ph.D. level), Behavioral Economics (Ph.D. level), and Insurance (Masters level). My Ph.D.-level teaching covers both theoretical issues and applied econometrics (data analysis).

(4) I have published extensively in peer-reviewed academic journals and elsewhere on topics concerning public policy, strategic behavior and competitive strategy, microeconomic theory, industrial organization, personal, corporate, and public finance, and other areas. Many of my academic studies entail detailed analysis of microeconomic data using econometric methods.

(5) I have served on the editorial boards of several professional journals, including *Econometrica*, the *Quarterly Journal of Economics*, the *Journal of Public Economics*, and the *Journal of Financial Intermediation*. I also recently served as a Co-Editor of the *American Economic Review*, which is the journal of the American Economics Association and the profession's most widely read periodical.

(6) I have received a number of awards and professional recognitions, including election as a Fellow of the American Academy of Arts and Sciences, election as a Fellow of the Econometric Society, a Guggenheim Fellowship, appointment as a Fellow of the Center for Advanced Studies in the Behavioral Sciences, an Alfred P. Sloan Foundation Research Fellowship, and an NBER-Olin Research Fellowship.

(7) I have been retained as a consultant or expert witness in numerous matters. I have conducted detailed studies of market conditions in a variety of industries, including health care, pharmaceuticals, financial markets, telecommunications, railroads, airlines, aerospace, and a number of manufactured products. I have assessed damages in a variety of matters involving goods and services such as vitamins, pharmaceutical products, insurance, securities brokerage services, and thermal fax paper. I have sponsored testimony concerning these studies before various government agencies and judicial bodies. A copy of my curriculum vita, including a list of my publications, is attached as Appendix A. A list of cases in which I have testified as an expert witness at any time during the past four years is attached as Appendix B.

I.2. Scope of charge

(8) I have been engaged by counsel for class plaintiffs to calculate overcharges, injury, and damages to class members associated with a conspiracy to fix the prices of Vitamin C products purchased from the defendants. The complaint defines the relevant class as follows:

> …all persons or entities, or assignees of such persons or entities, who directly purchased vitamin C for delivery in the United States, other than pursuant to a contract containing an arbitration clause, from any of defendants or their co-conspirators, other than Northeast Pharmaceutical, from December 1, 2001 to the present (the "damages" class). …Excluded from the classes are all government entities, defendants, their co-conspirators, and their respective subsidiaries and affiliates.[1]

(9) Further, I was instructed by counsel to assume that the defendants did in fact unlawfully conspire to violate U.S. antitrust law.

I.3. Summary of damage results

(10) My analysis of overcharges and damages employs generally accepted statistical methods to reconstruct the Vitamin C prices that would have prevailed but for the illegal activities of the cartel. Based on that analysis, I have concluded that the price of Vitamin C was substantially higher as a direct consequence of defendants' conspiracy to restrain trade and control prices. The impact of the conspiracy on Vitamin C prices affected U.S. purchasers from December 2001 to

[1] Second Amended Complaint for Antitrust Violations at 7, *Animal Science, et al. v. Hebei, et al.*, No. 1:05-CV-00453 (E.D.N.Y. Sept. 27, 2007).

June 2006. The observed elevation of prices during this time period is not attributable to competitive market factors. As a result of the conspiracy, the plaintiffs suffered damages of approximately $58.4 million. That amount excludes purchases that are subject to agreements that have arbitration clauses.

(11) Based on methodological principles and extensive sensitivity analyses, I conclude that my damages estimate is reliable and, if anything, conservative. My estimated overcharges are also consistent with an analysis of defendant profit margins, which increased substantially during the cartel period.

I.4. Summary of materials considered

(12) In preparing this report, I was provided with access to documents and materials produced by the plaintiffs and defendants in this matter, transcripts of depositions taken in this matter, and pertinent publicly available information sources. I instructed my research support team to identify information pertaining to the pricing of Vitamin C products, the factors that influenced the pricing of Vitamin C products, and the activities of the cartel. In providing these instructions, I stressed the importance of identifying for my subsequent review important documents bearing on the appropriate computation of damages in this case, irrespective of whether they were favorable to the positions of the plaintiffs or defendants. My support team requested pertinent documents and materials from the plaintiffs, assisted counsel with the formulation of requests for information from the defendants, and conducted searches of publicly available information sources. A complete list of the materials I reviewed can be found in Appendix C. I reserve the right to incorporate new materials or data into my analysis, if and when they become available.

(13) In preparing this report, I was assisted by a staff of expert economists and economic analysts at the consulting firm of Bates White, LLC. While engaged in this matter, I directed the activities of the team, made all final decisions concerning the analytic methods and its implementation, and prepared this report.

II. Vitamin C background

II.1. The demand for Vitamin C products

(14) Vitamin C, also known as ascorbic acid, plays an important role in the biosynthesis of collagen in skin and of connective tissue, bones, and teeth. It is thought to enhance the functioning of the immune system by acting as an antioxidant that destroys free radicals that can lead to tissue damage and cancer. It promotes the synthesis of bile acids, hormones, and neurotransmitters and stimulates male fertility. The use of ascorbic acid in animal nutrition is essentially limited to aquaculture, where it promotes egg production and shell development. Most non-primate animals can synthesize Vitamin C *in vivo* and do not require supplementation, although some Vitamin C is used to supplement animals suffering from stress or illness. Humans require small but regular amounts of Vitamin C to prevent scurvy, a disease that effects the formation of collagen and can result in death after sustained deprivation. Naturally occurring sources of Vitamin C include citrus fruit and green peppers, among others.[2]

(15) According to defendant documents, "Vitamin C is the No. 1 vitamin in the world in terms of consumption."[3] Its consumption has been increasing over time as it has found increasing usage in developing countries.[4] Figure 1 shows the total world consumption by region for 2003. Among global regions, Europe has the greatest consumption, with about 35,000 metric tons, followed by the United States with 30,000 metric tons. The remaining regions of the world, including Japan and China, total another 35,000 metric tons. Thus, according to defendant documents, the United States represents slightly less than one third of world consumption for Vitamin C.

(16) China is the source of an increasingly large portion of Vitamin C used in the United States. Figure 2 below shows Vitamin C imports from China to the U.S. for the period 2000 to 2007. The volume of Vitamin C imported from China increased over time. From 2003 to the present, imports from China represented about 20,000 to 25,000 metric tons of Vitamin C per year. The last column of Figure 2 shows average annual prices of Vitamin C imported from China. As discussed in much greater depth below, those prices were substantially elevated for much of the class period, notably in 2002 through 2004.

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2 U.S. National Institutes of Health, "Vitamin C source," *Medical Encyclopedia*, January 1, 2007, http://www.nlm.nih.gov/MEDLINEPLUS/ency/imagepages/18109.htm (accessed August 27, 2008).

3 HEB 5626-34.

4 HEB 5616 (on HEB 5623); WSC 13393; HEB 3607; HEB 3697; Nutraingredients.com, "Vitamin makers to recover ground in new growth markets," July 16, 2003, http://www.nutraingredients.com/Consumer-Trends/Vitamin-makers-to-recover-ground-in-new-growth-markets (accessed June 25, 2008).

Figure 1: Vitamin C worldwide purchases by region in 2003[5]

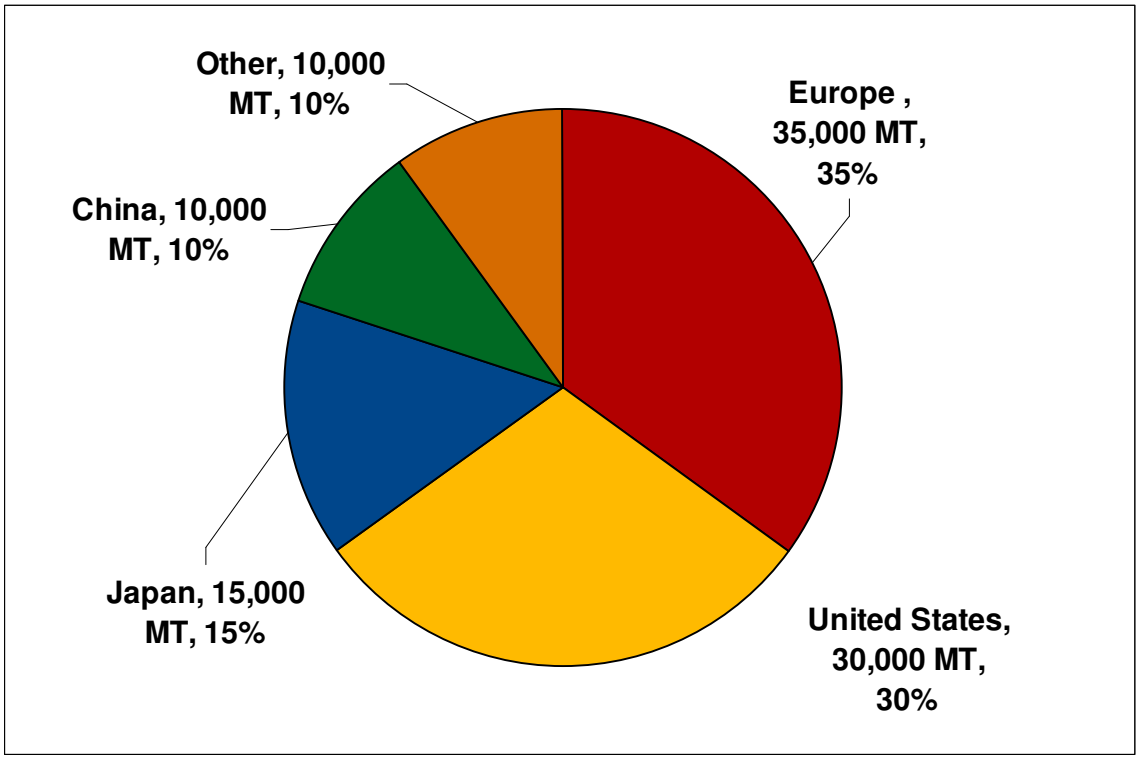


Figure 2: U.S. Vitamin C imports from China from 2000 to 2007[6]

Year	U.S. imports	Quantity	Average Price
2000	$ 51,189,041	11,059,586	$ 4.63
2001	$ 33,701,925	9,876,883	$ 3.41
2002	$ 52,406,291	14,761,265	$ 3.55
2003	$ 103,878,551	18,652,340	$ 5.57
2004	$ 114,189,560	23,042,754	$ 4.96
2005	$ 102,257,017	26,633,047	$ 3.84
2006	$ 75,912,203	23,355,559	$ 3.25
2007	$ 121,613,023	25,331,159	$ 4.80
Total	**$ 781,795,687**	**177,490,471**	**$ 4.40**

[5] HEB 5616-25.

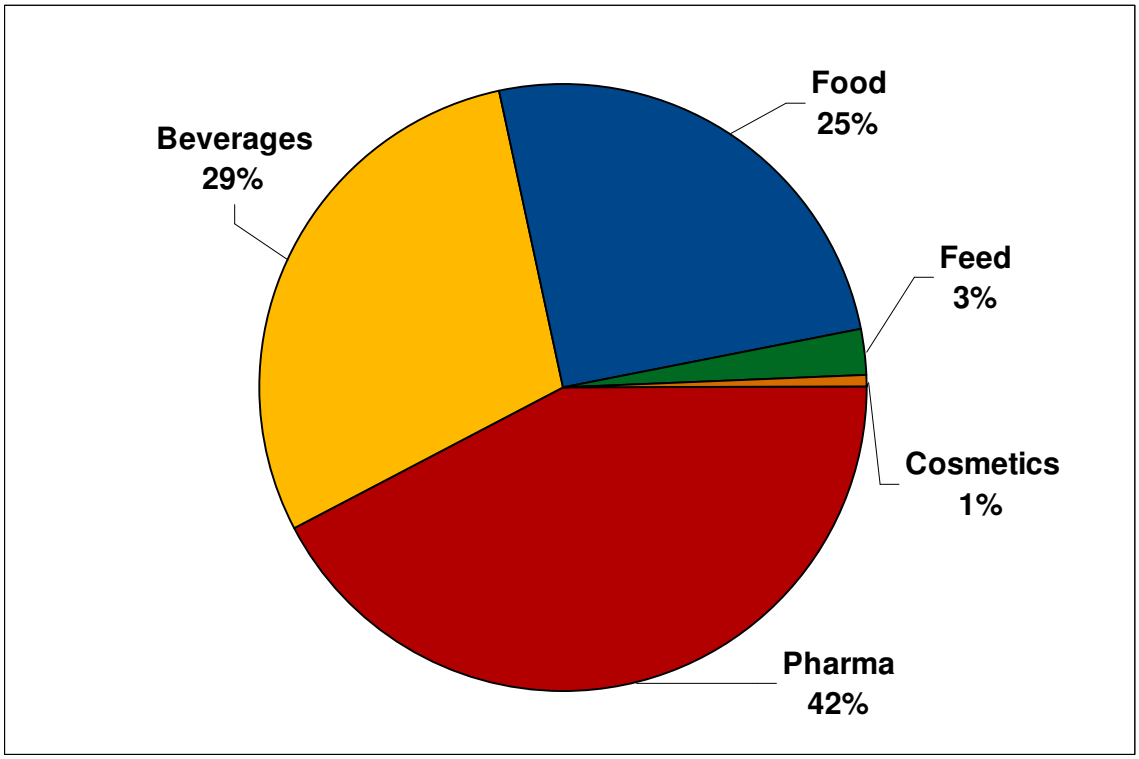
[6] U.S. International Trade Commission, Customs Data, "U.S. Consumption Imports of Vitamin C (Ascorbic Acid) and Its Derivatives," HTS Code 2936270000, http://dataweb.usitc.gov/scripts/user_set.asp (hereinafter *ITC data*).

(17) Defendant documents characterize Vitamin C demand as exhibiting steady and predictable growth.[7] Annual growth rates are typically less than 10%, with few unexpected fluctuations.[8]

(18) Bulk Vitamin C, as sold by defendants, is not consumed directly by humans or animals, but rather is incorporated into other products, such as multivitamins and breakfast cereals. Thus, the demand for bulk Vitamin C is derived from the demand for other products. The end uses of Vitamin C vary widely. It serves as a nutritional additive in food and beverages, a feed additive especially for aquaculture, a food preservative, and a cosmetic ingredient. It also has a variety of specialty uses in metallurgy, color film, dyes, paper, detergent, hair dyes, hair treatment, deodorant, and micro-electronics.[9] However, its main uses involve pharmaceutical products and human nutrition.[10] Figure 3 shows Vitamin C end uses for NEPG customers in 2001. Human consumption involving pharmaceuticals, foods, and beverages comprise 96% of all Vitamin C usage. Animal feed and cosmetics account for the remaining 4%. The various specialty applications likely comprise such a small portion of consumption that they are not reported separately. Many of the largest U.S. customers are distributors or intermediary producers that supply inputs to other manufacturers. They include vitamin resellers, chemicals companies, and firms that produce food and beverages.[11]

7 WSC 13393.
8 *Ibid.*; WSC 12461.
9 HEB 5616-25.
10 WSC 13393.
11 NEPG 28580; WSC 12461. Defendant transaction data list customer names.

Figure 3: NEPG customers' end use of Vitamin C in 2001[12]



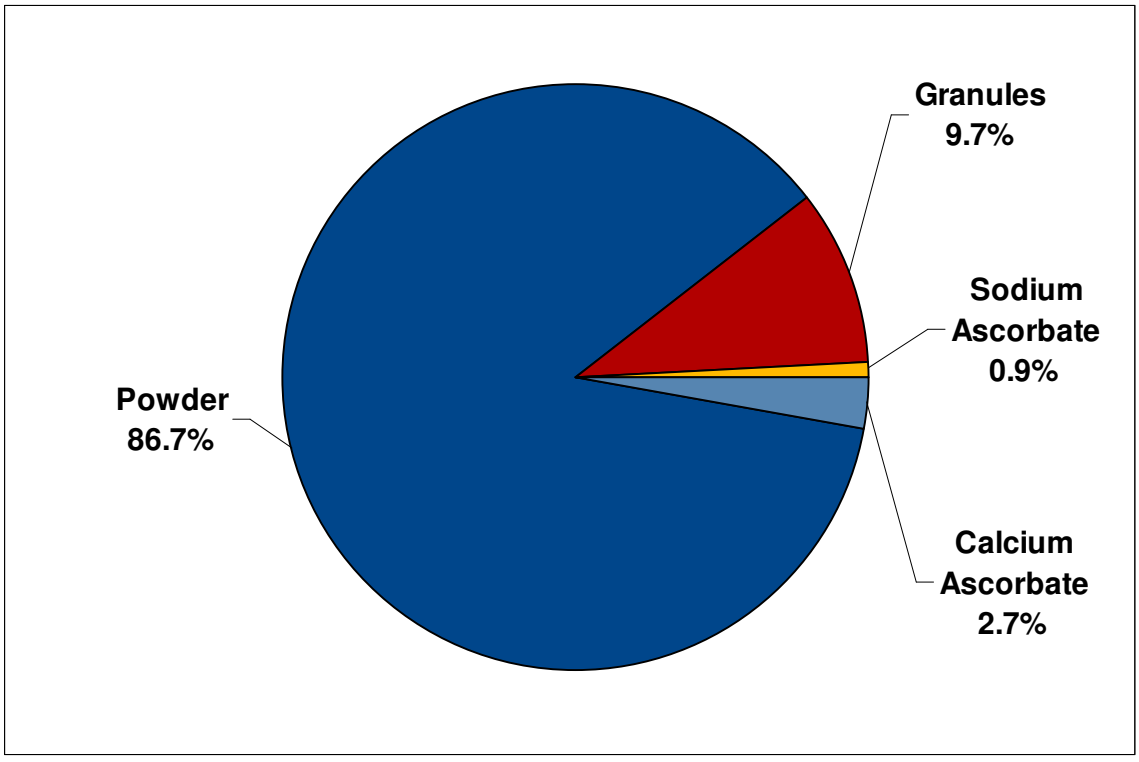
(19) Vitamin C comes in several forms. The most basic form is called ascorbic acid powder, also known as "raw" Vitamin C. Other formulations, often called "varieties," include ascorbic acid fine particle, coated ascorbic acid, sodium ascorbate crystal, calcium ascorbate, ascorbyl phosphate, and ascorbate acid palmitate. Vitamin C varieties are generally produced from raw Vitamin C crystals using appropriate finishing steps. Figure 4 lists specific end uses for several Vitamin C varieties produced by Hebei. According to Figure 5, raw Vitamin C accounted for 87% of Weisheng's U.S. sales in 2004. Figure 6 reports Hebei's Vitamin C varieties sales over time, showing that varieties increased in the late 1990s, but for 2000 to 2004 have been between 10% and 15% of sales. As described below, some manufacturers have been known to cease production of raw Vitamin C, and then purchase it from others to continue producing varieties.

[12] NEPG 28342.

Figure 4: Hebei end use of Vitamin C formulations[13]

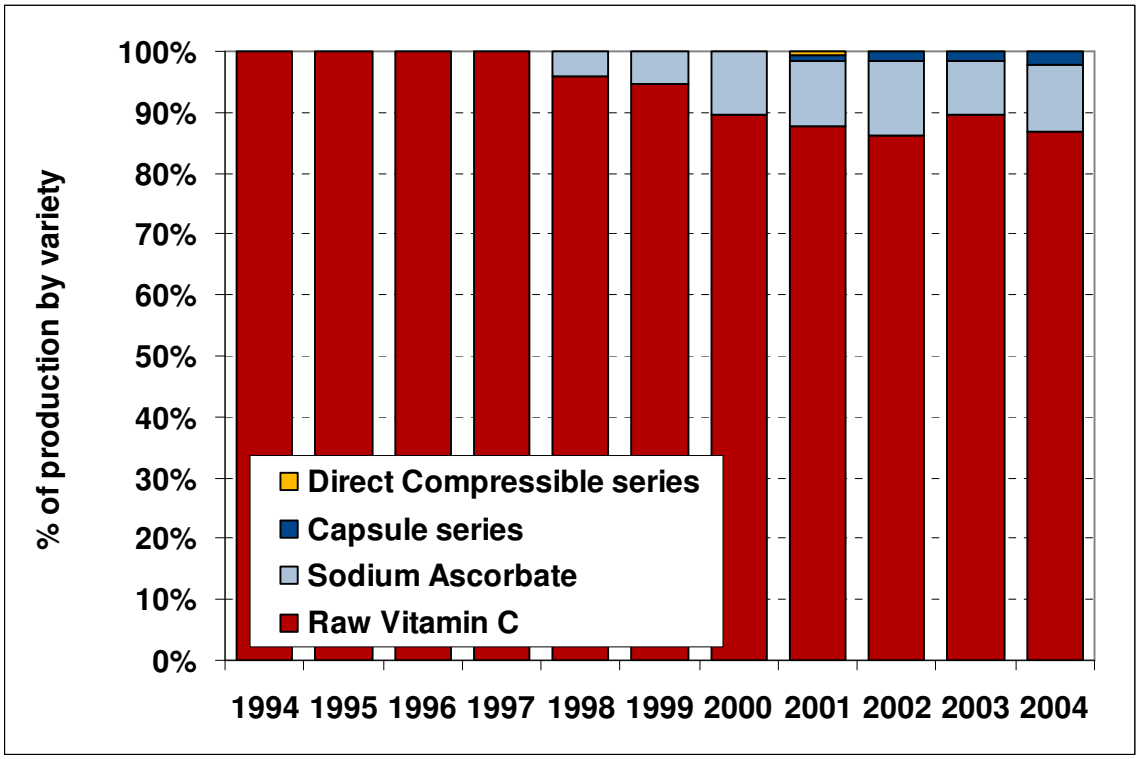
Formulation	End use
Ascorbic acid	Fortification of dry and liquid food, such as ready-to-eat solid beverage, nutritional food, juice, and soft drinks
Ascorbic acid fine particle	Flour improver; curing agent for meat processing; stabilizer for juice, soft drinks, beer, wine, and processed fruits and vegetables
Coated ascorbic acid	Fortification of dry food, such as ready-to-eat solid beverages, nutritional food, and processed potatoes
Sodium ascorbate crystal	Curing agent for meat processing; flour improver, stabilizer for processed potatoes, and fortification of dry and liquid foods
Calcium ascorbate	Fortification of dry food, especially for low-sodium food
Ascorbic acid palmitate	Stabilizer and anti-oxidant for fat, fatty foods, and processed potatoes

Figure 5: Varieties of Vitamin C sold by Weisheng in the U.S. in 2004[14]



[13] HEB 7557.
[14] WSC 12461.

Figure 6: Hebei sales of Vitamin C varieties over time[15]



(20) For final consumers seeking to increase their intake of Vitamin C, naturally occurring sources such as fruits and vegetables are potential substitutes for Vitamin C supplements and/or foods containing Vitamin C additives. Nevertheless, the defendants' customers had no feasible substitutes for bulk Vitamin C. For example, producers of Vitamin C tablets or breakfast cereals cannot substitute citrus fruit for raw Vitamin C.

(21) Raw Vitamin C is a nearly homogeneous commodity. The most important differentiating factor among defendants' products is price. Defendant documents cite price as one of the primary dimensions on which firms compete.[16] Documents further show that customers are cognizant of price differences among defendant manufacturers and negotiate lower prices by making direct price comparison.[17] Defendants respond to these price comparisons by matching their

[15] HEB 3621-3623.

[16] JJPC 36990. "The similarity of products means that any competition will only be launched targeting customer service and price."

[17] Deposition of Wang Qi, July 2, 2008, Exhibit 130, at 1. "We are still in hard negotiation with our customer. During this weekend I learnt [sic] that he got an offer for North East material cheaper by 5 US cents."

competitors' prices.[18] Other product characteristics, such as product quality, are not viewed as important distinguishing factors among Vitamin C manufacturers.[19]

(22) Raw Vitamin C accounts for a small fraction of the cost of end-use products. For example, a bottle of Vitamin C tablets could cost consumers from $5 to $20 or more but contain less than one dollar of raw Vitamin C (less than 0.1 kilogram per bottle).[20] For foods and beverages such as breakfast cereals and sports drinks, Vitamin C represents a much smaller fraction of the price paid by end users. Therefore, changes in the price of Vitamin C, even if passed completely through to end-use products, are unlikely to have a significant impact on the prices of those products. As a result, the quantity of Vitamin C demanded by consumers is unlikely to change significantly in response to movements in the price of raw Vitamin C.

(23) SARS, also known as Severe Acute Respiratory Syndrome, is a viral infection that affects the respiratory system and in a small fraction of cases proves fatal.[21] The first cases of SARS were reported in early March 2003.[22] Public awareness of SARS in the United States and around the world increased for a brief period around that time. Defendant documents suggest that awareness of SARS may have increased the demand for vitamins, including Vitamin C.[23] However, defendant documents also suggest that manufacturers quickly increased production to meet the SARS-induced demand and that the impact of SARS was short lived.[24]

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18 HEB 498-613 (on HEB 507). "Our company have [sic] a new price of vc this week. We will reduce our price so as to stand up to the competition. If you are interested in our products, please let me know."

19 "Major Vitamin C Producers in China Have No Intention to Manipulate Prices,"*Feedlink*, November 3, 2003, www.efeedlink.com (accessed July 24, 2004). "For the past few years, the Japanese importers have come to regard Vitamin C products produced in China are [sic] both competitive in price and not less inferior in quality from manufacturers elsewhere."

20 At GNC, a 90-pill bottle of American Health Ester-C® 1000mg vitamins cost $17.99, http://www.gnc.com/product/index.jsp?productId=3113946&cp=2626023.2272548&parentPage=family (accessed November 4, 2008). A 100-pill bottle of GNC Vitamin C 1000mg vitamins costs $6.29, http://www.gnc.com/product/index.jsp?productId=2133379&cp=2626023.2272548&parentPage=family (accessed November 4, 2008).

21 WHO Initiative for Vaccine Research (IVR) Severe Acute Respiratory Syndrome (SARS), http://www.who.int/vaccine_research/diseases/ari/en/index4.html (accessed October 27, 2008).

22 WHO worldwide SARS cases by date of report, http://www.who.int/csr/sars/epicurve/epiindex/en/index2.html (accessed October 27, 2008).

23 WSC 13393; HEB 7557; NEPG 26565; NEPG 28076; JJPC 43592; "Difficulty in Forecasting Price Trend of Vitamin C in Global Market; Chinese Production a Key Determinant," *Feedlink*, December 2, 2003, www.efeedlink.com (accessed July 24, 2004).

24 WSC 13393.

II.2. Suppliers and competition

II.2.1. Some historical developments

(24) Much of the vitamins industry was illegally cartelized during the 1990s. That cartel was at the time the largest price-fixing conspiracy ever documented. It lasted for nearly a decade and affected billions of dollars of U.S. commerce.[25] It encompassed a wide range of vitamin products, including Vitamin C.[26] While the record indicates that particular products were cartelized as early as January 1990 and as late as February 1999,[27] it also suggests that price-fixing for Vitamin C began in 1991 and ended in 1995.[28] Many firms pleaded guilty to fixing the prices of vitamins during that period, including the price of Vitamin C.[29] At the time, the producers of Vitamin C included Roche, BASF, Takeda, and Merck.[30]

(25) Fines and penalties were imposed on the original cartel members by various regulatory agencies. The United States Department of Justice (DOJ) imposed fines totaling $900 million including: $500 million for Roche, $225 million for BASF, $72 million for Takeda, and $14 million for Merck.[31] The European Commission (EC) imposed the following fines: €462 million for Roche, €331.13 million for BASF (later reduced to €273.82 million),[32] €37.05 million for Takeda, and €9.24 million for Merck.[33] EC fines for Vitamin C alone were €65.25 million for Roche, €14.68

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25 Belinda A. Barnett, U.S. Department of Justice, "Antitrust in the Twenty-First Century: Status Report on International Cartel Enforcement," Nov. 30, 2000, http://www.usdoj.gov/atr/public/speeches/7086.htm (accessed October 14, 2008).

26 U.S. Department of Justice, "F. Hoffmann-La Roche and BASF Agree to Pay Record Criminal Fines for Participating in International Vitamin Cartel," May 20, 1999, http://www.usdoj.gov/opa/pr/1999/May/196at.htm (accessed September 8, 2008).

27 U.S. Department of Justice, "F. Hoffmann-La Roche and BASF Agree to Pay Record Criminal Fines for Participating in International Vitamin Cartel," May 20, 1999, http://www.usdoj.gov/opa/pr/1999/May/196at.htm (accessed September 8, 2008); Commission of the European Communities, "Commission decision," November 21, 2001, ¶¶ 625–6.

28 U.S. Department of Justice, "Two German Firms and Two U.S. Corporations Agree to Plead Guilty to Participating in International Vitamin Cartels," May 5, 2000, http://www.usdoj.gov/opa/pr/2000/May/249at.htm (accessed November 4, 2008).

29 U.S. Department of Justice, "F. Hoffmann-La Roche and BASF Agree to Pay Record Criminal Fines for Participating in International Vitamin Cartel," May 20, 1999, http://www.usdoj.gov/opa/pr/1999/May/196at.htm (accessed September 8, 2008); U.S. Department of Justice, "Three Japanese Companies Agree To Plead Guilty, Pay Criminal Fines, For Participating In International Vitamin Cartel," September 9, 1999, http://www.usdoj.gov/opa/pr/1999/September/404at.htm (accessed September 8, 2008).

30 Commission of the European Communities, "Commission decision," November 21, 2001, ¶¶ 625–6.

31 U.S. Department of Justice, "Sherman Act Violations Yielding a Fine of $10 Million or More," March 28, 2001, http://www.usdoj.gov/atr/public/speeches/8063.htm (accessed September 8, 2008).

32 This total includes BASF's fine of €34.97 million for Choline. "Competition: Commission Imposes €66.34 Million Fines on Animal Feed Vitamin Cartel," December 9, 2004, http://europa.eu/rapid/pressReleasesAction.do?reference=IP/04/1454&format=PDF&aged=1&language=EN&guiLanguage=en (accessed September 9, 2008).

33 "Commission imposes fines on vitamin cartels," November 21, 2001,

million for BASF (reduced to €10.875 million), €28.28 million for Takeda, and €9.24 million for Merck.[34] DOJ fines and penalties did not specify the amounts specifically attributable to Vitamin C.

(26) The original cartel members may have stopped fixing the price of Vitamin C sooner than the prices of other products because elevated prices attracted entry and expansion by Chinese Vitamin C manufacturers. Chinese firms developed a two-stage fermentation process (described in further detail below), that allowed them to produce Vitamin C at lower costs than the incumbent firms.[35] Equipped with the new fermentation technology, many Chinese manufacturers entered the market and expanded production in the late 1980s and early 1990s.[36] Despite some initial quality concerns, consumers became increasingly willing to purchase Chinese Vitamin C, and the Chinese share of global sales began to increase steadily.[37] At one point, it appears that 20 or more Chinese firms served the global market.[38] Once the original vitamins cartel stopped fixing the price of Vitamin C in 1995, prices fell sharply.[39] A period of exit and consolidation among Chinese manufacturers followed, and the number of Chinese Vitamin C producers declined.[40] By 1998, that process left the Chinese production of Vitamin C largely concentrated within four major firms and their affiliates.[41]

(27) Falling prices and the entry of more efficient competitors led the incumbent manufacturers to downsize or withdraw from the market. In January 2001 BASF completed the acquisition of the bulk vitamins business of Takeda, consolidating two of the original Vitamin C cartel members.[42]

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http://europa.eu/rapid/pressReleasesAction.do?reference=IP/01/1625&format=HTML&aged=0&language=EN&guiLanguage=en (accessed September 9, 2008). BASF's EC fine was later reduced by 59.3 million Euros. "The CFI Reduces The Fines Imposed On BASF To 236.845 Million Euros And On Daiichi To 18 Million Euros For Their Participation In Cartels In Various Vitamin Markets," March 15, 2006, http://curia.europa.eu/en/actu/communiques/cp06/aff/cp060022en.pdf (accessed September 9, 2008).

34 "Commission Imposes Fines on Vitamin Cartels," November 21, 2001, http://europa.eu/rapid/pressReleasesAction.do?reference=IP/01/1625&format=HTML&aged=0&language=EN&guiLanguage=en (accessed September 9, 2008).

35 UK Competition Commission, "BASF AG and Takeda Chemical Industries Ltd: A Report on the Acquisition by BASF AG of Certain Assets of Takeda Chemical Industries Ltd," Appendix 4.4., July 2001, http://www.competition-commission.org.uk/rep_pub/reports/2001/fulltext/456a4.4.pdf.

36 *Ibid.*

37 *Ibid.*; HEB 7557.

38 HEB 3644-3653.

39 *Ibid*.

40 *Ibid*.

41 *Ibid.*; UK Competition Commission, "BASF AG and Takeda Chemical Industries Ltd: A Report on the Acquisition by BASF AG of Certain Assets of Takeda Chemical Industries Ltd," Appendix 4.2., July 2001, http://www.competition-commission.org.uk/rep_pub/reports/2001/fulltext/456a4.2.pdf.

42 UK Competition Commission, "BASF AG and Takeda Chemical Industries Ltd: A Report on the Acquisition by BASF AG of Certain Assets of Takeda Chemical Industries Ltd," Chapter 1, July 2001, http://www.competition-commission.org.uk/rep_pub/reports/2001/fulltext/456c1.pdf.

In 2002, BASF ceased producing raw Vitamin C at its U.S. plant located in Wilmington, North Carolina, though it continued producing varieties using raw Vitamin C obtained from other sources.[43] In 2005, BASF ceased raw Vitamin C production at its plant in Denmark but continued producing Vitamin C varieties using raw Vitamin C from the former Takeda plant in Japan.[44] Merck halted production of Vitamin C in August of 2002.[45] Roche sold its vitamins business to DSM in September 2003 for €2.25 billion.[46] In 2005, DSM closed its New Jersey Vitamin C production facility and subsequently relied solely on its Scotland plant for raw Vitamin C.[47]

(28) Both BASF and DSM have either entered into business partnerships with Chinese producers or have constructed their own Vitamin C manufacturing facilities in China. DSM has sought a cooperative partnership with North China Pharmaceutical Group Corporation in an effort to improve its competitive position in the Vitamin C market.[48] Similarly, since 1995, NEPG has provided BASF with Vitamin C under a formal supply agreement.[49]

II.2.2. Production and costs

(29) Defendants manufacture Vitamin C using a two-step fermentation procedure. This process begins with sorbitol, which is chemically altered through a series of steps.[50] The resulting acid reacts with methanol to produce sodium ascorbate.[51] Ascorbic acid is obtained after acidification and purification.[52] An illustration of this production process obtained from defendant documents is shown in Figure 7.

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43 BASF, "BASF restructures vitamin C production in NAFTA region," news release, November 15, 2001, http://www.basf.com/corporate/news2001/newswilmington_111501.html (accessed September 9, 2008).

44 BASF 2008 Factbook; http://www.corporate.basf.com/basfcorp/img/investor/publikationen/BASF_Factbook_2008.pdf?MTITEL=BASF+Factbook&typ=.pdf&id=21NO1Cr_Abcp2m; BASF, "BASF restructures vitamin C production in NAFTA region," news release, November 15, 2001, http://www.basf.com/corporate/news2001/newswilmington_111501.html (accessed September 9, 2008).

45 JJPC 43572.

46 DSM, "Roche sells vitamins and fine chemicals division to DSM," Press release, September 3, 2002, http://www.dsm.com/en_US/html/media/press_releases/27-Roche-vitamins.htm (accessed September 9, 2008).

47 DSM, "2005 annual report," 2006, http://www.dsm.com/en_US/downloads/invest/2005_annual_report_en.pdf.

48 *Ibid*.

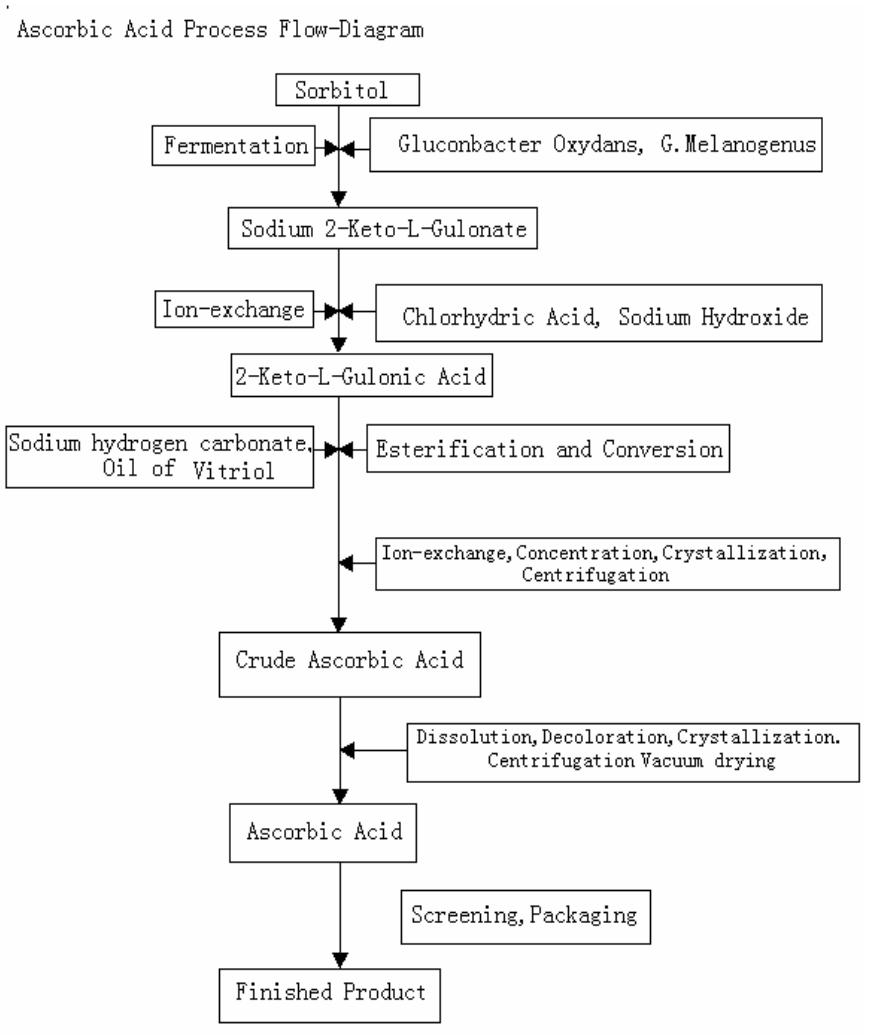
49 NEPG 26326.

50 NEPG 62036.

51 *Ibid*.

52 *Ibid*.

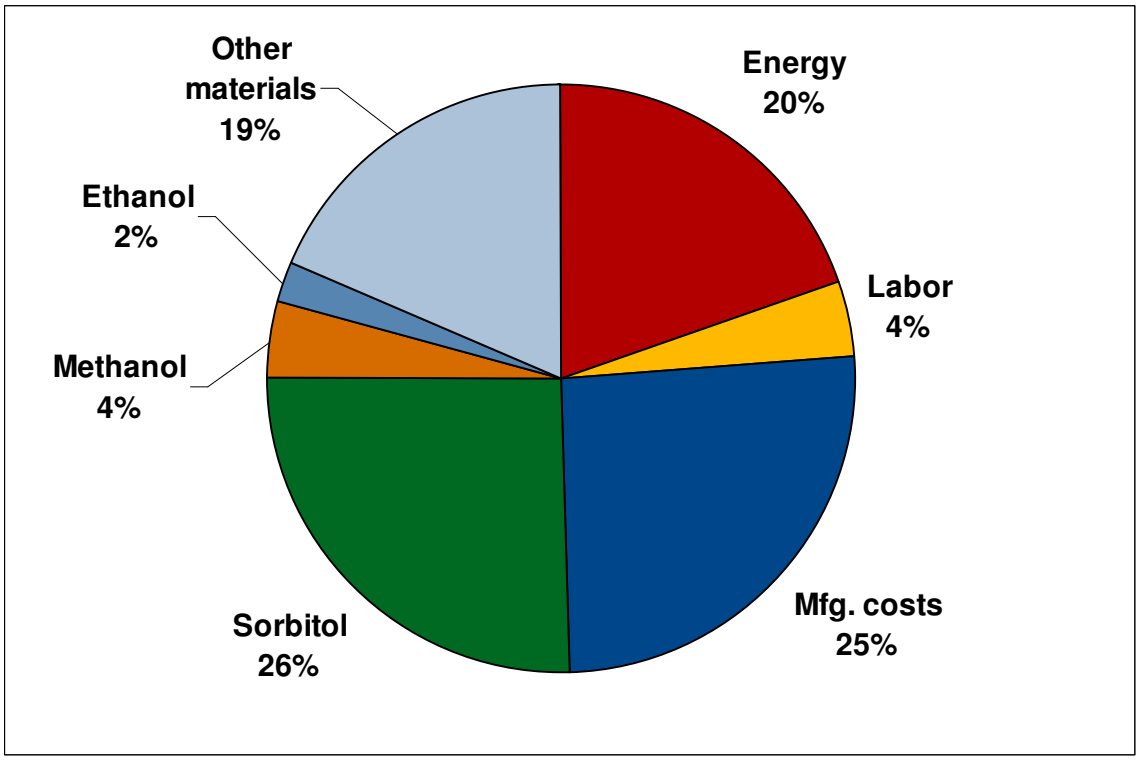
Figure 7: Vitamin C production process[53]



[53] WSC 16336.

(30) Figure 8 provides information concerning NEPG's Vitamin C production costs. According to this figure, sorbitol accounts for approximately one quarter of total costs, as do other materials (ethanol, methanol, etc.), energy, and manufacturing expenses. Labor accounts for a small fraction of total costs.

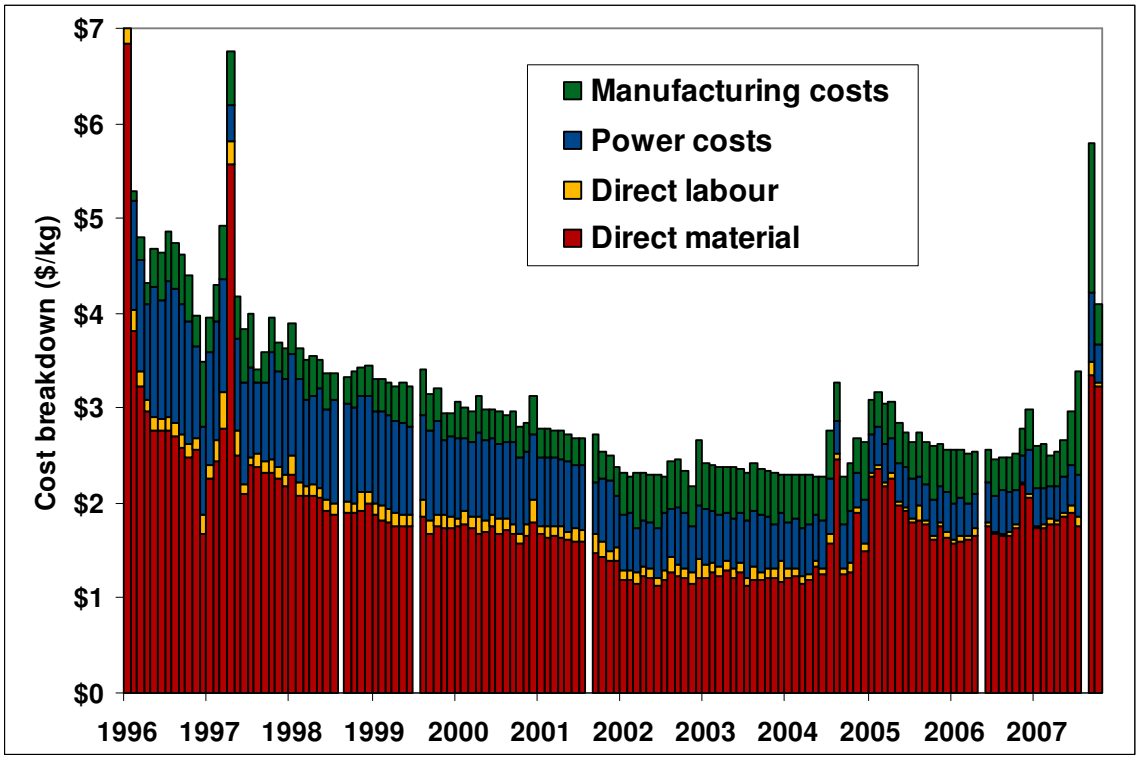
Figure 8: Cost Structure for NEPG[54]



[54] NEPG 59113.

(31) Figure 9 shows how the major components of Weisheng's production cost (materials, energy, labor, and manufacturing expenses), expressed in dollars per kilogram, have varied over time. Weisheng's cost structure is generally similar to NEPG's. In addition, the Weisheng data exhibit several trends. Most notably, per-unit production costs generally declined through time. Costs did not increase at all during 2003 and most of 2004, when Vitamin C prices rose dramatically.

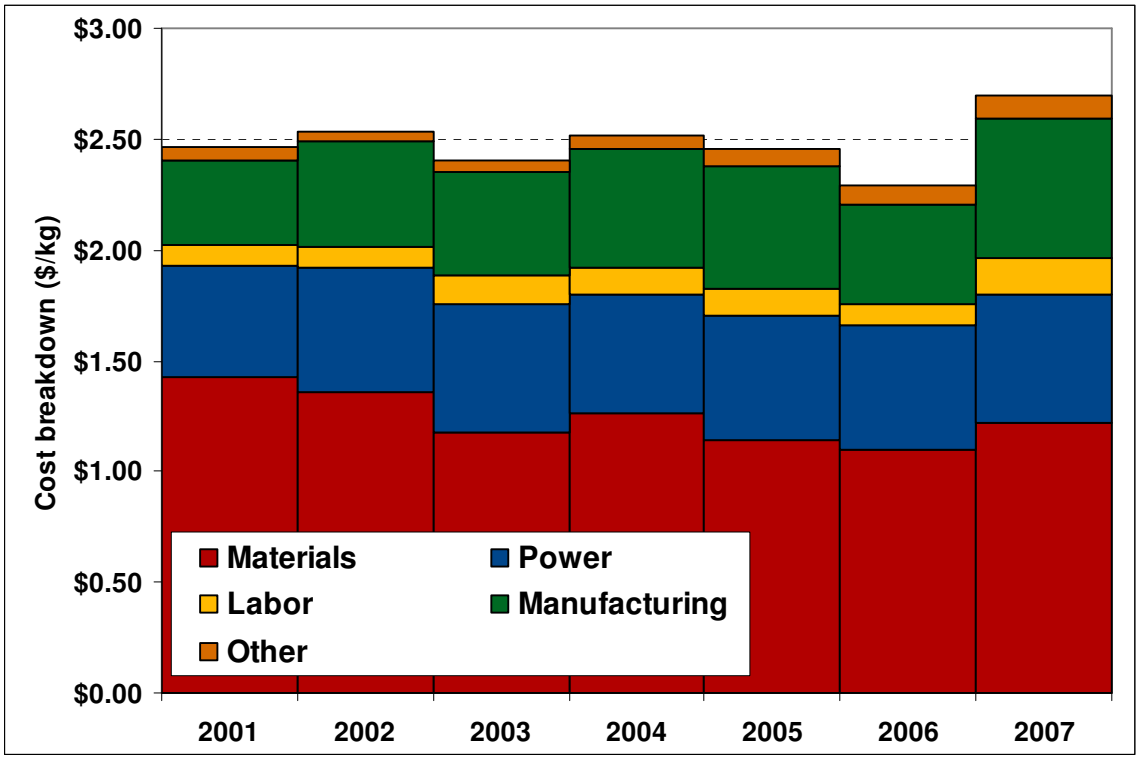
Figure 9: Weisheng per-unit production costs reported for major cost categories[55]



[55] WSC 14963; WSC 14964; WSC 14965; WSC 14966; WSC 14967; WSC 14968; WSC 14969; WSC 14970; WSC 14501; WSC 14370.

(32) Figure 10 shows how the major components of Hebei's production cost (materials, energy, labor, and manufacturing expenses), expressed in dollars per kilogram, have varied over time.

Figure 10: Hebei per-unit production costs reported for major cost categories[56]



(33) The observed declines in Weisheng's production costs are traceable to a number of developments, including (but not necessarily limited to) the following. First, Weisheng was able to reduce its consumption of raw materials by modifying methanol recovery devices and using by-product acid rather than synthetic acid.[57] Second, it improved its water systems, saving roughly 80,000 tons of water per month.[58] Third, it achieved a 5% reduction in power consumption by optimizing equipment parameters and reducing the amount of low temperature water and circulation water used.[59] It also saved 500,000 Yuan per month by extending the lifecycles of filter membranes.[60]

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56 HEB 13718.
57 WSC 10354.
58 *Ibid.*
59 *Ibid.*
60 *Ibid.*

Finally, Weisheng documents indicate that the company implemented measures to save on electrical power consumption.[61]

(34) Other companies also reduced production costs by improving efficiency. Hebei's documents indicate that the company improved the management of its energy system to "overcome the effect of [the] energy price rise."[62] Hebei sought to reduce the consumption of energy and materials and fully utilize existing resource recovery systems.[63] JJPC made "technical improvements in fermentation, extraction, conversion, environmental protection, and utility engineering… improving the yield rate and quality and in reducing consumptions."[64] JJPC documents from early 2005 refer to many cost-saving improvements, increasing production yields, a Redacted decline in consumption of the main raw materials, and a net decline in energy cost of Redacted per Vitamin C unit.[65]

II.2.3. Suppliers

(35) The Northeast Pharmaceutical Group Corporation (NEPG) is a pharmaceutical company located in Shenyang, China.[66] NEPG sells hundreds of different pharmaceutical products, including (but not limited to) antibiotics, vitamins, and cardiovascular drugs.[67] Its Vitamin C exports from China between 2001 and 2005 totaled 75,548 metric tons worldwide and 36,489 metric tons to the United States.[68] The company operates a Vitamin C production facility within China, located in Shenyang, Liaoning.[69] Beginning in 2002, NEPG supplied BASF with its North American Vitamin C requirements.[70]

(36) Weisheng Shijiazhuang Pharmaceutical Co. (WSPC or Weisheng), the Vitamin C manufacturing arm of Shijiazhuang Pharmaceutical Group, is located in China.[71] Weisheng sells a variety of Vitamin C products.[72] Its Vitamin C exports from China between 2001 and 2005 totaled 52,451

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61 WSC 10362.
62 HEB 7881.
63 HEB 3644 at HEB 3646.
64 JJPC 37065.
65 *Ibid*.
66 NEPG 26204.
67 NEPG 25973.
68 NEPG 26590; NEPG 28327; NEPG 62365; NEPG 28343; WSC 10308.
69 NEPG 42473.
70 NEPG 25569; NEPG 26203; NEPG 26326; NEPG 28513.
71 CSPC Weisheng Pharmaceuticals, "About us," 2004, http://www.e-cspc.com/english/index.aspx# (accessed November 4, 2008).
72 CSPC Weisheng Pharmaceuticals, "Products," 2004, http://www.e-wspc.com/en/products/products.aspx?p=0 (accessed September 9, 2008).

metric tons worldwide and 18,305 metric tons to the United States.[73] Weisheng operates a Vitamin C production facility within China, located in Shijiazhuang Hebei.[74]

(37) Hebei Welcome Pharmaceutical Company (Hebei) is located in China.[75] Hebei sells ascorbic acid, sodium ascorbate, calcium ascorbate, directly compressible Vitamin C, coated Vitamin C, gulonic acid, and L-ascorbate-2-polyhosphate.[76] Its Vitamin C exports from China between 2001 and 2005 totaled 49,866 metric tons worldwide and 12,120 metric tons to the United States.[77] It operates a Vitamin C production facility within China, located in Shijiazhuang Hebei.[78]

(38) Jiangsu Jiangshan Pharmaceutical Co., Ltd. (JJPC or Jiangsu), founded in 1990, manufactures a variety of nutritional supplements and tablets in China.[79] Its Vitamin C exports from China between 2001 and 2005 were 57,697 metric tons worldwide and 16,231 metric tons to the United States.[80] It operates a Vitamin C production facility within China, located in Jingjiang, Jiangsu.[81]

(39) JSPC America, Inc. (JSPCA) distributed Vitamin C and other vitamin products in the United States.[82] JSPCA was a subsidiary of Jiangsu Jiangshan Pharmaceutical Company, Ltd.[83] It was founded in 1994 in California and went out of business in 2003.[84] During that time, JSPCA typically purchased vitamin products from manufacturers, which it resold to other companies, primarily as an input for other products.[85]

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73 NEPG 26590; NEPG 28327; NEPG 62365; NEPG 28343; WSC 10308.

74 CSPC Weisheng Pharmaceuticals, "Contact us," 2004, http://www.e-wspc.com/en/products/products.aspx?p=0 (accessed September 9, 2008).

75 Hebei Welcome Pharmaceutical Co., Ltd., "Company Introduction," http://www.ncpcwelcome.com/qyjj/gsjj-e.htm (accessed September 9, 2008).

76 Hebei Welcome Pharmaceutical Co., Ltd., http://www.ncpcwelcome.com/cpjs/cpjs-e.htm (accessed September 9, 2008).

77 NEPG 26590; NEPG 28327; NEPG 62365; NEPG 28343; WSC 10308.

78 Hebei Welcome Pharmaceutical Co., Ltd., "Company Introduction," http://www.ncpcwelcome.com/qyjj/gsjj-e.htm (accessed September 9, 2008).

79 Jiangsu Jiangshan Pharmaceutical Co., Ltd., "Company profile," http://www.aland.com.cn/1about/about.htm (accessed September 9, 2008).

80 NEPG 26590; NEPG 28327; NEPG 62365; NEPG 28343; WSC 10308.

81 Jiangsu Jiangshan Pharmaceutical Co., Ltd., "Company profile," http://www.aland.com.cn/1about/about.htm (accessed September 9, 2008).

82 Declaration of Jianfeng ("Jeffery") Fang in Support of Defendants' Supplemental Memorandum in Opposition to Plaintiffs' Motion for Class Certification," No. 1:05-CV-00453 (E.D.N.Y. January 10, 2008).

83 *Ibid*.

84 *Ibid*.

85 *Ibid*.

(40) Legend Ingredients Group, Inc. (Legend) was founded in September 2002 in California as a vitamins distribution company.[86] While Legend and JJPC deny any ownership interest in one another,[87] that claim is contradicted by information stating that Legend is "a subsidiary of JSPC (Jiangsu Jiangshan Pharmaceutical Co.)."[88]

(41) Shandong Zibo Hualong Company, Ltd. (Hualong), founded in 2002, manufactures ascorbic acid, sodium ascorbate, calcium ascorbate, and coated ascorbic acid.[89] It operates a Vitamin C production facility with a capacity of more than 10,000 metric tons per annum.[90]

(42) Anhui Tiger Biotech Company, founded in 2001, is a joint venture between Chinese and foreign firms. It is located in Anhui province in the Hefei High-Tech Industrial Development Zone.[91] Its annual exports of Vitamin C varieties, including raw VC powder, VC phosphate (35%, 25%), coated VC (90%, 93%), and VC magnesium phosphate, totals roughly 5,000 metric tons.[92]

II.3. Historical market outcomes

II.3.1. Shares

(43) Vitamin C imports to the U.S. have increased over time, with China representing a growing fraction of those imports. Figure 11 shows U.S. imports of Vitamin C by exporting country from 1997 to 2007. The metric tonnage of Vitamin C imported from China more than tripled over this period. Further, China's share of all U.S. Vitamin C imports increased from approximately 60% in 1997 to over 80% by 2002. Vitamin C originating in China may also reach the United States through other countries; indeed, some of the countries listed as exporters in Figure 11 do not have raw Vitamin C production facilities. Thus, Chinese imports are by far the largest source of Vitamin C in the United States.

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86 *Ibid*.

87 *Ibid*.

88 Natural Products Insider, "Legend Ingredients Group Inc.," http://www.naturalproductsinsider.com/guide/Listing.asp/li/30617, (accessed July 28, 2007).

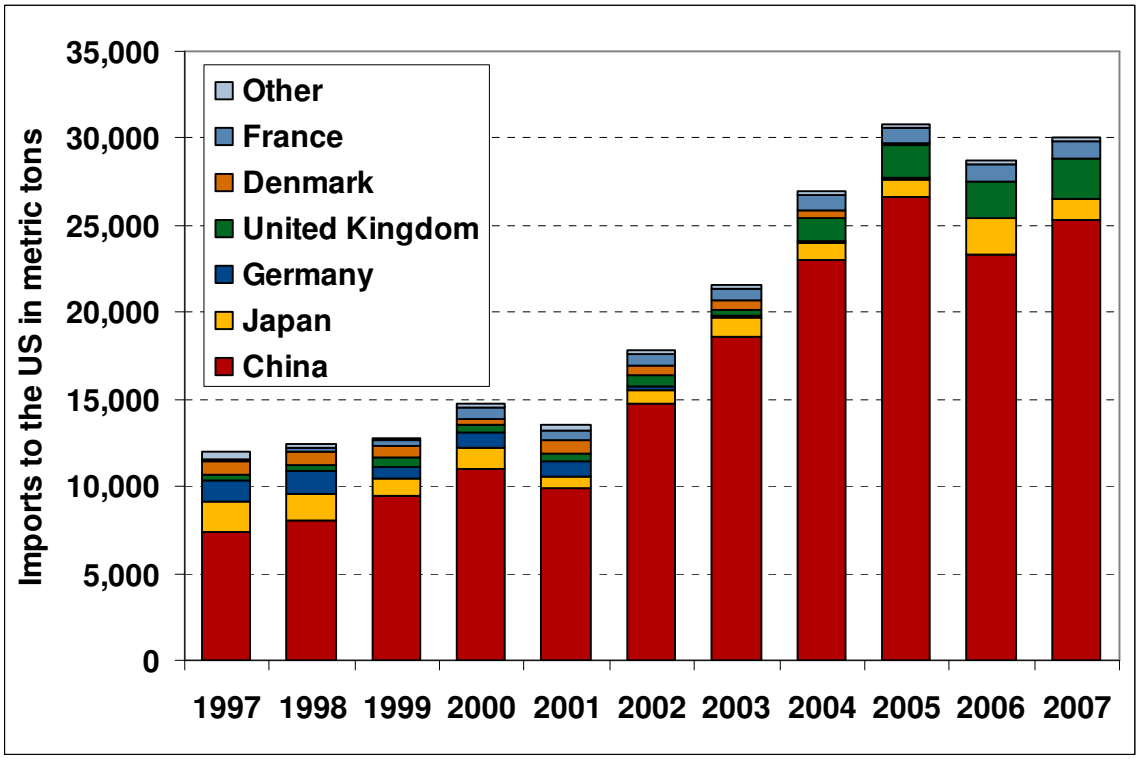
89 Zibo Hualong Pharmaceutical Co. Ltd., "Overview of the products," http://www.hlpc-vc.com/english/webinfo.asp?typeid=4&newsid=2571 (accessed October 14, 2008).

90 NEPG 30340.

91 MadeinChina.com, "Anhwei Tiger Biotech Co., Ltd.," http://www.madeinchina.com/919563/aboutus.shtml (accessed October 14, 2008).

92 NEPG 30340.

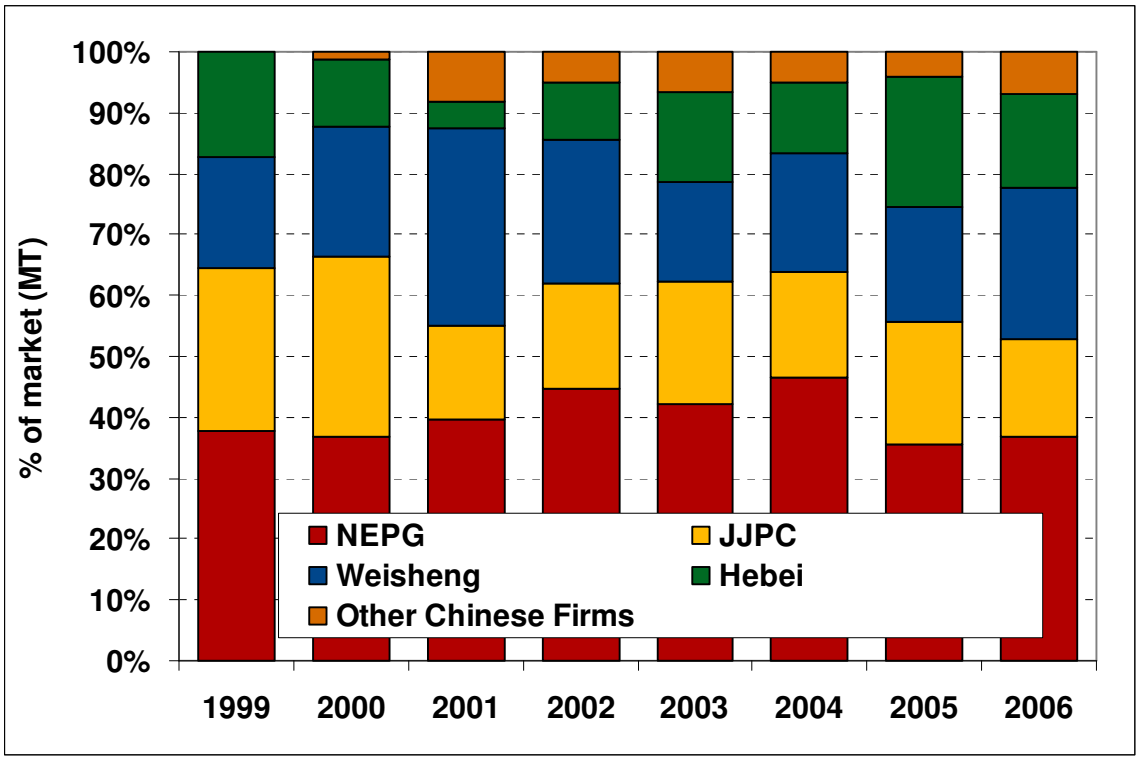
Figure 11: Vitamin C imports to the U.S. by country from 1997 to 2007[93]



[93] ITC data.

(44) Figure 12 shows how the composition of Chinese Vitamin C exports to the U.S. across manufacturers changed through time. The four defendant producers – Hebei, Weisheng, JJPC, and NEPG – accounted for roughly 95% of Chinese Vitamin C exports to the U.S. between 1999 and 2006. Though their shares fluctuated a bit from year to year, there were no persistent trends.

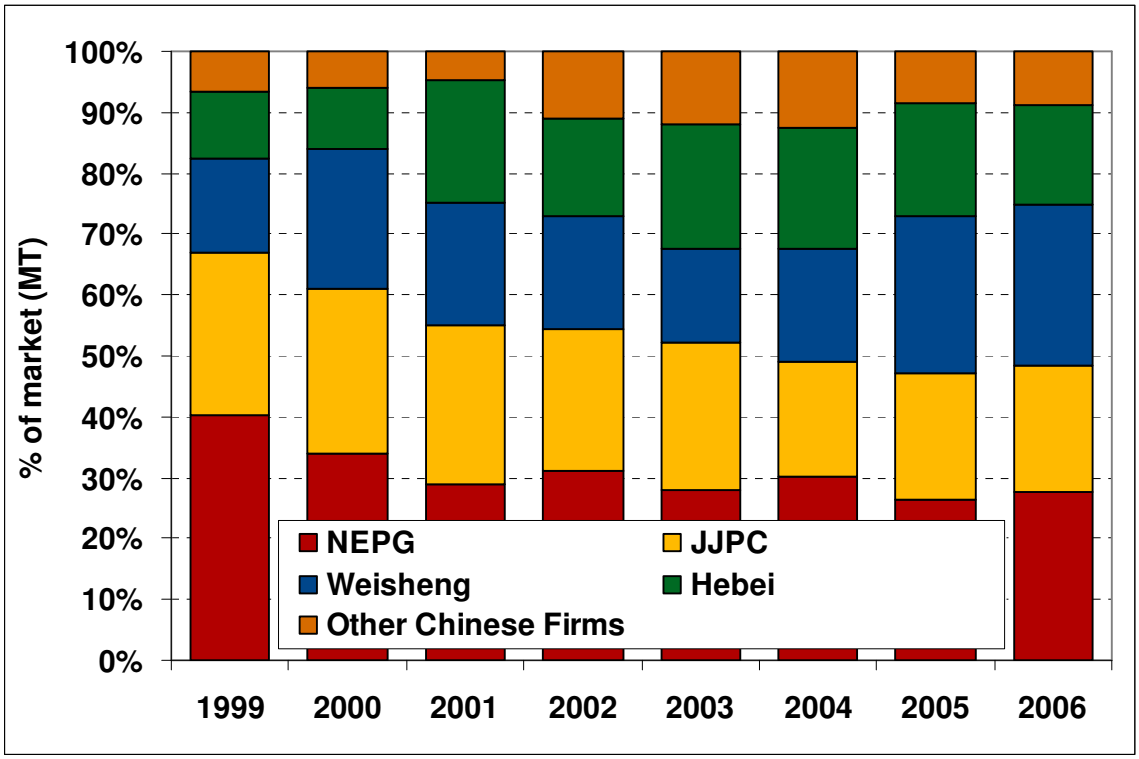
Figure 12: Firm-level volume shares of China's Vitamin C exports to the U.S.[94]



[94] NEPG 28343; NEPG 26590; NEPG 28327; NEPG 62365; WSC 10308.

(45) The same four manufacturers account for more than 90% of worldwide Chinese Vitamin C exports. Figure 13 shows how the composition of worldwide Chinese Vitamin C exports across manufacturers changed over time. Note that NEPG has been the largest Chinese exporter of Vitamin C, accounting for well over 30% of exports to the U.S. and nearly 30% of exports to the rest of the world.

Figure 13: Firm-level volume shares of China's worldwide Vitamin C exports[95]



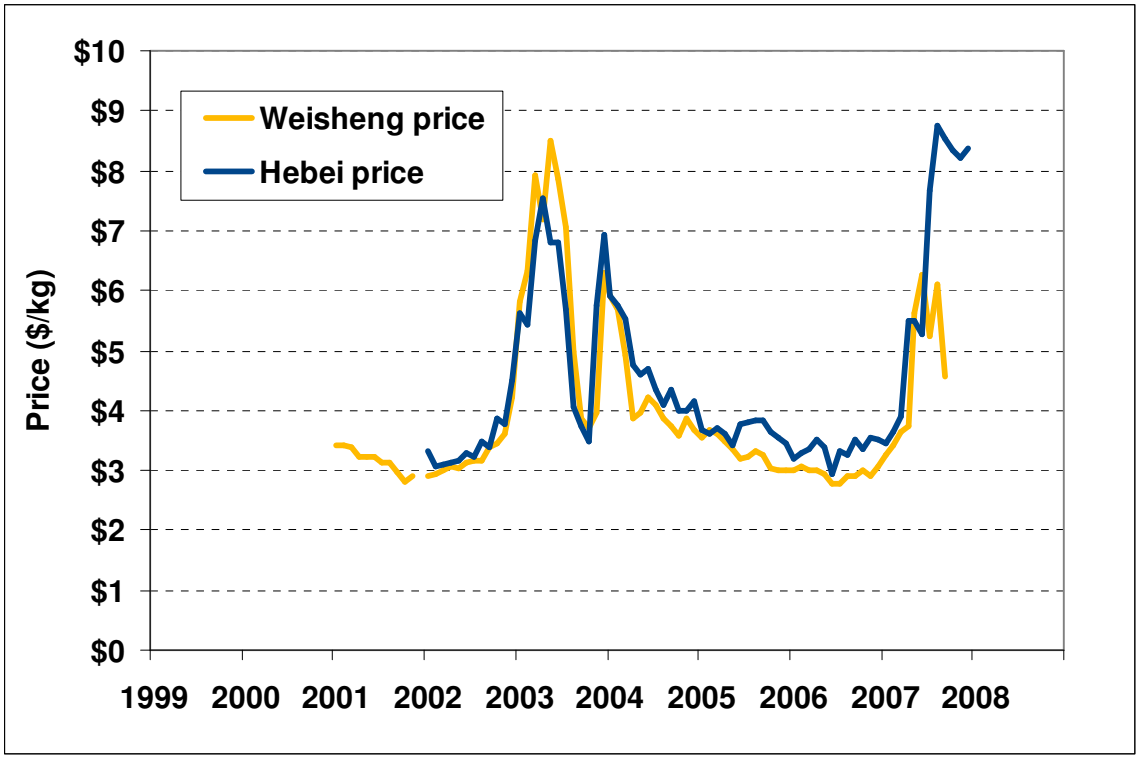
II.3.2. Prices

(46) Data on historical Vitamin C prices are available from several sources. First, the defendants disclosed limited price data in the context of this litigation. Second, one can also obtain price data from independent sources, most notably the U.S. International Trade Commission (ITC). The remainder of this section describes and compares the data available from these sources.

[95] NEPG 28343; NEPG 28327; NEPG 62365; WSC 10308.

(47) Figure 14 shows average prices charged by Hebei and Weisheng, according to the transactions-level data they provided. Although these companies generally charged similar average prices, Weisheng's prices peaked earlier and higher than Hebei's in 2003, and remained slightly higher than Hebei's in 2004. Unfortunately, transactions-level price data for the pre-conspiracy period are confined to 2001 in the case of Weisheng, and nonexistent in the case of Hebei. Moreover, neither JJPC nor NEPG provided price data in useable formats. Those limitations led me to obtain and use Vitamin C price data from another source.

Figure 14: Hebei and Weisheng price data[96]



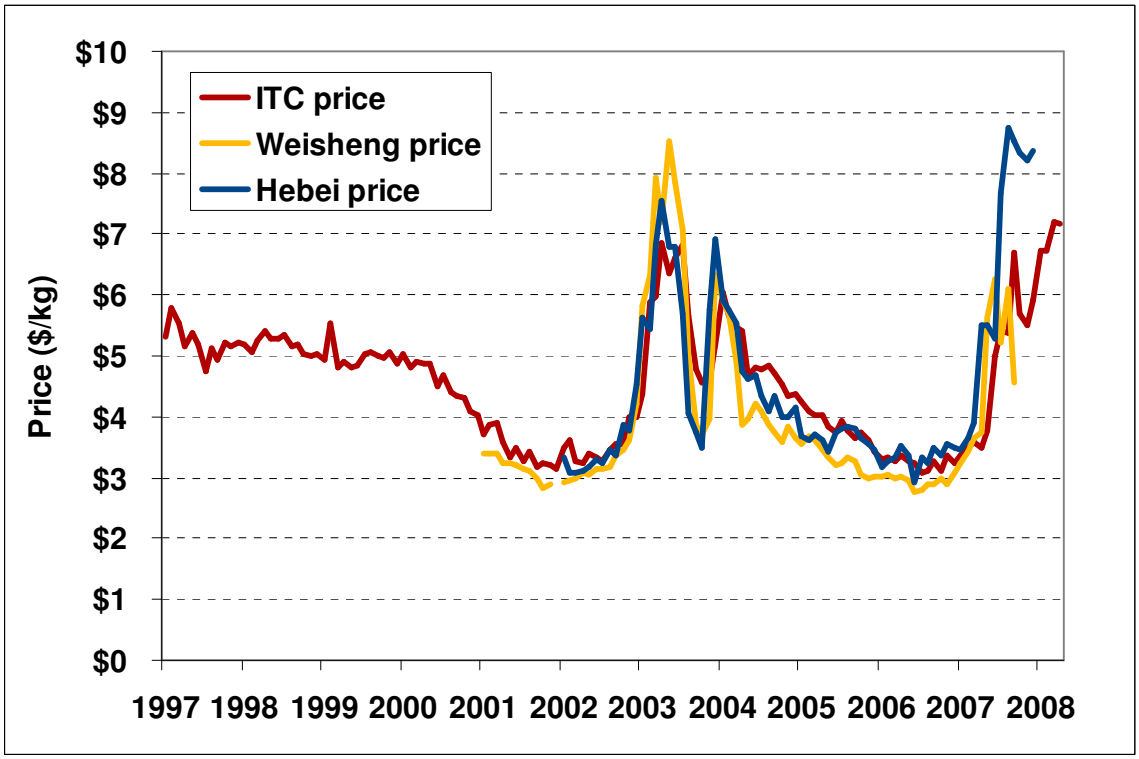
(48) The ITC maintains an extensive database on products imported into the U.S. The ITC data are derived from comprehensive information collected by the U.S. Customs Service, which tracks all

[96] Hebei electronic pricing data, *NYCDMS-1030668-v1-Hebei_2002_Breakdown_of_Sales_w_o_Arb.xls*, *NYCDMS-1030669-v1-Hebei_2003_Breakdown_of_Sales_w_o_Arb.xls*, *NYCDMS-1030670-v1-Hebei_2004_Breakdown_of_Sales_w_o_Arb.xls*, *NYCDMS-1030671-v1-Hebei_2005_Breakdown_of_Sales_w_o_Arb.xls*, provided December 4, 2007. HEB 13716, provided September 25, 2008. Weisheng electronic pricing data, *04 2001-2005年对美外销台帐.xls*, provided December 4, 2007; *2006.xls*, *200709.xl*, provided September 5, 2008 (hereinafter *Hebei and Weisheng transaction sales data*).

products imported into the U.S. by sea.[97] Available statistics include the total weight and cost of each imported product by exporting country and port of entry for a given month. U.S. Customs and the ITC track monthly imports of Vitamin C and Vitamin C derivative products using HTS Code 2936270000.[98]

(49) Figure 15 compares the ITC price data with the limited transactions-level data provided by Hebei and Weisheng.[99] The three data sources generally show similar movements during the periods in which they overlap.

Figure 15: Comparison of ITC data, Hebei, and Weisheng prices for Vitamin C[100]



97 U.S. Census Bureau, "Guide to Foreign Trade Statistics," August 13, 2008, http://www.census.gov/foreign-trade/guide/sec2.html. These data "measure the total of merchandise that has physically cleared through Customs either entering consumption channels immediately or entering after withdrawal for consumption from bonded warehouses under Customs custody or from Foreign Trade Zones."

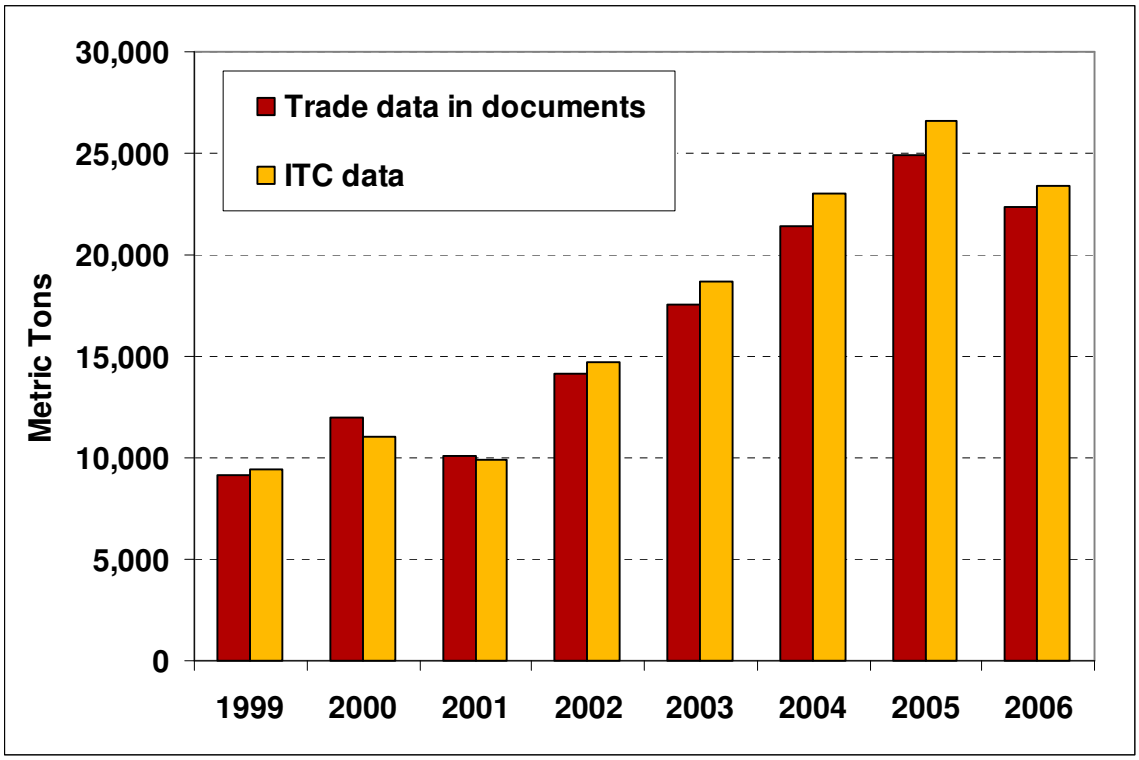
98 ITC data.

99 ITC data are shown through April 2008. My damages analysis does not account for any ongoing conspiracy after this point.

100 ITC data.

(50) As an additional check on the validity of the ITC data, I compared the annual volumes of U.S. Vitamin C imports from China as reported by the ITC to the volumes indicated in the defendants' documents. As shown in Figure 16, the reported volumes are similar throughout the relevant period.

Figure 16: Comparison of U.S. Vitamin C imports from China in ITC data and defendant documents[101]



II.4. The cartel

(51) During the class period, Chinese Vitamin C manufacturers met frequently to discuss price floors, quantity restrictions, and other methods of limiting competition. There are some indications in the record that the defendants may have been subject to externally imposed constraints on prices and quantities. In response to interrogatories, NEPG and Weisheng noted that Vitamin C manufacturers were subject to a price floor that was set at $3.35 per kilogram for most of the

[101] ITC data, NEPG 28343; NEPG 26590; NEPG 28327; NEPG 62365; WSC 10308.

class period.[102] NEPG also asserts that it "was subject to an export quota for Vitamin C for the years 1997 through 2001 and from June 23, 2006 through the present."[103] In neither case is it clear that the putative constraints arose from independent government action rather than from the cartel. For example, notes from the cartel meetings indicate that firms coordinated to set both prices and export quotas:

> The meeting, by way of hand voting, has unanimously passed the resolution on restricting the export volume and protecting the price. The contents of the resolution is as follows: in 2002, the export volume of the Chinese Vitamin C products will be 35,500 tons, among which, Northeast GPF will export 11,750 tons, Jiangsu Jiangshan will export 8,750 tons, Shijianzhuang Group and Weisheng will export 8,000 tons, and Hebei Welcome will export 7,000 tons.[104]

(52) Leaving aside the question of the government's role in setting price floors and export quotas, the price floor was plainly too low to account for the observed price elevation. Notably, NEPG interrogatory responses describe how the firm had its own internal minimum prices that were frequently higher than $3.35 per kilogram.[105] Du Chengxiang, Vice President of NEPG, has conceded that firms had full discretion to set prices above the floor: "The government set a minimum price and above that minimum price the Factory can set a price."[106]

(53) In addition, the record indicates that compliance with both the price floors and the export quotas was effectively voluntary. Accordingly, any supranormal price elevation cannot be attributed to external constraints imposed on the defendants.

(54) It is readily apparent from the companies' transactions data that during certain time periods sales took place at prices below the applicable price floor.[107] Indeed, JJPC's internal documents detail a

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[102] Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories at 17-18, *In Re Vitamin C Antitrust Litigation,* Master File 1:06-MD-1738 (E.D.N.Y. March 28, 2008); Defendant Shijianzhuang Pharma. Weisheng Pharmaceutical (Shijiazhuang) Co., Ltd.'s Second Amended Response to Plaintiff's Second Set of Interrogatories at 14, *In Re Vitamin C Antitrust Litigation,* Master File 1:06-MD-1738 (E.D.N.Y. March 26, 2008).

[103] Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories at 11-12, *In Re Vitamin C Antitrust Litigation,* Master File 1:06-MD-1738 (E.D.N.Y. March 28, 2008).

[104] JJPC 43068.

[105] Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories at 18-27, *In Re Vitamin C Antitrust Litigation,* Master File 1:06-MD-1738 (E.D.N.Y. March 28, 2008).

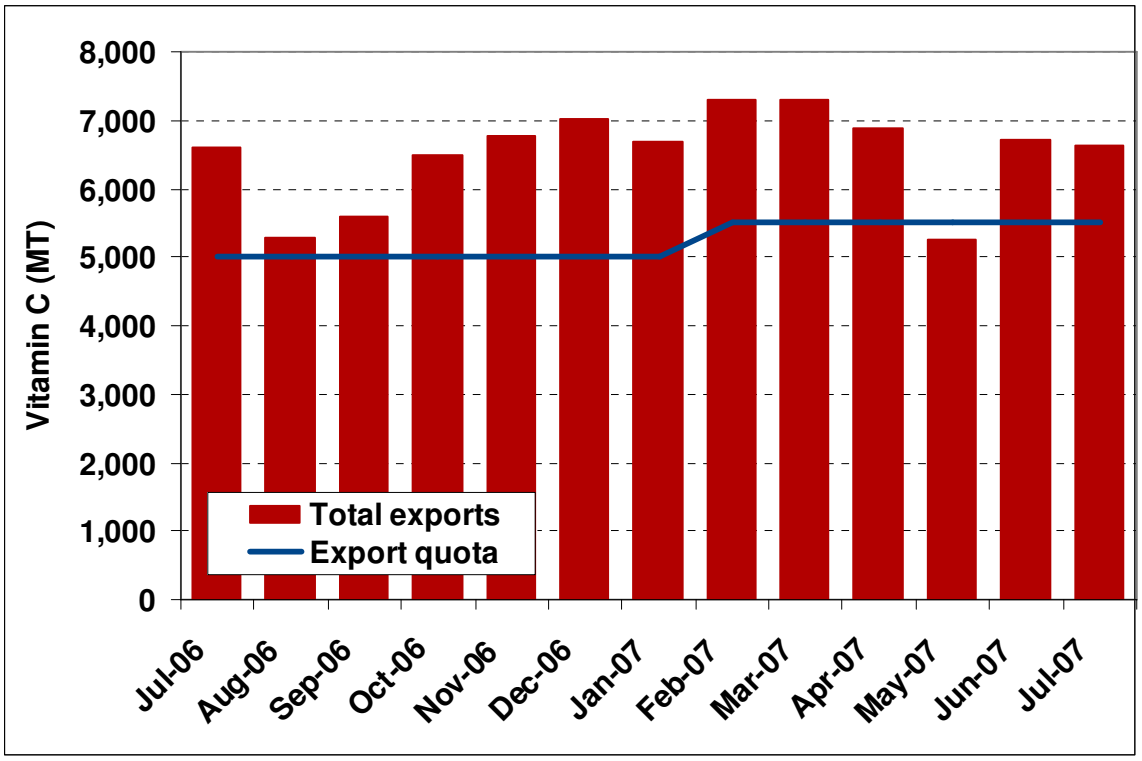
[106] Deposition of Du Chengxiang Deposition, July 23, 2008, at 18-19.

[107] Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories at 11-12, *In Re Vitamin C Antitrust Litigation,* Master File 1:06-MD-1738 (E.D.N.Y. March 28, 2008); Hebei and Weisheng transaction price data.

procedure for circumventing the price floor while creating the appearance of compliance, by initially charging $3.35 per kilogram, but then providing discounts that resulted in a lower price to customers.[108]

(55) Likewise, comparisons of actual exports to cited export quotas indicate that during certain time periods firms regularly exceeded their quotas. In 2002, all four major Vitamin C producers exceeded the quotas established in November 2001; NEPG exceeded its 11,750 metric ton quota by 2,002 metric tons and JJPC exceeded its 8,750 metric ton quota by 1,469 metric tons.[109] Figure 17 compares the export quotas cited in NEPG interrogatory responses to actual exports for 2006 and 2007. Actual exports exceeded the quota in 12 of 13 months and by an average of 24%.

Figure 17: Comparison of 2006 to 2007 export quotas with actual exports[110]



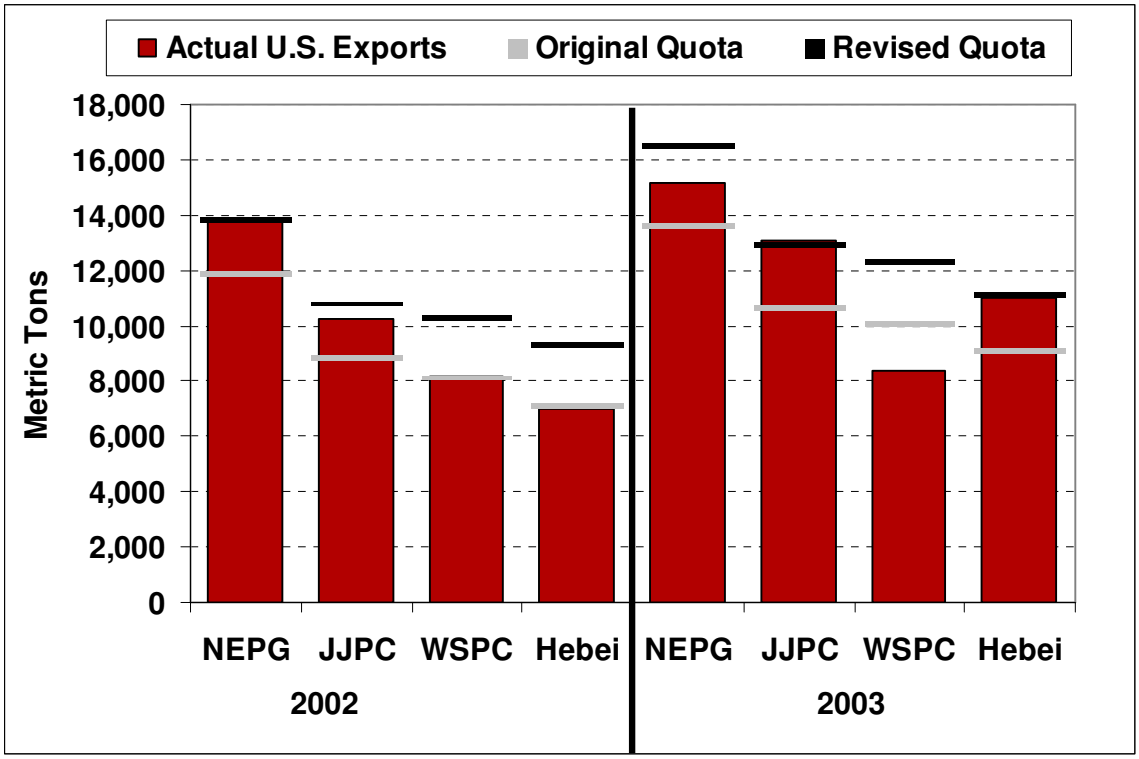
[108] Deposition of Wang Qi, July 2, 2008, Exhibit 130, at 2. Deposition of Wang Qi, July 2, 2008, 48-49; JJPC 44867.

[109] NEPG 28327; JJPC 43068; JJPC 43571.

[110] Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories at 11-12, *In Re Vitamin C Antitrust Litigation*, Master File 1:06-MD-1738 (E.D.N.Y. March 28, 2008); JJPC 35432; JJPC 35359.

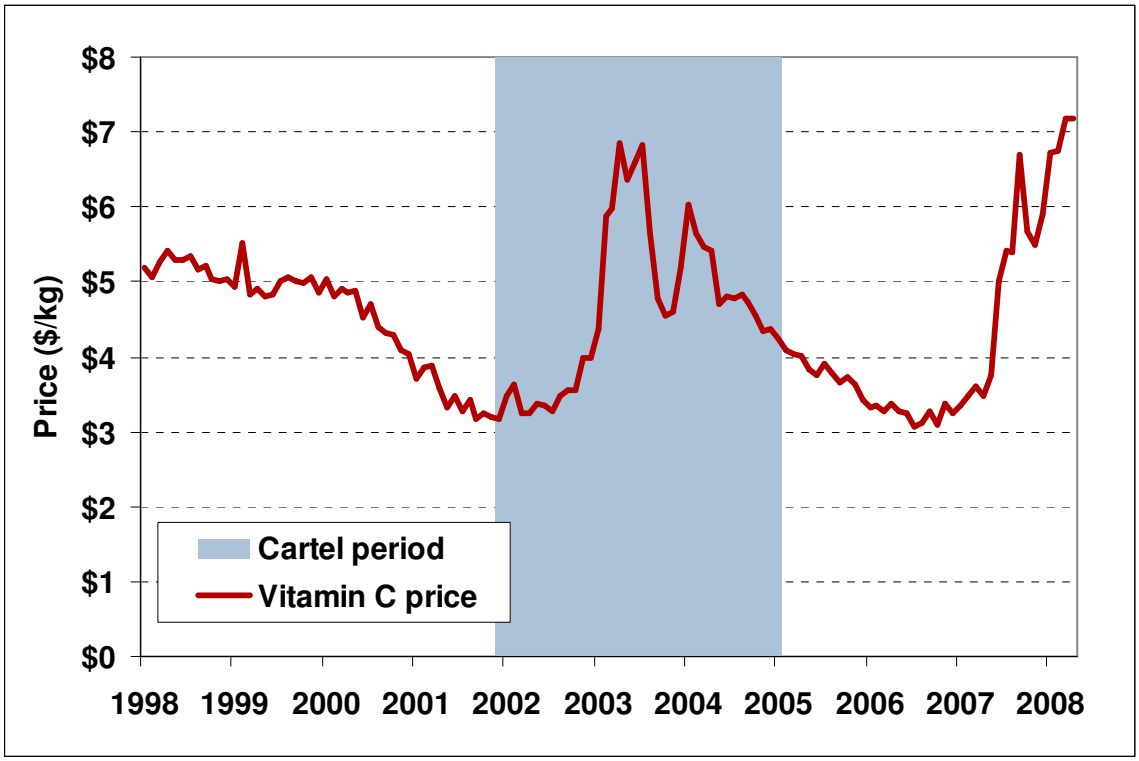
(56) In practice, quotas were revised to reflect reality. Figure 18 compares actual exports to initial and revised quotas for 2002 and 2003. The red bars show actual exports by defendant for each, the grey lines show the original export quotas, and the black lines show the subsequently revised quotas, as reported in NEPG's interrogatories. The chart shows that the initial export quotas were regularly exceeded, and in some cases the final quotas were exceeded as well. Given that the quotas were revised two years in a row after most firms exceeded them suggests that they were not credibly enforced.

Figure 18: Comparison of 2002 to 2003 export quotas with actual exports[111]



[111] Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories, March 28, 2008, p. 11-12; NEPG 28327; JJPC 43068; JJPC 43571; JJPC 43572.

Figure 19: Vitamin C prices through time



(57) Figure 19 illustrates the relationship between the cartel's activities and Vitamin C price movements. Prior to the class period (that is, until December 2001), Vitamin C prices were generally flat or falling. Declining prices can be a catalyst for cartelization because slim margins motivate firms to seek ways to restore profitability. Notably, the rate of decline accelerated in 2000. During that period, cartel members ineffectually discussed prices and quantities.[112]

(58) The class period began in December 2001 when a cartel agreement was announced and efforts by cartel members to halt the price decline became effective. Prices began to increase during the second half of 2002, at first slowly but then dramatically; the average price more than doubled in a span of less than a year.

(59) Many defendant documents describe the cartel's efforts to enforce supply restrictions and raise prices throughout that period. With the exception of a brief drop in prices in late 2003, price elevation persisted into 2004.

[112] NEPG 42592.

(60) The cartel began to unravel midway through 2004. Weisheng built a new plant and began production in May of that year.[113] It also refused to participate in one coordinated production downtime, leaving other manufacturers to consider whether they should scale back production without Weisheng's participation.[114] The present lawsuit was filed in January 2005, alerting the defendants that their collusive efforts were attracting close scrutiny by U.S. purchasers. Not surprisingly, Vitamin C prices declined steadily through the end of 2006. Prices began to increase again in 2007 though efforts at cartelization appear to have been largely ineffective; for example, the defendants exploited "loopholes" in export quotas and price floors.[115] Notably, the substantial price increases in 2007 and 2008 coincided with increases in the prices of materials and energy, as well as with a substantial increase in the USD-Yuan exchange rate.

[113] JJPC 37094; JJPC 31575.
[114] JJPC 37094.
[115] JJPC 44867; NEPG 42391.

III. Potential explanations for price movements

III.1. Overview

(61) In principle, non-conspiratorial factors could account for some or all of the price elevation observed during the class period. In this section, I investigate that possibility by identifying and examining the key determinants of Vitamin C prices. I discuss a wide range of factors that may have influenced Vitamin C supply and demand, and I examine how those factors varied over time. As I explain, none of that variation suggests a plausible non-conspiratorial explanation for the observed price elevation.

(62) Although the evidence presented in this section is highly suggestive, one cannot reach definitive conclusions by examining each potential explanation for price elevation in isolation. A pattern of elevated prices may reflect the combined effects of multiple contributory factors. In Sections IV and V, I evaluate that possibility using econometric methods. Those methods also allow me to determine with quantitative precision the extent to which non-conspiratorial factors account for the price elevation observed during the class period.

III.2. Supply factors

III.2.1. Costs

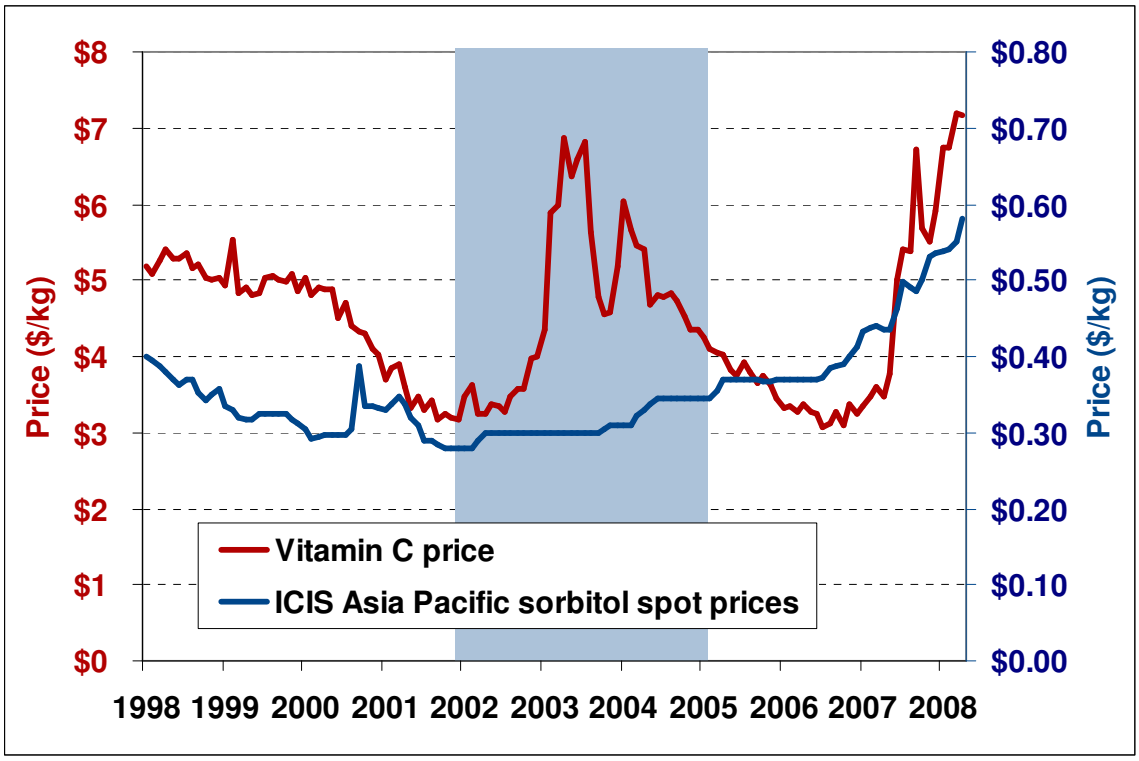
(63) Factors that raise production costs tend to generate higher prices. As shown below (and as one would expect), prices and costs often moved together *outside* the class period. However, when prices rose *during* the class period, costs remained low. Consequently, one cannot attribute the observed price elevation to production costs.

III.2.1.1. Input prices

(64) As discussed in Section II, sorbitol accounts for a far larger fraction of Vitamin C production costs than any other raw material; methanol is a distant second. Figure 20 compares Vitamin C prices with the Asia-Pacific sorbitol price for January 1998 through April 2008. The figure, like all others in this section, uses shading to distinguish between three distinct time periods. The first, January 1998 through November 2001 (unshaded), is the pre-class period. The second, December 2001 through January 2005 (shaded blue), runs from the start of the class period to the filing of the present lawsuit. I will henceforth refer to this as the "cartel period." The third period, January 2005 through April 2008 (unshaded), is the post-filing period.

(65) Notice that the cost of sorbitol and the price of Vitamin C both trended downward during the pre-class period. Similarly, both trended upward in the post-filing period. Thus, sorbitol price movements may help to explain the observed variation in the price of Vitamin C outside of the cartel period. However, sorbitol prices were historically low during the cartel period and did not start to rise until well after Vitamin C prices had peaked and begun to decline. Therefore, sorbitol prices cannot plausibly explain the Vitamin C price elevation observed in 2002 through 2004.

Figure 20: Comparison of Vitamin C price with sorbitol price[116]

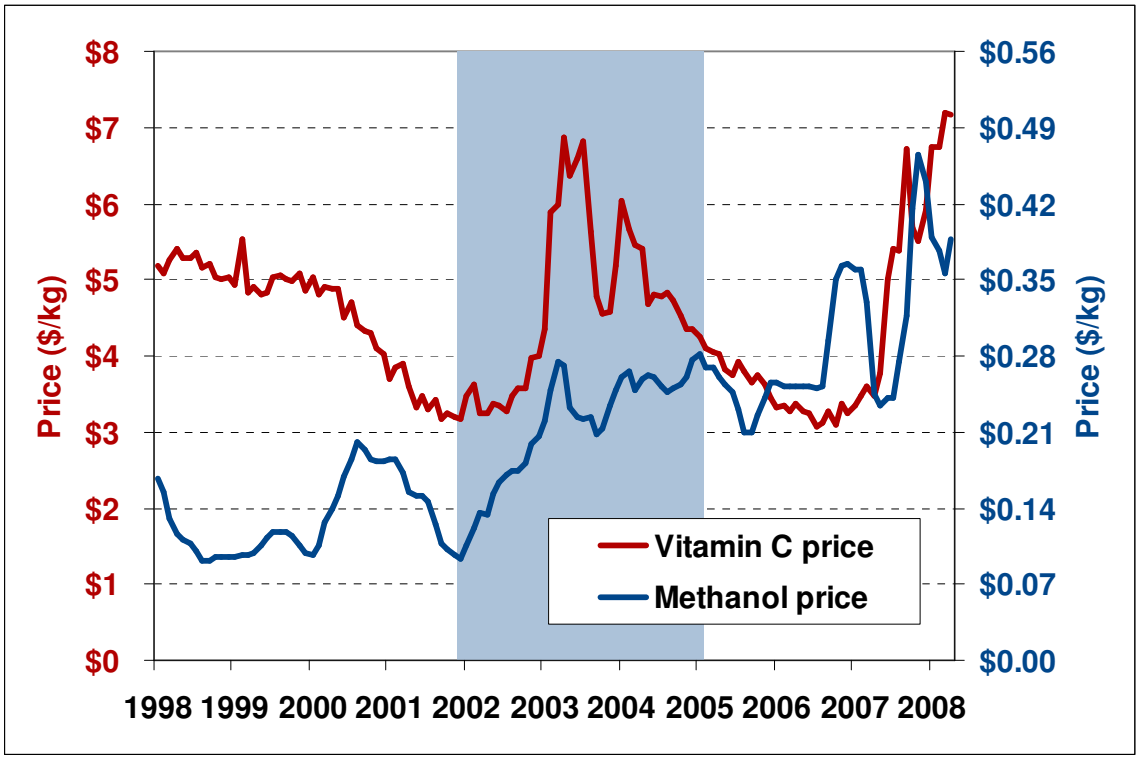


(66) Figure 21 compares Vitamin C prices with the China methanol price for January 1998 through April 2008. Generally, methanol prices followed an upward trend, with considerable volatility around that trend. As it happens, that volatility placed the methanol price at the bottom of a trough in early 2002, when Vitamin C prices were low, and at peak in early 2003, when Vitamin C prices were elevated. However, for three reasons, that swing cannot plausibly explain the Vitamin C price elevation. First, methanol only accounts for about 4% of Vitamin C costs. Assuming the variable cost of producing Vitamin C totaled $2 per kilogram (see Section III.2.1.2

[116] ITC data; ICIS, Sorbitol in Asia Pacific Spot FOB S.E.ASIA, 2008, http://www.icispricing.com.

below), doubling the price of methanol would add approximately eight cents to the cost of producing a kilogram of Vitamin C. In comparison, the price of Vitamin C rose by nearly $4 per kilogram between early 2002 and early 2003. Second, the price of methanol remained elevated from early 2003 to 2006, but the price of Vitamin C did not. Finally, as a general matter, Vitamin C prices did not track methanol price fluctuations outside the cartel period. Nor would we expect them to, given the low fraction of Vitamin C production costs attributable to methanol.

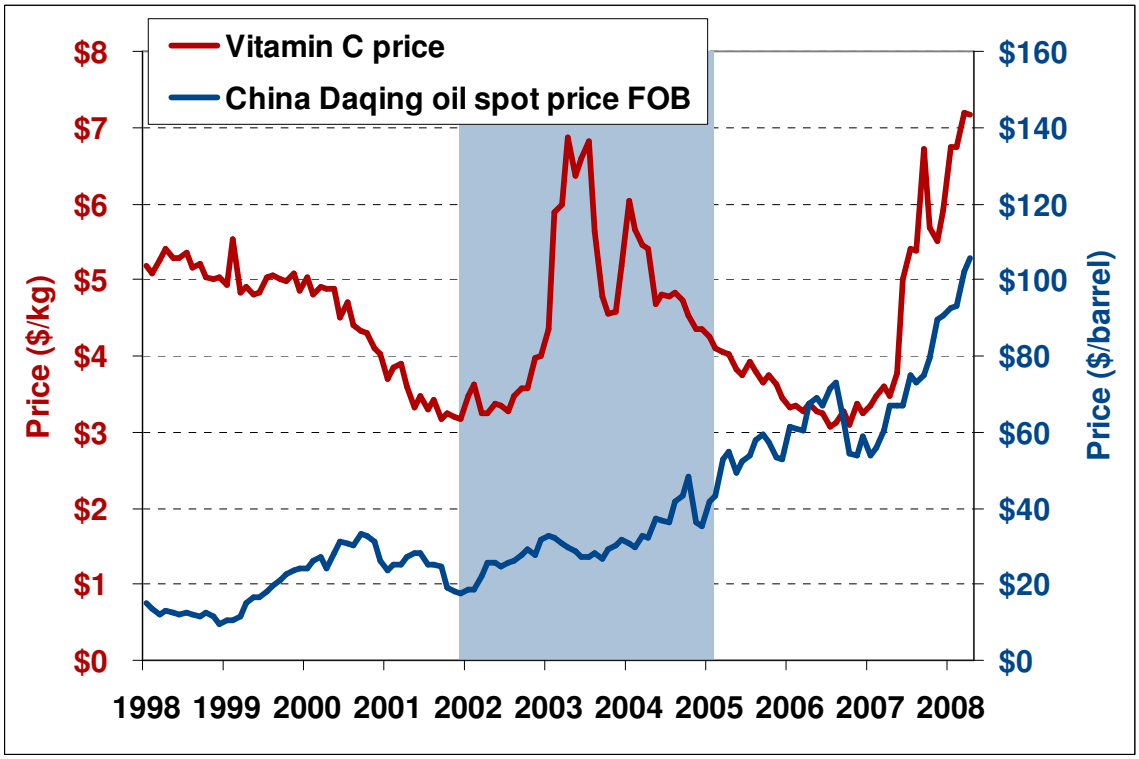
Figure 21: Comparison of Vitamin C price with China methanol price[117]



[117] ITC data; ICIS, LOR Methanol in Asia Pacific Spot CFR China, 2008, http://www.icispricing.com.

(67) Figure 22 compares Vitamin C prices with the China Daqing Oil Spot price for January 1998 through April 2008. One can interpret oil prices as a broad proxy for energy costs. The oil price rose at a fairly steady rate throughout most of the period. However, it actually fell slightly in 2003 when Vitamin C prices peaked. In contrast, rising Vitamin C prices in 2007 and 2008 coincided with a sharp increase in oil prices.

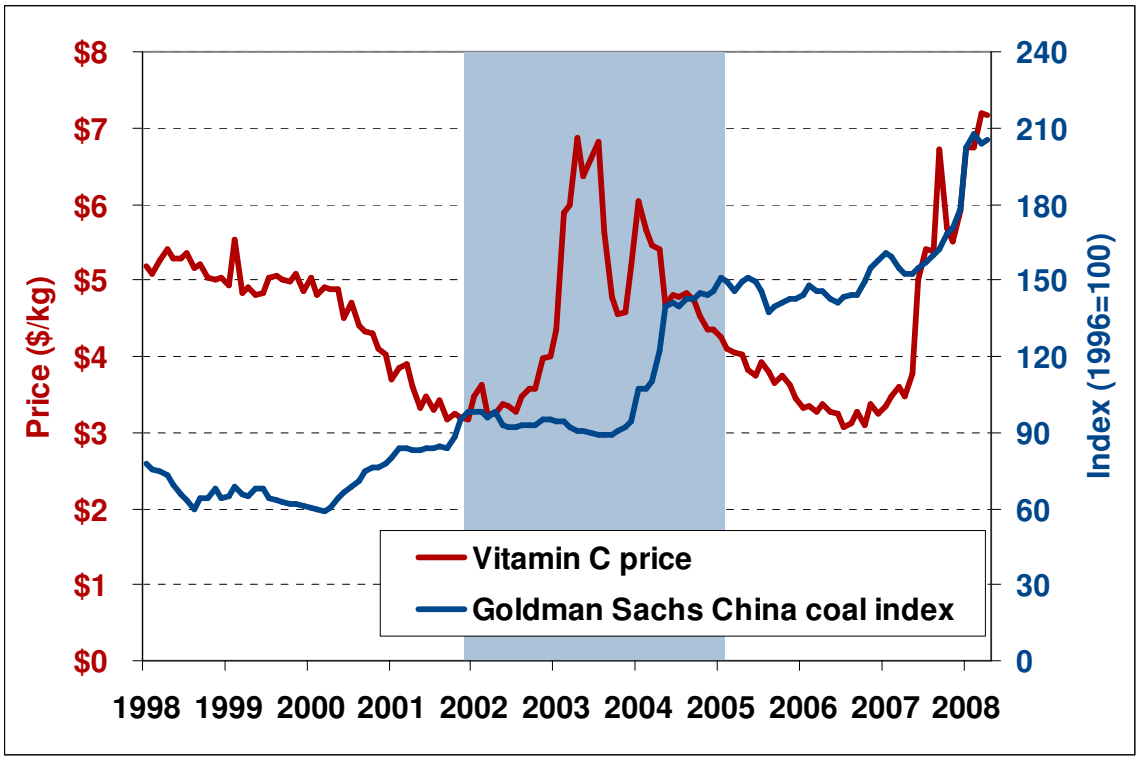
Figure 22: Comparison of Vitamin C price with the oil spot price[118]



[118] ITC data; Energy Information Administration, China Daqing oil Spot Price FOB, 2008, http://tonto.eia.doe.gov/dnav/pet/hist/wepcdaqw.htm.

(68) Figure 23 compares Vitamin C prices with the Goldman Sachs China coal index for January 1998 through April 2008. The coal price actually fell slightly in 2003 when Vitamin C prices peaked. Generally, the relationship between Vitamin C prices and coal prices is weak. Note, however, that Vitamin C prices and coal prices increased together in 2007 and 2008.

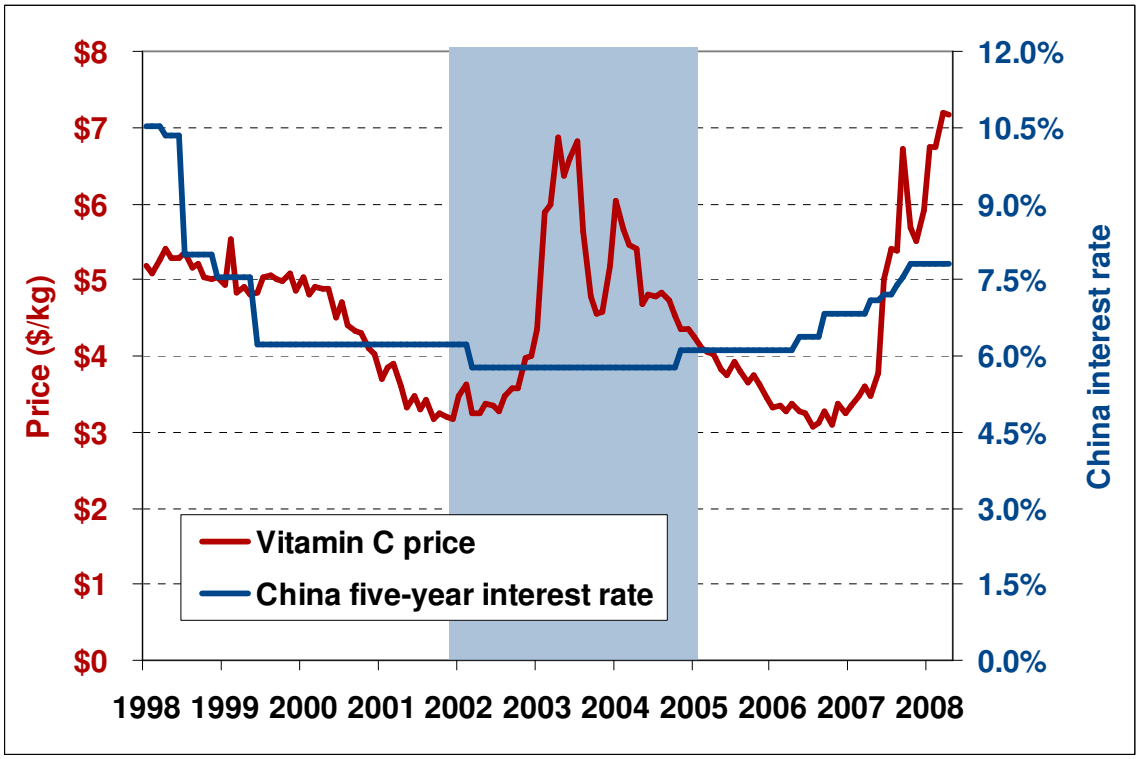
Figure 23: Comparison of Vitamin C price with the China coal index[119]



[119] ITC data; Goldman Sachs, China Coal Index, GSCPCA, 2008,www.bloomberg.com (accessed May 15, 2008).

(69) Figure 24 compares Vitamin C prices with China's five-year interest rate for January 1998 through April 2008. The interest rate is potentially relevant because it affects the costs of borrowing money, e.g., to construct new facilities or purchase equipment. However, as the figure illustrates, borrowing costs were unusually low for 2002 through 2004 when Vitamin C prices peaked.

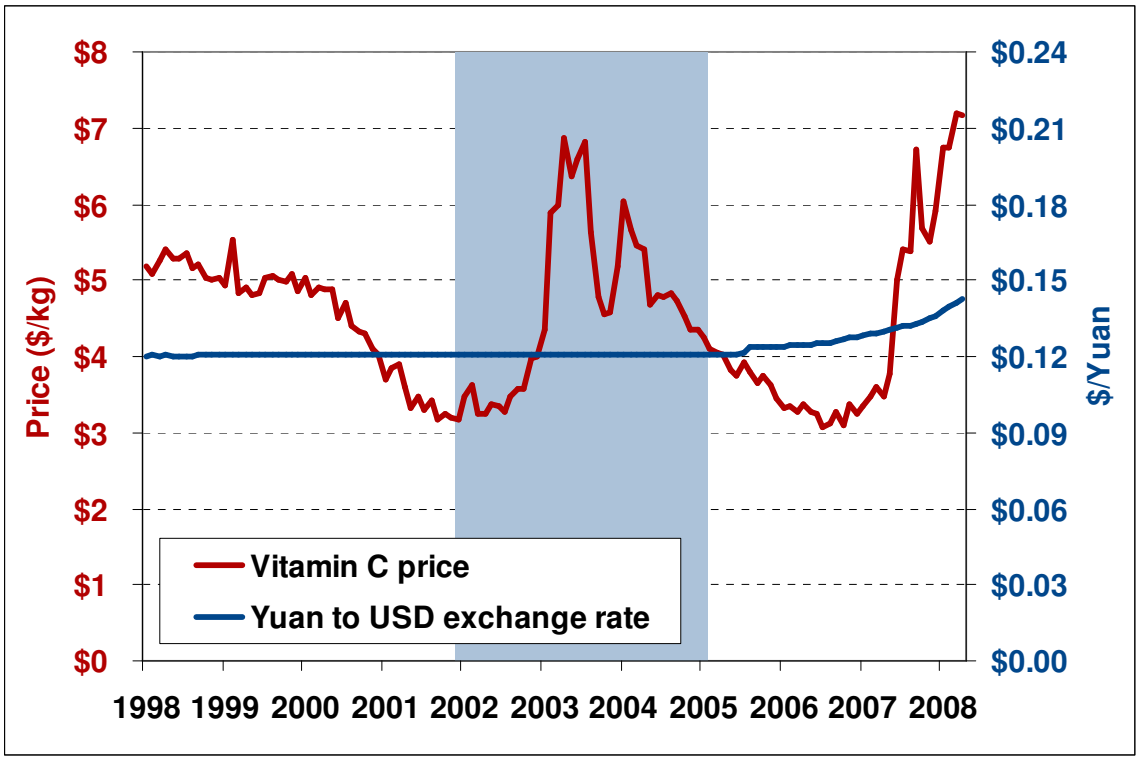
Figure 24: Comparison of Vitamin C price with China's five-year interest rate[120]



[120] ITC data; People's Bank of China (China Central Bank), Five-year interest rate, 2008, http://www.pbc.gov.cn/detail.asp?col=462&ID=1903.

(70) Figure 25 compares Vitamin C prices with the Yuan to USD exchange rate for January 1998 through April 2008.[121] An increase in the Yuan to USD exchange rate increases the USD cost of Chinese inputs, and therefore raises the USD cost of producing Vitamin C. However, when Vitamin C prices spiked for 2002 through 2004, the Yuan to USD exchange rate remained constant. In contrast, the falling value of the USD relative to the Yuan in 2007 and 2008 may have contributed to the rising USD price of Vitamin C.

Figure 25: Comparison of Vitamin C price with the Yuan to USD exchange rate[122]



III.2.1.2. Reported costs of production

(71) Weisheng, JJPC, and Hebei provided monthly data on various components of production costs. The advantage of using reported production costs is that, in principle, they subsume and

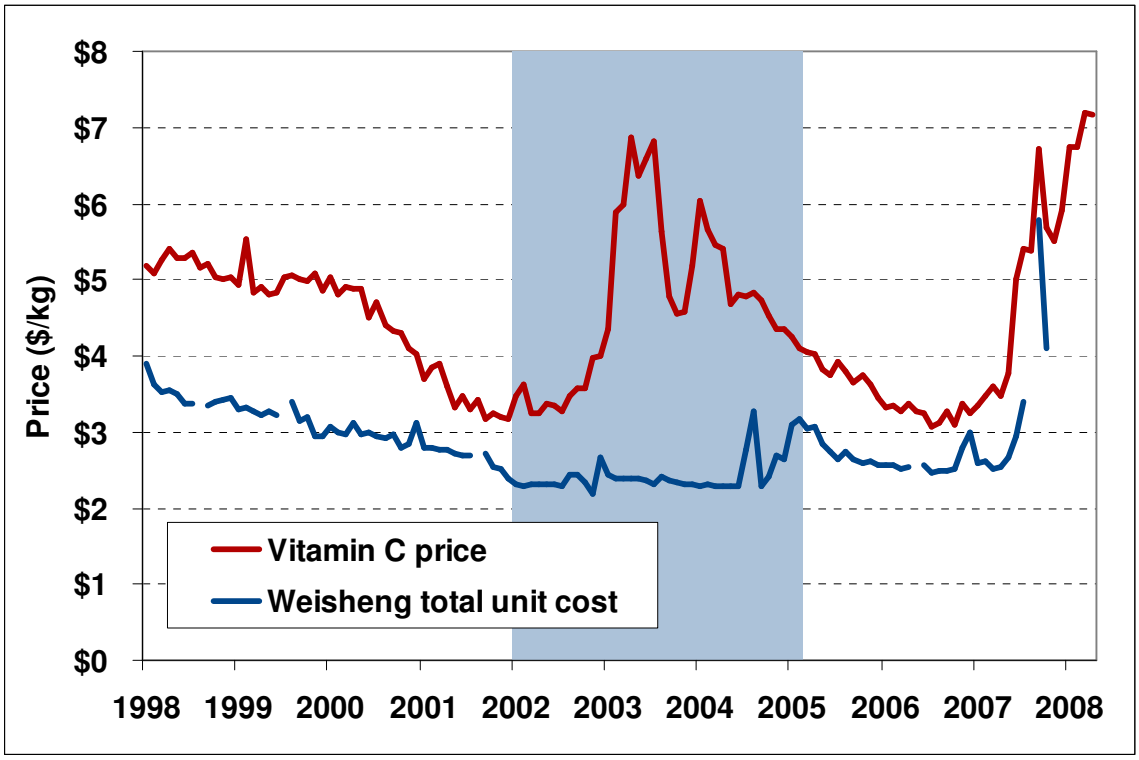
[121] Technically, one can view the exchange rate as either a supply factor (if one thinks of the Chinese producers as receiving USD) or a demand factor (if one thinks of U.S. purchasers as paying Chinese Yuan); these two perspectives are equivalent.

[122] ITC data; U.S. Federal Reserve Economic Data, "Chinese Yuan to One U.S. Dollar," 2008, http://research.stlouisfed.org/fred2/.

aggregate all factors bearing on costs. There are three potential problems with data of this sort. First, the depreciation schedules used for accounting purposes need not correspond to true economic depreciation. As a result, capital costs may be mismeasured. Second, companies that sell multiple products often incur joint costs of production, and the allocation of those costs across products is often arbitrary. For example, it is reasonably common for companies to allocate joint costs according to revenue shares. When a firm follows that procedure, any increase in the price of a good will tend to be associated with an increase in reported costs. It may then appear that a cost increase caused the price to rise, when in fact the rising price caused the increase in reported costs. Thus, in the context of price-fixing conspiracies, the use of accounting data is typically generous to defendants (in that it potentially yields spurious "explanations" for conspiratorial price increases) and conservative from the perspective of plaintiffs. Third, accounting measures of costs usually do not distinguish cleanly between fixed and variable costs. That distinction is potentially important because variable costs are more pertinent from the perspective of explaining short-term price fluctuations. Despite those qualifications, a detailed review of reported costs is, in this case, illuminating.

(72) Figure 26 compares Vitamin C prices with Weisheng's total unit cost. Notice that costs and prices both trended downward during the pre-class period. Similarly, both fell gradually in 2005 and rose sharply in 2007. Thus, cost movements may help to explain the observed variation in the price of Vitamin C outside of the cartel period. However, when Vitamin C prices spiked in 2002 through 2004, costs were low and essentially flat.[123] The spike in production costs in 2007 coincided with sharply decreased production, and may reflect the effects of a production stoppage rather than a true increase in production costs. As shown in the following graphs, this cost spike is specific to Weisheng, and is largely due to an increase in manufacturing costs rather than other costs that are more variable in nature, such as materials or energy.

Figure 26: Comparison of Vitamin C price with Weisheng total unit cost[124]

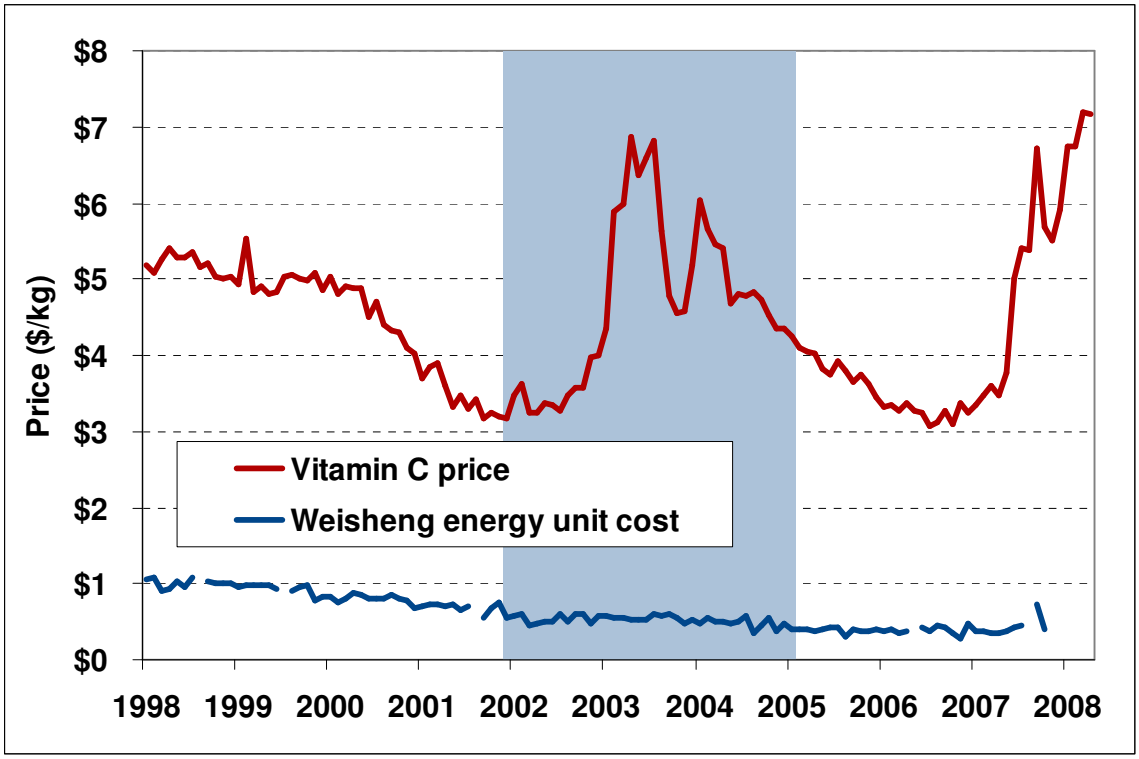


[123] WSC 14750.

[124] ITC data; WSC 14501.

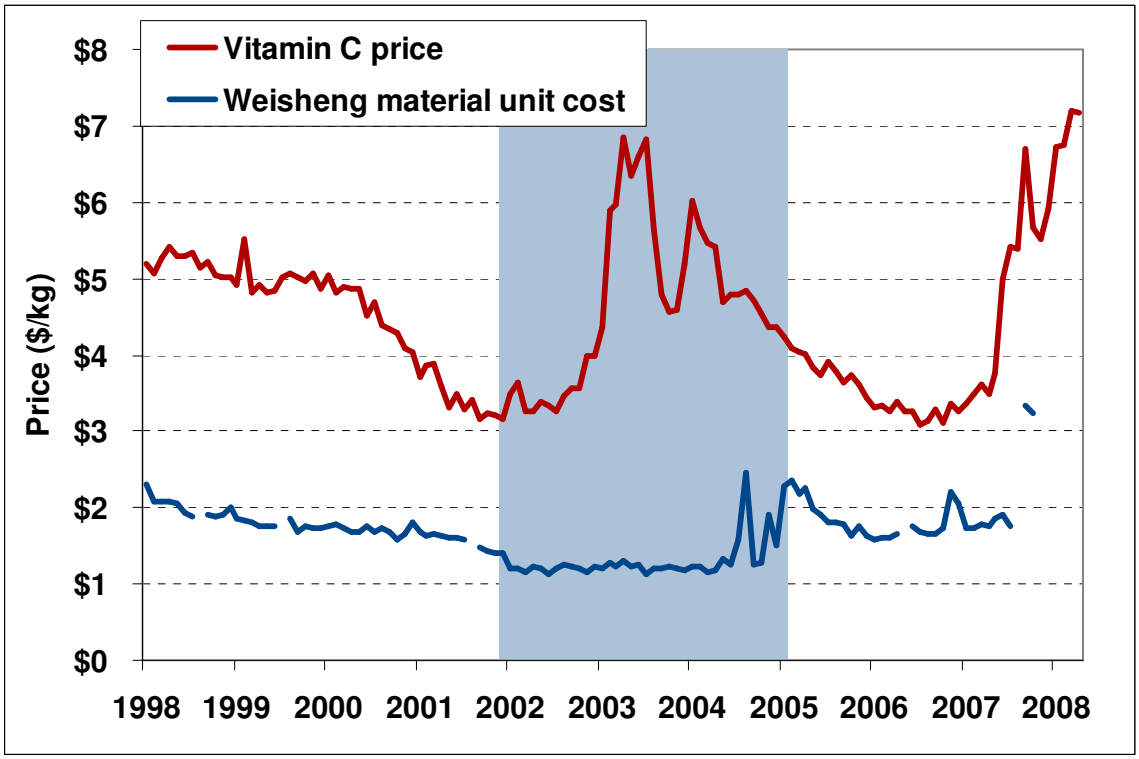
(73) Figure 27, Figure 28, Figure 29, and Figure 30 compare Vitamin C prices to, respectively, Weisheng's costs per unit for energy, materials, labor, and "manufacturing." The first three categories are likely dominated by variable costs. The last category is likely dominated by fixed costs. None of these categories exhibit noticeable elevation coincident with the Vitamin C price spikes during 2002 through 2004.

Figure 27: Comparison of Vitamin C price with Weisheng energy unit cost[125]



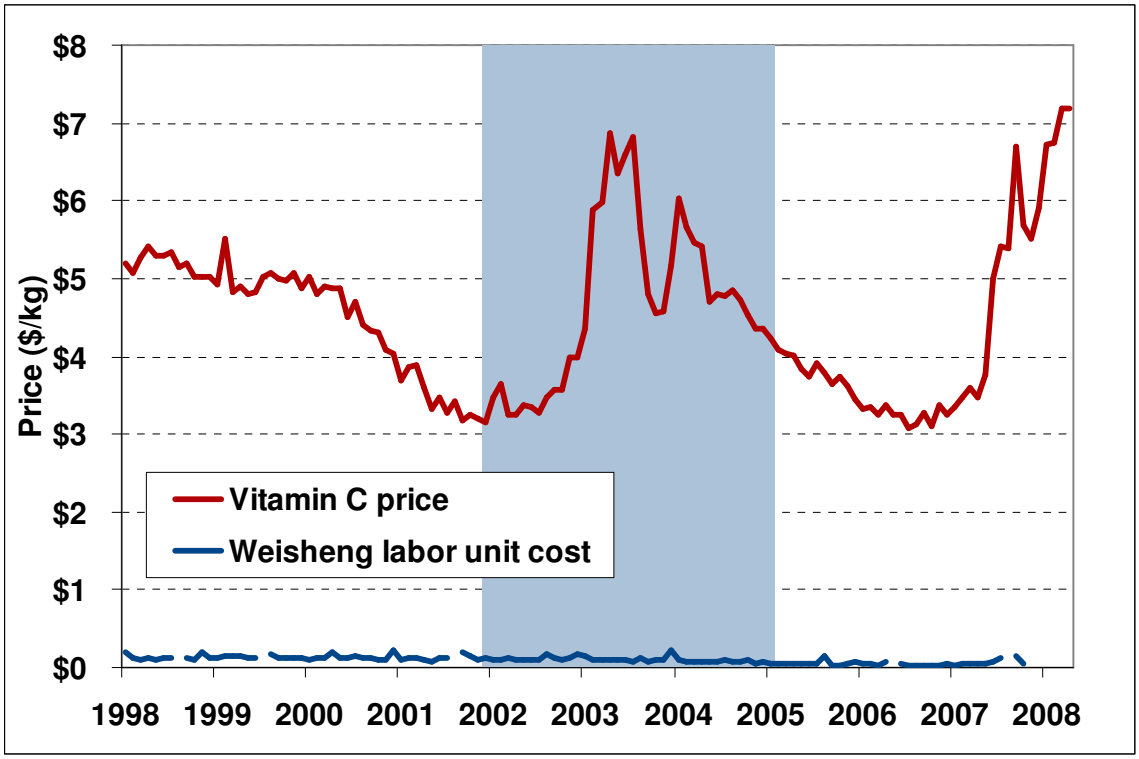
[125] *Ibid.*

Figure 28: Comparison of Vitamin C price with Weisheng material unit cost[126]



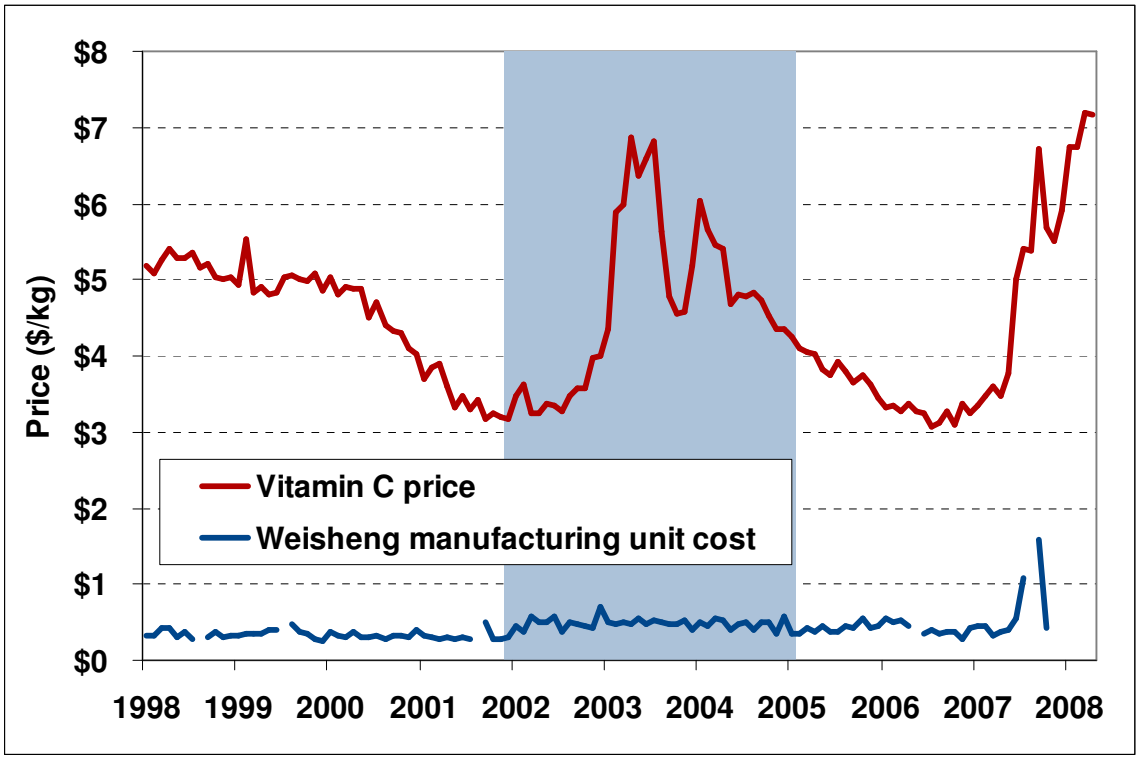
126 *Ibid.*

Figure 29: Comparison of Vitamin C price with Weisheng labor unit cost [127]



[127] *Ibid.*

Figure 30: Comparison of Vitamin C price with Weisheng manufacturing unit cost[128]



[128] *Ibid.*

(74) JJPC provided cost data covering 2002 through 2007. Figure 31 compares Vitamin C prices with JJPC's total unit cost. Figure 32 and Figure 33 compare Vitamin C prices to, respectively, JJPC's costs per unit for materials and for energy. None of these cost measures exhibit noticeable elevation coincident with the Vitamin C price spikes during 2002 through 2004.

Figure 31: Comparison of Vitamin C price with JJPC's total unit cost

Redacted

Figure 32: Comparison of Vitamin C price with JJPC's material unit cost[129]

Redacted

[129] ITC data; JJPC 51042; JJPC 51043; JJPC 51044; JJPC 51045; JJPC 51046; JJPC 51047.

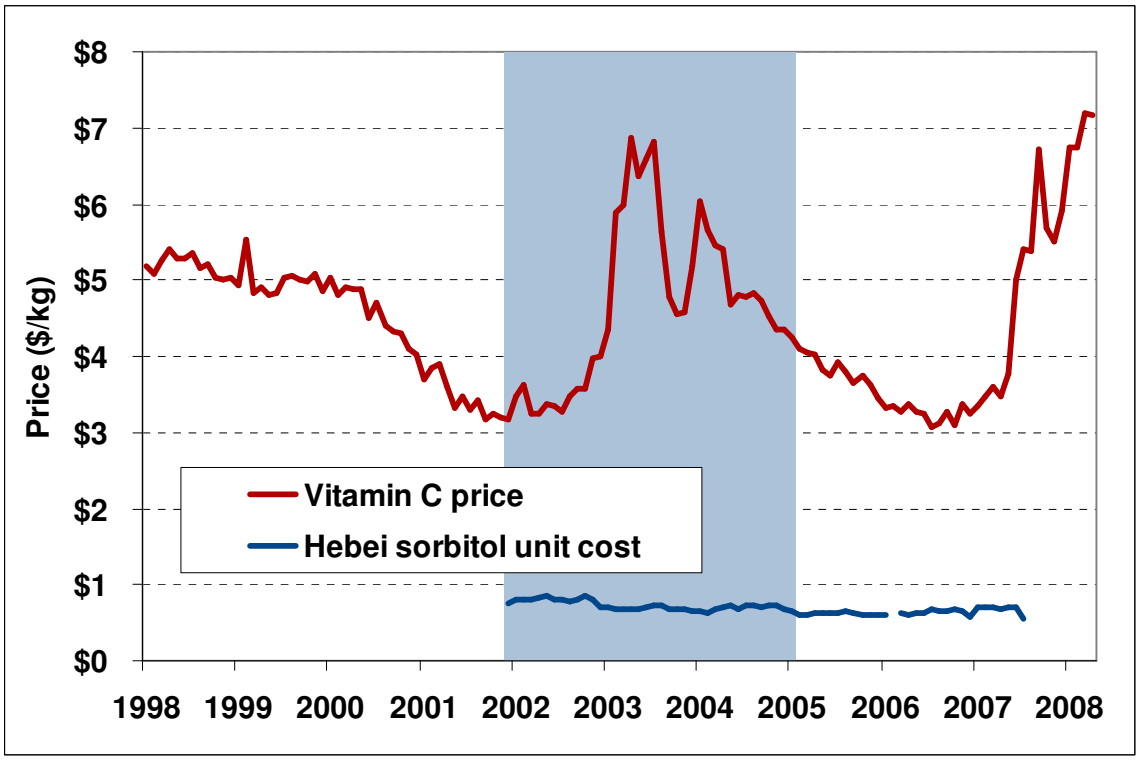
Figure 33: Comparison of Vitamin C price with JJPC's energy unit cost [130]

Redacted

[130] *Ibid.*

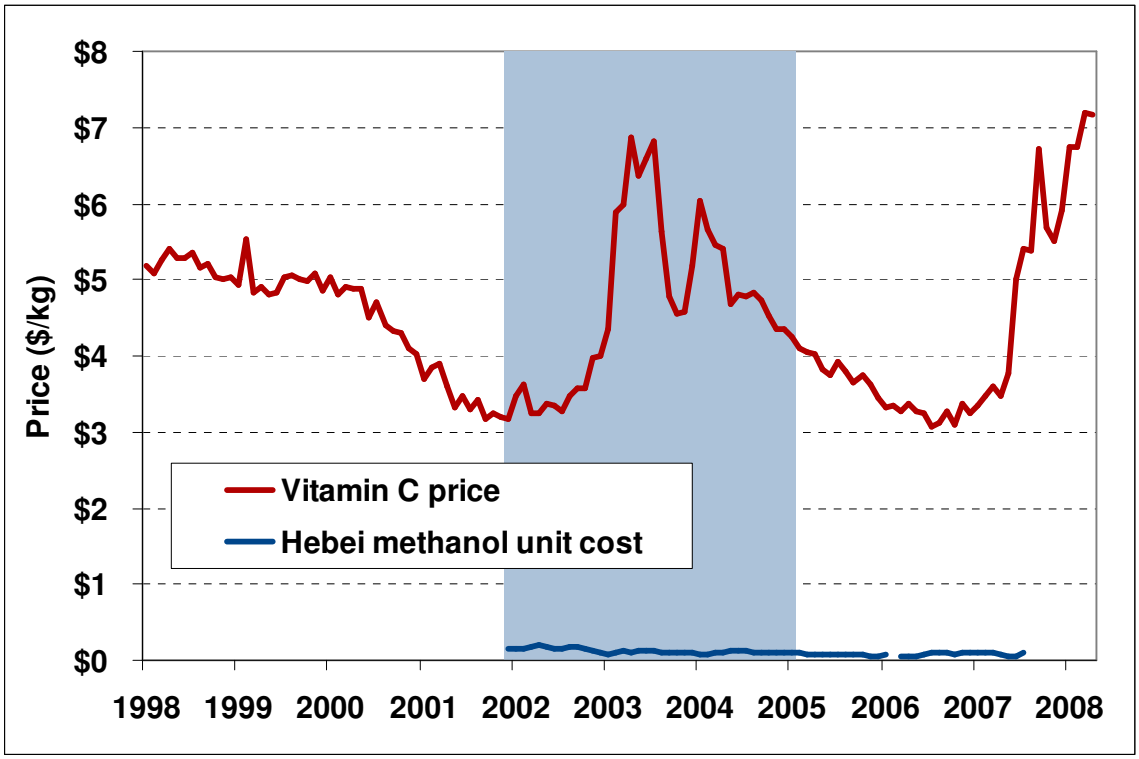
(75) Hebei also provided cost data covering 2002 through 2007. Figure 34, Figure 35, and Figure 36 compare Vitamin C prices to, respectively, Hebei's costs per unit for sorbitol, methanol, and energy. None of these cost measures exhibit noticeable elevation coincident with the Vitamin C price spikes during 2002 through 2004.

Figure 34: Comparison of Vitamin C price with Hebei sorbitol unit cost[131]



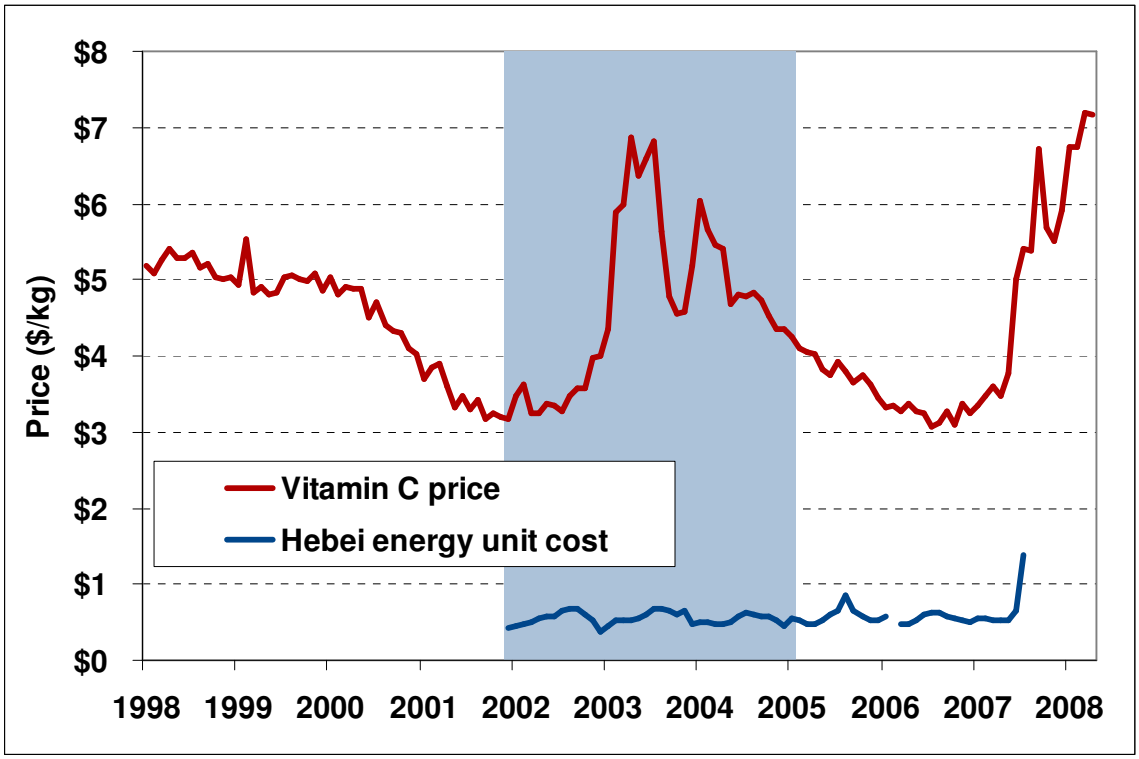
[131] ITC data; HEB 13719.

Figure 35: Comparison of Vitamin C price with Hebei methanol unit cost[132]



[132] *Ibid.*

Figure 36: Comparison of Vitamin C price with Hebei energy unit cost[133]



III.2.2. Competition

(76) As discussed in Section II.2.1, several non-Chinese producers of Vitamin C exited the market or withdrew production capacity in or after 2001. As a matter of economic principles, an exogenous non-conspiratorial reduction in the number and/or capacity of competitors can raise prices through two distinct mechanisms. First, with fewer firms and/or more concentrated production capacity, non-collusive oligopolistic competition tends to produce higher prices. Second, the partial or complete withdrawal of competitors may encourage and facilitate cartelization by the remaining firms. Thus, even if price elevation were attributable to the partial or complete withdrawal of competitors, further investigation would be required to determine whether the price increase resulted from collusion.

(77) An examination of historical patterns casts serious doubt on the theory that Vitamin C price elevation during 2002 through 2004 resulted from a lessening of non-collusive oligopolistic

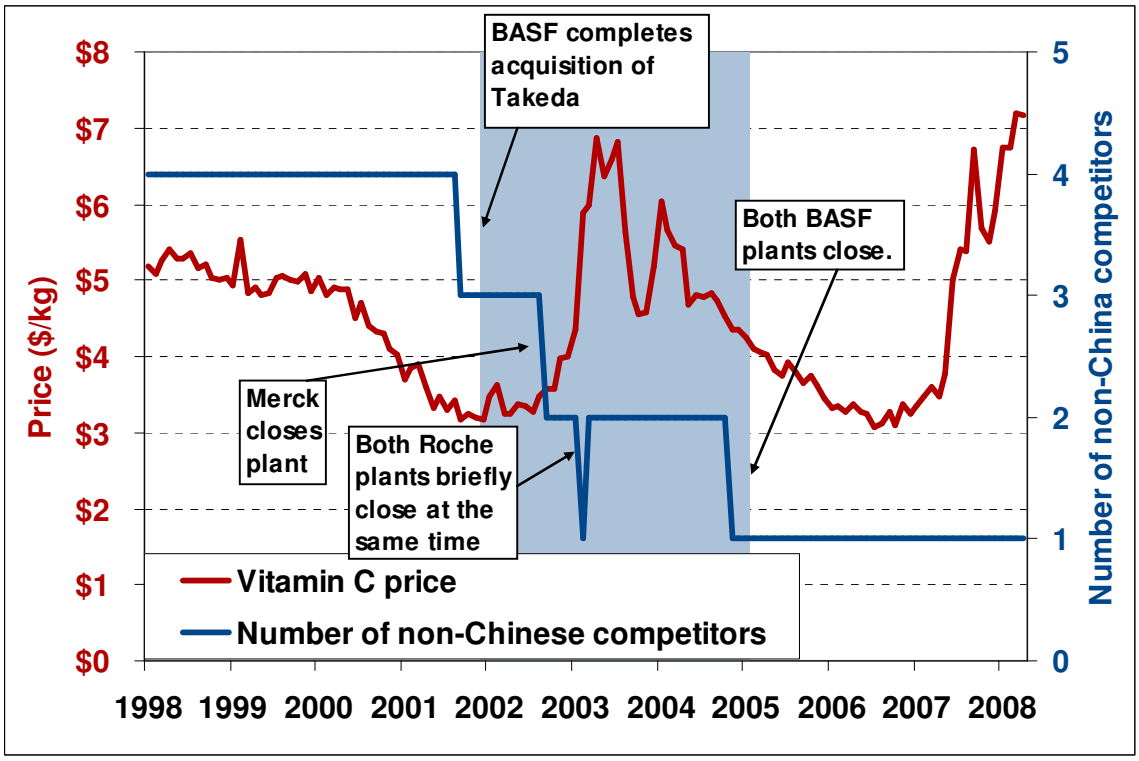
[133] *Ibid.*

competition following the withdrawal of non-Chinese competitors and/or capacity. Figure 37 compares Vitamin C prices with the number of non-Chinese Vitamin C manufacturers from January 1998 to April 2008. [134] The number of competitors is of interest because every competitor potentially provides an independent check on price.[135] Notice that the price elevation in 2002 through 2004 followed the exit of Merck in 2002. However, other patterns in the figure cast serious doubt on the hypothesis that the price increase was a non-conspiratorial consequence of Merck's withdrawal. In particular, (1) prices remained flat after Takeda's withdrawal in 2001, (2) prices spiked but did not remain high after Merck's withdrawal in 2002, and (3) prices continued to fall at a steady rate after BASF's withdrawal in 2005. In light of the fact that these companies were operating at a significant cost disadvantage relative to the Chinese firms, it is not surprising to find so little evidence of their competitive impact. Nevertheless, it remains possible that Merck's withdrawal provided a catalyst for the effective cartelization of Vitamin C production by Chinese firms.

[134] As described earlier, some firms ceased producing raw Vitamin C but continued to produce varieties using raw Vitamin C obtained from other manufacturers. Such suppliers are deemed as exiting the business because they no longer have any control over raw Vitamin C prices.

[135] As is well-recognized in the academic literature, one cannot necessarily infer causality from a correlation between those variables, because the number of competitors is determined as part of the market equilibrium.

Figure 37: Comparison of Vitamin C price with the number of non-Chinese Vitamin C manufacturers[136]

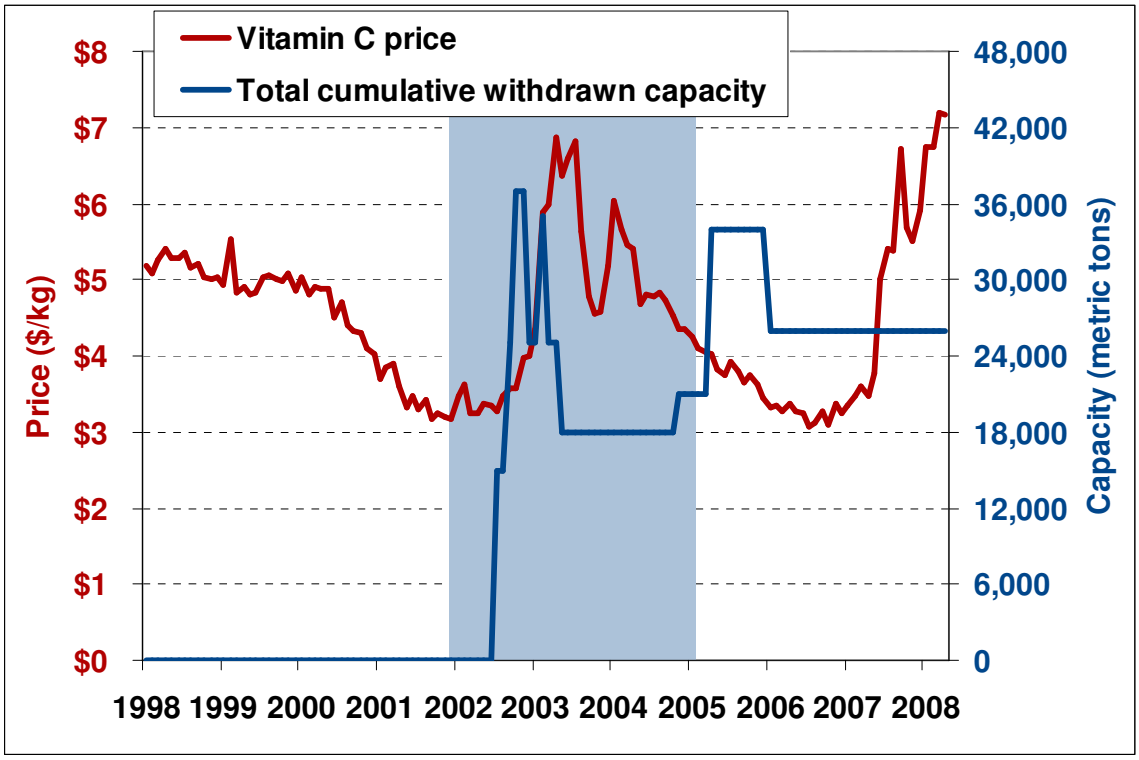


(78) Figure 38 compares Vitamin C prices with the worldwide cumulative production capacity that had been withdrawn by Roche, BASF, Takeda, and Merck as of any given date. Figure 39 and Figure 40 show the withdrawn capacity separately for the U.S. and the rest of the world. The figures show that capacity was withdrawn shortly before Vitamin C prices rose in early 2003. However, the sharp rise and peak in Vitamin C prices coincided with *addition* of capacity. Though non-Chinese capacity remained permanently lower after 2003, prices did not remain permanently higher and in fact continued to fall even when capacity was withdrawn in 2005. Consequently, taken as a whole, the figure cast serious doubt on the hypothesis that the price increase was a non-conspiratorial consequence of capacity withdrawal. Nevertheless, it remains

[136] ITC data; HEB 5626; JJPC 32999; JJPC 36990; JJPC 43401; JJPC 43571; JJPC 43572; JJPC 43573; JJPC 43743; JJPC 32999; NEPG 28580; WSC 12461; *Chemical Market Reporter*, "Major Vitamin Makers Launch Global Expansions." November 2, 1998; BASF, "BASF restructures vitamin C production in NAFTA region," November 15, 2001, http://www.basf.com/corporate/news2001/newswilmington_111501.html (accessed October 31, 2008); Nutraingredients, "Roche Vitamins opens SA plant," June 26, 2002, http://www.nutraingredients.com (accessed October 31, 2008); Food Navigator, "BASF's takeover of Takeda's vitamin approved," July 9, 2001, http://www.foodnavigator.com (accessed October 31, 2008); Nutraingredients, "DSM makes last stand against Chinese vitamin C," October 20, 2005, http://www.nutraingredients.com (accessed October 31, 2008).

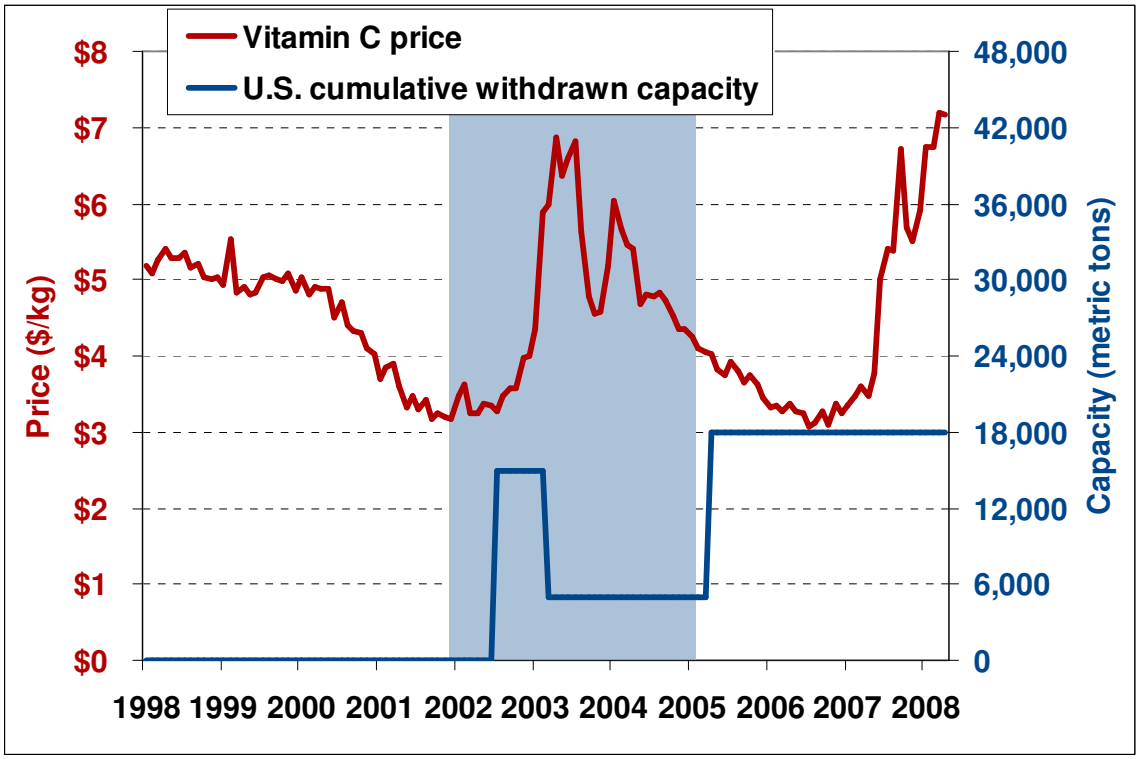
possible that capacity withdrawal in 2002 provided a catalyst for the effective cartelization of Vitamin C production by Chinese firms.

Figure 38: Comparison of Vitamin C price with the Vitamin C total cumulative withdrawn capacity[137]



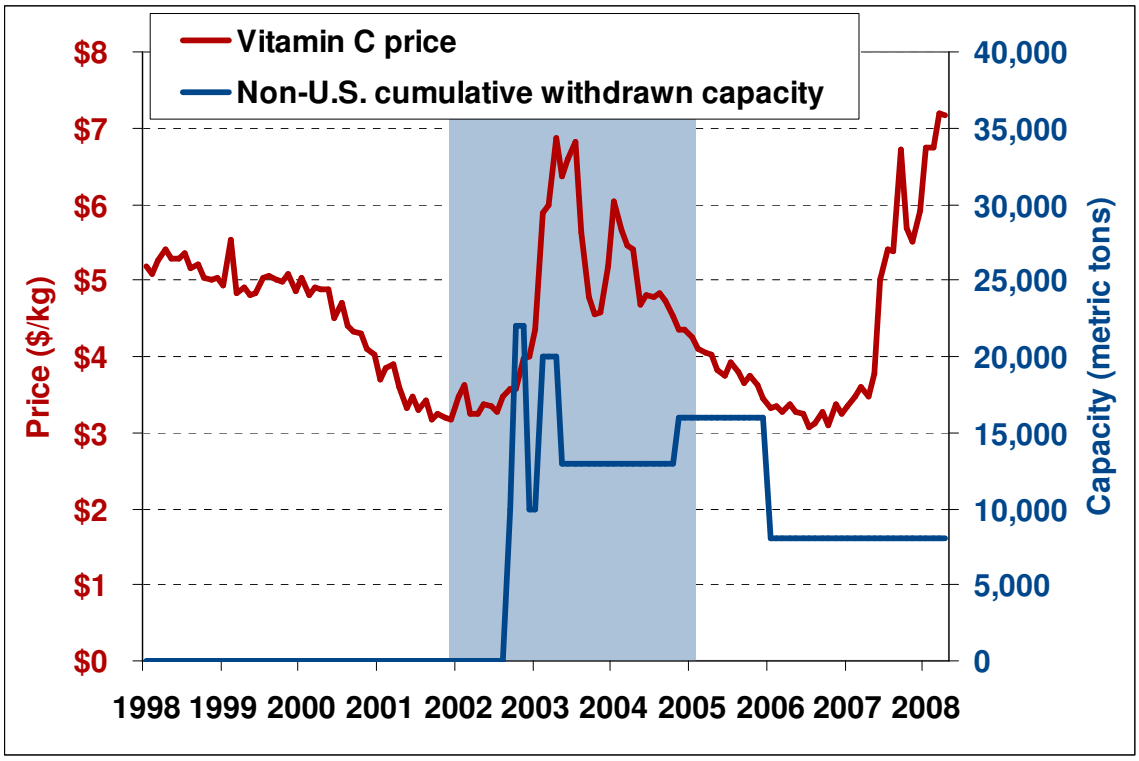
[137] *Ibid.*

Figure 39: Comparison of Vitamin C price with the U.S. Vitamin C cumulative withdrawn capacity[138]



[138] *Ibid.*

Figure 40: Comparison of Vitamin C price with the non-U.S. Vitamin C cumulative withdrawn capacity[139]



III.3. Demand factors

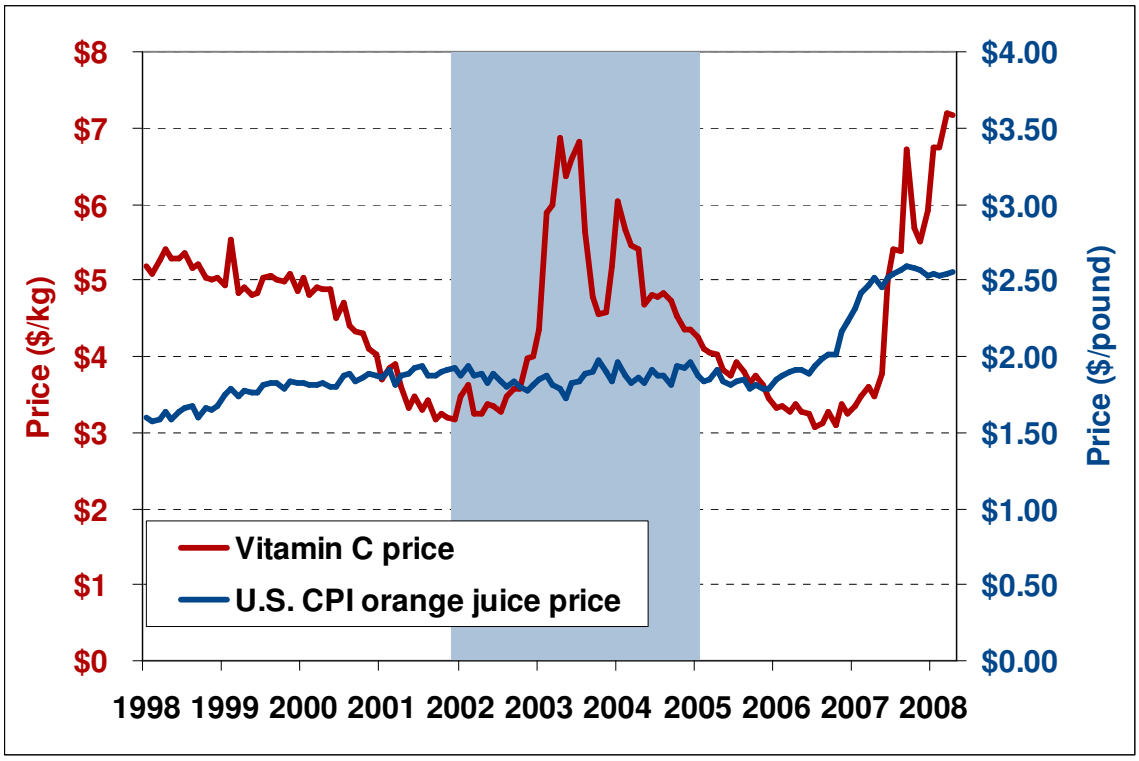
III.3.1. Substitutes

(79) As discussed in Section II, there are few substitutes for raw Vitamin C in the production of end-use products such as multivitamins, sports drinks, breakfast cereals, and the like. However, final consumers can in principle substitute between natural and synthetic sources of Vitamin C. An increase in the price of a substitute would increase the demand for Vitamin C, and could in principle account for Vitamin C price elevation. Figure 41 through Figure 45 compare Vitamin C prices to monthly U.S. BLS consumer price indexes for, respectively, orange juice (frozen concentrate, 12 oz. can, converted to 16 oz. units), fruit (including apples, bananas, citrus fruits, and other fresh fruits), vegetables (including potatoes, lettuce, tomatoes, and other fresh

[139] *Ibid.*

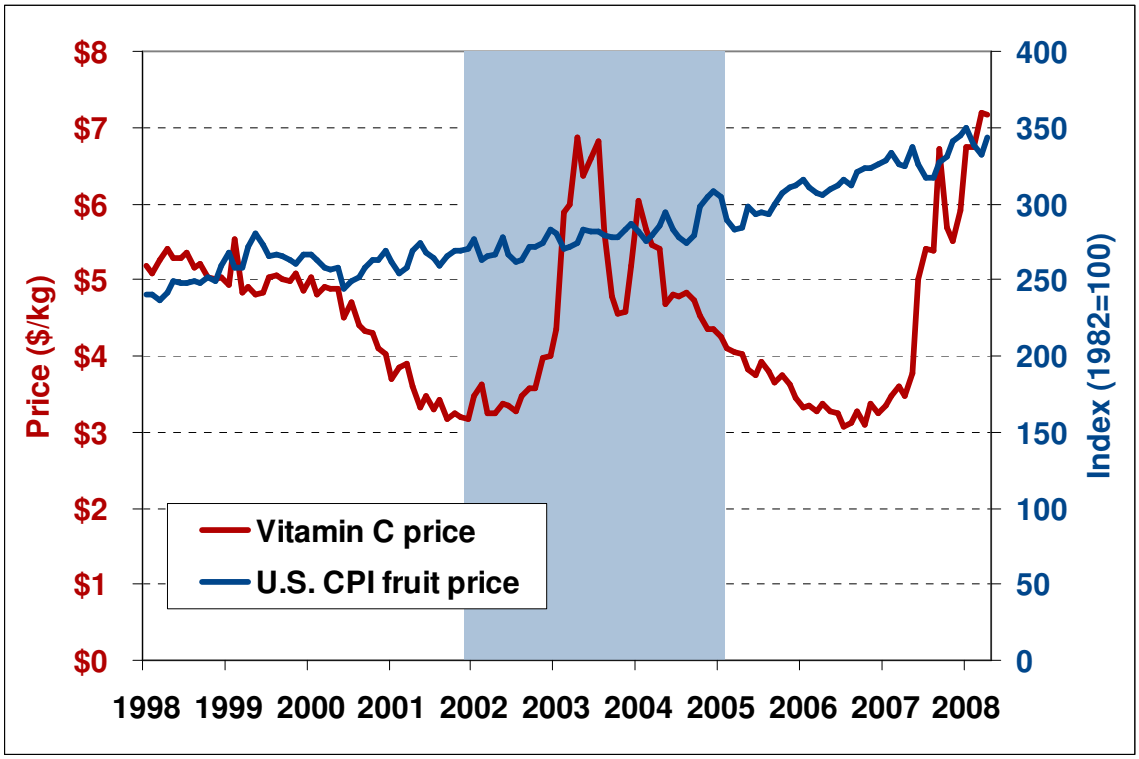
vegetables), fresh tomatoes, and fresh potatoes, all of which are naturally occurring sources of Vitamin C. Most of these series display an upward trend, in several cases with a cyclical or seasonal component. None suggests a plausible explanation for the Vitamin C price elevation observed in 2002 through 2004.

Figure 41: Comparison of Vitamin C price with orange juice consumer price index[140]



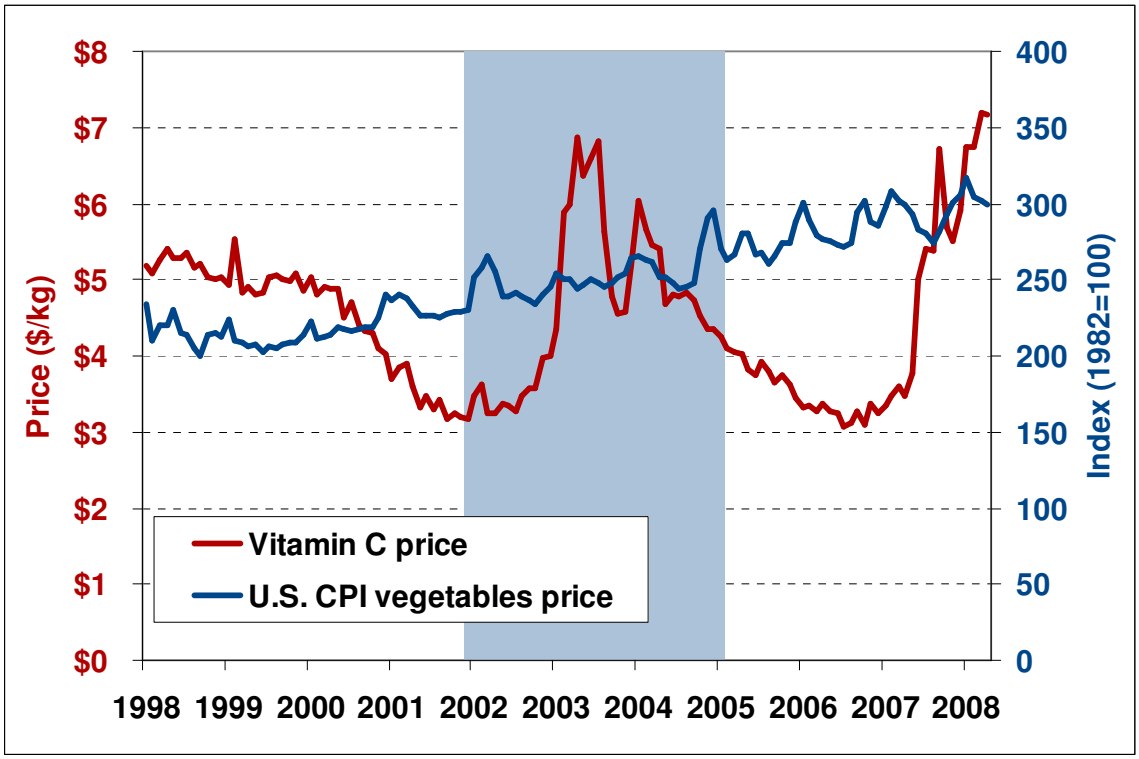
[140] ITC data; U.S. Bureau of Labor Statistics, Orange Juice Consumer Price Index APU0000713111, 2008, www.bls.gov/data.

Figure 42: Comparison of Vitamin C price with fruit consumer price index [141]



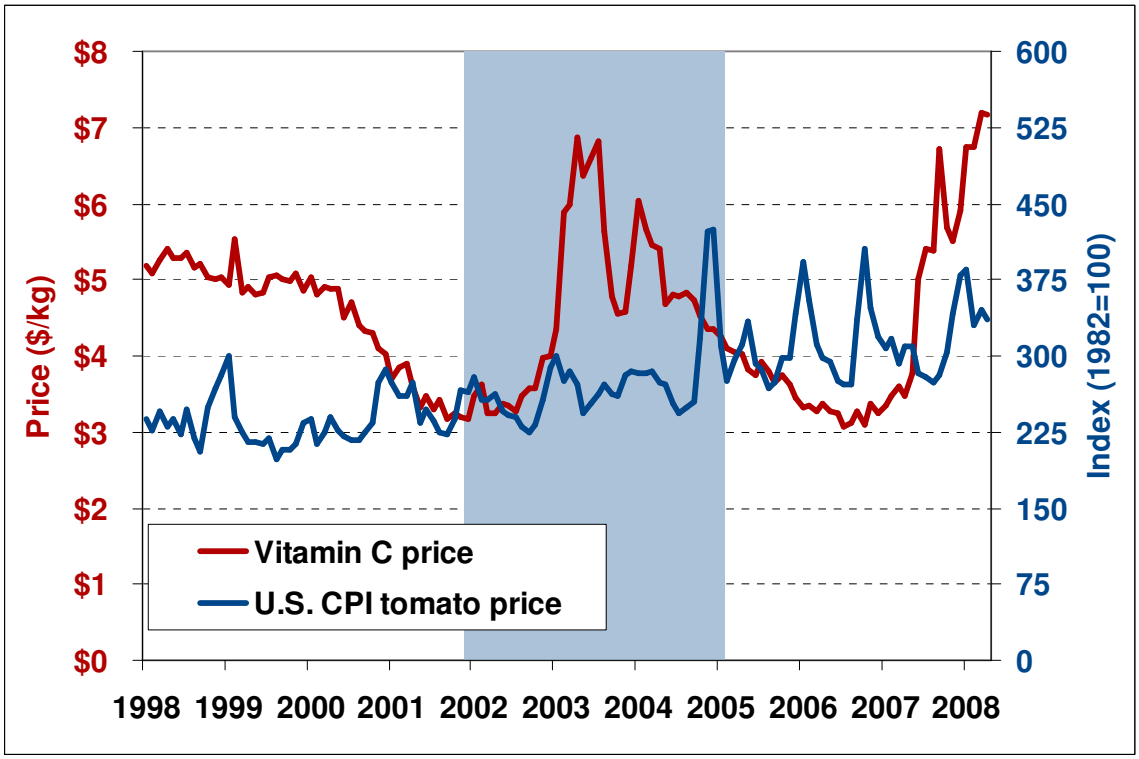
[141] ITC data; U.S. Bureau of Labor Statistics, Fresh fruit Consumer Price Index CUUR0000SEFK, 2008, www.bls.gov/data.

Figure 43: Comparison of Vitamin C price with vegetables consumer price index [142]



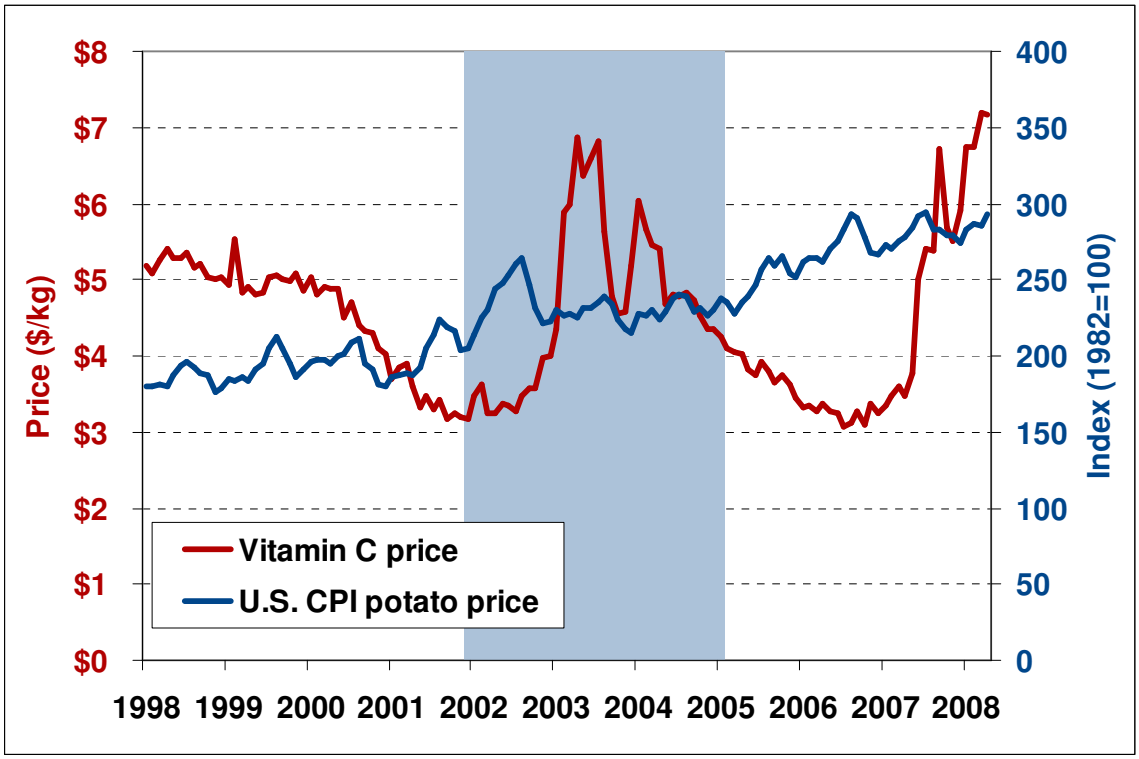
[142] ITC data; U.S. Bureau of Labor Statistics, Fresh vegetables Consumer Price Index.CUUR0000SEFL, 2008, www.bls.gov/data.

Figure 44: Comparison of Vitamin C price with tomato consumer price index[143]



[143] ITC data; U.S. Bureau of Labor Statistics, Tomato Consumer Price Index CUUR0000SEFL03 2008, www.bls.gov/data.

Figure 45: Comparison of Vitamin C price with potato consumer price index [144]



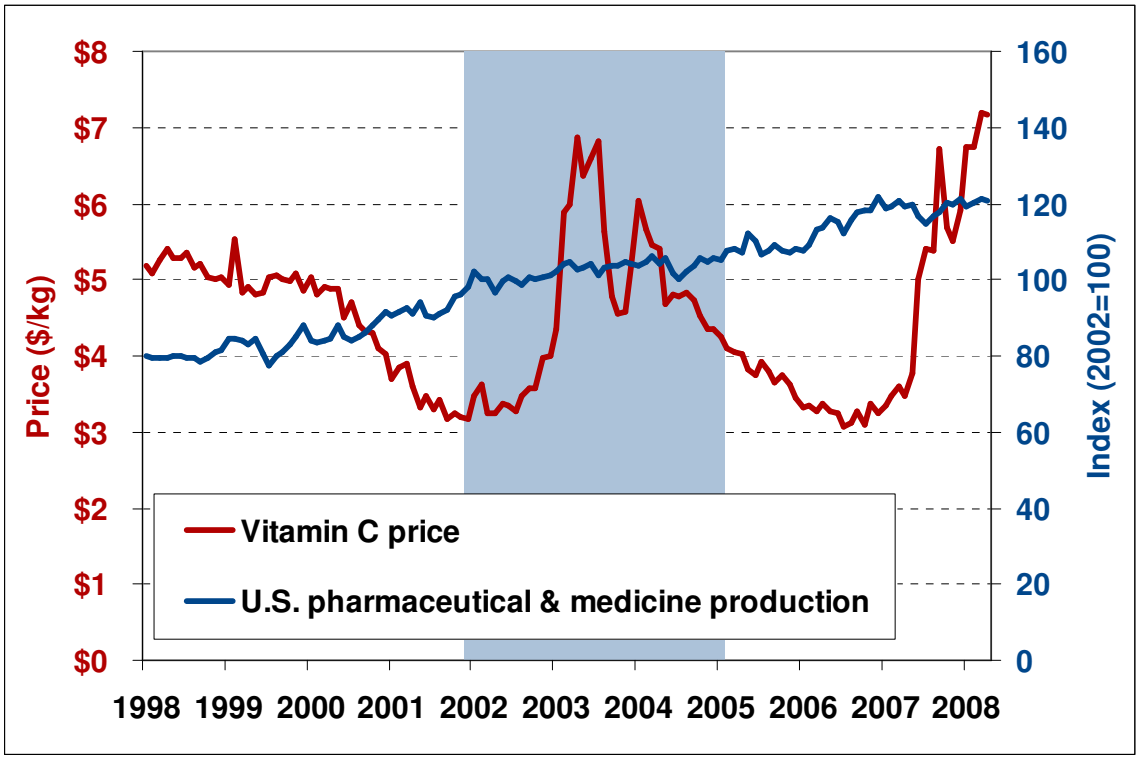
III.3.2. Factors affecting derived demand

(80) As shown in Figure 3, the demand for Vitamin C is derived primarily from pharmaceutical, beverage, and food products. An increase in the production of an end-use product containing Vitamin C would increase the demand for Vitamin C and could in principle account for Vitamin C price elevation. Figure 46 through Figure 48 compare Vitamin C prices to monthly data series describing, respectively, a U.S. drug production index (which measures the U.S. pharmaceutical and medicine industrial production), a U.S. soft drink and ice production index (which measures the U.S. production of soft drinks, bottled water, and ice), and a U.S. food production index (which measures the transformation of livestock and agricultural products into products for intermediate or final consumption, including dairy products, seafood, meat, fruit and preserved vegetables). Figure 49 and Figure 50 show Japan and EU soft drinks production. Figure 51 and Figure 52 compare Vitamin C prices to annual data describing, respectively, U.S. and world aquaculture production, as reported by the Food and Agriculture Organization of the

[144] ITC data; U.S. Bureau of Labor Statistics, Potato Consumer Price Index CUUR0000SEFL01, 2008, www.bls.gov/data.

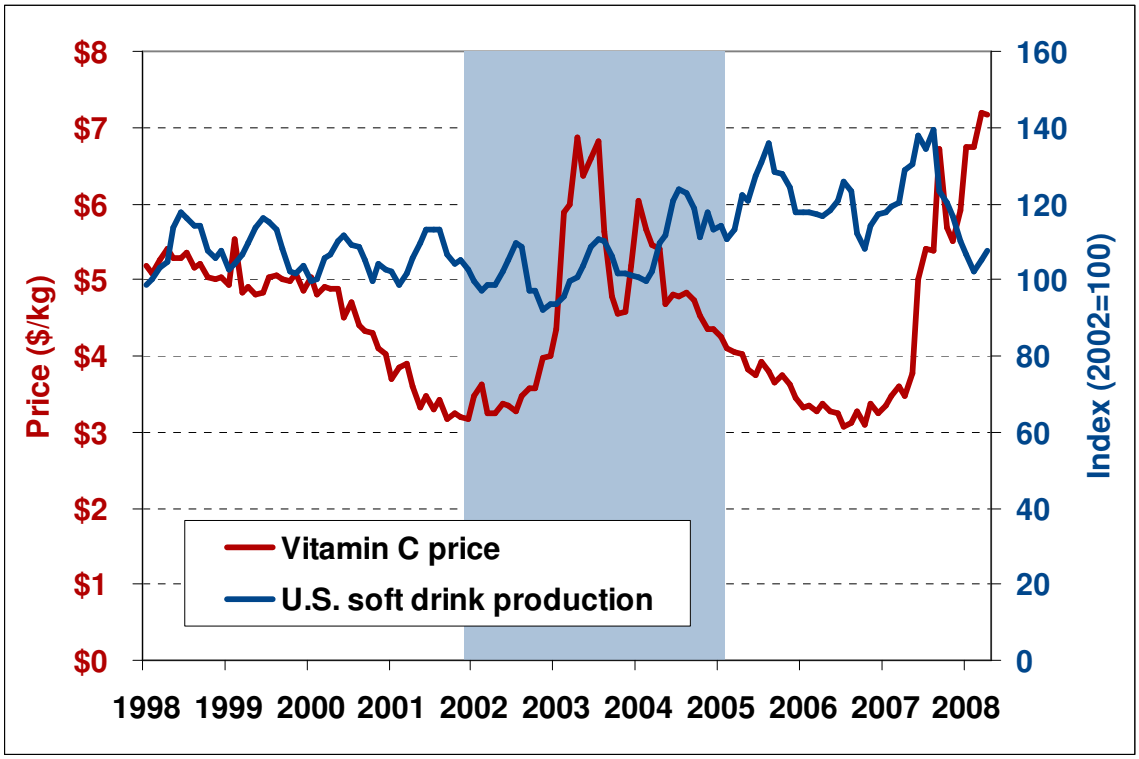
United Nations. These series include all species of aquaculture, including carp, salmon, trout, prawns, and others. I have singled out aquaculture because it is a major use of Vitamin C in animal feed. Most of these series display fairly steady growth, in several cases with a cyclical or seasonal component. None suggest a plausible explanation for the Vitamin C price elevation observed in 2002 through 2004.

Figure 46: Comparison of Vitamin C price with U.S. pharmaceutical and medicine production[145]



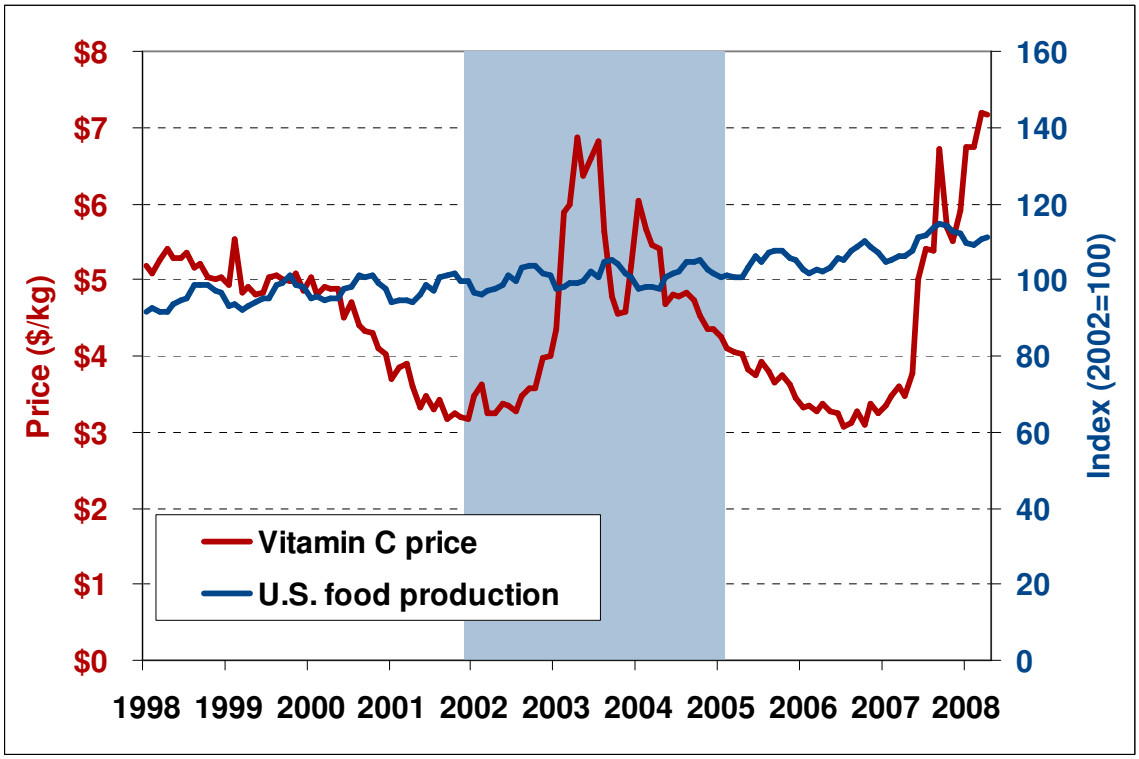
[145] ITC data; U.S. Federal Reserve, Board of Governors IPI data, NAICS 3254, 2008, http://www.federalreserve.gov/datadownload/Build.aspx?rel=G17.

Figure 47: Comparison of Vitamin C price with soft drink & ice production index[146]



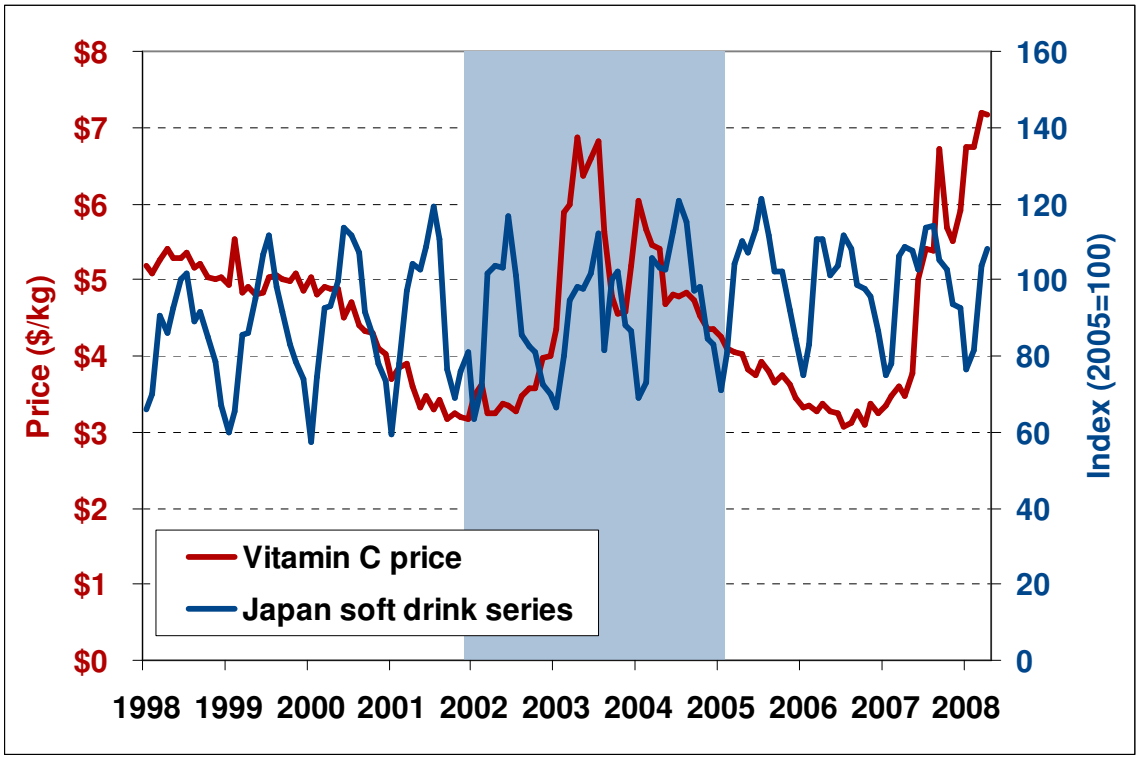
[146] ITC data; U.S. Federal Reserve, Board of Governors IPI data, NAICS 31211, 2008, http://www.federalreserve.gov/datadownload/Build.aspx?rel=G17.

Figure 48: Comparison of Vitamin C price with food production index[147]



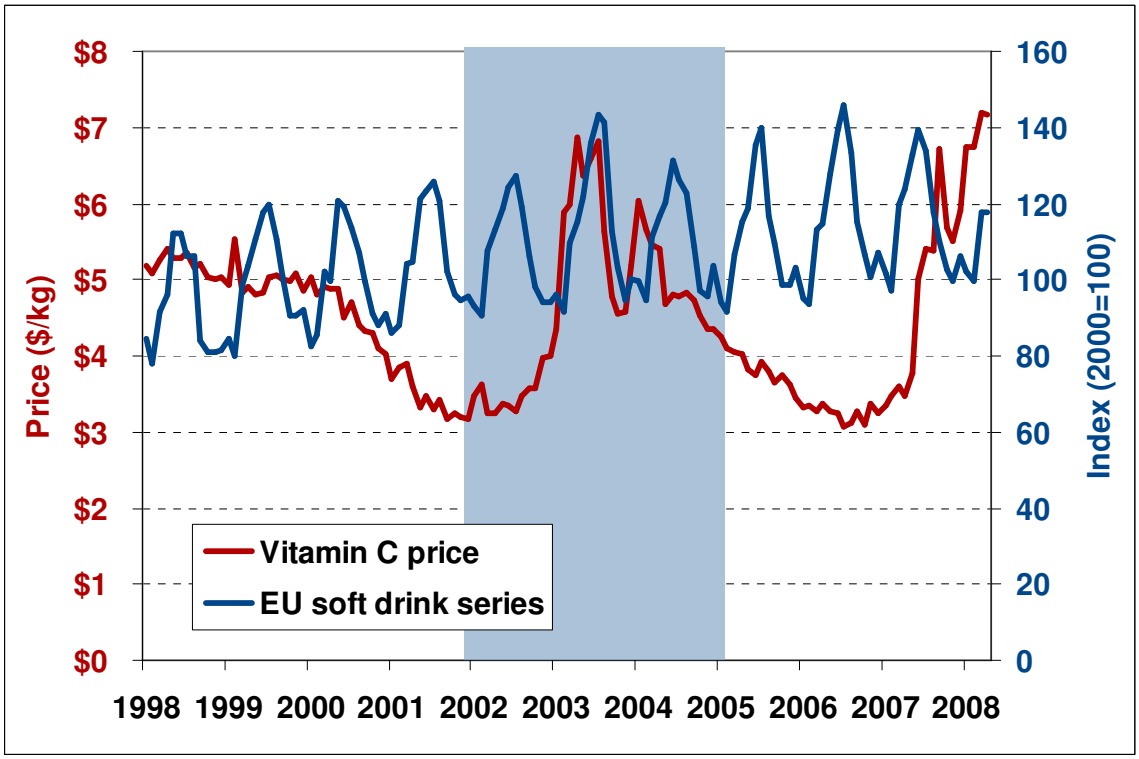
[147] ITC data; U.S. Federal Reserve, Board of Governors IPI data, NAICS 311, 2008, http://www.federalreserve.gov/datadownload/Build.aspx?rel=G17.

Figure 49: Comparison of Vitamin C price with Japan soft drinks index[148]



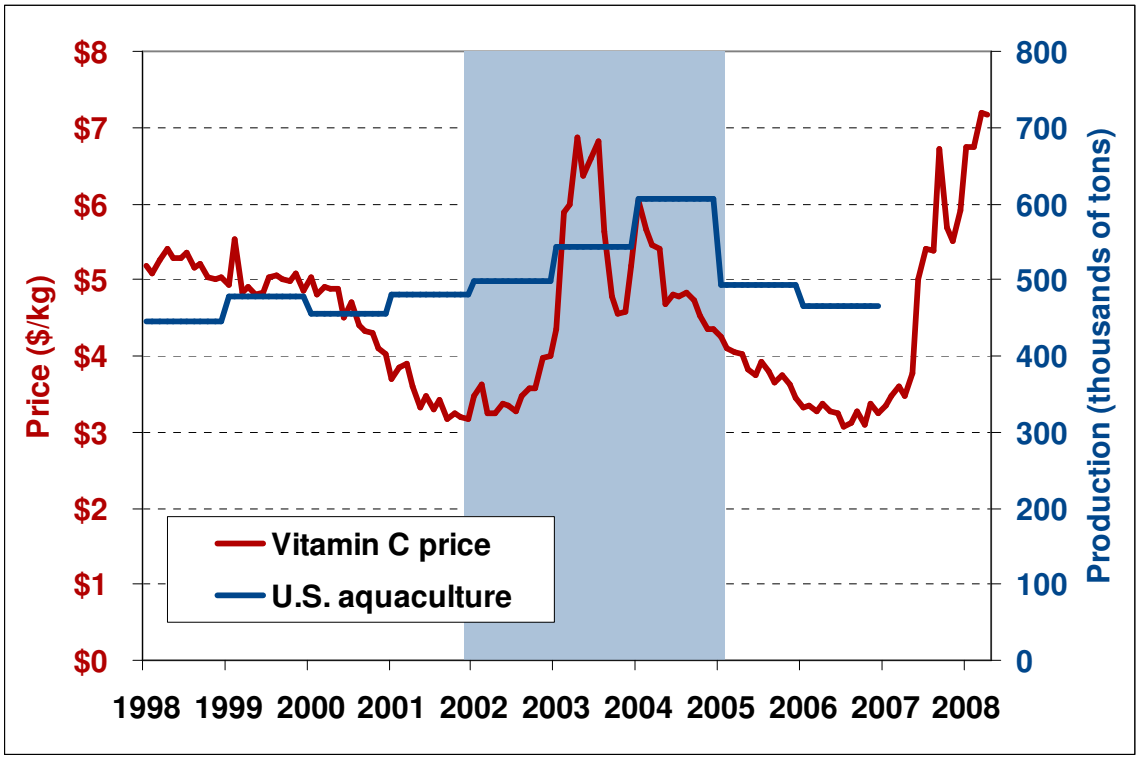
[148] Japan Soft Drinks, Thomson Datastream Advance Version 4.0 SP9 with Excel Add-in, Industrial Production - Soft Drinks, JPIPFTSFH, 2008, (accessed October 19, 2008).

Figure 50: Comparison of Vitamin C price with EU mineral water and soft drinks production[149]



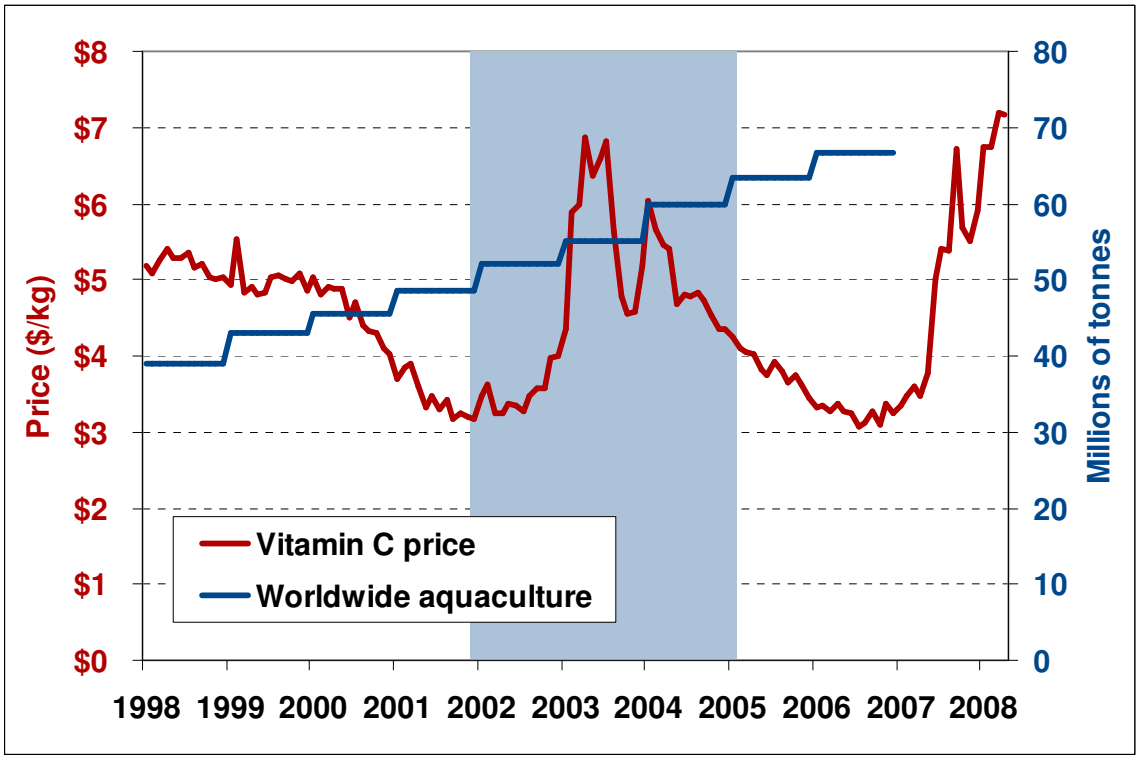
[149] EU Soft Drinks, Thomson Datastream Advance Version 4.0 SP9 with Excel Add-in, Industrial Production - Production of Mineral Waters & Soft Drinks (WDA), EXES1598H, 2008, (accessed October 19, 2008).

Figure 51: Comparison of Vitamin C price with U.S. aquaculture production[150]



[150] ITC data; Food and Agriculture Organization (FAO) of the United Nations "Aquaculture production 1950-2006" http://www.fao.org/fishery/statistics/global-aquaculture-production.

Figure 52: Comparison of Vitamin C price with worldwide aquaculture production[151]



III.3.3. SARS

(81) To the extent SARS stimulated the demand for Vitamin C in 2003 and 2004 it may have contributed to the observed price elevation. Figure 53 compares Vitamin C prices with the number of reported SARS cases from October 2002 through the first half of 2004. The World Health Organization (WHO) first identified SARS at the end of February 2003 and first began reporting cases of SARS in March 2003.[152] Reported cases peaked in April 2003. In contrast, Vitamin C prices leapt roughly $2.50 per kilogram between October 2002 and February 2003, from about $3.50 per kilogram to nearly $6 per kilogram, *before the first case of SARS was identified and reported*. Though SARS may have contributed to further price increases (specifically, the roughly $1 per kilogram increase from just under $6 per kilogram in February 2003 to just under $7 per kilogram in April 2003), SARS developed too late to account for the bulk of the observed run-up.

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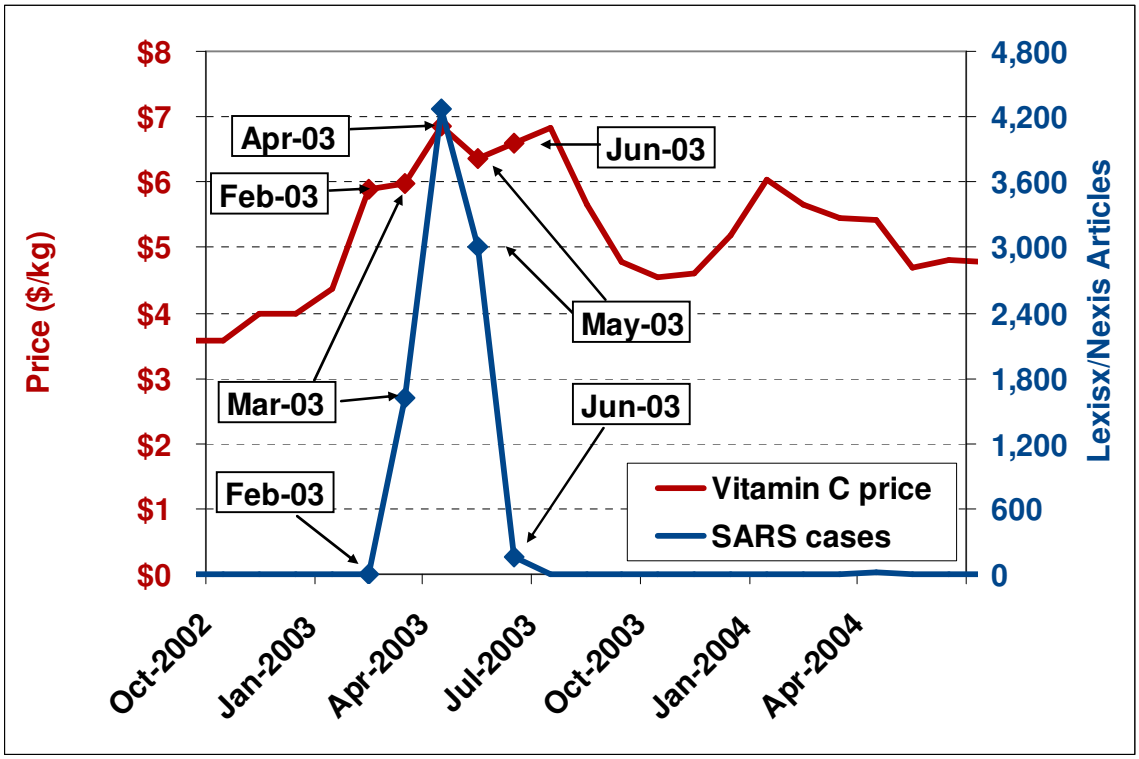
151 *Ibid.*

152 "SARS was first recognised on the February 26, 2003", World Health Organization, March 16, 2003, http://www.who.int/csr/don/2003_03_16/en/index.html (accessed October 30, 2008).

Figure 53: Comparison of Vitamin C price with number of reported SARS cases[153]

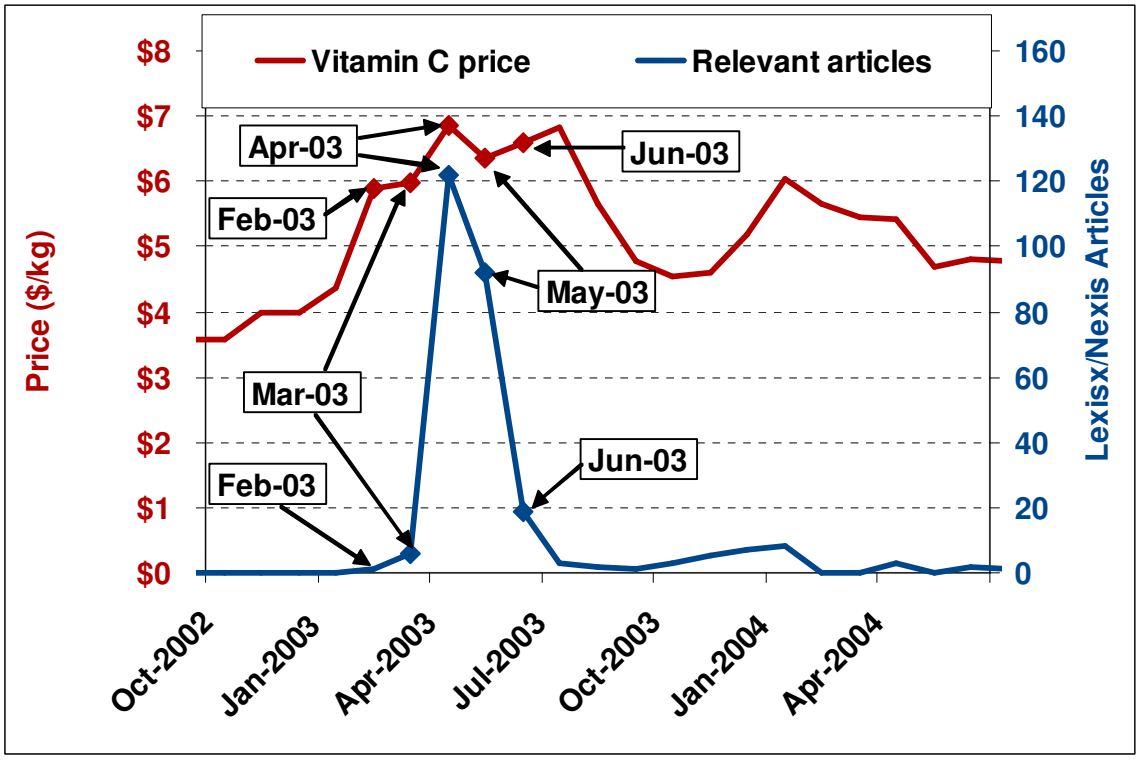


(82) Figure 53 likely overstates the speed at which SARS could have affected the demand for Vitamin C. Of necessity, there must have been some lag between the outbreak of the disease, widespread public awareness of the risk it posed, and the popularization of Vitamin C as a preventative measure. To obtain a better sense for the timing of the Vitamin C demand response, I performed a search of U.S. and non-U.S. English language news sources covered by Lexis/Nexis. Most of the articles appeared in U.S. publications but some came from Southeast Asia and English-speaking countries. The search identified articles containing the keywords "SARS" and either "Vitamin C" or "ascorbic acid." My support staff reviewed all articles to remove those that did not actually suggest a link between Vitamin C and SARS prevention.[154] Figure 54 shows the monthly counts of the news articles that survived this selection process. Only a handful of references appeared before April 2003. In April 2003 the references to a potential link between Vitamin C and SARS peaked before dropping off to occasional mentions starting in July.

[153] ITC data; Worldwide SARS cases by date of report, http://www.who.int/csr/sars/epicurve/epiindex/en/index2.html (accessed October 27, 2008).

[154] For example, my support staff would have excluded a news article that mentioned a number of diseases, such as SARS and the flu, and then discussed vitamins in the context of a disease other than SARS.

Figure 54: Comparison of Vitamin C price with number of articles containing "SARS" and "Vitamin C" or "ascorbic acid"[155]

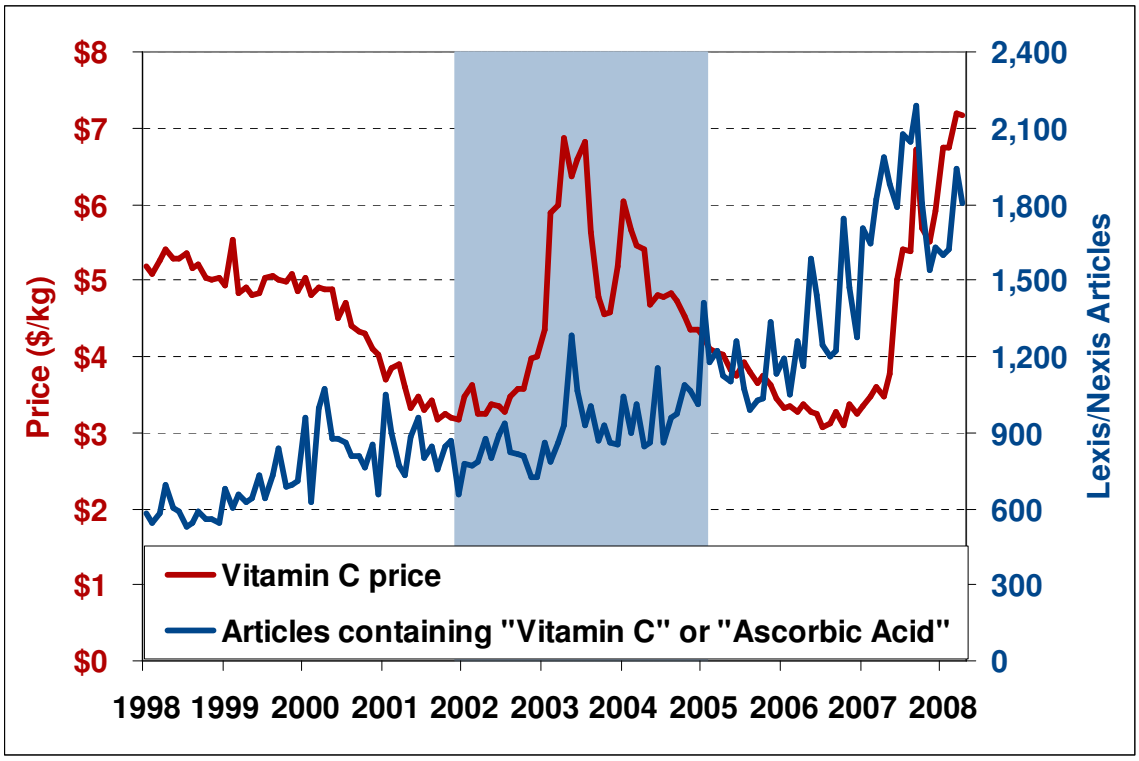


III.3.4. General indicators of demand

(83) The frequency of references to Vitamin C in the popular media can serve as a reasonable proxy for general consumer focus, attention, and/or awareness. Accordingly, I used Lexis/Nexis to identify news articles from U.S. and non-U.S. newspapers and newswires containing the keywords "Vitamin C" or "ascorbic acid" (without reference to SARS or other specific conditions). Figure 55 shows the monthly counts of those articles. Though the series is volatile, one can easily see that, as a general matter, references to Vitamin C were not unusually frequent in 2002 through 2004.

[155] ITC data; Lexis/Nexis. Number of articles from U.S., Southeast Asia, and English-language newspapers and newswires containing the phrases "SARS" and "Vitamin C" or "ascorbic acid" as found using Lexis/Nexis.

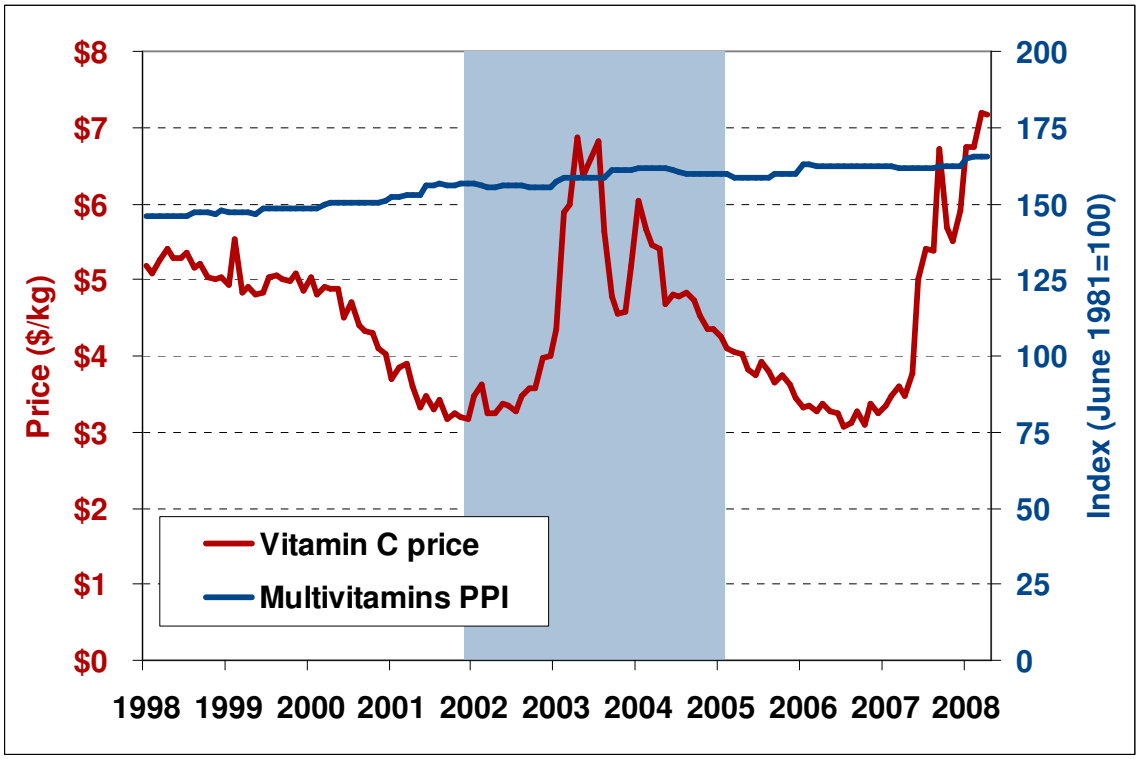
Figure 55: Comparison of Vitamin C price with number of articles containing "Vitamin C" or "ascorbic acid"[156]



(84) The price of multivitamin pharmaceutical preparations also proxies for consumer vitamin demand, with higher prices generally reflecting stronger demand. In principle, an increase in the price of Vitamin C could cause the cost, and hence the price, of multivitamins to rise, creating the spurious appearance that the Vitamin C price increase was demand-driven. However, that effect is likely to be quite small given that Vitamin C inputs account for a small fraction of multivitamin costs. Figure 56 compares the price of Vitamin C with the U.S. multivitamin PPI. Notably, the Vitamin C price elevation observed in 2002 through 2004 was not accompanied by an increase in multivitamins prices, which suggests that it was not driven by an increase in demand.

[156] ITC data; Lexis/Nexis. Number of articles from U.S., Southeast Asia, and English-language newspapers and newswires containing the phrases "Vitamin C" or "ascorbic acid" as found using Lexis/Nexis.

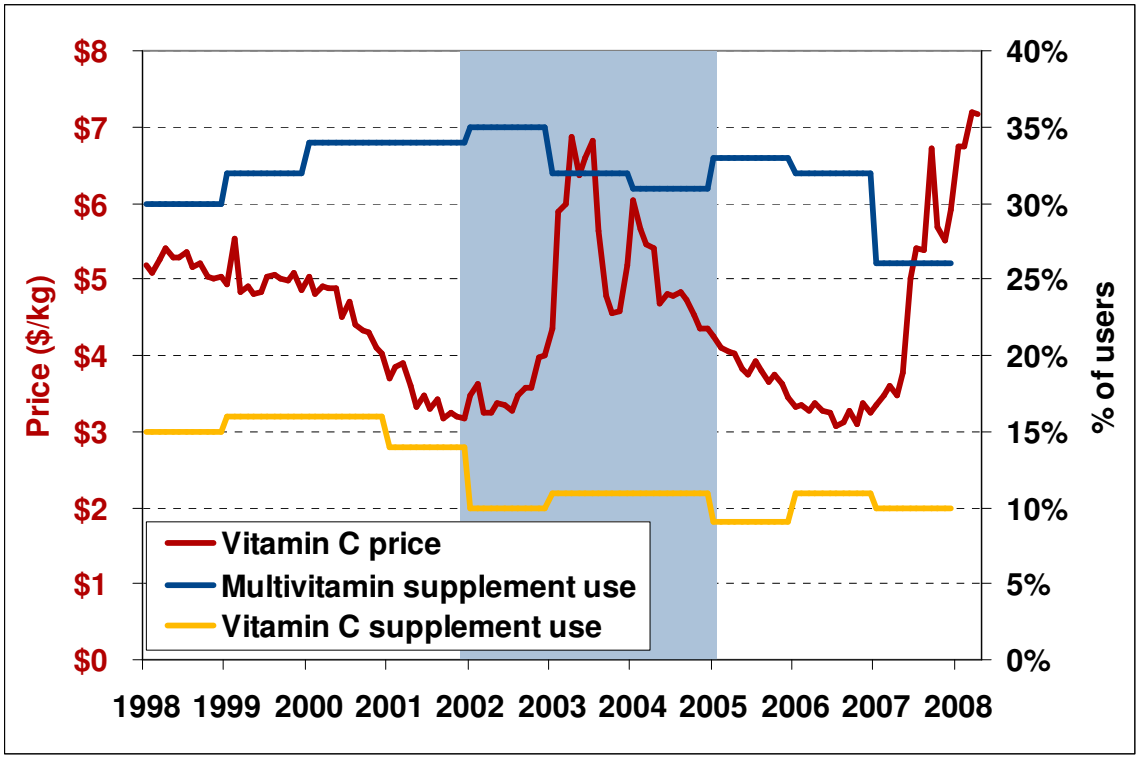
Figure 56: Comparison of Vitamin C price with multivitamin price index[157]



(85) The percentage of the population that uses vitamin supplements is another general proxy for vitamin demand. In principle, an increase in the price of Vitamin C could cause the cost, and hence the price, of vitamin supplements to rise, leading to a decline in the fraction of people who use those supplements. However, that effect is likely to be small given that Vitamin C inputs account for a small fraction of vitamin supplement costs (particularly multivitamins). Figure 57 compares the Vitamin C price with annual data on the percentage of Americans who regularly take Vitamin C and multivitamin supplements. Once again, there is no indication of that demand was significantly elevated when Vitamin C prices spiked in 2002 through 2004.

[157] United States Bureau of Labor Statistics, "Multivitamins PPI," PCU325412325412, www.bls.gov/data (accessed November 4, 2008).

Figure 57: Comparison of Vitamin C price with Gallup study of vitamin use in the U.S.[158]



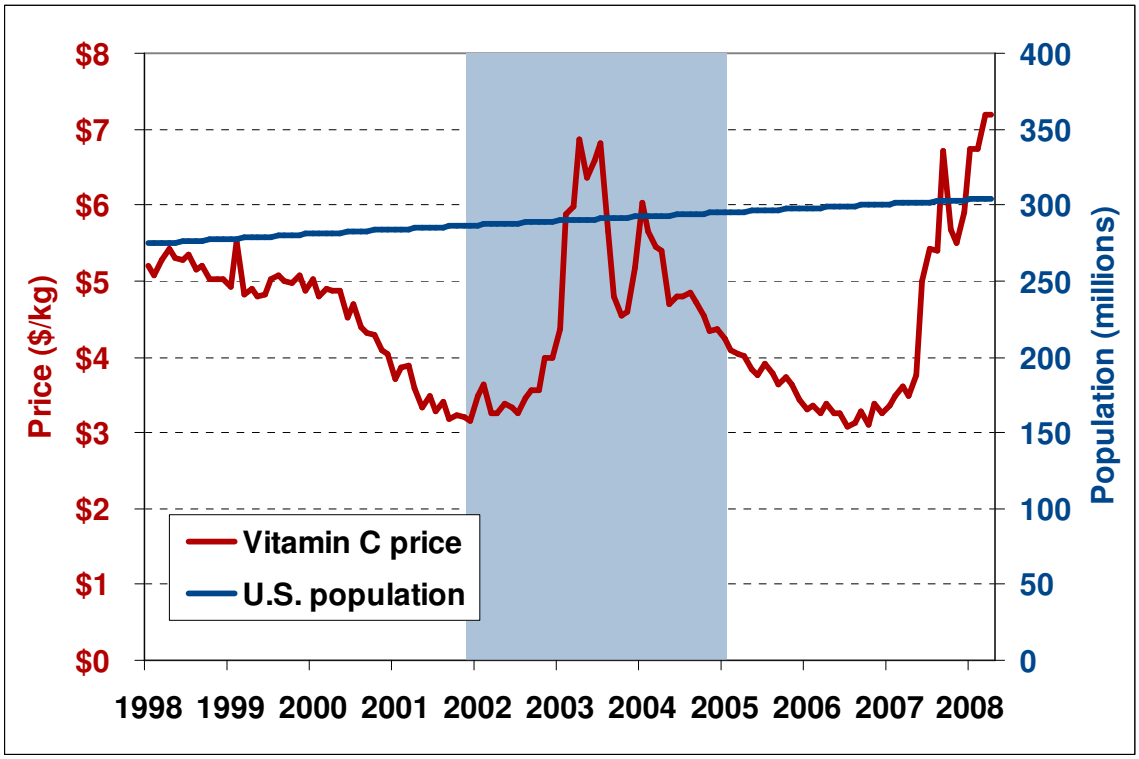
III.3.5. Other demand factors

(86) So far, I have focused on determinants of demand that are specific to Vitamin C. The demand for virtually all products is also driven, at least to some degree, by general factors such as population and disposable personal income. Neither factor is a likely explanation for the observed Vitamin C price elevation in 2002 through 2004, but I considered these factors nevertheless.

(87) Figure 58 and Figure 59 compare Vitamin C prices with, respectively, the U.S. and world populations, as reported by the U.S. Census Bureau. Figure 60 shows the population in developed countries as defined by the U.S. Census Bureau and the Euro area population (defined as countries that use the Euro currency) from the World Bank. As is readily evident from the figures, the population series are far too smooth to account for significant transitory changes in the price of Vitamin C.

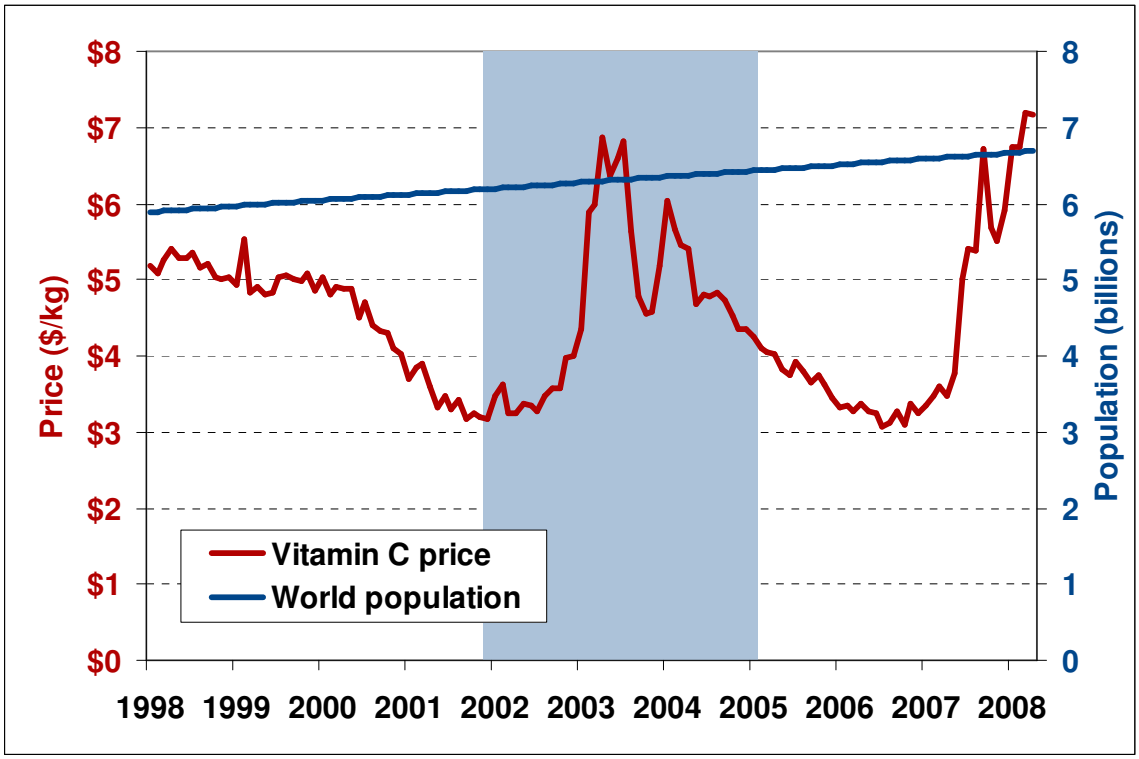
[158] Multi-Sponsor Surveys, Inc., "The Gallup Study of Vitamin Use in the U.S.," March 2008.

Figure 58: Comparison of Vitamin C price with U.S. Population[159]



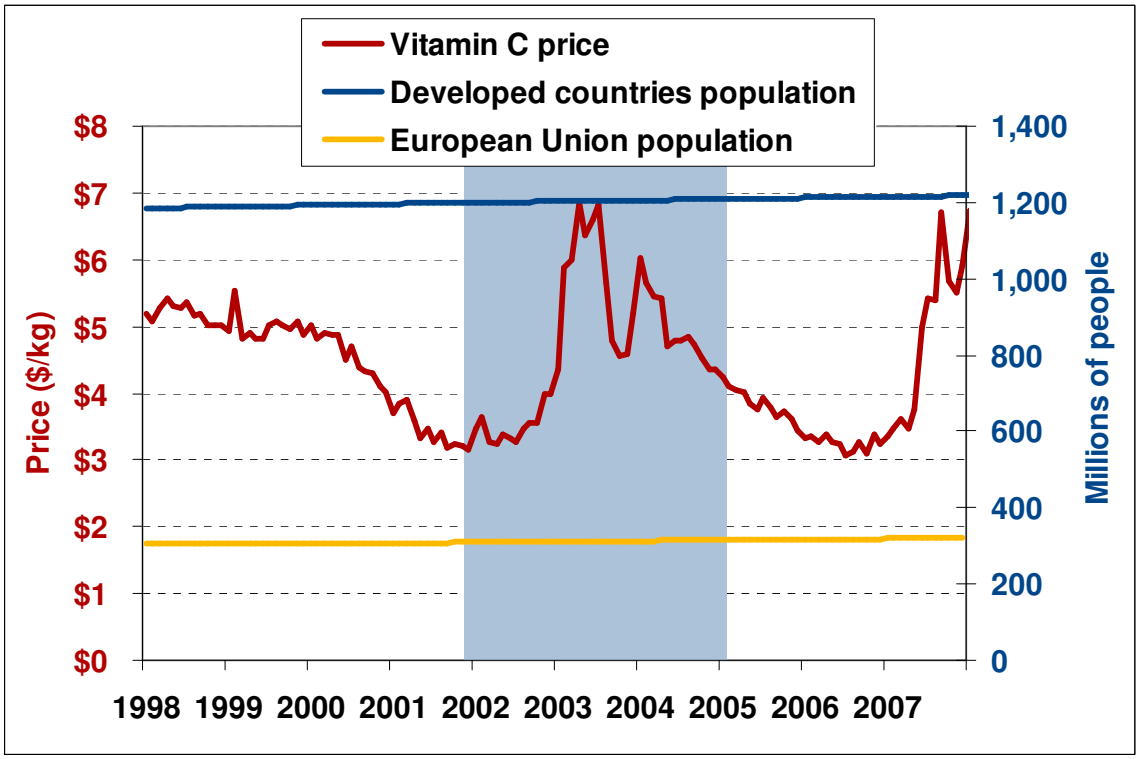
[159] ITC data; U.S. Census Bureau.

Figure 59: Comparison of Vitamin C price with world population[160]



[160] World Bank, Health, Nutrition, and Population, Data & Statistics, http://go.worldbank.org/9EQZCKCE00, (accessed October 30, 2008). Population data is annual. I created a straight-line extrapolation to get monthly data.

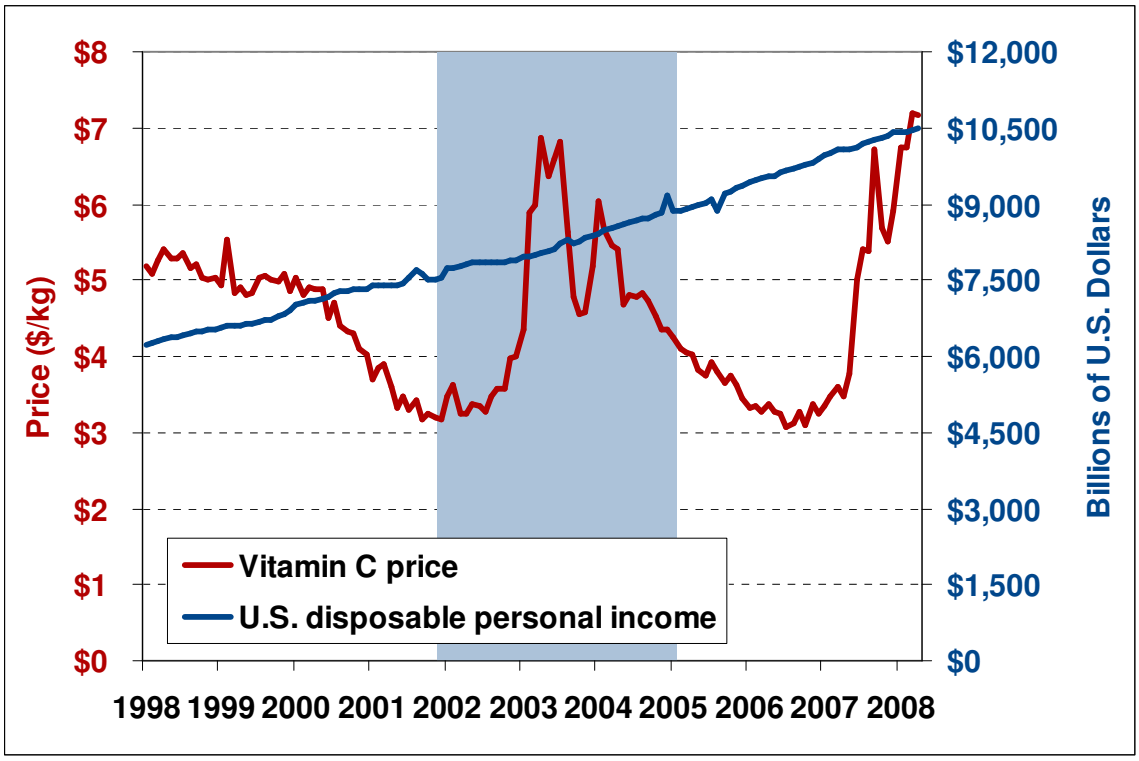
Figure 60: Comparison of Vitamin C price with developed world and Euro area population[161]



[161] *Ibid*; U.S. Census Bureau, International Data Base, More Developed Countries Total Midyear Population, June 18, 2008, http://www.census.gov/ipc/www/idb/tables.html, (accessed November 4, 2008).; ITC data.

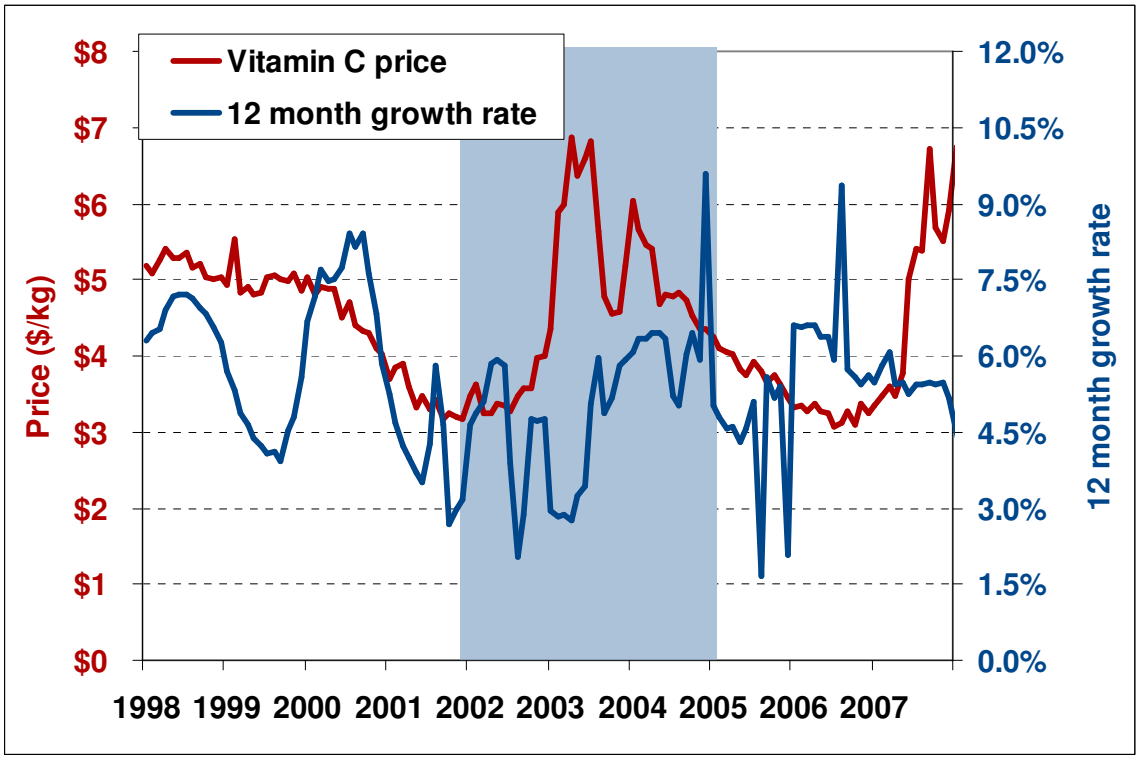
(88) Figure 61 and Figure 62 compare Vitamin C prices with, respectively, the level and growth rate of U.S. disposable personal income, as reported by the U.S. Department of Commerce. Plainly, the Vitamin C price elevation observed in 2002 through 2004 is not attributable to a sudden and transitory acceleration in the growth of personal income.

Figure 61: Comparison of Vitamin C price with U.S. disposable personal income[162]



[162] ITC data; U.S. Department of Commerce: Bureau of Economic Analysis, Disposable Personal Income, 2008, http://research.stlouisfed.org/fred2/series/DSPI/downloaddata?cid=110 (accessed October 30, 2008).

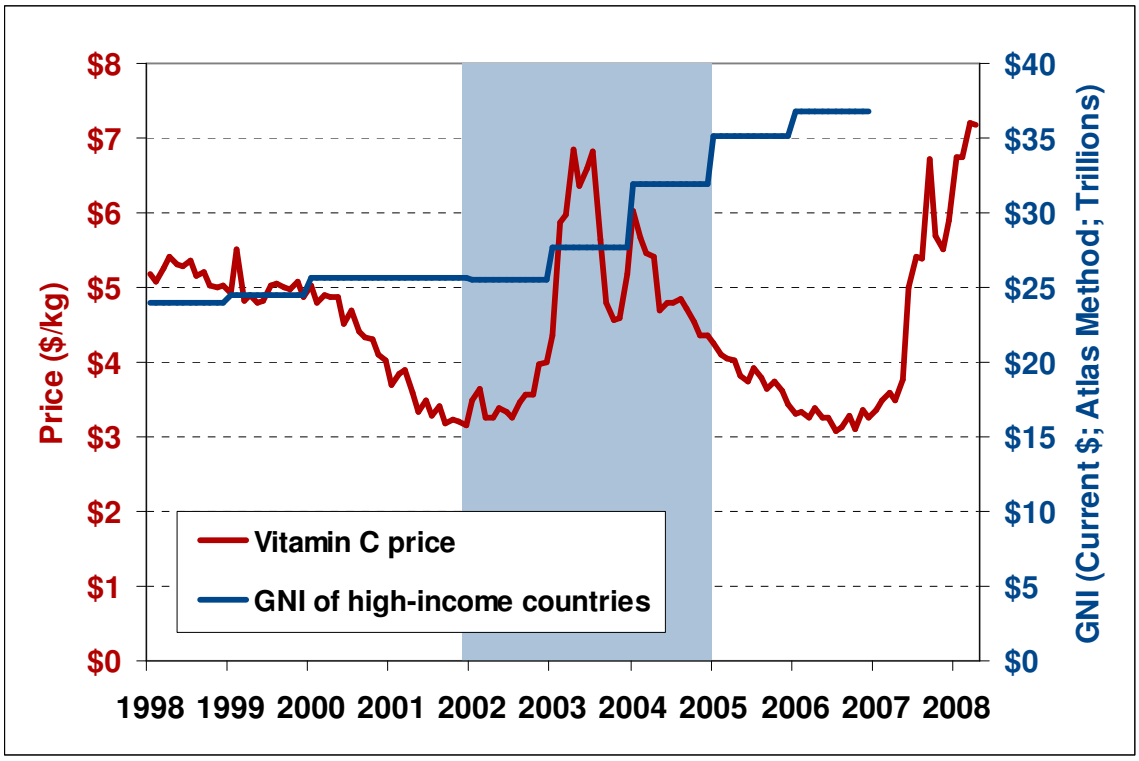
Figure 62: Comparison of Vitamin C price with U.S. disposable personal income growth rate[163]



[163] *Ibid.*

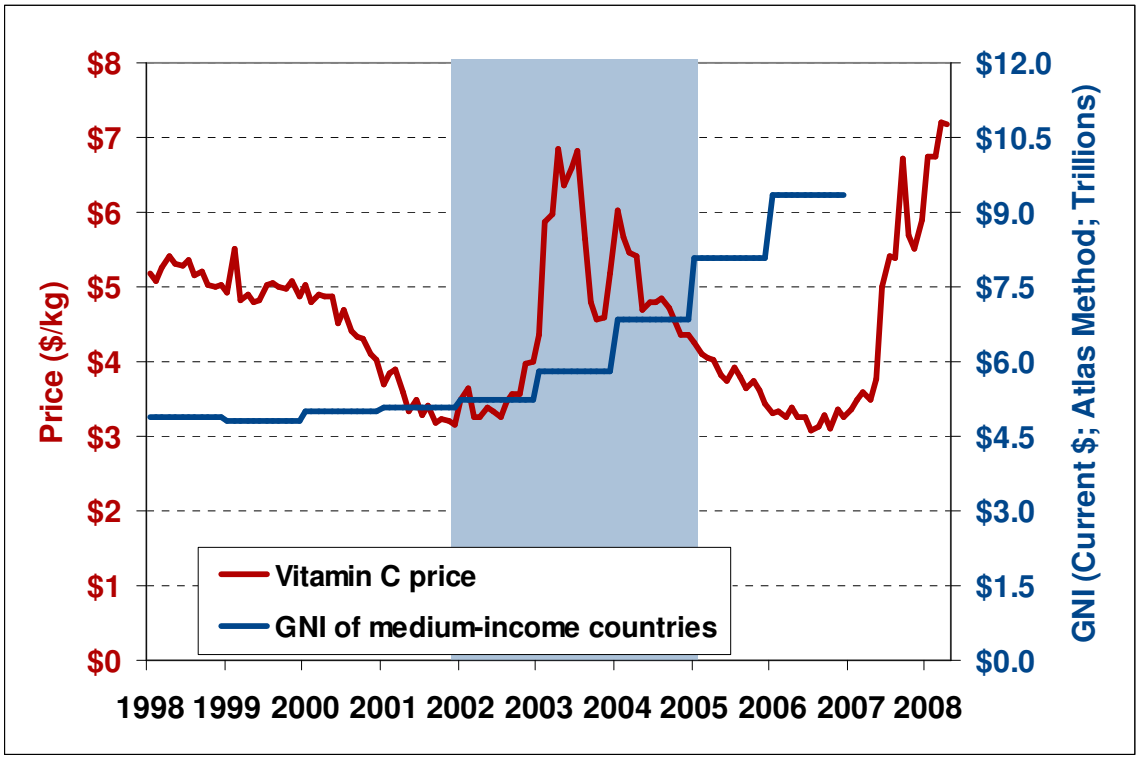
(89) Figure 63, Figure 64, and Figure 65 compare Vitamin C prices with annual data on the Gross National Incomes (GNI) of, respectively, high-, medium-, and low-income countries, as reported by the World Bank. All of these figures show some acceleration in income growth around 2003, but the higher growth rates are sustained rather than transitory. Figure 66 compares Vitamin C prices with disposable income in Japan. Consequently, they provide unlikely explanations for the transitory elevation of Vitamin C prices in 2002 through 2004.

Figure 63: Comparison of Vitamin C price with the GNI of high-income countries[164]



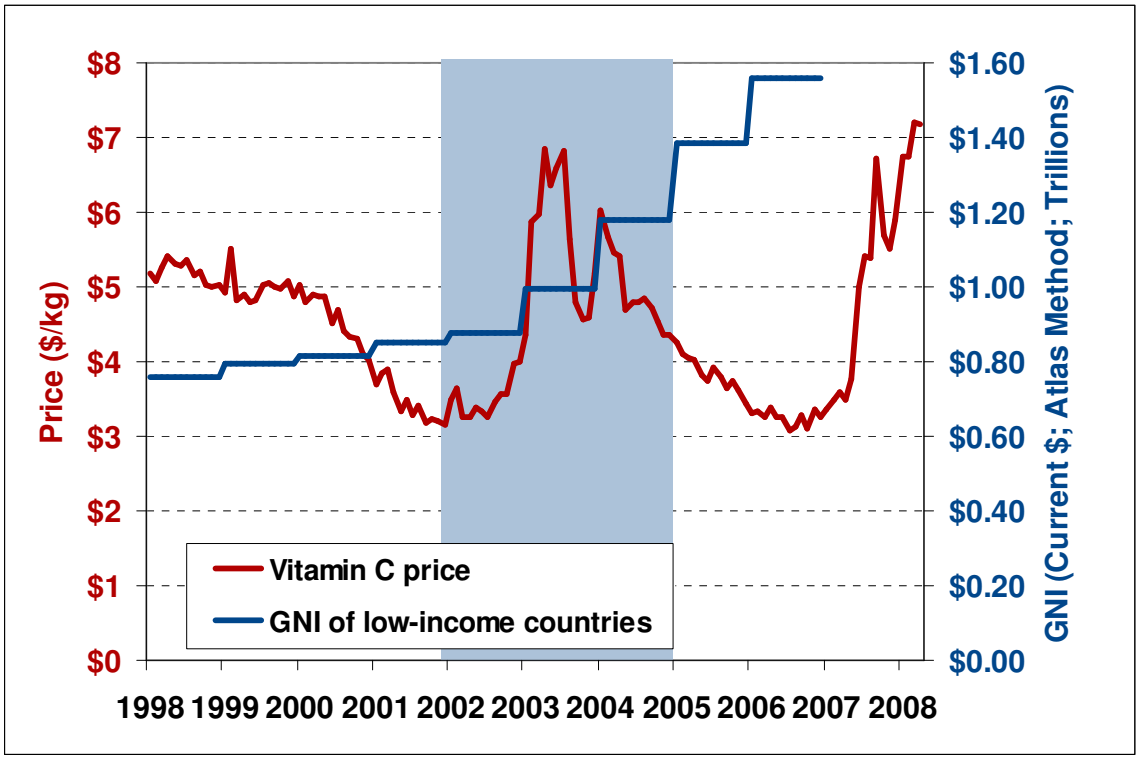
[164] World Bank, Health, Nutrition, and Population, Data & Statistics, http://go.worldbank.org/9EQZCKCE00 (accessed October 30, 2008).

Figure 64: Comparison of Vitamin C price with the GNI of medium-income countries[165]



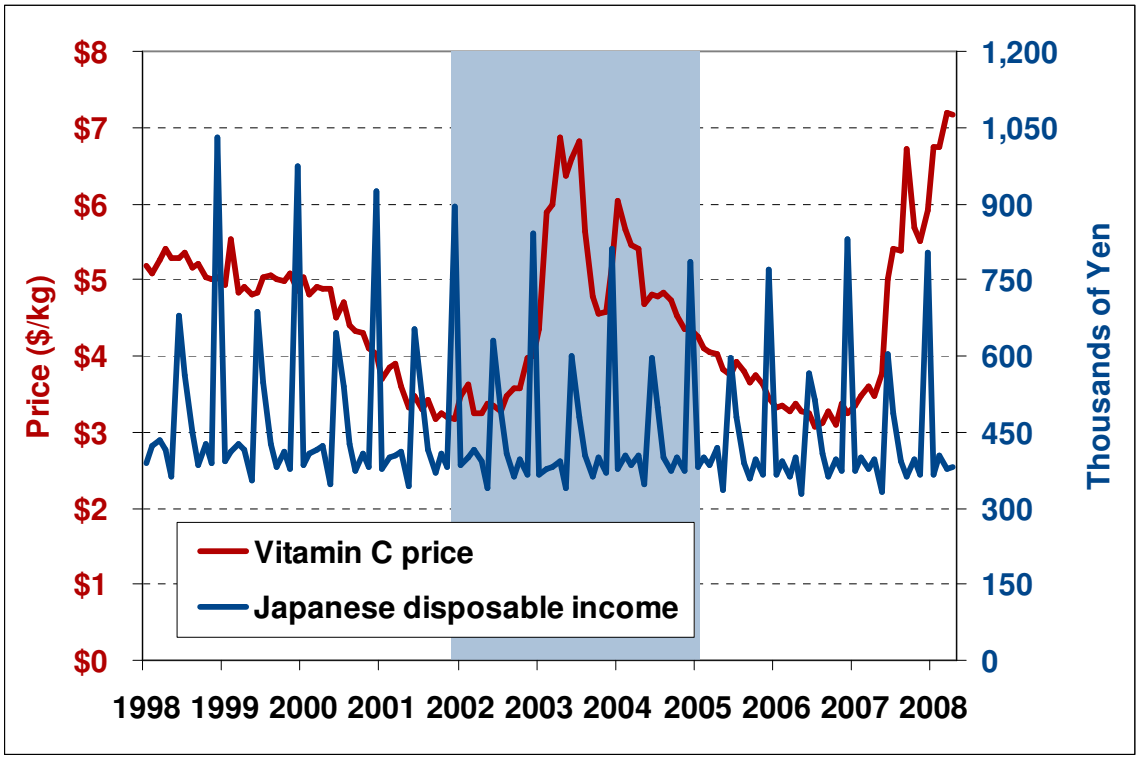
[165] *Ibid.*

Figure 65: Comparison of Vitamin C price with the GNI of low income countries[166]



166 *Ibid.*

Figure 66: Comparison of Vitamin C price with the Japanese disposable income[167]



[167] Japan Disposable Income, Thomson Datastream Advance Version 4.0 SP9 with Excel Add-in, Workers Household - Disposable Income, JPMDISPIA, 2008, (accessed October 19, 2008).

IV. Damages

IV.1. Summary of damage methodology

(90) I computed damages in four main steps. First, based on the manner in which Vitamin C prices varied with supply and demand conditions outside the period in which the cartel is thought to have operated effectively, I forecasted the prices that would have prevailed during the cartel period but for the conspiracy. Second, I made an appropriate adjustment for SARS. Third, I determined average overcharges by computing the difference between the actual average price and the adjusted but-for price in each month. Fourth, I multiplied the overcharges by the amounts sold in each month, net of transactions covered by arbitration clauses.

IV.2. Description of quantitative methods

(91) In this section, I describe and justify the quantitative methods that I used to estimate overcharges for Vitamin C products. These methods are completely standard, and they employ generally accepted statistical tools.

IV.2.1. The forecasting methodology

(92) The ultimate object of this analysis is to determine the prices that would have prevailed but for the conspiracy, for all sales occurring subsequent to the start of the relevant period, accounting for pertinent features of the economic environment. For this purpose, I employed a statistical model of Vitamin C prices. A statistical model is an equation that relates a "dependent variable" (here, the Vitamin C price) to a collection of other variables. As an example, consider the following equation:

$$Y = 15 + 4X - 7Z + \varepsilon \quad (1)$$

(93) In this equation, Y is the dependent variable. The equation relates Y to two other variables, X and Z. The numbers appearing next to X and Z are called "coefficients."[168] Finally, ε is a "statistical disturbance" term, reflecting factors that affect Y that are not included in the equation. When economists talk about "estimating" this type of statistical model, they are referring to the process

[168] The intercept, here equal to 15, is also an estimated coefficient in the equation. For the purpose of this discussion, I focus only on the coefficients of X and Z, and omit discussion of the intercept.

of using data (here, concerning Y, X, and Z) to determine the numerical values of the model's coefficients (here, 4 and -7) and the statistical distribution of ε.

(94) My approach is to estimate a statistical model describing the average monthly price of Vitamin C using data from periods in which the cartel did not operate as effectively; I then used that model to forecast Vitamin C prices for months in which the cartel allegedly operated effectively. In that way, I determined the prices that would have prevailed during the cartel period had the manufacturers of Vitamin C behaved as they did at other points in time. In effect, my approach amounts to a sophisticated form of "before-and-after" analysis – it is sophisticated in the sense that the statistical model adjusts for non-conspiratorial differences between the cartel period and the before-and-after periods. Notably, my but-for scenario does not presuppose perfect competition. Rather, it assumes that the level of competition and/or oligopolistic forbearance would have been the same during the relevant period as it was historically when the conspiracy was not in effect. The difference between actual and but-for prices represents the overcharge attributable to the cartel (subject to one further adjustment discussed in Section IV.2.8).

(95) My approach makes use of a predictive statistical model rather than an explanatory statistical model. An explanatory model purports to provide direct causal explanations for movements in the dependent variable. A predictive model simply provides a basis for forecasting the value of the dependent variable based on observable information. In the context of an explanatory model, the coefficient of each explanatory variable is intended to measure a particular causal effect (specifically, the impact of an intervention that changes that variable and nothing else). For example, if we were to interpret equation (1) as an explanatory model, we would think of X and Z as "explanatory variables," and we would conclude that a one unit increase in the variable X with all other factors held fixed causes Y to rise by four units (because the coefficient of X is 4). In contrast, in the context of a predictive model, the coefficients are interpreted as stable associations rather than causal effects. Indeed, each coefficient may reflect a complex blend of effects. If we were to interpret equation (1) as a predictive model, we would think of X and Z as "predictors," and we would conclude only that, when X rises by one unit, Y tends to rise by four units. For the purpose of prediction, it is not important to know whether the change in X causes the change in Y, or is simply correlated with something else that causes the change in Y. In either case, when we observe that X has risen by one unit, we predict that pertinent conditions – whatever they are – will cause Y to rise (on average) by four units. As is widely acknowledged by econometricians, standard statistical methods are well suited to the tasks of forecasting and prediction.

(96) When evaluating estimates of statistical models, whether predictive or explanatory, economists and statisticians often employ the notion of "bias." The technical meaning of that term differs

from its colloquial usage. An unbiased estimation procedure is one that gets an answer right on average; a biased procedure is one that does not. All else equal, economists and statisticians prefer to use unbiased procedures whenever possible. When evaluating an explanatory model, we often ask whether the coefficients are unbiased; in other words, we want to know whether the procedure used to estimate the model measures the direct causal effects of the explanatory variables correctly on average. In contrast, when evaluating a predictive model, we typically ask whether the prediction is unbiased. If our sole object is prediction, it not important to know whether the predictors' coefficients are unbiased estimates of their direct causal effects. Indeed, a prediction may be accurate precisely because each coefficient reflects a complex blend of associations and causal effects.

(97) To estimate my predictive model, I use a common statistical procedure known as "ordinary least squares regression analysis." Practitioners often refer to the procedure by its abbreviation, OLS, or as "regression analysis;" they sometimes speak of "regressing" the dependent variable on other variables. OLS is widely employed for the estimation of both explanatory and predictive models. When used to estimate explanatory models, OLS yields unbiased estimates of coefficients only under restrictive conditions. Various well known problems, such as the omission of important explanatory variables or the presence of reverse causation between the dependent variable and one or more of the explanatory variables ("endogeneity"), can cause the direct causal effects of included explanatory variables to be measured incorrectly. In contrast, when used to estimate predictive models, OLS generally yields unbiased predictions.[169] That statement remains true even if the coefficients of the predictors are "biased" in the sense that they have little or nothing to do with their causal effects on the dependent variable, whether due to omitted variables, endogeneity, or other conditions that would be problematic in an explanatory setting.

(98) A simple example helps to illustrate this important point. For the moment, let's interpret equation (1) as an explanatory model. If ε is uncorrelated with X and Z, then OLS will yield unbiased estimates of their coefficients. But suppose that instead of regressing Y on X and Z, we regress Y on X alone. In that case, if we still wish to interpret the abbreviated equation as an explanatory model, we potentially confront a problem known as "omitted variable bias." In particular, if X and Z are correlated, the estimated coefficient of X will not reflect its direct causal effect on Y. To take a simple case, imagine that X and Z are perfectly positively correlated (and to further

[169] See, for example, Davidson and MacKinnon (1993), p 211 – "that least squares estimates of β will be biased and inconsistent…Note that inconsistency of $\hat{\beta}$ is a problem only if we care about the parameter β. If, on the contrary, we were simply interested in finding the mean of y conditional on x, estimating equation (7.05) by least squares is precisely what we would want to do." Dufour (1984) (Dufour, Jean Marie (1984), Unbiasedness of predictions from estimated autoregressions when the true order is unknown, Econometrica, 52, 209-215) also shows that under weak conditions, any autoregressive model estimated by ordinary least squares yields unbiased forecasts even though the OLS coefficients are generally biased.

simplify matters, they are always numerically identical). If we estimate the abbreviated equation using OLS, we will obtain the following:

$$Y = 15 - 3X + \varepsilon \quad (2)$$

(99) The coefficient of X, -3, is simply the sum of the coefficients on X and Z from equation (1). Clearly, the causal effect of X on Y is mismeasured; in fact, it has the wrong sign. One might even be tempted to reject equation (2), on the grounds that the estimated "effect" of X is "implausible." And yet, equation (2) is completely valid as a predictive model. From an explanatory perspective, the coefficient of X in equation (2) is contaminated by the correlation between X and the omitted variable Z, but from a predictive perspective, that "contamination" is beneficial: if we want to predict Y using information on X alone, we need to account for the effects on Y of variables like Z that are correlated with X. That is precisely what the OLS regression accomplishes. To illustrate, let's substitute some numerical values. Suppose that X = 2. Because X and Z are perfectly correlated, we can infer that Z = 2 as well. Inserting those values into equation (1), we see that Y = 15 + 4×2 – 7×2 = 9 (on average). Using equation (2), we would correctly forecast that Y = 15 – 3×2 = 9. Now suppose that X increases by one unit, from 2 to 3. Because X and Z are perfectly correlated, we can infer that Z = 3 as well. Inserting those values into equation (1), we see that Y = 15 + 4×3 – 7×3 = 6 (on average). Using equation (2), we would correctly forecast that Y = 15 – 3×3 = 6. Thus, using equation (2), we correctly predict that an increase in X from 2 to 3 will be associated with a decline in Y from 9 to 6 (even though the separate causal effect of the increase in X would be to increase Y by four units).

(100) In my opinion, the forecasting approach described above is, in most contexts, the most reliable method for constructing but-for prices. However, some economists use an alternative method. Specifically, they estimate a statistical model of prices using data from *both* the conspiratorial *and* the non-conspiratorial periods. For the simplest versions of such models, the explanatory variables include a "cartel dummy variable" that takes a value of one during the conspiracy period, and a value of zero outside that period. The coefficient of the dummy variable is interpreted as the direct causal effect of the cartel on prices. Sometimes, the conspiracy period is divided into subperiods and a separate dummy variable is used for each, to allow for the possibility that the intensity of the cartel varied over time. Henceforth, I will refer to this method as the "dummy variable" approach.

(101) For several reasons, the dummy variable approach is usually inferior to the forecasting approach. First, it requires one to interpret the statistical equation as an explanatory model rather than as a predictive model. In particular, the approach presupposes that one can interpret a coefficient of an explanatory variable (the cartel dummy) as a direct causal effect. The conditions that justify

causal interpretations of regression coefficients are more stringent than those which justify predictions based on regression equations.

(102) Second, the use of a cartel dummy variable that spans multiple units of time imposes an artificial and peculiar restriction on the manner in which the cartel affected prices. To illustrate the implications of that restriction, it is useful to consider the case in which a single dummy variable is used for the entire cartel. This practice imposes two restrictions: first, that the cartel had the same effect on price at every point in time throughout the conspiracy period; second, that the conspiracy did not affect the sensitivity of price to any explanatory variable. Since the intensity of a cartel almost certainly waxes and wanes, and since it may also affect firms' responses to factors such as costs, these assumptions are likely false. More importantly, they can generate misleading results. Imagine, for example, that the actual effect of a cartel gradually intensified and then gradually declined. If, by chance, some other explanatory variable (or linear combination of variables) happen to exhibit a "hump" shape similar to the actual pattern of collusive intensity, then that variable, and not the cartel dummy, will tend to pick up the cartel's effect on price. In that case, the estimated coefficient of the cartel dummy variable may be small, even though the cartel had a large impact on price. Consequently, in this illustration, the dummy variable approach would underestimate the effect of the cartel.

(103) Within the dummy variable framework, one can manage with fewer restrictive assumptions by increasing the number of dummy variables and by having each of these reference a smaller portion of the cartel period. For example, one might use annual dummies rather than a single cartel dummy, or quarterly dummies rather than annual dummies. Normally, when the results of these procedures materially diverge, one should give preference to the results based on the dummies covering more narrow time periods, because these are predicated on less restrictive assumptions.

(104) The least restrictive version of the dummy variable model would include a separate dummy variable for every observation during the cartel period. But that procedure is mathematically equivalent to excluding the conspiracy period from the estimation sample; this is the essence of the forecasting approach. Thus, the forecasting approach corresponds to the least restrictive version of the dummy variable approach. Accordingly, when the two approaches yield different results, those differences are directly attributable to the fact that the dummy variable approach imposes false and arbitrary assumptions concerning the pattern of the cartel's effects on price through time.

IV.2.2. The forecasting equation

(105) The Vitamin C price model describes the relationship between the price of Vitamin C products at each point in time and a variety of predictor variables. Formally, the model is written as:

$$p_t = p_{t-1}\alpha + p_{t-2}\beta + x_{t-1}\gamma + \varepsilon_t, \quad (3)$$

(106) where t denotes the month, p_t is the natural logarithm of the Vitamin C price at time t, x_t is a vector of natural logarithms of supply-side and demand-side factors, α, β, and γ are coefficients to be estimated from the data, and ε_t is a stochastic disturbance.

(107) It is important to emphasize that, in addition to supply-side and demand-side factors, the list of predictor variables includes lagged natural logarithms of prices, p_{t-1} and p_{t-2}. This permits the model to generate a wide range of dynamic patterns, such as gradual adjustment from one price level to another. The model does not rule out the possibility that adjustments are instantaneous rather than gradual ($\alpha = \beta = 0$); it simply allows the data to resolve that issue. There are a variety of reasons to think that price adjustments may occur gradually. For example, manufacturers may incur costs when reallocating capacity (or creating new capacity) to accommodate the associated changes in production, competitive strategies may evolve as inventories accumulate or dissipate, expectations may change more slowly than market conditions, and prices for specific purchasers may be fixed in the short term through quarterly or annual contracts. The dynamic structure of the model also allows for the possibility that a temporary development (e.g., a flu outbreak) might have persistent (but dissipating) effects on prices that outlast the event itself.

IV.2.3. Prices

(108) If the manufacturers of Vitamin C had provided sufficient information concerning their transaction prices, it might have been possible to estimate a statistical model describing prices separately for each manufacturer. The manufacturers did not, however, disclose the requisite information. As discussed in Section II.3.2, transaction-level price data for the pre-conspiracy period are confined to 2001 in the case of Weisheng, and they are non-existent in the case of Hebei. In contrast, the ITC data (also discussed in Section II.3.2) includes imports by all manufacturers over a longer period of time. Consequently, my preferred model employs the ITC data and describes the average price of Vitamin C imports to the U.S. for all manufacturers rather than for any single manufacturer. A market-level approach using ITC data is appropriate in this situation. In relying on that data, I do not assume that all manufacturers charged the same average price. However, I do assume that the cartel elevated each firm's prices by the same amount. That

assumption is generally consistent with patterns that I have seen in other vitamin markets, as well as in the Vitamin C market at an earlier point in time.

(109) In Section II.3.2, I demonstrated that the ITC price data track the available Hebei and Weisheng price data rather well (see Figure 15). The fact that the defendants themselves rely on the ITC data corroborates its reliability. For example, the 2005 BASF-NEPG supply agreement states: "The quarterly adjusted QAPP [Quarterly adjusted Purchase price] shall be determined for the following calendar quarter based on published Customs Value and Quantity by the United States International Trade Commission." The agreement also points to the U.S. ITC website and references the same import data code (HTS 293627) used in my analysis.[170]

IV.2.4. Explanatory variables

(110) In Section III, I discussed a variety of factors that, in principle, may have affected the prices of Vitamin C products. In principle, one could use any or all of those factors as predictors. It is important, however, to be selective. The addition of each variable enhances the ability to account for variation in price, and this potentially improves the predictive power of the statistical relation. However, it also consumes a statistical "degree of freedom," thereby potentially increasing the variance of the prediction error. That tradeoff does not always favor the inclusion of additional variables. Indeed, if one is not selective, there is a risk of "overfitting" the statistical relation. There is a chance that, among a large set of potential predictors, one or more will track price reasonable well purely by coincidence. Models that incorporate such variables will tend to perform less well in terms of predictive validity than models that exclude them.

(111) In selecting the variables that I included in my preferred model, I employed five criteria. First, drawing on the discussion of demand and production in Section II, I focused on variables measuring important aspects of supply and demand that are as a matter of economic principles likely to affect price in a significant way. Second, I avoided redundancy (that is, multiple measures of the same factor). Third, for reasons discussed below, I avoided variables that were subject to the control or influence of cartel members. Fourth, I have examined standard diagnostics for evaluating the performance of my prediction equation, including the R-squared, the cross-validated root mean squared error (CVRMSE), and the residual autocorrelation.[171] Finally, after examining a large number of specifications (see Section V), I focused on the ones

[170] NEPG 26326.

[171] R-squared, CVRMSE, and residual autocorrelation are three standard criteria used to evaluate the performance of prediction models. See e.g., Diebold, Francis. X. Elements of Forecasting (Cincinnati: South-Western College Publishing, 1998), 25, 86-88, 117-118; Enders, Walter. Applied Econometric Time Series (Willey, 1995), 97-99.

that were generally representative of reasonable models and, if anything, somewhat conservative relative to that group.

(112) Variables that are under the control or subject to the influence of the cartel members are endogenous. Using such variables as predictors is obviously problematic. To take a simple illustration, imagine using the quantity sold of a vitamin product as an explanatory variable for price. Estimating the model with data from outside the cartel period, one would not be surprised to find a strong relationship between price and quantity.[172] One cannot, however, use that relationship along with data on actual quantities to predict but-for average prices. A cartel may effectuate an increase in price by restricting quantity. Consequently, quantity during the conspiracy period would have been different but for the conspiracy. Plugging actual quantities into the estimated relationship, therefore, normally produces unreliable estimates. Indeed, if the demand curve is stable through the relevant time period (so that the estimated relationship is identified by fluctuations in supply), then the conspiratorial restriction on quantity will perfectly (and spuriously) "explain" the observed increase in price. Other variables that are under the control or subject to the influence of the cartel, and that are therefore inappropriate to use as predictors, include capacity and elements of industry structure, such as concentration or the number of firms.

(113) For the reasons described in the preceding paragraph, it is generally preferable to exclude from the model all variables that are controlled or influenced by the cartel and to rely on a reduced-form approach that describes the market equilibrium as a function of "exogenous" factors.[173] There is, however, one important exception. As mentioned in Section IV.2.2, prices do not appear to adjust instantaneously to changes in market conditions. A standard and appropriate modeling strategy in this situation is to capture price dynamics by including lagged prices (prices from previous time periods) as explanatory variables. Obviously, these variables are under the control of the cartel. Consequently, when constructing but-for prices from the estimated relationship, it is important to plug in lagged but-for prices rather than lagged actual prices. In this way, one avoids making forecasts that are spuriously contaminated by conspiratorial behavior.

(114) Ultimately, I chose a preferred model that describes the average Vitamin C price as a function of a relatively small collection of important supply and demand variables. Plainly, many factors that could potentially affect price are excluded from this specification. If my method of estimating

[172] The correlation can be either positive or negative, depending upon whether historical variation in prices and quantities is primarily attributable to fluctuations in supply-side or demand-side factors.

[173] An alternative is to construct and estimate a structural model that simultaneously explains all of the variables that are under the control of the cartel and to use this model to construct mutually consistent but-for values for all of these variables. This, however, amounts to forecasting price with the reduced form of the structural model.

but-for prices required me to interpret the price equation as an explanatory model, the omission of those factors would be a source of potential concern, in that my estimated coefficients might suffer from omitted variables bias. It is therefore important to reiterate that I interpret and use the price equation as a predictive model. As discussed in Section IV.2.1, the omission of variables – even important ones – may preclude us from interpreting the coefficients of the included variables as measuring direct causal effects, but it does not lead to systematic bias in predictions.

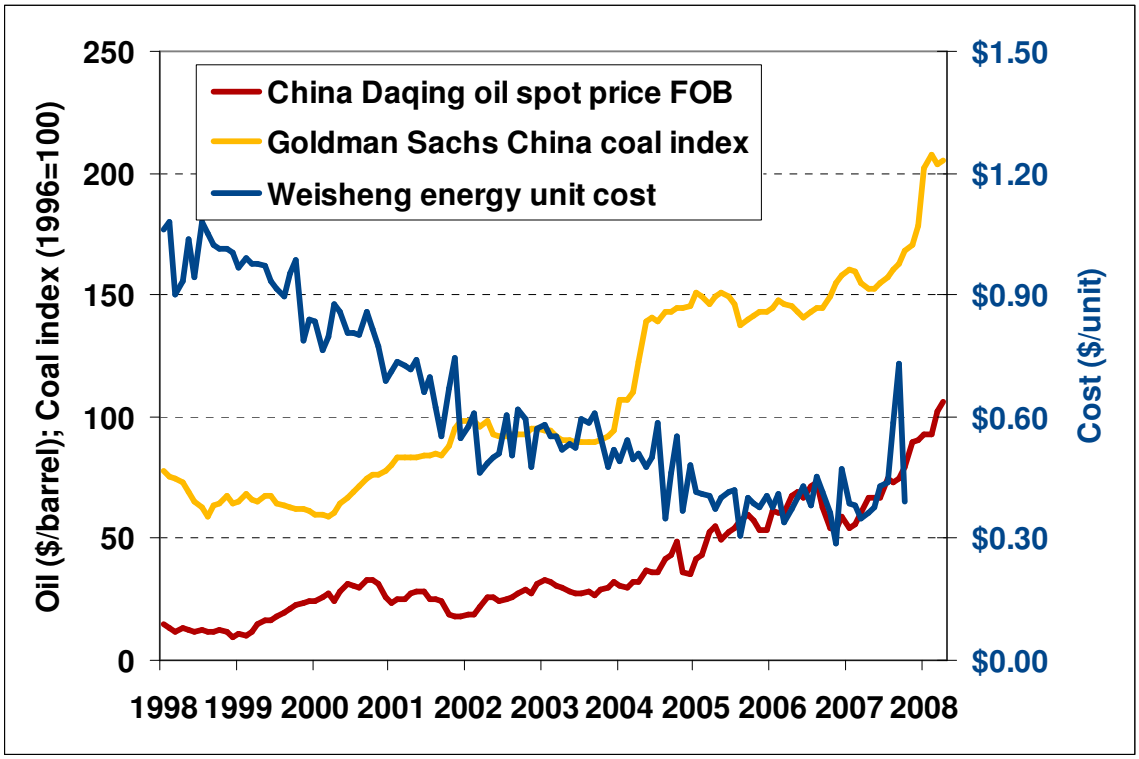
(115) On the supply side, my preferred model includes one variable measuring the cost of sorbitol and another measuring the cost of energy.[174] Figure 8 indicates that those two items account for roughly 45% of total production costs and nearly two-thirds of variables costs (given that most items classified as "manufacturing costs" are likely fixed rather than variable). Each of the remaining cost components – labor and various chemicals and other materials – accounts for a very small fraction of either total or variable costs; consequently, it is less likely that those variables would play useful roles in prediction.

(116) For the cost of sorbitol, I use Asia Pacific sorbitol spot prices published by ICIS. For energy cost, one natural alternative is to use variables such as the Asian market price of oil or coal. However, as illustrated in Figure 67, Weisheng's reported energy costs bear little relation to those prices. In fact, the correlations between Weisheng's reported energy costs and the prices of oil and coal are both negative. There are several possible explanations for that finding. First, the Chinese government sets the price of electricity and has historically insulated domestic manufacturers from fluctuations in the prices of fossil fuels.[175] Second, the downward trend in Weisheng's energy costs may reflect energy conservation, technological progress, or the benefits of learning-by-doing, which energy prices fail to capture. Though as a general matter I think there are good reasons to prefer the use of input prices to the use of accounting costs, in this instance the available input price series are in my view too far removed from actual energy costs, and consequently the benefits of using reported energy costs outweigh the disadvantages. For the cost of energy, I therefore use Weisheng's energy cost series. I have experimented extensively with other supply-side variables (including the prices of energy commodities) and have concluded that my results are robust with respect to reasonable alternatives (see Section V).

[174] For months where Weisheng data is unavailable I estimate costs as the average of the immediately adjacent months.

[175] Pittman, R and Zhang, V.Y., "Electricity Restructuring in China: The Elusive Quest for Competition," April 2008, http://www.usdoj.gov/atr/public/eag/232668.pdf (accessed November 4, 2008).

Figure 67: Comparison of oil, coal, and Weisheng energy unit cost[176]



(117) On the demand side, I control for one of the most important single sources of derived demand, soda production, as well as for the price of an important end-user substitute, orange juice. For the soda production series, I use soft drink and ice manufacturing industrial production reported by the U.S. Federal Reserve Board of Governors IPI data. For the orange juice price series, I use the orange juice CPI reported by the Bureau of Labor Statistics. I have experimented extensively with other demand-side variables (including other indicia of derived demand and potential prices of potential substitutes), and have concluded that my results are robust with respect to reasonable alternatives (see Section V).

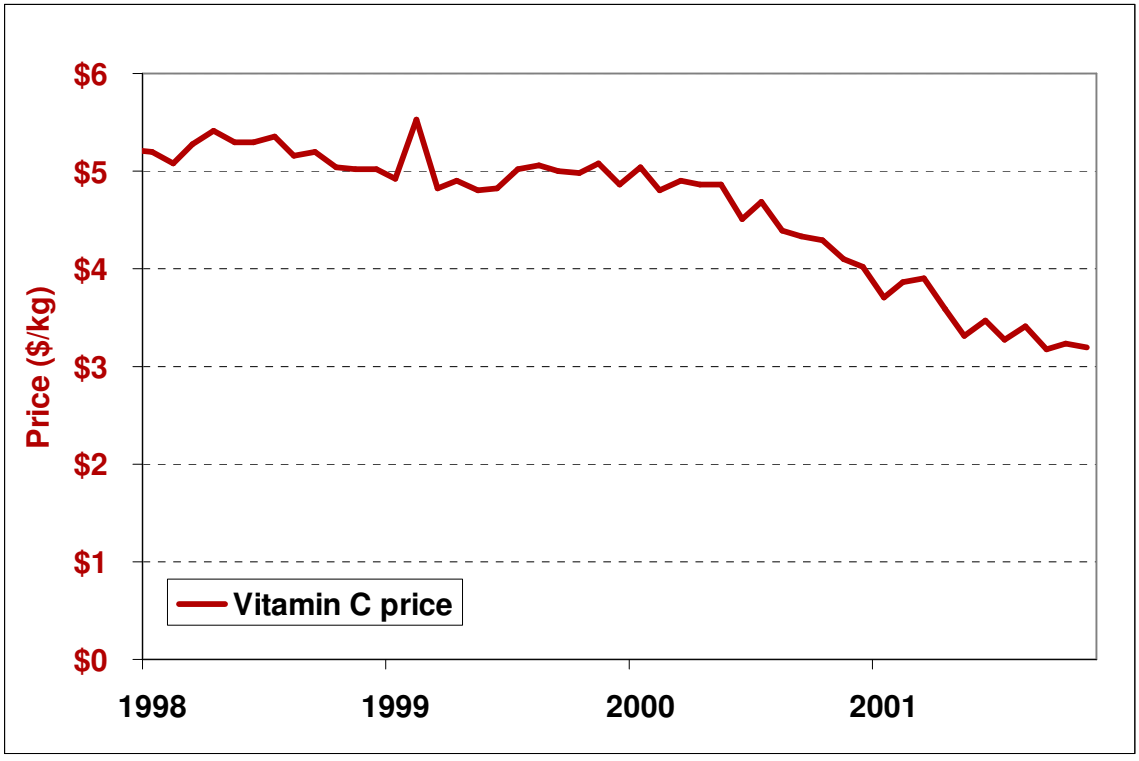
(118) In constructing the variables used in my analysis, I converted all currency amounts to U.S. dollars. Thus, my regression equation also reflects the effects of changes in exchange rates. However, I do not include the Yuan-USD exchange rate as a separate predictor. The inclusion of such a variable does not materially affect my conclusions (see Section V).

[176] EIA China Daqing oil Spot Price FOB, Goldman Sachs China Coal Index (Bloomberg), WSC 14501.

IV.2.5. Sample period

(119) The complaint in this matter alleges that the Vitamin C conspiracy began in December 2001 and continues through the present. Consequently, one natural alternative is to estimate the prediction model using data from the pre-conspiracy period only. Unfortunately, as is clear from an inspection of Figure 68, Vitamin C price movements during that period were dominated by a clear trend. As is widely recognized in the scholarly literature, in such situations, statistical regression techniques can pick up spurious correlations between the variables of interest and other trending variables.[177] That phenomenon renders econometric estimates (as well as forecasts based on those estimates) less reliable. In the current setting, the model simply extrapolates historical trends and produces falling but-for prices (see Section V).

Figure 68: Vitamin C prices pre-conspiracy, January 1998 to December 2001[178]



[177] See, e.g., Granger, C.W.J. and Newbold, P., "Spurious Regressions in Econometrics," *Journal of Econometrics*, vol. 2, 1974, pp.111-120 and Yule, G.U., "Why Do We Sometimes Get Nonsense Correlations Between Time Series?: A Study in Sampling and the Nature of Time Series," *Journal of the Royal Statistical Society*, 89, 1926, pp. 1-64.

[178] ITC data.

(120) There is, however, good reason to believe that the conspiracy did not continue in full force from December 2001 to the present. The complaint in this matter was filed in late January 2005. The defendants' documents indicate that they were well aware of the lawsuit,[179] and they no doubt understood that their behavior would be subject to close scrutiny. There are also indications, such as Weisheng's massive expansion of capacity during 2004 (discussed in Section II.4), that the cartel was already weakening prior to the filing of the complaint. Though prices did rise considerably during 2007 and 2008, and even though the defendants continued to meet during that period, those developments coincided with steep increases in the costs of sorbitol (Figure 20) and energy commodities (Figure 22 and Figure 23), as well as a substantial increase in the value of the Yuan relative to the U.S. dollar. Thus, the price increases in 2007 and 2008 were potentially non-conspiratorial.

(121) In light of these considerations, I estimate my forecasting model with data from the pre-cartel period and the post-complaint period. My decision to exclude the post-complaint period from the cartel period and include it in the estimation period is favorable to the defendants for two reasons. First, it grants the defendants' contention that the price increases during 2007 and 2008 were non-conspiratorial and attaches no damages to them. Second, to the extent the cartel did in fact continue to raise the price of Vitamin C during the post-complaint period relative to the pre-conspiracy benchmark, my prediction model will be partially contaminated by the effects of the cartel. Consequently, the model will generate but-for prices that reflect some continuing degree of cartelization rather than the level of competition that prevailed during the pre-conspiracy period. Were I able to remove that contamination, my estimated but-for prices would be lower and damages would be larger.

(122) My estimation sample also excludes all data prior to 1998. The original vitamins cartel of the 1990s and the subsequent expansion and consolidation of the Chinese Vitamin C producers potentially renders earlier data unrepresentative of the appropriate competitive benchmark. I have experimented with other sample periods and have concluded that my results are robust with respect to reasonable alternatives (see Section V).

IV.2.6. Computing the but-for price series

(123) The estimated model was used to construct the prices that would have prevailed but for the cartel, taking the historical pre-cartel data as given. Beginning with the first month in which the cartel is assumed to have potentially influenced price, i.e., December 2001, but-for prices were successively computed for each month using the historical values of the supply-side and demand-

[179] Deposition of Wang Qi, July 2, 2008, Exhibit 143.

side explanatory variables from the preceding month, the but-for prices from the preceding months,[180] and a disturbance term selected at random from a distribution conforming to the observed variance of the stochastic disturbance. Since prices may have remained artificially elevated even after the cartel period, but-for prices were computed through November 2007. This process was repeated 1,000 times in order to construct a median simulated price path. This method of constructing the but-for price path is known as the "Monte Carlo simulation method" and is a standard econometric tool.[181] I calculated damages from December 2001 through June 2006 ("damage period"), because July 2006 is the first month in which the but-for price returns to the same level as the actual price.

IV.2.7. Accounting for SARS

(124) As discussed in Section III.3.1, the SARS outbreak was entirely confined to the cartel period. Because I estimate my model using a sample period during which there is no alleged conspiracy and no SARS outbreak, the model predicts the prices that would have prevailed during the damage period both but for the conspiracy and but for SARS. Consequently, it is appropriate to adjust the but-for prices for the SARS outbreak.

(125) I accomplish this task by estimating a second statistical model that describes the evolution of Vitamin C prices *during* the cartel period (rather than *outside* the cartel period). To capture the effect of SARS on Vitamin C demand, the model includes a variable measuring the salience of the SARS-Vitamin C link (specifically, the number of news articles identified through Lexis/Nexis that link Vitamin C to SARS prevention). For simplicity, I present results based on a version of the model that otherwise includes the same variables as my original but-for model. There is, however, no compelling reason to think that the best models of conspiratorial and non-conspiratorial behavior would necessarily involve precisely the same variables; consequently, I examine the robustness of my results to a variety of alternative specifications below, in Section V.

(126) To compute the prices that would have prevailed during the conspiracy but for SARS, I set the SARS-Vitamin C salience variable equal to zero, and use the cartel period model to simulate the prices that would have prevailed given the historical values of the other independent variables, as well as the fitted values of the disturbance term. The SARS adjustment for any given month equals the difference between the actual and simulated prices. I add that effect to my but-for prices, thereby effectively absolving the defendants of the price elevation associated with SARS.

[180] In the first month of the conspiracy, the but-for lagged prices are the same as the actual lagged prices.
[181] Robert, C.P. and Casella, G., *Monte Carlo Statistical Methods*, New York, Springer-Verlag, 1998.

IV.2.8. Computing overcharges and damages

(127) By definition, overcharges equal the elevation in Vitamin C prices attributable to the cartel. Consequently, I calculate overcharges by taking the difference between actual prices and the prices that would have prevailed but for the conspiracy. The but-for prices are obtained by adding the SARS effect to the but-for prices from my first forecasting model (which describes the evolution of prices without either a cartel or SARS).

(128) To compute damages, I multiply the overcharge for each month by the affected quantity. I obtain information on monthly quantities from defendant data and Chinese customs data. Per counsel's instructions, all sales that have been identified as covered by arbitration clauses are excluded from my calculation. I compute total damages by summing monthly damages from December 2001 through June 2006.

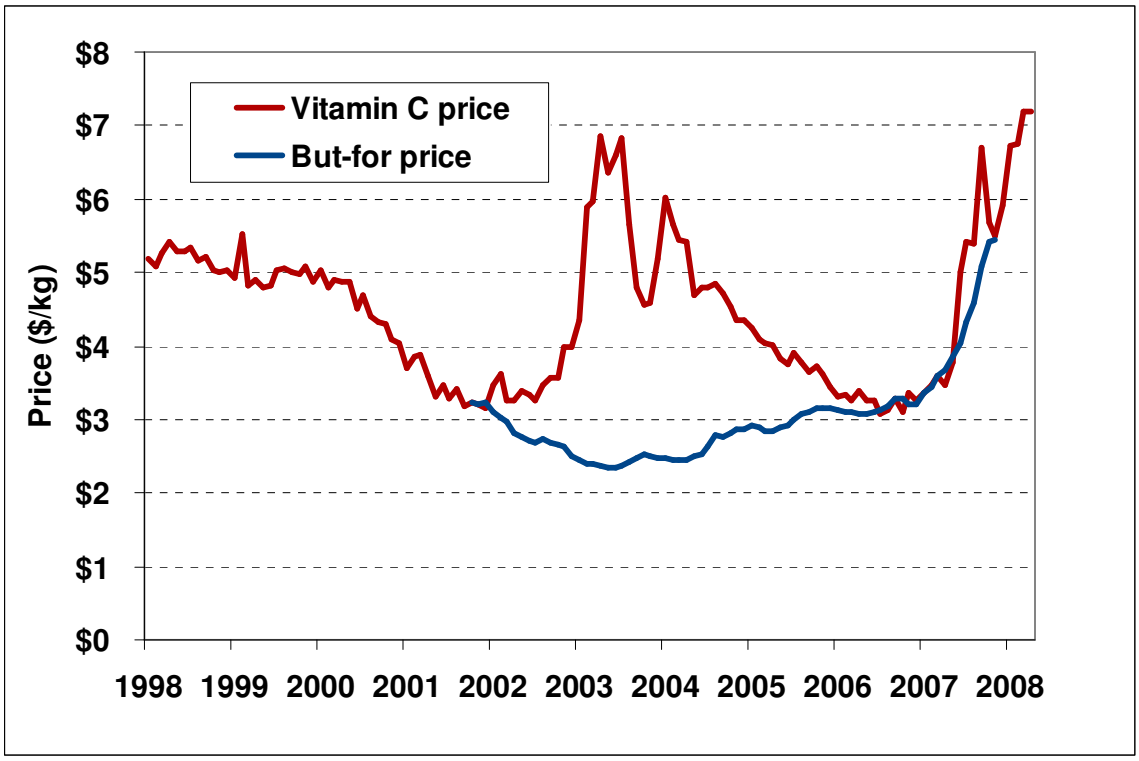
IV.3. Estimated damages

(129) In this section, I provide details concerning the actual calculations performed in assessing damages to class members.

IV.3.1. But-for prices

(130) Figure 69 depicts the actual prices for Vitamin C, along with the but-for prices predicted by my non-cartel forecasting model (reflecting price dynamics when the conspiracy was not in force). These are the prices that would have prevailed but for the conspiracy, and they include no adjustment for SARS.

Figure 69: Vitamin C price and but-for price based on the econometric model

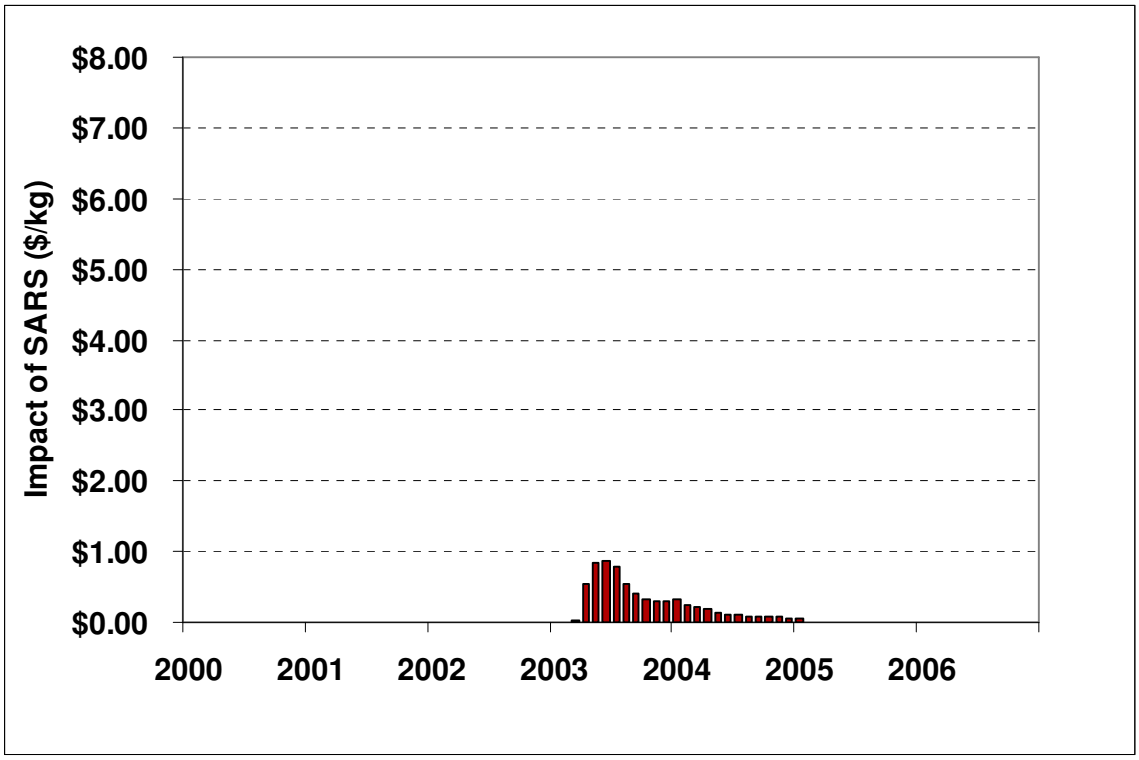


(131) I have also been asked by counsel to calculate damages based on the following two assumptions: (1) that the Chinese government would have enforced a price floor of $3.35 per kilogram, preventing the average price of Vitamin C from falling below that floor, and (2) that the price floor was not itself a consequence of the cartel, and that the cartel members bear no responsibility for its effects. I note that the first assumption is inconsistent with evidence indicating that the defendants did in fact charge prices below $3.35 and that they had ways of circumventing the price floor when it was supposedly in effect (see Section II.4). I have not investigated the legitimacy of the second assumption.

IV.3.2. The SARS adjustment

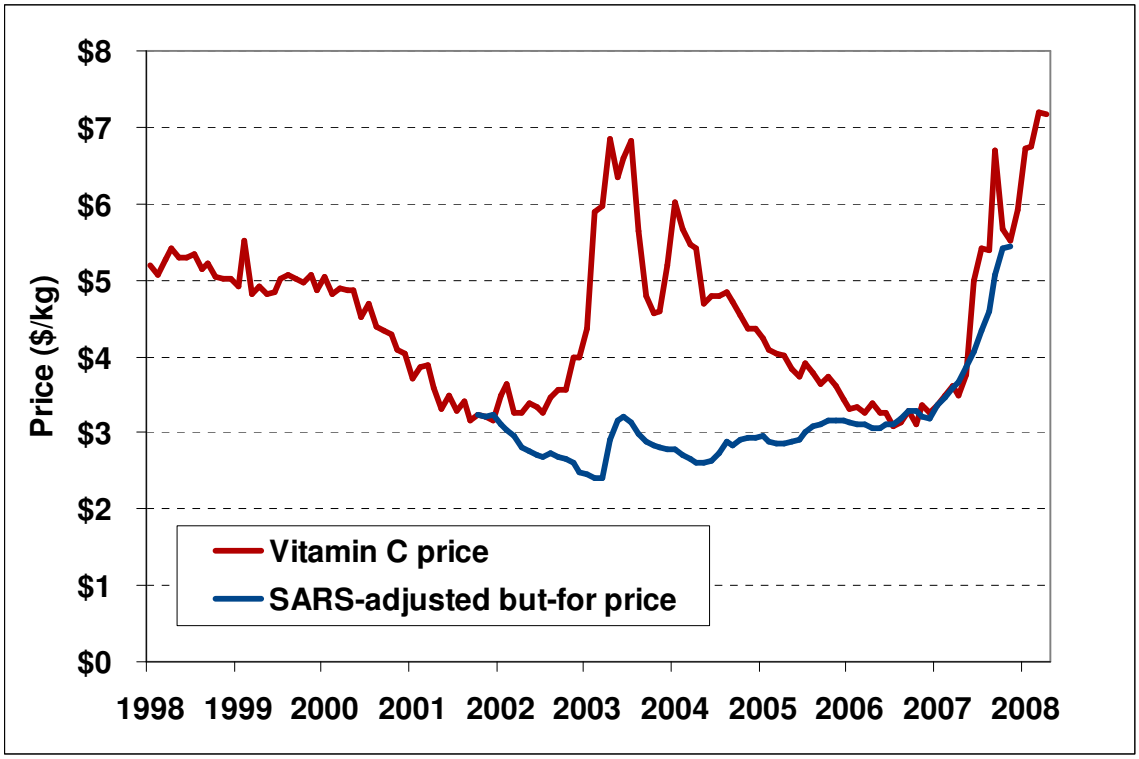
(132) Figure 70 depicts the difference between the actual prices of Vitamin C and the prices generated by my cartel period model when the SARS-Vitamin C salience variable is set equal to zero. This represents the effect of SARS on price.

Figure 70: Impact of SARS on Vitamin C prices



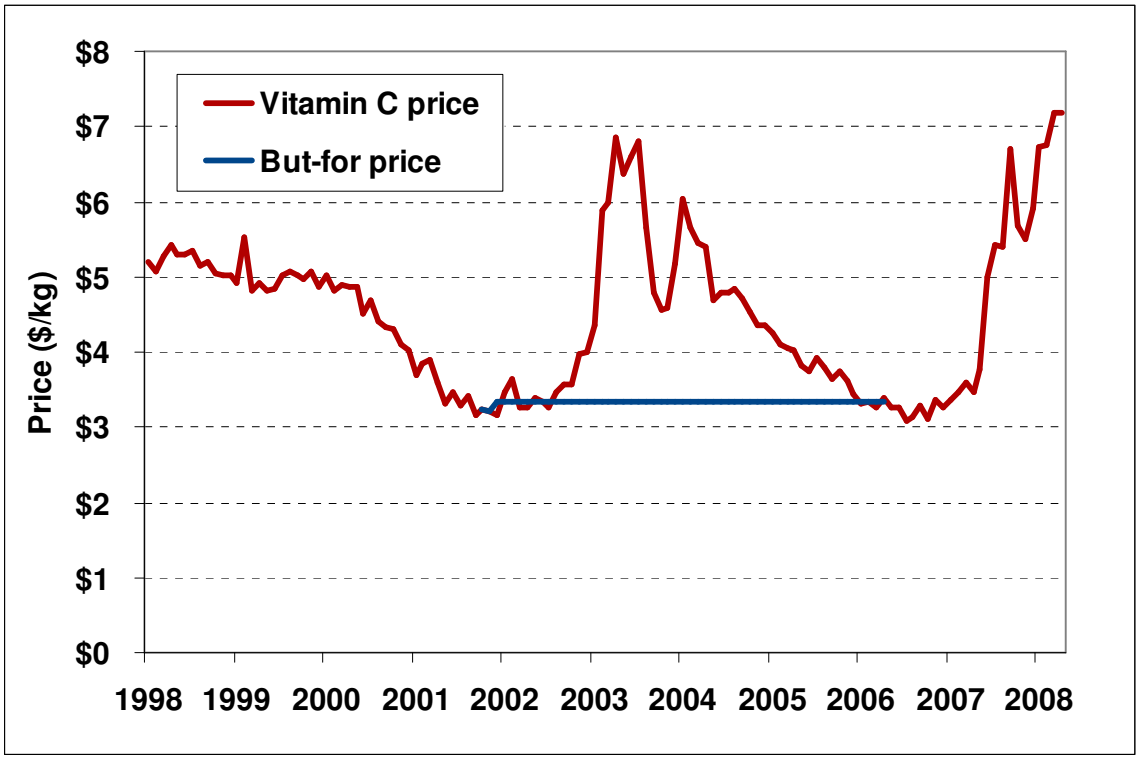
(133) Figure 71 shows actual Vitamin C prices along with the prices that would have prevailed during the damage period but for the conspiracy, after adjusting for SARS. A comparison of those price lines reveals that the conspiracy caused substantial price elevation during the damage period.

Figure 71: SARS-adjusted but-for price and actual price for Vitamin C



(134) Figure 72 shows actual Vitamin C prices along with the prices that would have prevailed during the damage period but for the conspiracy (after adjusting for SARS), assuming the government imposed a rigid price floor of $3.35 per kilogram. Note that the but-for prices (adjusted for SARS) in Figure 71 are consistently less than $3.35 per kilogram. Consequently, if a rigid price floor of $3.35 had been in effect, my forecasting model predicts that the floor would have been binding and that a price of $3.35 would have prevailed throughout this period. A comparison of the actual and but-for price lines in Figure 72 reveals that the conspiracy caused substantial price elevation during the damage period over and above the effects of the price floor.

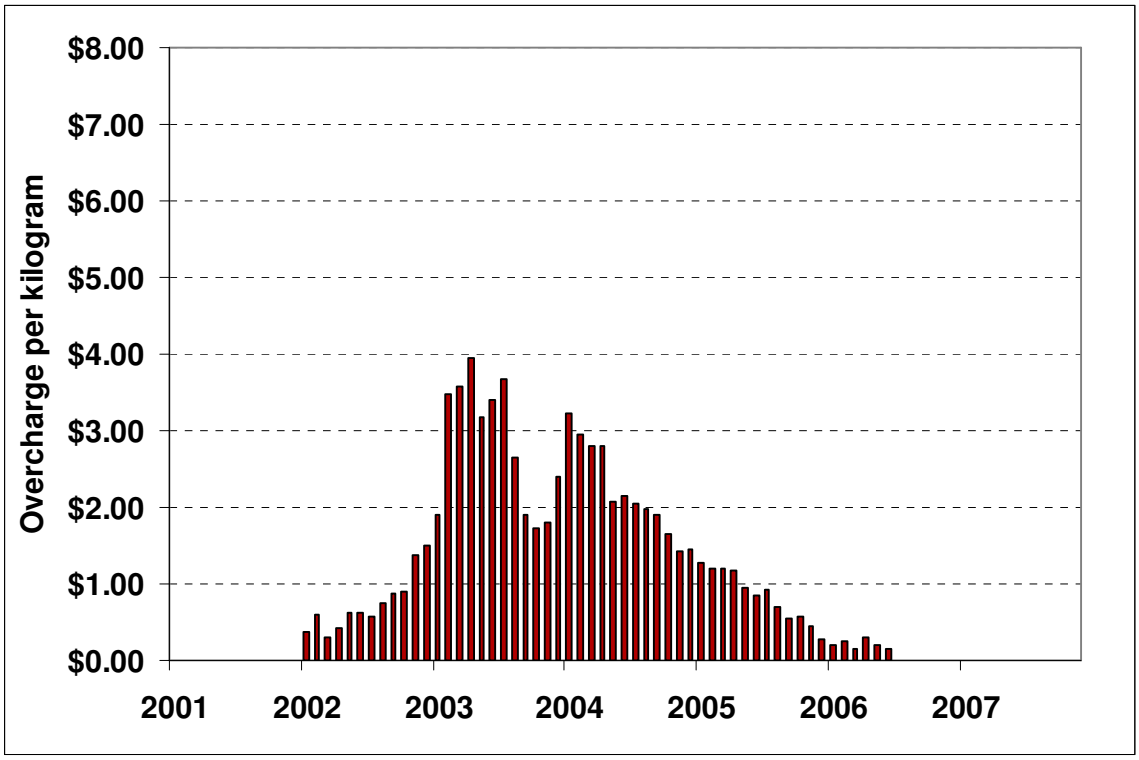
Figure 72: Vitamin C price and $3.35 price floor



IV.3.3. Overcharges

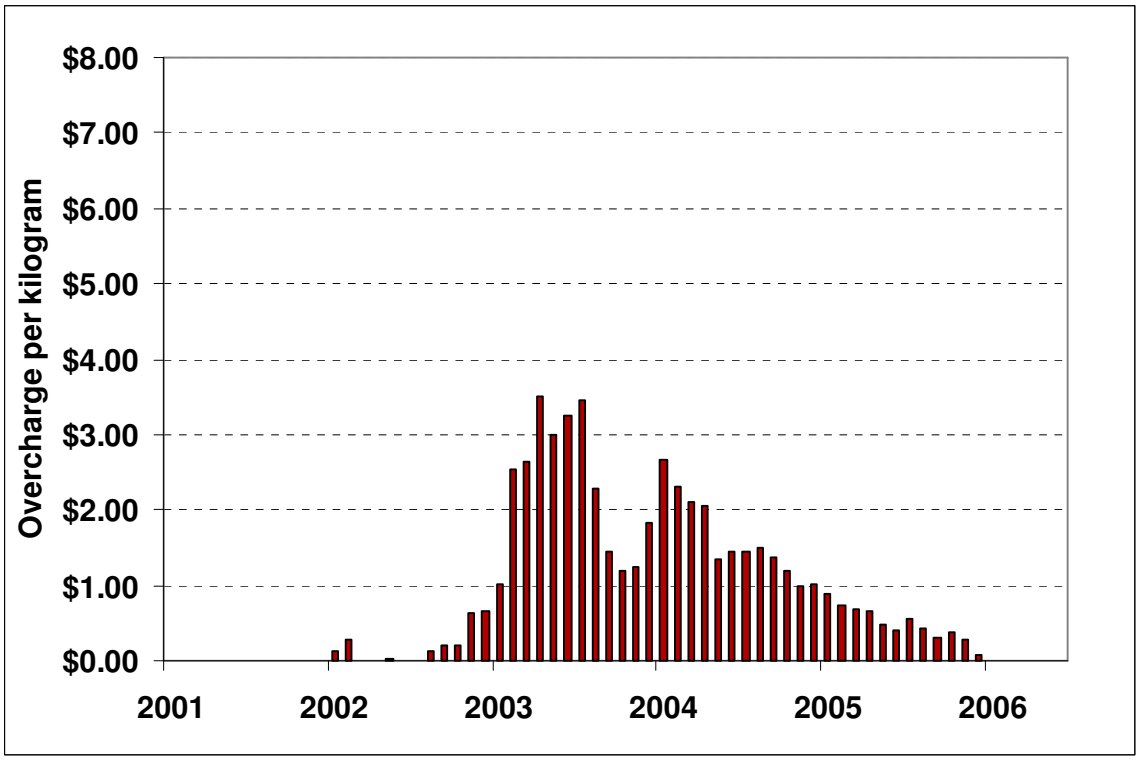
(135) Figure 73 depicts the per kilogram monthly overcharges of Vitamin C. The height of each bar equals the difference between the actual price and the price that would have prevailed without the conspiracy.

Figure 73: Monthly overcharges based on the SARS-adjusted but-for price



(136) Figure 74 depicts the monthly overcharges per kilogram of Vitamin C, assuming the Chinese government would have imposed a rigid price floor of $3.35 per kilogram. The height of each bar equals the difference between the actual price and the price that would have prevailed without the conspiracy.

Figure 74: Monthly overcharges based on the $3.35 price floor



IV.3.4. Relevant sales

(137) I have been instructed by counsel to consider damages only for sales not identified as having a contractual agreement to resolve disputes through arbitration. I refer to this as the "net damage amount." For completeness, I also calculated a "total damage amount"; this included all sales to the U.S. regardless of whether they contained an arbitration clause.

(138) To calculate the total quantity of Vitamin C sold monthly during the damage period for each defendant, I relied on documents and data received through discovery. Where available, I used transactional data provided by the defendants to measure total sales, which is available for Hebei from 2002 to 2007. When transactional data is not available, I used Chinese customs data found

in defendant documents.[182] These data reported export quantities, by firm, from China to the U.S. I used the trade data to provide volumes for JJPC, NEPG, and other conspirators during the entire period. I also used the trade data for total sales made by Hebei when its transaction data were not available in 2001, and for Weisheng in all years as their data appeared to exclude sales made with an arbitration clause. Review of JJPC documents suggest that their sales to the United States includes sales made to Legend and JSPCA, hence I did not calculate damages separately for either of these defendants under the assumption that they were included within JJPC.[183]

(139) I employed different methods to calculate sales net of arbitration clauses for each defendant. First, NEPG has represented that all of its Vitamin C sales agreements included arbitration clauses during the relevant period. Therefore, I excluded all NEPG quantities from the net damage calculation. Second, Hebei provided a transactions-level database containing an indicator for sales made with an arbitration clause.[184] I deducted these sales when calculating net damages for Hebei. Third, Weisheng provided transaction sales data that generally reflected lower sales than the trade data attributed to them. I have been instructed by counsel to assume that this difference is attributable to the exclusion of sales with arbitration clauses, and thus I used sales amounts from their transaction data in calculating damages net of arbitration clause transactions. Fourth, while JJPC total quantities were available from the trade data described above, I am not aware of any consolidated data source provided by JJPC that identified its sales net of arbitration clauses. Therefore, I relied on the Expert Report of Phil Innes, C.P.A., who has reviewed JJPC invoices to identify the monthly quantity of sales containing an arbitration clause.[185] I deducted these sales for the purposes of calculating net damages. Finally, I calculated damages for other suppliers found in the trade data under the instruction from counsel that they were to be included as unnamed co-conspirators. Estimates of sales made with arbitration clauses were unavailable for these co-conspirators, and thus I made no deductions when calculating their net damages.

(140) Figure 75 lists each co-conspirator's U.S. sales of Vitamin C, in kilograms. I reserve the right to update my damage calculations at a later date if and when the defendants supply the requisite data.

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182 NEPG 28327; NEPG 26590; JJPC 35359; JJPC 35432; JJPC 32450. Data for 2001-2003 are annual, therefore I divide by 12 to obtain estimates of monthly quantities.

183 JJPC 37229; JJPC 37238.

184 Letter to Tanya S Chutkan, Esq., from Christopher Chinn, May 15, 2008. Counsel has not confirmed whether Hebei has accurately reported sales made with an arbitration clause.

185 Expert Report of Phil Innes, C.P.A., November 7, 2008.

Figure 75: Annual total quantities (kilograms) of Vitamin C sold by conspirators

	Dec-2001	2002	2003	2004	2005	To Jun-2006	Total
Weisheng	273,225	3,343,515	2,872,950	4,134,125	4,675,850	2,512,100	**17,811,765**
JJPC	127,892	2,444,800	3,532,100	3,722,284	4,996,730	2,026,400	**16,850,206**
Hebei	35,732	1,520,600	2,810,000	2,364,190	5,826,390	1,331,525	**13,888,437**
NEPG	333,717	6,314,200	7,393,075	9,954,975	8,822,000	3,880,800	**36,698,767**
Other	68,507	729,513	1,182,800	1,010,950	1,621,859	763,836	**5,377,465**
Total	**839,072**	**14,352,628**	**17,790,925**	**21,186,524**	**25,942,829**	**10,514,661**	**90,626,639**

(141) Figure 76 lists each co-conspirator's U.S. sales of Vitamin C, in kilograms, excluding all transactions subject to arbitration clauses.

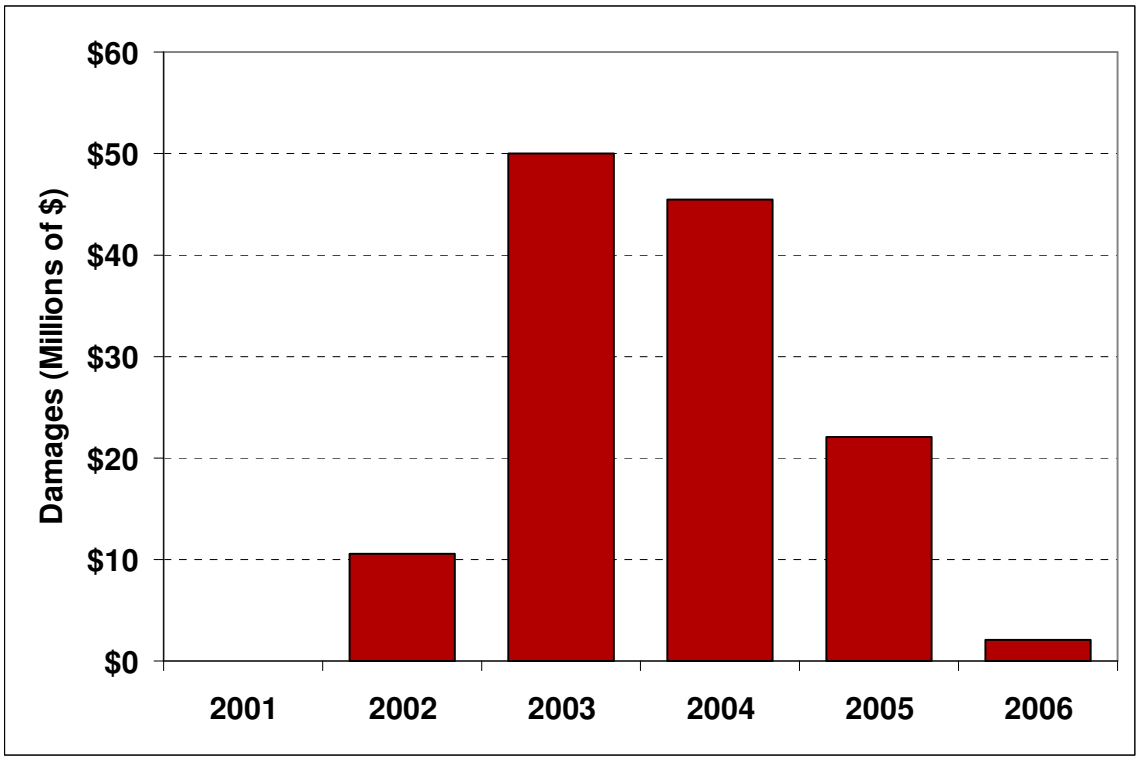
Figure 76: Annual quantities (kilograms) net of arbitration clauses of Vitamin C sold by conspirators

	Dec-2001	2002	2003	2004	2005	To Jun-2006	Total
Weisheng	-	2,779,725	2,662,100	3,506,800	4,826,000	2,286,100	**16,060,725**
JJPC	127,892	1,759,800	2,493,400	2,529,784	3,329,170	2,026,400	**12,266,446**
Hebei	35,732	1,233,600	1,793,000	2,173,715	1,492,390	1,331,525	**8,059,962**
NEPG	-	-	-	-	-	-	**-**
Other	68,507	729,513	1,182,800	1,010,950	1,621,859	763,836	**5,377,465**
Total	**232,130**	**6,502,638**	**8,131,300**	**9,221,249**	**11,269,419**	**6,407,861**	**41,764,597**

IV.3.5. Damages

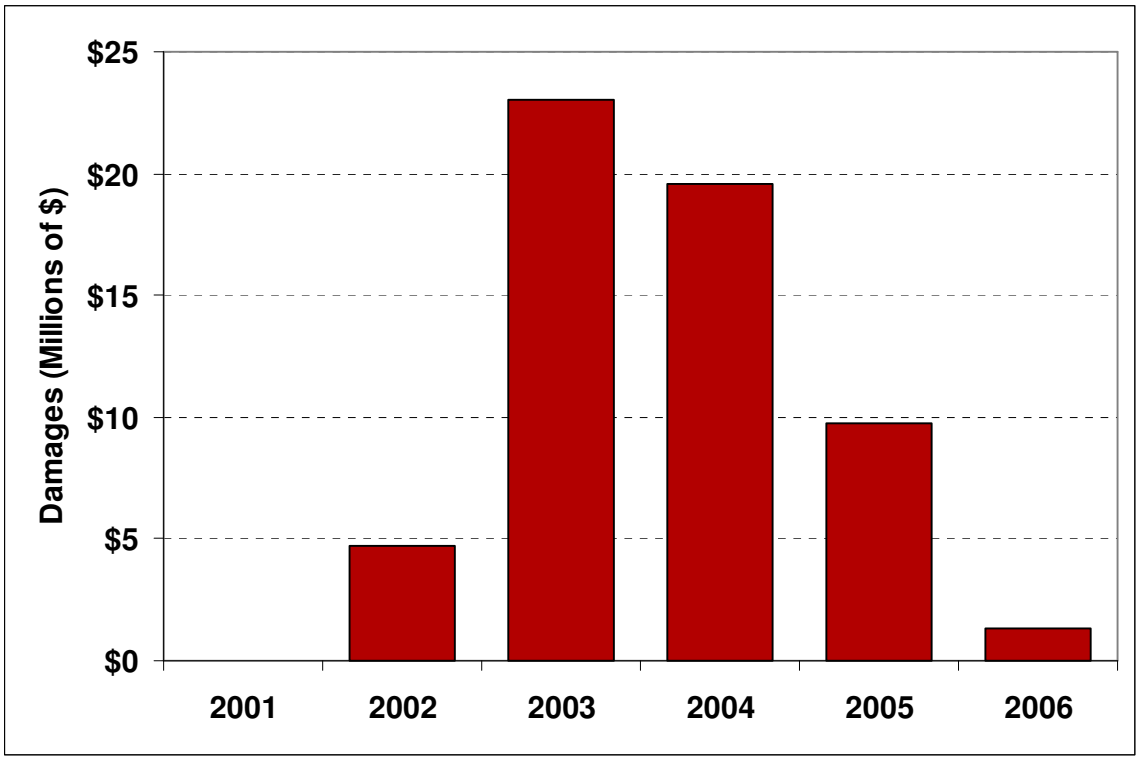
(142) I determined damages by applying the overcharges calculated in Section IV.3.3 (expressed as per kilogram dollar amounts) to the sales volumes listed in Section IV.3.4. I conclude that the conspiracy caused total damages of $130.2 million, with an average overcharge of 33.2%. Figure 77 graphically displays total damages by year.

Figure 77: Damages by year for all sales using the SARS-adjusted but-for price



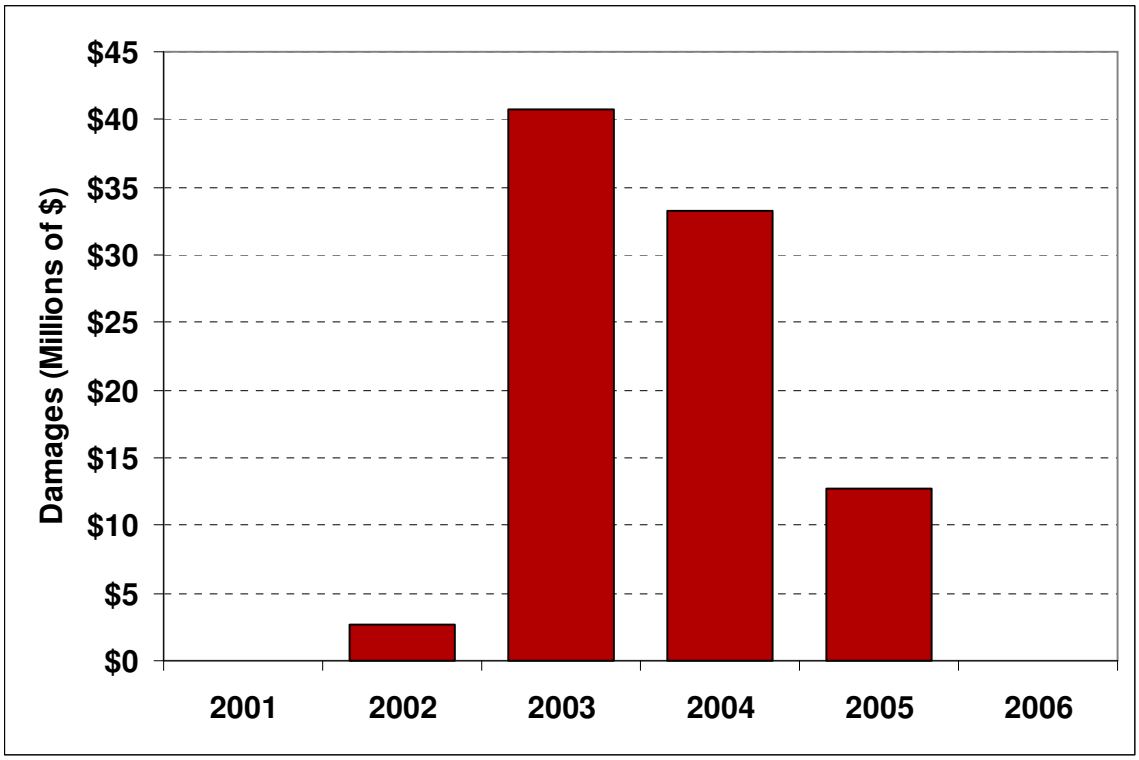
(143) Excluding transactions that were subject to arbitration clauses yields the net damage figure of $58.4 million, with an average overcharge of 32.6%. Figure 78 graphically displays damages by year after removing transactions that were subject to arbitration clauses.

Figure 78: Damages by year for sales without arbitration clauses using the SARS-adjusted but-for price



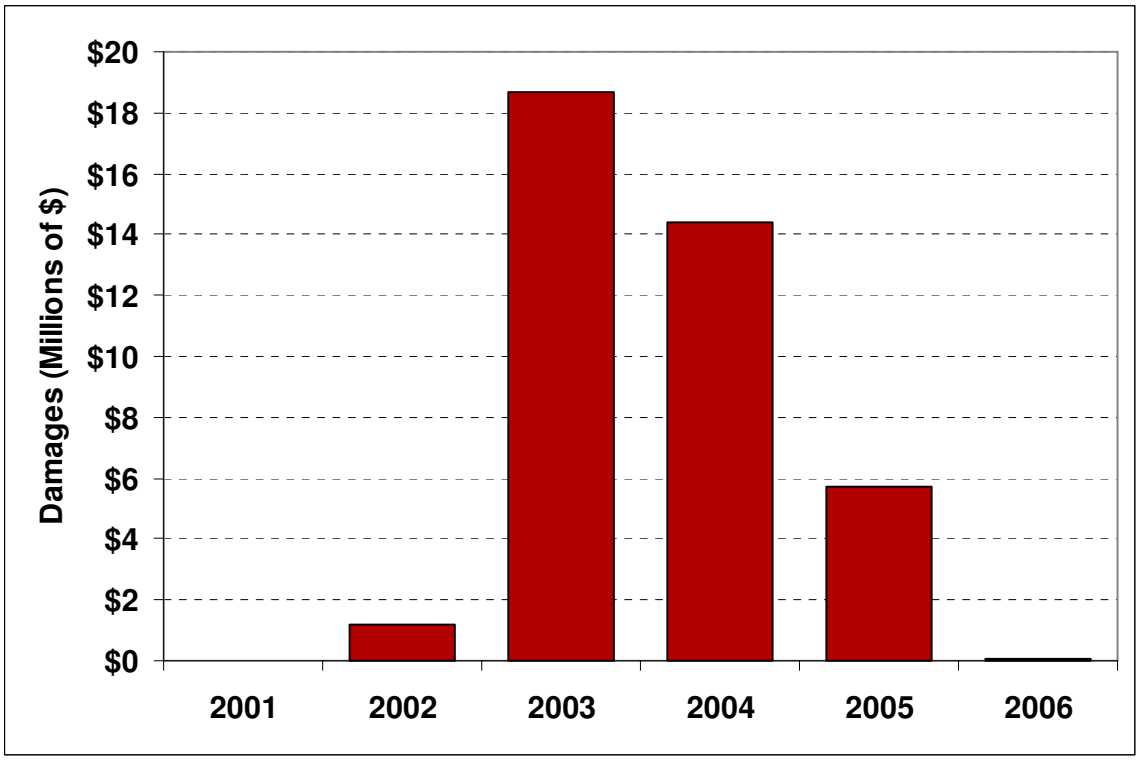
(144) I also calculated damages under the assumption that the Chinese government would have enforced a rigid price floor of $3.35 per kilogram. With that assumption, I conclude that the conspiracy caused total damages of $89.6 million, with an average overcharge of 22.9%. Figure 79 breaks down that total damages figure by year.

Figure 79: Damages by year for all sales using the $3.35 price floor



(145) Excluding transactions that were subject to arbitration clauses reduces the preceding damage figure to $40.0 million, with an average overcharge of 22.3%. Figure 80 breaks down the damages by year, excludes transactions that were subject to arbitration clauses, and assumes that the Chinese government would have imposed a price floor of $3.35 per kilogram.

Figure 80: Damages by year for sales without arbitration clauses using the $3.35 price floor



V. Corroboration and sensitivity analysis

V.1. Summary of corroborating analyses

(146) This section describes additional analyses that corroborate the damages estimates presented in Section IV. The first subsection provides an alternative damages estimate based on defendant profit margins. I find that, if defendants had set prices to generate similar profit margins during the conspiracy as immediately before and after it, the resulting prices would have been close to those predicted by my econometric model. The second subsection examines the sensitivity of my damages estimates to alternative econometric specifications and procedures. The analysis demonstrates that my conclusions are highly robust and, if anything, conservative.

V.2. Damages estimates based on margins

(147) Another straightforward and standard approach to estimating overcharges is predicated on the assumption that, but for the conspiracy, the relationship between price and variable costs during the cartel period would have been the same as it was outside the cartel period. This method allows one to examine whether rising costs justified price increases.

(148) In Section III above, I examined whether costs potentially justified Vitamin C price increases during the cartel period. Generally, while prices and costs seem to exhibit the expected relationship before and after the cartel period, costs do not appear to be a significant factor driving price increases during the cartel period. Further, defendant documents show that their profits were increasing during the cartel period. Thus, not surprisingly, the analysis that follows generally shows that, had prices during the cartel period remained at a similar profit margin as just before and after the cartel period, prices would have been much lower than those actually charged by the cartel.

(149) I used Weisheng data for my analysis below. Weisheng documents report monthly data containing average prices, per-unit production costs, and total profits from January 1996 through March 2006.[186] These data correspond to Weisheng's worldwide Vitamin C sales and are not specific to the United States. Since Weisheng apparently used this information when making contemporaneous business decisions, it is appropriate for my current purpose to take it at face value. Both Hebei and JJPC provided similar profitability data, however JJPC data were not available prior to 2002, and Hebei data were annual.

[186] WSC 14501; WSC 14370.

(150) When computing damages estimates based on margins, it is most appropriate to work with variable costs rather than total costs, which include fixed costs. That is because fixed costs do not affect the profit-maximizing quantity of an active firm. It is important to acknowledge that fixed costs may nevertheless affect equilibrium prices by influencing any given firm's choice between producing and not producing a product. In this instance, however, with a stable set of industry leaders that collectively account for the lion's share of production, the level of fixed cost is not likely to be an important determinant of short-term price fluctuations. Therefore, I included the costs of materials, energy, and labor, which tend to be variable, but excluded expenses categorized as "manufacturing costs," which tend to be fixed in the short run.

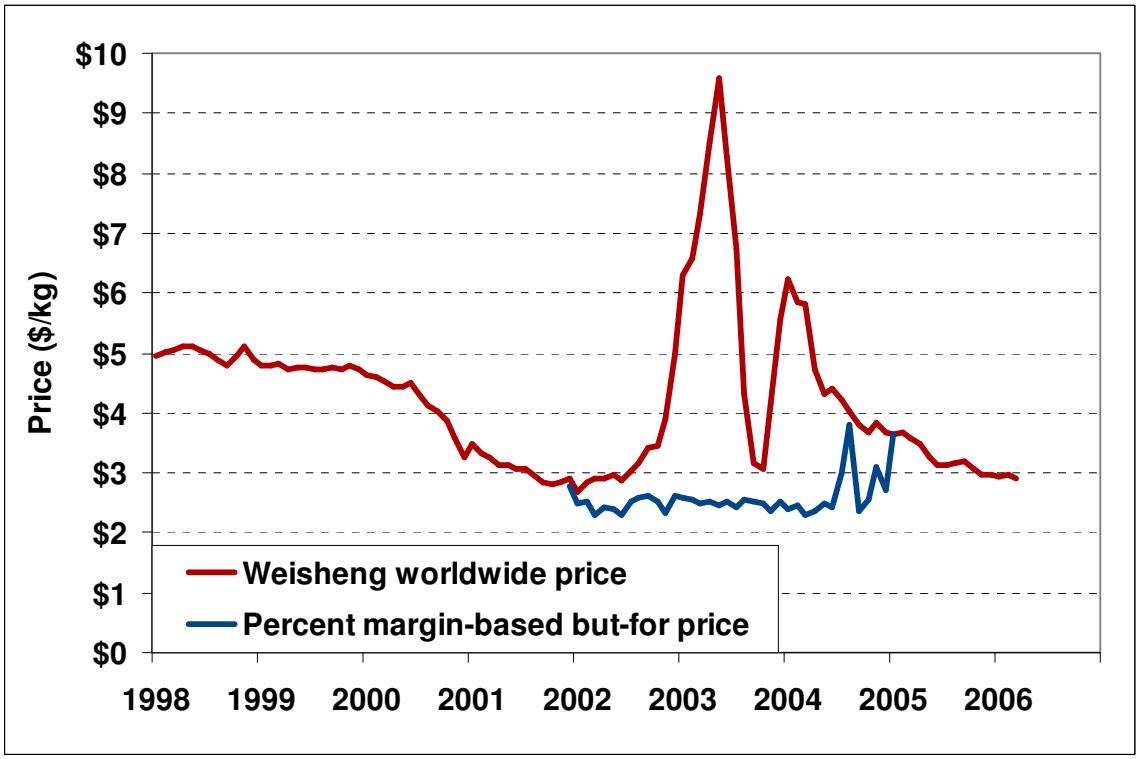
(151) My analysis of margins proceeded in two steps. First, I calculated an average percentage profit margin for a time period that excluded the cartel period. Second, I arrived at a but-for price by adding the computed profit margin to reported costs during the cartel period. I calculated these but-for prices using both percentage and absolute measures of profit margins. A constant percentage margin corresponds to profits that are the same percentage of price in each period, i.e., 10% profit margin, while a constant absolute margin denotes profits that are the same amount per unit, i.e., $0.30 per unit.

(152) To compute the non-cartel margin, I used data from two one-year time windows. The earlier window ended at the start of the cartel period and extends from December 2000 to November 2001; the other began the month after the complaint was filed and extended from February 2005 to January 2006.[187] Thus, my analysis of margins was another form of "before-and-after" calculation. It is, of course, possible to compute margins based on longer time windows. However, inasmuch as margin analysis involves no adjustments for changing economic conditions other that cost, data that are further removed in time from the cartel period are less likely to reflect the market conditions that prevailed during that period.

(153) Figure 81 compares this percentage constant-margin but-for price with the per-unit sales price from the same Weisheng data source. Figure 82 shows a similar comparison using the constant absolute dollar margin. Both show that Vitamin C prices would have been in the range of $2.50 to $3.00 for much of the cartel period, assuming that Weisheng had earned similar profits during the conspiracy as in the year just before and just after the cartel period.

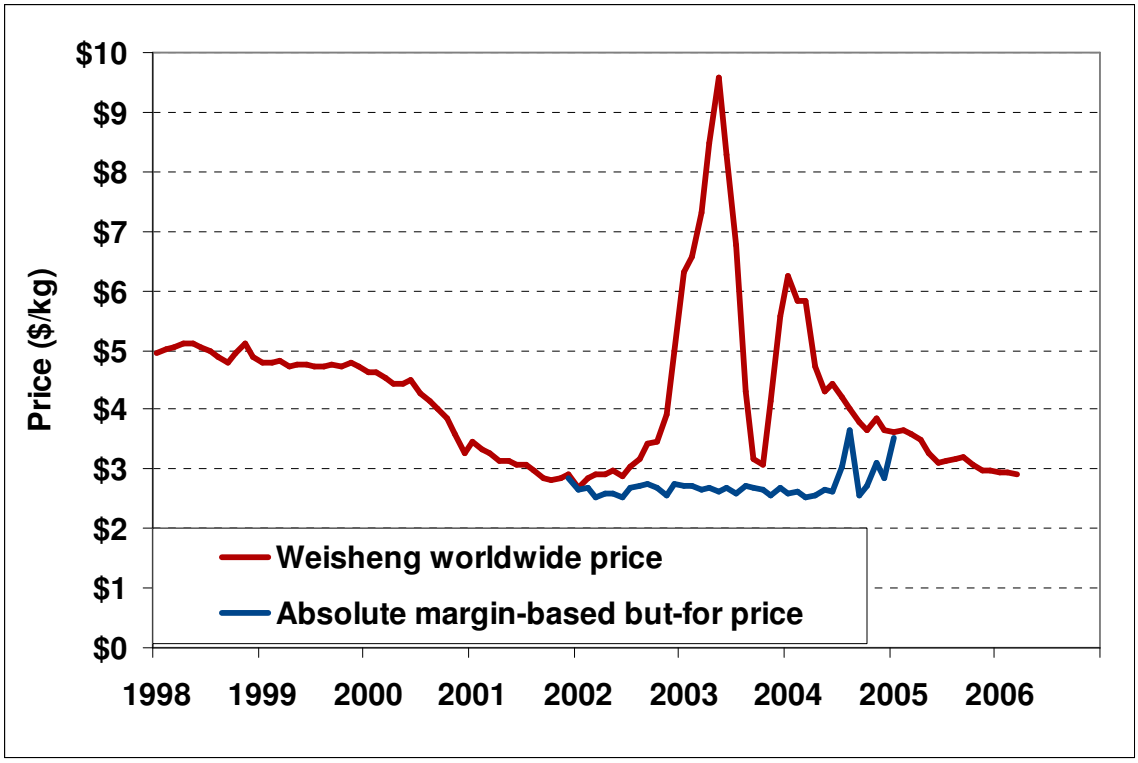
[187] This time frame is conservative, as my econometric damage analysis in Section IV shows effects of the cartel that persisted into this period. To the extent these effects result in higher profits for Weisheng, and thus higher margins, then this margin-based analysis would produce but-for prices that were inflated by the conspiracy.

Figure 81: Ascorbic acid aggregate 100 percent basis price with percentage margin price[188]



[188] WSC 14501; WSC 14370.

Figure 82: Ascorbic acid aggregate 100 percent basis price with absolute margin price[189]



V.3. Sensitivity analysis for the forecasting model

(154) The remainder of this section reviews a variety of sensitivity analyses. This includes sensitivities based on alternate econometric specifications, as well as specifications that include many of the supply and demand factors discussed in Section III.

V.3.1. The forecasting methodology

(155) To estimate the statistical model upon which my damage analysis is based, I relied on ordinary least squares regression analysis (OLS). As I noted in Section IV.2.1, OLS has the advantage of producing forecasting equations that generate unbiased predictions. I also

[189] *Ibid.*

observed that, all else equal, economists and statisticians prefer to use unbiased procedures whenever possible. However, all else is not always equal. An unbiased predictor can be a very bad predictor, particularly when one has only one opportunity to make a prediction, as in this litigation. To illustrate, if true damages for a particular vitamin are $100 million, a prediction technique that estimates damages to be zero half the time and $200 million half the time is unbiased, and a prediction technique that estimates damages to be $99.999 million all of the time is biased. Yet in my view, the second technique is clearly preferable.

(156) As the preceding example makes clear, the right criterion to use when evaluating different estimation techniques involves the size of the typical prediction error (plus or minus $100 million for the first technique, compared with $0.001 million for the second technique) rather than the degree of statistical bias alone. The size of the typical prediction error is summarized by mathematical criteria such as mean absolute error (MAE) and root mean squared error (RMSE).

(157) A well-known limitation of OLS is its tendency to "overfit" the data when relatively few observations are available. This can lead to relatively unreliable forecasts. Specifically, OLS estimates can be unstable in those contexts and can lead to large prediction errors in any single application, despite the absence of bias. So-called "shrinkage" estimators such as ridge regression and Lasso – which use statistical criteria to literally shrink the regression coefficients – can sometimes outperform OLS in terms of MAE and RMSE.[190] However, such procedures are not generally unbiased.

(158) Given the size of the sample used to estimate my preferred non-cartel model (79 observations), it is unlikely that overfitting is a problem. However, to check the reliability of my OLS forecasts, I re-estimated that model using ridge regression. In my previous work, I have found that ridge regression and Lasso perform equally well and generally yield identical results. I use ridge regression rather than Lasso here because ridge regression is more widely used, has a longer track record, and is easier to implement.

(159) As it turns out, ridge regression estimates of my preferred non-cartel model are identical to the OLS estimates; likewise, predictions based on those estimated models are also identical. Consequently, there is no reason to think that OLS suffers from an overfitting problem in this context, and there is every reason to believe that the OLS forecasts are reliable.

[190] Hoerl and Kennard, 1970a, 1970b, Tibshirani, 1996.

(160) Given the size of the sample used to estimate my preferred cartel model (36 observations), the potential for overfitting is a somewhat greater concern. As it turns out, ridge regression estimates of that model are close to the OLS estimates, as are the implied SARS adjustments (see Figure 83). Consequently, there is no reason to think that OLS suffers from an overfitting problem in this context, and every reason to believe that the OLS forecasts are reliable.

Figure 83: Ridge regression sensitivity for SARS adjustment

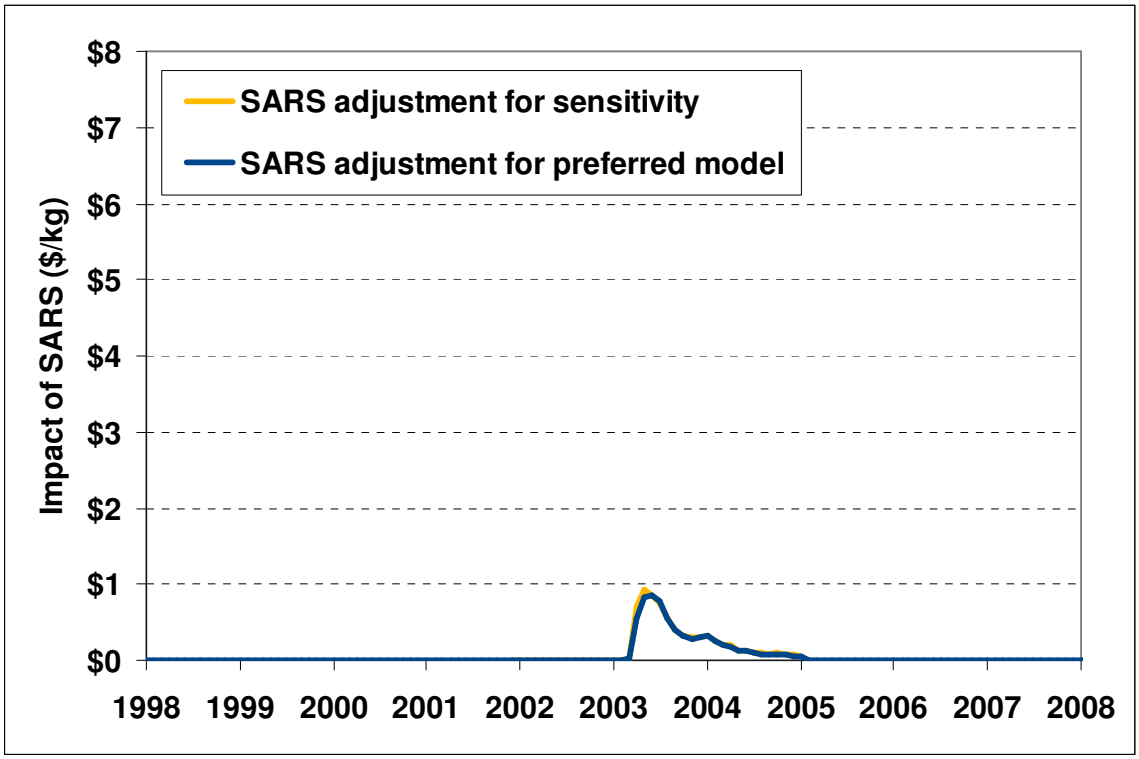
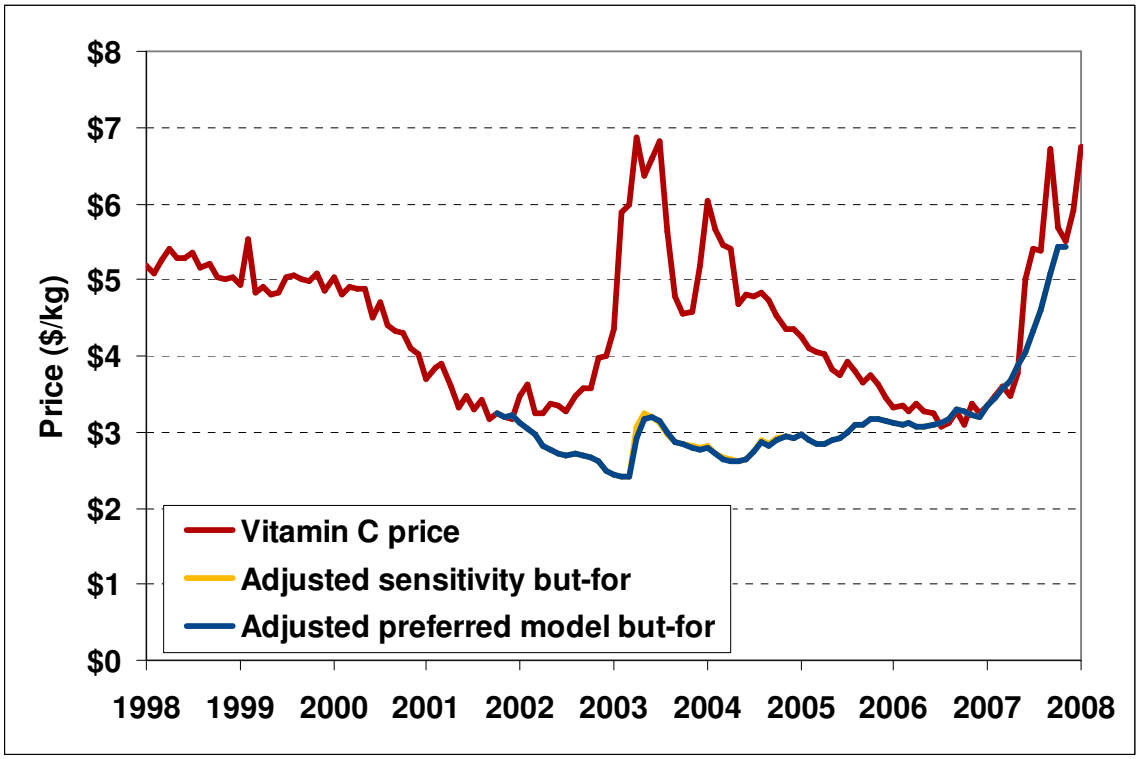


Figure 84: Ridge regression sensitivity compared to preferred SARS-adjusted but-for model



V.3.2. The forecasting equation

(161) The econometric models presented in Section IV describe current Vitamin C prices as a function of Vitamin C prices lagged once and twice (that is, the prices that prevailed in the prior two months), and other variables lagged once (that is, the values of those variables in the prior month). My findings are robust with respect to other dynamic structures. Figure 85 through Figure 87 are based on more restrictive specifications that include only one lag of the Vitamin C price rather than two. Figure 88 through Figure 90 are based on more flexible specifications that include three lags of the Vitamin C price. Figure 91 through Figure 93 are based on specifications that include current values of other variables rather than lagged values. In each case, the first figure in the series depicts the sensitivity of the basic but-for prices (without the SARS adjustment), and the second figure in the series depicts the sensitivity of the SARS adjustment. The third figure shows the total impact of the sensitivity exercise when the same change is made to both the cartel model and the non-cartel model.

Figure 85: One period lag sensitivity for but-for prices without SARS adjustment

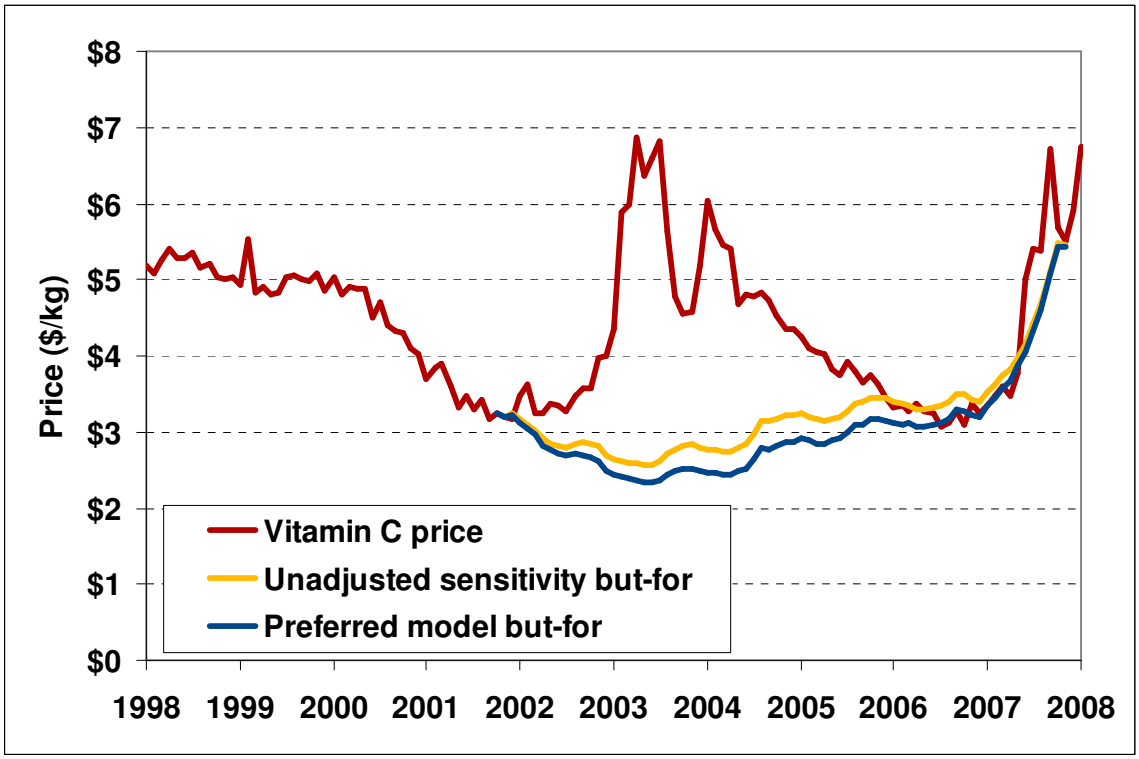


Figure 86: One period lag sensitivity for SARS adjustment

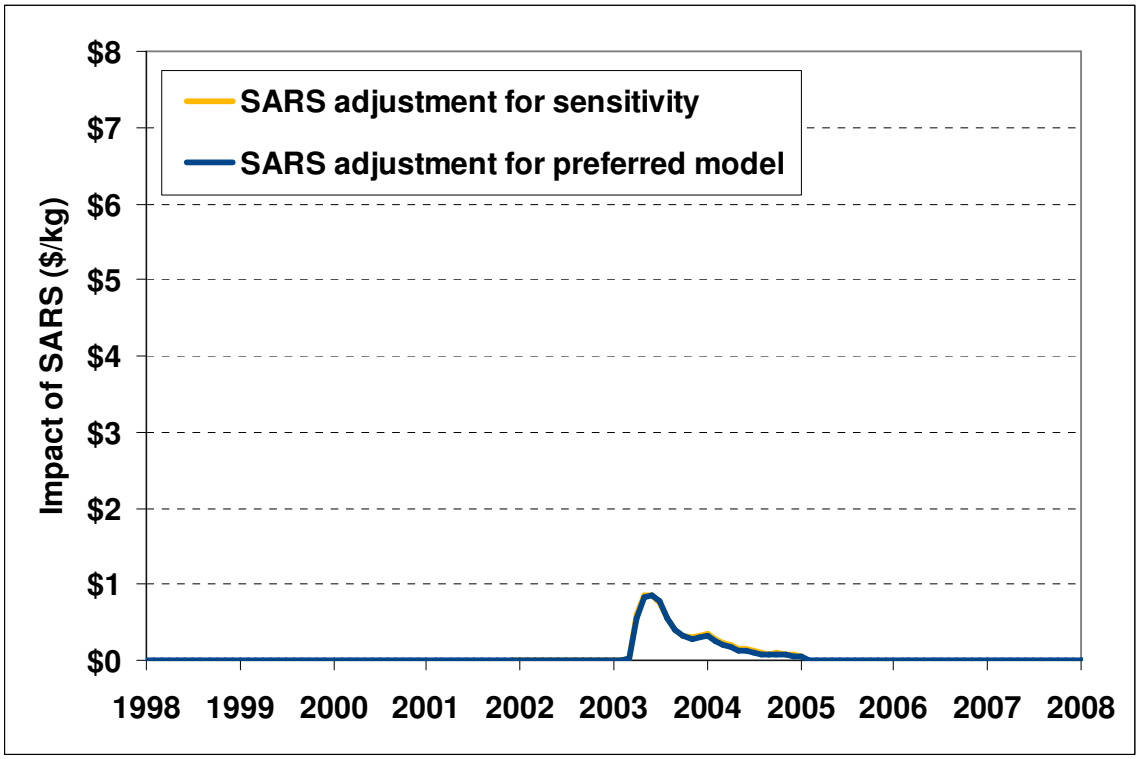


Figure 87: One period lag sensitivity for but-for prices with SARS adjustment

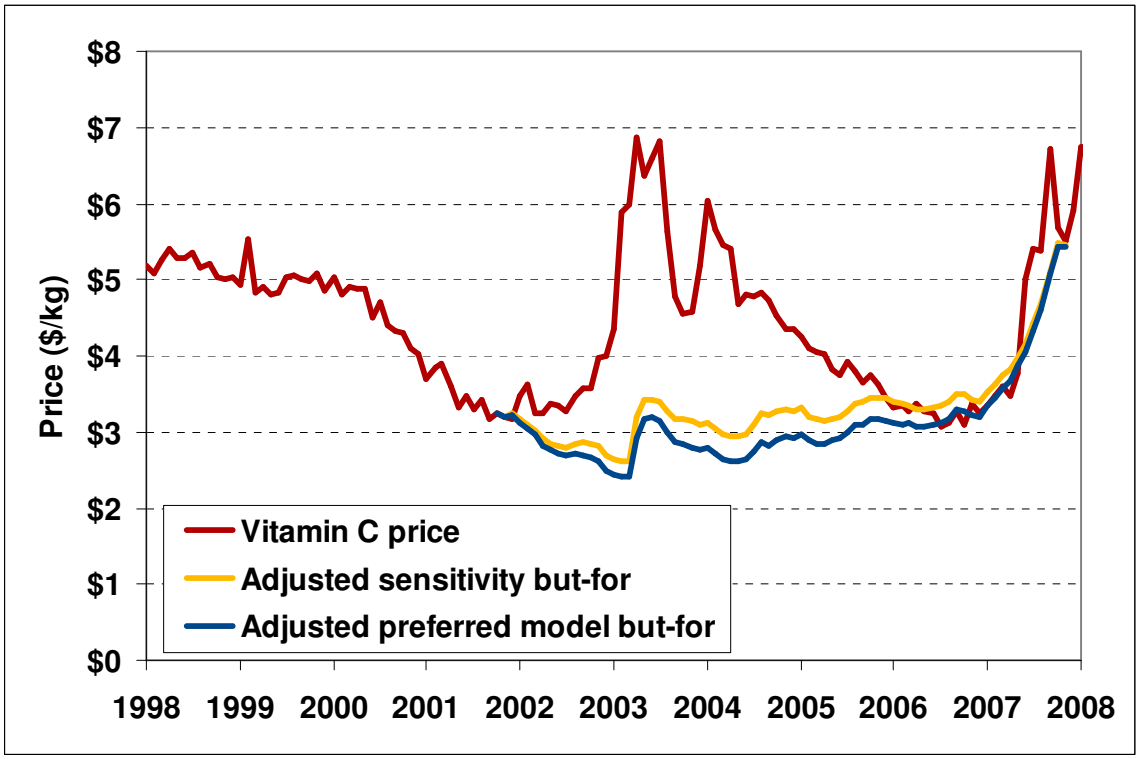


Figure 88: Three period lag sensitivity for but-for prices without SARS adjustment

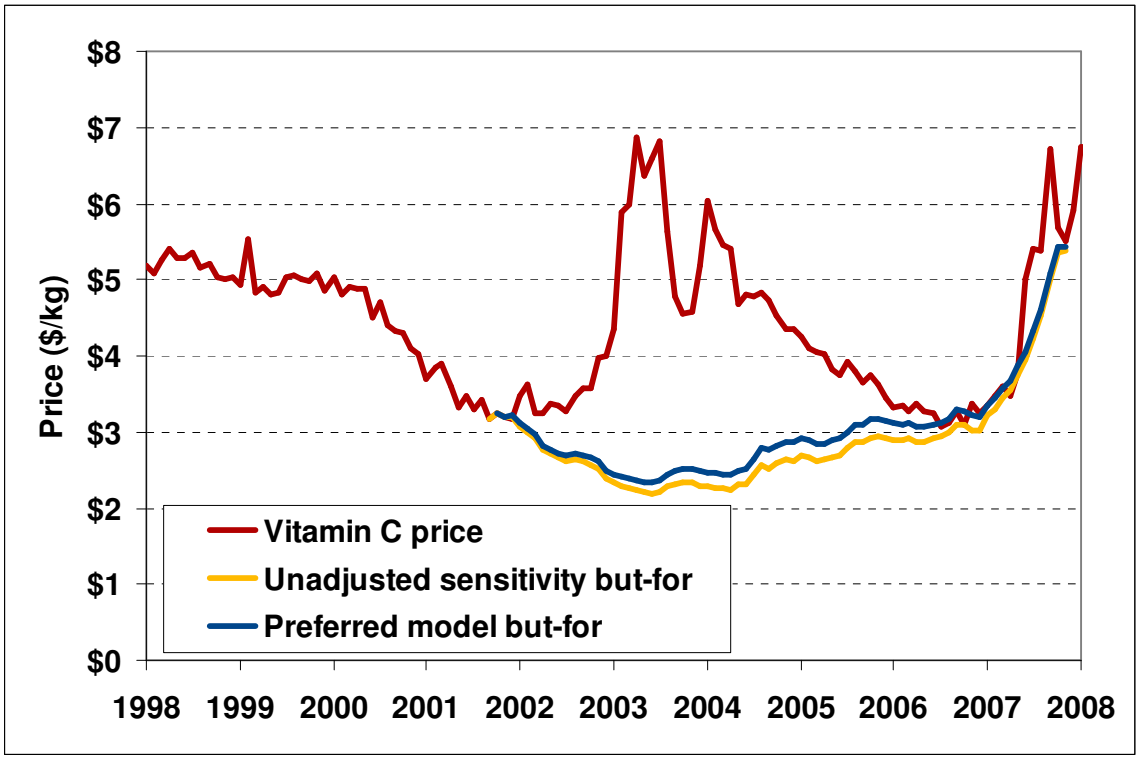


Figure 89: Three period lag sensitivity for SARS adjustment

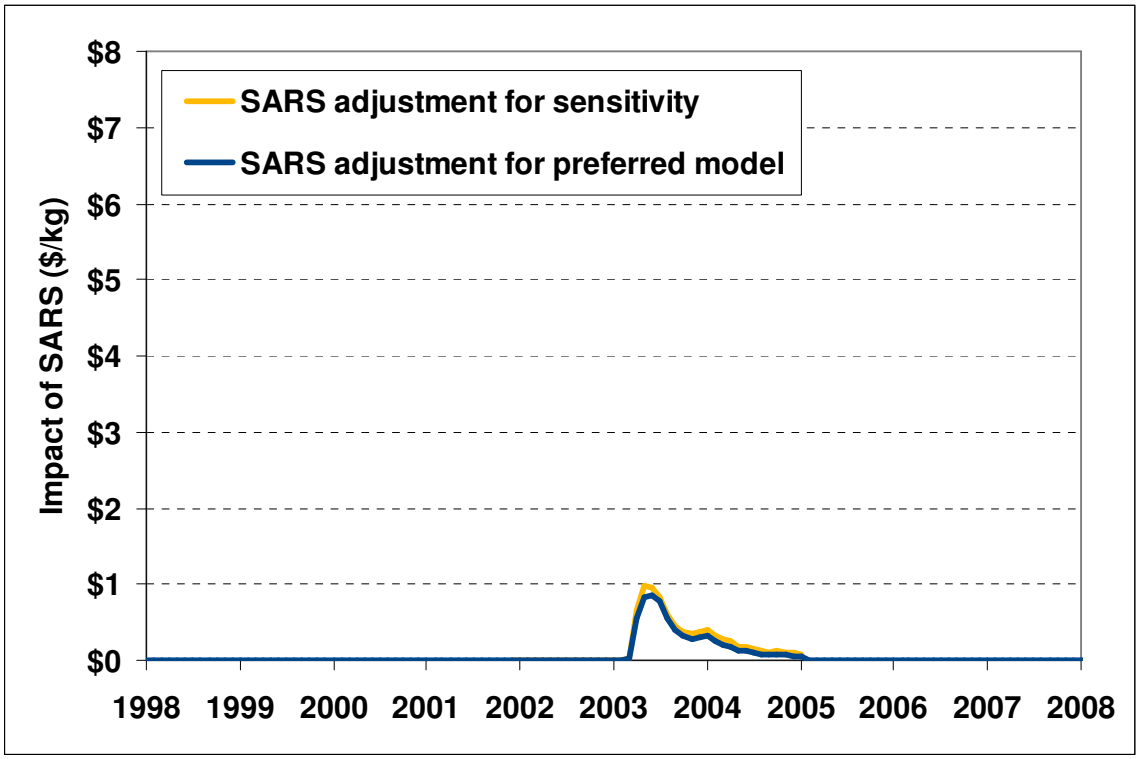


Figure 90: Three period lag sensitivity for but-for prices with SARS adjustment

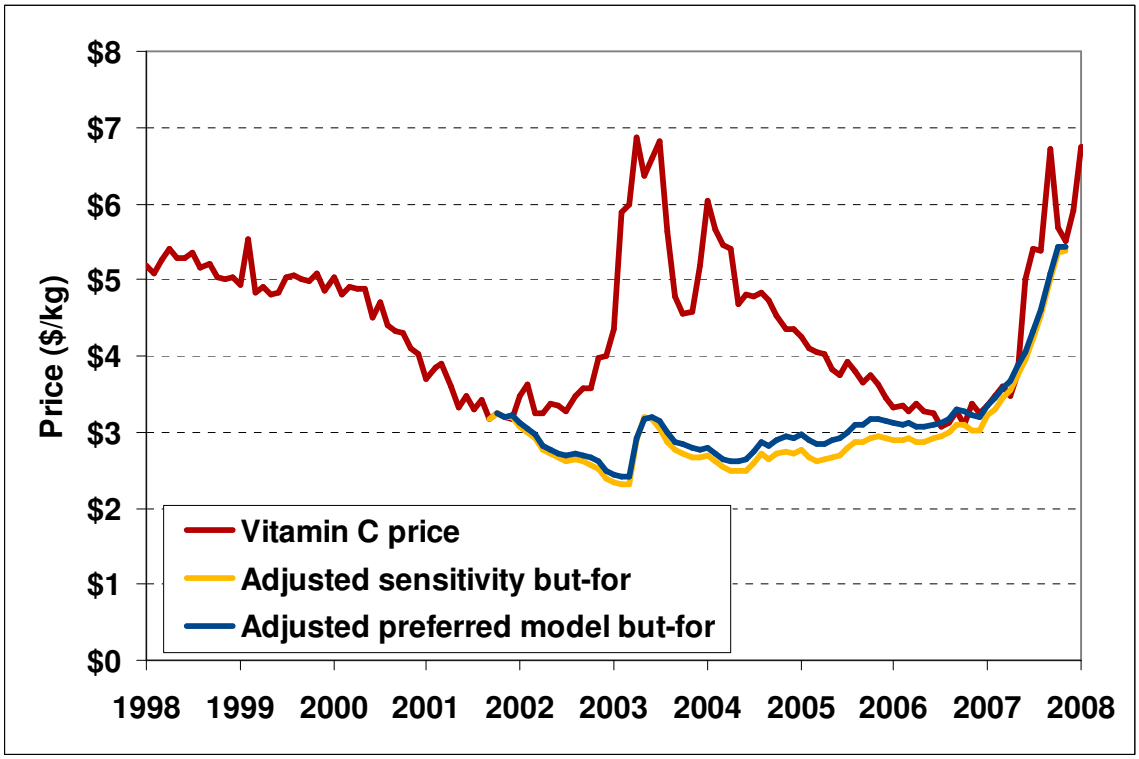


Figure 91: Contemporaneous sensitivity for but-for prices without SARS adjustment

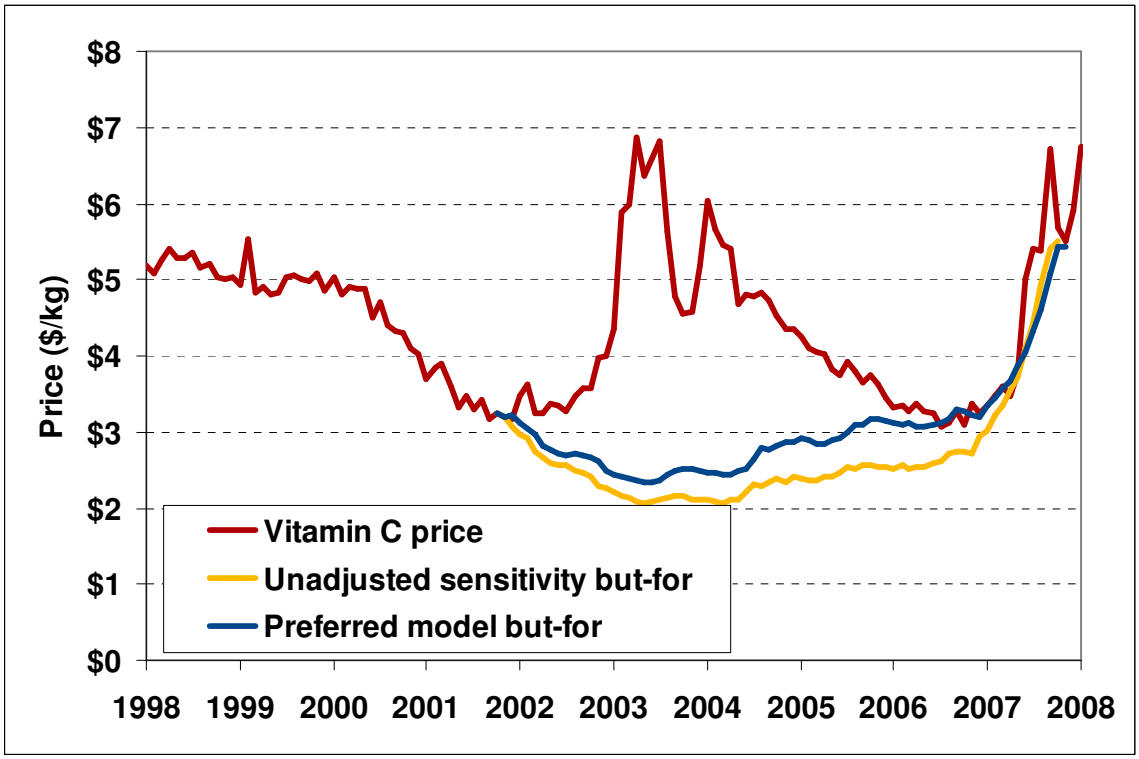


Figure 92: Contemporaneous sensitivity for SARS adjustment

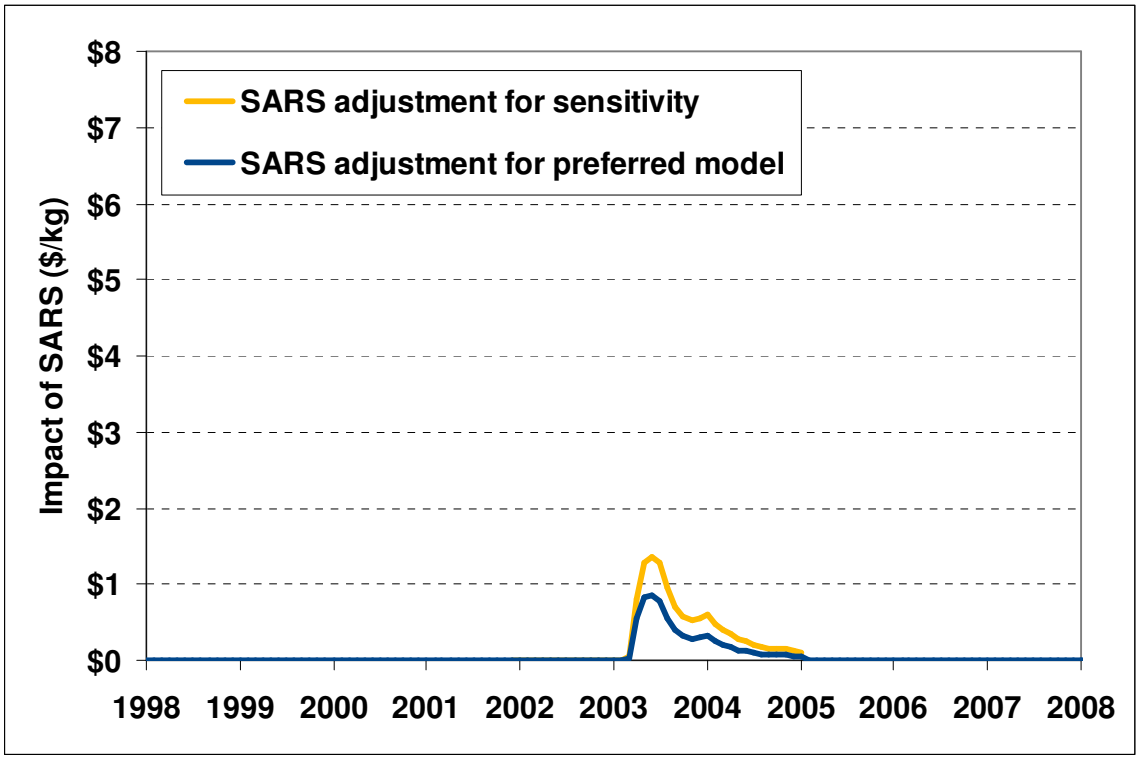
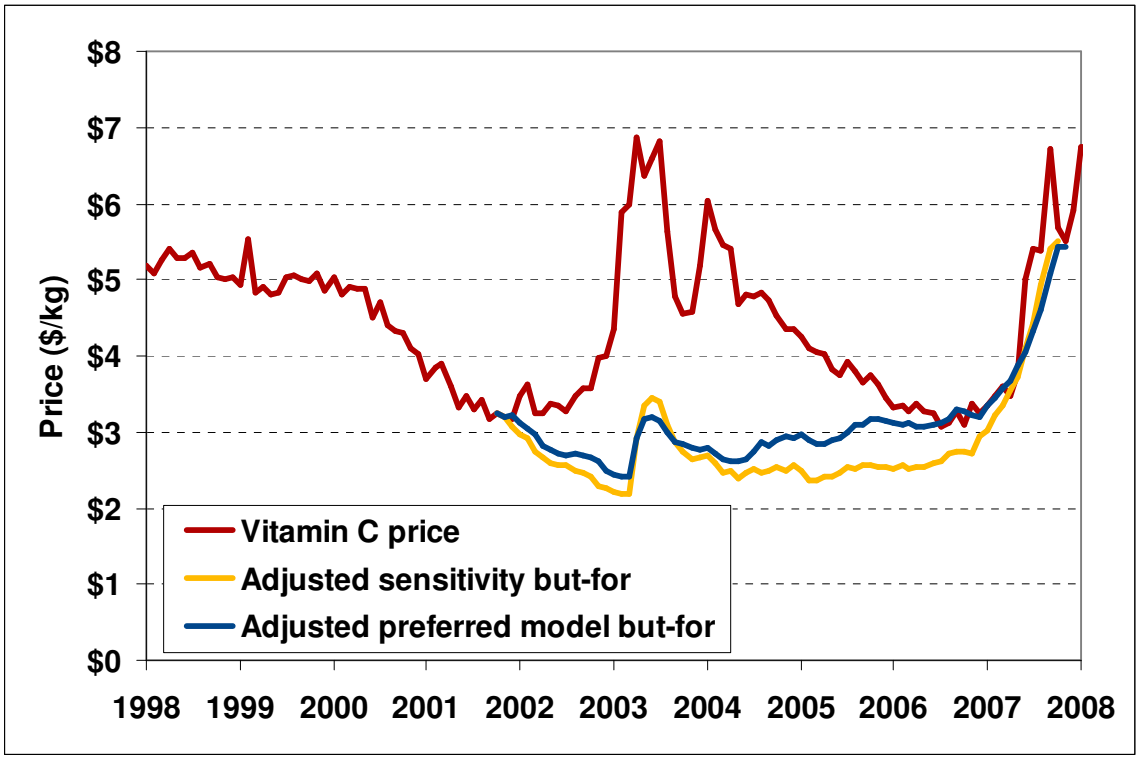


Figure 93: Contemporaneous sensitivity for but-for prices with SARS adjustment



V.3.3. Explanatory variables

(162) As I observed in Section III, Vitamin C prices may depend on a variety of supply and demand factors. Only a small number of those factors appear in my econometric models. In Section IV, I explained and justified my decision to include some variables and exclude others. Here, I demonstrate that my findings are robust with respect to the inclusion of additional variables.

(163) I considered the same collection of supply and demand variables discussed in Section III, excluding those for which insufficient data are available. In particular, I confined my attention to variables for which it is possible to obtain monthly data series covering the period 1998 to 2007. Altogether, I present the following eleven sensitivities (in each case, the variables listed are added to those that appear in my preferred model):

- Derived demand factors: includes U.S. Drug and U.S. food production indices (Figure 94 to Figure 96);
- Other demand: includes Japan disposable income, U.S. population and U.S. personal income (Figure 97 to Figure 99);

- End-user substitutes: includes PPI measures for tomatoes, potatoes, fruit and vegetables (Figure 100 to Figure 102);
- World demand indicators: includes European Union and Japan soft drink measures (Figure 103 to Figure 105);
- Production cost inputs: includes crude oil, methanol, and China coal price (Figure 106 to Figure 108);
- Other cost inputs: includes USD-Yuan exchange rate and Chinese five-year interest rate (Figure 109 to Figure 111);
- Weisheng production costs: includes materials, manufacturing, and labor costs per unit as provided by Weisheng (Figure 112 to Figure 114);
- Number of competitors: includes the number of non-China firms producing through time (Figure 115 to Figure 117);
- Withdrawn capacity: includes the cumulative amount of Vitamin C production capacity removed from operation over the relevant time period (Figure 118 to Figure 120);
- General indicators of demand: includes measures of Vitamin C demand as shown through counts of articles and multivitamins PPI (Figure 121 to Figure 123);
- All supply and demand factors: I include a specification that considers all of the above factors by relying on an iterative variable selection procedure which seeks to maximize predictive accuracy while preserving a parsimonious specification (Figure 124 to Figure 126).

(164) Once again, within each series of three figures, the first depicts the sensitivity of the basic but-for prices (without the SARS adjustment), the second depicts the sensitivity of the SARS adjustment, and the third shows the total impact of the sensitivity exercise when the same change is made to both the cartel model and the non-cartel model.

(165) In exploring the sensitivity of my analysis to the addition of these variables, by no means do I intend to suggest that every one of them is in principle a valid candidate for inclusion in my statistical models. In particular, it is inappropriate to include variables that are jointly determined (endogenous) with the Vitamin C price (unless one is prepared to construct separate models to determine how those variables would have behaved but for the conspiracy). As is widely recognized in the academic literature on industrial competition, both capacity and the number of firms are jointly determined with price. Consequently, but-for prices constructed from models that include those variables (as opposed to the supply and demand factors that determine those variables) are necessarily suspect.

Figure 94: Derived demand sensitivity for but-for prices without SARS adjustment

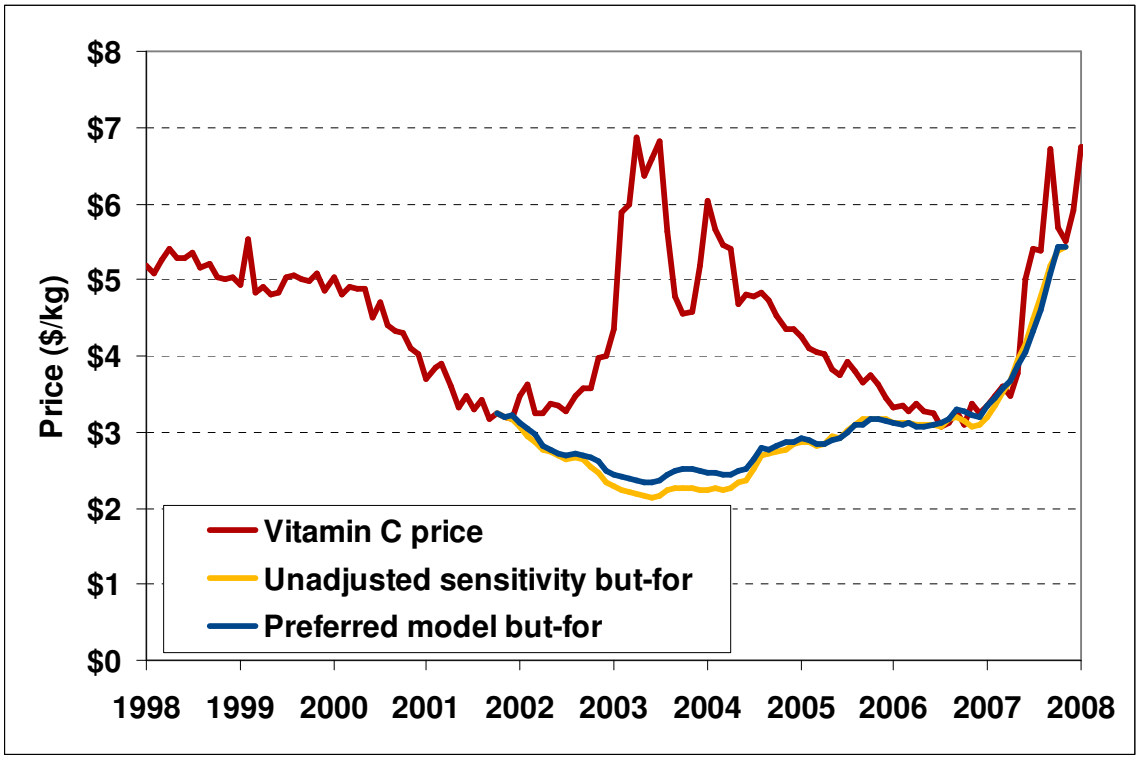


Figure 95: Derived demand sensitivity for SARS adjustment

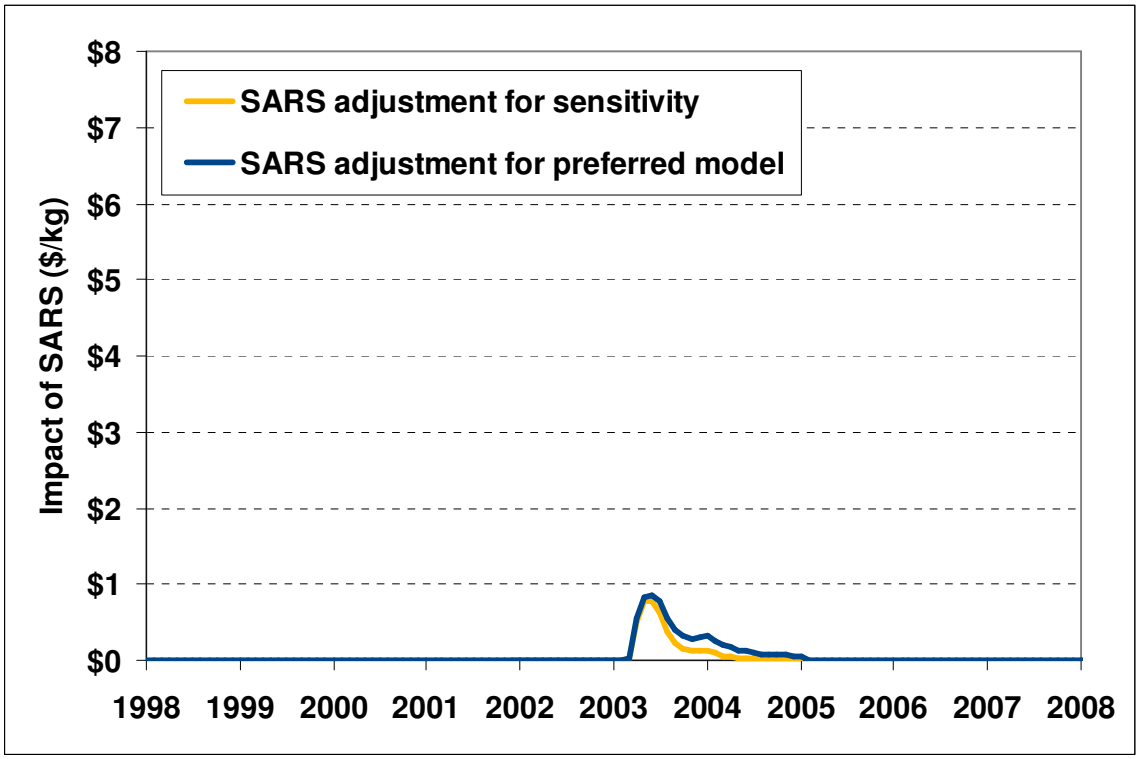


Figure 96: Derived demand sensitivity for but-for prices with SARS adjustment

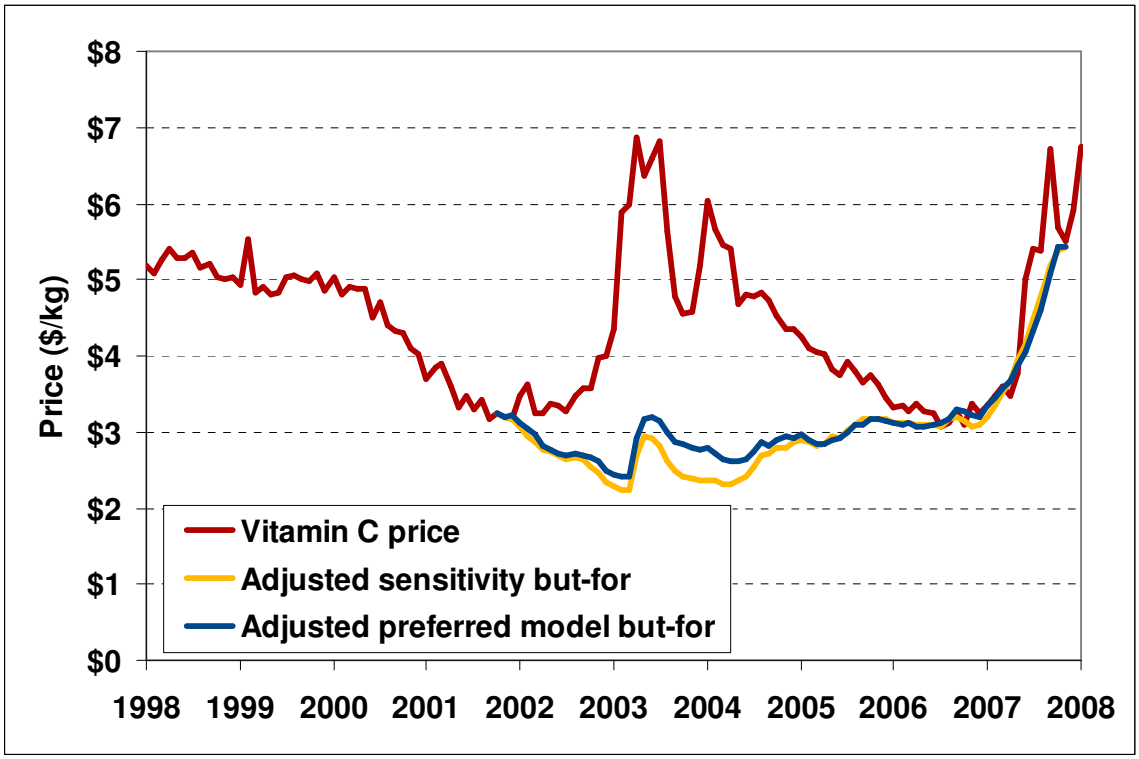


Figure 97: Other demand factors sensitivity for but-for prices without SARS adjustment

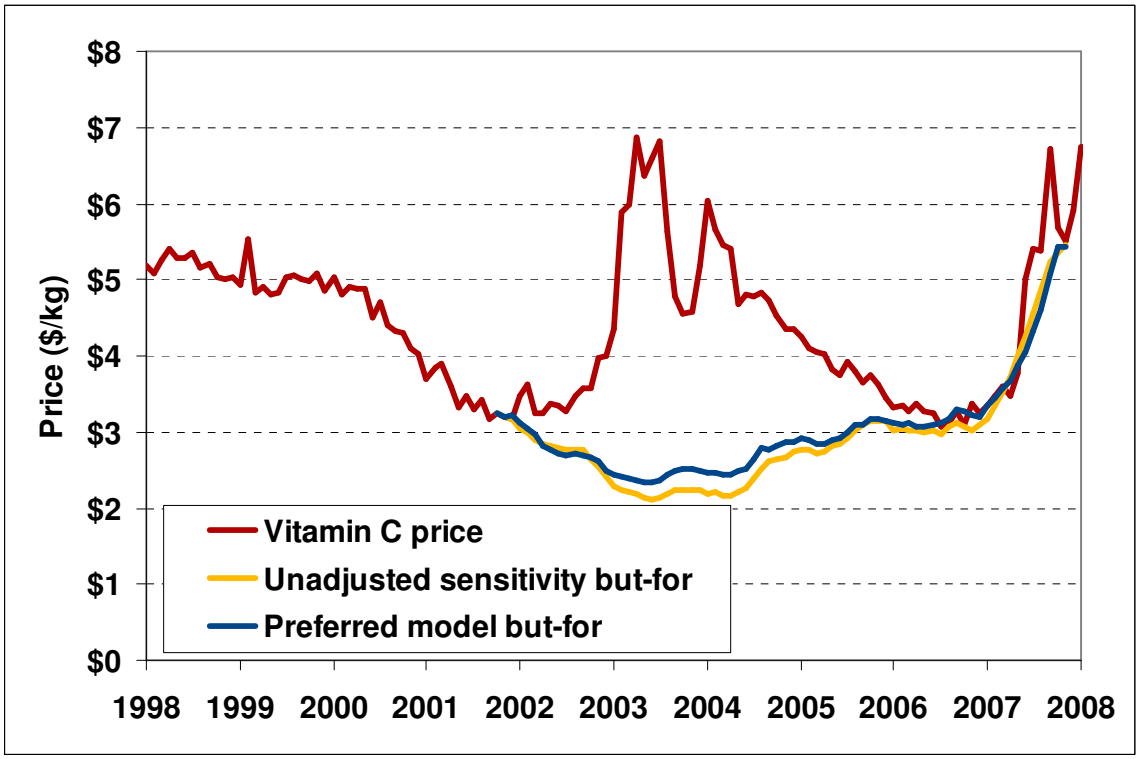


Figure 98: Other demand factors sensitivity for SARS adjustment

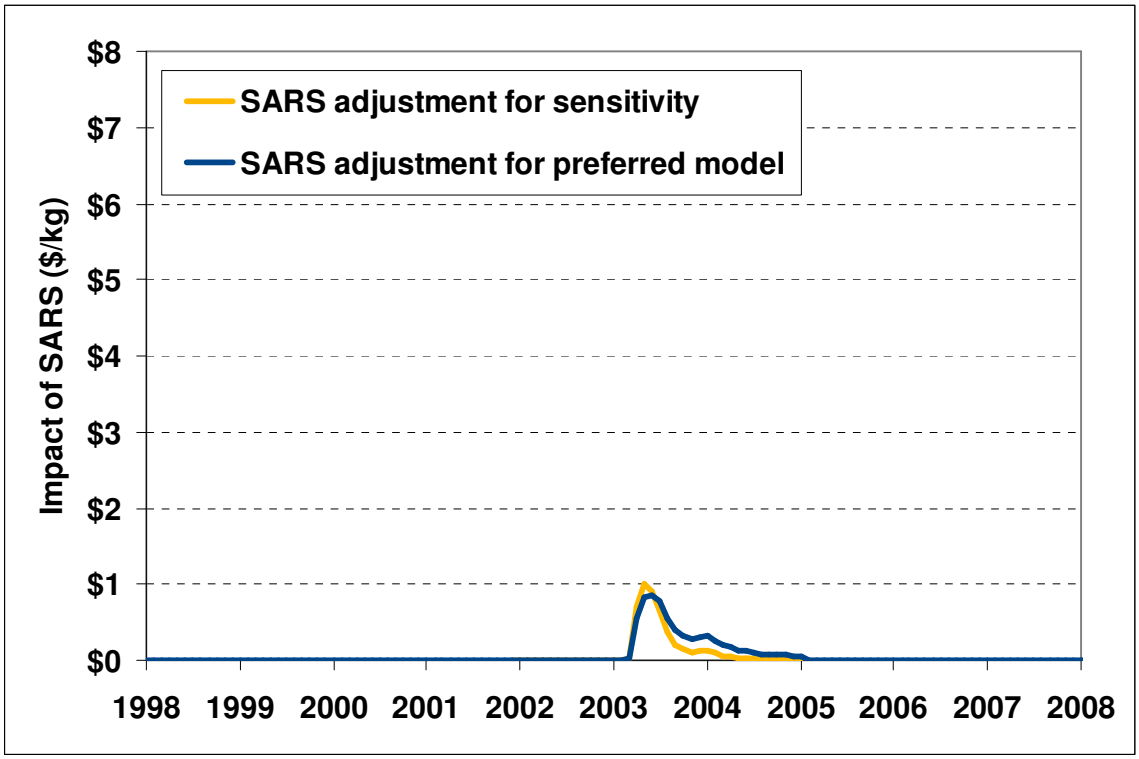


Figure 99: Other demand factors sensitivity for but-for prices with SARS adjustment

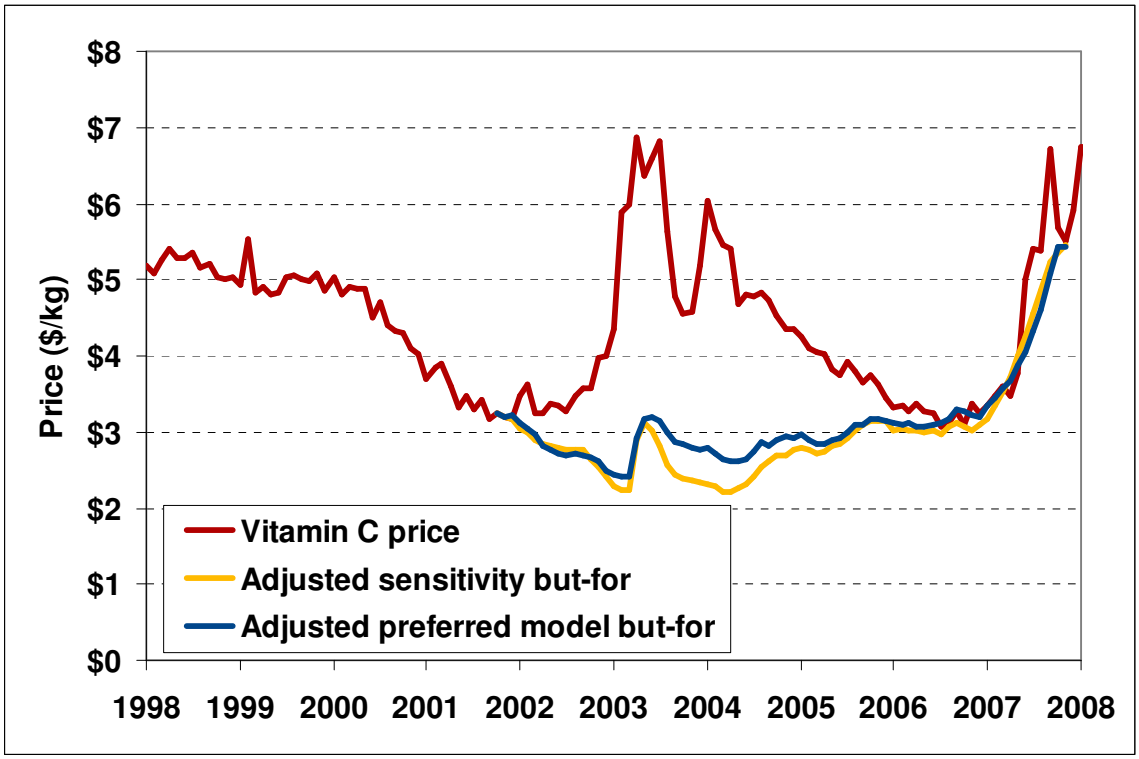


Figure 100: End-user substitutes sensitivity for but-for prices without SARS adjustment

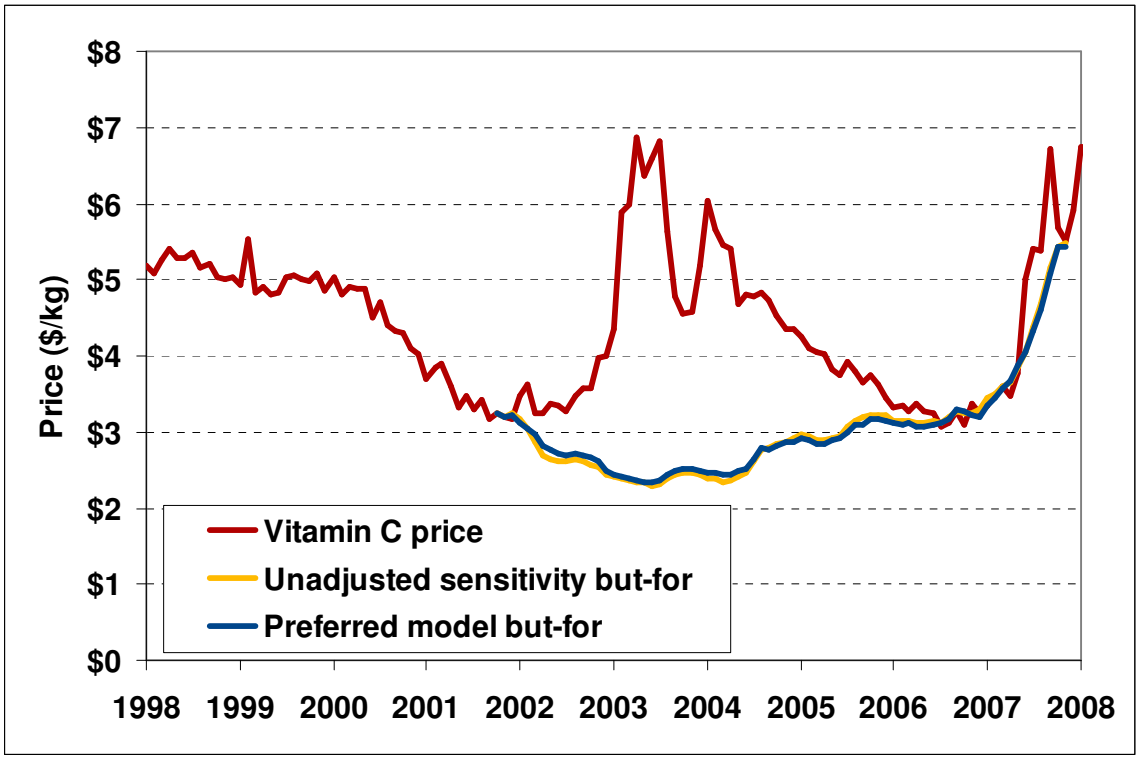


Figure 101: End-user substitutes sensitivity for SARS adjustment

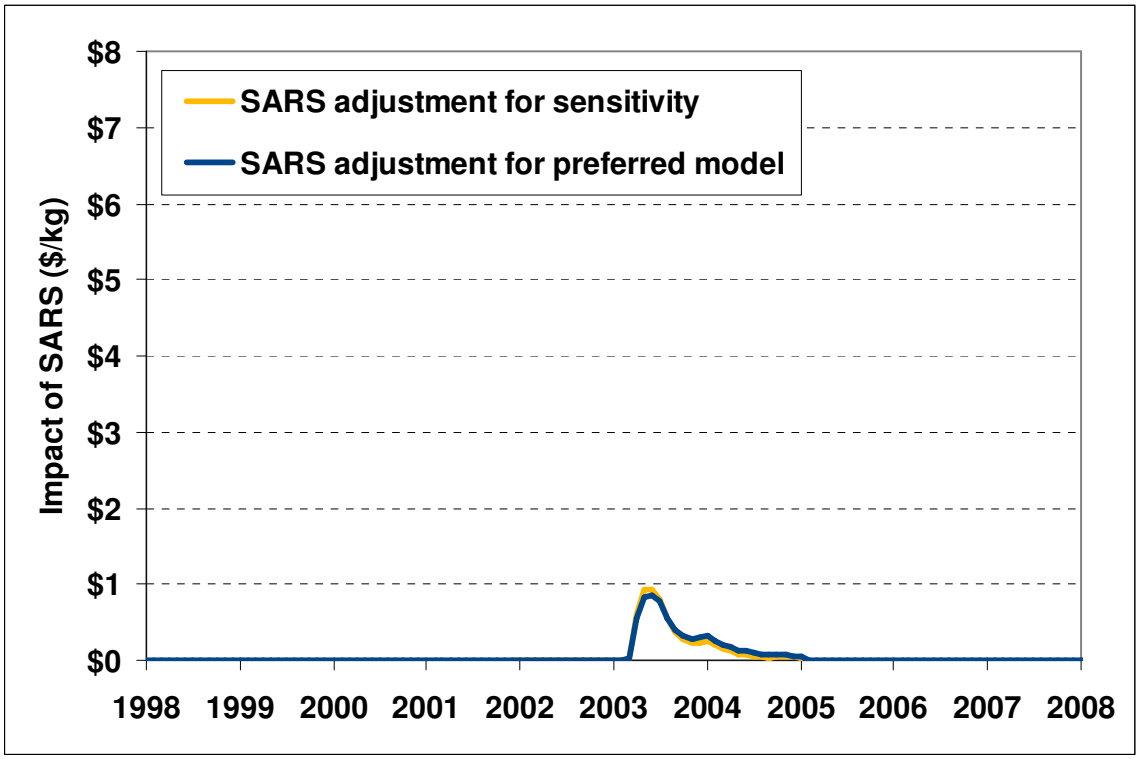


Figure 102: End-user substitutes sensitivity for but-for prices with SARS adjustment

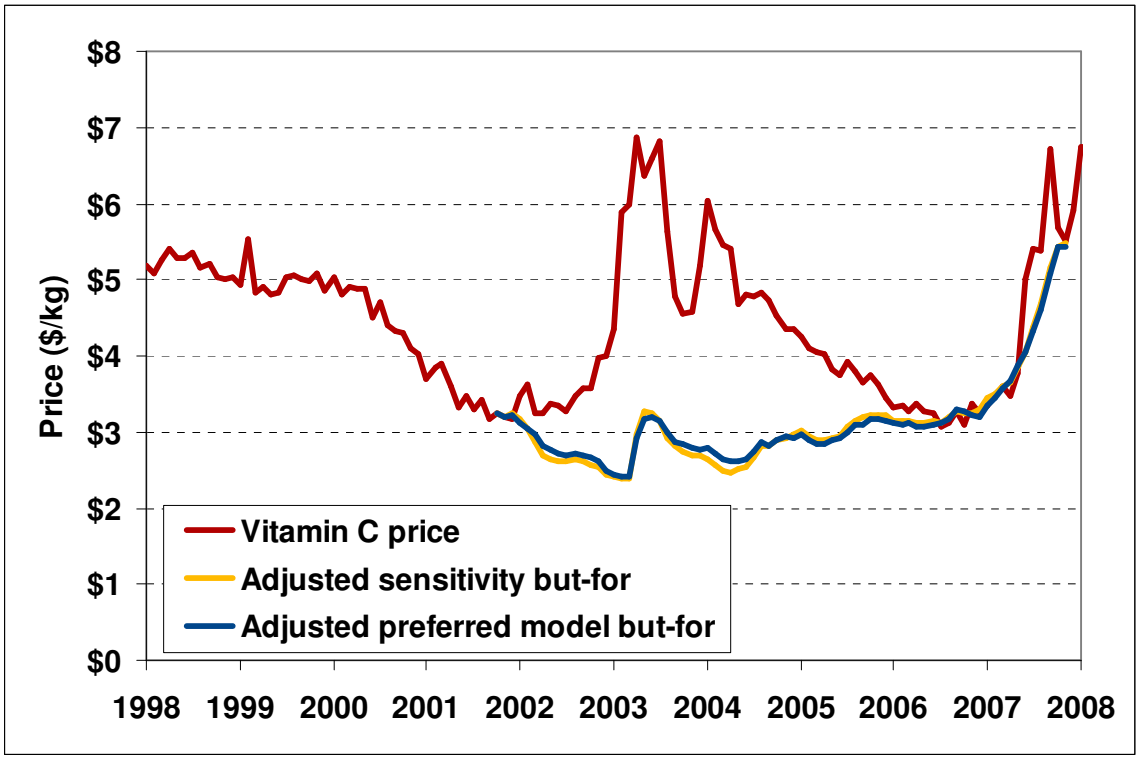


Figure 103: World demand indicators sensitivity for but-for prices without SARS adjustment

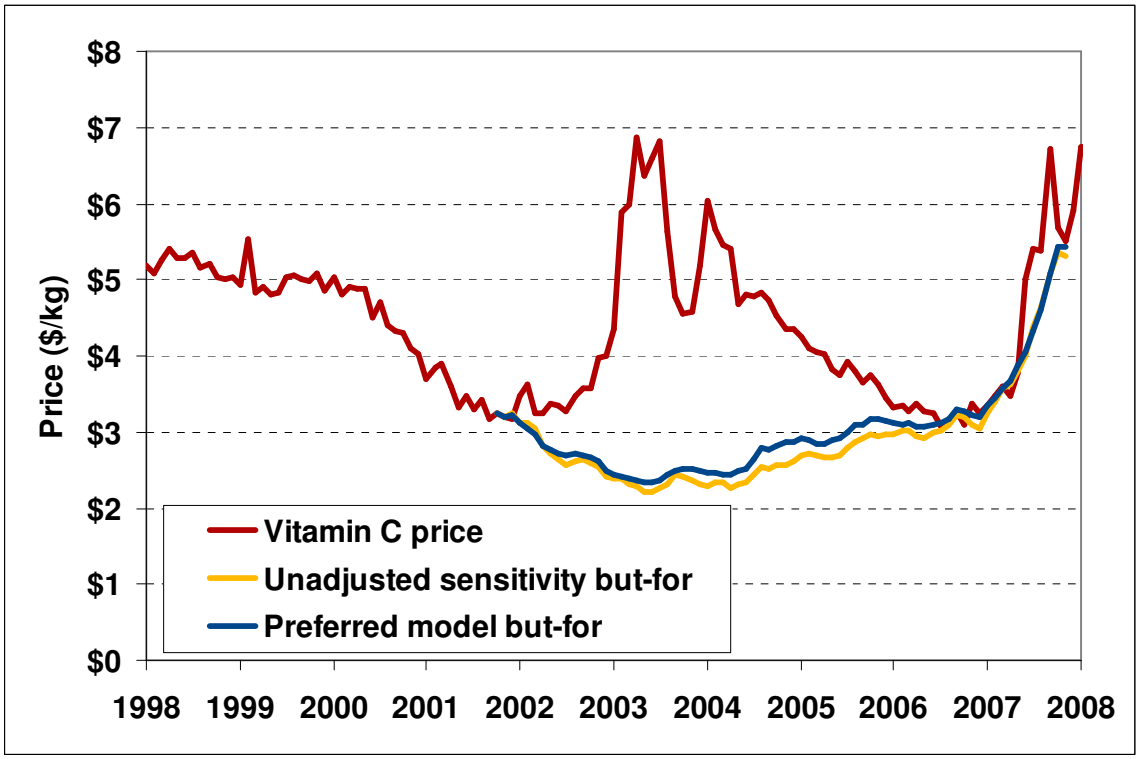


Figure 104: World demand indicators sensitivity for SARS adjustment

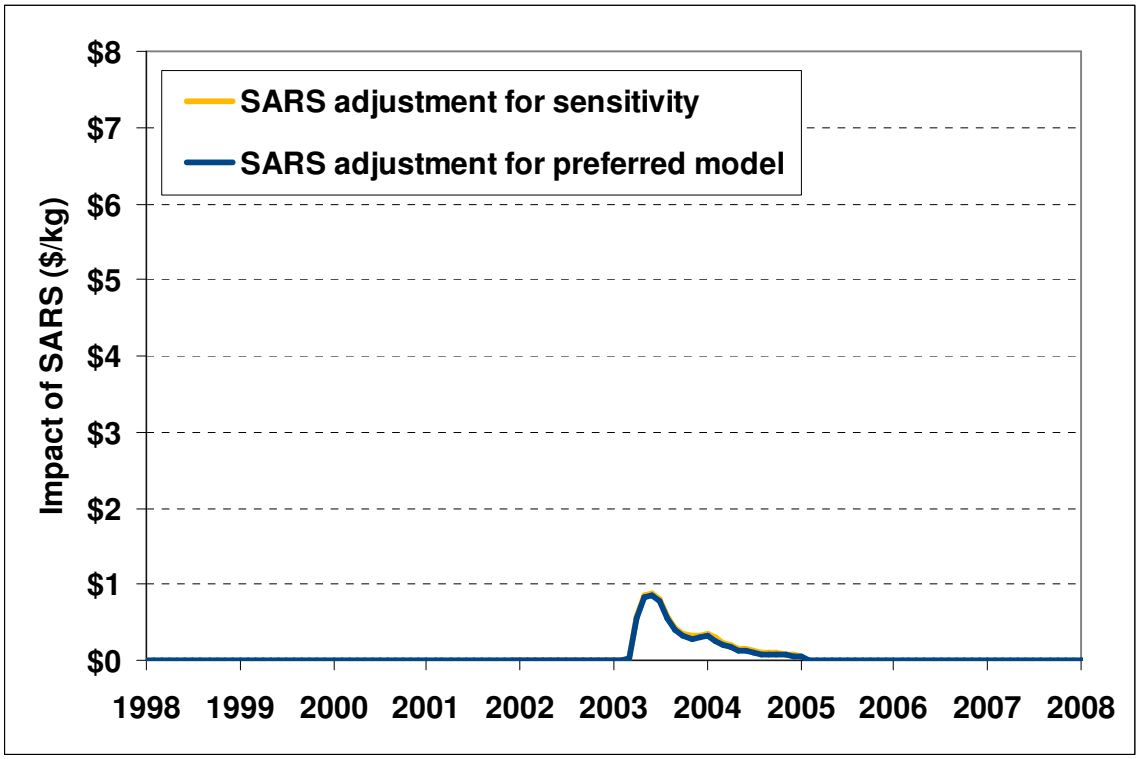


Figure 105: World demand indicators sensitivity for but-for prices with SARS adjustment

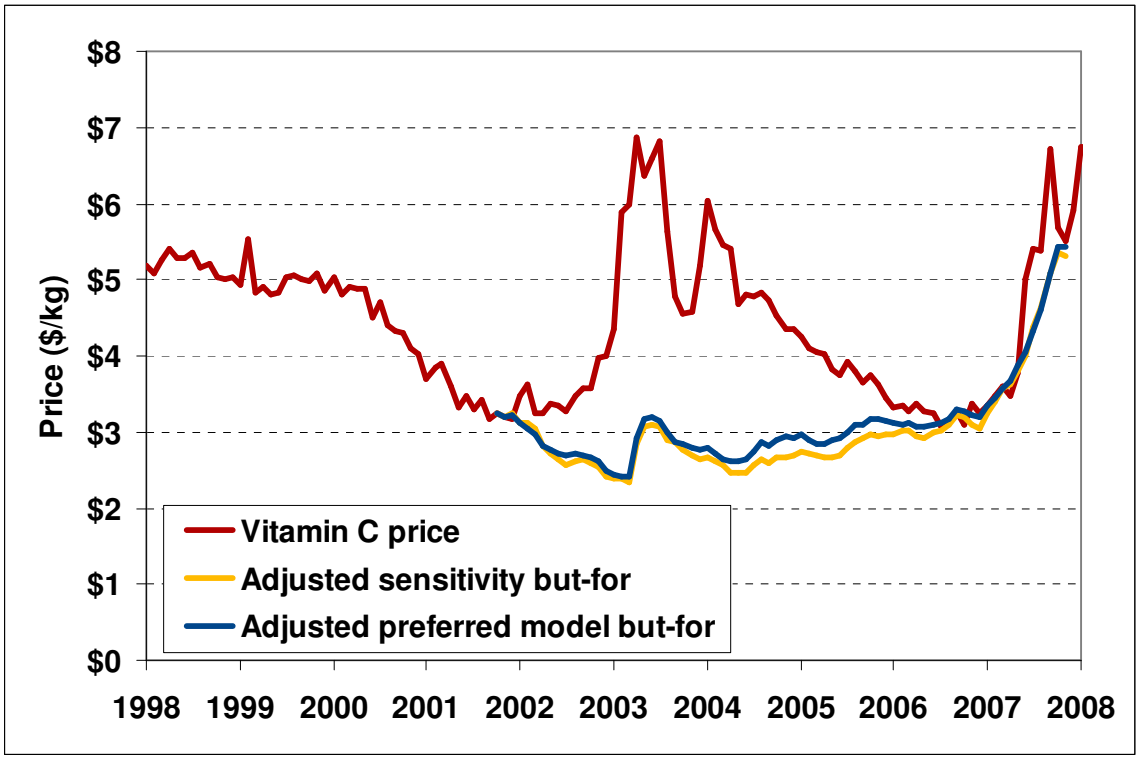


Figure 106: Production cost inputs sensitivity for but-for prices without SARS adjustment

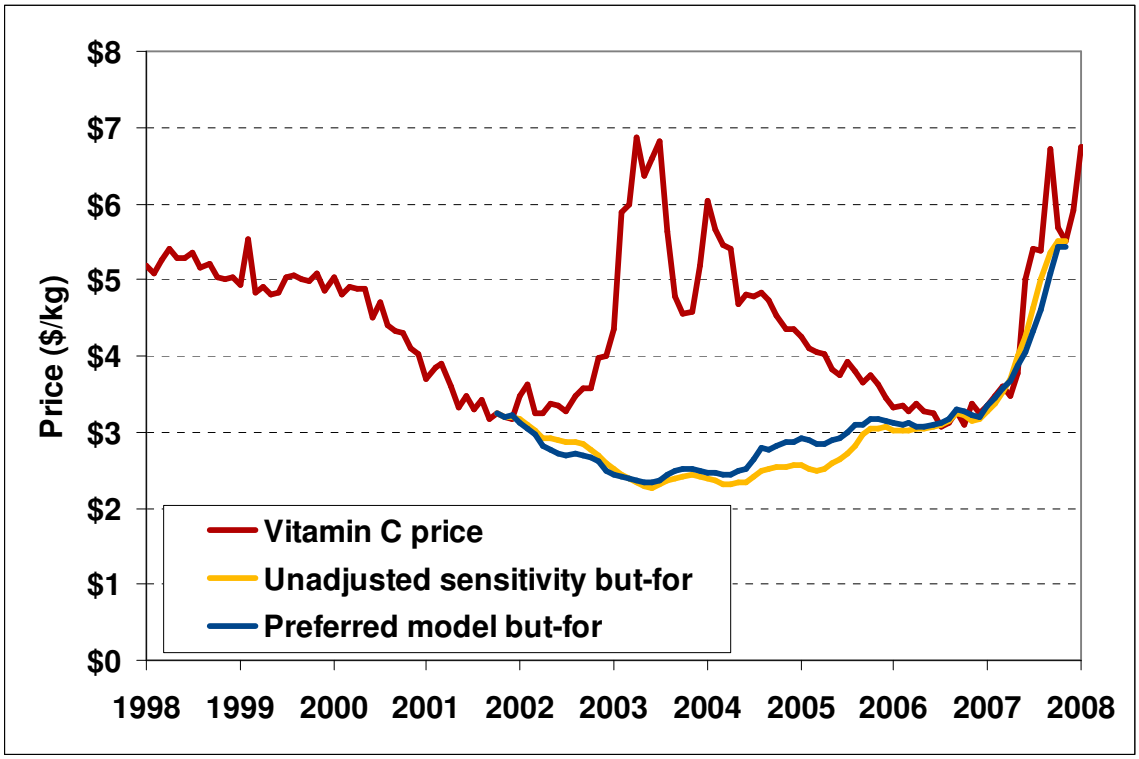


Figure 107: Production cost inputs sensitivity for SARS adjustment

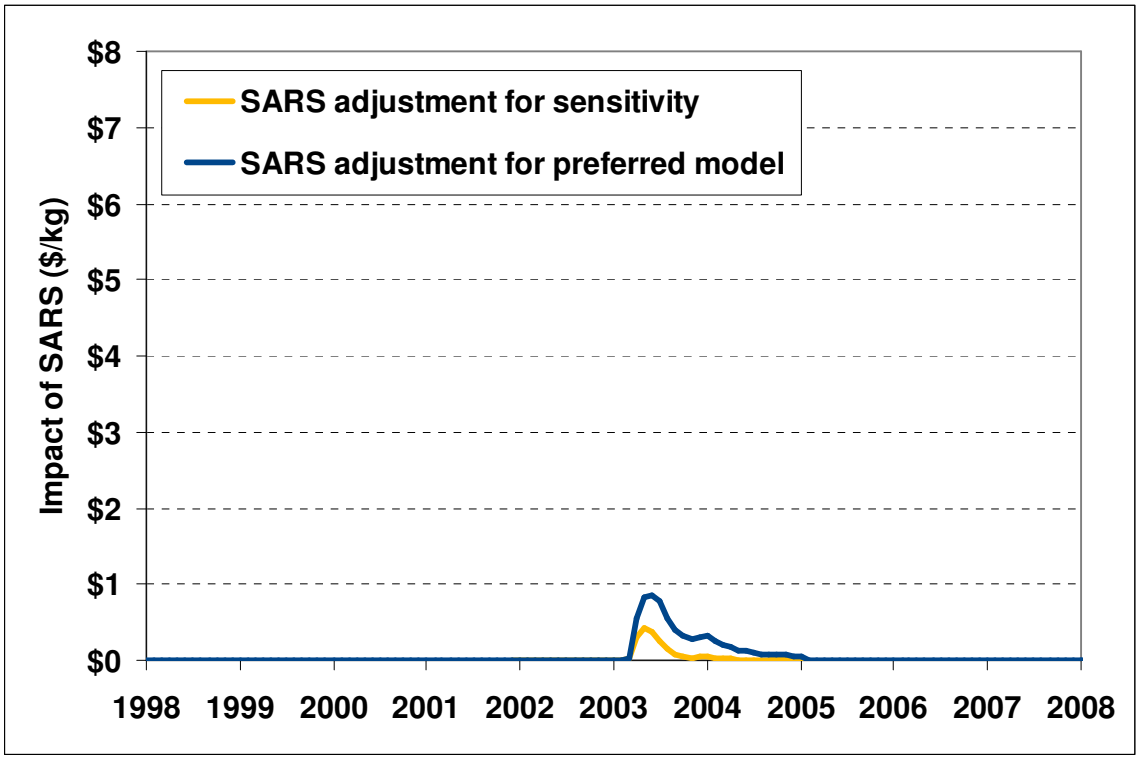


Figure 108: Production cost inputs sensitivity for but-for prices with SARS adjustment

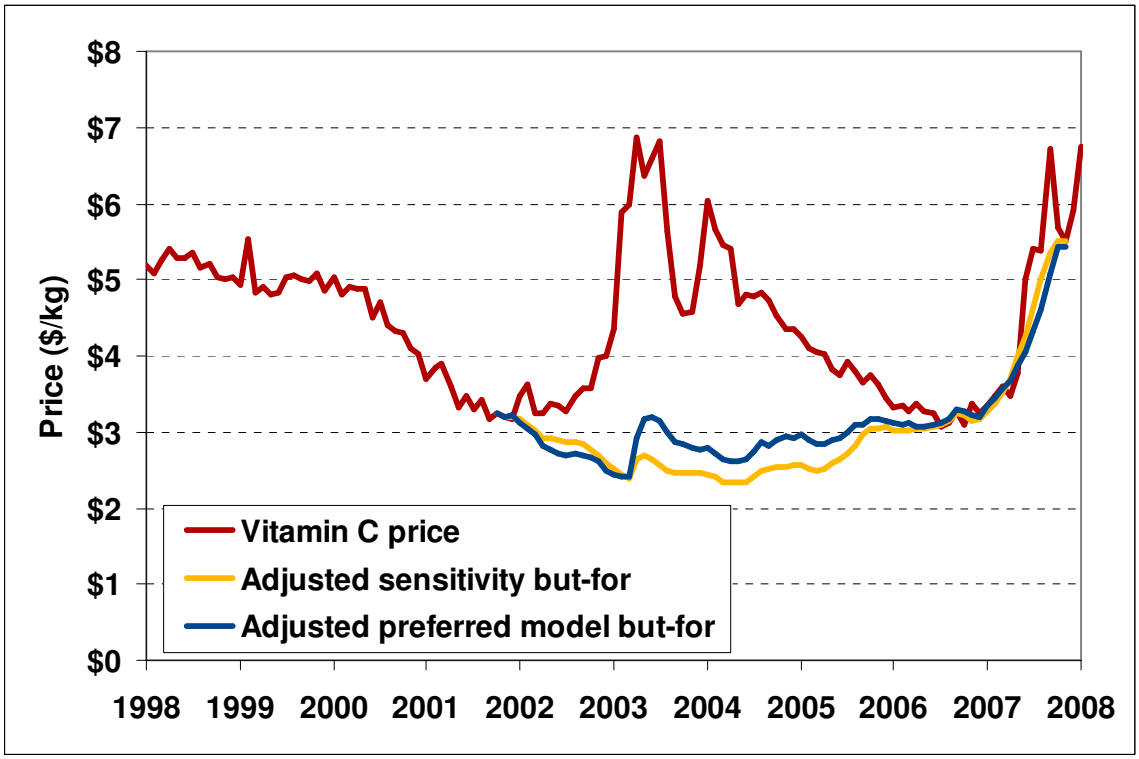


Figure 109: Other cost inputs sensitivity for but-for prices without SARS adjustment

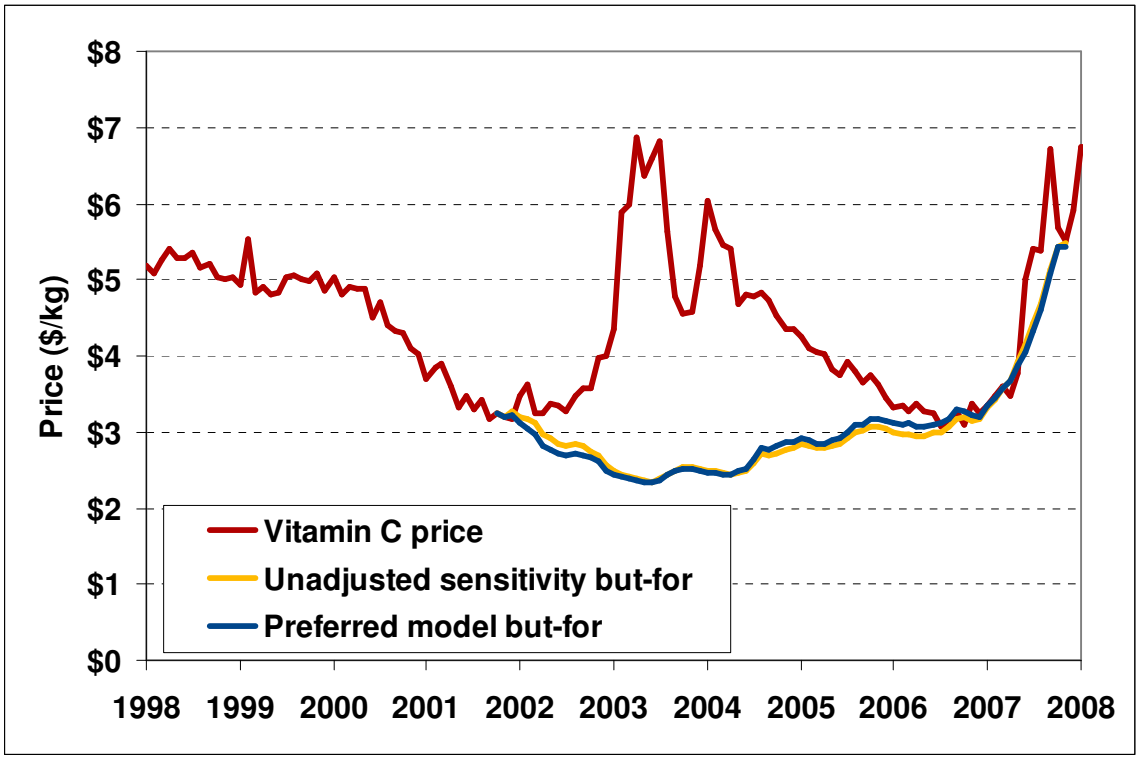


Figure 110: Other cost inputs sensitivity for SARS adjustment

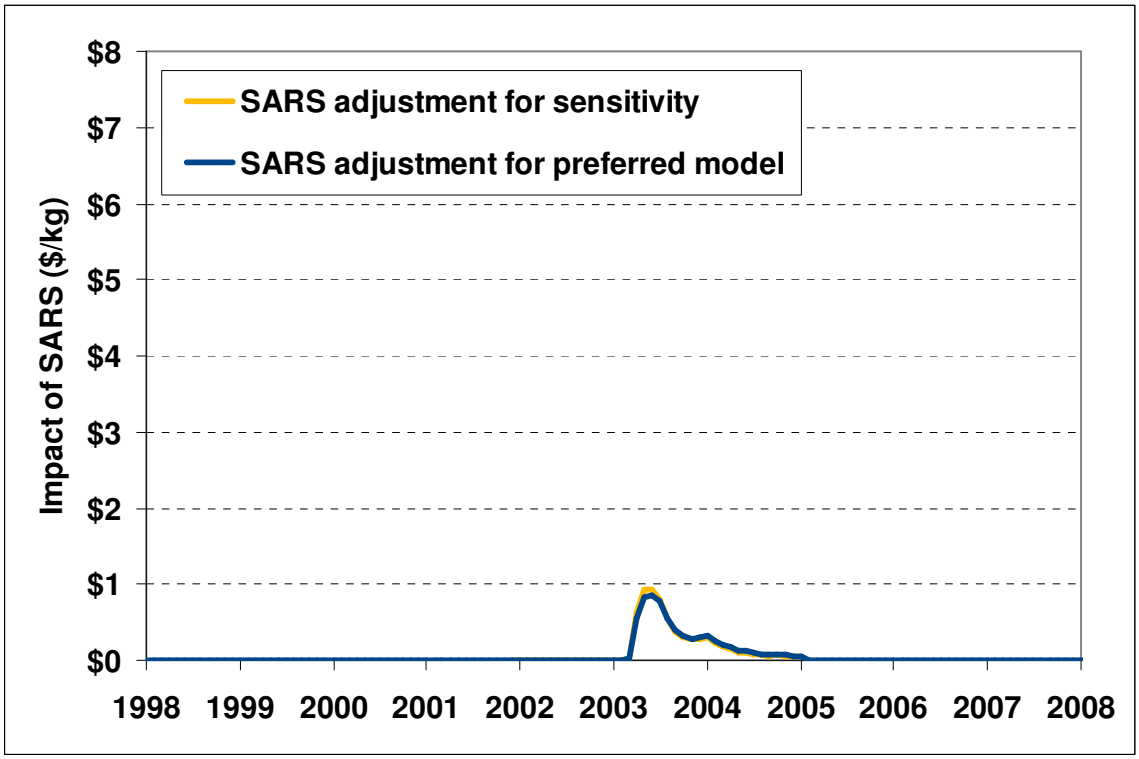


Figure 111: Other cost inputs sensitivity for but-for prices with SARS adjustment

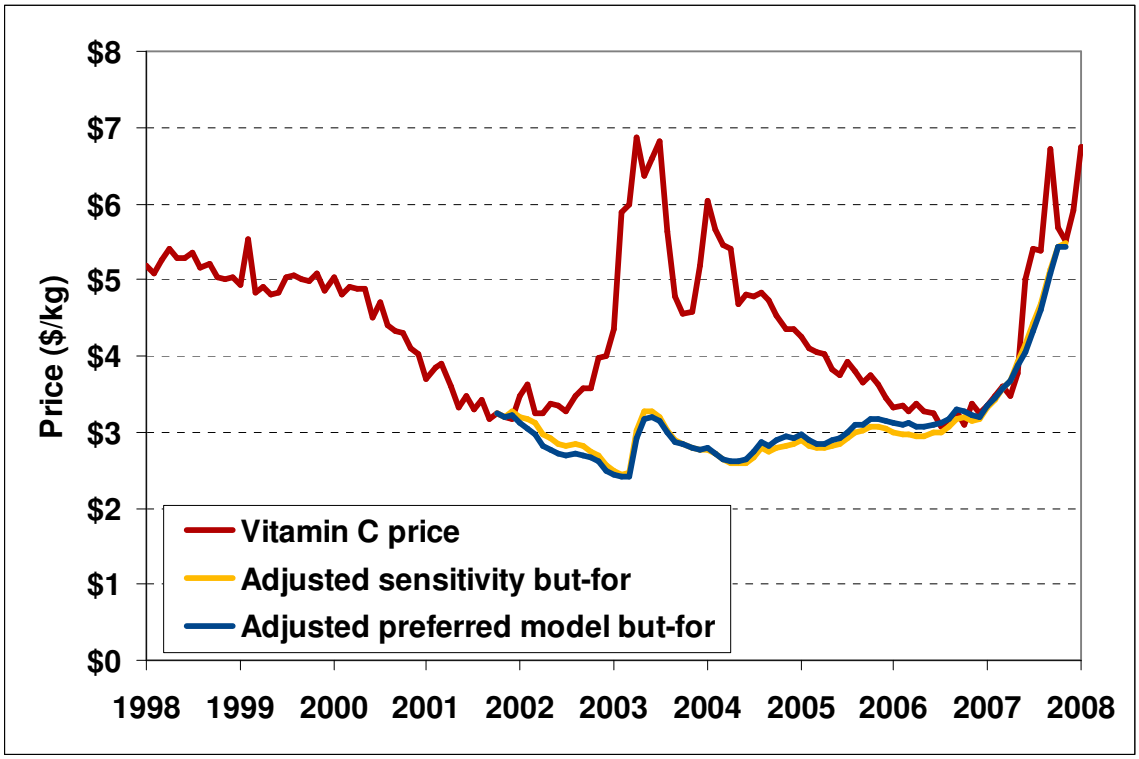


Figure 112: Weisheng production costs sensitivity for but-for prices without SARS adjustment

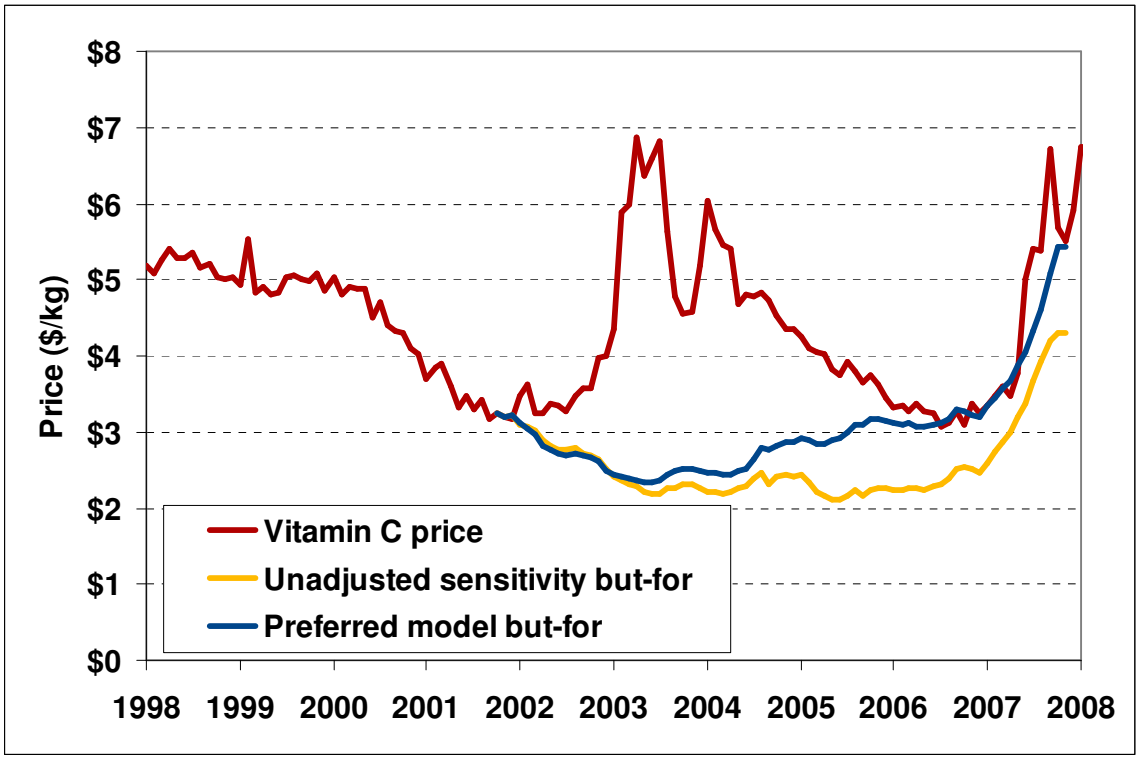


Figure 113: Weisheng production costs sensitivity for SARS adjustment

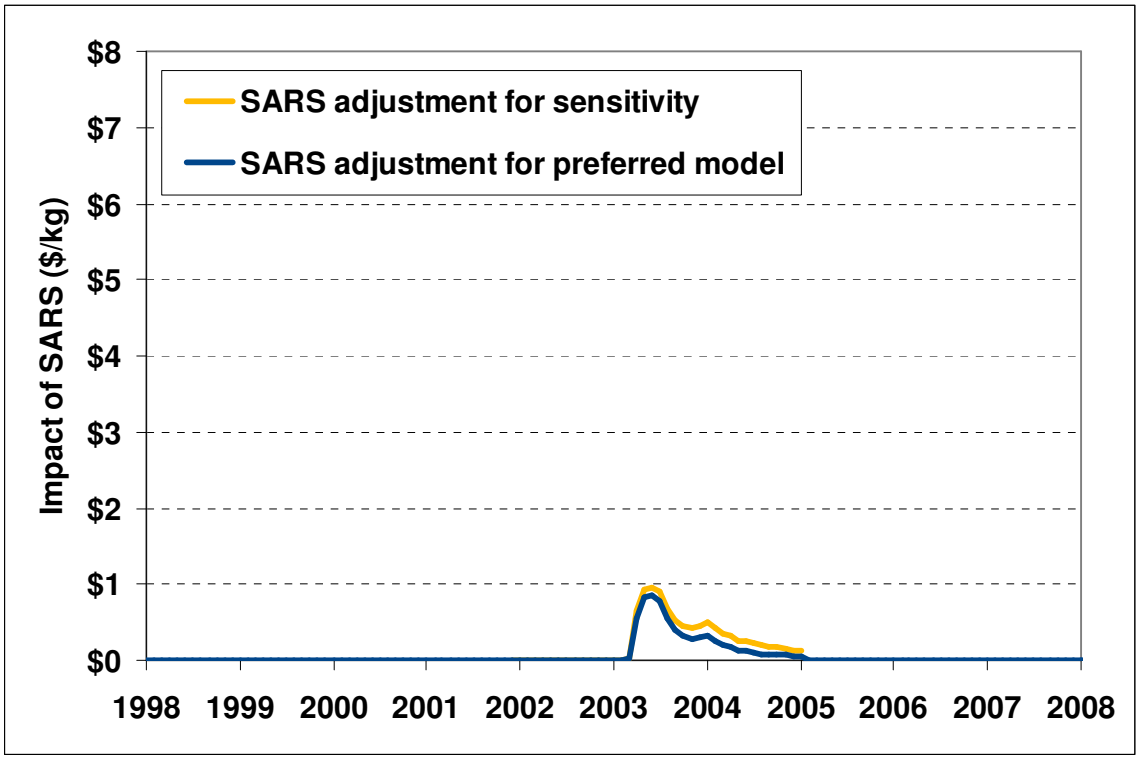


Figure 114: Weisheng production costs sensitivity for but-for prices with SARS adjustment

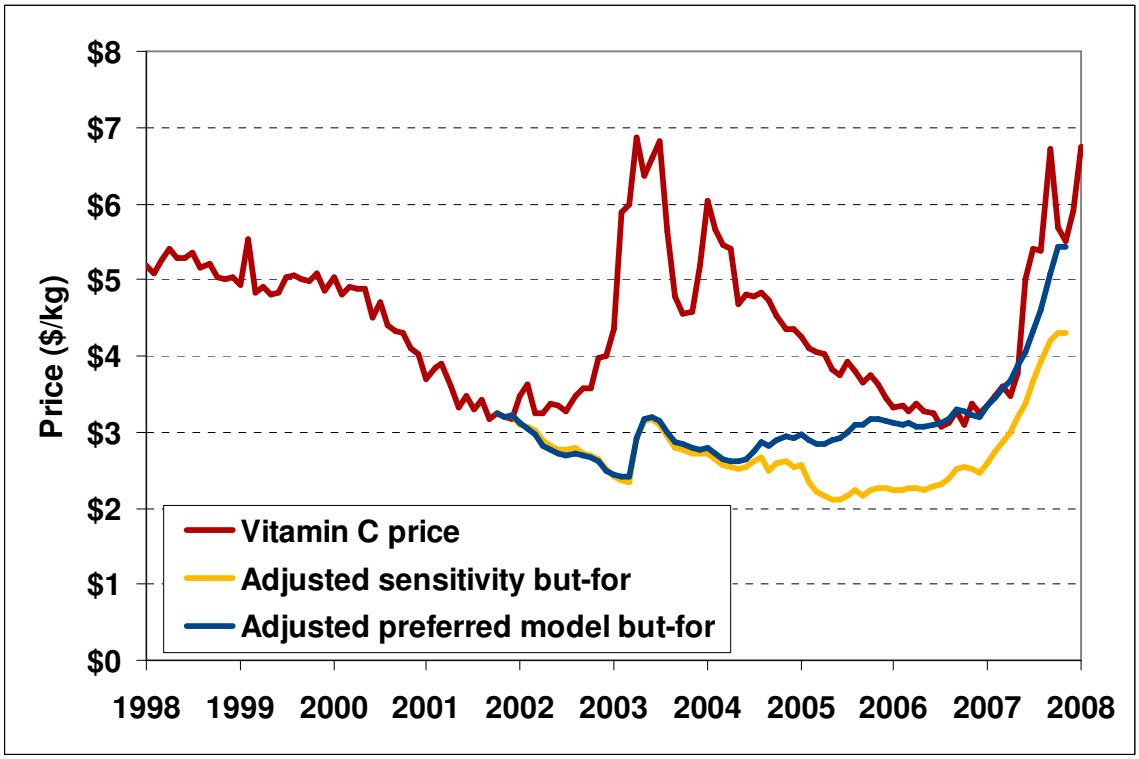


Figure 115: Number of competitors sensitivity for but-for prices without SARS adjustment

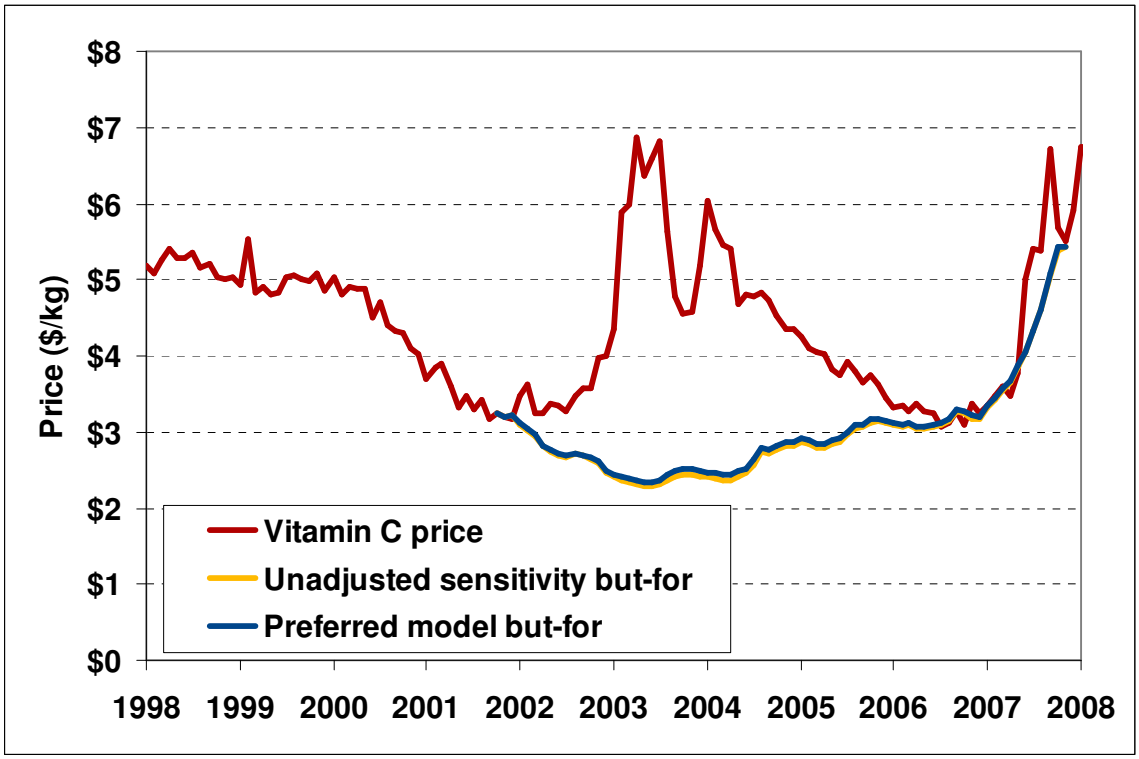


Figure 116: Number of competitors sensitivity for SARS adjustment

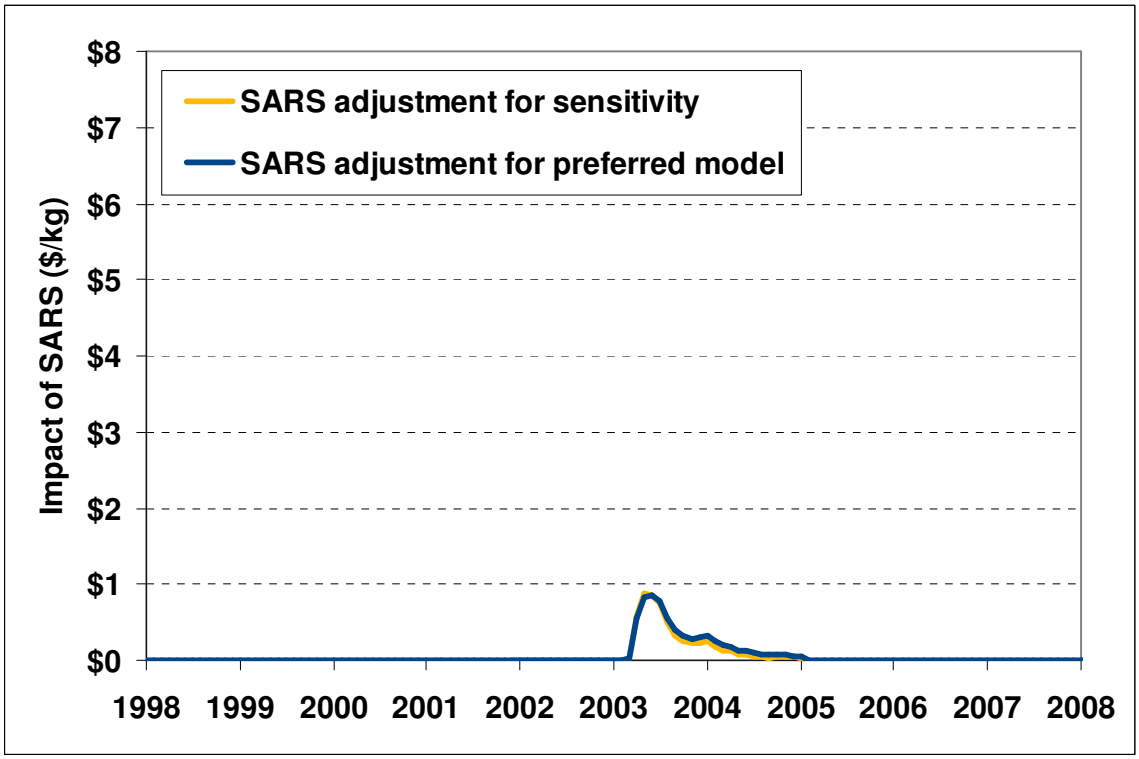


Figure 117: Number of competitors sensitivity for but-for prices with SARS adjustment

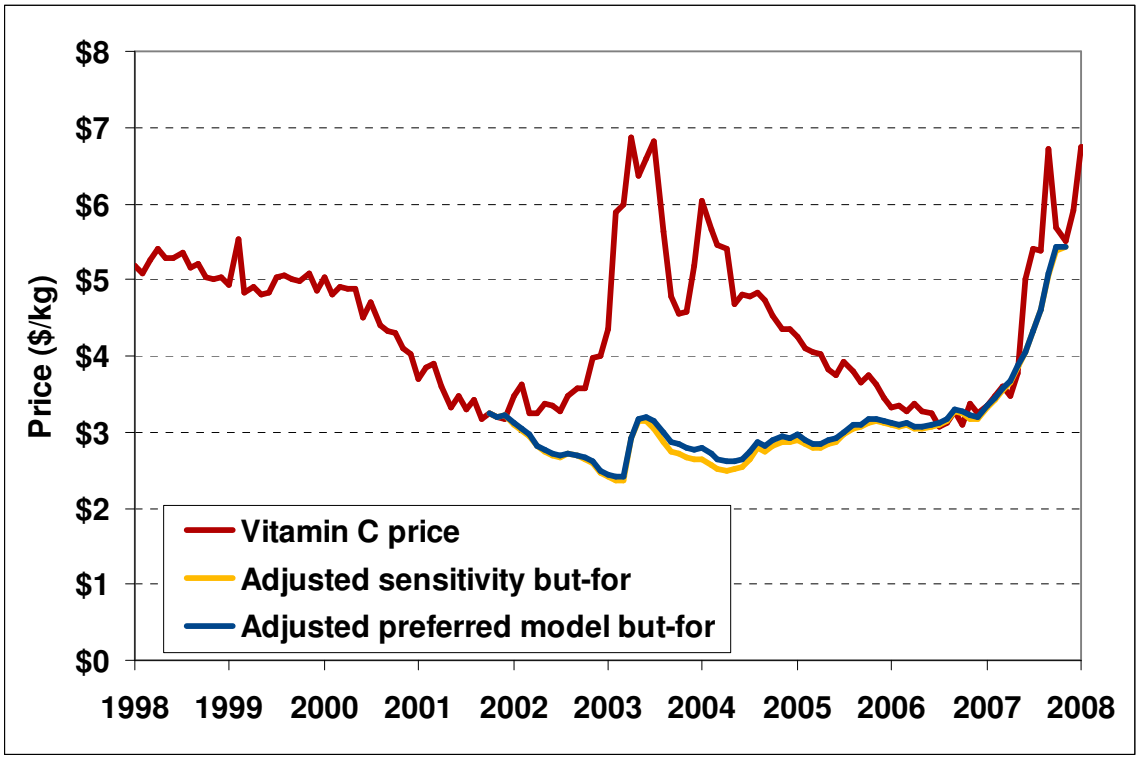


Figure 118: Withdrawn capacity sensitivity for but-for prices without SARS adjustment

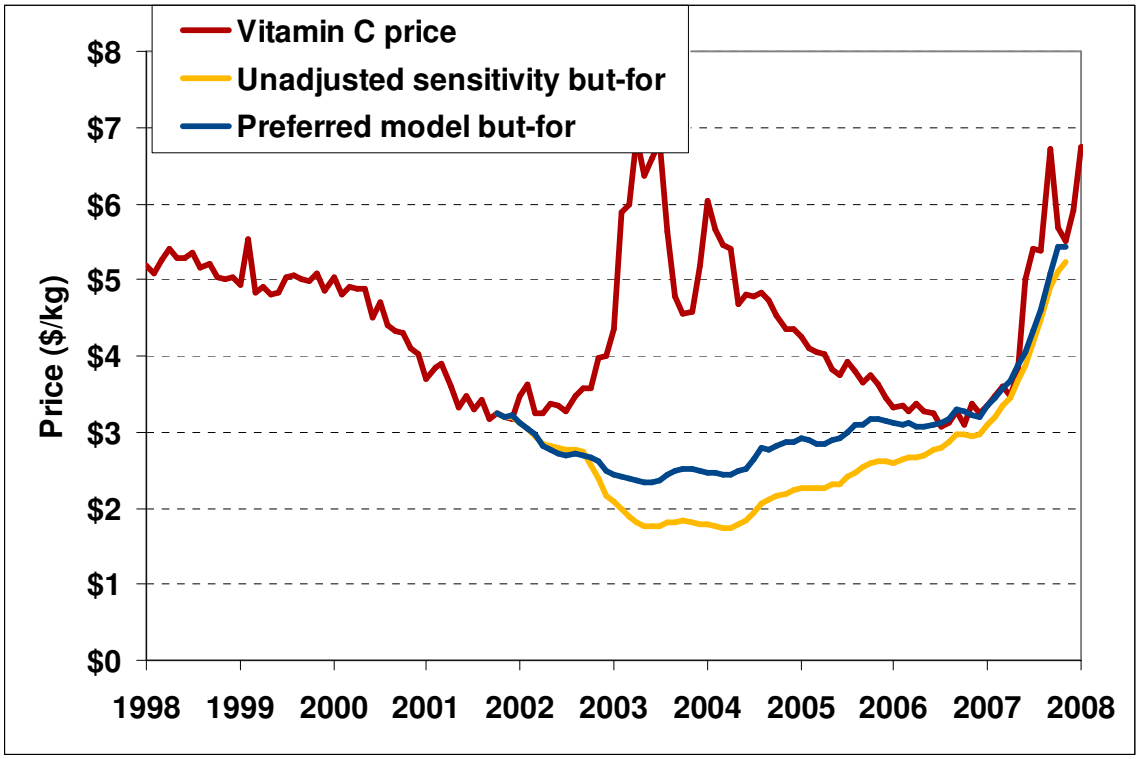


Figure 119: Withdrawn capacity sensitivity for SARS adjustment

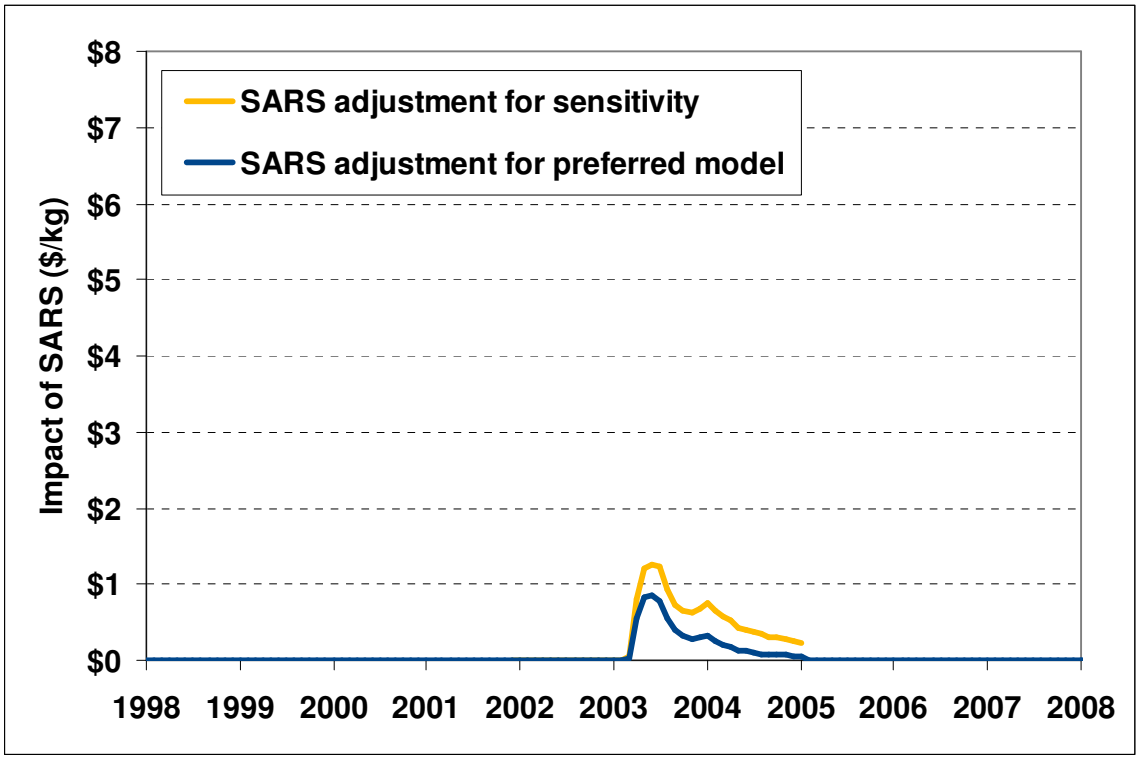


Figure 120: Withdrawn capacity sensitivity for but-for prices with SARS adjustment

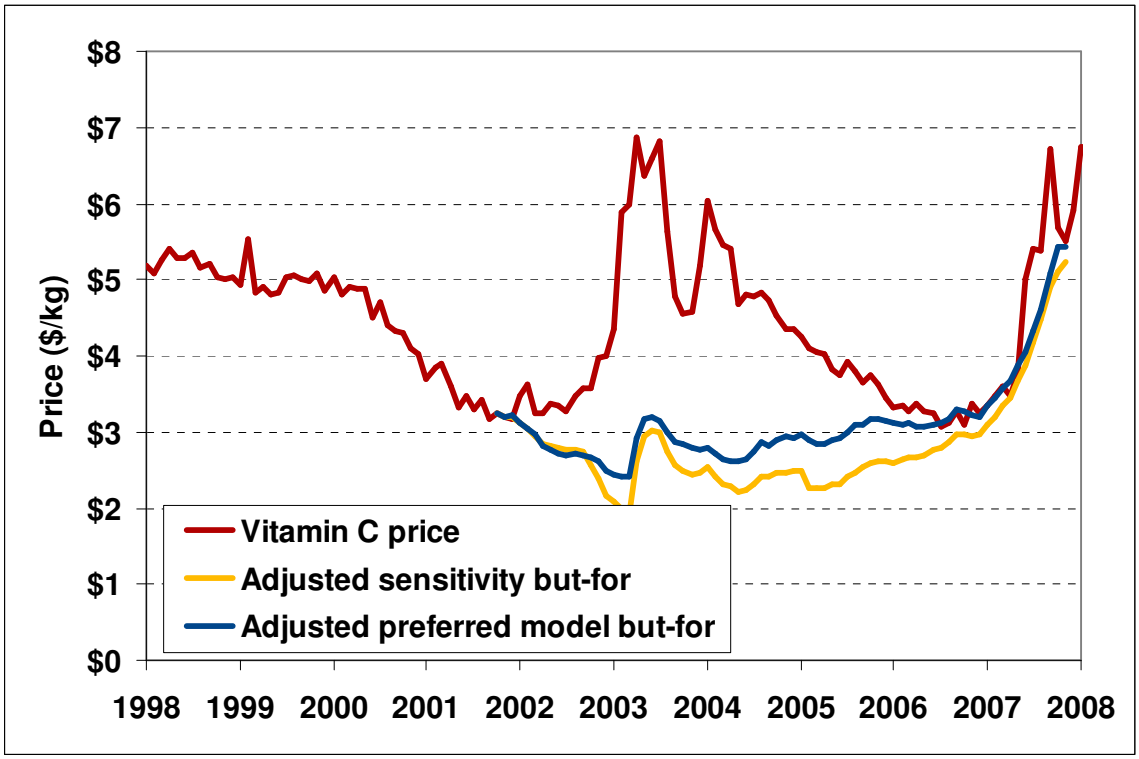


Figure 121: General indicators of demand sensitivity for but-for prices without SARS adjustment

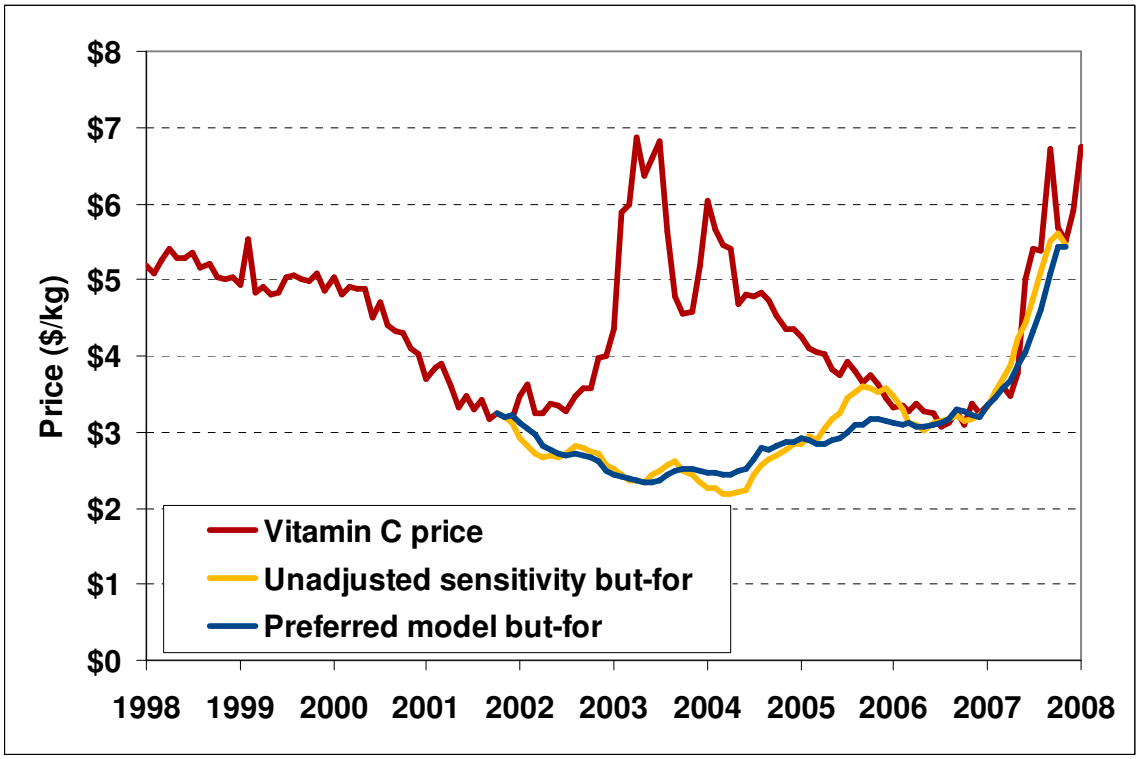


Figure 122: General indicators of demand sensitivity for SARS adjustment

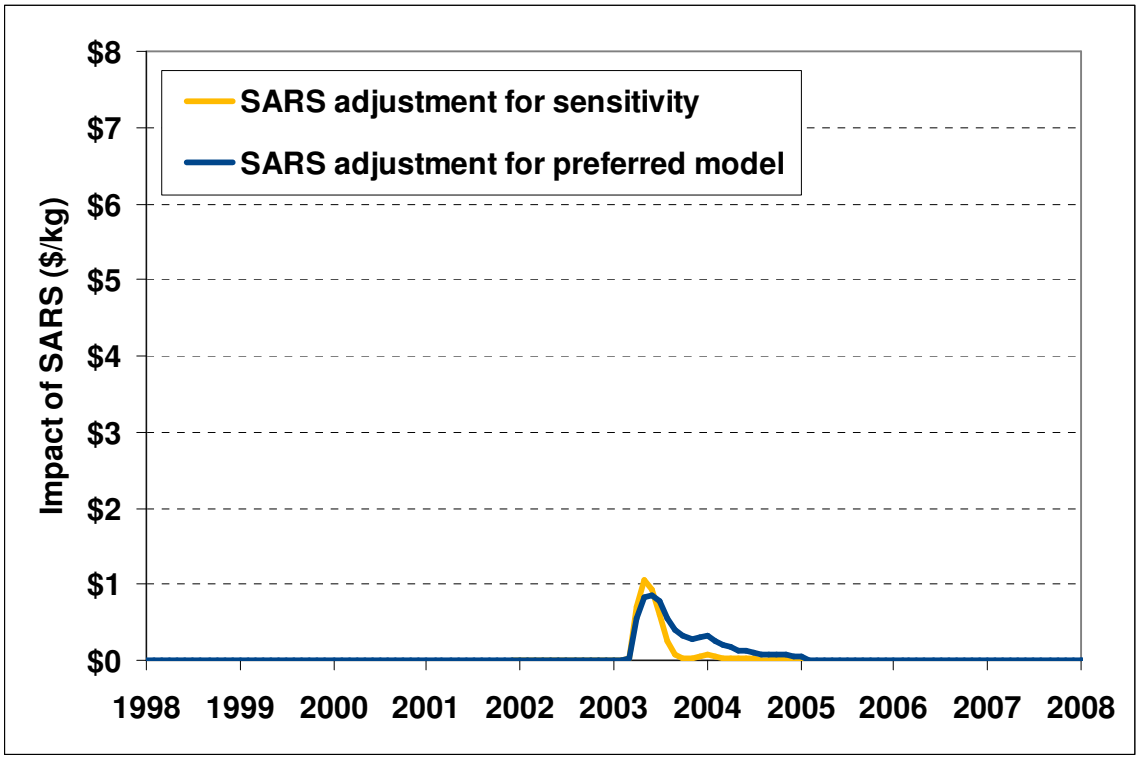


Figure 123: General indicators of demand sensitivity for but-for prices with SARS adjustment

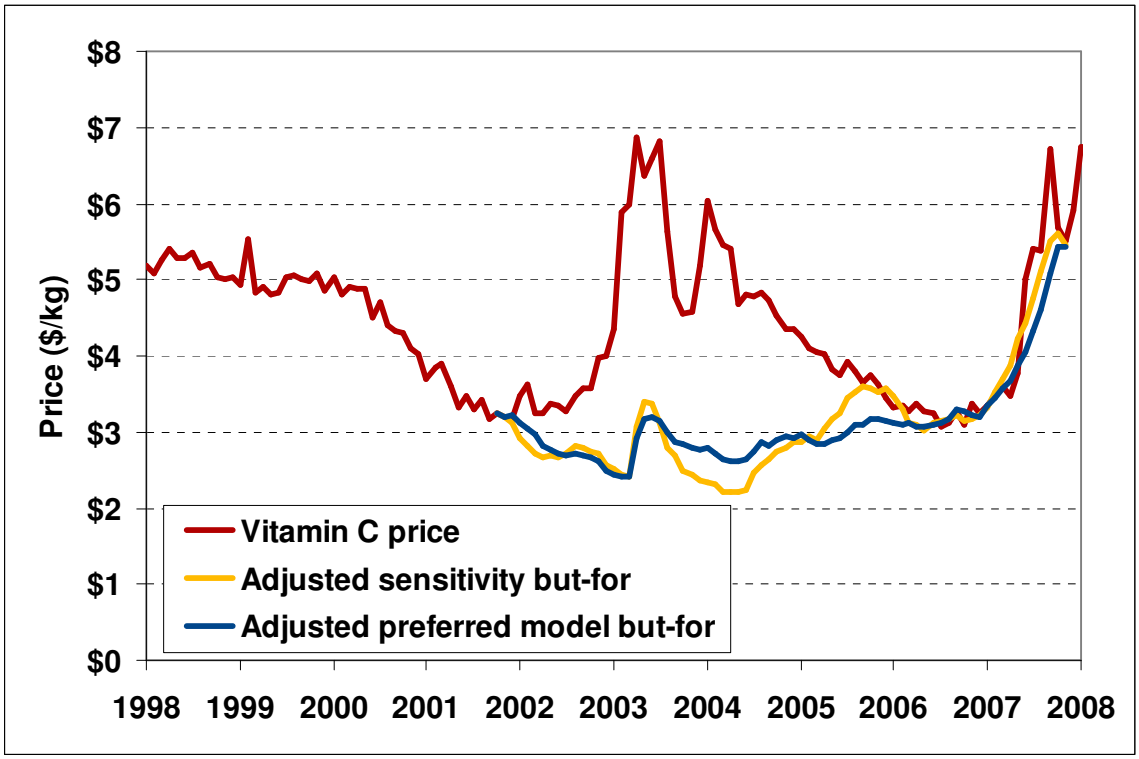


Figure 124: All supply and demand factors sensitivity for but-for prices without SARS adjustment

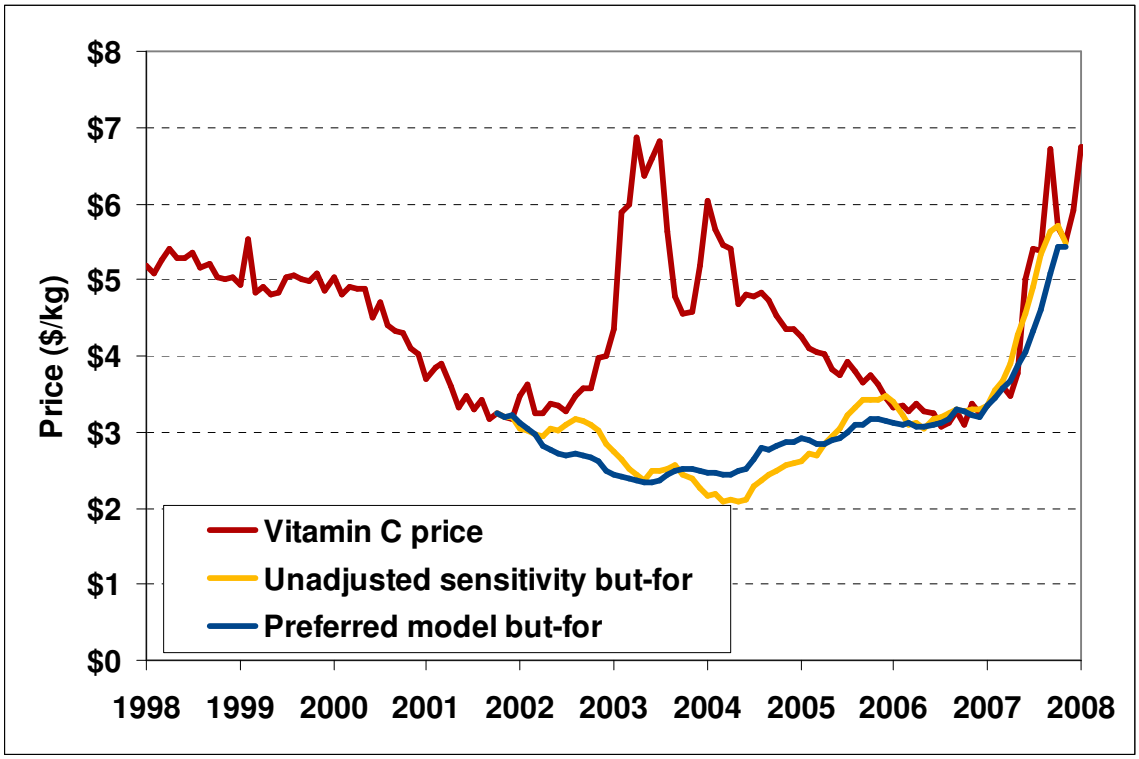


Figure 125: All supply and demand factors sensitivity for SARS adjustment

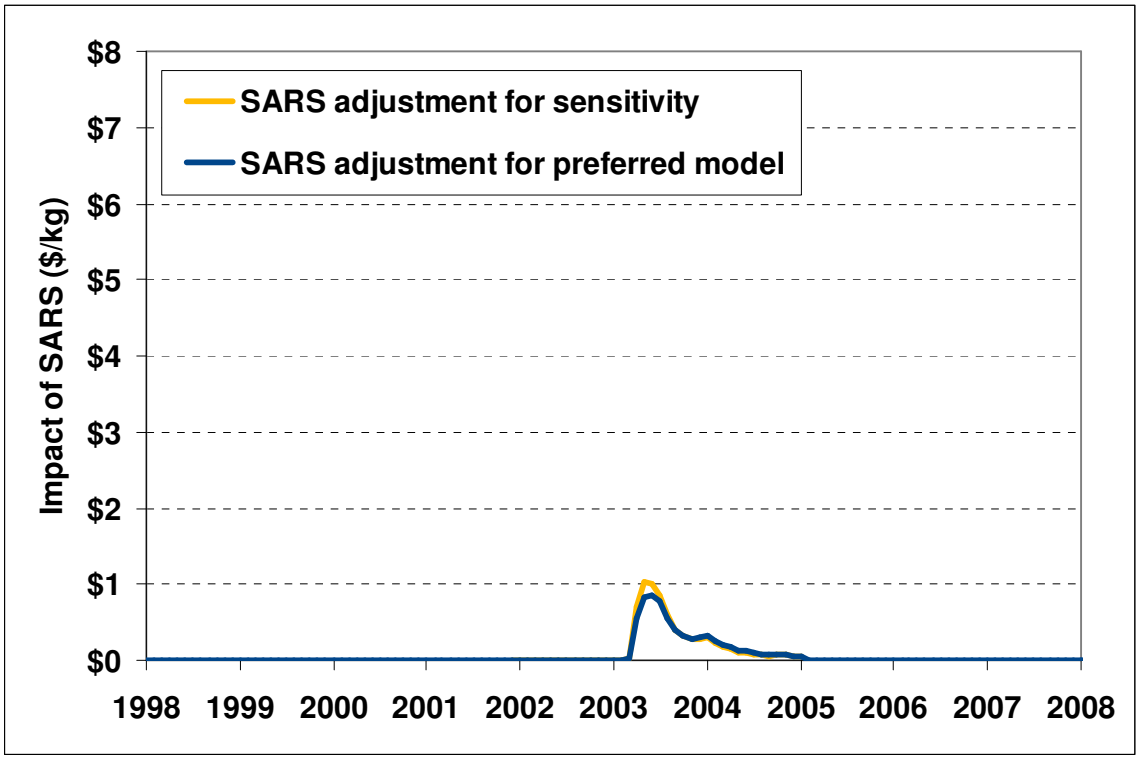
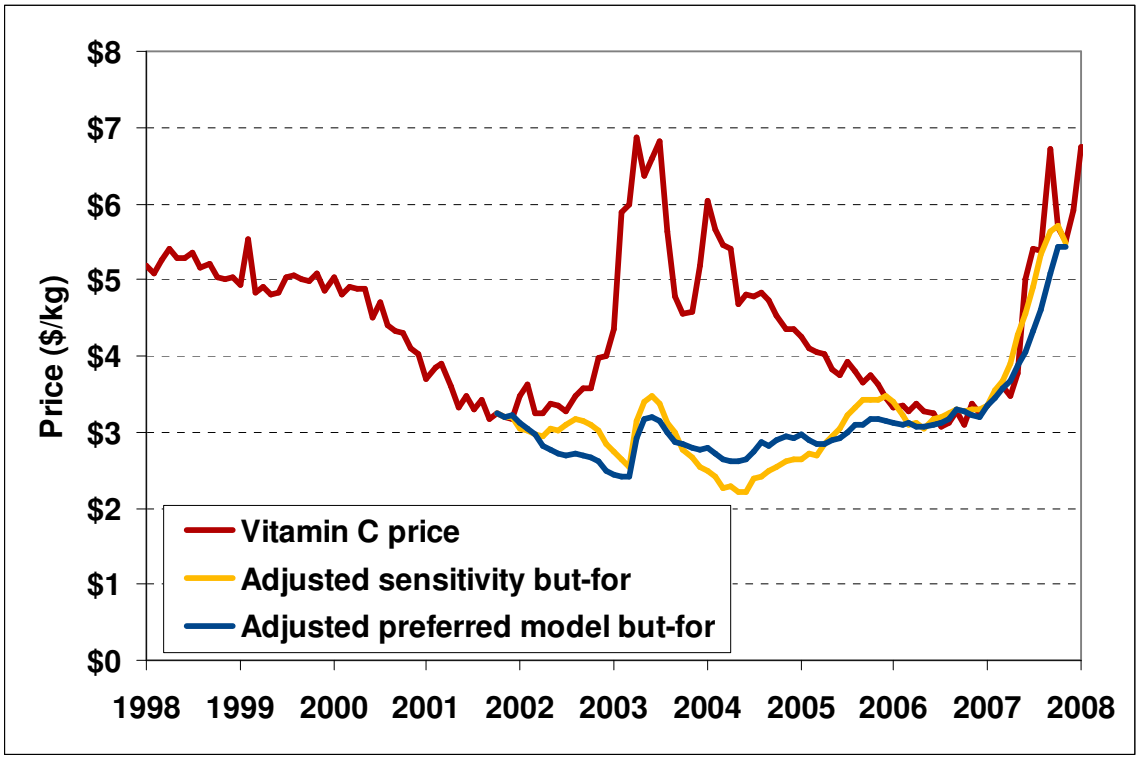


Figure 126: All supply and demand factors sensitivity for but-for prices with SARS adjustment



V.3.4. Sample period

(166) My findings are also robust with respect to the sample period used to estimate my statistical models. In this section, I present results based on four alternatives to my preferred approach. (1) I extended the estimation period (for the non-cartel model) back to January 1997 (Figure 127 through Figure 128), (2) I estimated the non-cartel model using data only from the pre-cartel period, and I estimated the cartel model using all data from the post-complaint period (Figure 129 through Figure 131). (3) I removed the first six months of post-filing data from the sample used to estimate the non-cartel model, and included it in the sample used to estimate the cartel model (Figure 132 through Figure 134). (4) I removed the first twelve months of post-filing data from the sample used to estimate the non-cartel model, and included it in the sample used to estimate the cartel model (Figure 135 through Figure 137). Once again, within each series of three figures, the first depicts the sensitivity of the basic but-for prices (without the SARS adjustment), the second depicts the sensitivity of the SARS adjustment, and the third shows the total impact of the sensitivity exercise when the same change is made to both the cartel model and the non-cartel model. Because the sensitivity to extending the estimation period (for the non-cartel model) back

to January 1997 changes only the non-cartel period estimation, the cartel estimation is unaffected. Figure 127 shows the sensitivity of the basic but-for prices (without the SARS adjustment), and Figure 128 depicts the total impact of the sensitivity exercise.

(167) With respect to the second sensitivity exercise performed in this section (estimating the non-cartel model using data only from the pre-cartel period, and estimating the cartel model using all data from the post-complaint period), it is particularly important to bear in mind the reasons given in Section IV.2.5 for discarding this approach. As I have explained, the pre-cartel data displays little more than a downward trend. As is widely recognized in the scholarly literature, in such situations, statistical regression techniques can pick up spurious correlations between the variables of interest and other trending variables. That phenomenon renders econometric estimates (as well as forecasts based on those estimates) less reliable. In the current setting, the model simply extrapolates historical trends and produces but-for prices that fall to unrealistic levels. In this situation, this downward trend leads to forecasts that appear to be below variable cost. Except in extreme situations, it is unrealistic to think that firms would charge prices below variable cost for prolonged periods.

Figure 127: Estimation from January 1997 for but-for prices without SARS adjustment

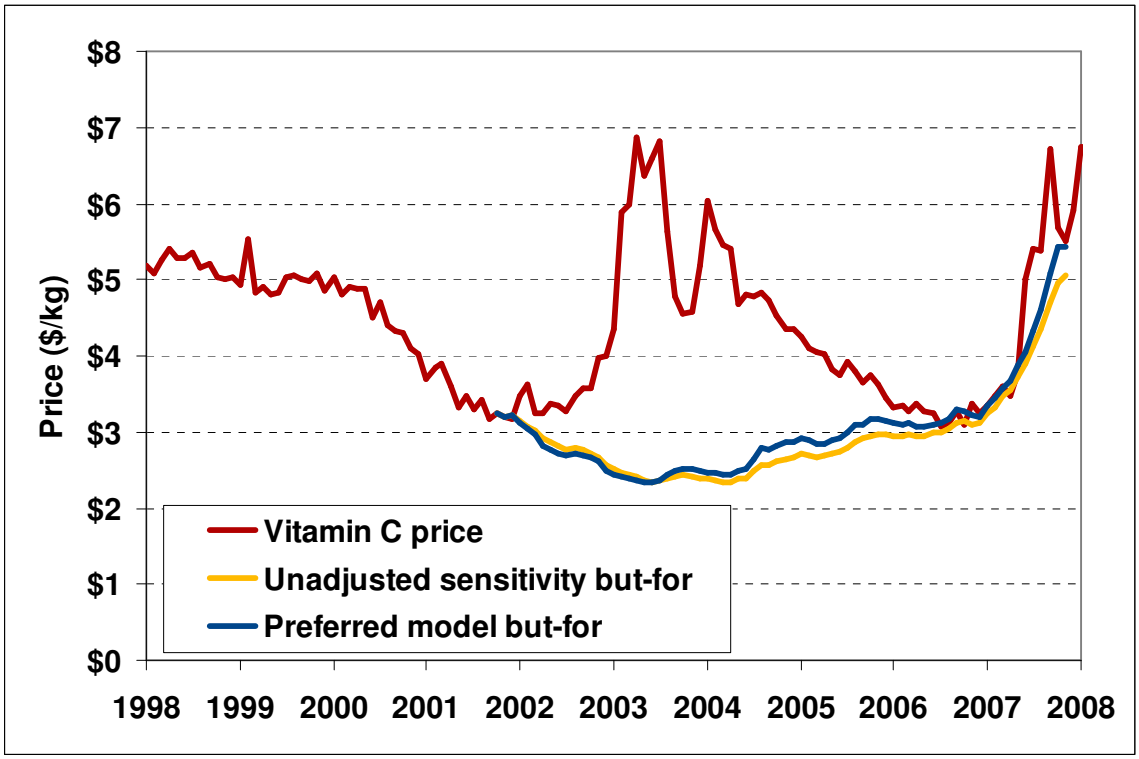


Figure 128: Estimation from January 1997 for but-for prices with SARS adjustment

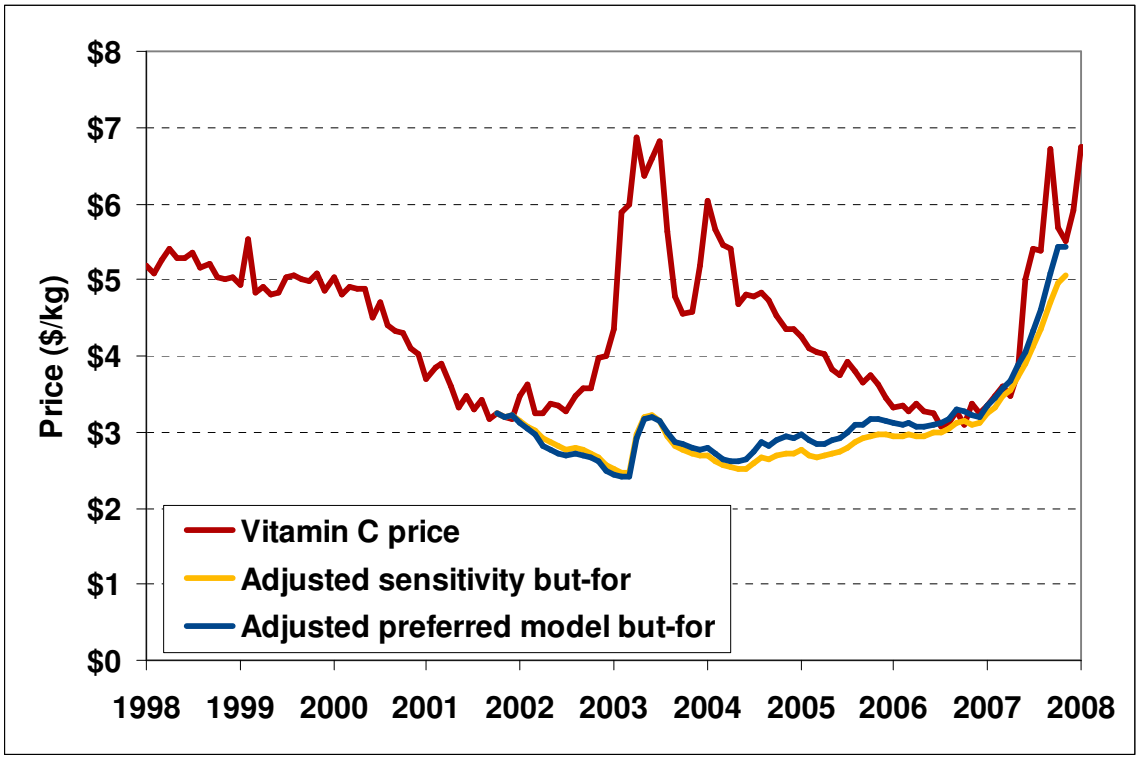


Figure 129: Estimation only pre-conduct sensitivity for but-for prices without SARS adjustment

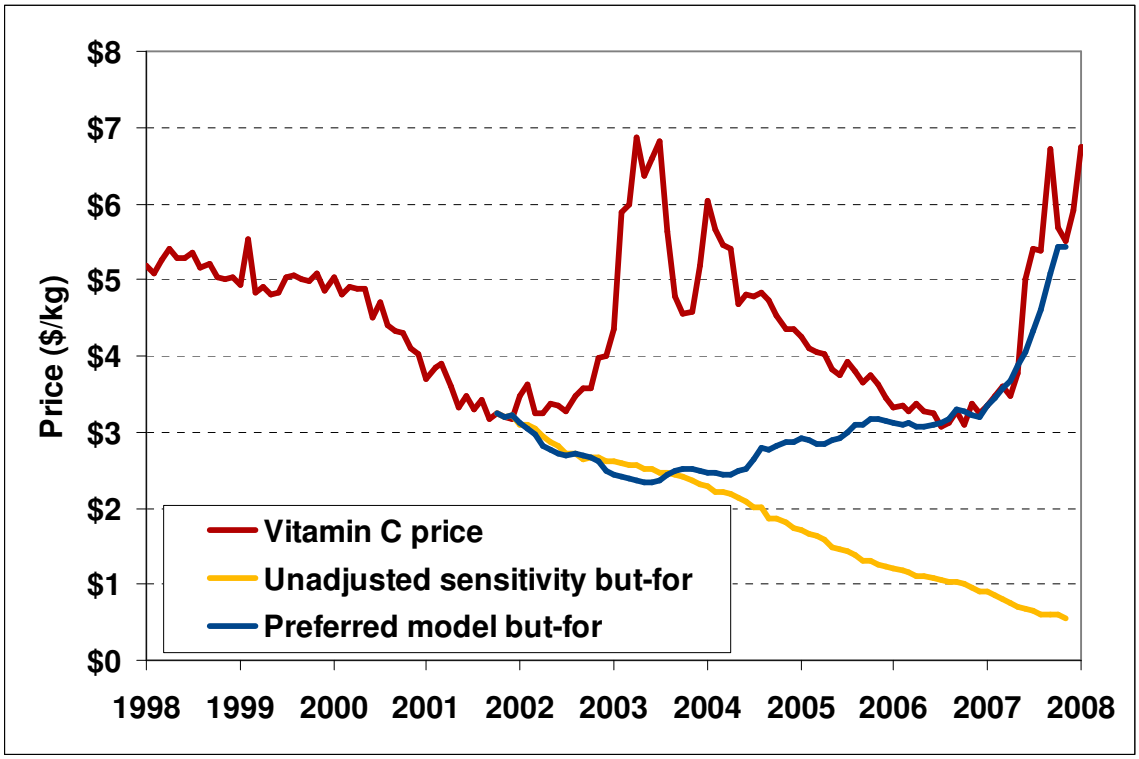


Figure 130: Estimation only pre-conduct sensitivity for SARS adjustment

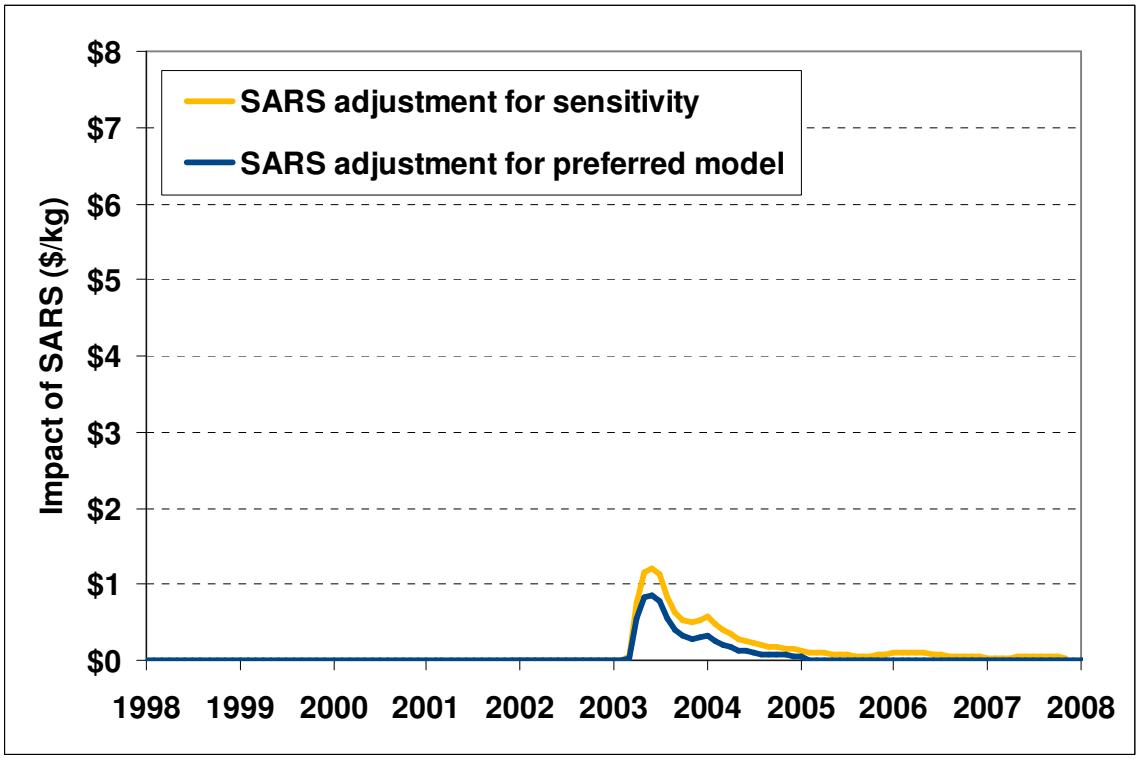


Figure 131: Estimation only pre-conduct sensitivity for but-for prices with SARS adjustment

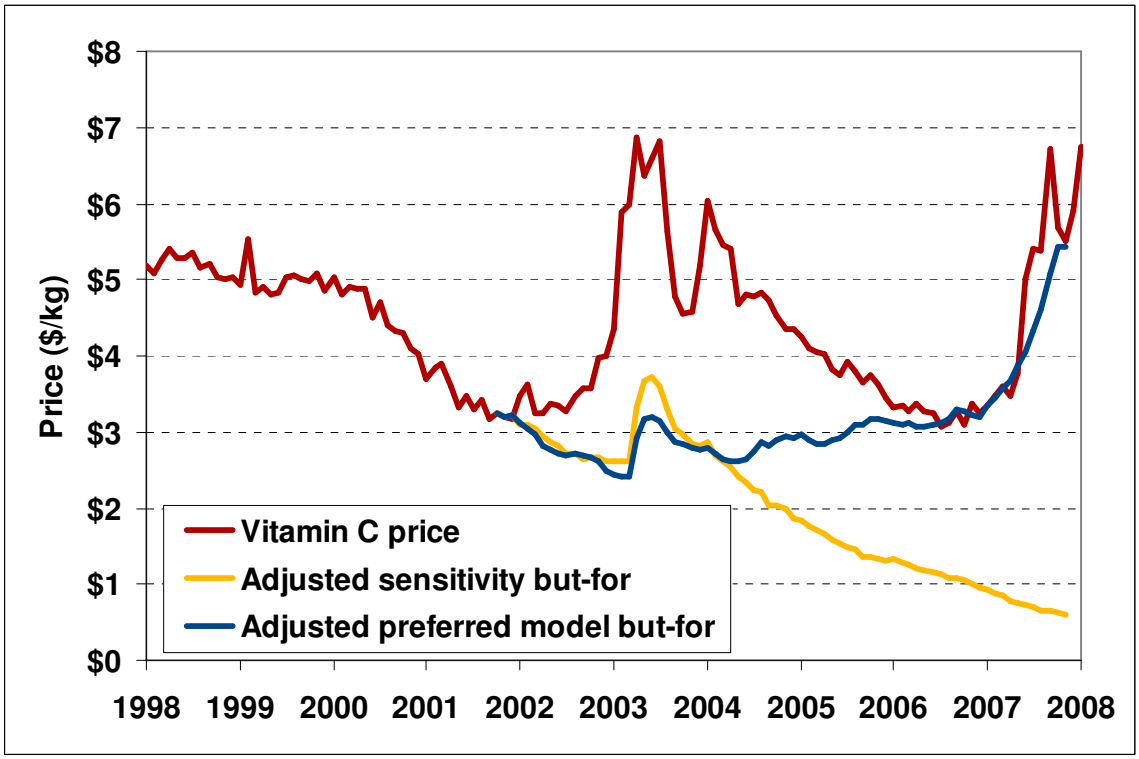


Figure 132: Estimation excluding 6 months post-cartel sensitivity for but-for prices without SARS adjustment

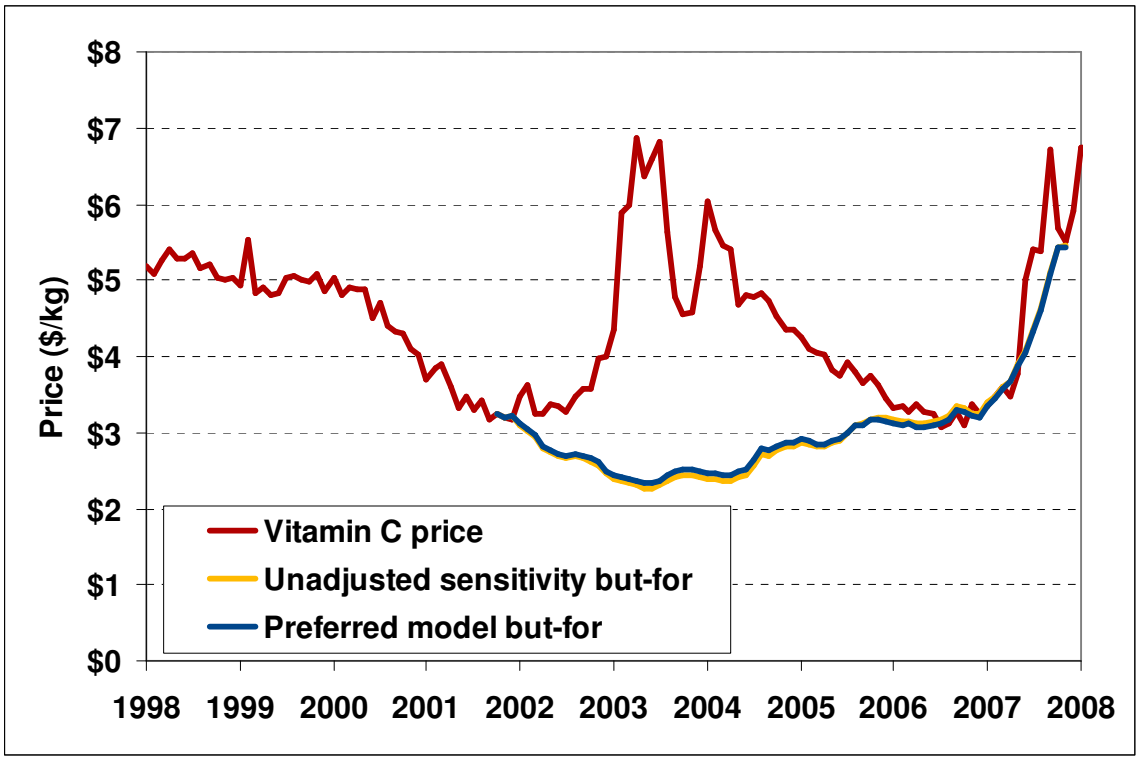


Figure 133: Estimation excluding 6 months post-cartel sensitivity for SARS adjustment

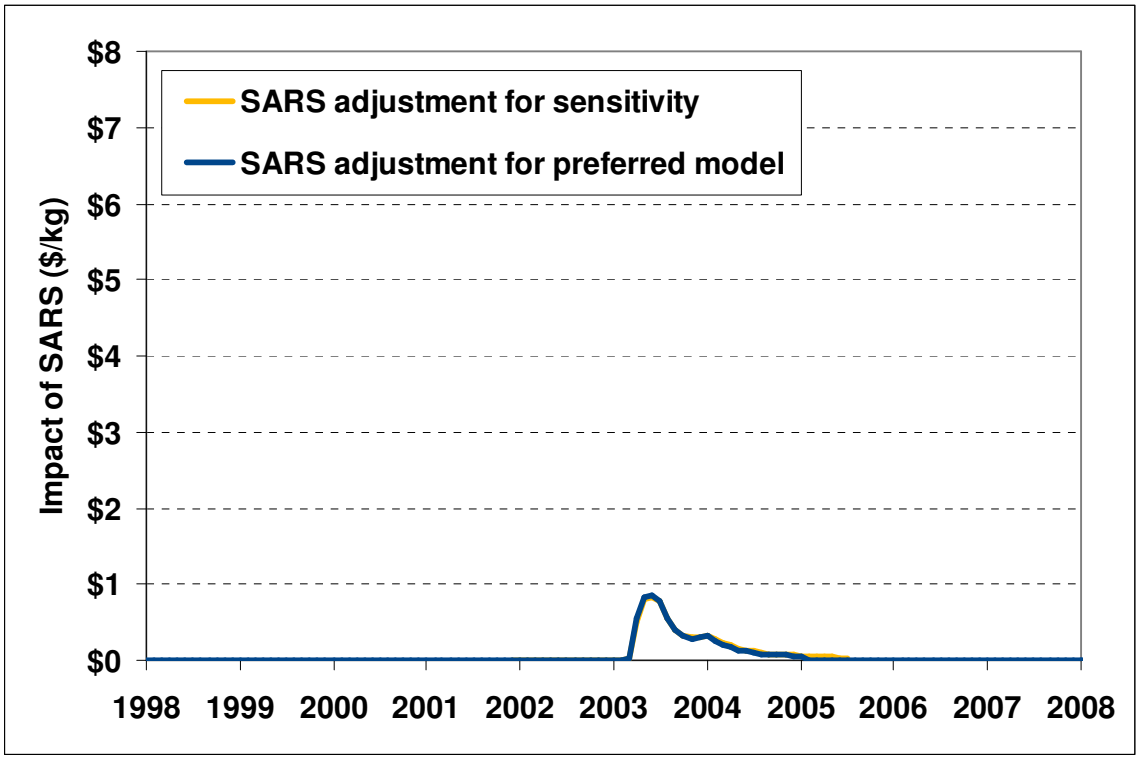


Figure 134: Estimation excluding 6 months post-cartel sensitivity for but-for prices with SARS adjustment

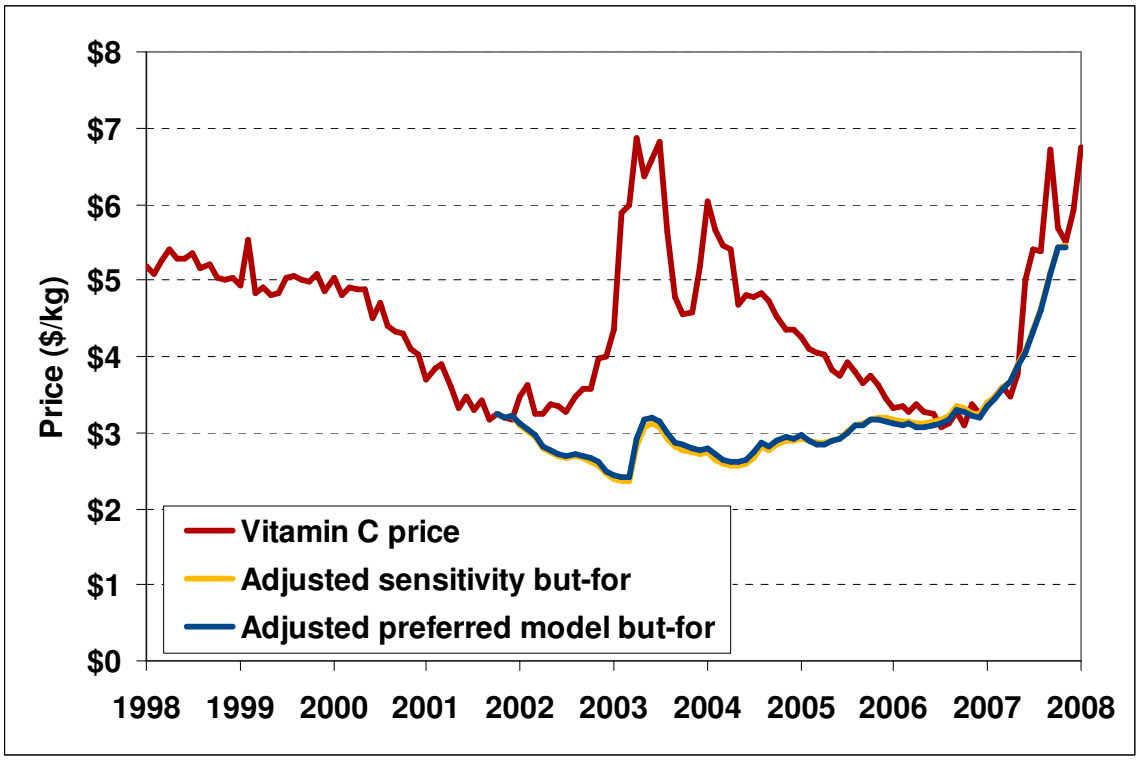


Figure 135: Estimation excluding 12 months post-cartel sensitivity for but-for prices without SARS adjustment

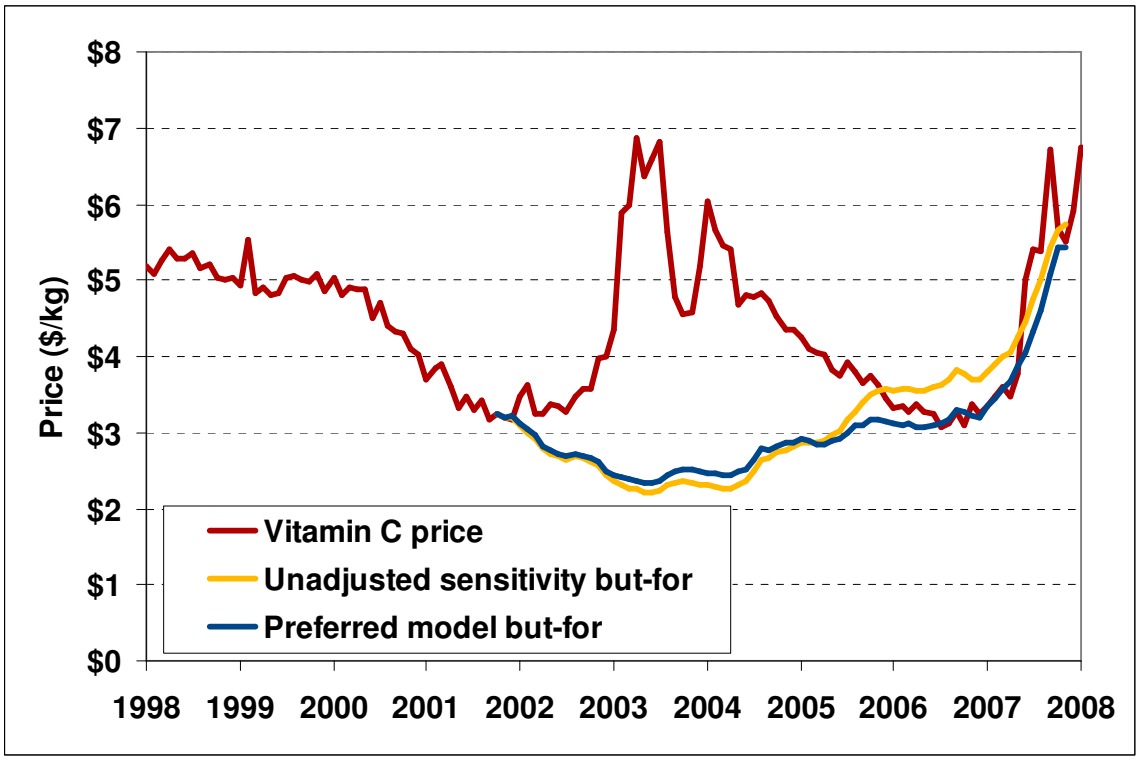


Figure 136: Estimation excluding 12 months post-cartel sensitivity for SARS adjustment

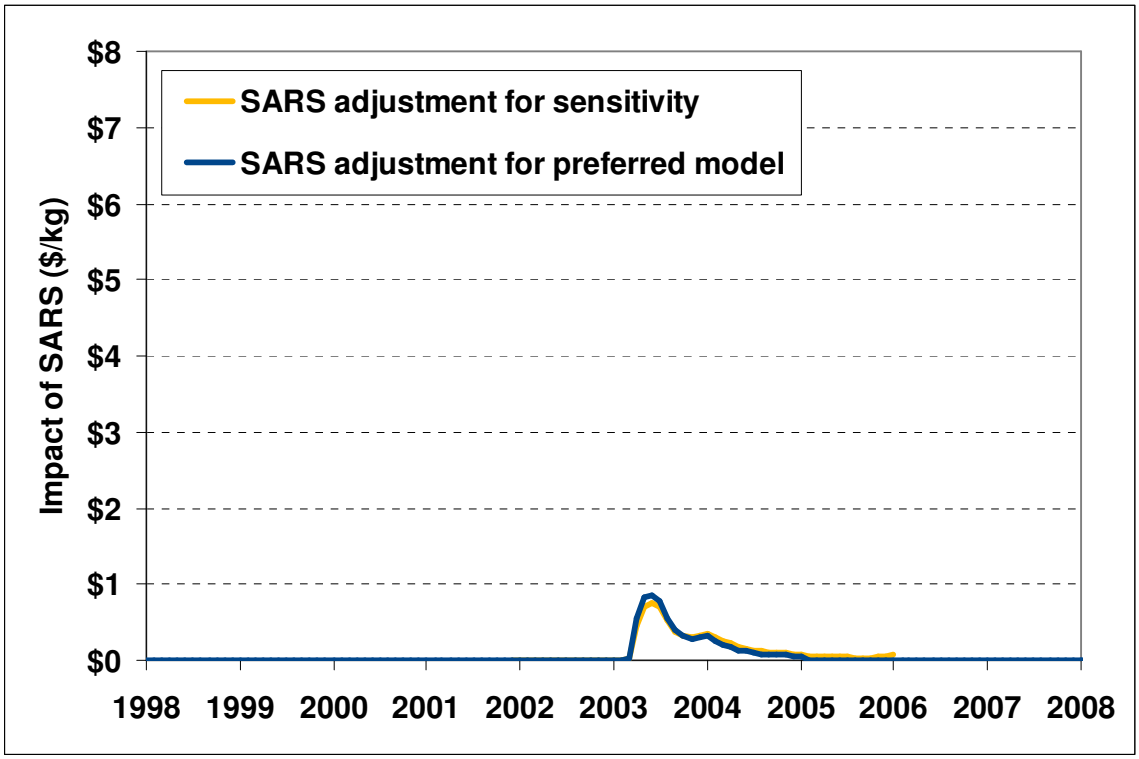
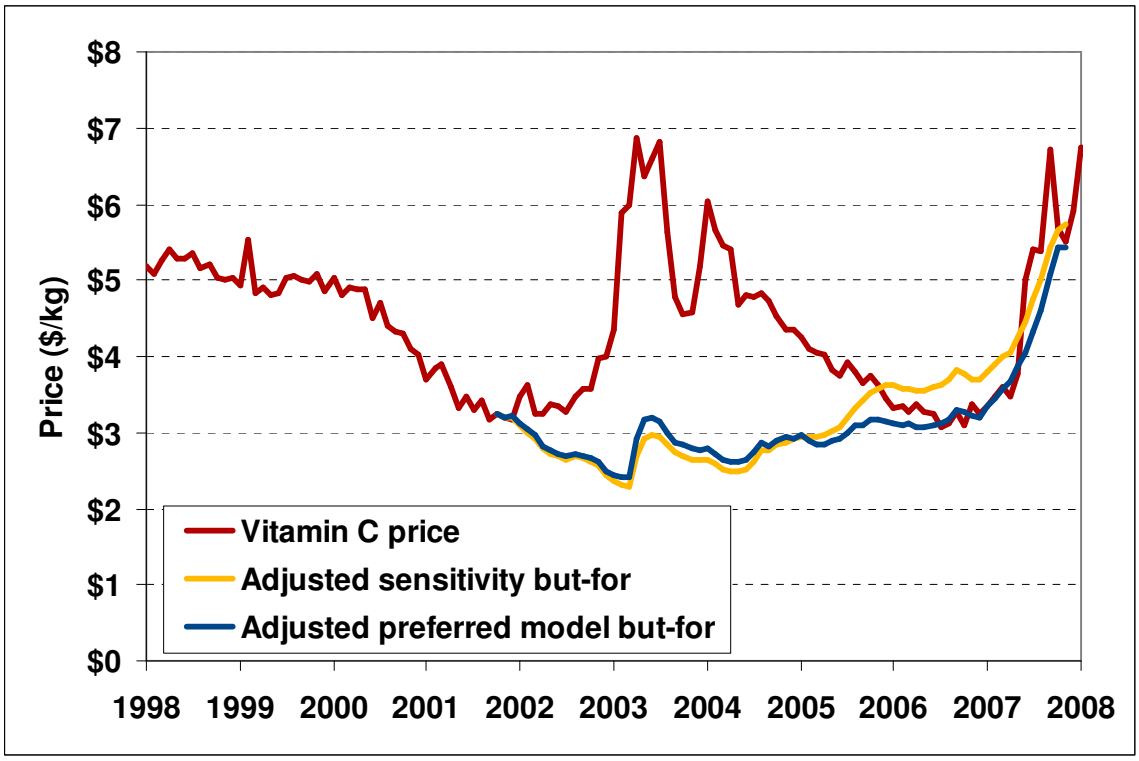


Figure 137: Estimation excluding 12 months post-cartel sensitivity for but-for prices with SARS adjustment



V.3.5. Measurement of the SARS adjustment

(168) My findings are also robust to alternate measures of the impact of SARS. Figure 138 and Figure 139 reports results from a sensitivity exercise that employs the number of reported SARS cases instead of the count of pertinent news articles, as shown in Figure 53 of Section III. Because this sensitivity changes only the cartel period estimation, the non-cartel estimation is unaffected. Figure 138 shows that this change reduces the size of the SARS adjustment, resulting in a lower but-for price line, shown in Figure 139.

Figure 138: Estimation using the number of SARS cases sensitivity for SARS adjustment

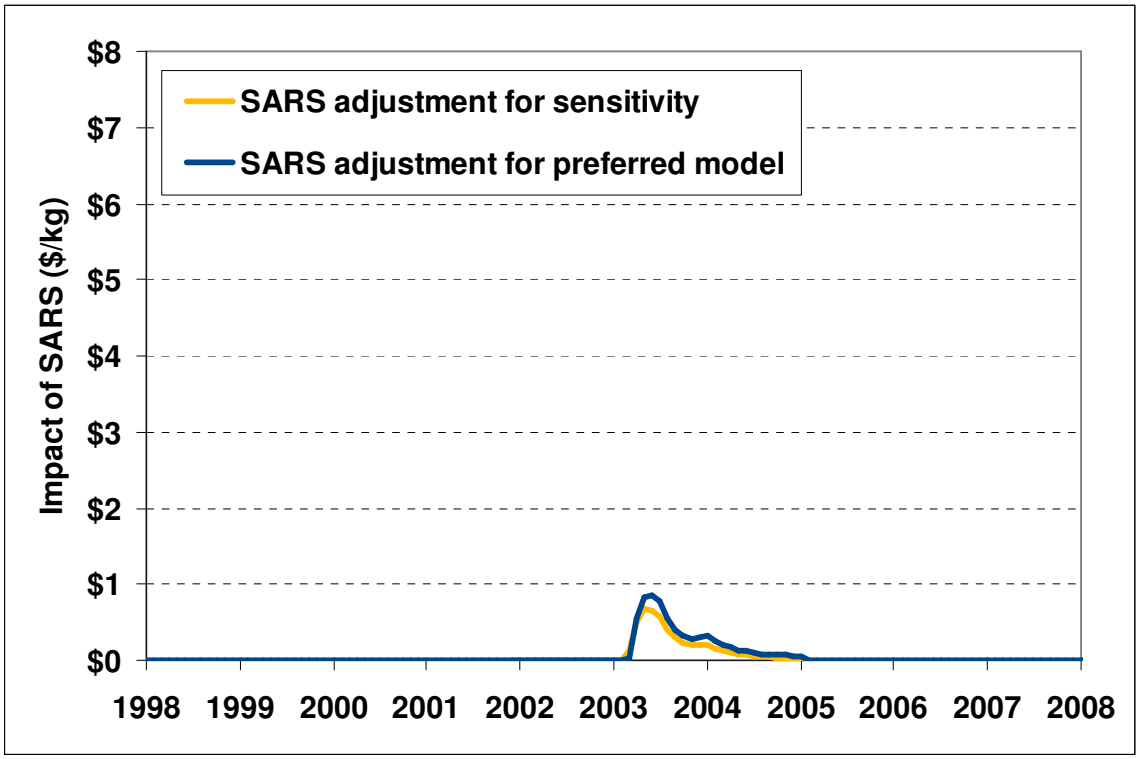
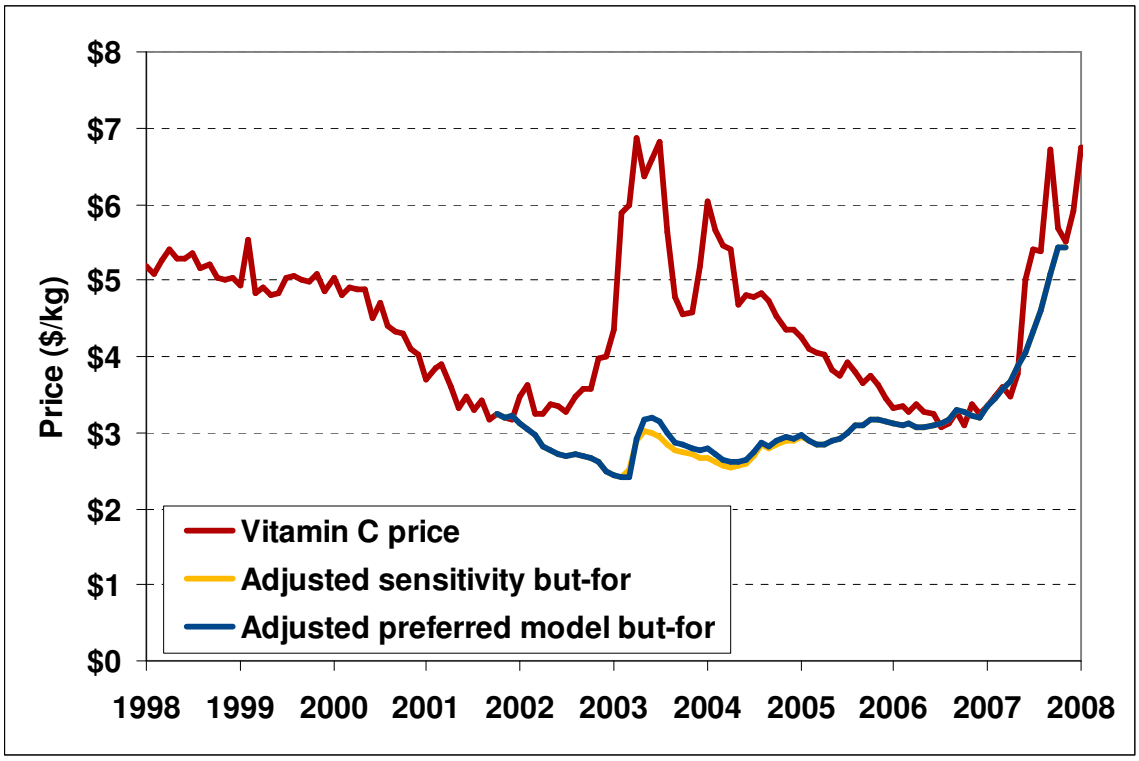


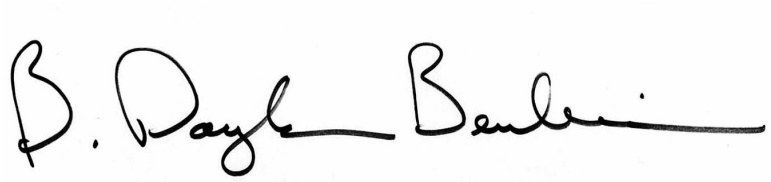
Figure 139: Estimation using the number of SARS cases sensitivity for but-for prices with SARS adjustment



VI. Conclusions

(169) My analysis of overcharges and damages employed generally accepted statistical methods to reconstruct the Vitamin C prices that would have prevailed but for the illegal activities of the cartel. Based on that analysis, I conclude that the price of Vitamin C was substantially higher as a direct consequence of defendants' conspiracy to restrain trade and control prices. The impact of the conspiracy on Vitamin C prices affected U.S. purchasers from December 2001 to June 2006. The observed elevation of prices during this time period is not attributable to non-conspiratorial factors. As a result of the conspiracy, the plaintiffs suffered damages of approximately $58.4 million. That amount excludes purchases subject to agreements with arbitration clauses.

(170) Based on methodological principles and extensive sensitivity analyses, I conclude that my damages estimate is reliable and, if anything, conservative. My estimated overcharges also are consistent with an analysis of defendant profit margins, which increased substantially during the cartel period.



November 14, 2008

B. Douglas Bernheim
Professor in Economics
Stanford University

Date

Appendix A: Curriculum vitae

Education

- Massachusetts Institute of Technology, 1979-1982, Ph.D.
- Harvard University, 1975-1979, A.B.

Academic Positions

- Stanford University, Department of Economics, 1994-present. Edward Ames Edmonds Professor of Economics (2005-present), Lewis and Virginia Eaton Professor of Economics (1994-2005).
- Princeton University, Department of Economics, 2007-2008, Professor of Economics.
- Princeton University, Department of Economics, 1990-1994. John L. Weinberg Professor of Economics and Business Policy.
- Northwestern University, J.L. Kellogg Graduate School of Management, Department of Finance, 1988-1990. Harold J. Hines Jr. Distinguished Professor of Risk Management.
- Stanford University, Department of Economics, 1987-1988. Associate Professor with tenure.
- Stanford University, Department of Economics, 1982-1987. Assistant Professor.

Honors and Awards

- John Simon Guggenheim Memorial Foundation Fellowship, 2001-02.
- Fellow, Center for Advanced Study in the Behavioral Sciences, 2001-02.
- Fellow of the American Academy of Arts and Sciences, elected 1997.
- Fellow of the Econometric Society, elected 1991.
- ACCF Center for Policy Research Fellowship, 1994.
- Alfred P. Sloan Foundation Research Fellow, 1987-1989.
- NBER-Olin Research Fellow, 1985-1986.
- Awarded Hoover National Fellowship, 1985-1986 (declined to accept NBER-Olin).

- National Science Foundation Graduate Fellowship, 1979-1982.
- John H. Williams Prize, 1979 (first ranked graduate in Economics).
- A.B. conferred Summa Cum Laude, 1979.
- Edward Whitaker Memorial Scholarship, 1978 (outstanding public speaker of college class).
- Phi Beta Kappa, 1978.
- College Freshman National Debate Champion, 1976.

Major Lectures

- The Schumpeter Lecture, Annual Congress of the European Economic Association, 2008 (upcoming).
- Plenary Speaker, Public Economic Theory (PET) Conference, 2007 ("Beyond Revealed Preference: Toward Choice-Theoretic Foundations for Behavioral Welfare Economics").
- Keynote Speaker, South West Economic Theory (SWET) Conference, 2007 ("Beyond Revealed Preference: Toward Choice-Theoretic Foundations for Behavioral Welfare Economics").
- Plenary Speaker, American Society of Health Economists Conference, 2006 ("Public Policy Towards Addictive Substances").
- The Crego Lecture, Vassar College, 2005 ("Public Policy Towards Addictive Substances: An Economist's Perspective").
- The Economic Journal Lecture, Royal Economic Society Meetings, 2004 ("Memory and Anticipation").
- The CORE Lectures, Universite Catholique de Louvain, 1999 ("Anticompetitive Exclusion and Foreclosure through Vertical Agreements").

Teaching

- Microeconomic Theory, Ph.D. level (Stanford and Princeton).
- Public Finance, Ph.D. level (Stanford, Northwestern, and Princeton).
- Industrial Organization, Ph.D. level (Princeton).

- Insurance and Risk Management, Masters level (Northwestern).
- Principles of Economics, undergraduate level (Stanford).
- Intermediate Microeconomics, undergraduate level (Stanford).
- Public Finance, undergraduate level (Stanford).
- Behavioral Economics, Ph.D. level (Stanford and Princeton).

Professional Activities

Research Affiliations

- Research Associate, National Bureau of Economic Research, 1986-present (Faculty Research Fellow from 1984 to 1986).
- Senior Fellow of the Stanford Institute for Economic Policy Research, 1998-present.
- Director, Stanford Institute for Theoretical Economics, 2001-2003.
- Co-Director, Tax and Budget Policy Program, Center for Economic Policy Research at Stanford University, 1997-2002.
- Co-Director, Center for Economic Policy Studies at Princeton University, 1993-1994.
- Visiting Scholar, Federal Reserve Bank of Philadelphia, September 1991-August 1992.

Editorial Boards

- *American Economic Review* (co-editor, 2002-2005, associate editor 2005-2006).
- *Journal of Public Economics* (associate editor, 1998-2002).
- *Journal of Financial Intermediation* (co-editor, 1989-1993).
- *Econometrica* (associate editor 1987-1990).
- *Quarterly Journal of Economics* (associate editor,1984-1990).

Organization of Conferences and Meetings

- Member, American Economic Association Program Committees: 2007 Winter Meeting, 2008 Winter Meeting.
- Co-Organizer, CDDRL-SIEPR Workshop on the Structure and Evolution of Institutions, November 4-6, 2005.
- Co-Organizer, Stanford Institute for Theoretical Economics Summer Workshops, Political Economy and Public Finance (2001), Psychology and Economics (2001, 2003, 2004, 2005, 2006).
- Organizer, CEPR/Stanford University Conference on Fundamental Tax Reform, December 1, 1995.
- Co-organizer, NBER Conference on Saving, January 6-7, 1989.
- Organizer, NBER Universities Research Conference on Social Insurance, April 28-29, 1989.
- Chairman, Program Committee for the 1989 Winter Meeting of the Econometric Society.
- Member, Econometric Society Program Committees: 1986 Winter Meeting, 1989 Summer Meeting, 1990 World Congress.

Other Professional Service

- Member, Nominating Committee, American Economic Association, 2008.
- Chair, Committee on Honors and Awards, American Economic Association, 2008-2011.
- Member, Committee on Honors and Awards, American Economic Association, 2006-2008.
- Member, Advisory Committee, Center on Advancing Decision Making in Aging, Stanford University, 2005-present.
- Member, Frisch Medal Selection Committee, Econometric Society, 2001-2002.
- Member of the Nominating Panel, American Academy of Arts and Sciences (Class III, Section 2 - Economics), 2000.
- Steering Committee, Economics Training Initiative, Social Science Research Council, 1997-2000.
- Steering Committee, Stanford Institute for Economic Policy Research, 1994-present.

- Member, Board of Directors, American Council for Capital Formation, Center for Policy Research, 1993-present.
- Member of the Panel on Social Security Privatization, National Academy of Social Insurance, and Chair of the Income Sub-Panel, 1997-1998.
- Advisory Board Member, Americans United to Save Social Security, 1997.
- Member, Board of Directors, Commission on Savings and Investment in America, 1993-1996.
- Member, Finance Committee, American Economics Association, 1989-1990.

Publications

Research Papers in Academic Journals

- "Beyond Revealed Preference: Choice-Theoretic Foundations for Behavioral Welfare Economics," *Quarterly Journal of Economics*, forthcoming (with Antonio Rangel).
- "A Solution Concept for Majority Rule in Dynamic Settings," *Review of Economic Studies*, forthcoming (with Sita Nataraj).
- "Neuroeconomics: A Sober (but Hopeful) Appraisal," *AEJ: Microeconomics*, forthcoming.
- "The Effects of Financial Education in the Workplace: Evidence from a Survey of Employers," *Economic Inquiry*, forthcoming (with Patrick Bayer and John Karl Scholz).
- "Toward Choice-Theoretic Foundations for Behavioral Welfare Economics," *American Economic Review Papers and Proceedings*, 97(2), May 2007, 464-470 (with Antonio Rangel).
- "The Power of the Last Word in Legislative Policy Making," *Econometrica*, 74(5), September 2006, 1161-90 (with Antonio Rangel and Luis Rayo).
- "From Neuroscience to Public Policy: A New Economic View of Addiction," *Swedish Economic Policy Review*, 2006 (with Antonio Rangel).
- "Saving and Life Insurance Holdings at Boston University – a Unique Case Study," *National Institute Economic Review*, 198, Oct 2006, 75-96 (with Solange Berstein, Jagadeesh Gokhale, and Laurence J. Kotlikoff).

- "Memory and Anticipation," *Economic Journal*, 115, April 2005, 271-304 (with Raphael Thomadsen).
- "How Do Residents Manage Personal Finances?" *American Journal of Surgery*, 189(2), February 2005, 134-139 (with Joel Teichman, Patricia Cecconi, Neva Kerbeshian, Manoj Monga, Debra DaRosa, and Martin Resnick).
- "Addiction and Cue-Triggered Decision Processes," *American Economic Review*, 94(5), December 2004, 1558-1590 (with Antonio Rangel).
    - Reprinted in *The Economics of Health Behaviours*, John H. Cawley and Donald S. Kenkel (eds.), Edward Elgar Publishing Ltd., forthcoming.
    - Reprinted in *The New Behavioral Economics*, Elias L. Khalil (ed.), Edward Elgar Publishing, Ltd., forthcoming.
- "Do Estate and Gift Taxes Affect the Timing of Private Transfers?" *Journal of Public Economics*, 88(12), December 2004, 2617-2634 (with Robert Lemke and John Karl Scholz).
- "Are Life Insurance Holdings Related to Financial Vulnerabilities?" *Economic Inquiry* 41(4), October 2003, 531-54 (with Katherine Carman, Jagadeesh Gokhale, and Laurence Kotlikoff).
- "Bequests as Signals: An Explanation for the Equal Division Puzzle,"*Journal of Political Economy* 111(4), August 2003, 733-764 (with Sergei Severinov).
- "The Mismatch Between Life Insurance and Financial Vulnerabilities: Evidence from the Health and Retirement Survey," *American Economic Review* 93(1), March 2003, 354-365 (with Lorenzo Forni, Jagadeesh Gokhale, and Laurence Kotlikoff).
- "The Effects of Financial Education in the Workplace: Evidence from a Survey of Households," *Journal of Public Economics* 87(7-8), August 2003, 1487-1519 (with Daniel M. Garrett).
- "Optimal Money Burning: Theory and Application to Corporate Dividend Policy," *Journal of Economics and Management Science* 10(4), Winter 2001, 463-507 (with Lee Redding).
- "What Accounts for the Variation in Retirement Saving Across U.S. Households?" *American Economic Review*, 91(4), September 2001, 832-857 (with Jonathan Skinner and Steven Weinberg).
- "How Do Urology Residents Manage Personal Finances?" *Urology*, 57(5), 2001, 866-871 (with Joel Teichman, Eric Espinosa, Patricia Parker, Joana Meyer, Margaret Pearle, Glenn Preminger, and Raymond Leveille).

- "Education and Saving: The Long-Term Effects of High School Financial Curriculum Mandates,"*Journal of Public Economics*, 80(3), June 2001, 435-465 (with Daniel M. Garrett and Dean Maki).
- "How Much Should Americans be Saving for Retirement?" *American Economic Review Papers and Proceedings*, 90(2), May 2000, 288-292.
- "Rational Strategic Choice Revisited," *Scandinavian Journal of Economics*, 100(2), 1998, 537-541.
- "Incomplete Contracts and Strategic Ambiguity," *American Economic Review*, 88(4), September 1998, 902-932 (with Michael Whinston).
- "Exclusive Dealing," *Journal of Political Economy*, 106(1), February 1998, 64-103 (with Michael Whinston).
- "Veblen Effects in a Theory of Conspicuous Consumption," *American Economic Review*, 86(3), June 1996, 349-373 (with Laurie Simon Bagwell).
- "Repeated Games with Asymptotically Finite Horizons," *Journal of Economic Theory*, 67(1), October 1995, 129-152 (with Aniruddha Dasgupta).
- "A Tax-Based Test of the Dividend Signaling Hypothesis," *American Economic Review*, 85(3), June 1995, 532-551 (with Adam Wantz).
- "A Theory of Conformity," *Journal of Political Economy* 102(5), October 1994, 841-877.
- "Private Saving and Public Policy," *Tax Policy and the Economy* 7, 1993, 73-110 (with J. Karl Scholz).
- "Tax Policy and the Dividend Puzzle," *Rand Journal of Economics* 22 (4), Winter 1991, 455-476.
- "Fiscal Policy with Impure Intergenerational Altruism," *Econometrica* 59 (6), November 1991, 1687-1712 (with Andrew Abel).
- "How Strong are Bequest Motives? Evidence Based on Estimates of the Demand for Life Insurance and Annuities," *Journal of Political Economy* 99 (5), October 1991, 899-927.
- "Multimarket Contact and Collusive Behavior," *Rand Journal of Economics* 21 (1), Spring 1990, 1-26 (with Michael Whinston).
    - Reprinted in L. Cabral (ed.), *Readings in Industrial Organization*, Oxford: Blackwell, 2000, 71-102.

- Reprinted in S. Salant and M. Levenstein (eds.), *Cartels*, forthcoming.

- "Collective Dynamic Consistency in Repeated Games," *Games and Economic Behavior* 1 (4), December 1989, 295-326 (with Debraj Ray).
- "Social Security and Saving: An Analysis of Expectations," *American Economic Review*, Papers and Proceedings 79, May 1989, 97-102 (with Lawrence Levin).
- "Incentive Effects of the Corporate Alternative Minimum Tax," *Tax Policy and the Economy* 3, 1989, 69-96.
- "A Neoclassical Perspective on Budget Deficits," *Journal of Economic Perspectives* 3, Spring 1989, 55-72.
  - Reprinted in G. Wood and L. Kaounides (eds.), *Debt and Deficits*, *Vol. 3: Debt Neutrality and the Theory of Fiscal Policy, 1970s to 1990s*, Edward Elgar Publishing Ltd.: London, 1992, 431-48.
  - Translated into Italian and reprinted in G. Eusepi (ed.), *Rassegna di lavori dell' ISCO*, ISCO: Rome, 1993.
- "Markov Perfect Equilibria in Altruistic Growth Economies with Production Uncertainty," *Journal of Economic Theory* 47, February 1989, 195-202 (with Debraj Ray).
- "Intergenerational Altruism, Dynastic Equilibria and Social Welfare," *Review of Economic Studies* 56, January 1989, 119-128.
- "Comparable Worth in a General Equilibrium Model of the U.S. Economy," *Research in Labor Economics* 9, 1988, 1-52 (with Perry Beider, Victor Fuchs, and John Shoven).
- "Altruism within the Family Reconsidered: Do Nice Guys Finish Last?" *American Economic Review* 78, December 1988, 1034-1045 (with Oded Stark).
  - Reprinted in Steven Zamagni (ed.), *The Economics of Altruism*, Edward Elgar Publishing Ltd: London, 1993.
- "Budget Deficits and the Balance of Trade," *Tax Policy and the Economy* 2, 1988, 1-32.
- "Is Everything Neutral?" *Journal of Political Economy* 96 (2), 1988, 308-338 (with Kyle Bagwell).
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- "Ricardian Equivalence: An Evaluation of Theory and Evidence," *NBER Macro Annual* 2, 1987, 263-304.
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- "The Economic Effects of Social Security: Towards a Reconciliation of Theory and Measurement," *Journal of Public Economics* 33 (3), August 1987, 273-304.
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- "Coalition Proof Nash Equilibria I: Concepts," *Journal of Economic Theory* 42 (1), June 1987, 1-12 (with Bezalel Peleg and Michael Whinston).
- "Coalition Proof Nash Equilibria II: Applications," *Journal of Economic Theory* 42 (1), June 1987, 13-29 (with Michael Whinston).
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- "On the Voluntary and Involuntary Provision of Public Goods," *American Economic Review* 76 (4), September 1986, 789-793.
- "Common Agency," *Econometrica* 54 (4), July 1986, 923-942 (with Michael Whinston).
- "Menu Auctions, Resource Allocation, and Economic Influence," *Quarterly Journal of Economics* 101 (1), February 1986, 1-31 (with Michael Whinston).
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- "Self Control, Saving, and the Low Asset Trap," mimeo, Stanford University, May 1999 (with Debraj Ray and Sevin Yeltekin).

Work in Progress

- "Behavioral Welfare Economics"
- "Are Preferences Identified?" (with Debraj Ray)
- "Identifying Choice Correspondences with Neural Evidence" (with Antonio Rangel and Colin Camerer)
- "Revealed Preference without Choice" (with Antonio Rangel and Colin Camerer)
- "Cheating within Imperfect Cartels"
- "Saving and Cue-Triggered Decision Processes" (with Antonio Rangel).
- "Memory and Re-experienced Utility" (with Peter Coles).
- "Power and Predictability in Legislative Bargaining"
- "The Effects of Marital Status Transitions on Living Standards" (with Laurence Kotlikoff, Katherine Carman, and Neva Kerbeshian).
- "Multidirectional Signaling" (with Sergei Severinov).
- "Reinforcement Learning and Intertemporal Choice" (with Antonio Rangel).

Research Grants

- "A Framework for Behavioral Welfare Analysis," National Science Foundation, recommended for funding, December 2007.
- "Theoretical Investigations of Some Empirical Puzzles Regarding Behavior in Relationships with Asymmetric Information," National Science Foundation, April 2005 through March 2008 (with Avinash Dixit).
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- "The Adequacy of Saving and Life Insurance - A Unique Case Study," National Institute on Aging, June 1999 through June 2002.
- "The Adequacy of Saving and Insurance of Americans Approaching Retirement," National Institute on Aging, June 1997 through June 2000.
- "Economic Literacy, Education, and Financial Behavior," National Science Foundation, July 1995 through July 1997 (co-sponsorship with Smith Richardson Foundation).
- "Economic Literacy, Education, and Personal Saving," Smith Richardson Foundation, June 1995 through June 1997 (co-sponsorship with National Science Foundation).
- "Behavioral Determinants of Household Financial Decisions," National Science Foundation, August 1994 through December 1995.
- "Informational Imperfections and Economic Behavior," National Science Foundation, July 1991 through December 1993 (with Michael Whinston).
- "Dividends and Corporate Financial Policy," National Science Foundation, July 1989 through December 1991 (with Laurie Bagwell).
- "The Risk Adjusted Cost of Capital: An International and Intertemporal Comparison," Center for Economic Policy Research at Stanford University, June 1988 through June 1989.
- "The Importance and Accuracy of Expectations," part of the NBER's project on the Economics of Aging, National Institute on Aging, December 1986 through December 1988.
- "Understanding Intergenerational Transfers," National Science Foundation, August 1986 through July 1988.
- "Comparable Worth," Center for Economic Policy Research at Stanford University, January 1986 through December 1986.

- "The Roles of Risk and Insurance in Alternative Models of Personal Wealth Accumulation," Center for Economic Policy Research at Stanford University, January 1985 through January 1986.
- "Planning Games," National Science Foundation, July 1984 through December 1986 (with Debraj Ray).
- "Pension Annuities and Private Wealth Reconsidered," Center for Economic Policy Research at Stanford University, June 1983 through June 1984.

Ph.D. Dissertation Committees – Completed

- Abe, Yukiko
- Ali, Nageeb
- Anand, Bharat
- Antman, Francisca
- Bayer, Patrick
- Besharov, Gregory
- Borzekowski, Ronald
- Bubna, Amit
- Buiter, Perry
- Cai, Hongbin
- Callega Alderete, Jaime
- Carman, Katherine
- Console Battilana, Silvia
- Corts, Kenneth
- Dasgupta, Aniruddha
- Dinc, Serdar
- Eisenberg, Daniel
- Facchini, Giovannni
- Fluck, Zsuzsanna
- Gale, William
- Garrett, Daniel
- Graddy, Kathryn
- Hege, Ulrich
- Henry, Emeric
- Ho, Benjamin
- Hodrick, Laurie
- Kanazawa, Mark
- Kartik, Navin
- Levenson, Alec
- Levin, Laurence
- Lindsey, Laura
- Mathai, Koshy
- Medina, Luis
- Miller, Amalia
- Nataraj, Sita
- Navarro, Neva
- Neher, Darwin
- Nichols, Donald
- O'Neill, Chanel
- O'Reilly, Terrence
- Ozler, Sule
- Pasha, Hafiz
- Rayo, Luis
- Redding, Lee
- Rork, Jonathan
- Scholz, John Karl
- Sen, Arijit
- Severinov, Sergei
- Sialm, Clemens
- Smart, Michael

- Stotsky, Janet
- Tao, Zhigang
- Thomadsen, Raphael
- Van der Taak, Steven
- Van Wesep, Edward
- Weinberg, Steven
- Williams, Michael
- Williams, Roberton
- Wolff, Raymond
- Yasuda, Ayako
- Zhang, Lei
- Zheng, Wentong
- Zhou, Li-An
- Zucker, John

Ph.D. Dissertation Committees – Current

- Arias, Luz Marina
- Augenblick, Edward
- Chong, Yeewai
- Fan, Xiaochen
- Li, Xinping
- McGuire, James
- Meer, Jonathan
- Meredith, Marc
- Miller, Darwin
- Nicholson, Scott
- Perez, Eduardo
- Todd, Annika
- Tzang, Philip

Appendix B: Summary of recent testifying experience

- In re: Vitamins Antitrust Litigation, U.S. District Court for the District of Columbia, deposition taken August 5–8, 2002, trial testimony on June 2, 2003.
- *Enron Creditors Recovery Corp., et al. v. Citigroup Inc., et al.*, United States Bankruptcy Court Southern District of New York. Deposition testimony November 28-29, 2007.
- *Amgen, Inc. v. F. Hoffman-La Roche Ltd., et al.*, U.S. District Court for the District of Massachusetts. Deposition testimony May 30, 2007, hearing testimony November 15, 2007 and December 5, 2007.

Appendix C: Materials considered

Litigation documents

Complaint

- Complaint for Antitrust Violations, U.S. District Court for the Eastern District of New York, Case No 1:05-CV-00453(DGT)(JO), January 26, 2005.
- Second Amended Complaint for Antitrust Violations, U.S. District Court for the Eastern District of New York, Case No 1:05-CV-00453(DGT)(JO), September 27, 2007.

Interrogatories

- Defendant China Pharmaceutical Group Ltd.'s Objections and Responses to Plaintiffs' First Set of Interrogatories, U.S. District Court for the Eastern District of New York, Animal Science Products, Inc., et al., v. Hebei Welcome Pharmaceutical Co., Ltd., et al., Case No 1:05-CV-00453(DGT)(JO), September 8, 2006.
- Defendant China Pharmaceutical Group Ltd.'s Objections to Plaintiffs' Third Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), September 8, 2006.
- Defendant China Pharmaceutical Group Ltd.'s Objections to Plaintiffs' Fourth Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), July 21, 2008.
- Defendant Hebei Welcome's First Amended Response to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), February 11, 2008.
- Defendant Hebei Welcome Pharmaceutical Co., Ltd.'s Objections and Responses to Plaintiffs' First Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), September 11, 2006.
- Defendant Hebei Welcome's Response to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), October 18, 2007.

- Defendant Hebei Welcome's Response to Plaintiffs' Third Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), July 14, 2008.
- Defendant Hebei Welcome's Response to Plaintiffs' Fourth Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), July 21, 2008.
- Defendant Jiangsu Jiangshan Pharmaceutical Co., Ltd.'s First Amended Responses and Objections to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), January 25, 2007.
- Defendant Jiangsu Jiangshan Pharmaceutical Co., Ltd.'s Second Amended Responses and Objections to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), March 26, 2008.
- Responses and Objections of Defendant Jiangsu Jiangshan Pharmaceutical Co., Ltd. to Plaintiffs' First Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), September 8, 2006.
- Defendant Jiangsu Jiangshan Pharmaceutical Co., Ltd. Objections and Responses to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), October 18, 2007.
- Defendant Jiangsu Jiangshan Pharmaceutical Co., Ltd. Objections and Responses to Plaintiffs' Third Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), July 14, 2008.
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- Defendant Northeast Pharmaceutical Group Co., Ltd.'s First Amended Response to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), January 22, 2008.

- Defendant Northeast Pharmaceutical Group Co., Ltd.'s Second Amended Response to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), February 8, 2008.
- Defendant Northeast Pharmaceutical Group Co., Ltd.'s Third Amended Response to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), March 28, 2008.
- Defendant Northeast Pharmaceutical Group Co., Ltd.'s Objections and Responses to Plaintiffs' First Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), September 8, 2006.
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- Defendant Shijiazhuang Pharma. Weisheng Pharmaceutical (Shiajiazhuang) Co., Ltd.'s Response to Plaintiffs' Second Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), October 18, 2007.
- Defendant Shijiazhuang Pharma. Weisheng Pharmaceutical (Shiajiazhuang) Co., Ltd.'s Response to Plaintiffs' Third Set of Interrogatories, U.S. District Court for the Eastern District of New York, In Re Vitamin C Antitrust Litigation, Master File 1:06-MD-1738(DGT)(JO), July 14, 2008.
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- Declaration of Jianfeng ("Jeffery") Fang in Support of Defendants' Supplemental Memorandum in Opposition to Plaintiffs' Motion for Class Certification," 10 January 2008.
- Expert Report of Phil Innes, C.P.A., November 7, 2008.
- Letter to Tanya S Chutkan, Esq., from Christopher Chinn, dated 5 May 2008, received 15 May 2008.

Data produced in litigation

- Chinese customs data: NEPG 28327, NEPG 26590. JJPC 35359, JJPC 35432, JJPC 32450.
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- World Bank, Health, Nutrition, and Population, Data & Statistics, http://go.worldbank.org/9EQZCKCE00.
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Depositions and deposition exhibits

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