

PUBLIC

UNITED STATES OF AMERICA
BEFORE THE FEDERAL TRADE COMMISSION
OFFICE OF ADMINISTRATIVE LAW JUDGES



In the Matter of

Tronox Limited
a corporation,

National Industrialization Company
(TASNEE)
a corporation,

National Titanium Dioxide Company
Limited (Cristal)
a corporation,

and

Cristal USA Inc.
a corporation.

PUBLIC

Docket No. 9377

COMPLAINT COUNSEL'S POST-TRIAL REPLY BRIEF

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INTRODUCTION

Complaint Counsel has put forth extensive and consistent real world evidence in support of its case. Complaint Counsel has provided the testimony of the three largest customers of TiO₂ in North America—Sherwin-Williams, PPG, and Masco—along with testimony from other customers. Complaint Counsel has provided the trial testimony of Kronos, a competing TiO₂ supplier. Complaint Counsel has cited extensively to Respondents' own contemporaneous documents and public statements to investors. Each of these sources of real world evidence paints a consistent picture: that North American customers demand chloride TiO₂ and will not switch to sulfate; that TiO₂ pricing differs regionally; that customers cannot defeat those regional price differences through arbitrage; and that the merger is likely to lead to higher prices and less output. The previous court decisions highlighting the history of anticompetitive conduct in the TiO₂ industry only heighten the concerns raised by the merger.¹ The extensive real world evidence presented by Complaint Counsel plainly demonstrates that the proposed merger is likely to substantially reduce competition and should be blocked.

Respondents, by contrast, offer only the self-serving testimony of their own executives and paid expert witnesses. Respondents have not offered a single declaration by a customer or industry participant in support of the Merger or the claimed efficiencies. Respondents did not call any customers, competitors, or other third parties to testify at the administrative trial. Moreover, the testimony offered by Respondents' executives and experts is inconsistent with Respondents' own documents, inconsistent with Tronox's public statements to its investors, inconsistent with the previous court decisions analyzing the industry, and inconsistent with the view of other industry participants that provided declarations and testified at trial.

¹ *Valspar Corp. v. E. I. Du Pont De Nemours & Co.*, 873 F.3d 185 (3d Cir. 2017); *In re Titanium Dioxide Antitrust Litig.*, 959 F. Supp. 2d 799 (D. Md. 2013).

Throughout this matter, Respondents have repeatedly invited Complaint Counsel to seek a preliminary injunction, despite not being able to close the proposed transaction, so that Tronox can have its day in court. Tronox, of course, had a full and fair opportunity to present its case before this Court in the completed administrative trial. But once Tronox finally obtained regulatory clearance from the European Commission, removing the last hurdle to Tronox's ability to close the transaction, Complaint Counsel did indeed seek a preliminary injunction. On the same evidentiary record before this Court, and with the benefit of a three-day hearing and live witness testimony, the District Court held that the Commission established a presumption of anticompetitive effects:

The Commission has shown a likelihood that Tronox's acquisition of Cristal's titanium dioxide business will substantially impair market competition. It has demonstrated that the relevant market should be defined as the chloride-process TiO₂ sold in North America. The FTC's evidence credibly suggests that the merger will greatly increase concentration in an already concentrated market, and that it will create incentives for the remaining industry participants to engage in strategic withholding of TiO₂ supplies to maintain higher prices.

FTC v. Tronox Ltd., Case No. 1:18-cv-01622 (TNM), slip op. at 9 (D.D.C. Sept. 12, 2018) (attached hereto as Ex. A). The District Court thoughtfully rejected Respondents' arguments with respect to product market (*Tronox*, slip op. at 9-17), geographic market (*Tronox*, slip op. at 17-24), the likelihood of competitive effects (*Tronox*, slip op. at 26-35), expansion by Chinese suppliers (*Tronox*, slip op. at 36-40), and efficiencies (*Tronox*, slip op. at 40-43). With respect to Respondents' rebuttal arguments on entry and efficiencies, the District Court concluded that "neither argument, alone or in tandem, can overcome the Commission's strong presumption of anticompetitive effects." *Tronox*, slip op. at 35. For the reasons explained below, this Court should similarly reject Respondents' various arguments and defenses as unsupported by the law and the extensive evidence presented in this case.

ARGUMENT

I. RESPONDENT'S "BACKGROUND" SECTION IS MISLEADING

In their "Background" section, Respondents purport to describe characteristics of the TiO₂ industry and details relating to the merger. But that section is replete with misleading, incomplete, and irrelevant statements supported by little more than the self-serving testimony of their employees and experts that is belied by the weight of the evidence. Some of the most egregious examples are addressed below.

First, citing only to a Tronox executive, Respondents argue that the finishing process affects the quality of a TiO₂ grade "more than the manufacturing process (chloride or sulfate)." Resps.' Post-Trial Br. at 6. As explained *infra* in Section III.B., this self-serving testimony should be given little weight. It is contrary to Tronox's own prior statements about the differences between chloride and sulfate TiO₂, it is contrary to the trial testimony of Kronos, who actually makes both chloride and sulfate TiO₂, and most importantly, it is contrary to the testimony of customers who actually use TiO₂ in their products. Respondents also claim that the finishing processes are the same for both chloride and sulfate TiO₂, but Chemours explained that [REDACTED] [REDACTED] } (CCFF ¶ 84).

Second, Respondents paint a misleading picture of competition from China, including, in particular, mischaracterizing the competitive significance of Lomon Billions in North America. For example, Respondents' assertion that Lomon Billions has "proprietary chloride technology" (Resps.' Br. at 12) ignores that Lomon Billions has struggled with whatever chloride TiO₂

technology it does possess.² Lomon Billions { [REDACTED]
 [REDACTED]
 [REDACTED] } (CCFF ¶ 760); *see* (CCFF ¶ 742 (PX2055 at 025) (Cristal presentation
 { [REDACTED] })).

Indeed, Respondents themselves acknowledge that Lomon Billions' chloride TiO₂ plant is operating significantly below its capacity. Resps.' Post-Trial Br. at 13 (stating that Lomon Billions' existing chloride plant has 100,000 tons of capacity but is operating at about 70,000 tons a year).³

Respondents also claim that Lomon Billions is one of the lowest-cost producers in the TiO₂ industry (Resps.' Br. at 12), but as discussed *infra* in Section V.A., Lomon Billions is not a low-cost producer of *chloride* TiO₂. (CCFF ¶ 769); *see* (CCFF ¶¶ 766-74) (explaining that there is no cost advantage to manufacturing chloride TiO₂ in China). Respondents further assert that Lomon Billions is a "significant competitor," but the evidence—including statements from Respondents themselves—makes clear that Lomon Billions is not a meaningful competitor for chloride TiO₂ in North America. *See, e.g., infra* in Section V.A.; (CCFF ¶¶ 745, 747-65, 794-807). Indeed, North American customers consistently testified that Lomon Billions' chloride TiO₂ does not meet their quality standards, and Chinese chloride TiO₂, including from Lomon Billions, accounts for only { [REDACTED] }% of North American chloride TiO₂ sales. (CCFF ¶¶ 749, 755).

Respondents point to Lomon Billions' announcement of plans to expand its chloride TiO₂ capacity by 2020, but as discussed *infra* in Section V.A., it is highly uncertain that Lomon Billions will actually bring this capacity online in that timeframe. And as Tronox's CEO

² [REDACTED]
 [REDACTED] } (CCFF ¶ 760).

³ Respondents overstate the output of Lomon Billions' chloride TiO₂ plant. Lomon Billions testified that it operates at just 60,000 tons per year. (CCFF ¶ 801).

recently explained to investors, even if it does, that expansion is unlikely to have any impact on market dynamics because it will be absorbed by rising demand. *See infra* at 76-77, (CCFF ¶ 795) (Tronox CEO Jeffrey Quinn: Lomon’s possible chloride expansion “would sort of balance the incremental, you know, global growth.”).

Respondents also point to [REDACTED]

[REDACTED]

Resps.’ Post-Trial Br. at 13. But customer testimony is clear that sulfate TiO₂ competes only in limited, low-end applications in North America. (CCFF ¶¶ 54-57). Customer testimony is likewise clear that Lomon Billions’ chloride TiO₂ does not meet their quality standards in North America, and that they do not view Lomon Billions as a reliable supply option for chloride TiO₂. (CCFF ¶¶ (749, 753-54). Moreover, as the District Court in *Tronox* observed, “[i]solated examples of potential substitutability simply do not outweigh the consistent testimony and representations of industry participants or the empirical evidence provided by Dr. Hill.” *Tronox*, slip op. at 16-17.

As the District Court found with respect to Lomon Billions: “[T]he pertinent question here is whether the emergence of Lomon Billions can be ‘rapid enough to make unprofitable overall the [predicted] actions’ that otherwise lead to the Commission’s concerns about anticompetitive effects. The evidence suggests that it cannot.” *Tronox*, slip op. at 36-37 (quoting *Merger Guidelines* § 9.1).

Respondents admit that they compete with other Chinese TiO₂ producers “primarily in Asia.” Resps.’ Post-Trial Br. at 13. Their assertion that these producers are also “branching out” to make their competitive reach more global is belied by the evidence and contrary to what Tronox has told its investors. (CCFF ¶¶ 755-88); (CCFF ¶ 780) (Tronox Q3 2016 Earnings Call:

“As demand grows domestically [in China], more and more supply will go into the domestic market, which means less will be available for the export market, and Chinese share in the global market we think is going to decline over the next several years.”).

Respondents note that Masco purchases chloride TiO₂ from JinZhou, a Chinese supplier. Resps.’ Post-Trial Br. at 16. They ignore, however, that Masco { [REDACTED] [REDACTED] [REDACTED] }. (CCRRFF ¶ 473). They also fail to mention that { [REDACTED] [REDACTED] } (CCRRFF ¶ 473). Respondents note that Masco purchases sulfate TiO₂. Resps.’ Br. at 16. But Masco explained { [REDACTED] [REDACTED] } (CCFF ¶¶ 39, 47, 53-54, 64, 72, 130; CCRRFF ¶ 417). Respondents also assert that { [REDACTED] [REDACTED] } Resps.’ Post-Trial Br. at 17. { [REDACTED] [REDACTED] }. (Pschaidt, Tr. 1015 (*in camera*); CCRRFF ¶ 417).

Third, Respondents claim that because many TiO₂ customers are large, multinational companies, they { [REDACTED] [REDACTED] } Resps.’ Post-Trial Br. at 14. But TiO₂ customers do not have the buying power that Respondents allege. Undisputed customer testimony described a market { [REDACTED] [REDACTED] } (CCFF ¶¶ 638-39; CCRRFF ¶ 534). Moreover, customers testified that they will have less leverage in pricing

negotiations post-merger. (CCFF ¶¶ 714-15). Consistent with this, { [REDACTED] } (CCFF ¶ 724).

Fourth, Respondents seek to misleadingly portray business conditions in the TiO2 industry as somehow justifying this Merger. Respondents begin by attempting to tie the company's 2009 bankruptcy filing to competitive conditions in the TiO2 industry. Tronox Post-Trial Brief at 17. However, Tronox's bankruptcy filing had little, if anything, to do with the performance of its core TiO2 business. Instead, the filing stemmed from { [REDACTED] } (CCRRFF ¶¶ 544, 567; Romano, Tr. 2208-11 (*in camera*)). Further, Tronox's closure of the Savannah plant in 2009 was { [REDACTED] } (CCRRFF ¶ 544). Indeed, when it closed the plant, Tronox { [REDACTED] } and emphasized that the closure was { [REDACTED] } (CCFF ¶¶ 590-91).

Respondents next try to characterize their multiple decisions to reduce TiO2 production since the bankruptcy as a "response to [] dire conditions" in the TiO2 market, Resps.' Post-Trial Br. at 18, but those claims are belied by the real world evidence. As discussed *infra* at 56-59, Respondents reduced output at their North American plants at least { [REDACTED] } (CCFF ¶¶ 600, 604, 612, 625-26). During all of those periods, Respondents were earning { [REDACTED] } (CCFF ¶¶ 600, 604, 612, 625-26). And for Tronox, each reduction was accompanied by company

statements crediting those reductions with supporting higher North American pricing.⁴ (CCRRFF ¶¶ 547-56, 566-68). As the District Court found, “[s]tatements from Tronox executives evince an understanding that TiO₂ producers recognize the benefits of strategically withholding supply from consumers to maintain higher prices” and that “Tronox documents suggest that the firm has withheld TiO₂ supply to shore up prices in the past” *Tronox*, slip op. at 27. While Tronox claims that it always restarted idled plants as soon as possible, Resps.’ Post-Trial Br. at 19, the company’s investor statements belie that contention. (CCFF ¶ 473) (PX 9003 at 010 (Tronox Q1 2016 Earnings Call) (“[W]e don’t intend to bring back the full production instantaneously simply because we see the very first signs of price recovery.”)).

Fifth, Respondents misleadingly tout the purported advantages of vertical integration—having both feedstock and pigment production capability—and cite it as one of the rationales for the Merger. Resps.’ Post-Trial Br. at 20-21. But other than a handful of self-serving statements from their employees and their so-called industry expert, Mr. Ken Stern—who has no discernable TiO₂ industry experience—Respondents have provided no support for the proposition that vertical integration provides a significant advantage to chloride TiO₂ producers (or, more importantly, results in savings to customers). (CCRRFF ¶ 72). Indeed, [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Tronox asserts that the deal would address the fact that it is “long” in feedstock (*i.e.*, has

⁴ Tronox suggests that its decision to cut output in 2015 contributed to its claimed financial distress, Resps.’ Post-Trial Br. at 19-20, but it provides little support for that connection, citing only the testimony of its investor relations manager. Indeed, Tronox’s then-CFO acknowledged that Tronox was in a “strong liquidity position” in 2015, and documents confirm that. (CCRRFF ¶ 567). Moreover, Tronox witnesses and contemporaneous documents confirm that reduced production in 2015 contributed to higher TiO₂ pricing. (CCFF ¶¶ 606-11; CCRRFF ¶¶ 566-68).

more feedstock than it currently consumes). Resps.’ Post-Trial Br. at 20-21. But Tronox is only slightly long in high-grade feedstock. And { [REDACTED] }
 [REDACTED]
 [REDACTED]. }
 (CCRRFF ¶ 22; CCF ¶ 1010).

Moreover, Respondents neglect to address the myriad evidence that Tronox could enhance its vertical integration on a stand-alone basis. One of the key ways to achieve that would be for the company { [REDACTED] }
 Tronox, however, has consistently rejected doing so. (CCFF ¶¶ 994, 1000-10). The impact that increasing output would have on chloride TiO₂ prices appears to be a significant driver of the company’s decision not to expand output. [REDACTED]
 { [REDACTED] }
 [REDACTED] } (CCRRFF ¶ 101). In contrast, a { [REDACTED] }
 [REDACTED]
 [REDACTED] } (CCRRFF ¶ 101). Indeed, since becoming vertically integrated in 2012, Tronox has on multiple occasions *reduced* its output of both feedstock and TiO₂ pigment, fully cognizant of the upward pressure it would put on prices for both. (CCFF ¶¶ 994-1002). Moreover, the Merger increases Tronox’s incentives to maintain that approach. As the District Court recognized, “the merger will increase already prevalent incentives to engage in strategic output withholding.” *Tronox*, slip op. at 35. Accordingly, the record belies Tronox’s claims regarding the benefits of vertical integration.

Finally, Respondents state that Complaint Counsel “declined to seek an injunctive action in federal court” at the same time as filing the administrative complaint. Resps.’ Post-Trial Br. at

28. But the Commission confirmed that there was no need for Complaint Counsel to seek a preliminary injunction when Respondents were still unable to close the transaction,⁵ and the District Court expressed doubt as to whether Complaint Counsel could even have done so. As the District Court observed, “preliminary injunctions are equitable remedies to be used sparingly and in exigent circumstances.” *Tronox*, slip op. at 46. The District Court further explained that “until foreign regulators approved the proposed merger, there was no imminent threat to competition, so a request for injunctive relief would have likely been unripe.” *Id.* at 46. The District Court also observed that because the administrative trial has already concluded, “the harm to Defendants from a preliminary injunction is lower than in the typical case, in which the administrative process would not yet have begun.” *Id.* at 47. Finally, the District Court noted that any delay was the result of Respondents’ own decisions, stating that they “painted themselves into this corner” because of the approach they elected to take in the European Commission review process. *Id.* at 46-47.

II. COMPLAINT COUNSEL’S EVIDENCE IS BOTH COMPLETE AND RELIABLE

Respondents contend that Complaint Counsel has relied on selective and incomplete evidence to show that the Merger would be anticompetitive. Resps.’ Post-Trial Br. at 31. That assertion is not true. As addressed below, Complaint Counsel has presented extensive and credible evidence from a wide range of sources—including testimony and documents from the

⁵ In unanimously denying Respondents’ motion to stay the administrative proceedings, the Commission rejected Respondents’ argument that Complaint Counsel should have filed for a preliminary injunction earlier:

Respondents misunderstand the role of a preliminary injunction in the context of the Commission’s Part 3 adjudicative process. The Commission may seek a preliminary injunction to preserve the status quo, i.e., to prevent consummation of the proposed transaction, until the administrative proceeding on the merits takes place. *See, e.g., FTC v. H.J. Heinz Co.*, 246 F.3d 708, 726-27 (D.C. Cir. 2001). At present, there is no need for a preliminary injunction action to preserve the status quo.

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Respondents and other industry participants as well as sound economic evidence and testimony—that consistently show that the Merger would likely harm competition in the market for the sale of chloride TiO₂ to North American customers.

A. Complaint Counsel’s Case is Based on Voluminous Evidence from A Variety of Sources

Respondents begin by incorrectly asserting that Complaint Counsel “selectively relied on a small and unrepresentative sample of TiO₂ customers.” Resps.’ Post-Trial Br. at 31. But Complaint Counsel’s case is based on voluminous evidence from a variety of sources, including from customers (both large and small), producers, and the parties themselves. Complaint Counsel’s evidence includes both trial and deposition testimony, as well as extensive evidence from the parties’ internal business documents and public statements. Complaint Counsel’s evidence also includes purchasing data from North American TiO₂ customers and sales data from TiO₂ producers. This extensive evidence consistently supports Complaint Counsel’s market definition and the competitive harm likely to result from the merger.

Respondents claim that Complaint Counsel “cherry-picked” evidence, but Complaint Counsel put on live testimony from—by far—the three largest consumers of TiO₂ in North America: PPG, Sherwin-Williams, and Masco. As Respondents acknowledge, architectural and industrial coatings account for 60% of TiO₂ consumption in North America. Resps.’ Post-Trial Br. at 32; (CCFF ¶ 15). PPG and Sherwin-Williams both make architectural and industrial coatings, and Masco makes architectural coatings. (CCRRFF ¶ 387). Therefore, they are the largest customers within the largest end-use segment for TiO₂ in North America. In addition to presenting testimony from the three largest customers, Complaint Counsel presented live testimony from True Value, a small coatings customer, and from Deceuninck, a plastics

customer.⁶ Complaint Counsel also presented live testimony from Kronos, one of the major North American TiO₂ producers. Kronos supplies TiO₂ to a range of North American customers across various end-uses. (CCRRFF ¶ 375). In contrast to Complaint Counsel, Respondents called no customers at trial. Nor did they call any other TiO₂ producers. Indeed, Respondents did not even call any Cristal witnesses—despite including Cristal executives on their witness list. Instead, Respondents only presented testimony from Tronox executives and their paid expert witnesses.

Complaint Counsel's evidence, of course, consists of far more than the customer testimony put on at trial. Numerous depositions were conducted in this case—of customers, other producers, and party witnesses. Complaint Counsel cites extensively to these depositions. *See* Complaint Counsel's Proposed Findings of Fact. Complaint Counsel also cites extensively to the parties' business documents, Tronox's public statements, and to documents from customers and other producers. *See id.* Complaint Counsel issued civil investigative demands ("CIDs") to 20 of the largest customers of TiO₂ in North America (as identified by Respondents), covering a range of end use segments.⁷ The purchase data customers provided in response to these CIDs shows that chloride TiO₂ accounts for the vast majority of TiO₂ purchases in North America regardless of the price premium for chloride TiO₂. (CCFF ¶ 117). This is consistent with what the producer invoice data showed. (CCFF ¶ 117).

Respondents cite to deposition testimony from Westlake, a plastics manufacturer, and Ashland, a producer of gel coatings and adhesives, and suggest that this testimony is inconsistent with a chloride TiO₂ product market. Resps.' Post-Trial Br. at 32-33. It is not. The selectively

⁶ Plastics account for 25% of the end use consumption of TiO₂ in North America. (CCFF ¶ 15).

⁷ Respondents assert that the FTC issued CIDs to 23 customers, but the FTC actually issued CIDs to 20 customers and 3 competitors. Also, although irrelevant, Respondents' characterization of the customer CIDs as "lengthy questionnaires" is inaccurate. The customer CIDs consisted of three questions, including a request for purchase data.

cited testimony gives a misleading picture of the witnesses' actual testimony. Westlake's witness, Juan Septien, testified that { [REDACTED]

[REDACTED] } (CCRRFF ¶ 385). { [REDACTED] } (Resps.' Post-Trial Br. at 32) [REDACTED]

[REDACTED] } (CCRRFF ¶ 385). [REDACTED] Ashland's witness,

Antonio Tong, testified that { [REDACTED] } (CCRRFF ¶ 385). Mr. Tong testified that { [REDACTED]

[REDACTED] } (CCRRFF ¶ 385). Contrary to Respondents' arguments, { [REDACTED]

[REDACTED] } sulfate TiO₂, which has a yellow tint and confers less

brightness than chloride TiO₂. *See* (CCFF ¶¶ 67-74).

B. Dr. Malichky's Testimony is Credible, Consistent With the Weight of the Evidence, and Should Be Given Significant Weight

Respondents next argue that the testimony of Dr. Paul Malichky, a long-time PPG employee, is unreliable and should not be credited. Dr. Malichky, however, is a highly experienced executive with extensive personal knowledge and first-hand experience with Respondents and with the TiO₂ business generally. Indeed, Tronox and Cristal are { [REDACTED]

[REDACTED] } (CCFF ¶ 698). Dr. Malichky's testimony is consistent with the testimony of other TiO₂

customers that testified in this matter, consistent with contemporaneous PPG documents

produced in this case, and consistent with Tronox's own internal statements about Cristal's behavior in the market. As the representative of a large customer that would be significantly affected by the merger, Dr. Malichky's testimony should be given significant weight. *Merger Guidelines* § 2.2.2 (recognizing importance of customer testimony on host of issues); *Commentary on the Horizontal Merger Guidelines* at 9 (2006) ("Customers typically are the best source . . . of critical information on the factors that govern their ability and willingness to substitute in the event of a price increase."); *FTC v. Staples, Inc.*, 190 F. Supp. 3d 100, 119 (D.D.C. 2016) (citing customer testimony as evidence of pricing) (hereinafter *Staples 2016*); *FTC v. Sysco Corp.*, 113 F. Supp. 3d 1, 32 (D.D.C. 2015) (using customer testimony as evidence of proper product market).

Indeed, in granting a preliminary injunction in this matter, the District Court credited Dr. Malichky's testimony on several key issues, including the characteristics and interchangeability of chloride and sulfate TiO₂, the regional nature of TiO₂ markets, the challenges faced by customers in securing TiO₂ supply, and that PPG has few if any suppliers other than Respondents it could turn to in the face of a price increase. *Tronox*, slip op. at 3, 11-12, 18-19, 30. This Court should similarly credit Dr. Malichky's consistent, well-supported, and highly relevant testimony.

Dr. Malichky has been employed by PPG for about ten years. (CCRRFF ¶ 326). For the last five years, he has served as PPG's Director of Raw Material Sourcing. (CCRRFF ¶ 326). In that role, Dr. Malichky is directly responsible for negotiating the purchase of approximately { } million of TiO₂ for use in the United States and Canada. (CCRRFF ¶ 326). He is also responsible for purchasing TiO₂ in other world regions. (CCRRFF ¶ 326). He holds several advanced degrees, including an MBA and a PhD in Pharmacology and Toxicology. (CCRRFF ¶

51). But most importantly, Dr. Malichky is directly responsible for negotiating significant TiO₂ purchases from both Tronox and Cristal in North America, and has engaged in direct discussions with Tronox with respect to the proposed transaction. (CCFF ¶¶ 698-99).

Dr. Malichky's testimony regarding the characteristics of the North American market for chloride TiO₂ is highly consistent with the testimony of other TiO₂ customers. For example, Dr. Malichky testified that, for the vast majority of PPG's applications in North America, sulfate and chloride TiO₂ are not interchangeable. (CCFF ¶ 35). { [REDACTED]

[REDACTED] }
(CCFF ¶ 36 (Sherwin Williams); CCFF ¶¶ 39, 53 (Masco); CCFF ¶¶ 48, 50 (Deceunink)). Dr.

Malichky testified that { [REDACTED] }, as did Sherwin Williams,

Deceunink, Kronos, and other industry participants, including the merging parties themselves.

(CCFF ¶¶ 175, 179-80 (PPG); CCFF ¶¶ 174, 192 (Sherwin Williams); CCFF ¶ 227 (Kronos);

CCFF ¶¶ 154, 200 (Tronox); CCFF ¶ 155 (Cristal)). Dr. Malichky testified that { [REDACTED]

[REDACTED] }, as did representatives from

Deceunink and Mississippi Polymers. (CCFF ¶ 556). Respondents do not seriously contest Dr.

Malichky's testimony on any of these points.

Instead, Respondents' primary concern is with Dr. Malichky's testimony that Tronox's chief commercial officer, John Romano, explicitly told PPG that Tronox intends to raise Cristal's price to PPG after the merger, and that Cristal lacks "market discipline." (CCFF ¶ 699). But that testimony was unrefuted. Indeed, Respondents called Mr. Romano as a witness at trial, but *never asked him any questions about his meeting with Dr. Malichky or his comments about raising PPG's prices.* Respondents also questioned Tronox employee, Ian Mouland, at trial. Mr. Mouland had participated in the PPG meeting with Mr. Romano. (Malichky, Tr. 279;

CCRRFF ¶ 526). But although Mr. Mouland discussed Tronox's ongoing negotiations with PPG with respect to a potential memorandum of understanding between the parties—on which the parties never reached an agreement—Mr. Mouland never disputed Dr. Malichky's assertions that Mr. Romano told PPG that Tronox was going to increase the Cristal price.

Contemporaneous documents in the record corroborate Dr. Malichky's testimony about Mr. Romano's statement that Tronox would raise PPG's prices. (Malichky, Tr. 280-81; CCFF ¶ 710). Immediately following the meeting with Tronox, Dr. Malichky drafted and sent an email for his supervisor summarizing his conversation with Tronox executives. (PX4079 at 002 (Malichky email) (*in camera*); CCFF ¶ 710). This contemporaneous account confirms that

{ [REDACTED]

[REDACTED]

[REDACTED] } (PX4079 at 002 (Malichky email) (*in camera*); CCFF ¶ 710). Moreover, Dr.

Malichky's account of Tronox's statements to PPG regarding Cristal's lower pricing and lack of market discipline are consistent with Tronox's own internal statements. For example, Mr.

Mouland, who was present at the meeting with Dr. Malichky, separately observed to another

Tronox employee that he was { [REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶ 707).

Unable to refute Dr. Malichky's testimony that Tronox expressly told PPG it would raise prices to PPG after the merger, Respondents direct their complaints and criticisms of Dr.

Malichky's testimony to minor factual issues that have little if any relevance to the antitrust

analysis at issue in this matter. For example, Respondents complain that, through approximately five hours of cross-examination involving numerous documents, there were a few documents for

which Dr. Malichky did not recall every specific detail. Resps.’ Post-Trial Br. at 36-37. Given the sheer volume of documents at issue in this matter, that is neither surprising nor an indictment of Dr. Malichky’s credibility. Respondents also point out that, at the time of Dr. Malichky’s meeting with Tronox, Mr. Romano did not know Cristal’s exact prices. Resps.’ Post-Trial Br. at 38-39. But that is irrelevant. Both Mr. Romano and Mr. Mouland did know that { [REDACTED] } (Malichky, Tr. 280, 620-21; Mouland, Tr. 1283-84; CCRRFF ¶ 526). Respondents also raise an exchange where Dr. Malichky disputes whether he ever referred to a particular contractual clause as a “most favored nation” clause. Resps.’ Post-Trial Br. at 39-41. Again, whether Dr. Malichky correctly or incorrectly recalled his use of the specific term “MFN” throughout the entirety of his interactions with Tronox is simply irrelevant to the issues in this case, nor is it a significant enough issue to even come close to justifying disregarding the balance of Dr. Malichky’s highly relevant and probative testimony.

C. Dr. Hill’s Analysis and Testimony are Reliable

Respondents also attack aspects of Dr. Hill’s testimony in an attempt to portray his testimony and reports as unreliable, but their attacks are meritless. As his testimony and reports demonstrate, Dr. Hill faithfully implemented the *Merger Guidelines* framework and his opinions and conclusions are wholly consistent with the overwhelming weight of the record evidence.

Dr. Hill began his analysis by defining a relevant market—the sale of chloride TiO₂ to North American customers—that passed the hypothetical monopolist test. (CCFF ¶¶ 324-27). Next, he measured the level of concentration in that market and found that the market was highly concentrated and the increase in concentration so great that the merger was presumptively anticompetitive. (CCFF ¶¶ 390-93). As his testimony and reports show, he then evaluated the economic evidence, including documents, data, and testimony from a wide range of sources.

That information led him to the conclusion that the merger was likely to result in both coordinated harm (an increased likelihood of interdependent and coordinated conduct) and unilateral harm (greater incentives to withhold chloride TiO₂ from the market) as described by the *Merger Guidelines*. (CCFF ¶¶ 399-402, 659). Dr. Hill next used two models to test those conclusions, with both confirming that the merger is likely to result in competitive harm. (CCFF ¶¶ 659-70, 680-84). Dr. Hill finished his analysis by determining that neither entry nor efficiencies would counteract the anticompetitive effects of the merger. (CCFF ¶¶ 741, 796, 994, 1002). In short, Dr. Hill followed the approach laid out in the *Merger Guidelines* to a tee.

In an unavailing attempt to distract from the soundness of Dr. Hill's work, Respondents open with a couple of ad hominem attacks on Dr. Hill. Respondents first assert that Dr. Hill "lacks prior experience as a testifying economic expert." Resps.' Post-Trial Br. at 41. But that has no bearing on Dr. Hill's competence to serve as an expert economic witness. Dr. Hill possesses impeccable qualifications for assessing the economic impact of a proposed merger. After earning his doctorate in economics, Dr. Hill has devoted his entire professional career, both within and outside government, to analyzing the competitive effects of mergers using the relevant framework laid out in the *Merger Guidelines*. (Hill, Tr. 1656-59, 1663). Dr. Hill estimated that he had performed that task at least 50 times across a wide-range of industries, including dozens in commodity industries like the one at issue here. (CCRRFF ¶ 79). Given this relevant background and experience, it is unsurprising that Respondents did not object when Complaint Counsel proffered Dr. Hill as an expert.

Respondents also claim that Dr. Hill's prior government service somehow "makes him primed to be biased in favor of the government," but they provide no foundation for this contention. Resps.' Post-Trial Br. at 42. As Dr. Hill testified, both in government and as a

consultant for a number of private parties, he has evaluated many mergers and concluded that they did not raise competitive concerns. (CCRRFF ¶ 79). Moreover, neither his compensation nor that of his employer, Bates White, depended on the outcome in this case. (CCRRFF ¶ 79). Indeed, if Respondents' litmus test were somehow relevant, their own economic expert, Dr. Ramsey Shehadeh, who has built his entire career around taking aggressive positions on behalf of merging parties before the United States antitrust agencies, and been soundly criticized by at least one federal court for doing so, would fail. (CCRRFF ¶ 79); *United States v. Bazaarvoice, Inc.*, No. 13-00133, 2014 WL 203966, at *35 (N.D. Cal. Jan. 8, 2014).

1. Dr. Hill's Market Definition Analysis Follows the *Merger Guidelines*

Although equally unpersuasive, Respondents begin their substantive criticisms of Dr. Hill's analysis by accusing him of "assum[ing]" his market definition conclusions. (Resps.' Post-Trial Br. at 42). But Dr. Hill did no such thing, following the approach laid out in the *Merger Guidelines* to identify the relevant markets here. Consistent with that approach, Dr. Hill began his market definition analysis by identifying a potential candidate market where the merger could have competitive effects. Dr. Hill found that Respondents both sell chloride TiO₂ in North America, (CCFF ¶¶ 5, 9), and that the qualitative and quantitative evidence revealed that North American customers have an overwhelming preference for chloride TiO₂ that is likely stronger than in other regions.⁸ (CCFF ¶¶ 301-22). Given those facts, a market defined as the sale of chloride TiO₂ to customers in North America is a natural market to consider. (CCRRFF ¶ 334). After identifying that as a potential candidate market, Dr. Hill then used the hypothetical monopolist test prescribed by the *Merger Guidelines* to test and *confirm*—not *assume* as

⁸ Because customers in other regions are more willing to switch between chloride and sulfate TiO₂, the competitive impact of a merger between two chloride TiO₂ producers would likely differ. (CCFF ¶ 301).

Respondents contend—that the sale of chloride TiO₂ to customers in North America is indeed a relevant market. (CCFF ¶¶ 25, 323-29; CCRRFF ¶ 334).

The hypothetical monopolist test asks whether a hypothetical firm that is the only seller of the relevant product (chloride TiO₂) to customers in the relevant geography (North America) could profitably impose a SSNIP. To be conservative, Dr. Hill implemented the hypothetical monopolist test not one, but multiple ways. (CCFF ¶ 327). Three involved using a critical loss analysis, a method specifically endorsed by the *Merger Guidelines* for assessing whether a candidate market passes the hypothetical monopolist test. *Merger Guidelines* § 4.1.3 (discussing using critical loss as a way to implement the hypothetical monopolist test). Critical loss compares whether the hypothetical monopolist's profits would increase or decrease if it implemented a SSNIP. (CCFF ¶ 326); *Merger Guidelines* § 4.1.3. If the former, then the market passes the hypothetical monopolist test, but if the latter, the market fails. (CCFF ¶¶ 326-27).

Dr. Hill used three different measures of the predicted loss resulting from a 10% SSNIP, including two that relied on materials from the Respondents. (CCFF ¶ 327). Dr. Hill first used his estimate of North American customers' willingness to switch from chloride to sulfate TiO₂ (the "price elasticity of demand" measure) to determine whether enough North American customers would switch to another product to defeat a SSNIP by the hypothetical monopolist. (CCRRFF ¶ 442). That measure, consistent with the qualitative evidence, showed that demand for chloride TiO₂ by North American customers was inelastic (██████). (CCRRFF ¶ 442). As a result, switching to other products by North American customers would prove inadequate to defeat a SSNIP. (CCRRFF ¶ 442).

Dr. Hill next used a "substitution components" measure, using data from Respondents' own advocacy, to ascertain whether increased imports or repatriated exports responding to a

SSNIP, combined with lost sales, would render the SSNIP unprofitable for the hypothetical monopolist. (CCFF ¶ 327; CCRRFF ¶ 442). As Dr. Hill explains, this is an especially conservative approach to the hypothetical monopolist test because it allows for an increase in supply even though the market here includes (and the hypothetical monopolist controls) all sales in North America. (CCRRFF ¶ 442). Even using this approach and this data, which Complaint Counsel does not consider reliable, a SSNIP would be profitable, which further shows the robustness of a market defined as the sale of chloride TiO₂ to North American customers. (CCFF ¶ 327; CCRRFF ¶ 442). Dr. Hill's third critical loss measure relied on Tronox's own estimate of the maximum North American sulfate TiO₂ demand to determine whether a sufficient number of North American customers would switch to sulfate TiO₂ to defeat a SSNIP, and found that they would not. (CCFF ¶ 327; CCRRFF ¶ 442). Dr. Hill's final method directly used the measure of price elasticity of demand for chloride TiO₂ in North America to determine whether demand would remain inelastic if prices increased by a SSNIP. (CCFF ¶ 327; CCRRFF ¶ 442). He found that it would, once again establishing that the sale of chloride TiO₂ to North American customers passes the hypothetical monopolist test. (CCFF ¶ 328).

In sum, Dr. Hill did not "assume" his market definition conclusions. Rather, he followed the *Merger Guidelines* and, using the hypothetical monopolist test, demonstrated that North American customers' substitution of sulfate TiO₂ for chloride TiO₂ and use of arbitrage would not be sufficiently prevalent to defeat a SSNIP in a market for the sale of chloride TiO₂ to customers in North America. (CCFF ¶¶ 327-29).

2. The Capacity Closure Model is Reliable

Respondents next criticize Dr. Hill's capacity closure model ("CCM"), but their critiques are unavailing. First, Respondents claim that the CCM is not "widely accepted in the economic

community.” Resps.’ Post-Trial Br. at 43. They ignore, however, that the CCM is wholly consistent with prevailing antitrust principles. It is based directly on the fundamental and well-accepted economics underlying § 6.3 of the *Merger Guidelines*—that a larger firm (resulting from a merger) in a commodity industry would capture more of the benefit of withholding output and therefore have a greater incentive to do so. (CCFF ¶¶ 658-59); *Merger Guidelines* § 6.3 (“the merger may provide the merged firm a larger base of sales on which to benefit from the resulting price rise”). The CCM merely provides a mechanism to test whether a merger would create such an incentive by assessing the real world costs—based on actual company data—of lowering output as well as the likely responses by both customer and rivals to such an effort, also based on real-world data of responses to prior price changes. (CCFF ¶¶ 665-67). For that reason, the CCM has been accepted by at least one federal court, *United States v. Abitibi Consolidated, Inc.*, 584 F Supp. 2d 162 (D.D.C. 2008), and has been routinely employed by economists at the Department of Justice’s Antitrust Division to assess the competitive impact of mergers in commodity industries. (CCFF ¶ 662).

Further, the CCM’s prediction that the merged firm here has incentives to reduce output closely fits the reality of the North American chloride TiO₂ market over the past decade. North American chloride TiO₂ producers—including the Respondents—have, on many occasions over the past several years, either temporarily or permanently reduced output and consistently credited those reductions with supporting higher TiO₂ prices. (CCFF §§ V.B.ii-iii). The fact that the CCM predicts that the merged firm would have an incentive to reduce output, where none exists for either firm standing alone today, both aligns with past industry practice and is hardly surprising because the merger will make reducing output even more profitable for the merged firm. (CCFF ¶¶ 668-70). As the District Court found, the “real-world evidence . . . suggests that

. . . to counter declining prices, chloride TiO₂ producers have incentives and the means to withhold supply,” *Tronox*, slip op. at 30, and that “the merger will increase already prevalent incentives to engage in strategic output withholding.” *Tronox*, slip op. at 35.

Finally, the CCM’s prediction of competitive harm from this merger is also consistent with those of a second model Dr. Hill used, the Cournot model. (CCFF ¶ 680). The Cournot model is a standard framework for testing the impact of mergers in homogenous goods industries. (CCFF ¶ 686). That the Cournot model also predicts significant competitive harm from this merger—a price increase in excess of 8%—further buttresses the robustness and reliability of the CCM’s predictions. (CCFF ¶¶ 683-84; CRRFF ¶ 688).

Second, Respondents contend that Dr. Hill’s CCM “assum[es] away” competitive responses by other chloride TiO₂ producers in the form of redirected imports, increased output, or increased chloride TiO₂ imports to North America. Resps.’ Post-Trial Br. at 43. As explained in Complaint Counsel’s Post-Trial Brief, Dr. Hill did no such thing. CC’s Post-Trial Br. at 54-56. Rather, Dr. Hill analyzed real-world evidence and data of prior competitive responses to changes in North American chloride TiO₂ prices to determine likely future responses, incorporated them into his model, and found them insufficient to render an output reduction by the merged firm unprofitable. (CCFF ¶¶ 667-68).

Where market history indicated a competitive response to North American prices changes in the past, Dr. Hill estimated that likely response based on evidence of the scope of that prior response, and incorporated it into the CCM. For example, the record showed that TiO₂ imports increased slightly in response to North American price increases for chloride TiO₂ (although never exceeded more than {█} of North American sales), and based on that evidence he incorporated a response into the CCM. (CCFF ¶¶ 645, 667).

In contrast, where market history showed that there had not been a prior response to North American price changes—*e.g.*, redirected exports where history showed no change even when North American TiO₂ prices doubled and were significantly higher than they are today—Dr. Hill incorporated that absence of a response into his model. (CCFF ¶¶ 643-44, 652-57, 667). Similarly, while Dr. Hill does allow for an increase in North American domestic production of chloride TiO₂ at the historical rate of growth in demand—the typical rate that the various industry debottlenecking efforts have increased capacity—he does not include more significant output increases because there is no evidence that they have occurred in response to higher North American TiO₂ prices. (CCFF ¶¶ 667, 738).

Significantly, as discussed in Complaint Counsel’s Post-Trial Brief, Dr. Hill’s assessment of likely responses to North American chloride TiO₂ price increases align with the qualitative evidence showing muted competitive responses in the past, even when North American chloride TiO₂ prices were significantly higher than elsewhere. CC’s Post-Trial Br. at 55-56. While Respondents posit that the CCM does not account for certain rival responses even if prices were to increase by 79%, Resps.’ Post-Trial Br. at 43, the facts show that even when North American chloride TiO₂ prices *increased by 100%* in 2011 and 2012, there was no significant North American output increase,⁹ imports remained limited, and North American producers never redirected imports back to North America. (CCFF ¶¶ 636, 640-45, 729).

For example, despite dramatically higher North American chloride TiO₂ prices, North American chloride TiO₂ imports have never accounted for more than {█} of domestic supply.

⁹ Moreover, a significant North American output expansion is unlikely to occur in the future, especially in response to an effort by the merged firm to withhold output. First, any significant plant expansion is expensive and time consuming. (CCFF ¶¶ 667, 737, 739-40). Second, the high current TiO₂ operating rates preclude a quick response by ramping up production. (CCFF ¶¶ 637-39). Perhaps most importantly, though, rival North American producers in an oligopoly market have little incentive to increase output in response to a rival’s output reduction because it would likely drive price back down. (CCFF ¶¶ 636, 735-36). As the District Court found, the record “suggest[s] that firms are generally unwilling to take actions that will lower industry-wide prices.” *Tronox*, slip op. at 34.

(CCFF ¶ 141). As the District Court found, “that North American customers will not be able to secure meaningful increases in TiO₂ from foreign sources appears to comport with the industry’s economic realities.” *Tronox*, slip op. at 24. Likewise, the real-world evidence showed that North American producers were reluctant to redirect imports in response to price changes because of the importance of long-term customer relationships and security of supply. (CCFF ¶¶ 652-57). And the data supported that: as Dr. Hill found, there has been no evidence of export repatriation in the past, as shown by the persistent price difference between North America and other regions. (CCFF ¶¶ 643-44). Given this evidence, the District Court specifically credited that sizeable export repatriation would not occur. *Tronox*, slip op. at 22-23.

Finally, Respondents ignore that the second model Dr. Hill ran, the Cournot model, does allow for unrestrained rival responses to price increases, and that model also predicted the merger would result in significant competitive harm. (CCFF ¶¶ 682-84).

Third, Respondents argue that the CCM fails to account for Chemours’s real-world behavior, and therefore fails “its own validity checks.” Resps.’ Post-Trial Br. at 43-44. The basis for this claim appears to be Dr. Shehadeh’s calculation that Chemours sold more TiO₂ in 2016 than the model predicted it should. As noted in Complaint Counsel’s Post-Trial Brief, though, Chemours had recently taken steps to reduce its output capacity, and data shows that

{ [REDACTED] } (CC’s Post-Trial Br. at 58; CCFF ¶¶ 430, 585, 678; CCRRFF ¶ 618). Additionally, as Dr. Hill explained, the detailed internal cost data needed to accurately implement the CCM was unavailable from Chemours (or any firm other than the Respondents). (CCFF ¶ 678). Thus, Dr. Shehadeh’s CCM estimates for Chemours are unreliable. (CCRRFF ¶¶ 618-19).

Respondents misleadingly claim that the differences in results between Dr. Hill's corrected CCM and the original running of the model show that the CCM is "extremely sensitive" to "small changes." Resps.' Post-Trial Br. at 44-45. This assertion is simply wrong. Dr. Hill fixed minor coding errors. That affected the mathematical results, but not the model's conclusion. The fact that the corrected model yielded different mathematical results—greater predictions of harm—has no bearing on whether the model is sensitive to changes in certain assumptions or to the reliability of the underlying model. To illustrate, while $9+4$ yields a different answer from $9-4$, it would be improper to come away from that example believing that arithmetic is not reliable because of sensitivity to its "coding." And it is not the model's prediction of the precise number of lines the merged firm would shut down that matters. Rather, it is the fact that the model corroborates the presumption of competitive harm from this merger, and reflects the economic intuition of the *Merger Guidelines* and the other economic evidence in this case.

As shown above, Dr. Hill's testimony is reliable.¹⁰ Dr. Hill is a highly-qualified economic expert, and his analysis of this merger is wholly consistent with the weight of the evidence and the *Merger Guidelines* framework. He used the hypothetical monopolist test to identify the relevant market, found that this merger was presumptively anticompetitive in that market, and then relied on the economic evidence in this case, corroborated by the two economic models he ran, to conclude that the merger is, in fact, likely to result in competitive harm. It is not surprising, then, that the District Court found that Dr. Hill's report and testimony "bolster" the factual evidence and that "Dr. Hill's overall conclusions are more consistent with the

¹⁰ Respondents note that they raise additional criticisms regarding Dr. Hill's analysis in other sections of their brief. Resps.' Post-Trial Br. at 45. Those criticisms are equally unavailing as those raised above and Complaint Counsel addresses them where they arise.

business realities of the TiO₂ industry” than those offered by Respondents’ expert economist, Dr. Shehadeh. *Tronox*, slip op. at 13, 34.

III. COMPLAINT COUNSEL PROVED THE SALE OF CHLORIDE TIO₂ TO NORTH AMERICAN CUSTOMERS IS A RELEVANT MARKET

The relevant product market “identifies the product and services with which the defendants’ products compete,” while the relevant geographic market “identifies the geographic area in which the defendants compete in marketing their products or services.” *FTC v. CCC Holdings Inc.*, 605 F. Supp. 2d 26, 37 (D.D.C. 2009). These markets must “correspond to the commercial realities of the industry and be economically significant.” *Brown Shoe Co. v. United States*, 370 U.S. 294, 336 (1962) (internal quotation marks omitted). Complaint Counsel’s market, defined as the sale of chloride TiO₂ to North American customers, reflects both the market reality and established antitrust principles. Respondents’ attempts to broaden both the product and geographic market is contrary to the overwhelming weight of the evidence and those antitrust principles. The District Court agreed. *Tronox*, slip op. at 24.

A. North America is a Relevant Geographic Market

As shown in Complaint Counsel’s opening Post-Trial Brief, Complaint Counsel’s relevant geographic market for the sale of chloride TiO₂—North America (the United States and Canada)—is consistent with both the market reality as well as established antitrust principles. CC’s Post-Trial Br. at 18-26; *see also Tronox*, slip op. at 24. The global geographic market urged by the Respondents is neither.

The purpose of market definition is to determine the scope of the geographic area where customers “can practically turn for alternative sources of the product.” *FTC v. Cardinal Health, Inc.*, 12 F. Supp. 2d 34, 49 (D.D.C. 1998) (citations omitted). Commission precedent and the *Merger Guidelines* recognize that where, as here, suppliers deliver the relevant product to their

customers' locations, those suppliers can price discriminate against customers based on their geographic location, and customers cannot avoid those targeted price increases through arbitrage, the geographic market should be defined around the location of the targeted customer locations. *Merger Guidelines* § 4.2.2; *In re Polypore Int'l Inc.*, 150 FTC 586 at *16 (2010), *aff'd sub nom.*, *Polypore Int'l, Inc. v. FTC*, 686 F.3d 1208 (11th Cir. 2012). That market includes all sales of the relevant product to the targeted customers within the geographic market. *Merger Guidelines* § 4.2.2; *In re Polypore Int'l*, 150 FTC 586 at *16.

As laid out in Complaint Counsel's Post-Trial Brief, the real-world evidence overwhelmingly shows that all those factors are present in the market for the sale of chloride TiO₂ to North American customers: TiO₂ suppliers deliver the product to North American customers (CCFF ¶¶ 165-71), producers can and do charge different prices to North American chloride TiO₂ customers than to customers elsewhere (CCFF ¶¶ 148-64), and North American customers cannot defeat that price difference by turning to arbitrage, even in the face of a SSNIP (CCFF ¶¶ 259-77).¹¹ CC's Post-Trial Br. at 18-26. Accordingly, a North American geographic market passes the hypothetical monopolist test. (CCFF ¶ 327).

The evidence supporting a North American market is overwhelming. Respondents' own public investor statements and documents confirm that pricing varies by region, with North American pricing often higher. (CC's Post-Trial Br. at 19-22; CCFF ¶¶ 199-231). For example, Tronox's then-CEO, Tom Casey, explained the following to investors in 2014: "Are there

¹¹ Respondents claim that "Complaint Counsel's economic modeling shows that a hypothetical monopolist could not profitably impose a SSNIP in North America," Resps.' Post-Trial Br. at 47, but this contention is both wrong and highly misleading (nor is it supported by the cited findings of fact). Respondents appear to conflate the Cournot model—a model used to estimate competitive effects—with the hypothetical monopolist test used to define markets. Moreover, contrary to the purpose of the hypothetical monopolist test, which intentionally gives the monopolist control over all supply in the market, *Merger Guidelines* § 4.2.2, Dr. Hill's Cournot model unites only two of the firms selling into North America, not all of them, and specifically anticipates competitive responses from the remaining rivals. (CCFF ¶ 682). Accordingly, the Cournot model is inappropriate for determining whether a hypothetical *monopolist* would find a SSNIP to be profitable.

different prices in the regional markets in which we do business? The answer to that question is yes. The European and Asian market prices and the Latin American market prices are relatively closely bunched with the North American price staying somewhat higher.” (CCFF ¶ 252; CCRRFF ¶ 79). On another earnings call in 2016, Mr. Casey expressed Tronox’s view “that prices in Europe and in Asia were lower than prices in the United States and in . . . the other North American markets.” (CCFF ¶ 257). And Tronox told a customer that { [REDACTED] } [REDACTED] } (CCFF ¶ 202). Likewise, Tronox’s Chief Commercial Office explained that { [REDACTED] } [REDACTED] } (CCFF ¶ 215). Cristal also recognizes that TiO₂ pricing is “driven by supply and demand dynamics in . . . particular regions,” (CCFF ¶ 157), and accordingly, { [REDACTED] } [REDACTED] } (CCFF ¶ 155). Other TiO₂ producers have a similar view of the regional nature of TiO₂ markets. (CCFF ¶¶ 226-31).

Customers, meanwhile, confirm the regional nature of TiO₂ pricing, explaining that they pay different prices in different regions, and negotiate pricing regionally, even if buying from the same supplier in multiple regions. (CCFF ¶¶ 172-92). As PPG testified, { [REDACTED] } [REDACTED] } (CCFF ¶ 175). Indeed, chloride TiO₂ prices { [REDACTED] } [REDACTED] } (CCFF ¶ 236).

Persistent regional pricing gaps show that North American customers have been unable to turn to arbitrage—by buying product in a low-priced region and moving the product back to North America—to defeat higher North American prices. (CCFF ¶ 266); *see also Tronox*, slip op. at 19 (recognizing that the pricing gaps suggest the absence of arbitrage). As explained in Complaint Counsel’s Post-Trial Brief, customers universally testified that a number of factors preclude customer arbitrage. (CC’s Post-Trial Br. at 22-25; CCFF ¶¶ 260-61, 272-77, 283, 285, 295-99, 305-06, 308-12, 319-21). Those factors include the high costs of import duties and shipping as well as various logistical challenges. (CCFF ¶¶ 260-77). Consistent with the *Merger Guidelines* and Commission precedent, the evidence establishes that North America is a proper geographic market to assess the competitive effects of this Merger.

1. The Existence of Trade Flows Does Not Undermine a North American Market

Respondents argue that TiO₂ is a globally traded commodity, Resps.’ Post-Trial Br. at 47-49, but the mere existence of global trade is insufficient to establish a relevant antitrust market. Rather, as discussed above, the relevant antitrust question here is where North American customers would turn for chloride TiO₂ in the face of SSNIP. *See, e.g., FTC v. Advocate Health Care Network*, 841 F.3d 460, 468 (7th Cir. 2016). Because North American chloride TiO₂ customers have the TiO₂ delivered to their plant locations and chloride TiO₂ suppliers can and do charge different prices in North America than elsewhere, CCFF ¶¶ 148-258, the central question in that analysis is whether customers can “avoid targeted price increases through arbitrage.” *In re Polypore Int’l Inc.*, 150 FTC at *16; *Merger Guidelines* § 4.2.2.

The evidence shows that North American customers do not engage in arbitrage—by buying TiO₂ in another region and bringing it into North America, for example—to defeat these price differences. (CCFF ¶¶ 259-322). Indeed, throughout the five-year period between 2012

and 2017, North American chloride TiO₂ prices were at least { [REDACTED] } higher—and often much more—than those in other regions, and yet there is no evidence that North American customers engaged in meaningful arbitrage. (CCFF ¶¶ 236-58). If the chloride TiO₂ market were truly global, as Respondents claim, then significant regional price differences should not persist across regions for such prolonged periods. Rather, they should be quickly competed away as customers turn to other regions for supply. But significant regional price differences for chloride TiO₂ have persisted, confirming the regional nature of TiO₂ markets. (CCFF ¶¶ 232-57); *see also Tronox*, slip op. at 19 (noting that “[i]n a single, global market, sustained regional price variances are unlikely, as customers would engage in arbitrage . . . that equalizes prices over time.”).

Respondents point to Sherwin-Williams and PPG as examples of potential arbitrage (Resps.’ Post-Trial Br. at 49), but both show the opposite. { [REDACTED] }
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED] } (CCFF ¶¶
277, 297, CCRRFF ¶ 328). { [REDACTED] }
[REDACTED]
[REDACTED]
[REDACTED] }
(CCFF ¶ 296).

Respondents identify the fact that { [REDACTED] }
[REDACTED]

[REDACTED] } Resps.’ Post-Trial Br. at 49. But the mere ability to move TiO₂ across regions in the face of severe supply shortages—{ [REDACTED] [REDACTED] }—reveals nothing about the relevant antitrust question: whether it would make commercial sense for a sufficiently large number of customers to move product to defeat a SSNIP. (CCFF ¶¶ 142, 324-25; CRRFF ¶ 348; CC’s Conclusions of Law ¶¶ 19, 21). And indeed, the record evidence overwhelmingly shows that it does not. (CCFF ¶¶ 142, 259-322, 324-25). The high cost of transportation and duties as well as the many logistical burdens involved preclude North American customers from engaging in arbitrage to overcome a SSNIP. (CCFF ¶¶ 259-322); *Merger Guidelines* § 3 (“Arbitrage on a modest scale may be possible but sufficiently costly or limited that it would not deter or defeat a discriminatory pricing strategy.”).

Respondents suggest that the existence of global trade flows recently ended North America’s extended run as the highest price region. Resps.’ Post-Trial Br. at 48. Respondents ignore, however, that this development did not result from trade flows or arbitrage, but from severe supply disruptions in other regions of the world leading to sharp price escalations outside of North America. (CCFF ¶¶ 258, 631-33, 771-74, 779-81). Specifically, the fire at Venator’s Pori plant in Finland and rising feedstock costs and demand in Asia, along with environmental shutdowns in China, led to higher prices and reduced output in those regions. (CCFF ¶¶ 258, 631-33, 771-74, 779-81). Indeed, the rapid price escalation in regions outside North America in response to these shortages (e.g., prices increased over { [REDACTED] } in Europe versus around { [REDACTED] } in North America in 2017) shows both that trade flows are inadequate to discipline regional pricing disparities and the existence of regional markets. (CCFF ¶¶ 631-33); *Tronox*, slip op. at 19.

Respondents also cite the purported growth in Chinese TiO₂ imports to North America from 2010 to 2016 as evidence of a global market. Resps.’ Post-Trial Br. at 48. However, the

presence of Chinese imports is not a rebuttal to the geographic market definition. Consistent with the *Merger Guidelines*, the geographic market here is properly defined around the location of customers, not suppliers, and therefore includes all sales to North American customers, regardless of their country of origin. (CCFF ¶¶ 141-42, 324). Therefore, to the limited extent they occur, Chinese chloride TiO₂ imports to North America are already included as sales by the hypothetical monopolist to this market. (CCFF ¶¶ 141-42, 324).

Moreover, even if the supposed growth in Chinese imports were relevant to market definition, the evidence is clear that Chinese TiO₂ supply does not discipline North American chloride TiO₂ prices. (CCFF ¶¶ 745-65, 786-93); *see also infra* at 72-79. The vast majority of Chinese production and exports to North America are sulfate TiO₂. (CCFF ¶ 752). Moreover, the amount of Chinese chloride TiO₂ imported to North America is minimal—Chinese chloride TiO₂ imports comprise only { [REDACTED] } of the North American market for chloride TiO₂—and the quality and reliability are typically poor. (CCFF ¶¶ 750-51, 753, 755, 761). As a result, most North American customers could not use or even credibly threaten to use Chinese TiO₂ to obtain lower pricing. (CCFF ¶¶ 749-53, 808-12). Indeed, North American chloride TiO₂ prices remained higher than those elsewhere for more than five years despite the supposed rise of Chinese TiO₂ imports during that period. (CCFF ¶¶ 236-58). Moreover, the growth in Chinese TiO₂ imports, such as it is, appears to be ebbing as strong domestic and Asian demand and supply cuts limit the amount of Chinese TiO₂ available for export to North America. (CCFF ¶¶ 775-86). Indeed, overall TiO₂ imports from China to North America have actually been *declining* since 2016. (CCFF ¶¶ 755, 786).

2. Respondents Reliance on Correlation and Cointegration Does Not Address Market Definition

Next, Respondents claim that North American prices are “correlated” and “co-integrated” with global prices, therefore proving a global market. Resps.’ Post-Trial Br. at 48-49. But correlation and co-integration analyses look only at *prices*. Neither addresses the relevant antitrust question of whether customers change their purchases in response to relative price changes.¹² (CCFF ¶¶ 353-59); *Tronox*, slip op. at 14-15 (rejecting price co-movements as a valid market definition tool because “the mere fact that the prices of two goods move upward or downward together need not mean they are substitutes”). As a former head of the FTC’s Bureau of Economics, Professor Jonathan Baker, wrote, “price correlation tests contain little or no information relevant to the issue of market definition” and “antitrust market definition analyses based upon price correlation information . . . should not be relied upon.”¹³ And Respondents’ expert, Dr. Shehadeh, could not identify any papers from the past 25 years supporting the use of price co-movement as a tool to define relevant markets. (CCRRFF ¶ 309). Moreover, Tronox’s Vice President of Sales for the Americas testified at trial—under questioning from his own counsel—that prices among regions { [REDACTED] } to pricing. (CCFF ¶ 151).

As the *Merger Guidelines* and case law recognize, the right analysis to determine the relevant market—and the one employed by Complaint Counsel—is the hypothetical monopolist test, which assesses changes in purchases in response to a price increase. *Merger Guidelines* § 4.1.1 (“The Agencies employ the hypothetical monopolist test to evaluate whether groups of products in candidate markets are sufficiently broad to constitute relevant antitrust markets.”); *FTC v. Penn State Hershey Med. Ctr.*, 838 F.3d 327, 338 (3d Cir. 2016); *Staples 2016*, 190 F.

¹² Dr. Shehadeh cites a paper by FTC economists that he claims supports his approach, but that paper predates the subsequent research showing the method’s flaws for antitrust market definition purposes. (CCFF ¶ 358, CCRRFF ¶ 309).

¹³ Jonathan Baker, “Why Price Correlations Do Not Define Antitrust Markets: On Econometric Algorithms for Market Definition,” 7, 45 (FTC Bureau of Economics Working Paper No. 149 (1987)) (attached hereto as Ex. B.).

Supp. 3d at 121-22. If a market passes the hypothetical monopolist test—as the North American market does here—this conclusively establishes a market for the purposes of antitrust analysis, regardless of whether prices are correlated or cointegrated. (CCFF ¶¶ 134-42, 323-29).

In addition to its general unsuitability as a market definition tool, the specific cointegration analysis Dr. Shehadeh performed suffers from some well-known flaws that further undermine its reliability. (CCFF ¶¶ 355-57). For example, Dr. Shehadeh’s data sample, which is limited to 24 observations, is too small—an issue that results in finding cointegration where none, in fact, exists. (CCRRFF ¶ 309). As the economic literature recognizes, even one hundred observations, many times the number Dr. Shehadeh relied upon, “seem incapable of distinguishing between two goods that are in the same market and two goods that are not.”¹⁴ (CCRRFF ¶ 309). Indeed, based on price movements, the same cointegration analysis performed by Dr. Shehadeh shows that propane and crude oil are in the same market, but that is clearly wrong. (CCFF ¶ 359).

Respondents appear to argue that because pricing is negotiated with individual customers, “there is no ‘regional price’ for TiO₂,” and that prices are therefore, correlated globally. Resps.’ Post-Trial Br. at 49. The relevant question is not, however, whether prices are individually negotiated, but whether suppliers can charge different prices based on the customers’ location. *Merger Guidelines* § 4.2.2. That prices are individually negotiated provides TiO₂ producers with the means to price discriminate based on their customers’ geographic locations. Indeed, evidence of individual price negotiations bolsters the ability of firms to price discriminate. *See, e.g., FTC v. Sysco Corp.*, 113 F. Supp. 3d 1, 46 (D.D.C. 2015) (identifying individual price negotiations as a factor in determining a supplier’s ability to price discriminate); *see also Merger*

¹⁴ *See, e.g.,* Patrick Coe & David Krause, *An Analysis of Price-Based Tests of Antitrust Market Delineation*, 4 J. Competition L. & Econ. 983, 1001 (2008) (attached hereto as Ex. C).

focuses solely on demand substitution factors”); *FTC v. Wilh. Wilhelmsen Holding ASA*, Civ. A. No. 1:18-cv-00414-TSC, slip op. at 12, 33 n.6 (D.D.C. July 21, 2018) (“demand substitution” is the very “touchstone” of market definition). Moreover, in addition to being irrelevant to an analysis of the relevant geographic market, as discussed below, Respondents’ contention that imports respond to higher North American prices is also factually wrong. *See infra* at 54-56.

3. Respondents’ Attack on Complaint Counsel’s Hypothetical Monopolist Test is Erroneous

Respondents contend that Complaint Counsel erred in applying the hypothetical monopolist test by “giv[ing] the hypothetical monopolist control over supply both inside *and outside* the proposed relevant market.” Resps.’ Post-Trial Br. at 50 (emphasis in original). That is wrong. The *Merger Guidelines* specify that in a market based on the location of customers, as here, the hypothetical monopolist is defined as “the only present or future seller of the relevant product(s) to customers in that region,” and that all sales made to North American customers, “regardless of the location of the supplier making those sales” are attributed to the hypothetical monopolist. *Merger Guidelines* § 4.2.2. When conducting this analysis, “the terms of sale for products sold to all customers outside the region are held constant.” *Merger Guidelines* § 4.2.2. That is precisely what Dr. Hill did, assessing whether a monopolist supplier of chloride TiO₂ to customers in North America could raise prices by a SSNIP, and finding that it could. (CCFF ¶¶ 142).

Respondents’ contend that product sold outside the candidate market might be reallocated back to the candidate market in response to a SSNIP and must be considered. Resps.’ Post-Trial Br. at 50. First, that argument is factually wrong—there is no evidence that imports or exports would respond sufficiently to defeat a SSNIP. (CCFF ¶¶ 640-57). Second, by introducing additional sources of supply, Respondents attempt to make an end run around the *Merger*

Guidelines and relevant case law by introducing supply responses into market definition analysis where none belong. (CCFF ¶¶ 360-62); *Merger Guidelines* § 4 (“Market definition focuses solely on demand substitution factors”); *Wilhelmsen*, slip op. at 12 (recognizing that “demand substitution” is the very “touchstone” of market definition.”).

Dr. Shehadeh’s consideration of changes to imports or exports as a form of arbitrage is directly at odds with the meaning of arbitrage in the *Merger Guidelines*, which is limited to actions taken by consumers (demand side responses). (CCFF ¶ 362). Consistent with the *Merger Guidelines*, here those demand side responses would consist of a North American TiO₂ customer traveling outside of North America to purchase product itself or buying from a customer outside of North America, and then assuming the costs and effort associated with getting the product to its plant. (CCFF ¶ 362; CCRRFF ¶¶ 343-47); *Merger Guidelines* § 4.2.2. Anything else would be a supply side response and must be attributed to the hypothetical monopolist. Accordingly, Respondents attacks on Complaint Counsel’s hypothetical monopolist test fail.

In sum, Respondents’ arguments that the relevant market is global conflicts with the real world evidence and the *Merger Guidelines* approach to geographic market definition and must be rejected.

B. The Relevant Product Market Is Chloride TiO₂

Respondents assert that the relevant product must include both sulfate and chloride TiO₂ because the two products are “interchangeable in the vast majority of applications.” Resps.’ Post-Trial Br. at 50. But the fact that—as a technical matter—a company can make paint (for example) with chloride or sulfate TiO₂ says nothing about the proper antitrust market. *Customers* in North America generally do not make paint with sulfate TiO₂ because U.S. and

Citing to an article from 2000, Respondents assert that a chloride TiO₂ product market cannot be reconciled with the FTC's position regarding the proposed DuPont/ICI merger in 1998. Resps.' Post-Trial Br. at 51 (citing RX1598). But the FTC's investigation of the proposed DuPont/ICI merger twenty years ago is not relevant here. Complaint Counsel's definition of the market in this case is based on evidence about the sale and use of TiO₂ *today*, not twenty years ago. Moreover, contrary to what Respondents claim, the article they cite does *not* say that the FTC found direct competition between sulfate and chloride TiO₂; it says only that ICI was trying to develop sulfate TiO₂ to compete with DuPont's chloride TiO₂. (CCRRFF ¶ 438 (citing RX1598 at 13)). Customer testimony and purchasing data make clear that that effort was unsuccessful: for the vast majority of TiO₂ purchases in North America today, sulfate TiO₂ does not compete against chloride TiO₂. (CCFF ¶¶ 26-133).

Importantly, Respondents fail to mention that the Commission had similar concerns regarding the DuPont/ICI merger as Complaint Counsel has here. Specifically, the Commission was concerned that "the elimination of an important competitor like ICI could facilitate or increase the likelihood of coordinated behavior." (CCRRFF ¶ 438 (quoting RX1598 at 13)). DuPont's remedy proposals failed to "address the elimination of a competitor that stood in the way of coordinated behavior," and the parties ultimately abandoned the transaction. (CCRRFF ¶ 438 (quoting RX1598 at 13)).

Respondents point out that some North American customers do buy both chloride and sulfate TiO₂. Resps.' Post-Trial Br. at 51. But they fail to mention that those customers use sulfate TiO₂ *only* for low-end products such as primers and traffic paint. True Value testified that { [REDACTED] } (CCFF ¶ 56). PPG testified that it { [REDACTED] }

[REDACTED] } (CCFF ¶¶ 57, 129;

CCRRFF ¶ 387). Likewise, Respondents state that [REDACTED]

[REDACTED] } (CCRRFF ¶ 387 (Christian, Tr. 940-941)). Respondents claim that

{ [REDACTED] }, Resps.’ Post-Trial

Br. at 51, but this is actually the same example of { [REDACTED]

[REDACTED] } (CCRRFF ¶ 387). { [REDACTED]

[REDACTED] } and further explained that ({ [REDACTED]

[REDACTED] } (CCRRFF ¶ 387; CCFF ¶ 130).¹⁸ Respondents also point to a

2013 statement that [REDACTED]

[REDACTED] (CCRRFF ¶ 387). Valspar is now part of Sherwin-Williams, and { [REDACTED]

[REDACTED] } (CCRRFF ¶ 387).

There is voluminous evidence—including from customers, other producers, and the parties themselves—that chloride TiO₂ has superior performance characteristics to sulfate TiO₂.

(CCFF ¶¶ 58-92). Respondents claim to refute this evidence by citing to testimony from their

¹⁷ Behr and Kilz are actually separate Masco brands; Behr does not make Kilz. *See* (CCRRFF ¶ 387).

¹⁸ Respondents cite to a statement in a Barclays report that chloride and sulfate TiO₂ are fungible. Resps.’ Post-Trial Br. at 51. But Barclays is a bank, not a TiO₂ market participant, and its statements should be accorded far less weight than those of actual TiO₂ customers. Moreover, the Barclays report was not specific to North America, and Barclays acknowledged pushback to its view that sulfate and chloride TiO₂ are fungible, stating by way of example that “Chinese exports [of sulfate TiO₂] are not going to replace a high-quality Western supplier in S[herwin-]W[illiams]’s North American architectural paint business.” (CCRRFF ¶ 388 (quoting RX0251 at 4)).

own executives that the finishing process (as opposed to the chloride or sulfate manufacturing process) is what determines TiO₂'s qualities, and that chloride and sulfate TiO₂ "can look the same." Resps.' Post-Trial Br. at 52. But this self-serving testimony from Tronox executives should be given little weight.¹⁹ (CCRRFF ¶¶ 372, 381-82). First, it is contrary to Tronox's own prior statements that chloride and sulfate TiO₂ do not look the same. (CCFF ¶ 73 (quoting Tronox presentations: { [REDACTED] [REDACTED] [REDACTED] }, and "[c]hloride technology yields consistently whiter, brighter pigment grades . . .")). It is also contrary to the trial testimony of Kronos, who, unlike Tronox, actually makes both chloride and sulfate TiO₂. (CCFF ¶ 74 ("An SP [sulfate TiO₂] product is going to produce what we would call a yellowish undertone, where the CP [chloride TiO₂] product is going to have a brighter white to it, or we call it a bluish undertone."); CCFF ¶ 92 ("Like I mentioned earlier, it's a superior product on its optical, you know properties, whether . . . its color undertone, or its tinting strength, durability, a whole host of different ways of evaluating a grade of TiO₂, and chloride products tend to outperform sulfate products.")). And most importantly, it is contrary to the testimony of customers who actually use TiO₂ in their products. These customers consistently testified that chloride TiO₂ has superior performance characteristics to sulfate TiO₂, therefore limiting the substitutability between the two products in North America. (CCFF ¶¶ 33-39, 46-58, 62-68, 70-72, 75-80, 85-91, 123-33).

Indeed, customers' testimony about their own businesses, how they buy and use the relevant product, and their ability to substitute to other products is critical: "[c]ustomers typically are the best source, and in some cases they may be the only source, of critical information on the

¹⁹ In fact, Chemours explained that { [REDACTED] [REDACTED] (CCFF ¶ 84).

factors that govern their ability and willingness to substitute in the event of a price increase.”

Commentary on the Horizontal Merger Guidelines at 9 (2006). The *Merger Guidelines* themselves recognize the importance of customer testimony on a host of issues, including “their own purchasing behavior and choices,” “how they would likely respond to a price increase,” and “the relative attractiveness of different products or suppliers.” *Merger Guidelines* § 2.2.2. Courts routinely rely upon third party testimony to gain an understanding of the market. *Staples 2016*, 190 F. Supp. 3d at 119 (citing customer testimony as evidence of pricing); *FTC v. Sysco Corp.*, 113 F. Supp. 3d 1, 32 (D.D.C. 2015) (using customer testimony as evidence of the proper product market). Here, the customer testimony is overwhelming that sulfate TiO₂ is not a suitable substitute for chloride TiO₂ in North America. (CCFF ¶¶ 33-39, 46-58, 62-68, 70-72, 75-80, 85-91, 123-33).

Respondents’ assertion that [REDACTED]

[REDACTED]

[REDACTED] (RFF ¶ 398). But PPG testified that { [REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶ 57). And

Sherwin-Williams testified that { [REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶ 37). Moreover, it is not

clear that the testimony cited even relates to lost sales in North America. Likewise, Respondents

claim that [REDACTED]

[REDACTED] Resps.’ Post-Trial Br. at 52. But the testimony Respondents cite does not relate to

competition for customers; instead it is a [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]}²² (CCRRFF ¶ 392). And [REDACTED] did not relate specifically to switching from chloride to sulfate TiO₂. (CCRRFF ¶ 395 (Pschaidt, Tr. 1012)).

Contrary to Respondents' assertions, the evidence shows that it is uncommon for North America customers to switch from chloride TiO₂ to sulfate TiO₂. (CCFF ¶ 117 ([REDACTED] [REDACTED])); CCFF ¶ 94 (Kronos: testifying that it is "pretty rare" for customers to reformulate from chloride to sulfate TiO₂, and that doing so "would entail a significant amount of work" and "a lot of trials"). To switch to sulfate TiO₂, even for limited quantities and product lines, North American customers currently purchasing chloride TiO₂ would need to reformulate their product lines and complete extensive testing to qualify the sulfate TiO₂, a process that would be costly and could take several years to complete. (CCFF ¶¶ 93-104).

Citing to their economic expert, Dr. Shehadeh, Respondents assert that that there is a "long-term relationship" between sulfate and chloride TiO₂ prices characterized by "statistically and economically significant co-movement of prices." Resps.' Post-Trial Br. at 53. But the statistical approaches Dr. Shehadeh used—the correlation and cointegration of prices—are unreliable for defining an antitrust market. (CCFF ¶¶ 353-59). Correlation analysis is prone to false positives that stem from common demand or supply factors, but Dr. Shehadeh did not

²² [REDACTED] (CCRRFF ¶ 392). [REDACTED] (CCRRFF ¶¶ 392, 616).

control for such factors. (CCFF ¶¶ 355-56).²³ As the District Court explained, “the mere fact that the prices of two goods move upward or downward together need not mean that they are substitutes.” *Tronox*, slip op. at 14. Dr. Shehadeh’s cointegration analysis relies on a statistical test that research has shown requires orders of magnitude more observations than Dr. Shehadeh used. (CCFF ¶ 357). For example, if one performed the same cointegration analysis used by Dr. Shehadeh, it would show that propane and crude oil are in the same product market, but that is clearly erroneous. (CCFF ¶ 359). Moreover, Dr. Shehadeh’s analysis is counter to the weight of the evidence, including Respondents’ own documents, which demonstrates that the TiO₂ producers do not view chloride TiO₂ and sulfate TiO₂ as interchangeable. (CCFF ¶¶ 32, 40-45, 58-61, 73-74, 81-84, 92, 94-95, 108, 113-15, 119-22).

Respondents claim that Complaint Counsel’s economist, Dr. Hill, conceded that the fire at Venator’s sulfate TiO₂ plant in Pori, Finland, affected Tronox’s TiO₂ prices. That is factually inaccurate and misleading. In fact, Dr. Hill testified that “[t]he link between the Pori fire and prices in North America is not clear.” (CCRRFF ¶ 431). Moreover, Dr. Hill testified that prices rose significantly in Europe relative to North America after the Pori fire. (CCFF ¶ 633; CCRFF ¶ 431).

As the District Court found, “[t]he evidence from customers and suppliers suggests a lack of significant interchangeability between chloride and sulfate TiO₂[,]” and “the report and testimony of the Commission’s expert economist, Dr. Hill, bolster this evidence.” *Tronox*, slip op. at 13. Therefore, the District Court found that the Commission had “sufficiently shown a relevant product market” of chloride TiO₂. *Id.*

²³ Respondents themselves explain that, for instance, “when GDP grows, consumers have more disposable income and demand for TiO₂ grows, too.” Resps.’ Post-Trial Br. at 8. Presumably, this statement applies equally to both chloride and sulfate TiO₂.

C. The Proposed Acquisition is Presumptively Unlawful Because it Would Substantially Increase Concentration in the Relevant Market

Respondents do not dispute that their Merger is presumptively unlawful in a relevant market of sales of chloride TiO₂ to customers in the United States and Canada. Instead, they argue that if market shares are calculated on the basis of a global rutile TiO₂ market, no presumption applies. Resps.' Post-Trial Br. at 53. The evidence, however, shows that the correct market in which to analyze the effects of the merger is sales of chloride TiO₂ to North American customers. (CCFF ¶¶ 23-322); *Tronox*, slip op. at 24 (“The Court finds that the FTC has carried its burden, and that the market for chloride-process TiO₂ in North America is the relevant market in which to assess the potential anticompetitive effects of Tronox’s acquisition of Critsal.”).

Respondents’ suggested approach, by contrast, makes the precise mistake that the *Merger Guidelines* caution against: “Defining a market broadly to include relatively distant product or geographic substitutes can lead to misleading market shares. This is because the competitive significance of distant substitutes is unlikely to be commensurate with their shares in a broad market.” *Merger Guidelines* § 4.0. Another court criticized Respondents’ expert, Dr. Shehadeh’s conclusion as “not credible” when he similarly attempted to include distant competitors in the relevant market. *United States v. Bazaarvoice, Inc.*, No. 13-00133, 2014 WL 203966, at *35 (N.D. Cal. Jan. 8, 2014).

In the alternative, Respondents argue that even if the relevant market is limited to the United States, market shares should be based on global capacity that is “readily available” to serve the market. Resps.’ Post-Trial Br. at 54. But the *Merger Guidelines* teach that the preferred method is to base market shares on individual firms’ current sales in the relevant market. *Merger Guidelines* § 5.2. That is because “[r]evenues in the relevant market tend to be

the best measure of attractiveness to customers, since they reflect the real-world ability of firms to surmount all of the obstacles necessary to offer products on terms and conditions that are attractive to customers.” *Id.* Consistent with the Merger Guidelines, Complaint Counsel’s market shares include all chloride TiO₂ sales in North America, regardless of where that chloride TiO₂ was manufactured, meaning that chloride TiO₂ imports into North America are already included in the market shares. (CCFF ¶¶ 141, 382).

By contrast, including firms in the market that have “readily available” capacity to do so is appropriate only when such firms 1) have efficient idle capacity or readily available “swing” capacity in adjacent markets, 2) would “very likely provide rapid supply responses with direct competitive impact in the event of a SSNIP,” and 3) can enter without incurring significant sunk costs. *Merger Guidelines § 5.1; see also Merger Guidelines § 5.2* (“[W]hen market shares are measured based on firms’ readily available capacities, the Agencies do not include capacity that is committed or so profitably employed outside the relevant market, or so high-cost, that it would not likely be used to respond to a SSNIP in the relevant market.”). None of those Guidelines’ conditions for relying on “readily available” capacity are met here. As a result, it would be “misleading” to base market shares on global capacity. *Merger Guidelines § 4.0*.

First, Respondents make no effort to show that any suppliers have idle capacity or readily available “swing” capacity that could be shifted to supply North American customers. Indeed, for example, the evidence shows that Chinese chloride TiO₂ producers have limited available capacity due to growing chloride TiO₂ demand in China. (CCFF ¶¶ 775-777, 780).

Second, there is no indication that foreign suppliers would, or could, rapidly supply chloride TiO₂ into North America to discipline a SSNIP. Outside North America, most global TiO₂ capacity is for *sulfate* TiO₂, which North American customers will not use for the majority

of their products, and which therefore would not discipline a SSNIP on chloride TiO₂ in North America. (CCFF ¶¶ 31-92, 808). Other than the North American producers, only a handful of firms even have chloride TiO₂ capacity, and the combined capacity of those firms represents only { }% of worldwide chloride TiO₂ capacity.²⁴ (CCFF ¶ 382). And to supply chloride TiO₂ to North American customers, those firms would need to satisfy substantial, and lengthy, qualification requirements. That qualification process can take years—making clear that such entry would not be “rapid.” (CCFF ¶¶ 102-03, 754). Moreover, rather than indicating that foreign suppliers likely would rapidly supply chloride TiO₂ into North America to discipline a SSNIP, history shows the opposite: foreign suppliers have not shifted their sales to the North American market in response to a SSNIP. Indeed, { }
 { }
 { }
 { }. (CCFF ¶ 645).²⁵

Third, suppliers could not supply North American customers with chloride TiO₂ without incurring substantial sunk costs. As noted above, most global capacity is for sulfate TiO₂. Suppliers would have to build new chloride TiO₂ capacity to further supply North American customers. Such expansion would { }. (CCFF ¶¶ 731-32).

Likewise, in addition to showing that foreign capacity (including that of the major domestic producers) has not been redeployed to serve the North American market in response to a SSNIP, the evidence also shows that the major domestic producers are unlikely to repatriate exports back to North America in meaningful amounts in response to a SSNIP on chloride TiO₂

²⁴ These firms include a few Chinese producers, Ishihara in Japan, and KMML in India. (CCFF ¶ 382). The de minimis sales of chloride TiO₂ from these other producers into North America are already included in the market shares. (CCFF ¶ 382)

²⁵ Moreover, the high costs of importing TiO₂ into North America, including shipping and duties, limit imports. (CCFF ¶¶ 645-50). Because of those costs, { }
 { }. (CCFF ¶ 647).

in North America. (CCFF ¶¶ 652-57). Therefore, it would result in “misleading market shares” to base those producers’ market shares on global capacity, when the evidence indicates that they would be unlikely to use that capacity to respond to a SSNIP on chloride TiO₂ in North America.

Finally, Respondents incorrectly assert that Complaint Counsel “declined to propose any alternative markets.” Resps.’ Post-Trial Br. at 54. But Complaint Counsel has shown that the merger would be presumptively illegal even in a market for sales of all rutile TiO₂ (i.e., both chloride and sulfate rutile TiO₂) in North America. (CCFF ¶¶ 394-97). The weight of the evidence, however, shows that the appropriate market in which to assess the competitive effects of this merger is the sale of chloride TiO₂ to North American customers. (CCFF ¶¶ 23-322); *Tronox*, slip op. at 24. The merger is presumptively illegal because it would significantly increase market concentration in that market. (CC Br. at 28-29; CCFF ¶¶ 390-93); *Tronox*, slip op. at 26 (“Because it would increase the HHI score by well over 200 points, and because it would result in a highly concentrated market, the proposed transaction is presumptively anticompetitive under the Merger Guidelines.”).

IV. EVIDENCE OF LIKELY HARM BOLSTERS THE PRESUMPTION

A. Real-World Evidence and Fundamental Economic Principles Both Confirm That the Merger is Likely to Result in Output Withholding

Respondents contend that Complaint Counsel has failed to show that the merger is likely to lead to reduced chloride TiO₂ output. Resps.’ Post-Trial Br. at 54-57. Respondents devote the bulk of their argument to attacking one of the economic models that Complaint Counsel’s economic expert, Dr. Nicholas Hill, used, Capacity Closure Model (“CCM”). Not only do Respondents’ specific attacks on the CCM lack merit, but the CCM is merely one piece of evidence that Complaint Counsel relies upon to show that the Merger will increase the merged

firm's incentives to withhold output. Rather, the substantial quantitative and qualitative evidence in the record, along with fundamental antitrust and economic principles incorporated into the *Merger Guidelines*, demonstrate that the Respondents already engage in and recognize the benefits of output reduction and that the merger makes that conduct even more likely. (CCFF ¶ 658). The CCM, and the other model Dr. Hill employs, the Cournot model, serve as corroboration, rather than the basis for, that conclusion.

Respondents assert that Complaint Counsel relies on “untested theories” to support its unilateral effects case, but that claim is wrong. Resps.’ Post-Trial Br. at 57. The economic and antitrust principles that support the notion that a merger like this one increases the likelihood of output withholding have been incorporated into the *Merger Guidelines*. The *Merger Guidelines* explicitly recognize that “[i]n markets involving relatively undifferentiated products,” such as the one at issue here, a merged firm may “find it profitable unilaterally to suppress output and elevate the market price. A firm may leave capacity idle, refrain from building or obtaining capacity that would have been obtained absent the merger, or eliminate preexisting production capabilities.” *Merger Guidelines* § 6.3. This is because the “merger may provide the merged firm a larger base of sales on which to benefit from the resulting price rise.” *Merger Guidelines* § 6.3. In other words, the larger a firm's market share, the greater benefit it captures from the higher prices resulting from the output curtailment, increasing the firm's incentives to do so. (CCFF ¶¶ 562-64; CC's Conclusions of Law ¶ 35).

Tronox and other North American TiO₂ producers already recognize these basic economic principles and incorporate them into their output decisions. As explained in Complaint Counsel's Post-Trial Brief, North American TiO₂ producers—either permanently through plant or line closures or temporarily through idling or temporary shutdowns—have withheld output a

number of times over the past decade. CC's Post-Trial Br. at 46-51; (CCFF ¶¶ 586-630). Tronox and other industry participants consistently acknowledge that those reductions have supported higher pricing. (CCFF ¶¶ 568-85). This industry reality of frequent output curtailment is consistent with the fundamental economic principle from the *Merger Guidelines* that larger firms have greater incentives to reduce output. And it supports the conclusion that this Merger will increase incentives for the merged firm to withhold output because Tronox will have an even greater ability and incentive to do so. (CCFF ¶ 551). No economic models are necessary to reach that conclusion. As the District Court found, there is “real-world proof of meaningful market incentives to manage prices by withholding TiO₂ supply.” *Tronox*, slip op. at 27.

Indeed, as discussed above, *supra* at 21-27, it was only after reaching that same conclusion in the first instance based on the full range of evidence—including documents, data, and testimony—that Dr. Hill then turned to economic modeling to *corroborate* his conclusion. Dr. Hill ran two standard models commonly applied to commodity markets, the CCM and Cournot model, both of which confirmed, consistent with the real-world evidence, that the Merger would likely result in the merged firm having a greater incentive to withhold output. (CCFF ¶ 659).

1. Respondents' Attacks on the Capacity Closure Model Are Unavailing

Respondents aim a number of specific attacks at the CCM, many that repeat arguments they have previously raised. None are availing. Respondents first argue that the CCM is not widely accepted in the economic community. Resps.' Post-Trial Br. at 55. As explained above, however, that is not true. *See supra* at 21-22. The CCM builds on antitrust principles incorporated into the *Merger Guidelines* that a larger firm has greater incentives to withhold

output. The CCM merely tests—using real-world data regarding the company’s specific costs of lowering output as well as likely rival responses based on how rivals have reacted to North American price changes in the past—whether it would be profitable for the merged entity to actually do so. (CCFF ¶¶ 665-67). The CCM finding that the Merger would increase incentives for the merged firm to withhold output comports with the real-world evidence showing that the individual Respondents have, with some frequency, reduced output for extended periods of time over the past decade. (CCFF ¶ 668). It is also consistent with the second model Dr. Hill ran, the Cournot model, which showed that the merged firm would have strong incentives to reduce output. (CCFF ¶ 684).

Next, Respondents repeat their claim that Dr. Hill’s CCM “assumes” away “competitive reactions by rivals” to a price increase brought about by the merged firm’s output reduction, even if prices were to increase substantially. Resps.’ Post-Trial Br. at 55. As addressed more fully in Complaint Counsel’s opening Post-Trial Brief and above, Dr. Hill did no such thing. CC’s Post-Trial Br. at 54-56; *supra* at 23-25. Dr. Hill carefully analyzed real-world evidence and data to determine likely rival responses to a chloride TiO₂ price increase in North America—domestic expansion, imports, and redirect exports—and incorporated those results into his model. (CCFF ¶¶ 667-68). Dr. Hill did not “assume,” for example, that redirected exports to North America would not defeat a price increase. Rather, he analyzed both the qualitative and quantitative evidence showing that North American producers had not repatriated exports back to North America, even when North American chloride TiO₂ prices were significantly higher than they are today (or would be with a 10% price increase). (CCFF ¶¶ 643-44, 652-57). The evidence showed that North American producers were reluctant to redirect imports in response to price changes because of the importance of long-term customer relationships and security of supply.

(CCFF ¶¶ 652-57). And the data supported that: as Dr. Hill found, there has been no evidence of export repatriation in the past, as shown by the persistent price difference between North America and other regions. (CCFF ¶¶ 643-44). Given this evidence, the District Court specifically credited that sizeable export repatriation would not occur. *Tronox*, slip op. at 22-23.

Respondents ignore this real-world evidence regarding rival responses and instead rely on their economic expert, Dr. Shehadeh, in an effort to support their otherwise unfounded contention that imports and exports would respond more aggressively to North American price changes. Dr. Shehadeh's estimates, however, are deeply flawed.

First, Dr. Shehadeh appears to rely on little more than a superficial eyeballing of a figure in Dr. Hill's report showing slight fluctuations in raw import volumes and assumed that those minor shifts must correspond to North American price changes. (CCRRFF ¶ 660); Shehadeh Tr. 3366 ("When we looked at those charts, we saw variation over time..."). But he made no attempt to determine whether such a relationship existed. (CCRRFF ¶ 660). And if he had tried, he would have found the opposite (*i.e.*, there was little relationship between TiO₂ imports and North American pricing and certainly not enough to defeat a post-merger price increase). (CCFF ¶¶ 641-42, 667).

Second, Dr. Shehadeh tried to calculate his own import elasticity estimate, but this calculation is also unreliable. Without justification, Dr. Shehadeh cherry-picked the time period of the data he relied on, excluding the recent data, resulting in a significant overestimate of the responsiveness of imports to price changes in North America. (CCFF ¶ 672). When fixed, Dr. Shehadeh's approach yielded results similar to Dr. Hill's showing that, consistent with real-world experience, there would be a very limited import response.²⁶ (CCFF ¶ 672).

²⁶ Dr. Shehadeh's own calculation of import elasticity also suffers from a multicollinearity problem. (CCFF ¶ 672). Multicollinearity arises when variables included in a regression are highly correlated. When this is the case,

Third, Dr. Shehadeh cited to an estimate of import elasticity derived from the economic literature that he claims is an import elasticity, but it shows no such thing. (CCFF ¶ 673). Rather, it estimates the willingness of U.S. customers to substitute between TiO₂ imports from different countries, not whether they would switch to imported TiO₂ over domestic TiO₂. (CCFF ¶ 673). As a result, the measure from the literature also greatly overstates the likely responsiveness of imports to a North American price increase. (CCFF ¶ 673).

Respondents next reiterate their contention that the CCM does not “fit the real-world TiO₂ industry” because Dr. Shehadeh calculated that Chemours sold more TiO₂ in 2016 than the model predicted it should. Resps.’ Post-Trial Br. at 55-56. As discussed above, *supra* at 25, Respondents ignore key evidence showing that { [REDACTED] } (CC’s Post-Trial Br. at 58; CCFF ¶¶ 430, 585, 678; CCRRFF ¶ 618). The detailed company-specific cost data necessary to accurately run the CCM was also unavailable for Chemours, a particular concern for Chemours because of the company’s proprietary production process. (CCFF ¶ 678; Resps.’ FF ¶ 23).

Respondents final attack on the CCM is that only a “small” rival response is necessary to defeat prices increases predicted by the CCM. (Resps.’ Post-Trial Br. at 55-56). As explained in Complaint Counsel’s opening Post-Trial Brief, however, Respondents once again ignore that Dr. Hill analyzed real-world data showing rival responses, incorporated that into his model, and still found that the output reduction would be profitable. CC’s Post-Trial Br. at 51-52; (CCFF ¶ 667-69). { [REDACTED] }

regression analysis cannot reliably identify the effect caused by each variable separately, a problem especially problematic when the sample, like Dr. Shehadeh’s here, is small. As Dr. Hill explained, Dr. Shehadeh’s calculation suffers from this very problem, rendering the result unreliable. (CCFF ¶ 672). When the offending variable is removed, though, the result is similar to Dr. Hill’s results. (CCFF ¶ 672).

[REDACTED]

[REDACTED] } (CCFF ¶

679). This is hardly the “small” change Respondents imply.

2. Respondents Have Unilaterally Reduced Output To Increase Prices

Following their attack on the CCM, Respondents contend that Complaint Counsel is incorrect that they have reduced—or even could reduce—output in order to increase prices, claiming that they have only ever reduced output “as a matter of last resort” under the most dire financial circumstances and never with any ability or intention of raising prices. (Resps.’ Post-Trial Br. at 56-57). But Complaint Counsel has thoroughly debunked Respondents’ assertion that they only reduced output as a matter of financial necessity. By analyzing the Respondents’ production data, Dr. Hill identified { [REDACTED]

[REDACTED] } (CCFF ¶¶ 595-612, 625).²⁷ All of those periods occurred when Respondents were [REDACTED]

[REDACTED] (CCFF ¶¶ 600, 604, 612, 625-26).

And Respondents’ history shows that when they have reduced output in the past, they understand that reducing output supports higher TiO₂ prices, and that they can reduce output again—particularly after the merger—when they will have an even greater ability and incentive to do so. (CC’s Post-Trial Br. at 45-52; CCFF ¶¶ 551-630). The District Court reached a similar

²⁷ Respondents assert that the CCM predicts that they did not have an incentive to withhold output when they were, in fact, doing so. Resps.’ Post-Trial Br. at 56. Respondents misunderstand the CCM. The CCM does not consider whether a firm should produce less than their plant’s nameplate capacity, but rather whether that firm should withhold output from their actual production, whatever that level may be. This is evidenced by the fact that the CCM relies on invoice data and not nameplate capacity. (CCRRFF ¶ 626-27). The CCM found that neither stand-alone firm should have been producing less TiO₂ than it did in 2016. (CCRRFF ¶ 626-27). However, the CCM did show that if the two firms merged, their profit-maximizing output would have been less than the collective production of the stand-alone firms, demonstrating that the Merger increases incentives to reduce output. (CCFF ¶¶ 668, 670).

conclusion, finding that the “real-world evidence . . . suggests that . . . to counter declining prices, chloride TiO₂ producers have incentives and the means to withhold supply,” *Tronox*, slip op. at 30, and that “the merger will increase already prevalent incentives to engage in strategic output withholding.” *Tronox*, slip op. at 35.

That practice is likely to increase with the merger. Tronox’s then-CEO, Mr. Tom Casey, assured investors that after the merger the company would “still balance our supply with demand,” and an internal Tronox document { [REDACTED] } (CCFF ¶¶ 616-18).

Moreover, running under capacity is clearly not the financial burden that Respondents purport it to be. Resps.’ Post-Trial Br. at 57. Not only have they done it with some regularity (as noted above), but as Tronox management explained to investors, fixed costs are not a deterrent: operating at 80 percent capacity utilization is “not an uncomfortable position for us. Obviously we would like to be operating in the high 90s but we have reconfigured some of our activities and think we can do it profitably without a lot of fixed costs overhang associated with it.” (CCFF ¶ 594).

Despite Respondents’ claims to the contrary, the price implications of these output reductions are clear. Respondents and other North American TiO₂ producers consistently credit industry output reductions—either outright facility closures or temporary shutdowns—with contributing to higher chloride TiO₂ prices. CC’s Post-Trial Br. at 46-51; (CCFF ¶¶ 568-82, 583-85, 590-91, 593, 596, 603, 606, 608-11). Indeed, as the District Court found, “[s]tatements from Tronox executives evince an understanding that TiO₂ producers recognize the benefits of strategically withholding supply from consumers to maintain higher prices,” and that “Tronox documents suggest the firm has withheld TiO₂ supply to shore up prices in the past.” *Tronox*,

slip op. at 27.

For example, in connection with Tronox’s idling two lines at its Hamilton plant from May 2015 through January 2016, the company’s then-CEO, Mr. Casey, told investors “that an upward move in selling prices will be predicated on a reduction of supply in the pigment market relative to demand.” (CCFF ¶ 606). He later explained that Tronox had taken steps to “manag[e] our production, so that inventories get reduced to normal or below normal levels; and when that happens, prices will rise.” (CCFF ¶ 610). And { [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶ 611).

This impact is not surprising given the basic principles of the chloride TiO₂ market where price is undisputedly driven by supply and demand. (CCFF ¶¶ 157, 188, 191, 233, 554-55). As PPG described at trial, { [REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶ 557).

As Complaint Counsel has shown, real-world economic evidence of past output reduction, supported by fundamental antitrust and economic principles, demonstrates that the merged firm would have an increased incentive to unilaterally withhold output.

B. Complaint Counsel Has Shown that the Acquisition Would Increase the Likelihood of Coordination in an Already Vulnerable Market

Complaint Counsel also shows that the merger would increase the likelihood of coordination among North American chloride TiO₂ producers. Respondents criticize Complaint Counsel’s argument that the market will become more concentrated and thus more susceptible to

coordinated pricing. But the evidence demonstrates that the Acquisition will substantially increase concentration in a market already vulnerable to coordinated conduct.²⁸ And case law and basic economics show that such an increase will make this already-concentrated industry even more susceptible to coordinated conduct going forward.

The market share statistics here render the Acquisition presumptively anticompetitive. CC Br. at 28-29; *see Staples 2016*, 190 F. Supp. 3d at 128; *Sysco*, 113 F. Supp. 3d at 52-53; *United States v. Aetna Inc.*, 240 F. Supp. 3d 1, 42-43 (D.D.C. 2017). Here, the Acquisition would *triple* the increase that renders an acquisition presumptively unlawful, and would leave Tronox and Chemours in control of {█}% of North American sales. (CCFF ¶ 391).

Such a merger increases the likelihood of coordinated interaction after the merger and is therefore unlawful: “Merger law rests upon the theory that, where rivals are few, firms will be able to coordinate their behavior, either by overt collusion or implicit understanding, in order to restrict output and achieve profits above competitive levels.” *Heinz*, 246 F.3d at 715 (internal quotation marks omitted); *see also CCC Holdings*, 605 F. Supp. 2d at 60 (“[A]bsent extraordinary circumstances, a merger that results in an increase in concentration above certain levels raise[s] a likelihood of ‘interdependent anticompetitive conduct.’”) (citation and internal quotation marks omitted) (quoting *United States v. General Dynamics Corp.*, 415 U.S. 486, 497 (1974)).²⁹

Because Complaint Counsel has established a *prima facie* case, Respondents bear the burden of “produc[ing] evidence of ‘structural market barriers to collusion’ specific to this

²⁸ Respondents’ citation to *United States v. Oracle Corp.*, 331 F. Supp. 2d 1098, 1109 (N.D. Cal. 2004), is misplaced. Resps.’ Post-Trial Br. at 57. In that case, the government did not put forth evidence on coordinated effects. *Oracle*, 331 F. Supp. 2d at 1113.

²⁹ As the court explained in *CCC Holdings*, “With only two dominant firms left in the market, the incentives to preserve market shares would be even greater, and the costs of price cutting riskier, as an attempt by either firm to undercut the other may result in a debilitating race to the bottom.” 605 F. Supp. 2d at 67.

industry that would defeat the ‘ordinary presumption of collusion’ that attaches to a merger in a highly concentrated market.” *United States v. H&R Block*, 833 F. Supp. 2d 36, 77 (D.D.C. 2011) (quoting *Heinz*, 246 F.3d at 725); accord *CCC Holdings*, 605 F. Supp. 2d at 60. Respondents’ have failed to do so here. Instead, the record evidence bolsters the presumption. This additional evidence shows that the market is already vulnerable to coordinated conduct, and that the Merger will increase the likelihood of coordination by removing one of the few significant competitors, by increasing transparency, and by replacing a firm that has competed aggressively in the past with one committed to market discipline.

1. The Market for North American Sales of Chloride TiO₂ Is Vulnerable to Coordination and Operates as an Interdependent Oligopoly

Respondents contend that coordination is “not possible” because of negotiated pricing and “fierce competition” (Resps.’ Post-Trial Br. at 58), but this is belied by the evidence. The evidence shows not only that the market is vulnerable to coordination, but that it is already characterized by anticompetitive interdependence. (CC’s Post-Trial Br. at 36-45; CCFF ¶¶ 405-499). Indeed, three federal courts have come to the same conclusion. *Valspar Corp. v. E.I. du Pont de Nemours & Co.*, 873 F.3d 185, 197 (3rd Cir. 2017) (“There is no dispute that the [TiO₂] market was primed for anticompetitive interdependence and that it operated in that manner.”); *Valspar Corp. v. E. I. Du Pont De Nemours & Co.*, 152 F. Supp. 3d 234, 250 (D. Del. 2016) (“It appears that, in making those [business] decisions, DuPont and the other defendants undertook actions that could plausibly be interpreted as ‘collusive.’”); *id.* at 253 (“The evidence cited by Valspar demonstrates that the titanium dioxide industry is an oligopoly.”); *In re Titanium Dioxide Antitrust Litig.*, 959 F. Supp. 2d 799, 823 (D. Md. 2013) (“The record contains ample evidence for concluding that the [d]efendants agreed to raise prices and shared commercially sensitive information . . . to facilitate their conspiracy.”). The District Court in the preliminary

injunction case similarly recognized the “real-world proof of meaningful market incentives to manage prices by withholding TiO₂ supply.” *Tronox*, slip op. at 27. As discussed below, Professor Herbert Hovenkamp has a forthcoming article that explains why a merger in the TiO₂ industry is problematic. *See infra* at 66-68, 72 (discussing Herbert Hovenkamp, *Prophylactic Merger Policy*, HASTINGS L.J. (forthcoming 2018) (attached hereto as Ex. D)).

Despite Respondents’ assertion to the contrary, TiO₂ producers obtain detailed information about their competitors’ prices, [REDACTED], often from the customers themselves. (CCFF ¶¶ 476-85; CCRRFF ¶ 707 (PX2460 (Cristal North America Weekly Report)). Moreover, Respondents’ suggestion that producers must know their competitors’ precise prices at each customer in order to coordinate is a red herring. Producers can coordinate on price movements and enact parallel price increases without knowing the exact price at each customer, and the Third Circuit has already observed that this very thing happens in the TiO₂ industry. *See Valspar*, 873 F.3d at 195 (observing that TiO₂ producers engaged in interdependent, parallel pricing). Indeed, even general information about whether competitors are increasing price is useful to producers and allows them to coordinate pricing efforts. *See* (CC Post-Trial Br. at 39; CCFF ¶¶ 412-25; CRRFF ¶ 714 [REDACTED]

[REDACTED]

[REDACTED]

Producers obtain significant non-price information about competitors as well. Through sources such as earnings calls, investor presentations, TZMI reports, customer intelligence, and price increase announcements, producers are able obtain a wealth of information regarding competitors’ behavior, including specific information on output and price levels. (CC Br. 37-41; CCFF ¶¶ 460-92, 768-69). For example, internal Tronox and Cristal business intelligence emails

identify ‘key’ comments from competitors’ earnings calls, including comments on price increase announcements and implementation, inventory levels, plant utilization rates, and expectations for future pricing. (CCFF ¶¶ 464-69).

All of this information significantly increases transparency regarding competitors’ pricing, capacity utilization and inventory levels, and competitive responses (or lack thereof). And it is particularly useful for interdependent conduct because, as Respondents’ acknowledge, TiO₂ pricing is “driven by supply and demand, capacity utilization, and inventory levels.” (Resps.’ Post-Trial Br. at 9).

The evidence therefore shows that Respondents’ assertion of “fierce competition” in the market is both factually wrong and misses the point. The existence of some competition is not a defense to an otherwise anticompetitive merger. CC’s Post-Trial Br. at 44.³⁰ Moreover, voluminous evidence shows that far from being “fiercely competitive,” the TiO₂ industry in North America is an oligopoly characterized by anticompetitive interdependence. (CCFF ¶¶ 403-59). In fact, although Respondents assert that customers are able to obtain lower pricing by “leveraging producers against one another,” customers do not have the bargaining power that Respondents allege. Undisputed customer testimony described a market [REDACTED] [REDACTED] } (CCFF ¶¶ 638-39 (tight market); CCRRFF ¶ 534 (series of price increases)). { [REDACTED] [REDACTED] } (CCRRFF ¶ 534).

Moreover, customer testimony and purchasing data make clear that for most of their TiO₂ needs, North American customers are limited to the chloride TiO₂ produced by the handful

³⁰ As the Third Circuit observed in *Valspar*, “it is generally unremarkable for the pendulum in oligopolistic markets to swing from less to more interdependent and cooperative.” 873 F.3d at 196 (internal quotation marks and citations omitted).

provide the necessary margins to also contribute towards covering heavy fixed costs, “the sellers will have a big incentive to fix prices.”).

Respondents argue that public price announcements, “some of which occurred close in time and were similar in amount,” reflect nothing more than “independent business decisions.” Resps.’ Post-Trial Br. at 59. But the evidence unambiguously shows that the major producers base their price increase decisions in part on whether, when, and in what amount the other major producers are increasing their prices. (CCFF ¶¶ 412-25). That is tacit coordination. As the *Valspar* court observed about this very industry:

DuPont [now Chemours] does not claim that the competitors’ numerous parallel price increases were discrete events – nor could it do so with a straight face. But it doesn’t need to. The theory of interdependence recognizes that price movement in an oligopoly will be just that: *interdependent*. And that phenomenon frequently will lead to successive price increases, because oligopolists may “conclude that the industry as a whole would be better off by raising prices.”

873 F.3d at 195 (citation omitted). This pattern of price increases that are close in time and for similar amounts continues today. *See* (CCFF ¶ 426; CCRRFF ¶ 714 (Pschaidt, Tr. 975 (“Usually the TiO₂ manufacturers announce price increases very close to each other,” and “usually the amounts of these increases are very close to each other.”)); CCRRFF ¶ 714 (Arrowood, Tr. 1091-1092 (“Usually, when a supplier, TiO₂ supplier, announces a price increase, within a matter of just a few days the other suppliers will also announce a price increase,” typically for “very similar” amounts)).

Respondents argue that plant closures reflect efforts to lower the overall cost of production. Resps.’ Post-Trial Br. at 60. But North American chloride TiO₂ producers’ output decisions are highly interdependent, and the producers recognize that withholding output supports higher prices. (CCFF ¶¶ 427-32, 471-74, 568-85). Both Tronox and Cristal have reduced output on a number of occasions in order to support North American chloride TiO₂

prices. (CCFF ¶¶ 586-630). And there has been no new TiO₂ entry in North America for many years, and there is no evidence of any large-scale output expansions by North American producers. (CCFF ¶ 729).

Respondents also argue that the “varied incentives and cost structures” of TiO₂ producers impede coordination. But this merger will actually *increase* the symmetry between the combined firm and market leader Chemours, resulting in post-merger Tronox and Chemours having incentives that are more aligned, thereby making coordination easier and even more likely. (CCFF ¶¶ 545-50). As the District Court in *Tronox* observed, post-merger Tronox and Chemours will control roughly three-quarters of all chloride TiO₂ production, allowing these firms to “more easily ‘stop the price erosion in the market’ and ‘slow down production’ across the industry, as customers will often be left with no meaningful alternative sources of supply.” *Tronox*, slip op. at 29 (quoting PX1435 at 001 and PX9000 at 012 (Tronox Q4 2016 Earnings call)); see *Tronox*, slip op. at 30 (“Chemours and the Tronox-Cristal entity would often be able to maintain price discipline and control supply in a post-merger market simply by competing less vigorously against each other for major accounts.”).

Respondents’ assertion that the merger will “further reduce[] transparency in the cost structure and incentives of the post-transaction entity” is baffling and contrary to the facts. Resps.’ Post-Trial Br. at 61. As publicly traded companies, Tronox, Chemours, Venator, and Kronos are all required to conduct earnings calls and file quarterly and annual reports. In these public disclosures, the TiO₂ producers often provide a treasure trove of information about topics such as their margins, their plant utilization rates, their inventory levels, their expectations for production, and their plans and expectations for pricing. (CCFF ¶¶ 462-75). As a privately held company, today Cristal does not make these public disclosures, meaning there is less

transparency into Cristal's business. This merger would change that, resulting in Tronox making public disclosures about Cristal's competitive activities that Cristal does not make today.

2. This Is Precisely the Type of Merger That the Clayton Act is Intended to Address

This merger will substantially increase concentration in a market that is already characterized by oligopolistic interdependence. This is *precisely* the type of merger that Section 7 of the Clayton Act is intended to address. See Herbert Hovenkamp, *Prophylactic Merger Policy* (Ex. D at 12).

Merger law is designed to prevent opportunities for coordinated conduct *before* they occur. *Chi. Bridge & Iron v. FTC*, 534 F.3d 410, 423 (5th Cir. 2008) (“The words ‘may be’ have been in Section 7 of the Clayton Act since 1914. The concept of reasonable probability conveyed by these words is a necessary element in any statute which seeks to arrest restraints of trade in their incipiency and before they develop into full-fledged restraints violative of the Sherman Act.” (quoting *Brown Shoe Co. v. United States*, 370 U.S. 294, 323 n.39 (1962))); *Merger Guidelines* § 1 (“these Guidelines reflect the congressional intent that merger enforcement should interdict competitive problems in their incipiency . . .”); Hovenkamp, *Prophylactic Merger Policy* (Ex. D at 1-4). Oligopolies pose a unique problem, because the interdependence, conscious parallelism, and tacit coordination that often characterize oligopolies cannot easily be controlled by the antitrust laws. See *Heinz*, 246 F.3d at 725 (explaining that tacit coordination is “feared by antitrust policy even more than express collusion, for tacit coordination, even when observed, cannot easily be controlled directly by the antitrust laws.”). Therefore, as the D.C. Circuit has made clear, “[A] central object of merger policy [is] to obstruct the creation or reinforcement by merger of such oligopolistic market structures in which tacit coordination can occur.” *Id.* (quoting 4 Phillip E. Areeda, Herbert Hovenkamp & John L.

Solow, Antitrust Law ¶ 901b2, at 9 (rev. ed. 1998)).

In contrast to Section 7 of the Clayton Act, Section 1 of the Sherman Act applies only when there is an *agreement* to restrain trade, so interdependent or consciously parallel behavior, though anticompetitive and harmful to consumers, does not implicate Section 1. *Valspar*, 873 F.3d at 191. That is why mergers that increase concentration in an already concentrated market are so problematic: oligopolists are more easily able to engage in anticompetitive (but legal) parallel conduct without resorting to an actual agreement that would violate Section 1 of the Sherman Act. See Hovenkamp, *Prophylactic Merger Policy* (Ex. D at 10-11) (citing *Valspar*, 873 F.3d at 193). Consequently, it is actually *more* difficult to prove a Sherman Act violation in an oligopoly. As the *Valspar* court explained:

In non-oligopolistic markets, “[p]arallel behavior among competitors is especially probative of price fixing because it is the sine qua non of a price fixing conspiracy.” But in an oligopolistic market, parallel behavior “can be a necessary fact of life,” and “[a]ccordingly, evidence of conscious parallelism cannot alone create a reasonable inference of a conspiracy.” Therefore, to prove an oligopolistic conspiracy with proof of parallel behavior, that evidence “must go beyond mere interdependence” and “be so unusual that in the absence of an advance agreement, no reasonable firm would have engaged in it.”

873 F.3d at 193 (citations omitted). As a result, merger enforcement is particularly important in a market, like this one, that is already an oligopoly characterized by interdependent conduct, and where future tacit coordination is likely to fall outside the reach of the Sherman Act:

[O]ne important trigger for horizontal merger enforcement should be a market, as the *Valspar* case suggests, where existing Sherman § 1 case law would be unlikely to infer a § 1 violation from parallel conduct in the post merger market. This makes more aggressive merger enforcement necessary to limit the number of such situations.

Hovenkamp, *Prophylactic Merger Policy* (Ex. D at 12).

Far from being inapposite, as Respondents assert, the decisions in the *Valspar* and *In re Titanium Dioxide* price fixing cases serve as further confirmation of what the evidence in this

case clearly shows: that the market is conducive to coordinated conduct and in fact has exhibited such conduct. All three federal courts that issued opinions in the price-fixing litigations observed that the TiO₂ industry is an oligopoly characterized by coordinated conduct—be it anticompetitive interdependence (*Valspar* litigation), or actual price-fixing (*In re Titanium Dioxide*). In *Valspar*, the Third Circuit affirmed summary judgment for defendant DuPont (now Chemours), finding that Valspar had succeeded in showing “anticompetitive interdependence,” but not an illegal conspiracy. *Valspar*, 873 F.3d at 196-97. In the *Valspar* litigation, the lower court granted summary judgment for DuPont because the evidence was “as consistent with interdependence as with a conspiracy.” *Valspar*, 152 F. Supp. 3d at 252-53 (citation omitted). In doing so, the court observed that “[t]he evidence cited by Valspar demonstrates that the titanium dioxide industry is an oligopoly,” and that the “oligopoly may well have caused substantial anticompetitive harm to Valspar.” *Id.* at 253. The court in *In re Titanium Dioxide* reached a different result, finding that the plaintiffs had provided sufficient evidence to support their allegations of a TiO₂ price fixing conspiracy:

Having carefully considered the sheer number of parallel price increase announcements, the structure of the titanium dioxide industry, the industry crisis in the decade before the Class Period, the Defendants’ alleged acts against their self-interest, and the myriad non-economic evidence implying a conspiracy, this Court finds that the Plaintiffs put forward sufficient evidence tending to exclude the possibility of independent action.

959 F. Supp. 2d at 830.

Tronox notes that it was not a party to the TiO₂ price fixing cases, but it was a full participant in the oligopolistic market at issue and was an alleged *coconspirator*. The alleged conspirators in those cases were the five producers of TiO₂ in North America: Chemours (formerly DuPont), Tronox, Cristal USA, Kronos, and Venator (formerly Huntsman). *In re Titanium Dioxide Antitrust Litig.*, 959 F. Supp. 2d at 802 & n.2. Tronox was only omitted as a

named defendant because it was in bankruptcy at the time those cases were filed. *Id.*

Moreover, the Third Circuit in *Valspar* did not “specifically reject coordination,” as Respondents assert. Resps.’ Post-Trial Br. at 61. To the contrary, the *Valspar* court found the existence of *tacit* coordination—the primary concern of merger law; indeed, the Court expressly stated that Valspar had “succeeded in showing interdependence but not conspiracy.” *Valspar*, 873 F.3d at 196. This finding was central to the *Valspar* court’s decision affirming summary judgment for DuPont. As the court explained, “oligopolistic conscious parallelism is *by nature* anticompetitive *and also* legal” under Section 1 of the Sherman Act. *Valspar*, 873 F.3d at 200 (emphasis in original). But that is precisely why tacit coordination a central focus of *merger law*. *See Heinz*, 246 F.3d at 725 (“[A] central object of merger policy [is] to obstruct the creation or *reinforcement* by merger of such oligopolistic market structures in which tacit coordination can occur.”) (citation omitted) (emphasis added); *Merger Guidelines* § 7.0 (Coordination includes conduct ranging from outright collusion, to tacit coordination, to “parallel accommodating conduct,” which “includes situations in which each rival’s response to competitive moves made by others is individually rational . . . but nevertheless emboldens price increases and weakens competitive incentives to reduce prices . . .”).

Respondents incorrectly contend that the *Valspar* and *In re Titanium Dioxide* opinions are inapposite because the TDMA information sharing program no longer exists. Resps.’ Post-Trial Br. at 62. But as explained in Complaint Counsel’s Post-Trial Brief, in both cases, the courts cited to a wide variety of other evidence that was suggestive of conspiracy (*In re Titanium Dioxide*) or “anticompetitive interdependence” (*Valspar*). CC’s Post-Trial Br. at 31-32.

Finally, Respondents suggest that it is somehow telling that Complaint Counsel did not ask witnesses at trial about the *Valspar* and *In re Titanium Dioxide* opinions. But asking fact

witnesses for their views on these *legal opinions* would have been wholly improper and would not have generated admissible evidence. Instead, Complaint Counsel asked witnesses about their *experience with and knowledge of the TiO₂ industry in North America*. The third-party market participants described a market consistent with that observed by the *Valspar* and *In re Titanium Dioxide* courts: an oligopoly characterized by parallel conduct. *See, e.g.*, (CCFF ¶¶ 375, 426, CCRRFF ¶ 714 (Pschaidt, Tr. 975 (“Usually the TiO₂ manufacturers announce price increases very close to each other,” and “usually the amounts of these increases are very close to each other.”)); CCRRFF ¶ 714 (Arrowood, Tr. 1091-92 (“Usually, when a supplier, TiO₂ supplier, announces a price increase, within a matter of just a few days the other suppliers will also announce a price increase,” typically for “very similar” amounts)).

3. The Acquisition Will Increase the Likelihood of Coordination

Complaint Counsel’s coordinated effects case does not depend on an economic model, as Respondents suggest. Resps.’ Post-Trial Br. at 63. Complaint Counsel’s economic models merely corroborate what the evidence establishes: that the merger is likely to substantially lessen competition.³¹ As set forth above, because the merger will result in “a firm controlling an undue percentage share of the relevant market” with “a significant increase in the concentration of firms in that market,” it is presumptively illegal. *Heinz*, 246 F.3d at 715 (citation and internal quotations omitted); *id.* at 715-16 (“Increases in concentration above certain levels are thought to ‘raise[] a likelihood of interdependent anticompetitive conduct.’”) (citation omitted).

Complaint Counsel put forth voluminous additional evidence bolstering the presumption,

³¹ Dr. Hill’s application of the Capacity Closure Model to coordinated effects is just another data point confirming what the presumption and the additional evidence already shows—that the merger makes coordination in the North American chloride TiO₂ market more likely. Dr. Hill used the model to test generically whether coordination between the merged firm and Chemours to reduce output in North America would prove profitable for both firms over the long run, and the model showed that it would. (CCRRFF ¶¶ 730-31). Accordingly, the model corroborated that the merger increases the incentives, and therefore the likelihood, for post-merger coordination. The District Court agreed. *Tronox*, slip op. at 30. Moreover, Dr. Hill’s model represents just one possible way coordination could occur in the North American chloride TiO₂ market, not the only way.

including evidence showing that the market is already vulnerable to coordinated conduct, and that the Merger will increase the likelihood of coordination by removing one of the few significant competitors, by increasing transparency, and by replacing a firm that has competed aggressively in the past with one committed to market discipline. (CCFF ¶¶ 398-550). Indeed, Tronox itself acknowledged as much when it told PPG that Cristal lacks “market discipline” and that its “price is too low in the market.” (CCFF ¶¶ 699, 709-10). Likewise, [REDACTED] [REDACTED] [REDACTED] } (CCFF ¶ 724). And major producer Kronos advised investors in September 2017 that “[h]igher concentration increases likelihood of continued capacity constraints.” (CCFF ¶ 722).

At the end of the day, the evidence shows that this merger will substantially increase concentration in a market already characterized by oligopolistic interdependence, that the merger increases the likelihood of coordination in that market, and that future coordination is unlikely to fall within § 1 of the Sherman Act. As Professor Hovenkamp observes, this is exactly the type of merger that requires merger enforcement under the Clayton Act. Hovenkamp, *Prophylactic Merger Policy* (Ex. D at 12). And as the District Court in *Tronox* found, “[t]he available real world evidence thus suggests that (1) to counter declining prices, chloride TiO₂ producers have incentives and the means to withhold supply; and (2) the proposed transaction, which would create two firms with nearly three-quarters of the total market share, will likely increase these incentives and make implicit price coordination easier.” *Tronox*, slip op. at 30.

V. RESPONDENTS DID NOT REBUT THE STRONG PRESUMPTION OF ILLEGALITY

Having established a “strong presumption of anticompetitive effects,” *Tronox*, slip op. at 35, the burden then shifts to the Respondents to “produce evidence that ‘show[s] that the market-

share statistics [give] an inaccurate account of the merger’s probable effects on competition’ in the relevant market.” *Heinz*, 246 F.3d at 715 (quoting *United States v. Citizens & S. Nat’l Bank*, 422 U.S. 86, 120 (1975)). Respondents’ burden is heavy, given the strength of Complaint Counsel’s *prima facie* case, and Respondents fail to meet it.

A. Entry and Expansion by Chinese TiO₂ Producers Would Not Be Timely, Likely, and Sufficient

Respondents “carry the burden of showing that the entry or expansion of competitors will be ‘timely, likely and sufficient in its magnitude, character, and scope to deter or counteract the competitive effects of concern.’” *Staples 2016*, 190 F. Supp. 3d at 133 (citation omitted).

Respondents have not met that burden. Contrary to Respondents’ assertions, the evidence shows that Chinese TiO₂ producers are not meaningful competitors in North America today, and that entry or expansion by Chinese TiO₂ producers in North America cannot to deter or counteract the harm from the merger. (CC Post-Trial Br. at 61-68; CCFF ¶¶ 745-812). The District Court in *Tronox* agreed, finding that “[t]he limited presence of Lomon Billions in the North America chloride market today, the substantial barriers to entry, and China’s internal TiO₂ demand trends do not paint a picture of rapid entrants ready to replace the loss of Cristal as a source of competition.” *Tronox*, slip op. at 39.

Respondents’ claim that Chinese market entrants are “disrupting competition” in North America (Resps.’ Post-Trial Br. at 71) is belied by the evidence, and is contrary to what Tronox has told its investors.³² For example, in November 2016, Tronox’s then-CEO responded to an investor question about Chinese TiO₂ exports, stating that, “the question for us is, do we confront China-produced supply in the market as a competitive alternative to our supply. And as

³² At trial, Tronox’s Vice President of Investor Relations testified that statements to investors are made on behalf of Tronox as a whole and that the company uses its best efforts to ensure that its statements to investors are accurate, complete, and not misleading. (CCFF ¶ 462).

I've said, we don't. . . . [T]he kind of customers that will buy our high-quality pigments are not simultaneously looking at for the same supply need Chinese product.” (CCFF ¶ 745 (Tronox Q3 2016 Earnings Call)). In August 2015, Tronox’s then-CEO explained to investors that “[w]e do not see that exports from China or from Europe are playing a material role in the competitive balance in the North American market.” (CCFF ¶ 745 (Tronox Q2 2015 Earnings Call)). The other evidence in this case supports those statements to Tronox’s investors. In fact, the vast majority of TiO₂ produced in China is sulfate TiO₂, which North American customers will not use in the majority of their products. (CCFF ¶¶ 31-92, 808). Chinese chloride TiO₂ accounts for only {█}% of North American chloride TiO₂ sales, and overall TiO₂ imports from China to North America have actually been *declining* since 2016. (CCFF ¶¶ 755, 786).³³

Respondents claim that competition from Chinese producers “drives down prices.” Resps.’ Post-Trial Br. at 72. But TiO₂ prices have been increasing, with Tronox’s and Cristal’s average North American price increasing by {█}% and {█}%, respectively, from January 2017 to December 2017. (CCFF ¶ 633; *see also* CCRRFF ¶ 463 (PX9102 at 005 (Tronox’s selling prices increased 26% from Q4 2016 to Q4 2017)). Moreover, with increasing demand in China and decreased Chinese capacity due to environmental regulation, the price of Chinese TiO₂ has increased dramatically in recent years, {█} {█} (CCFF ¶¶ 258, 779, 784-85).

Respondents assert that the “ongoing threat of low-cost production from Chinese rivals threatens both Tronox and Cristal.” Resps.’ Post-Trial Br. at 72. But as explained in Complaint Counsel’s Proposed Findings of Fact, there is no cost advantage to manufacturing chloride TiO₂ in China. (CCFF ¶¶ 766-74). Fewer people are required to operate a chloride TiO₂ plant than a

³³ {█}

{█} (CCRRFF ¶ 299).

sulfate TiO₂ plant, which neutralizes the benefit that cheaper labor provides for manufacturing sulfate TiO₂ in China. (CCFF ¶ 770; CCRRFF ¶ 505 (Christian, Tr. 796)). And unlike for sulfate TiO₂, Chinese chloride TiO₂ producers do not benefit from cheaper feedstock costs because the high-grade feedstock required to run a chloride TiO₂ plant must be imported into China from the same locations and suppliers that other producers use. (CCFF ¶ 771-72; CCRRFF ¶ 517). In addition, the sulfate TiO₂ process generates a significant amount of environmental waste compared to the chloride process, so historically laxer environmental enforcement in China provided a cost advantage to sulfate TiO₂ manufacturing that does not exist for the more environmentally-friendly manufacture of chloride TiO₂. (CCFF ¶ 770). Respondents point specifically to Lomon Billions as benefiting from low costs (Resps.’ Post-Trial Br. at 72), but TZMI reports that { [REDACTED] } (CCFF ¶ 769). Even the cost advantage that Chinese sulfate-TiO₂ manufacturers have had is diminishing, as the Chinese government imposes stricter environmental controls and as the { [REDACTED] } (CCFF ¶¶ 771-774).

Under the *Merger Guidelines*, firms that do not sell into the relevant market but who “would very likely provide rapid supply responses with direct competitive impact in the event of a SSNIP” are market participants because they are “rapid entrants.” *Merger Guidelines*, § 5.1. Respondents argue that the Chinese TiO₂ producers should be deemed “rapid entrants.” Resps.’ Post-Trial Br. at 72. But Chinese TiO₂ producers do not meet the requirements to be considered “rapid entrants.”

As noted above, the vast majority of Chinese TiO₂ capacity is for sulfate TiO₂, which

North America customers will not use for the majority of their products. (CCFF ¶¶ 31-92, 808). For Chinese chloride TiO₂, the evidence shows (1) that Chinese producers have struggled with chloride technology and been plagued by low utilization rates (CCFF ¶¶ 756-65); (2) that the quality of Chinese chloride TiO₂ is unacceptable to customers in North America for anything other than small-volume, low-end applications (CCFF ¶¶ 748-54); (3) that Chinese chloride TiO₂ producers have limited available capacity due to growing chloride TiO₂ demand in China (CCFF ¶¶ 775-77, 780); (4) that import costs and other logistical issues are barriers to increasing imports of Chinese chloride TiO₂ into North America (CCFF ¶¶ 778, 789-93); (5) that Chinese TiO₂ producers cannot manufacture chloride TiO₂ at a low enough cost to overcome transportation costs and duties to counter price increases in North America (CCFF ¶¶ 296, 766-774); and (6) that even if Chinese producers were someday able to produce chloride TiO₂ that meets North American customers' quality requirements, customers would still have to qualify the TiO₂, a process that can take years. (CCFF ¶¶ 102-03, 754). All of this demonstrates that Chinese TiO₂ producers are *not* “very likely [to] provide rapid supply responses with direct competitive impact in the event of a SSNIP,” that they could not “easily and rapidly” sell significant volumes of chloride TiO₂ into North America, that they do not “clearly possess the necessary assets to supply into the relevant market,” and that they do not have “readily available” capacity to supply North America. *Merger Guidelines*, § 5.1.

Respondents point specifically to Lomon Billions' announcement of plans to expand its chloride TiO₂ capacity by 200,000 tons by 2020.³⁴ Resps.' Post-Trial Br. at 73. But it is highly uncertain that Lomon Billions will actually bring this capacity online in that timeframe. Lomon Billions has struggled to operate its existing 100,000-ton chloride TiO₂ plant, achieving only

³⁴ Respondents state that Lomon Billions has over 705,000 tons of TiO₂ capacity today (Resps.' Post-Trial Br. at 73), but only 100,000 tons of this capacity is for chloride TiO₂. (CCFF ¶ 801).

60% capacity utilization, and { [REDACTED] } (CCFF ¶¶ 760, 801-803; *see* CCFF ¶ 806). In addition, Lomon Billions is { [REDACTED] } (CCFF ¶¶ 760-764).³⁵ Moreover, as Tronox’s CEO recently explained to investors, even if Lomon Billions is able to successfully expand its chloride capacity, that expansion is unlikely to have any impact on market dynamics because it will be absorbed by rising demand. (CCFF ¶ 795) (Tronox CEO Jeffrey Quinn: Lomon’s possible chloride expansion “would sort of balance the incremental, you know, global growth.”); *see also* (CCFF ¶ 796) (Dr. Hill testifying that the Lomon Billions expansion, if it were to occur, “will likely be absorbed by growth in demand in the Asia-Pacific region.”); (CCFF ¶ 795) (TZMI: even accounting for the announced Billions expansion, “[t]he capacity changes from 2019-2022 are expected to net far less supply than is required to meet the additional demand.”).

Respondents’ assertion that Chinese TiO₂ producers are “vigorously expanding” their presence in the North American TiO₂ market appears to contradict what Tronox has told its investors. *See* (CCFF ¶ 795) (Tronox Q4 2017 Earnings Call: “I think we’re seeing all the incremental expansion over the next 18 to 24 months, will really kind of just be soaked up by the incremental global growth. So we don’t see that, that incremental expansion will significantly change the current dynamics.”); (CCFF ¶ 780) (Tronox Q3 2016 Earnings Call: “As demand grows domestically [in China], more and more supply will go into the domestic market, which

³⁵ Respondents cite to testimony from Mr. Romano in support of the assertion that some Lomon Billions’ products are “as good as or better than Tronox products and are capable of competing directly with them.” Resps.’ Post-Trial Br. at 72. But Mr. Romano did not specify what Lomon Billions’ grades he was referencing, whether those grades are sulfate or chloride, or in what regions the grades are used. At trial, [REDACTED] (CCFF ¶ 749).

[REDACTED] (CCFF ¶¶ 31-92).

means less will be available for the export market, and Chinese share in the global market we think is going to decline over the next several years.”).

Likewise, Respondents’ assertion that Chinese producers “benefit from low capital costs” and “support from the Chinese government” (Resps.’ Post-Trial Br. at 73) is [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶¶ 258,773); *see also* (CCFF ¶ 782). And Respondents’ assertion that Chinese producers benefit from “inherited intellectual property” ignores the difficulty that these producers have had operating chloride TiO₂ technology. (*See* CCFF ¶¶ 756-65). As Tronox itself has explained, simply possessing intellectual property for chloride TiO₂ is not enough:

[REDACTED]

[REDACTED]

(CCFF ¶ 757).

Respondents claim that Chinese TiO₂ compensated for the supply shortfalls in Europe following the fire at Venator’s Pori, Finland sulfate TiO₂ plant. Resps.’ Post-Trial Br. at 73-74.

[REDACTED]

[REDACTED]

[REDACTED] } (CCFF ¶¶ 631-35, 812). This does not suggest that Chinese suppliers are in any position to “rapidly” enter the North American market for chloride TiO2 or discipline a North American price increase resulting from the merger.

Given that Chinese TiO2 producers are not a “material competitive presence” in North America today (CCFF ¶ 745), and given the significant barriers preventing them from becoming such a presence, Respondents have failed to carry their burden of “showing that the entry or expansion of competitors will be ‘timely, likely and sufficient in its magnitude, character, and scope to deter or counteract the competitive effects of concern.’” *Staples 2016*, 190 F. Supp. 3d at 133 (citation omitted). Indeed, { [REDACTED]

[REDACTED]
[REDACTED] }
(CCFF ¶ 762) { [REDACTED]

[REDACTED]
[REDACTED]
[REDACTED]

[REDACTED] };³⁶ *see Wilhelmsen*, slip op. at 48 (“[t]he relevant time frame for consideration . . . is two to three years”) (quoting *Staples 2016*, 190 F. Supp. 3d at 133); *United States v. BazaarVoice, Inc.*, No. 13-00133, 2014 U.S. Dist. LEXIS 3284, at *248 (N.D. Cal. Jan. 8, 2014) (“While a few companies have entered the market recently, their entry is of such a minimal scale

³⁶ *E.g.*, (CCFF ¶ 762) [REDACTED] ; (CCFF ¶ 753) [REDACTED] .

that it is not close today, and is unlikely to be close in the next two years, to replacing PowerReviews.”).

B. Respondents’ Efficiencies Claims Do Not Rebut the Presumption of Harm

In another effort to rebut the presumption, Respondents claim that “[t]he proposed transaction is pro-competitive because it will expand output and make the parties’ TiO₂ plants more competitive in an already competitive marketplace.” Resps.’ Post-Trial Br. at 64. But the arguments they rely on to support this claim do not address the key criteria for demonstrating cognizable efficiencies. As the Horizontal Merger Guidelines state, “[c]ognizable efficiencies are merger-specific efficiencies that have been verified and do not arise from anticompetitive reductions in output or service.” *Merger Guidelines* § 10. Respondents bear the burden to show their claimed efficiencies are cognizable. *Merger Guidelines* § 10; *Penn State Hershey Med. Ctr.*, 838 F.3d at 347; *H&R Block*, 833 F. Supp. 2d at 89. Respondents fall well short of meeting this burden.

Respondents claim that “[c]ombining the two companies’ feedstock and TiO₂-producing capabilities will create greater vertical integration, leading to lower costs, expanded output, and lower pricing.” Resps.’ Post-Trial Br. at 64. As discussed below, this claim is not verifiable. Moreover, Respondents’ past behavior contradicts this assertion. Since becoming vertically integrated in 2012 through its acquisition of Exxaro, Tronox has on multiple occasions *reduced* its production of both feedstock and TiO₂ pigment. (CCFF ¶¶ 994-1002). As the District Court found, “the titanium dioxide industry features significant incentives, depending on prices, to withhold or manage output to maximize profits.” *Tronox*, slip op. at 41. Past experience also shows that Tronox’s efforts have had the effect of *increasing* TiO₂ prices in North America. (CCFF ¶¶ 587-612). Consistent with past experience, Dr. Hill’s economic modeling

demonstrates that Tronox would have even greater incentive to withhold output post-merger than Respondents currently have on a stand-alone basis, pushing prices still higher. (CCFF ¶¶ 658-70).

Respondents also claim that “the transaction presents important and procompetitive opportunities to increase production at Cristal’s plants.” Resps.’ Post-Trial Br. at 64. Again, Respondents completely fail to address the question of whether any claimed increases in production are cognizable efficiencies, and rely almost exclusively on the testimony of Tronox executives. In fact, Respondents’ output claims in many instances are highly uncertain or rely on insufficient information, unfounded assumptions, or the unverifiable judgment of Tronox’s executives. (CCFF ¶¶ 845-59, 898-908, 933-37, 941-43, 945-48). Consistent with this, Complaint Counsel’s expert Dr. Zmijewski, who was the only expert in this matter to opine about Respondents’ claimed efficiencies under a Guidelines framework, found that Respondents’ output claims cannot be independently verified. (CCFF ¶¶ 860, 902, 938, 944, 947). The District Court concluded: “[T]he success of Tronox’s planned improvements to the Yanbu plant and Jazan slagger cannot be reasonably verified before such improvements occur.” *Tronox*, slip op. at 41. Moreover, Respondents rely almost exclusively on the testimony of Tronox executives, but ignore *Cristal’s own* testimony and documents showing that Cristal has been making efforts and considering options to expand its output by means other than merging with a competitor. (CCFF ¶¶ 861-86, 909-31). This evidence directly contradicts Respondents’ arguments that their claimed output expansion synergies are merger-specific.

Finally, although Respondents claim that “increasing output of TiO₂ will benefit customers,” Resps.’ Post-Trial Br. at 65, they fail to demonstrate that any output increase would benefit the *relevant* customers, i.e., North American customers of chloride TiO₂. On the

contrary, Tronox’s CEO himself acknowledged that the “overwhelming majority” of the claimed operational synergies are related to non-U.S. assets. (CCFF ¶ 1011). Nor has Tronox has even attempted to quantify the impact, if any, of its claimed efficiencies on North American customers. (CCFF ¶ 1012). Because Respondents have not shown cognizable efficiencies that are likely to benefit customers in the relevant market, their efficiencies claims fail.

1. Respondents Have Not Demonstrated that Vertical Integration Will Result in Cognizable Efficiencies

Respondents claim that “[t]he combined company will also realize significant synergies by reducing fixed costs through vertical integration.” Resps.’ Post-Trial Br. at 65. But Respondents neglect to address the myriad evidence that Tronox could enhance its vertical integration on a stand-alone basis. Indeed, Tronox has in the past actively considered expanding its downstream TiO₂ production organically to take advantage of its long feedstock position. (CCFF ¶¶ 1003-10). Given the availability of this practical alternative, Respondents have failed to show that any benefits flowing from enhanced vertical integration due to the proposed transaction would be merger-specific.

Respondents also claim that enhanced vertical integration “almost certainly will increase total pigment production and total feedstock supply in the market.” Resps.’ Post-Trial Br. at 66. Again, Respondents do not address the impact on supply in the *relevant* market, that is, chloride TiO₂ sold to North American customers. Moreover, past experience belies their claim. Since becoming vertically integrated through its acquisition of Exxaro in 2012, Tronox has on multiple occasions *reduced* its output of both feedstock and TiO₂ pigment, fully cognizant of the upward pressure it would put on prices for both. (CCFF ¶¶ 994-1002). Indeed, in a 2017 strategic plan, Tronox { [REDACTED] } (CCRRFF ¶ 101). Thus, it is unlikely that

customers would benefit from any enhanced vertical integration as a result of the proposed transaction.

2. Respondents' Output-Enhancing Synergy Claims Are Not Cognizable

Respondents claim that “the proposed transaction presents a unique opportunity to enhance TiO₂ output by improving Cristal’s TiO₂ plant in Yanbu, Saudi Arabia,” and argue that those improvements “would not occur if the transaction were blocked.” Resps.’ Post-Trial Br. at 66. Respondents’ brief argues that Cristal cannot improve Yanbu on a stand-alone basis, but cites only testimony of Tronox executives for support. Yet the testimony of Cristal’s own executives, corroborated by internal Cristal documents, makes clear that: (1) Yanbu has already been showing improvement (CCFF ¶¶ 865-67, 871); (2) Cristal has planned the very same types of improvements on its own that Tronox plans to make post-transaction (CCFF ¶¶ 868-69); and (3) Cristal would continue to improve Yanbu absent the proposed transaction (CCFF ¶¶ 880-82). Respondents rely heavily on the testimony of Tronox employee Dick Dean, but at trial, Mr. Dean could not explain why Cristal needs a merger to implement several of the operational excellence measures Tronox claims it would make at Yanbu. (CCFF ¶ 883). These facts overwhelmingly contradict the notion that the Yanbu improvement synergy is merger-specific.

Respondents also rely on the testimony of { [REDACTED] } that improvements to Yanbu “may” benefit consumers. Resps.’ Post-Trial Br. at 67. But that customer’s guess about what may happen in the future lacks the necessary foundation to be credited. And the testimony falls short of addressing whether the improvements will benefit the *relevant* consumers—North American customers of chloride TiO₂. On the contrary, as Respondents’ expert acknowledged, { [REDACTED] } (CCRRFF ¶¶ 100-01; CCFF ¶ 1013).

Respondents claim that the proposed transaction will improve Yanbu through “Tronox’s particular expertise,” and claim that “[t]he Yanbu plant is nearly identical in every material way to Tronox’s TiO₂ plants.” Resps.’ Post-Trial Br. at 67. But these claims ignore several challenges that are unique to Yanbu, most notably { [REDACTED] }. (CCFF ¶¶ 851-54). Tronox does not operate plants of any kind in Saudi Arabia, meaning it cannot simply map its experience at other plants to Yanbu. (CCFF ¶ 851, 854). Respondents’ failure to account for this difference is one of the reasons Dr. Zmijewski was unable to verify their Yanbu synergy claim. (CCRFF ¶ 133; CCFF ¶ 860). Moreover, to the extent Tronox plans to improve the culture at Yanbu, those improvements are likely not merger specific. For example, { [REDACTED] } { [REDACTED] } (CCFF ¶ 885), and Respondents do not point to any reason Cristal could not do the same on a stand-alone basis.

Respondents make the sweeping claim that “[o]nly Tronox has the incentive and interest in operationalizing Jazan to increase feedstock production for TiO₂,” and that “no entity other than Tronox can and will fix the Jazan slagger.” Resps.’ Post-Trial Br. at 67-68. Again, Respondents cite only the testimony of their own executives, who lack foundation to speak to the incentives and interests of other companies. And again, Cristal’s documents and testimony tell a different story. As multiple Cristal executives acknowledged, { [REDACTED] } { [REDACTED] }. (CCFF ¶¶ 910-11). Indeed, before the proposed transaction was announced, Cristal had been taking concrete steps toward that goal, including { [REDACTED] } { [REDACTED] }. (CCFF ¶¶ 912-31). The fact that Cristal was

actively considering ways to repair the Jazan slagger other than the proposed transaction demonstrates that the Jazan synergy is not merger-specific.

Respondents claim that “Tronox has ‘always considered’ the Jazan slagger as being a ‘part of the Transaction.’” Resps.’ Post-Trial Br. at 68. Regardless of what Tronox “considered,” Respondents acknowledge that “[t]he Tronox-Cristal transaction does not include the Jazan Slagger.” (CCFF ¶ 891; CCRRFF ¶ 209). Respondents further claim that “[t]he Option Agreement and TSA are concrete and certain agreements to purchase the Jazan slagger.” Resps.’ Post-Trial Br. at 68. But Tronox is not certain to purchase Jazan. As Tronox’s CEO Mr. Quinn admitted, “*there’s no certainty* that that will actually occur.” (CCRRFF ¶ 217; CCFF ¶ 900). Respondents also claim that “Tronox has agreed to invest substantial financial resources in addition to its technical knowledge.” Resps.’ Post-Trial Br. at 68. This, too, misleads, because if Tronox does not ultimately acquire Jazan, Cristal must reimburse Tronox for its “investment.” (CCFF ¶ 899). In fact, the very existence of the option agreement and its mechanisms for hedging against the risk of failure are strong evidence that the Jazan synergy is speculative. See also *Tronox*, slip op. at 42 (“Tronox, in other words, has taken understandable precautions in case the planned output-enhancing improvements cannot be actualized.”)

3. Respondents’ Cost Saving Synergy Claims Are Not Cognizable

Respondents claim that the proposed transaction will result in “sizable cost savings synergies.” Resps.’ Post-Trial Br. at 68-69. But Respondents provided only high-level descriptions of types of savings that Tronox expects, and neglected to provide any specifics about their quantity or timing. Resps.’ Post-Trial Br. at 68-69. Just as importantly, Respondents fail to address the key questions under the Guidelines and case law of whether the savings are cognizable. In fact, Respondents’ cost savings claims in many instances rely on unfounded

assumptions or unverifiable business judgment, and as a result Dr. Zmijewski was unable to verify them. (CCFF ¶¶ 949-93). Nor do Respondents even attempt to address the extent to which any cost savings would benefit customers in North America. For these reasons, the Court should not credit any cost savings claims as cognizable.

4. KPMG’s Diligence Does Not Demonstrate Verifiable Efficiencies under the Merger Guidelines

Respondents attempt to demonstrate that their synergy claims are verifiable by citing due diligence performed by KPMG, which Tronox hired to perform various work in connection with the proposed transaction. Resps.’ Post-Trial Br. at 69. However, Respondents improperly conflate the business diligence KPMG performed with the analysis of verifiability called for by the Merger Guidelines and case law. As Dr. Zmijewski explained, “The Merger Guidelines have specific criteria for accepting an efficiency as an offset against anticompetitive harm. That’s not the purpose of any due diligence analysis. It’s all about figuring out if the price is justifiable. So it has a different goal. It’s not about verifying.” (Zmijewski, Tr. 1439 *in camera*); CCRFF ¶¶ 238-48). Even by its own standards, KPMG identified numerous synergies “with insufficient supporting data to provide management with sufficient confidence in the synergy value.” (PX0006 at 005 (KPMG Report) *in camera*); see CCFF ¶¶ 936, 955, 959, 969). Moreover, far from performing an independent verification, KPMG { [REDACTED] [REDACTED] }. (CCFF ¶¶ 859, 908). Also, as the District Court found, “Nor did Defendants hire KPMG to identify ‘merger-specific’ cost savings for antitrust purposes, but to ‘provide consulting support’ for the ‘sign-to-close period’ of the deal.” *Tronox*, slip op. at 42 (citing PX7045 (Nolan, Dep. at 012)). Thus, Respondents cannot rely on KPMG’s diligence to establish cognizable efficiencies for antitrust purposes.

5. Dr. Zmijewski's Expertise and Experience in Applying the Guidelines' Efficiencies Criteria Are Well-Suited to Analyzing Respondents' Claims

Respondents claim that “Dr. Zmijewski lacks the necessary and relevant expertise to evaluate the technical assessments that underlie Respondents’ synergies,” and that “he has expressed no opinion on the likelihood that any particular synergies will or will not come about.” Resps.’ Post-Trial Br. at 70. On both counts, Respondents misapprehend Dr. Zmijewski’s role as an expert in this matter. As he has done in multiple past matters, Dr. Zmijewski is using his expertise in accounting, economics, and finance to apply the criteria set forth in the Horizontal Merger Guidelines. (CCRRFF ¶¶ 227-30). Based on those criteria, his task is not to apply his own judgment of what synergies Respondents should be able to achieve, but to assess whether their claimed synergies are *verifiable*, that is, whether Respondents have provided sufficient “data, documents, analysis, calculations, other type of information, that can be used to substantiate the claimed efficiencies.” (Zmijewski, Tr. 1431; CCRRFF ¶¶ 231-32). As he testified at trial, “I don’t see a number as accurate or inaccurate. The verification process, that’s not the purpose. . . . I don’t make decisions if it’s right or wrong. It’s all about identifying foundation for verification purposes.” (Zmijewski, Tr. 1521-22; CCRRFF ¶¶ 231-32). Courts in the past have recognized his expertise in performing such analysis. (Zmijewski, Tr. 1431; CCRRFF ¶¶ 227-30). Moreover, Respondents’ brief cites no examples of efficiencies experts in merger cases being disqualified for lack of “technical” expertise. More to the point, when Complaint Counsel tendered Dr. Zmijewski as an expert at trial, Respondents did not object. (CCRRFF ¶¶ 227-30).

Respondents claim that “Dr. Zmijewski also offers no alternative analysis of the proposed synergies, including no alternative calculations [or] estimations of what synergies are more likely.” Resps.’ Post-Trial Br. at 70. Again, that is not Dr. Zmijewski’s job. As referenced

above, extensive authority places the burden of demonstrating cognizable efficiencies squarely on Respondents, not on Complaint Counsel. *Merger Guidelines* § 10; see also *Penn State Hershey Med. Ctr.*, 838 F.3d at 347; *H&R Block*, 833 F. Supp. 2d at 89; *FTC v. Staples, Inc.*, 970 F. Supp. 1066, 1089 (D.D.C. 1997); *Staples 2016*, 190 F. Supp. 3d at 137 n.15. Respondents have failed to carry their burden of demonstrating cognizable efficiencies that outweigh the significant anticompetitive harm of the proposed transaction.

CONCLUSION

For the foregoing reasons, the evidence presented at trial and admitted to the record establishes that Tronox's acquisition of Cristal violates Section 7 of the Clayton Act and Section 5 of the Federal Trade Commission Act, as alleged in the complaint, and justifies entry of an Order by the Court granting the relief sought herein.

Dated: September 17, 2018

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EXHIBIT A

**UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA****FEDERAL TRADE COMMISSION,**

Plaintiff,

v.

TRONOX LIMITED *et al.*,

Defendants.

Case No. 1:18-cv-01622 (TNM)

MEMORANDUM OPINION^{*}

Last year, two of the world’s largest titanium dioxide (“TiO₂”) producers announced their intent to merge. Tronox Limited agreed to acquire the National Titanium Dioxide Company’s TiO₂ business, known as “Cristal,” for \$1.67 billion in cash and a 24% equity stake in the combined firm. Believing that the acquisition would likely violate federal antitrust laws, the Federal Trade Commission issued an administrative complaint challenging the deal.

TiO₂ is a pigment used to add whiteness, brightness, and opacity to products like paints, plastics, and paper. It is manufactured by subjecting raw titanium ores to either a chloride or a sulfate production process. Chloride-process TiO₂ comprises nearly all the pigment sold in the United States and Canada. The FTC believes that the Tronox-Cristal merger will significantly reduce competition for chloride TiO₂ in these two countries, a combined market referred to herein and by the parties as “North America.”

Following discovery and briefing by the parties, the FTC’s Administrative Law Judge (“ALJ”) held a month-long trial to determine the legality of the proposed transaction. The trial recently concluded, and the ALJ will soon issue an initial decision. That ruling is reviewable by

* The Memorandum Opinion was issued under seal on September 5, 2018. This version contains redactions of confidential and competitively sensitive information. The Court has also made minor modifications, citing to publicly available, rather than confidential, information where appropriate.

the FTC's Commissioners, and a federal appeals court may in turn review the agency's final decision.

The transaction has now received conditional or final approval from the FTC's counterparts in the European Union, China, Saudi Arabia, and elsewhere. The Commission therefore seeks a preliminary injunction under Section 13(b) of the Federal Trade Commission Act to prevent Tronox and Cristal from consummating the merger until the agency's review process and any later judicial proceedings have concluded.

The Court finds that the FTC has met its burden under Section 13(b). It has shown a likelihood that the proposed transaction will substantially lessen competition for chloride-process TiO₂ in North America, and it has shown that issuing a preliminary injunction is in the public interest. The Court will therefore grant the Commission's motion for preliminary injunctive relief.

I. BACKGROUND

A. The Titanium Dioxide Industry

Titanium dioxide is commercially available in two crystalline structures: anatase and rutile. Anatase is used in textiles, cosmetics, pharmaceuticals, and food, while rutile is typically used in architectural and industrial paints and plastics. PX5000-013.¹ Cristal estimates that roughly 60% of all titanium dioxide produced worldwide is used in paints and coatings, while the rest is used in plastics, paper, and various other applications. *Id.* at 018. Rutile is thus the predominant form of TiO₂; anatase accounts for only 10% of global production. *Id.* at 013.

The sulfate production process can create either anatase or rutile TiO₂. PX5000-016. It

¹ The FTC's exhibits are identified by a "PX" followed by the exhibit number and a page number. The Defendants' exhibits use "RX" followed by the exhibit and page numbers.

involves dissolving naturally occurring titanium ores (the “feedstock”) into sulfuric acid to separate the titanium from other impurities in the ore. *Id.* The sulfate process relies on simpler technology than the chloride process, requires less skilled labor, and, because it produces TiO₂ in batches, does not require an uninterrupted power supply. *Id.* Roughly half of all TiO₂ made globally is produced using the sulfate process. PX5000-017. China accounts for the largest single-nation share of sulfate-process TiO₂, producing 1.67 million metric tons in 2016. *Id.*

The chloride production process can only create rutile TiO₂, and it involves using chlorine gas to produce titanium tetrachloride, which is then oxidized to produce TiO₂. PX5000-015. The chloride process is continuous, so it requires an uninterrupted power supply. PX3011-013. Compared to sulfate, chloride tends to produce a higher grade TiO₂ pigment, features lower conversion and labor costs, and results in less waste. *Id.* The process requires a highly skilled labor force, and its “superior technology” is “closely guarded by Western producers.” PX3011-019. In 2016, 99% of the TiO₂ produced in the United States and Canada was made using the chloride process. PX5000-016. By contrast, in Europe, only 39% of all TiO₂ manufactured was produced using chloride. *Id.*

Customers and suppliers generally agree that there are noticeable differences between chloride- and sulfate-process TiO₂. A 2015 Tronox presentation notes, for example, that the chloride pigment is “bluer in tone than sulfate pigment,” which has a “more yellow tone of white.” PX1322-003. Dr. Paul Malichky, the Director of Raw Material Sourcing at PPG, a major multinational paints and coatings company, explained that while “both would appear white if you physically looked at them,” in a final product (like a can of white paint) with “two colors, one with a chloride and one with a sulfate, the color would be different.” Hr’g Tr. 100:6-13. *See also* PX7020-013 (George Young, a senior executive at Sherwin-Williams, another major paint

company, stating that “sulfate grade is not as bright a white as a chloride. It doesn’t deliver the same physical performance as a chloride.”).

Chloride TiO₂ can also be more durable than its sulfate counterpart. Sulfate has “impurities that come as part of the process; most specifically, iron . . . [which] decreases the durability.” Hr’g Tr. 100:14-19. Chloride-process TiO₂ products feature “better durability, scrubability, and various other performance characteristics.” Hr’g Tr. 169:19. And, because of “the [consumer] preference for whiteness and durability, sulfate grades are not widely preferred for applications that have prolonged outdoor exposure.” PX8005-002.

Titanium dioxide is generally sold to customers in two formulations: “dry” and “slurry.” PX5000-017. Dry TiO₂ is sold in a powdered form typically packaged in bags; slurry TiO₂ is dry titanium dioxide combined with an aqueous solution. *Id.* While most TiO₂ sold globally is dry, large North American paint companies prefer slurry. PX0001-030.

B. The Competitive Landscape

The titanium dioxide market has been described as an “oligopoly,” as TiO₂ is a “commodity-like product with no substitutes, the market is dominated by a handful of firms, and there are substantial barriers to entry.” *Valspar Corp. v. E.I. Du Pont De Nemours and Co.*, 873 F.3d 185, 190 (3d Cir. 2017). Jeffrey Quinn, the CEO of Tronox, explained that there are “dozens and dozens of competitors worldwide, but there are really six companies that often are referred to as sort of the global TiO₂ producers or the global companies.” Hr’g Tr. 585:9-11. These firms are Chemours, Tronox, Cristal, Kronos, Venator, and Lomon Billions. *Id.* at 585:13-586:2.

Of the six, the first five dominate the production of chloride TiO₂. PX1532-051. In 2016, roughly 2.77 million metric tons of the pigment was produced globally. *Id.* Chemours, the world’s largest TiO₂ firm, accounted for about 37% of 2016 chloride production capacity.

PX5000-021. With Chemours, Cristal (21%), Tronox (15%), Kronos (13%), and Venator (7%), together accounted for 93% of total chloride production capacity. *Id.* Based on this data, the proposed transaction would result in two firms, Chemours and the Tronox-Cristal entity, that control nearly three-quarters of the global chloride TiO₂ supply.

Chinese manufacturers control around 51% of global sulfate production capacity. *Id.* Sulfate production is more dispersed than chloride. Lomon Billions is China's largest TiO₂ firm, and in 2016 it accounted for 13% of global supply. *Id.* A smattering of other Chinese firms had roughly 38%, while domestically, Venator (12%) and Kronos (4%) are also significant producers of sulfate TiO₂. *Id.*

The paint and coatings industry is the largest overall consumer of titanium dioxide, and PPG, Sherwin-Williams, RPM, and Masco (Behr) are among the largest paint producers. *See* PX9020-009; PX5000 at 18, 044-045. Representatives from these firms, other paint and plastics manufacturers, and Chemours, Tronox, Cristal, Kronos, and Venator provided testimonial and documentary evidence about the TiO₂ market during the administrative proceedings before the Commission. Additionally, Dr. Malichky (PPG), Mr. Christian (Kronos), Mr. Quinn (Tronox), and the parties' economic experts (Dr. Nicholas Hill for the Commission and Dr. Ramsey Shehadeh for the Defendants) testified about the market and the proposed merger during a three-day evidentiary hearing here.

C. History of Proceedings in This Case

On December 5, 2017, the Commissioners of the FTC voted 2-0 to authorize the filing of an administrative complaint to block the Tronox-Cristal transaction, as they found reason to believe that it would violate Section 7 of the Clayton Act, 15 U.S.C. § 18. The Commissioners'

vote also authorized the FTC to seek a temporary restraining order (“TRO”) and preliminary injunction against the merger in federal district court.

After several months of discovery, the ALJ held an administrative trial from May 18 to June 22, 2018. The parties filed post-trial briefs, proposed findings of fact, and proposed conclusions of law with the ALJ last month. They will offer closing statements to him once briefing has concluded. His resulting decision may be reviewed by the Commission and potentially, an appellate court.

On July 10, 2018, the FTC petitioned this Court for a TRO and a preliminary injunction to halt a potential closing of the deal. The Commission explained that “[a]bsent such provisional relief, Tronox and Cristal . . . will likely be free to consummate the merger as soon as July 16, 2018, the earliest date it appears the European Commission (“EC”) is likely to complete its [antitrust regulatory review] process by approving” remedies to mitigate the deal’s anticompetitive effects in Europe. Compl. 2. Approval from the EC was “the only remaining hurdle preventing Defendants from consummating the Acquisition.” *Id.*

Three days later, the Court held a hearing on the Commission’s TRO motion. Following that hearing, the parties stipulated that Tronox and Cristal would not seek to consummate the proposed transaction until four business days after the Court decided the Commission’s request for a preliminary injunction. *See* Ex. A (Agreement Not to Close Transaction) 2, ECF No. 44-1.

On August 7, 2018, the Court began a three-day evidentiary hearing on the FTC’s motion for injunctive relief. The Commission proposed that the hearing proceed with oral arguments based solely on the closed evidentiary record before the ALJ. *See* Pl.’s Proposed Hr’g Schedule 2, ECF No. 45. The Defendants objected, ultimately proposing that each side be allowed to

present live testimony from two expert witnesses and a fact witness. *See* Defs.’ Proposed Hr’g Schedule 4, ECF No. 47. The Court allowed each side to present live testimony from three witnesses of their choosing, and to present opening and closing arguments.² The parties also submitted briefs outlining their positions and the complete administrative record before the ALJ.

II. LEGAL STANDARDS

Section 7 of the Clayton Act prohibits acquisitions “the effect of [which] may be substantially to lessen competition, or to tend to create a monopoly” in “any line of commerce or in any activity affecting commerce in any section of the country.” 15 U.S.C. § 18. If the FTC has reason to believe “that a corporation is violating, or is about to violate, Section 7 of the Clayton Act, [it] may seek a preliminary injunction to prevent a merger pending the Commission’s administrative adjudication of the merger’s legality.” *F.T.C. v. H.J. Heinz Co.*, 246 F.3d 708, 714 (D.C. Cir. 2001). Section 13(b) of the Federal Trade Commission Act authorizes district courts to grant a preliminary injunction where “such action would be in the public interest—as determined by a weighing of the equities and a consideration of the Commission’s likelihood of success on the merits.” *Id.*; *see* 15 U.S.C. § 53(b).

For relief under Section 13(b), the Commission must establish that “there is a reasonable probability that the challenged transaction will substantially impair competition.” *F.T.C. v. Staples Inc.*, 190 F. Supp. 3d 100, 114 (D.D.C. 2016). Congress “intended this standard to depart from what it regarded as the then-traditional equity standard, which it characterized as requiring the plaintiff to show: (1) irreparable damage, (2) probability of success on the merits and (3) a balance of equities favoring the plaintiff.” *Heinz*, 246 F.3d at 714. The FTC is “not

² The Defendants ultimately elected to call only two witnesses, as they were running low on time under the parties’ agreed-upon “chess clock” system. *See* Hr’g Tr. 581:3-9.

held to the high thresholds applicable where private parties seek interim restraining orders,” and Section 13(b) instead creates a “unique public interest standard . . . rather than the more stringent, traditional equity standard for injunctive relief.” *Id.* (cleaned up).

The public interest standard requires courts to “measure the probability that, after an administrative hearing on the merits, the Commission will succeed in proving that the effect of the [proposed transaction] may be substantially to lessen competition” in violation of the Clayton Act. *F.T.C. v. Sysco Corp.*, 113 F. Supp. 3d 1, 22 (D.D.C. 2015). The Commission meets this standard if it “has raised questions going to the merits so serious, substantial, difficult and doubtful as to make them fair ground for thorough investigation, study, deliberation and determination by the FTC in the first instance and ultimately by the Court of Appeals.” *Id.* at 23 (citing *Heinz*, 246 F.3d at 714-15).

To determine the Commission’s likelihood of success on the merits, the Court applies the burden-shifting framework established by *United States v. Baker Hughes, Inc.*, 908 F.2d 981, 982-93 (D.C. Cir. 1990). First, the FTC must show that the Tronox-Cristal merger will lead to “undue concentration in the market for a particular product in a particular geographic area.” *Id.* at 982. The Commission thus bears the initial burden of (1) defining the appropriate product market, (2) defining the appropriate geographic market, and (3) showing that the merger will lead to undue concentration in the relevant product and geographic market. *See F.T.C. v. Arch Coal, Inc.*, 329 F. Supp. 2d 109, 117 (D.D.C. 2004). Such a showing establishes a presumption that the merger will substantially lessen competition. *Baker Hughes*, 908 F.2d at 982.

The Defendants can rebut this presumption by showing that the Commission’s “prima facie case inaccurately predicts the [merger’s] probable effect on future competition.” *Id.* at 991. If the Defendants make this showing, the burden of producing further evidence of

anticompetitive effects shifts back to the government. *Id.* at 983. The “ultimate burden of persuasion . . . remains with the government at all times.” *Id.* In evaluating either party’s evidence, “antitrust theory and speculation cannot trump facts.” *Arch Coal*, 329 F. Supp. 2d at 116.

In addition to evaluating the Commission’s prima facie case and any rebuttal evidence proffered by the Defendants, the Court must also weigh the equities involved. The “public interest in effective enforcement of the antitrust laws is of primary importance,” and “a showing of likely success on the merits will presumptively warrant an injunction.” *Arch Coal*, 329 F. Supp. 2d at 116. If, on the other hand, the FTC cannot show a likelihood of success on the merits, “equities alone will not justify an injunction.” *Id.*

III. ANALYSIS

A. The FTC has Established a Presumption of Anticompetitive Effects

The Commission has shown a likelihood that Tronox’s acquisition of Cristal’s titanium dioxide business will substantially impair market competition. It has demonstrated that the relevant market should be defined as the chloride-process TiO₂ sold in North America. The FTC’s evidence credibly suggests that the merger will greatly increase concentration in an already concentrated market, and that it will create incentives for the remaining industry participants to engage in strategic withholding of TiO₂ supplies to maintain higher prices.

1. Chloride-Process Titanium Dioxide is the Relevant Product Market

A market’s “outer boundaries” are determined by the “reasonable interchangeability of use or the cross-elasticity of demand between the product itself and substitutes for it.” *Brown Shoe Co. v. United States*, 370 U.S. 294, 325 (1962). Within this market, however, “well-defined submarkets may exist which, in themselves, constitute product markets for antitrust

purposes.” *Id.* The appropriate submarket can be identified “by examining such practical indicia as industry or public recognition of the submarket as a separate economic entity, the product’s peculiar characteristics and uses, unique production facilities, distinct customers, distinct prices, sensitivity to price changes, and specialized vendors.” *Id.* “[E]vidence of industry or public recognition of the submarket as a separate economic unit matters because we assume that economic actors usually have accurate perceptions of economic realities.” *United States v. H & R Block, Inc.*, 833 F. Supp. 2d 36, 53 (D.D.C. 2011).

The Defendants contend that the market, properly defined, includes both chloride- and sulfate-process TiO₂, but the Commission believes the correct market includes only the former. Both the economic realities of the industry, as described by TiO₂ producers and consumers, and the evidence presented by the expert economists show that the FTC has carried its burden.

a. Producers and Consumers View Chloride TiO₂ as a Separate Product, and the Expert Evidence Supports this View

Manufacturers of titanium dioxide consistently recognize the existence of a chloride TiO₂ submarket in North America. In 2014, for example, Tronox’s Content Communications Manager emailed then-CEO Tom Casey talking points ahead of a town hall meeting. PX1427. The talking points convey that, unlike sulfate, “[c]hloride process uses higher-quality feedstocks and makes better-quality TiO₂” and that “[s]ubstitution in US/Europe not likely.” *Id.* at 003. A 2015 Tronox presentation notes that the “North American market is ~90% chloride. There is no sulfate production (except a small plant in Canada, Kronos). Limited imports.” PX1322-003. At the evidentiary hearing, Tronox CEO Jeffrey Quinn³ conceded that “the way things have

³ Mr. Quinn’s testimony was credible, and he gave candid responses even when they were not necessarily helpful to the Defendants. Though he has been on Tronox’s board of directors for several years, Mr. Quinn only became Tronox’s CEO in December 2017. Because he was not actively involved in the daily

developed here in the U.S. is as a chloride market.” Hr’g Tr. 641:17-19. He added that chloride TiO₂ uses a different manufacturing process, is “viewed as more environmentally friendly, and it has – so I think it’s a different product.” Hr’g Tr. 648:18-21.

Mr. Christian,⁴ from the Defendants’ competitor Kronos, similarly testified that chloride TiO₂’s “brighter, more reflective white” and its “better durability, scrubability, and various other performance characteristics” when compared to sulfate TiO₂ make it a “higher-quality product that [is] preferred, all things being equal, by the customers.” Hr’g Tr. 169:10-20. Kronos’s chloride TiO₂ products “are more environmentally friendly . . . have a lower cost structure, and . . . command higher prices in the marketplace.” Hr’g Tr. 174:18-21. Consistent with this view, other TiO₂ suppliers distinguish between their chloride- and sulfate-process TiO₂ products.⁵

Like suppliers, customers recognize a submarket for chloride-process TiO₂, reflecting the product’s particular traits and uses. Dr. Malichky⁶ testified that chloride and sulfate TiO₂ are “not substitutable on a color basis” and that if “you don’t want [a paint product] to degrade or

management of Tronox before then, his capacity to offer insights into the TiO₂ industry was somewhat limited.

⁴ During the evidentiary hearing, Mr. Christian provided testimony on Kronos’s TiO₂ production and on his views about the TiO₂ industry and competitive landscape. The Court credited his testimony; he gave thoughtful answers and did not appear to have a preferred outcome about the proposed transaction. He provided good perspectives and insights into an industry supplier’s viewpoint, although his understanding of the customers’ perspective was necessarily limited.

⁵ See, e.g., PX5000-043 (describing a Cristal email stating that “[w]hat we really would like to avoid is to accept that T595 [a chloride pigment] could be compared to a low sulphate [sic] quality product.”); PX9121 at 007 (Chemours 2017 10-K) (“Our portfolio of premium performance TiO₂ pigment grades provides end-users with benefits beyond opacity, such as longer-lasting performance, brighter colors, and the brilliant whites achievable only through chloride-manufactured pigment.”).

⁶ During the evidentiary hearing, counsel for Tronox advised that the Court should be “wary of self-serving statements by customers.” Hr’g Tr. 64:10-16. When Dr. Malichky made statements revealing self-serving interests, the Court weighed his assertions in that context. Generally, the Court credited Dr. Malichky’s statements if they appeared to track the perspectives offered by other TiO₂ consumers and industry participants, as evidenced by documents in the record.

fade” the product would “require chloride.” Hr’g Tr. 100:12-19. Masco, maker of Behr paints, adds that the “ultra pure white feature” of its paints is “[e]xtremely important” for the firm’s brand, and that “to achieve that [feature], we need to use TiO₂ produced based on the chloride process.” Admin. Trial Tr. 972:16-973:20.⁷

In fact, customers do not substitute away from chloride TiO₂ even when prices are “very high” or when sulfate prices have “been as much as [REDACTED] cheaper than chloride TiO₂.” See PX8001-002; PX8003-003. [REDACTED] reported that, “[e]xcept for our traffic marking paint, we have not used sulfate TiO₂ in our products in North America even though sulfate grades generally are less expensive than chloride grades.” PX8003-003. Switching from chloride to sulfate TiO₂ involves “[t]housands of hours” of labor due to the complexities associated with color-matching and product reformulation (*i.e.*, ensuring that paint colors made with chloride TiO₂ are not visibly different from the colors as made with sulfate TiO₂). Hr’g Tr. 104:14-105:6.

The Defendants suggest that the market is not so black and white. “Chloride-process TiO₂ *can* be used interchangeably with sulfate-process TiO₂ in the vast majority of end-use applications,” they argue, and consumers “regularly *try* to leverage sulfate-process TiO₂ prices in negotiations with suppliers about chloride-process TiO₂.” Defs.’ Redacted Opp. to Prelim. Inj. 11, ECF No. 70 (emphasis added). But the relevant question concerns not just the hypothetical possibility of substitution, but whether customers do in fact exhibit a willingness to substitute chloride- and sulfate-process TiO₂. See *Arch Coal*, 329 F. Supp. 2d at 119.

⁷ See also PX8001-002 (statement from [REDACTED] noting that the firm “only uses chloride grade titanium dioxide. [REDACTED]”); PX5000-045 (collecting similar statements from customers like [REDACTED] and [REDACTED]).

Compare the market perspectives discussed above with those offered by the consumers in *Arch Coal*. There, the court considered how much utilities companies substitute between two types of coal – 8800 Btu and 8400 Btu. It found that “virtually all the utilities acknowledged that they can and do purchase and consume both 8800 and 8400 Btu coal, and that they actively solicit and consider both in their coal bidding procedures.” *Id.* at 121. Customers testified that their facilities “were designed to burn, and have burned” both types of coal, that they “purchased both 8400 and 8800 coal in the past five years” and that managers “purchase 8400 to 8800 Btu coal depending on which coal has the best evaluated price.” *Id.* at 121-22. The court thus concluded that the “evidence of significant interchangeability” between 8800 and 8400 Btu coal, combined with a “reluctance of [the FTC’s] own expert to conclude that 8800 Btu coal is a separate relevant market,” meant that the Commission failed to carry its burden of establishing its proffered product market. *Id.* at 122-23.

Here, the Commission has sufficiently shown a relevant product market. The evidence from customers and suppliers suggests a lack of significant interchangeability between chloride and sulfate TiO₂. And the report and testimony of the Commission’s expert economist, Dr. Hill, bolster this evidence.⁸

Using producer invoices and data published by the International Trade Commission and the United Nations, Dr. Hill evaluated price trends for chloride and sulfate TiO₂. He found that,

⁸ Dr. Hill has a doctorate in economics from Johns Hopkins University, and serves as a partner at Bates White, an economic consulting firm. As one of the FTC’s three witnesses during the evidentiary hearing, Dr. Hill provided his own analysis and opinions. He also served as a summary witness of sorts, enabling the Commission to highlight relevant aspects of the extensive administrative record. The Court found his testimony and report to be credible. But his models and the conclusions they suggest are susceptible to some valid critiques. So while the Court found them ultimately consistent with the other evidence presented, his analysis was not dispositive on either the relevant market or the likelihood that the merger will increase market concentration.

from 2012 to 2017, “chloride titanium dioxide was on average \$532 per ton, or 21 percent, more expensive than sulfate titanium dioxide.” PX5000-046. Yet, despite this price premium for chloride TiO₂, “the proportion of sales accounted for by chloride titanium dioxide has held steady [in North America].” *Id.* The existence of distinct prices and a consistent market share for chloride TiO₂ are “not what one would expect if North American customers were willing and able to substitute one type of titanium dioxide for another in response to a change in their relative prices.” *Id.*

b. The Defendants’ Product Market Counterarguments are Unavailing

Dr. Shehadeh, the Defendants’ expert, attacked Dr. Hill’s findings, countering that “[e]conomically significant co-movement between prices for chloride-produced TiO₂ and prices for sulfate-produced TiO₂ establishes a single market” for the two products. RX0170.0143.⁹ Using data from Cristal, Venator, and Kronos, Dr. Shehadeh showed “the correlation between and co-integration of monthly chloride and sulfate TiO₂ prices for” the three firms from 2010 to 2017. *Id.* at 0144-46. This price correlation, according to Dr. Shehadeh, suggests that chloride and sulfate TiO₂ are substitutable.

But the mere fact that the prices of two goods move upward or downward together need not mean that they are substitutes. As Dr. Hill explained during the evidentiary hearing, “If you think about the sale of hamburger buns and hot dog buns, their prices will be highly correlated. Their demands are both seasonal—high in the summer, low in other seasons—and they’re made

⁹ Dr. Shehadeh has a PhD in economics from Cornell and is a managing director at NERA, an economic consulting firm. He too both summarized his modeling and synthesized his side’s key evidence during the evidentiary hearing. The Court found Dr. Shehadeh’s testimony and analysis to be entitled to some weight but ultimately unconvincing on several key points.

with the same ingredients. So their prices will be highly correlated. But they're not close substitutes for each other." Hr'g Tr. 407:24-408:4.

Price correlation between the two types of TiO₂ may reflect changes in feedstock prices, or a correlation in the demand for different types of paints (like low-end traffic marking paint, which tends to use sulfate TiO₂, and high-end exterior home paint, which uses the chloride pigment). In other words, "rather than high cross-elasticity of demand, correlated price movements might reflect the similar responses of different markets to similar changes, as when all prices move up in response to changes in common costs." 2B Phillip E. Areeda & Herbert Hovenkamp, *Antitrust Law* ¶ 534c (4th ed. 2014) ("Areeda & Hovenkamp").¹⁰

The Defendants raise two additional arguments. *First*, they note that "[a]pproximately 80% of TiO₂ end-use products can be made with either sulfate- or chloride-process TiO₂ [and] only 10% of products are more compatible with one process or the other." Defs.' Redacted Opp. To Prelim. Inj. 12. But for antitrust purposes, the "[r]elevant market analysis is based on the narrowest market principle." *Arch Coal*, 329 F. Supp. 2d at 120. This principle holds that, because "a relevant market cannot meaningfully encompass an infinite range of products," it must be "drawn narrowly to exclude any other product to which, within reasonable variations in price, only a limited number of buyers will turn." *Sysco*, 113 F. Supp. 3d at 26.

So, even if only 10% of the products that use titanium dioxide are more compatible with chloride-process TiO₂ than the sulfate alternative, the firms manufacturing that 10% can

¹⁰ Reflecting their limitations as an approach to defining markets, Dr. Jonathan Baker, a former director of the FTC's Bureau of Economics and Chief Economist at the Federal Communications Commission concluded that "price correlation tests contain little or no information relevant to the issue of antitrust market definition." Jonathan B. Baker, *Why Price Correlations Do Not Define Antitrust Markets* 7, Fed. Trade Comm'n Working Paper No. 149 (1987). *See also* Gregory J. Werden and Luke Froeb, *Correlation, Causality, and All that Jazz: The Inherent Shortcomings of Price Tests for Antitrust Market Delineation*, 8 Rev. of Indus. Org. 329, 332-338 (1993) (highlighting some problems with using price correlation to define antitrust markets).

constitute a relevant antitrust submarket. And here, the evidence suggests a much larger percentage of firms—at least in the relevant geographic market—cannot easily switch from chloride to sulfate. *See, e.g.*, PX5000 at 044-045 (collecting statements from many customers, who suggest, for instance, that for “over 90 percent [of applications] in the U.S., we can’t switch between chloride and sulfate” and “[u]sing sulfate TiO₂ would compromise our end products in North America, which is something we are not willing to do.”).

Second, the Defendants identify two examples of individual chloride-process TiO₂ products competing with sulfate-process products. *See* Defs.’ Unredacted Opp. to Prelim. Inj. 13, ECF No. 68-3. They note that “[o]ne of Tronox’s leading chloride-process grades, CR-828, competes directly with R-996, a sulfate-process grade of TiO₂ manufactured by Chinese producer Lomon Billions,” and that another Tronox product, “██████████”, has lost business to sulfate-process TiO₂ from Chinese producers.” *Id.* These statements, however, provide no indication of sales volumes or the context or extent to which the two chloride-process products have competed with their sulfate alternatives.

“Whatever the market urged by the [FTC], the other party can usually contend plausibly that something relevant was left out, that too much was included, or that dividing lines between inclusion and exclusion were arbitrary.” *Areeda & Hovenkamp* at ¶ 530d. “The Supreme Court has wisely recognized there is ‘some artificiality’ in any boundaries, but that ‘such fuzziness’ is inherent in bounding any market.” *Id.* (citing *United States v. Philadelphia Nat’l Bank*, 374 U.S. 321, 359 n.36 & 360 n.37 (1963)). Isolated examples of potential substitutability simply do not outweigh the consistent testimony and representations of industry participants or the empirical evidence provided by Dr. Hill. Thus, for the purposes of a preliminary injunction, the FTC has shown that the relevant product market is limited to chloride-process titanium dioxide.

2. “North America” is the Relevant Geographic Market

a. Industry Participants Believe that Distinct Regional Markets Exist

Like the product market, the relevant geographic market must “correspond to the commercial realities of the industry and be economically significant.” *Brown Shoe Co.*, 370 U.S. at 336. It encompasses the “area to which consumers can practically turn for alternative sources of the product and in which the antitrust defendants face competition.” *F.T.C. v. Cardinal Health, Inc.*, 12 F. Supp. 2d 34, 49 (D.D.C. 1998). Recall that in defining a market for antitrust purposes, the narrowest market principle applies.¹¹ While the Defendants believe that the relevant market is global, the Commission contends that it should be limited to the United States and Canada.

Here too, the statements of titanium dioxide suppliers are instructive. On a 2014 earnings call, then-Tronox CEO Tom Casey asked, “are there different prices in the regional markets in which we do business? The answer to that question is yes. The European and Asian market prices and the Latin American market prices are relatively closely bunched, with the North American price being somewhat higher.” PX9008-008. On another earnings call in 2016, Mr. Casey expressed Tronox’s view “that prices in Europe and in Asia were lower than prices in the United States and in other North American – the other North American markets.” PX9001-007. Ian Mouland, Tronox’s vice president of sales for the Americas, suggested in an internal email that a customer “need[s] to stop being concerned about regional price differences and accept that regions are different . . . unless he is telling you that [he] sell[s] a can of paint in Mexico for the same price as in Germany?!” PX1085-001. Tronox acknowledged that TiO₂ pricing “depends

¹¹ The Defendants have not suggested that the relevant market should be any narrower than the FTC’s proposal.

upon the region . . . [REDACTED]

[REDACTED].” PX7001-032.

Like Tronox, the other major producers segment their customers by location. Kronos has “a European region . . . [a]nd then we have North America, which represents the United States and Canada. And then we have [LatAm], which is Latin America, Central America, the Caribbean, and South America. And then the export market, which is for us rest of world.” Hr’g Tr. 167:22-168:7. [REDACTED] “separates customer locations into five different regions: North America (United States and Canada); Europe, the Middle East, and Africa; Asia-Pacific excluding China; China; and Latin America (including Mexico).” PX8004-002. [REDACTED] explained that “customers in the North American region generally have different requirements than in other regions.” *Id.* See also PX5000-062 (featuring similar statements from Cristal representatives).

Titanium dioxide customers also acknowledge the existence of a distinct North American TiO₂ markets. Sherwin-Williams paints “have different pallets in different regions of the world,” and customer demands require that the company has “different performance standards around the world as well.” PX7020-014. The firm has thus found that “sulfate has not been suitable for our formulations in North America [but in] other regions of the world with different quality standards, there has [sic] been levels of suitability.” Admin Trial Tr. 642:25-643:3. Dr. Malichky testified that “[i]n PPG jargon, we would call [the North American market] USCA, U.S. and Canada, and Mexico is different. The suppliers consider Mexico different, as well.” Hr’g Tr. 97:17-19. He added that, for the North American market, “[t]he vast majority [of TiO₂ PPG uses] is chloride,” but that “in Europe, we use more sulfate.” Hr’g Tr. 101:16-18; 103:17-20.

b. Quantitative Evidence and the Hypothetical Monopolist Test Further Support Treating North America as a Separate Market

The available quantitative evidence also supports the existence of regional TiO₂ markets. In a single, global market, sustained regional price variances are unlikely, as customers would engage in arbitrage—like importing TiO₂ or purchasing it indirectly from other customers—that equalizes prices over time. *See* U.S. Dep’t of Justice & F.T.C. Horizontal Merger Guidelines § 4.2.2 (2010) (“Merger Guidelines”). But by evaluating data from Tronox and Cristal, Dr. Hill showed that, from 2012 to 2017, the average difference in TiO₂ prices between North America and the rest of the world ranged from \$250 - \$525 per metric ton. PX5000 at 063-064.

A recent TiO₂ supply restriction in Europe provides more proof of regionalized markets. In January 2017, a fire at a large TiO₂ plant in Pori, Finland, decreased the available titanium dioxide in Europe and caused a rapid and significant price increase. PX5004-039. Producer invoice data suggest that, before the fire, North American TiO₂ prices were roughly \$200 - \$250 per metric ton higher than European prices. After the fire, however, European prices significantly exceeded those in North America. From January to October 2017, Cristal’s and Tronox’s European prices each rose by [REDACTED] (compared to [REDACTED] and [REDACTED] increases in North America respectively). *Id.* The Pori fire thus shows a dramatic relative increase in European prices not “disciplined by customer arbitrage.” *Id.*

Dr. Hill also conducted several iterations of the “hypothetical monopolist test” to prove that the relevant market consists of North American sales of chloride-process TiO₂. The test seeks to determine whether a hypothetical company that is the only seller of the relevant product to customers in the relevant geography could profitably impose a “small but significant and non-transitory increase in price” (“SSNIP”). *See* Merger Guidelines §§ 4.1.1; 4.2.2. If this hypothetical monopolist can profit from imposing a SSNIP without losing a critical mass of

customers, then a relevant antitrust market has been defined. If, on the other hand, customers can defeat the price increase “by substitution away from the relevant product or by arbitrage,” the market definition must be broadened. *Id.* See also *Sysco*, 113 F. Supp. 3d at 33-34.

To run the test, Dr. Hill conducted a “critical loss analysis.” PX5000-049. He began by calculating the “critical loss,” which is the percentage of “lost unit sales that would leave profits unchanged” if a hypothetical monopolist imposed a SSNIP. Merger Guidelines § 4.1.3. Dr. Hill determined that, with an SSNIP of 10%, a hypothetical monopolist could lose up to 15.4% of its sales and still break even. PX5000-051. The critical loss threshold is thus 15.4%.

Next, Dr. Hill estimated the “predicted loss” that would be observed in the event of a SSNIP of 10%. If the predicted loss is less than the critical loss, imposing a SSNIP would be profitable for the hypothetical monopolist, and the relevant antitrust market has been correctly defined. Dr. Hill used three methods to calculate the predicted loss: the “price elasticity of demand” method, a “substitution components” method, and a “documentary evidence” method. Each showed that a hypothetical monopolist could profitably raise North American chloride TiO₂ prices by 10%. See PX5000 at 051-057.

Price elasticity of demand measures the responsiveness of a product’s sales to a 1% change in the product’s price. PX5000-051. Demand for a product is “elastic” if a 1% price increase decreases demand by more than 1%. It is “inelastic” if a 1% price increase decreases demand by less than 1%. The more inelastic a product’s demand, the less likely it is that the product has adequate substitutes. Dr. Hill found that the price elasticity of North American chloride TiO₂ is -0.45% (*i.e.*, a 1% increase in price reduces sales by 0.45%). He multiplied this number and a 10% SSNIP to show that the predicted loss of sales, 4.5%, would be considerably lower than the critical loss of 15.4%. PX5000-052. In other words, estimates of price elasticity

show that a hypothetical monopolist could profitably increase North American chloride TiO₂ prices by 10%.

Dr. Hill's "substitution components method" used the Defendants' data to estimate the expected increase of TiO₂ imports in response to a 10% SSNIP. The TiO₂ that firms acquire from imports or from other producers repatriating their exports represents lost sales for a hypothetical monopolist. Dr. Hill found that a 10% SSNIP would lead to roughly 75,000 more metric tons of TiO₂ being imported or repatriated, and another 3% decrease in the monopolist's sales of rutile TiO₂. PX5000-054. Together, this represents roughly 12.6% of total North American chloride TiO₂ sales. *Id.* As a 12.6% loss is lower than the critical loss threshold of 15.4%, the substitution components method predicts that the hypothetical monopolist could profitably raise prices.

Finally, Dr. Hill used data from Tronox documents. At some future point, Tronox contends, "Chinese sulfate could take up to 15 percent of [all TiO₂] applications" in North America, thus "reducing the share of chloride titanium dioxide by at most five percent." PX5000-055. Dr. Hill assumed that such sulfate substitution would occur in response to a 10% SSNIP. He and calculated that the resulting loss of sales to the hypothetical monopolist would be about 8.7%, which again is lower than the critical loss threshold. PX5000-056. Based on these calculations and his other analyses, Dr. Hill concluded that the relevant market for evaluating the merger's potential anticompetitive effects consists of North American chloride TiO₂ sales.

c. The Defendants Define the Market Too Broadly

The Defendants argue that the Commission's geographic market definition is impermissibly narrow, and they challenge many of Dr. Hill's calculations. The FTC's "claim that the relevant geographic market is limited to North America," they contend, "ignores that

TiO₂ is a globally-traded commodity.” Defs.’ Unredacted Opp. to Prelim. Inj. 8. If Dr. Hill’s hypothetical monopolist “were to attempt to implement a SSNIP post-merger, the significant volume of TiO₂ ‘on the water’ that would be diverted to North America . . . would exceed the critical loss . . . within the FTC’s candidate market.” RX0170.0015. This is because global trade in TiO₂ is “highly elastic.” *Id.*

True, global trade flows of TiO₂ are substantial. In 2016, 46% of the chloride TiO₂ produced in North America was exported. PX5000-037. The largest producers of the chloride pigment in North America—Chemours, Tronox, and Cristal—are also its largest exporters. *Id.* at 038. Upon a price increase in North America, these producers could conceivably repatriate some of this exported TiO₂ to increase their profit margins.

The Commission, however, provided plausible explanations for why sizeable repatriation of titanium dioxide would not occur. First, there has been no evidence of this behavior in the past. As mentioned earlier, Dr. Hill’s analysis suggests a persistent variance in prices between North America and other regions. Regional price differences show that profiting from export repatriation is possible. But the persistence of these differences shows that nontrivial repatriation does not happen in practice.

One offered reason is that, in the TiO₂ industry, “customer relationships” and “security of supply” are essential. Hr’g Tr. 399:15-22. TiO₂ producers have large customers in export markets, and “alienating a customer base” could result in the long-term loss of business. *Id.* As revenues depend on both sales volume and product price, “making a large change invoking the ire of your customers for a short period is probably not worth it.” Hr’g Tr. 399:25-400:2. *See also* PX8005-004 (Venator explaining that “[o]ur European business is stable, and our primary focus is on serving the established relationships we have built over time with large customers in

Europe. Given the cost of shipping and duties, we are generally better off selling in Europe than exporting to North America. We have not seen a sustained gap between North American prices and European prices large enough over a long enough period that it would make sense for us to export more to North America.”).

The North American preference for slurry rather than dry TiO₂ presents another reason to question the extent to which export repatriation might defeat a price hike imposed by the hypothetical monopolist. The “North American market is almost exclusively slurry,” and customers in this region have “some of the most strict” quality of product and service demands. Hr’g Tr. 177:21-22; 178:5-11. While all titanium dioxide trading is subject to logistical challenges, import duties, and shipping costs, slurry TiO₂ requires at least some additional capital expenditure (such as physical locations at which the dry TiO₂ is mixed with an aqueous solution and repackaged). These costs may make export repatriation even more unlikely absent a large and sustained regional price disparity. Together, the persistence of regionalized pricing, the lack of evidence of prior export repatriation, the incentives for maintaining customer relationships and supply security, and the domestic preference for slurry raise significant questions about whether customers could import enough TiO₂ to offset a SSNIP.

Aside from ignoring global trade flows, the Defendants contend that the Commission’s market definition is wrong because of the “flawed method with which” Dr. Hill implemented the hypothetical monopolist test. RX0170.0129. According to them, Dr. Hill wrongly “gives the hypothetical monopolist control over supply both inside and outside his hypothesized relevant market.” *Id.* at 0130. This modeling decision means that “customers in North America could not get additional supply” from plants and producers in Europe or other regions. *Id.*

But an assumption that North American customers will not be able to secure meaningful increases in TiO₂ from foreign sources appears to comport with the industry's economic realities as described above. Moreover, the Merger Guidelines suggest that “[w]hen the hypothetical monopolist could discriminate based on customer location, [the Commission] may define geographic markets based on the locations of targeted customers Geographic markets of this type encompass the region into which sales are made.” Merger Guidelines § 4.2.2. Persistent regional pricing shows that TiO₂ producers can discriminate based on customers' locations. And, as Dr. Shehadeh testified, the Merger Guidelines are “an excellent summary of a very broad set of tools that are used by economists” to engage in antitrust analysis. Hr'g Tr. 478:6-8. They have also been repeatedly relied on by the courts. *See, e.g., Sysco*, 113 F. Supp. 3d at 38 (“The Merger Guidelines are not binding, but the Court of Appeals and other courts have looked to them for guidance in previous merger cases.”) (citing *Heinz*, 246 F.3d at 716; *H & R Block*, 833 F. Supp. 2d at 52 n. 10). Thus, Dr. Hill's modeling assumptions seem reasonable given the nature of the TiO₂ industry.

In summary, though the TiO₂ market is characterized by considerable global trade, the Commission has credibly suggested that North American customers could not overcome a 10% SSNIP by increasing imports from foreign sources. It has also shown that customers cannot substitute away from chloride by using sulfate TiO₂ in their coatings, paints, and plastics. The Court finds that the FTC has carried its burden, and that the market for chloride-process TiO₂ in North America is the relevant market in which to assess the potential anticompetitive effects of Tronox's acquisition of Cristal.

3. The Chloride-Process TiO₂ Market in North America is Concentrated, and the Proposed Transaction Would Substantially Increase Concentration

Chemours, Cristal, Tronox, Kronos, and Venator dominate the market for chloride-process TiO₂ in the United States and Canada. From producer invoices, customer data, and third-party cost studies, Dr. Hill estimates that roughly 831,000 metric tons of chloride TiO₂ was sold in North America in 2016. Of this volume, Chemours accounted for [REDACTED] of sales. Together, Tronox and Cristal accounted for [REDACTED]. PX5000-068. Kronos accounted for [REDACTED], and Venator for [REDACTED], of 2016 sales. *Id.* Together, the five firms sold nearly 99.5% of total chloride TiO₂ in 2016, and the proposed merger would create a market in which the top two companies control around 73% of total production capacity.

The Merger Guidelines explain that “[m]arket concentration is often one useful indicator of likely competitive effects of a merger,” and that the Herfindahl-Hirschman Index (“HHI”) is a common economic measure of such concentration. Merger Guidelines § 5.3. Courts agree. *See, e.g., Heinz*, 246 F.3d at 716.

The HHI is calculated by squaring the market share of each firm in the market and adding up these squares (so, if there are three firms with market shares of 50%, 30%, and 20%, the HHI would be $50^2 + 30^2 + 20^2 = 3,800$). Squaring the individual market shares allocates proportionately greater weight to firms with larger shares, reflecting the larger threat to competitive behavior they pose. *See* Merger Guidelines § 5.3. For antitrust purposes, the FTC and the U.S. Department of Justice generally classify markets as “unconcentrated,” “moderately concentrated,” and “highly concentrated.” An unconcentrated market features an HHI of below 1,500. A moderately concentrated market has an HHI of between 1,500 and 2,500, while a highly concentrated market has an HHI that is greater than 2,500. *Id.*

Economists calculate the HHI score of an industry before and after the proposed merger. Transactions that result in an HHI increase of fewer than 100 points “are unlikely to have adverse competitive effects.” *Id.* In moderately concentrated markets, a transaction that increases the HHI by more than 100 points “potentially raise[s] significant competitive concerns and often warrant[s] scrutiny.” *Id.* Mergers “resulting in highly concentrated markets that involve an increase in the HHI of more than 200 points will be presumed to be likely to enhance market power.” *Id.* This presumption of anticompetitive effects “may be rebutted by persuasive evidence showing that the merger is unlikely to enhance market power.” *Id.*

The Defendants did not attack Dr. Hill’s HHI analysis. He determined that the present-day North American chloride TiO₂ market features an HHI score of 2,320, which suggests that the market is moderately concentrated. PX5000-068. Should Tronox and Cristal merge, the new four-firm market would feature an HHI of 3,046. The merger would thus increase the HHI by 726 points, resulting in a highly concentrated market. Because it would increase the HHI score by well over 200 points, and because it would result in a highly concentrated market, the proposed transaction is presumptively anticompetitive under the Merger Guidelines. *See also Heinz*, 246 F.3d at 716 (noting that the proposed merger would “increase the HHI by 510,” and that this “creates, by a wide margin, a presumption that the merger will lessen competition” in the relevant market).

4. Post-Merger Strategic Output Withholding is Likely

Beyond its market-share analysis, the Commission’s evidence suggests a reasonable probability that the proposed transaction will lead to anticompetitive behavior among the industry’s remaining players. Although the Defendants offer nontrivial critiques of Dr. Hill’s

theoretical models suggesting this behavior, they cannot overcome the real-world proof of meaningful market incentives to manage prices by withholding TiO₂ supply.

a. The Documentary and Testimonial Evidence Points to Incentives for and a History of Strategic Output Withholding

Statements from Tronox executives evince an understanding that TiO₂ producers recognize the benefits of strategically withholding supply from consumers to maintain higher prices. In 2012, the firm's Chief Commercial Officer advised against aggressive competition with producers, as this would cause "price to deteriorate further and [Tronox does] not want to facilitate or fuel that process." PX5000-077. He instead suggested the company "slow down production so that we minimize or eliminate the inventory build that will occur if we continue running at the existing rates." *Id.* On a 2015 earnings call, Mr. Casey noted that Tronox was "addressing when the prices turn" by "managing our production so that inventories get reduced to normal or below normal levels. And when that happens, prices will rise." PX9005-010. On a 2016 earnings call, Mr. Casey explained that "a very disciplined approach to production, to managing supply relative to demand, is what has facilitated the recovery in our markets, and we intend to continue to be disciplined about that." PX9003-010. And on the February 2017 earnings call to announce and discuss the proposed merger with Cristal, Mr. Casey said, "we have tried to be economically rational over these last several years. If there was surplus supply in the market we slow down our production." PX9000-012.

Tronox documents suggest the firm has withheld TiO₂ supply to shore up prices in the past and that avoiding price competition with fellow suppliers can be beneficial. In 2016, Arjen Duvekot, then a managing director, told a distributor that "to stop the price erosion in the market we reduced the production output in our pigment plants mid 2015 by 15%," adding that this withholding "presents a great opportunity to turn around the price trend of the last 4 years and

improve the prices for Tronox TiO₂ pigment in the market.” PX5002-009. Similarly, in 2015, Mr. Duvekot told a colleague that offering a consumer a lower price “will cause a reaction from the competition, at this account or elsewhere in the market, which will just lead to more price erosion in the market. Tronox does not want to play this game (anymore).” PX1432-001.

Other TiO₂ firms also acknowledge the benefits of strategic output withholding. *See* PX2022, PX2116, and PX2083 (statements in Cristal documents about idling production to raise prices); PX3000 at 003-004 (██████████ noting that “capacity rationalization” and an “increasingly structured and consolidated market (Tronox / Cristal)” mean that the “[s]ignificant recovery in TiO₂ prices [is] expected to continue through 2017 and 2018”); PX5000-079 (describing plans by Chemours to “dial back production” at some plants in response to adding production capacity at a facility in Mexico).

There is, of course, nothing improper about a firm making independent production decisions to maximize profits. But a core purpose of antitrust law is to scrutinize mergers that may make it easier for firms to collectively reduce output, and indeed, to prevent mergers that are likely to do so. *See Heinz*, 246 F.3d at 371 (“Merger law rests upon the theory that, where rivals are few, firms will be able to coordinate their behavior, either by overt collusion or implicit understanding, in order to restrict output and achieve profits above competitive levels.”); *F.T.C. v. Elders Grain, Inc.*, 868 F.2d 901, 906 (7th Cir. 1989) (Posner, J.) (noting that antitrust theory “teaches that an acquisition which reduces the number of significant sellers in a market already highly concentrated and prone to collusion by reason of its history and circumstances is unlawful in the absence of special circumstances.”).

A Tronox-Cristal merger will make TiO₂ supply reductions easier to coordinate through implicit understanding and sheer market power, in a market where producers have already shown

an awareness that implicit coordination would be beneficial.¹² The post-merger market would feature two firms that control roughly three quarters of all chloride TiO₂ production – Chemours and the Tronox-Cristal entity. These firms could more easily “stop the price erosion in the market” and “slow down production” across the industry, as customers will often be left with no meaningful alternative sources of supply.

Consider two examples. First, [REDACTED] “spends about [REDACTED] annually to buy a specialty chloride grade of titanium dioxide from Tronox.” PX8001-001. [REDACTED]

[REDACTED] While the firm “prefers to use Tronox’s . . . titanium dioxide, it has purchased . . . from [REDACTED] and [REDACTED] in the past, and is willing to purchase it [from these Tronox rivals] in the future,” based on product pricing and availability. *Id.*

Recently, Tronox offered [REDACTED] a new “one-year contract at a significant price increase, about [REDACTED] above” the firm’s current contract price. *Id.* at 002. The company “reached out to [REDACTED] and [REDACTED], its two previous titanium dioxide suppliers,” but “[REDACTED] responded that they do not have supply to offer, and [REDACTED] failed to respond at all.” *Id.* Seeking to avoid paying Tronox’s higher price, the company “anticipate[s] reaching out to Cristal in the near future” to see if Cristal would be willing to offer a supply proposal. *Id.*

Second, [REDACTED] has a supply agreement with Tronox that [REDACTED]

¹² The Commission alleges a history of overt collusion in the TiO₂ industry, pointing to recent price-fixing allegations and litigation. *See Valspar Corp. v. E.I. Du Pont De Nemours and Co.*, 873 F.3d 185 (3d Cir. 2017); *In re Titanium Dioxide Antitrust Litig.*, 959 F. Supp. 2d 799 (D. Md. 2013); Pl.’s Mem. in Supp. of Pl.’s Mot. for Prelim. Inj. 3, ECF. No. 6 (“the TiO₂ industry in North America has a long history of price-fixing litigation and subsequent court decisions outline pervasive anticompetitive conduct.”). The Defendants vigorously contest these assertions. *See* Defs.’ Redacted Opp. to Prelim. Inj. 28-29. That said, the Court need not decide the merits of these claims, as the proposed merger will increase the likelihood of collective output withholding without explicit agreements or attempted price-fixing.

in other words, strengthens the Commission's assertion that the Tronox-Cristal merger raises serious and substantial questions about likely anticompetitive effects.

b. Dr. Hill's Capacity Closure and Cournot Models are Subject to Valid Critiques, but Their Conclusions Track Business Realities

Dr. Hill used two economic models to prove that the merger will increase incentives to withhold TiO₂ supply. He first presented findings from a new analysis he calls the "Capacity Closure" model. PX5000-085. It seeks to quantify the costs and benefits to the Tronox-Cristal entity associated with output reductions. Generally, the cost of reducing production is the lost profit on each unit of TiO₂ that is withheld, while the benefit is the higher profit margin, attributable to a higher market price, of each unit that is sold. *Id.* at 086. The model allows "imports of chloride titanium dioxide to be affected by changes in the price," but it does not "allow for an increase in North American domestic production of chloride titanium dioxide because of the current high operating rates in North America." *Id.* at 087.

The Capacity Closure model predicts that, "under current market conditions, the merged firm would have an incentive to withhold output by idling two production lines at [Tronox's] Hamilton plant [in Mississippi]." *Id.* at 087. Specifically, the "most profitable output withholding strategy is predicted to lead to a price increase of 23% and cause harm of \$419 million per year." The model outlines many profitable withholding strategies that would result in price increases to consumers ranging from 8 - 38%. *Id.*

The Defendants present two criticisms of the Capacity Closure model that limit the persuasiveness of its conclusions. Dr. Shehadeh contends that the model is invalid as it "predicts that Chemours should supply less to North America under current competitive conditions than Chemours is actually supplying." RX0170.0038. Because the model's predictions are unreliable

for “Chemours’ actual conduct today,” he argues, they are unreliable as they pertain to future conduct by the merged entity. *Id.*

Dr. Hill’s rebuttal report does not respond directly to this allegation. *See* PX5004 at 041-045. During the evidentiary hearing, he explained that he did not try to address the issue, as he did not apply his model to Chemours. Hr’g Tr. 447:2-448:1. Instead, he claimed that he was unwilling to “rely on the data” used by Dr. Shehadeh, because “Chemours has a different production process than its rivals,” and this makes “margin information” on the firm unreliable. *See id.* Dr. Hill did use this data, however, in conducting some of his hypothetical monopolist testing, as there he “was able to mitigate the concerns about the data.” Hr’g Tr. 448:5-7. While it is true that data fit for one purpose may not be fit for another, Dr. Hill’s response does not fully allay the concerns raised by Dr. Shehadeh, and there is reason to question the model’s predictive power.

Dr. Shehadeh also questions the justification for the assumption that the “current high operating rates in North America” mean that producers cannot increase capacity at all. After all, high operating rates do not prevent firms from “engaging in [the type of] expansions that have been so evident in the industry.” RX0170.0039. Dr. Hill’s rebuttal focuses on statements made by Venator and Chemours executives, who predict sustained capacity constraints and suggest that the industry’s high utilization rate is unlikely to change over the next few years. *See* PX5004 at 043-44. But these statements assume that the status quo will continue, and not that a new Tronox-Cristal entity will increase its output withholding. It therefore seems reasonable to expect *some* efforts by rivals to increase capacity if such efforts could be profitable.

Unlike the Capacity Closure model, the Cournot model is a “fundamental economic” tool used to analyze oligopolies. PX5000-090. Its “key insight is that firms in oligopoly markets will

recognize their mutual interdependence and restrict output—thereby increasing the market price above the competitive level.” *Id.* And unlike the Capacity Closure method, the Cournot model allows firms to adjust output, so that each firm can expand capacity if it so chooses. *Id.* Dr. Hill’s Cournot analysis suggests that “the merger would lead to a higher chloride titanium dioxide price unless the merger were to generate a more than 74% reduction in the merged firm’s marginal cost as compared to those of the stand-alone firms.” *Id.* Unless the cost savings from the acquisition are so great as to reduce the price of producing a unit of TiO₂ pigment by 74%, the Cournot model suggests that the merged entity would gain more from raising prices than increasing supply.

Dr. Shehadeh contends that, in some circumstances, use of the Cournot model is not appropriate and leads to results that are inconsistent with market realities. RX0170.0044. Here, for instance, the Cournot model “significantly” understates the existing marginal costs of production. *Id.* at 0045. Chemours’ marginal cost of producing TiO₂ is, according to the model, “more than [REDACTED]” lower than the “actual” marginal cost as measured by Dr. Hill. *Id.* Because of this “glaring inconsistency with basic industry facts,” the Cournot model cannot yield reliable conclusions about the market. *Id.*

The Defendants also highlight, and Dr. Hill confirms, that his “Cournot model predicts that in the North American chloride TiO₂ market the merger will be unprofitable with respect to variable costs.” Hr’g Tr. 450:21-24. He added that he did not use the Cournot model to analyze the overall profitability of the merger, but that a “merger that generates significant fixed cost savings” would still be profitable on an overall basis. Hr’g Tr. 452:18-453:14.

Dr. Hill rejects the contention that these findings make the Cournot model inconsistent with market realities. He counters that Dr. Shehadeh “confused the total cost of production,”

which is used in the Capacity Closure model, with “the concept of marginal cost of production.” PX5004-046. Using a corrected, apples-to-apples comparison, the data offers “striking support for the Cournot model’s validity.” *Id.* Dr. Hill also suggests that the purpose of the Cournot model is not to analyze merger profitability, but rather to test the effects of output withholding. Hr’g Tr. 467:15-24.

The Court finds that Dr. Hill’s overall conclusions are more consistent with the business realities of the TiO₂ industry than those proffered by Dr. Shehadeh, even if the Cournot and Capacity Closure models are subject to valid criticisms. Dr. Hill buttresses his modeling with several producer statements that support his findings. TiO₂ producers are aware, for example, of their interdependence and the downsides of expanding output. *See* PX5000-093 (collecting Tronox executives’ statements like, “we have not gained market share by trying to reduce price [and we] don’t think that’s the appropriate strategy going forward,” and [REDACTED] [REDACTED] [REDACTED]. These statements lend credibility to the models’ conclusions, as they suggest that firms are generally unwilling to take actions that will lower industry-wide prices.

Ultimately, this Court need not decisively sift through various models and theories. *See Sysco*, 113 F. Supp. at 36-37 (noting that the court “hesitates to rely on” an expert’s precise calculations where such calculations are subject to valid criticism, and concluding that “when evaluated against the record as a whole, [the expert’s] conclusions are more consistent with the business realities” of the relevant market). Rather, the question here is whether the FTC “has raised questions going to the merits so serious, substantial, difficult and doubtful as to make them fair ground for thorough investigation, study, deliberation and determination by the FTC in

the first instance and ultimately by the Court of Appeals.” *Heinz*, 246 F.3d at 714-15 (internal quotation omitted).

The FTC clears this bar. It has established its prima facie case by proving that the Tronox-Cristal merger will likely result in undue concentration in the North American chloride-process TiO₂ market. It has strengthened this case by showing that the merger will increase already prevalent incentives to engage in strategic output withholding. The Commission has therefore established a presumption that the proposed transaction will have anticompetitive effects in violation of the Clayton Act.

B. The Defendants’ Rebuttal Evidence Does Not Overcome the Presumption of Anticompetitive Effects

The Defendants can rebut the presumption that their merger will substantially lessen competition either by “discrediting the data underlying the initial presumption in the government’s favor,” or by “affirmatively showing why [the deal] is unlikely to substantially lessen competition.” *Baker Hughes*, 908 F.2d at 991. Generally, “[t]he more compelling the [FTC’s] prima facie case, the more evidence [the Defendants] must present to rebut it successfully.” *Id.* As discussed above, the Defendants have not sufficiently discredited the Commission’s data and evidence.

They marshal two additional arguments suggesting that the market will remain competitive post-acquisition. First, they contend that the current market is “fiercely competitive,” and that the Defendants face increased pressure from “the rise of Chinese market entrants who are disrupting competition globally.” Defs.’ Unredacted Opp. to Prelim. Inj. 24, 29. Second, they assert that consumers will benefit from the transaction’s output-enhancing synergies and efficiencies. Neither argument, alone nor in tandem, can overcome the Commission’s strong presumption of anticompetitive effects.

1. Chinese Producers are Not Yet Positioned to Replace the Competition That Would be Lost by a Tronox-Cristal Merger

Entry or expansion into the relevant market by new competitors can mitigate the expected anticompetitive effects of a proposed transaction. *H & R Block*, 833 F. Supp. 2d at 73. This is because, “[i]n the absence of significant barriers, a company probably cannot maintain supracompetitive pricing for any length of time.” *Baker Hughes*, 908 F.2d at 987. The Merger Guidelines thus suggest that companies that are “not current producers in a relevant market, but that would very likely provide rapid supply responses with direct competitive impact in the event of a SSNIP, without incurring significant sunk costs, are also considered market participants.” Merger Guidelines § 5.1. Sunk costs include the “entry or exit costs that cannot be recovered outside the relevant market.” *Id.*

The Defendants contend that, in defining the market and assessing the deal’s likely harm, the Commission “wrongly dismisses the importance of Chinese TiO₂ producers, particularly Lomon Billions, the fourth largest TiO₂ supplier in the world by capacity.” Defs.’ Unredacted Opp. to Prelim. Inj. 30. Lomon Billions “plans to expand its chloride capacity . . . by adding 200,000 tons per year during the year 2019 . . . and 300,000 tons per year sometime in the mid-2020s.” *Id.* at 30-31. Based on 2016 data, this expansion would make Lomon Billions almost twice as large as the current market leader in chloride-process production (Chemours, with roughly 290,000 tons), and would expand the overall chloride market by nearly 60%. *See* PX5000-068. Lomon’s bold growth plan is feasible, “real and unspeculative,” the Defendants warn, because the firm “benefit[s] from low capital costs, support from the Chinese government, and from inherited intellectual property.” Defs.’ Unredacted Opp. to Prelim. Inj. 30-31.

It is no doubt possible, and perhaps inevitable, that competition from Lomon Billions and other Chinese TiO₂ producers will someday redefine the North American market. But the

pertinent question here is whether the emergence of Lomon Billions can be “rapid enough to make unprofitable overall the [predicted] actions” that otherwise lead to the Commission’s concerns about anticompetitive effects. Merger Guidelines § 9.1. The evidence suggests that it cannot.

Currently, neither Lomon Billions nor any supplier other than Chemours, Tronox, Cristal, Kronos, or Venator account for even 1% of North American chloride-process TiO₂ supply. PX5000-068. Lomon Billions, like other Chinese firms, is “predominantly” a sulfate-process TiO₂ producer. Hr’g Tr. 184:9-11. Tronox documents from 2016 suggest that “China has built multiple chloride plants but struggles to commission them,” and that “almost no commercial grade [chloride] pigment is produced today.” PX5000-113.

Major TiO₂ manufacturers do not appear to be worried about the prospect of a near-term increase in Chinese chloride production. In a 2015 email, then-Tronox CEO Mr. Casey said, “I think it is a very remote prospect that China will be producing chloride capacity of any magnitude in the next 3-5 years. The only facility is a 30,000 ton plant being built by Billions, which they cannot get to work.” PX1065-001.

Similarly, from Kronos’s perspective, Lomon Billions is “just not a material threat today We’ve been thinking [about] this for a while, [and] we just don’t see a lots [sic] of Chinese [chloride-process] products in the markets in which we compete.” Hr’g Tr. 183:24-184:8. Kronos does not see its “customers . . . switching from our [chloride-process] products to Lomon Billions.” Hr’g Tr. 184:16-17. As Mr. Christian persuasively explained, Chinese companies’ typical advantages are low labor costs and a relaxed environmental regulatory regime. Hr’g Tr. 186:11-25. These advantages are of little help in the chloride-process business. *Id.*

Indeed, the experiences of Chinese TiO₂ manufacturers confirm the existence of two substantial barriers rendering rapid entry into the North American market unlikely: capital costs and technology constraints. Tronox estimates that “on average, the greenfield cost per ton of TiO₂ is between \$5,000-\$6,000 for chloride pigment plants.” PX003-013. The construction of a new 200,000-ton plant would therefore cost between \$1-\$1.2 billion. *See also* PX5000-110 (noting similar estimates from Cristal and Kronos).

In addition to high entry costs, chloride-process TiO₂ requires advanced technology and intellectual property that is “closely guarded by Western producers.” PX3011-019. Lomon Billions has “struggled with the technology. They don’t produce utilization rates anywhere near their . . . nameplate capacity [and] they’ve had to lower the nameplate capacity of their plant.” Hr’g Tr. 184:23-185:3. *See also* PX5000-113 (“[redacted] deemed efforts by the largest Chinese producer, Lomon Billions, to produce chloride titanium dioxide a ‘technology failure.’”); PX1000-018 (Tronox presentation noting that the “[l]egitimacy of [Chinese] base technology [is] questionable,” and that Chinese firms have “[n]o know-how/experience of running CP plant”).

Customers, like TiO₂ producers, believe that technology and quality constraints preclude Chinese manufacturers from meaningful participation in the chloride market. [redacted] has tested Lomon Billions’ chloride TiO₂ but found it lacking. PX5000-114. [redacted] has an established supply relationship with Lomon Billions, but they “weren’t able to deliver the material that we ordered when we wanted it.” [redacted] *See also* Admin. Trial Tr. 1094:21-1095:9 (North American customer noting that buying “titanium dioxide from China” would “really be a last resort for us.”).

Finally, even if Chinese producers can radically increase their chloride TiO₂ production over the next few years, recent trends show that much of this supply may be consumed by their

domestic demand. China is currently a net importer of chloride TiO₂. PX5000-115. As its economy grows and per capita incomes increase, demand for household paints and other products using TiO₂ is expected to rise. An industry study, for example, estimates that China's share of TiO₂ demand will "expand[] from 4% of global demand in 2005 to an anticipated share of 27% in 2020." PX5000-115. [REDACTED]

[REDACTED] *See also* PX3032 at 001 ("Chinese TiO₂ growth is primarily feeding local and Asian demand."). Reflecting these trends, Mr. Casey estimated that China's "first production [of chloride TiO₂] will go into the domestic market so the export market impact will be quite a while." PX1065-001.

The limited presence of Lomon Billions in the North American chloride market today, the substantial barriers to entry, and China's internal TiO₂ demand trends do not paint a picture of rapid entrants ready to replace the loss of Cristal as a source of competition. Rather, the emerging threat from Chinese producers here is like the prospective competition from Amazon that the court considered in *Staples*, 190 F. Supp. 3d at 133-136. Evaluating a proposed merger between Staples and Office Depot, the court there found that the Commission had established its prima facie case. *See id.* at 131. The *Staples* defendants responded by suggesting that competition from "Amazon Business" would nullify any suggested anticompetitive effects. *Id.* at 133. They asserted that Amazon "wants to take over the office supply industry," and that the firm would "eventually transform the [business-to-business] office supply space." *Id.*

The court was unconvinced. It found "significant institutional and structural challenges" that prevented Amazon from being "in a position to restore [lost] competition." *Id.* at 134. The court found that "customers still do not view Amazon Business as a viable alternative," and that

Amazon had “yet to successfully bid to be a large [business-to-business] customer’s primary vendor.” *Id.* Amazon, in other words, would “not be in a position to compete” in the relevant market “with the proposed merged entity within three years.” *Id.* at 136. So too here. Lomon Billions is not yet positioned to compete meaningfully with the producers that would remain in a post-merger North American chloride TiO₂ market.

2. The Transaction’s Purported Synergies and Efficiencies do not Rebut the Commission’s Prima Facie Case

When a court “finds high market concentration levels, defendants must present proof of extraordinary efficiencies to rebut the government’s prima facie case.” *Sysco*, 113 F. Supp. 3d at 81. Courts have “rarely, if ever, denied a preliminary injunction solely based on the likely efficiencies.” *Id.* at 82 (quoting *F.T.C. v. CCC Holdings, Inc.*, 605 F. Supp. 2d. 26, 72 (D.D.C. 2009)). To be able to offset a merger’s likely anticompetitive effects, purported synergies and efficiencies must “represent more than mere speculation and promises about post-merger behavior.” *Heinz*, 246 F.3d at 721. They must be “merger-specific,” meaning that they “cannot be achieved by either company alone.” *Id.* at 721-722. And they must be “reasonably verifiable by an independent party.” *H & R Block*, 833 F. Supp. 2d at 89. The Defendants have identified several merger-specific, but ultimately unverifiable, synergies and efficiencies.

The Tronox-Cristal merger, they argue, will increase global production of TiO₂ for three reasons. First, “Tronox produces more TiO₂ feedstock than its TiO₂ pigment plants can consume, while Cristal’s TiO₂ production exceeds its feedstock production.” Defs.’ Unredacted Opp. to Prelim. Inj. 24. The merger would thus allow “greater vertical integration” leading to expanded TiO₂ output. *Id.* Second, Tronox believes that Cristal is not producing as much TiO₂ as it could, in part because of the “extremely subpar” performance of its titanium dioxide plant in Yanbu, Saudi Arabia. *Id.* at 27. Kerr McGee, Tronox’s predecessor firm, “built Yanbu with its

own technology,” and Tronox believes it has a “unique skill set” and expertise that will allow it to boost production at the plant. *Id.* (emphasis in original). Third, Tronox believes that it can “repair and restart” the “Jazan slagger,” a currently non-operational feedstock-producing facility in Saudi Arabia that is owned by Cristal. *Id.* Such repairs would increase the available feedstock for TiO₂, thereby increasing the pigment’s production. And an increase in global TiO₂ production will, all else equal, benefit consumers by lowering prices.

Although the Court does not doubt their desire to operationalize these efficiency-improving plans, the Defendants have not shown that the merger will necessarily increase overall output. As discussed above, the titanium dioxide industry features significant incentives, depending on prices, to withhold or manage output to maximize profits. The Defendants contend that the “great opportunity costs” associated with reducing TiO₂ production mean that “TiO₂ manufacturers, when they have their facility, they run it flat out, they run it all out, they try to gain . . . 100 percent realization.” Hr’g Tr. 40:25-41:3. But this assertion is belied by the observable economic reality of the industry: to prevent falling prices, firms can and do find it profitable to reduce output.

Still more, the success of Tronox’s planned improvements to the Yanbu plant and Jazan slagger cannot be reasonably verified before such improvements occur. TiO₂ plants, Tronox CEO Jeffry Quinn explained, are “like living organisms. You make mistakes. You do things, and sometimes it doesn’t work.” Hr’g Tr. 603:13-15. He added that the Jazan slagger has “had several failed start-ups in the past.” Hr’g Tr. 618:21.

Reflecting this uncertainty, Tronox signed an Option Agreement with Cristal related to the slagger. The Option Agreement “obligated [Tronox] to make financial investments to help fix the Jazan facility,” and “if certain performance metrics are met,” Tronox is “obligated to

purchase [the slagger] in the future.” Hr’g Tr. 619:8-19. But if these performance metrics are not met, then “the \$120 million that we are advancing, gets converted to a loan, either we get paid back or that we get it paid back in terms of a reduced price for buying feedstocks to come out of the furnace.” Hr’g Tr. 620:5-12. Tronox, in other words, has taken understandable precautions in case the planned output-enhancing improvements cannot be actualized.

The Defendants also suggest that the merger will result in “sizeable cost savings synergies” stemming from the “reduction in personnel” and “supply chain synergies, including volume purchase discounts.” Defs.’ Unredacted Opp. to Prelim. Inj. 28-29. The Defendants hired KPMG, a professional services company, “to verify the synergy estimates.” *Id.* at 29. After “performing [an] extensive review of the Tronox and Cristal transaction, with access to the ‘entire data room’ in this matter,” KPMG submitted a report showing that they “had assessed and validated” the deal’s cost savings. *Id.*

Again, while the Court credits the intent to achieve these cost savings, it is difficult to independently verify the scale or likely success of the deal’s synergies. In measuring the general administrative cost savings of the deal, for instance, KPMG’s “synergy tracking model” relied in part on revised estimates of operational synergies “that the business had identified.” PX7045-013. KPMG’s conclusions on cost savings were thus partially based on estimates and assumptions made by the Defendants’ internal business teams.

Nor did Defendants hire KPMG to identify “merger-specific” cost savings for antitrust purposes, but to “provide consulting support” for the “sign-to-close period” of the deal. *Id.* at 012. It is thus difficult to evaluate and compare the deal’s synergies to the dollar amount of cost savings that may have been achievable by either Tronox or Cristal absent a merger. *See Sysco*, 113 F. Supp. 3d at 83 (“Sysco did not hire McKinsey to identify merger-specific savings for

antitrust purposes McKinsey was not given instructions on identifying merger-specific savings.” As a result, “Defendants have not shown that [the cost savings] could not be achieved independently of the merger.”)

In sum, neither emerging competition from Chinese producers nor the transaction’s purported synergies and efficiencies sufficiently prove that the Tronox-Cristal merger will in fact be pro-competitive. The Court finds that the FTC has met its burden by raising “questions going to the merits so serious, substantial, difficult and doubtful” as to warrant further proceedings by the FTC and, potentially, the Court of Appeals. *Heinz*, 246 F.3d at 714-715.

C. The Equities Favor Granting the Commission a Preliminary Injunction

Although the FTC’s showing creates a presumption in favor of a preliminary injunction, the Court must still weigh the equities to determine whether this relief would be in the public interest. 15 U.S.C. § 53(b). The Court must consider the interests of the public, “either in having the merger go through or in preventing the merger,” and the private equities, which “include the corporate interests” of the Defendants. *F.T.C. v. Swedish Match*, 131 F. Supp. 2d 151, 172 (D.D.C. 2000). Here, effective enforcement of federal antitrust laws and the need to preserve the Commission’s capacity to order meaningful relief require granting the FTC the injunction it seeks.

1. The Public Equities Support Injunctive Relief

As the FTC has shown a likelihood that the proposed transaction will substantially lessen competition, the “public interest in effective enforcement of the antitrust law” weighs in favor of granting an injunction. *Heinz*, 246 F.3d at 726. *See also Swedish Match*, 131 F. Supp. 2d at 173 (“There is a strong public interest in the effective enforcement of the antitrust laws that weighs heavily in favor of an injunction in this case.”).

Also supporting an injunction is the “public interest in ensuring that the FTC has the ability to order effective relief if it succeeds at the merits trial.” *Sysco*, 113 F. Supp. 3d at 86. The Defendants contend that a post-merger divestiture of two Cristal plants in Ashtabula, Ohio, would sufficiently alleviate any anticompetitive concerns the Commission has. Defs.’ Unredacted Opp. to Prelim. Inj. 40. They are incorrect. “Section 13(b) [of the FTC Act] itself embodies congressional recognition of the fact that divestiture is an inadequate and unsatisfactory remedy in a merger case.” *Heinz*, 246 F.3d at 726. *See also F.T.C. v. Dean Foods Co.*, 384 U.S. 597, 606 n. 5 (1966) (“Administrative experience shows that the Commission’s inability to unscramble merged assets frequently prevents entry of an effective order of divestiture.”). The FTC explained that “divestitures are really hard to do, particularly post-consummation divestitures” and that they can take up to “seven years to sort out.” Hr’g Tr. 770:10-21.

Divestitures may not succeed at restoring competition to the post-merger market. A recent FTC study, for instance, notes that “[i]t may be particularly difficult to restore the pre-merger state of competition if the merging parties have commingled, sold, or closed assets; integrated or dismissed employees . . . or shared confidential information.” Fed. Trade Comm’n, *The FTC’s Merger Remedies 2006-2012* 18 (2017). In fact, for consummated mergers from 2006 - 2012, only about 25% of the remedies that the Commission ordered were considered “a success.” *Id.* Thus, the public interest in ensuring the FTC can order a practicable remedy to preserve market competition supports granting a preliminary injunction.

Pointing to *F.T.C. v. Weyerhaeuser Corp.*, 655 F.2d 1072 (D.C. Cir. 1981), the Defendants suggest that “[i]f strong equities favor consummation of the transaction, a hold separate order [rather than an injunction] will check interim competitive harm, and such an order

will permit adequate ultimate relief.” Hr’g Tr. 826:5-8. In *Weyerhaeuser*, the district court permitted a proposed merger to proceed, but it required the defendants “to hold separate a portion of the assets” during the FTC proceedings. 655 F.2d at 1074. Tronox asks the Court to issue a similar order here.

Putting aside the fact that this 1981 case appears to be the last time the D.C. Circuit blessed such an arrangement, the proposed merger is different in several crucial respects to the *Weyerhaeuser* merger. There, the FTC challenged only part of the deal, the firm being acquired was “a privately held family corporation with about ninety shareholders,” and the court found that the merger would result in an “almost certain” increase in product supply. *Id.* at 1074-75. The court also determined that a post-merger divestiture of the asset in question, a corrugating medium mill, would be a “feasible remedy.” *Id.* at 1075. Cristal is not a small, privately held family corporation, it is possible that the proposed transaction will create incentives to decrease—rather than increase—TiO₂ supply, and the Ashtabula plants are not small assets that can be summarily divested.¹³ Thus, a hold-separate order will not suffice.

2. The Private Equities do not Outweigh the Public Equities

The Defendants strenuously argue that the Commission has proceeded in bad faith. They contend that “[t]he FTC has unreasonably delayed its request for a preliminary injunction.” Defs.’ Unredacted Opp. to Prelim. Inj. 34-35. The Commission, they allege, used “its regulatory processes to increase the costs and burdens of moving forward with the transaction instead of seeking a fair and expeditious resolution of the legal issues.” *Id.* at 38. To keep the deal alive,

¹³ See *Tronox Submits Definitive Agreement to the European Commission Required for Approval of Cristal Acquisition*, available at <https://www.tronox.com/tronox-submits-definitive-agreement-to-the-european-commission-required-for-approval-of-cristal-acquisition/> (last accessed August 28, 2018) (valuing the Ashtabula plants at between \$900 million and \$1.1 billion).

Tronox has “had to agree to more than \$130 million in additional consideration that it would not have had to pay if the FTC had promptly sought injunctive relief months ago.” *Id.* at 39.

To be sure, the posture of this case is unique as, typically, the FTC seeks injunctive relief before an administrative trial has occurred. *See* Admin. Trial Hr’g Tr. 11:25-12:4, ECF No. 70-6 (ALJ noting that “this is the first case I’m aware of, in a nonconsummated merger, where we’re in this position, going to trial, where the Government has not moved for a preliminary injunction. It’s never happened as far as I know.”). Thus, the Defendants have borne additional costs by presenting their arguments both here and before the Commission’s ALJ, and they have devoted additional time and resources to the proposed transaction. This is unfortunate.

The Court is not, however, persuaded by the Defendants’ gloss on the FTC’s motives. Preliminary injunctions are equitable remedies to be used sparingly and in exigent circumstances. *See Sysco*, 113 F. Supp. at 23 (“The issuance of a preliminary injunction prior to a full trial on the merits is an extraordinary and drastic remedy.”) (cleaned up). Until foreign regulators approved the proposed merger, there was no imminent threat to competition, so a request for injunctive relief would have likely been unripe. *See Lewis v. Continental Bank Corp.*, 494 U.S. 472, 477 (1990) (“[F]ederal courts may adjudicate only actual, ongoing cases or controversies.”).

And it is far from clear that, but for the injunction request, the Defendants would have consummated the merger without having to negotiate an extended closing deadline. The Defendants went through a lengthy regulatory review process in the European Union. European regulators conditioned their approval of the merger upon a partial divestiture of assets from a Tronox facility in the Netherlands (the “Botlek plant”). Mr. Quinn claimed that Tronox “could have any point just agreed to sell the Botlek plant and, you know, been assured of a resolution in

Europe.” Hr’g Tr. 609:2-4. Selling the plant would have removed this roadblock, forcing the FTC to file an injunction sooner. Indeed, the FTC filed this action because approval from European regulators was “the only remaining hurdle preventing Defendants from consummating the Acquisition.” Compl. 2.

But Tronox did not sell the Botlek plant to hasten resolution of the regulatory process, as the firm believed that “a divestiture of a whole plant . . . was completely disproportionate to any theories of harm that the EU was asserting.” Hr’g Tr. 640:6-8. Thus, the Defendants had discussions with the European Commission “for a number of months,” presented evidence at a formal hearing process, and negotiated approval based on a narrower divestiture. Hr’g Tr. 609:11-610:15. While the Defendants had every right to press their case with the EC, they—not the FTC—painted themselves into this corner. The EC announced its approval of the merger on July 4, 2018,¹⁴ and the FTC filed its Motion for Preliminary Injunction less than a week later.

Finally, the harm to the Defendants from putative delays caused by the FTC is at least somewhat mitigated by the fact that any injunctive relief imposed here would be brief compared with a typical Section 13(b) action. In the ordinary case, an injunction means a merger cannot be consummated until the Commission completes its investigative and adjudicative activities. Here, the FTC has already scrutinized the deal and held an administrative trial. The ALJ will likely issue his initial decision before the end of the year, allowing the parties to obtain a decision on the merits within a matter of months. Thus, the harm to the Defendants from a preliminary injunction is lower than in the typical case, in which the administrative process would not yet have begun.

¹⁴ See *Commission Approves Tronox’s Acquisition of Cristal, Subject to Conditions*, available at http://europa.eu/rapid/press-release_IP-18-4361_en.htm (last accessed August 28, 2018).

The equities weigh in favor of granting the Commission a preliminary injunction. There are strong public interests in ensuring the effective enforcement of antitrust laws and in equipping the FTC with the ability to order appropriate remedies. These interests cannot be overcome by the private equities proffered by the Defendants.

IV. CONCLUSION

The Commission has successfully shown that, in evaluating the proposed merger between Tronox and Cristal, the relevant antitrust market comprises sales of chloride-process titanium dioxide in the United States and Canada. It has raised serious, substantial, and difficult questions about the merger's possible anticompetitive effects. It has presented credible evidence that the merger will create a highly concentrated market in which producers face greater incentives to engage in strategic output withholding. Because of these showings, and because the equities favor injunctive relief, the Court will grant the FTC's Motion for Preliminary Injunction. A separate order will issue.

Dated: September 12, 2018

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TREVOR N. MCFADDEN, U.S.D.J.

EXHIBIT B

WORKING PAPERS



**WHY PRICE CORRELATIONS DO NOT DEFINE ANTITRUST MARKETS:
ON ECONOMETRIC ALGORITHMS FOR MARKET DEFINITION**

Jonathan B. Baker

WORKING PAPER NO. 149

January 1987

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**BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580**

Why Price Correlations
Do Not Define Antitrust Markets:
On Econometric Algorithms for Market Definition

Jonathan B. Baker

Abstract

This paper compares two econometric methods that have been proposed for market definition: price correlations and residual demand curve estimation. Econometric theory is used to demonstrate that price correlations among firms will likely contain little or no information relevant to defining antitrust markets, under the assumption that a hypothetical cartel facing a downward sloping residual demand curve constitutes an antitrust market (defined according to the DOJ Guidelines). Hence price correlation analyses are likely to have little value for antitrust market definition. In terms of the literature on empirical techniques for market definition, this paper shows that if the econometric market definition algorithm based on residual demand curve estimation of Scheffman and Spiller (1985) is correct, then the econometric market definition algorithms based on price correlations of Stigler and Sherwin (1985) and Horowitz (1982) will not be valuable for antitrust enforcement. In the process of establishing these results, the paper clarifies the significance for antitrust market definition of reduced form price equations for single firms.

Why Price Correlations

Do Not Define Antitrust Markets:

On Econometric Algorithms for Market Definition

Jonathan B. Baker¹

In a competitive market where sellers and buyers have full information and goods are homogeneous, the ability of market participants to practice arbitrage ensures that all sales at any one time will tend to be made at the same price.² Relying on this price theory proposition, some antitrust commentators have argued that, for the purpose of applying antitrust law, a market should be defined as a group of products in a geographic area

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²For an econometric method of assessing transportation and other transaction cost differentials limiting arbitrage of a homogeneous product, see Spiller and Huang (1986).

When products are differentiated by having specific locations in geographic or characteristics space, prices in a monopolistically competitive market will tend to differ only by a constant differential representing transportation costs (when differentiation is geographic) or quality differences for marginal consumers (when differentiation is in terms of product characteristics), assuming perfect buyer information.

among which prices tend to be uniform.³ Several statistical tests implementing this proposed definition have been developed, all based generally on correlations of price levels or price changes among candidate market members over time. The most widely known price correlation tests are those proposed by Stigler and Sherwin (1985) and by Horowitz (1981). This paper explains why the price correlation methodology is a suspect tool for antitrust market definition, notwithstanding the possible utility of the price uniformity approach for defining markets for research purposes unrelated to antitrust.

An antitrust market is defined for one reason: because courts and government enforcers analyze the ability of firms to exercise market power within such markets. Hence the proper definition of an antitrust market must be related to the antitrust goal of interdicting the exercise of market power. This insight is incorporated in the U.S. Department of Justice Merger Guidelines (DOJ Guidelines), which define a market for the purpose of evaluating acquisitions under the antitrust laws as a group of products in a geographic region that could raise price profitably if that group were a cartel, with its output controlled by a hypothetical monopolist.⁴

³See, e.g., Stigler and Sherwin (1985). A comparison of this antitrust market definition approach with the leading alternatives can be found in ABA Antitrust Section (1986), pp. 89-110.

⁴Formally, a market is defined as a product or group of products and a geographic area in which it is sold such that a hypothetical, profit-maximizing firm, not subject to price regulation, that was the only present and future seller of those

A market defined by a tendency toward price uniformity need have no relation to an antitrust market, properly defined according to the DOJ Guidelines definition. In an important recent paper, Scheffman and Spiller (1985) consider the relation between these market definition concepts.⁵ They define "antitrust markets" in accordance with the DOJ Guidelines and point out that price correlation tests are predicated on a different market notion, "economic markets." Economic markets are defined by the presence of arbitrage, a market mechanism tending to produce price uniformity.

Scheffman and Spiller explain that economic markets need not be the same as antitrust markets, for two simple reasons. An economic market will be smaller than an antitrust market if

products in that area would impose a 'small but significant and nontransitory' increase in price above prevailing or likely future levels. The group of products and geographic area that comprise a market will be referred to respectively as the 'product market' and the 'geographic market.'" U.S. Dept. of Justice Merger Guidelines §2.0 (June 14, 1984). Although an infinite number of markets, each larger than the last by the addition of other products in the economy or other geographic regions, will satisfy this test, the Department generally considers the relevant market to be the smallest group of products or regions which satisfies this test. DOJ Guidelines §§2.11, 2.31. In most contexts, a "small but significant and nontransitory" price increase means a 5% increase lasting for one year. DOJ Guidelines §2.11. Since the Department of Justice adopted it in 1982, this approach to antitrust market definition has been endorsed by a number of commentators. See generally, ABA Antitrust Section (1986), pp. 106, 106n.531, & 106n.532.

⁵Scheffman and Spiller (1985), pp.10 -11; see also Spiller and Huang (1986). Scheffman and Spiller also show how to operationalize the DOJ Guidelines approach to antitrust market definition by applying an econometric technique for estimating residual demand elasticities developed by Baker and Bresnahan (1984).

potential competition from firms not presently engaged in sales subject to the possibility of arbitrage constrains incumbent producers from supracompetitive pricing; the antitrust market then includes the potential competitors while the economic market does not.⁶ On the other hand, an economic market will be larger than an antitrust market if some participants in an economic market are unable to expand supply following a price increase above competitive levels by the other market participants; the subgroup of firms excluding the capacity constrained producers would be free of competitive discipline so would constitute an antitrust market.⁷

The present paper makes related points through an econometric argument comparing price correlations tests, a tool for identifying economic markets, with residual demand estimation, the tool employed by Scheffman and Spiller to identify antitrust markets. This comparison shows that the two market definition algorithms will likely lead to very different

⁶Scheffman and Spiller (1985), p. 4n.6.

⁷Scheffman and Spiller (1985), pp. 4-6. Spiller and Huang (1986) estimate the typical maximum price differential between two physically homogeneous goods subject to arbitrage, and use this price differential as an estimator of the transactions costs of arbitrage. This information is a lower bound to the arbitrage costs relevant to antitrust market definition, however. The observed maximum price differential is less than the maximum that a hypothetical cartel including all present competitors could profitably raise price, unless the arbitraging competitors are known to have a perfectly elastic supply curve, or unless potential competitors are capable of arbitrage at the same margin sufficient to induce arbitrage by incumbent competitors. Hence Spiller and Huang's method of inferring the extent of economic markets cannot be used to infer the extent of antitrust markets. See Spiller and Huang (1986), p. 143.

market definitions. On the assumption that antitrust markets are of primary interest, the employment of a tool for identifying economic markets, price correlations tests, will likely create substantial errors in market definition. The particular price correlation tests studied involve both the price level correlations tests advocated by Stigler and Sherwin, and the price change correlations tests employed by Horowitz.

Section A of this paper summarizes the primary results by cataloguing the ways price correlations tests can mislead as to antitrust market definition. Section B analyzes the relationship between single firm reduced form price equations and antitrust market definition. This analysis underlies the remainder of the paper because price correlations tests can be thought of as inferring the extent of markets from reduced form price equations. Through this discussion, the conceptual experiment for antitrust market definition is clarified. A new concept, the "market defining" cost shift variable, is defined as an exogenous variable that shifts the supply curves of all members of the smallest antitrust market including a given firm, without affecting the supply curves of any other firms in the economy. This discussion also incorporates an exposition of the residual demand curve estimation techniques employed by Baker and Bresnahan (1984) and Scheffman and Spiller (1985), and indicates what can be learned about antitrust markets from reduced form price equations for single firms.

With this background, Sections C, D, and E study the

implications of price level correlations tests and price change correlations tests for market definition. These sections derive what econometric theory predicts would be revealed by the correlation of single firm reduced form price equations. The correlation results are then compared to what must be revealed in order for the statistical test to provide antitrust market definition information, according to the prior analysis of Section B. The main conclusion from this comparison is that price correlation tests contain little or no information relevant to the issue of antitrust market definition.

A. Summary of Argument

The econometric argument of this paper shows that the price correlation approach can mislead as to market definition. The price correlation methodology creates errors both by excluding firms which should properly be included in any antitrust market involving a given producer, and by including firms which are not in the smallest antitrust market involving that producer.

Incorrect exclusion will occur if the prices of two products are imperfectly correlated, yet the two exert competitive discipline upon each other. Suppose, for example, Chevy and Ford each (individually) face demand curves that are not perfectly elastic, but have some downward slope reflecting product differentiation. If so, cost increases or decreases limited to Chevy could lead to changes in the relative price at which the two firms sell their products. If firm-individuated cost shifts

are the only reason for price changes, as would be true if industry-wide cost or demand shift variables did not fluctuate over the sample period, then price levels need not be correlated highly and price changes will be uncorrelated. Using price correlation tests, one might conclude that the two products are not found in the same antitrust market. Yet nothing in this hypothetical example precludes the possibility that the two firms could raise price substantially if they collude, either just with each other or in a cartel incorporating other producers such as Chrysler; the aggregate (industry) demand curve may well be substantially less elastic than either firm's demand curve. If so, the two automobile brands, perhaps in league with a handful of other producers, could form an antitrust market defined by the DOJ algorithm. Yet these firms might be improperly placed in separate markets if a price correlation methodology is applied.⁸

Incorrect inclusion will instead occur when prices are highly correlated for reasons unrelated to the economic forces tending to create price uniformity within a market.⁹ High

⁸This econometric argument reasons from assumptions which in effect presume that Chevy and Ford are potential, not actual, competitors over the sample period. Hence the two firms would not be placed in a market defined by arbitrage, but should be incorporated within an antitrust market. In this way, the present econometric argument for underinclusion by price correlation tests has an analogue in the economic argument for underinclusion of economic markets relative to antitrust markets made by Scheffman and Spiller.

⁹Another, less significant mechanism will cause price correlations test to incorrectly include firms in antitrust markets. Suppose Ford's automobile output cannot increase beyond a low level, but Chevy faces no capacity constraint. The price charged by Ford and the price charged by Chevy will be perfectly

correlations may reflect instead similar economic forces affecting disparate markets. If so, a market definition based on price correlations will overstate the extent of the market.¹⁰

For example, assume that automobile and truck prices, both levels and differences, are highly correlated over some sample period as a result of the effect of changing real rates of interest on the demand for durable goods. Further, assume that the two products are not demand substitutes for most purchasers, and that they are built on dedicated production lines so they are not supply substitutes over a period of several years. Under these assumptions, the price correlation analyst will place automobiles and trucks in the same market, yet the products provide no competitive discipline for each other and do not satisfy the market definition algorithm of the DOJ Guidelines. This statistical difficulty with the price correlation test arises because the prices are correlated for reasons unrelated to

correlated if arbitrage can occur, so the price correlation analyst would place the two firms in the same market. Yet if Ford and Chrysler were able to raise price through coordinated behavior, Chevy's price would also increase but additional Chevy production would not be forthcoming. Chevy would therefore exert no competitive discipline on anticompetitive action by Ford and Chrysler. Hence Chevy would not be a part of the smallest antitrust market which includes Ford. Under these assumptions, the price correlation methodology overstates the scope of the relevant antitrust market. This econometric argument is based on the assumption that Ford's production capacity is constrained; it has an analogue in the economic argument for overinclusion by price correlation tests made by Scheffman and Spiller.

¹⁰This difficulty has been remarked upon by several commentators. See Giffin and Kushner (1982); R. Rogowsky & W. Shugart (1982); Uri, Howell, & Rifkin (1985); see generally ABA Antitrust Section (1986), pp. 104, 104n.519.

arbitrage. Under the above assumptions, automobiles and trucks are neither in the same economic market nor in the same antitrust market, yet the price correlation methodology would improperly place them in the same market.

The remainder of this paper applies econometric theory to demonstrate how the difficulties described above infect market definition analyses based on price correlations tests.

B. Residual Demand Curves and Antitrust Market Definition

To evaluate the utility of price correlation tests, their statistical properties will be compared with the properties of the econometric tool employed by Scheffman and Spiller to identify antitrust markets: the estimation of a residual demand curve for a proposed market aggregate. This section describes the relation between reduced form price equations and residual demand curves. The relation is first discussed in the context of the residual demand curve defined for a single firm, where it is most easily understood, and then considered in the context of the residual demand curve defined for a market aggregate, where it will be applied to the antitrust market definition problem. The primary significance of Section B is to indicate how each cost shift variable with a non-zero coefficient in the reduced form price equation for a single firm can be used to define an antitrust market including that firm, and how the smallest such antitrust market can be identified.

1. The Residual Demand Curve for the Single Firm¹¹

The residual demand curve for any single firm is identified by the conceptual experiment of shifting costs for the single firm alone. This experiment gives the firm an incentive to raise price and allows the market forces imposing competitive discipline on that price rise to work. We can then observe whether on balance the firm is able to raise its price, showing a downward sloping residual demand curve, or whether instead the firm must absorb the cost increase without raising price, exhibiting a flat residual demand curve. This conceptual experiment is significant because it has an important consequence for the interpretation of the reduced form price equation.

Consider the residual demand curve for a single firm denoted firm a, defined by equation (1).

$$(1) \quad Q^a = R(P^a, Z, Y)$$

In equation (1), Q^a and P^a represent the quantity and price chosen by firm a. Z and Y are cost and demand shift variables respectively.¹² The demand shift variable Y affects firm a either directly or indirectly through its effect on the behavior

¹¹The Appendix to this paper proves the assertions of Section B.1 for the case of a firm in a linear duopoly, by deriving a residual demand curve and reduced form equations for price and quantity for a single firm and demonstrating the relation among these functions. A general analysis is found in Baker & Bresnahan (1984).

¹²For simplicity, the cost and demand shift variables W , Z , and Y are taken to be scalars; the points made in this paper would not change were they instead vectors of exogenous variables.

of firm a's rivals. The cost shift variable Z appears in the residual demand curve only by altering the behavior of the firm's rivals; it is either an industry-wide cost shift variables or a variable increasing the costs of rivals without affecting firm a's costs. The oligopoly solution concept is assumed stable and suppressed. Equation (1) is assumed differentiable, so that its slope is always defined.

The reduced form price and quantity equations take the following form:

$$(2) \quad p^a = p^a(W, Z, Y)$$

$$(3) \quad Q^a = Q^a(W, Z, Y)$$

These equations include a variable W not present in the residual demand function; W is a cost shift variable affecting firm a without affecting any other firm.

The slope of the residual demand curve (1) facing firm a is related to derivatives of the reduced form equations (2) and (3). As the conceptual experiment described above suggests, the following relation holds¹³:

¹³ In general, given two simultaneous equations in X and Y, $X = f(Y, A, B)$ and $X = g(Y, A, C)$, then $f_Y = \delta f / \delta Y = [\delta X / \delta C] / [\delta Y / \delta C]$. This can be seen by solving the two simultaneous equations created by totally differentiating the functions f() and g(), then setting the differentials $dA = dB = 0$. The resulting system of differential equations can be written as follows: $dX - f_Y dY = 0$ and $dX - g_Y dY = g_C dC$. These equations solve for f_Y .

The econometric analogue of equation (4) -- relating the coefficient of an endogenous variable in the ordinary least squares estimation of one of a system of simultaneous equations to the ratio of coefficients of an exogenous instrumental variable in reduced form equations -- is well known. See Haavelmo (1943).

$$(4) \quad \delta R / \delta P^a = (\delta Q^a / \delta W) / (\delta P^a / \delta W).$$

Equation (4) explains that the slope of the residual demand curve equals the ratio of the partial derivative of the reduced form quantity equation with respect to a firm individuated cost shift variable to the partial derivative of the reduced form price equation with respect to the same cost shift variable.

Equation (4) has an important implication for the analysis of this paper: the partial derivative of the reduced form price equation with respect to a firm individuated cost shift variable ($\delta P^a / \delta W$) is a sufficient statistic for identifying single firm market power. Firm a has no market power if and only if $\delta P^a / \delta W = 0$. Only then can the ratio $(\delta Q^a / \delta W) / (\delta P^a / \delta W)$ grow without limit. Appendix A demonstrates this point for a linear duopoly example.

2. Reduced Form Price Equation for a Collusive Group

This section describes how a residual demand curve for a multi-firm aggregate identifies an antitrust market. The present exposition differs from that of Scheffman and Spiller (1985) in order to highlight the relation between a residual demand curve and a reduced form price equation for a hypothetical collusive group of firms. Further, the present discussion treats in the margin several econometric issues raised by the residual demand curve methodology for market definition not addressed by Scheffman and Spiller.

An antitrust market is identified, the DOJ Guidelines

instruct, if a hypothetical collusive group of firms would be able to exercise market power. Whether a hypothetical cartel possesses market power depends upon the elasticity of the residual demand curve facing the group.¹⁴ If the demand curve facing the group is perfectly elastic, the provisional antitrust market must be expanded to include additional producers. If the demand curve facing the group is inelastic, the collusive group has market power.¹⁵ In that case, the collusive group forms an antitrust market, although a smaller collusive group might also form an antitrust market.

The conceptual experiment that identifies a residual demand curve for a hypothetical collusive group is analogous to the experiment which identifies a residual demand curve for a single firm. The collusive group's demand curve is identified in the following way: raise costs for all members of the hypothetical group but for no other firms, and see if the equilibrium price charged by the group increases. If the firms, acting in

¹⁴See Landes & Posner (1981); Scheffman & Spiller (1985).

¹⁵It is not the purpose of this paper to determine how inelastic the demand curve must be before an antitrust market is inferred. However, it may be useful to note that if the hypothetical cartel at issue acts as a Stackelberg leader, and if the collusive group faces a demand curve of constant elasticity, then the Lerner Index markup $[(\text{price} - \text{marginal cost})/\text{price}]$ likely to be achieved by the cartel equals the inverse of the negative of the elasticity. See Baker & Bresnahan (1984), pp. 12-15; Scheffman & Spiller (1985), p. 30. Under these assumptions, a demand elasticity of -20 for the collusive group translates into a 5% markup, and a demand elasticity closer to zero translates into a greater markup. An example of antitrust geographic market definition undertaken by estimating the residual demand curve for the hypothetical collusive group appears in Scheffman & Spiller (1985).

coordination, are able to pass the cost increase through to customers, they face a downward sloping demand curve and, as a group, would possess market power. If they are unable to pass through the price increase -- whether that competitive discipline arises from demand substitution, the threat of entry, or the nature of interfirm rivalry -- they do not as a group possess market power so do not form an antitrust market.

It is noteworthy that the conceptual experiment identifying a residual demand curve for a hypothetical collusive group is the very market definition algorithm employed by the DOJ Guidelines. This equivalence provides the intuitive justification for an empirical approach to antitrust market definition relying on the estimation of the residual demand curve for an aggregate composed of the members of a proposed antitrust market.¹⁶

To formalize this discussion, equation (1) can be reinterpreted as describing the residual demand curve facing entity a , an aggregation of candidate members of an antitrust market. Consistent with this reinterpretation, P^a represents the average price received by the aggregate entity¹⁷, and Q^a represents the total output of the aggregate. This reinterpretation suppresses the nature of the rivalry (oligopoly

¹⁶Scheffman & Spiller (1985) were the first to employ this approach to an actual market definition problem by identifying geographic markets for refined gasoline in the Eastern U.S. When used as an empirical test for identifying antitrust markets, the methodology is subject to several qualifications described in notes 18 and 19, *infra*. These qualifications are assumed away in the present discussion.

¹⁷If the goods are homogeneous, P^a will be the market price.

behavior) within entity a¹⁸ and is subject to several other qualifications ignored in the present discussion.¹⁹ Y is reinterpreted as a variable which shifts demand for any of the products aggregated in entity a, either directly or indirectly by affecting the behavior of rival firms outside the aggregate. The variable Z is reinterpreted as shifting costs common both to entity a and to firms outside that aggregate, or as shifting

¹⁸A cartel will typically have an incentive to reduce the quantity of some goods by more than others. For a brief discussion of the effect of this incentive on econometric estimates of the market power gains from merger, see Baker & Bresnahan, *The Gains from Merger or Collusion in Product-Differentiated Industries* (1985), p. 441n.20. This possibility is ignored in the aggregation presumed to form the hypothetical collusive group in the text.

¹⁹Aggregation in residual demand curve estimation raises several econometric issues assumed away in the present discussion as not related to the significance of price correlation tests for market definition. The analysis here and in Scheffman and Spiller (1985) aggregates the market demand curves of many individual firms, the optimizing actors in the model, into a multi-firm hypothetical cartel as suggested by the DOJ market definition algorithm. Estimated residual demand elasticities for multi-firm aggregates will overestimate market power if collusion leads to entry by new competitors of a type not previously threatened, hence not apparent in the data. Baker & Bresnahan (1985), p. 427n.1. In addition, in differentiated product industries, an aggregate price and quantity may not be well defined, particularly when the goods are not close substitutes in demand. If so, it is preferable in theory to infer gains from hypothetical collusion by estimating partial residual demand curves, as is undertaken in Baker & Bresnahan (1985). Even when aggregation across firms is sensible, estimates of residual demand elasticities may be biased. Baker & Bresnahan (1984), p. 49 (considering bias in residual demand curve estimation arising "if firm-individuated demand curves are aggregated into hypothetical merged firms or an industry cartel"). Further, the econometric analysis in both the single firm and aggregated entity contexts presumes that product attributes and the oligopoly solution concept are stable over the sample period. For an example of a correction for this problem, see Baker & Bresnahan (1984), pp. 19-20 (role of Lite beer).

costs borne by firms outside entity a but not borne by firms in that group. W raises costs for one, several, or all firms within group a, but not for rival firms.

The slope of the residual demand curve for group a will be perfectly elastic if and only if the hypothetical collusive group does not form an antitrust market. If instead the residual demand curve has slope, then group a forms an antitrust market (although not necessarily the smallest such market).

As in the single firm case, the slope of the reduced form price equation for group a is a test statistic for the presence of group market power. As the previous discussion of equation (4) makes clear, if the derivative of this reduced form price equation with respect to a group individuated cost shift variable is non-zero, the multi-firm aggregate would face a downward sloping residual demand curve, implying that group a would presence of market power were it to act as a collusive group.

An example of the interpretation of a reduced form price equation for a market aggregate is presented below and will reappear in modified form to illustrate points made in later sections. Although this example involves antitrust product market definition, the example could equally well have involved geographic market definition.

Suppose the following reduced form equation is estimated for an average beer price:

$$(5) \quad P(\text{beer}) = a + bY(\text{income}) + cP(\text{hops}) \\ + dP(\text{bottling machinery}) + eP(\text{labor})$$

Equation (5) relates the price of beer to one demand shift variable (income) and three cost shift variables (the price of hops, the rental value for bottling machinery, and the wage rate in the United States). Hops are a factor of production for brewers but not for any other firms. Bottling machinery and labor are costs to brewers and to producers of substitutes to beer. Assume that equation (5) does not omit any relevant cost or demand shift variables and that its functional form is correctly specified²⁰. If the coefficient on the price of hops, a brewing industry individuated cost shift variable, is significantly greater than zero in equation (5), then the group of brewers in the aggregate have a downward sloping residual demand curve. Hence brewing would constitute an antitrust product market.²¹ If the price of hops instead has a coefficient

²⁰The assumption that the analyst can specify the full list of demand and cost shift variables affecting the firms in an industry does not require that the analyst perform a market definition exercise prior to the reduced form market definition analysis. The assumption requires no more than familiarity with the range of plausible production technologies for the products at issue, and a plausible set of candidate demand substitutes. This general prior information does not mandate any particular boundary for an antitrust market.

²¹Before making this inference in practice, it would be important to confirm that hops are indeed a significant cost shift variable for brewers. Even if hops are known to be part of the recipe for beer, they might not appear in the reduced form price equation if they have an insignificant cost share in beer production or if their price does not vary over the sample period. (Indeed, while hops provide a convenient vehicle for explaining the significance of cost shift variables because they are an input used only by brewers, they account for a tiny fraction of brewing cost so are unlikely to have empirical significance in a reduced form price equation for any firm in the brewing industry.) The significance of hops as a cost shift variable for brewers can be confirmed by examining whether the

of zero, a hypothetical collusive group formed by all brewers would not be able to raise price, so would not form an antitrust market.

3. Reduced Form Price Equation for a Single Firm

This section argues that the reduced form price equation for a single firm contains the same market-identifying information as is found in the reduced form price equation for a proposed market aggregate including that firm. If so, the correlation of two product prices could contain some information relevant for antitrust market definition. However, later sections of this paper will argue that the relevant information is not in practice revealed by price correlations.

Consider equation (6), a reduced form price equation for Budweiser beer.

$$(6) \quad P(\text{Budweiser}) = a + bY(\text{income}) + cP(\text{hops}) \\ + dP(\text{bottling machinery}) + eP(\text{labor})$$

The reduced form price equation for Budweiser must include as independent variables all variables that appear in the reduced form price equation for a brewing industry aggregate, equation (5). Any variable affecting the demand or supply of beer, and hence the price of beer, necessarily also affects the price of Budweiser. The converse must also hold: all variables affecting

price of hops enters into the parallel reduced form equation for quantity. If the analysis establishes that changes in the price of hops alter the quantity of beer sold without affecting the price of beer, then brewing would not form an antitrust product market.

the demand or supply of Budweiser, hence present in the reduced form price equation for that brand, necessarily affect the price of beer.

For the purpose of antitrust market definition, equation (6) can be interpreted as a misspecification of equation (5) with one crucial difference: the price of one brand, here Budweiser, is employed as a proxy for the true dependent variable, the price of beer.²² Hence if the coefficient of a brewing individuated cost shift variable, here hops, is non-zero, then a collusive group of brewers would be able to exercise market power. Therefore, if the coefficient on the price of hops in equation (6) is significantly different from zero, Budweiser can be said to be a member of an antitrust product market that includes all other hops users, namely all brewers. If the price of hops has a coefficient of zero, the smallest antitrust product market including Budweiser is broader than brewers.²³

When viewed as an econometric problem, the misspecification of equation (5) as equation (6) reduces the power of the resulting coefficient estimates but is not likely to bias them²⁴.

²²It is possible that the two reduced form price equations will differ in their functional form. If this were to occur, it would be a consequence of a problem in aggregation, assumed away in the present discussion.

²³This analysis continues to assume that shifts in the price of hops affect Busweiser quantity even if the price of hops has no effect on Budweiser price. See note 21, *infra*.

²⁴It is unlikely that changes in any hypothetical cartel member's price will be systematically related to the firm's price level if quality differentials among differentiated products are related to tastes independent of prices, so will be preserved by

If the hypothetical cartel has market power, every member firm will likely share in a price increase generated by an increase in a common cost, so the coefficient on the common cost shift variable will be non-zero in the reduced form price equation for each member. If the hypothetical cartel lacks market power, an increase in a cost variable common to the group but not affecting outside firms will not generate a price increase for any group member; all will absorb the cost increase by reducing quantity.

Under this analysis, each cost shift variable in a single firm's reduced form price equation can be interpreted as redefining the scope of the corresponding hypothetical collusive group. If the reduced form price equation for a single firm is correctly specified and estimated, and the coefficient of a cost shift variable W in that equation is positive, then the single firm must be part of an antitrust market that includes all other firms for which W is also a cost shift variable, although this antitrust market need not be the smallest possible antitrust market. In this way, each common cost shift variable identifies a hypothetical collusive group.²⁵

the hypothetical cartel. Hence the price of any brand of beer can be viewed as having a fixed differential from the industry price.

²⁵This reduced form price equation approach to antitrust product market definition is a useful conceptual device for understanding the significance of correlations of prices. Yet the approach may well be more difficult to implement than the equivalent residual demand curve methodology. The experience of Baker and Bresnahan (1984) in estimating residual demand curves suggests that the residual demand elasticity (quantity coefficient) may often be precisely estimated while estimated coefficients on factor prices may not be robust to specification

The antitrust market identified by a positive coefficient on a cost shift variable is not necessarily the smallest antitrust market. If the price of bottling machinery, another factor of production, enters equation (6) with a positive coefficient, Budweiser is properly shown to be included in an antitrust product market along with bottled water, bottled soft drinks, and other bottled products, regardless of whether some smaller antitrust market containing Budweiser can also be defined. If the average wage for U.S. production workers is included as an exogenous cost shift variable and has a positive coefficient, as is likely, this would imply that a collusive group formed by all firms in the economy which employ labor as a factor of production would successfully be able to raise price. Then it would be proper to conclude that the entire economy forms an antitrust market, but this is almost certainly not the smallest antitrust

changes. This may occur because estimates of the coefficients on factor prices are more sensitive to biases from omitted cost and demand shift variables than are estimates of the coefficients on quantity. If coefficients on factor prices in reduced form equations are similarly not robust to specification changes, or if the likely collinearity of factor prices makes it difficult to discover whether the coefficient of any individual factor price in a reduced form equation is significantly different from zero, then the residual demand elasticity approach to antitrust market definition will be substantially preferable to the reduced form price equation approach. Further, the reduced form approach never allows inference of the extent of market power achievable by a hypothetical cartel, unlike the residual demand approach. (The extent of potential anticompetitive gains may be an appropriate consideration in the exercise of antitrust enforcement discretion.)

The reduced form approach does have one important advantage over residual demand curve estimation. The reduced form approach avoids the need to correct for simultaneity; ordinary least squares estimates of reduced form price and quantity equations are unbiased.

market that includes Budweiser. In the discussion below, the cost shift variable with non-zero coefficient in the reduced form price equation that identifies the smallest antitrust market including the particular firm at issue will be termed a "market defining" variable for that firm.²⁶ As the practical market definition exercise in antitrust cases involves the smallest antitrust market, it is proper to limit attention to market defining cost shift variables.

In contrast to the significance of cost shift variables, no inference about market definition can be made from the coefficient of the demand shift variable income in the estimated reduced form price equation. This is because demand shift variables are not excluded exogenous variables from the perspective of the residual demand curve facing a hypothetical collusive group.²⁷

²⁶If some producers in an industry are capacity constrained, their output should not be aggregated into the smallest hypothetical cartel. In this situation there may well be no cost shift variable which is unique to the members of the smallest antitrust market, as any candidate will also increase costs and prices of the capacity constrained producers. If so, the apparent "market defining" cost shift variable will identify the smallest antitrust market observable using this method, but not the smallest such market that actually exists. This difficulty has little practical significance if the slope of the supply curve of firms placed in an antitrust market can be ascertained, and will be ignored in the remaining analysis.

²⁷The "supply relation" that defines equilibrium in conjunction with the residual demand curve is defined in note 47, supra. It includes parameters from the demand curve so long as the hypothetical collusive group acts other than as a price taker. For example, an exogenous group-individuated demand shift variable appears in both the residual demand curve and the supply relation, so will not identify either. Hence if beer demand rises because of a decline in the drinking age for beer

The analysis of the significance of single firm reduced form price equations for antitrust market definition is summarized by the following propositions:

(P.1) If the price of good a increases following an increase in a cost shift variable W affecting products a and b, then the two products, along with all other products whose costs also increase when W increases, collectively form an antitrust market (not necessarily the smallest antitrust market).

(Definition) A cost shift variable W^* that defines the smallest antitrust market including product a will be termed a "market defining" cost shift variable for product a.

(P.2) If the price of good a does not increase following an increase in a cost shift variable W affecting only products a and b, while the quantity of good a sold falls, then the two products, along with all other products with costs which also increase when W increases, do not collectively form an antitrust market.

(P.3) Variation in the price of good a arising from any other source, including price variation arising from variation in

(while the drinking age for all other alcoholic beverages remains unchanged), then the average price of beer will increase regardless of whether brewers as a hypothetical collusive group could exercise market power, so long as the marginal cost curve of the brewing industry is upward sloping.

demand shift variables, provides no information for antitrust market definition.

4. Reduced Form Price Equations for Two Firms

The previous discussion of the significance of reduced form price equations for antitrust market definition is applied in this section to identify the circumstances under which simultaneous variation in the prices received by two firms suggests that the two fall within the same antitrust market. For obvious reasons, this issue underlies the analysis of price correlation tests of antitrust market definition.

Suppose the prices (or the price changes) of Budweiser and Miller, the flagship brands of the two leading U.S. brewers, move together. If similar movements in the two firm's prices arise from variation in a common cost shift variable, such as the price of hops, and the common cost shift variable affects only the producers in a narrowly defined group, as the price of hops might affect the prices received by brewers alone, then the price movement comparison correctly suggests that Budweiser and Miller are part of the same antitrust market. Under these assumptions, a price correlation analysis is not misleading; brewing will indeed constitute an antitrust product market. The price of all other beer brands can be expected to vary similarly with that of these two firms, as all will be affected by the price of hops. However, the price of wine or soft drinks, which do not respond

to variation in the price of hops, may well vary independently from the price of beer.

If instead the similar price movement arises from variation in a common cost shift variable, like the wage rate, that also affects a large number of other firms in the economy, no antitrust market definition inference can be made from the price correlation. This interpretive difference from the case of variation in the price of hops arises because, if brewing is an antitrust market, the price of hops is a market defining cost shift variable for both Budweiser and Miller, while the wage rate is not.

If the prices of Budweiser and Miller are highly correlated because price movements in both are driven by a common demand shift variable, the degree of price correlation gives no information about market definition. Further, if price movements are uncorrelated, yet common cost shift variables are unchanged over the sample period, the firms may or may not lie in the same antitrust market. In that case price correlations are uninformative concerning market definition.

In short, the significance of price correlations for antitrust market definition depends first upon the source of observed price correlations or the reason for the absence of price correlations, and second, if the price correlations arise from a common cost shift variable, upon whether that variable is a market-defining cost shift variable. Unfortunately, as later sections of this paper will demonstrate, it is impossible to

identify the information in price correlations relevant to antitrust market definition without bringing to the analysis sufficient additional information tantamount to performing a residual demand analysis. It will then be the residual demand analysis and not the price correlation which performs the antitrust market definition.

An example of outside information will clarify this important point. One common method of importing outside information into the price correlation analysis is the simultaneous examination of the price correlations among many related brands. In defining a market that includes Budweiser, for example, the analyst would likely correlate its price with the prices of a number of other beverages such as Miller, Pabst, Coke, and Maxwell House. These are not randomly selected goods from throughout the economy. They are chosen because the analyst recognizes, explicitly or implicitly, that they likely share common cost or demand shift variables with Budweiser. If high price correlations are found among products employing hops as an input, but not between those products and products not employing hops, it may be appropriate to conclude that hops users (brewers) form an antitrust market. As the previous discussion has demonstrated, this conclusion can properly be reached if the analyst also establishes that hops form a significant cost share for those firms using them as an input, that the factor cost of hops varies over the sample period, and no significant demand shift variables affect the hops users without affecting products

among the other brands studied. These additional pieces of information, however, implicitly convert the price correlation study into a rough and ready residual demand analysis of antitrust market definition. Further, it is unlikely that the outside information necessary to convert the price correlation study into a market definition test will be unambiguous without statistical analysis. In particular, only when the rare "natural experiment" occurs is it likely to be possible to assign a single primary cause to price variation. In general, statistical techniques such as estimation of the reduced form price equation are likely to be necessary in order to isolate the contributions of a market-defining cost shift variable in affecting price variation.²⁸

²⁸The analysis of the previous section also suggests that if the (correctly specified) reduced form price equations for two goods, such as Budweiser and Miller, contain different exogenous demand or cost shift variables, then the two goods are in separate antitrust markets. This can be seen by supposing that equation (6) is a noisy but unbiased misspecification of equation (5), because Budweiser is in the beer market and beer is the smallest antitrust market containing Budweiser. Then equation (6a) below, a reduced form price equation for a second brewer, would also proxy equation (5).

$$(6a) \quad P(\text{Miller}) = a + bY(\text{income}) + cP(\text{hops}) \\ + dP(\text{bottling machinery}) + eP(\text{labor})$$

Under these assumptions, equation (6a) should have identical coefficients as equation (6), the reduced form price equation for Budweiser, except the two intercepts will vary to reflect the quality differential to the marginal customers.

If instead the reduced form price equations for Budweiser and Miller have different independent demand or cost shift variables, then each brand would be capable of sustaining a price increase that would not be competed away by its rival. Hence the smallest antitrust markets containing each brand must be separate.

Unfortunately, this analysis does not lead to a practical empirical technique for market definition because it would place firms in different antitrust markets whenever a single firm has

C. Time Series Representation of Reduced Form Price Equations

The main conclusions of this paper are derived from linear reduced form equilibrium equations for the price of two products. The two products studied, possibly differentiated, are denoted a and b. These products should be thought of as candidates for being included in the same antitrust market, varying in either geographic or product characteristic space. The equations analyzed may be understood as linear approximations to reduced form price equations of unspecified functional form. To further motivate these equations, the Appendix shows that linear reduced forms arise directly from a linear duopoly model. This section sets forth their time series representation under simple assumptions about the evolution of the exogenous variables.

1. Structural Representation of Reduced Form Price Equations

The particular reduced form price equations assumed are stated as equations (7) and (8). The expression P_t^i represents the price of good i at time t.

$$(7) \quad P_t^a = a_0 + a_1R_t + a_2S_t + e_t$$

$$(8) \quad P_t^b = b_0 + b_1R_t + b_2T_t + v_t$$

The variables R, S and T represent all the exogenous demand and supply shift variables affecting price, including such

market power, implicitly identifying single firms with market power as antitrust markets. Single firms cannot constitute markets in antitrust analysis, however.

variables as factor prices and income. Without loss of generality, the analysis is limited to the case of one common exogenous variable R , and two product individuated variables S and T . R , S , and T could each represent either a cost or demand shift variable.²⁹ This notation emphasizes that without additional information, the price correlation analyst does not know the source of price movements and correlations.

In equations (7) and (8), the a 's and b 's with numbered subscripts are parameters. The subscript t identifies the time period of the observation. These equations are stochastic, where e and v are independently and identically distributed errors with mean zero and variance σ_e^2 and σ_v^2 respectively. The covariance of e and v is assumed to be zero.

2. Significance of Parameters of Reduce Form Price

Equations for Antitrust Market Definition

Propositions P.1 to P.3 of the previous section can be

²⁹This formulation is more general than arises from the linear duopoly model of the Appendix because each reduced form price equation (7) and (8) includes a shift variable not present in the other reduced form price equation. Under the oligopoly model of the Appendix, the two reduced form price equations (A.7) and (A.8) include the same variables, but one can imagine other plausible models in which some variables would affect the price charged by some but not all firms. For example, a factor price affecting the costs of a dominant firm but not the costs of its competitive fringe would appear in the dominant firm's reduced form price equation but not in the reduced form equation for fringe pricing. Further, in the linear model of the Appendix, the reduced form quantity equations exclude variables directly affecting only the demand curve faced by the rival producer; it is likely that a simple alteration of the solution concept would produce reduced form price equations with similarly excluded variables.

applied to the interpretation of the reduced form price equations (7) and (8) in order to indicate the significance of the parameters of those equations for antitrust market definition. Those propositions imply that entity b is in some antitrust market (not necessarily the smallest antitrust market) that includes entity a if and only if (i) the common variable R is a cost shift variable for both entities, and (ii) the parameters a_1 and b_1 are non-zero. Only if R is a market defining cost shift variable for firm a is entity b a member of the smallest antitrust market including entity a. The remainder of this paper assesses what can be learned about the parameters a_1 and b_1 , and consequently what can be learned about antitrust market definition, from the correlation of p^a with p^b .

3. Time Series Representation of Reduced Form Price Equations

By assumption, each of the exogenous variables (R, S, and T) evolves according to a first order autoregressive process. Although more general time series processes might be postulated, this simple assumption, an approximation to the behavior of many economic time series, is sufficient to show the potentially misleading nature of price correlation tests.

$$(9) \quad R_t = c_0 + c_1 R_{t-1} + \theta_t$$

$$(10) \quad S_t = d_0 + d_1 S_{t-1} + \mu_t$$

$$(11) \quad T_t = e_0 + e_1 T_{t-1} + \phi_t$$

Here θ , μ , and ϕ are independent and identically distributed

random variables with no covariance across time and no covariance either with each other or with e or v . They each have mean zero and variance σ^2_i , where i indexes the random variable at issue.

Equations (9), (10), and (11) can be written in the following equivalent moving average forms, assuming that c_1 , d_1 , and e_1 are less than unity in absolute value (that is, that each autoregressive process is stationary):

$$(9') \quad R_t = c_0(1 + c_1 + c_1^2 + c_1^3 + \dots) \\ + (\theta_t + c_1\theta_{t-1} + c_1^2\theta_{t-2} + c_1^3\theta_{t-3} + \dots)$$

$$(10') \quad S_t = d_0(1 + d_1 + d_1^2 + d_1^3 + \dots) \\ + (\mu_t + d_1\mu_{t-1} + d_1^2\mu_{t-2} + d_1^3\mu_{t-3} + \dots)$$

$$(11') \quad T_t = e_0(1 + e_1 + e_1^2 + e_1^3 + \dots) \\ + (\phi_t + e_1\phi_{t-1} + e_1^2\phi_{t-2} + e_1^3\phi_{t-3} + \dots)$$

Substituting (9'), (10'), and (11') into equations (7) and (8) allows the reduced form equilibrium equations for price to be represented in a form entirely dependent upon the parameters and random innovations. The resulting equations, (7') and (8'), are indicated below.

$$(7') \quad P^a_t = a_0 + \\ a_1[c_0(1 + c_1 + c_1^2 + c_1^3 + \dots) \\ + (\theta_t + c_1\theta_{t-1} + c_1^2\theta_{t-2} + c_1^3\theta_{t-3} + \dots)] + \\ a_2[d_0(1 + d_1 + d_1^2 + d_1^3 + \dots) \\ + (\mu_t + d_1\mu_{t-1} + d_1^2\mu_{t-2} + d_1^3\mu_{t-3} + \dots)] + e_t$$

$$(8') \quad P^b_t = b_0 + \\ b_1[c_0(1 + c_1 + c_1^2 + c_1^3 + \dots) \\ + (\theta_t + c_1\theta_{t-1} + c_1^2\theta_{t-2} + c_1^3\theta_{t-3} + \dots)] +$$

$$b_2[e_0(1 + e_1 + e_1^2 + e_1^3 + \dots) + (\phi_t + e_1\phi_{t-1} + e_1^2\phi_{t-2} + e_1^3\phi_{t-3} + \dots)] + v_t$$

Equations (7') and (8') will allow the identification of the source of price correlations in later sections of this paper.

D. Price Level Correlations

This section analyzes the significance of price correlations for market definition. The standard price correlations approach involves the estimation of the simple correlation coefficient between the prices charged by two firms. This approach implicitly assumes that the two prices are connected by a linear relation such as equation (12).³⁰

$$(12) \quad p_t^b = \beta_0 + \beta_1 p_t^a + \varepsilon_t$$

Those who employ price correlations to define markets believe that two products are in the same market if the estimated simple correlation coefficient for their two price series is near unity³¹, while an estimated correlation coefficient near zero indicates that the products are in separate markets.

The price level correlation approach described above incorporates the essence of the various price correlation studies conducted by Stigler and Sherwin. At various times, Stigler and

³⁰Under this approach, the constant term β_0 would represent the equilibrium transportation cost or quality differential for the marginal purchaser.

³¹This interpretation presumes that the products at issue are substitutes. Market definition issues for complements in demand or supply are analyzed in ABA Antitrust Section (1986), pp. 138-141.

Sherwin correlate price levels and first differences in price levels; further, they generally transform prices into logarithms before undertaking the correlation analysis.³² The interpretation of the variables P, R, S, and T in the above equations can be varied so that equation (12) represents each such method employed. (The implicit functional form of the reduced form price equation (7) and the interpretation of the autoregressive process followed by each exogenous variable would also vary in a corresponding manner.)

Equations (7') and (8') allow the identification of the large sample properties of the crucial correlation coefficient. This statistic is consistently estimated by the ratio of the covariance of P_a and P_b to the product of the standard deviations of P_a and P_b .³³ This ratio of moments of the price variable distributions can be computed from the time series representation of the reduced form price equations (7') and (8'), again assuming that the autoregressive processes describing the evolution of the

³²See, e.g. Stigler & Sherwin (1985), pp. 559 (first differences), 566 (levels and first differences of logarithms), 570 (first differences of logarithms), 574 (levels and first differences of logarithms), and 576 (first differences of logarithms). Stigler and Sherwin's Appendix identifies the correlation between first differences in logarithms of price series as the "critical statistic" for determining whether two locations are in the same geographic market.

³³In the two variable linear model of equation (12), the simple correlation coefficient between the two price series (r^2) is related to the slope coefficient because, in probability limit, the correlation equals the expression $\beta_1 \sigma_a / \sigma_b$, where σ_i is the standard error of P^i . In large samples, β_1 will equal σ_{ab} / σ_a^2 , where σ_{ab} is the covariance between prices, and r^2 will equal $\sigma_{ab} / (\sigma_a \sigma_b)$. J. Johnston (1972), pp. 34-35.

exogenous variables are stationary:

$$(13) \quad \text{plim } r^2 = \sigma_{ab} / \sigma_a \sigma_b =$$

$$\frac{[a_1 b_1 f(c_1) \sigma_\Theta^2]}{\{[a_1^2 f(c_1) \sigma_\Theta^2 + a_2^2 f(d_1) \sigma_\mu^2 + \sigma_e^2]^{1/2} [b_1^2 f(c_1) \sigma_\Theta^2 + b_2^2 f(e_1) \sigma_\phi^2 + \sigma_v^2]^{1/2}\}}$$

where $f(x) = (1 + x^2 + x^4 + \dots)$

The remainder of this section demonstrates that the test statistic r^2 can be near zero even if the products a and b are in the same antitrust market, and near unity even if they are in different antitrust markets. It is evident from equation (13) that only in one situation can r^2 provide information about the crucial market definition parameters a_1 and b_1 , namely when σ_Θ^2 is large relative to σ_μ^2 , σ_ϕ^2 , σ_e^2 , and σ_v^2 . Even then, antitrust market definition will also require that the analyst know that the common variable affecting both prices is a cost shift variable, and that this variable is a market defining variable.

The likely value of r^2 , the price level relationship test statistic, will be assessed under three alternative assumptions about the source of innovations, encompassing the complete set of significant influences on price variation in the model. As will be seen, each such assumption determines the value of r^2 , yet only one bears any necessary or consistent relationship to an antitrust market identifying experiment, and even that assumption is not sufficient for the price correlation test to identify an antitrust market.

First, assume that σ^2_e is large (or, equivalently, that σ^2_v is large). This assumption presumes that there are many random price changes unrelated to shifts in exogenous variables. This will most plausibly happen if the oligopoly solution concept is unstable or if there are fluctuations in product quality or transaction lot size. Then, as equation (13) shows, r^2 will approach zero regardless of the result of the antitrust market definition identifying conceptual experiment, that is regardless of whether both prices rise in response to an increase in R if R is a market defining cost shift variable for products a and b . The price correlations analyst will infer that the two products are not in the same antitrust market, whether they are in the same market or not. In this situation, the two products may exert competitive discipline on each other, yet their prices will be imperfectly correlated because price changes are largely random.

Next, suppose that σ^2_μ or σ^2_ϕ is large. This will occur if most of the price variation is caused by variation in product individuated cost shift variables.³⁴ Again, equation (13) shows that the estimate of r^2 will likely be low, approaching zero, regardless of whether products a and b are in the same antitrust market. These products may exert competitive discipline on each other, yet their prices will be imperfectly correlated because no

³⁴In a differentiated product industry, it is not implausible that individual firms have a slight amount of market power, sufficient for variations in firm-individuated costs to produce price changes, without having sufficient market power to constitute a collusive group on their own.

market defining experiment occurred in the data.

Finally, suppose that σ^2_ϕ , σ^2_μ , σ^2_ν , and σ^2_e are dominated by σ^2_θ . This assumes that most price variation arises from variation in the common exogenous variable R. Equation (13) then implies that r^2 approaches unity in probability limit. The price correlation analyst will then conclude that the two products are in the same antitrust market. If R is a common demand shift variable, however, that conclusion could easily be erroneous, as the proper market definition experiment relies on common cost shift variables. This suggests the most likely error to arise from using price correlation tests for market definition: the price of shoes and the price of automobiles might be highly correlated in a period of rising income if the demand for both rises substantially as a result, yet the two products are not in the same antitrust market.

If instead R is a common cost shift variable, and if it affects the costs of both products comparably, the price correlation test properly implies that a and b are in the same antitrust market. However, the implied antitrust market is not limited to products a and b. It also includes all other products for which R is a cost shift variable. If the price of Budweiser and the price of Pabst are highly correlated because increases in bottling costs raise the marginal cost of both, fruit juice and other bottled products are also in the implied product market; we cannot infer from an r^2 of unity that the product market is limited to beer. If instead the prices are correlated because

price variation results primarily from the changing price of hops, a likely market defining cost shift variable, the brewing industry forms an antitrust market.

Without imposing additional information, the price correlation analyst has no way of identifying the cost shift variable inducing the correlation, even if, somehow, he were aware that the correlation resulted from a common supply side variable rather than a demand side variable. He will therefore be unable to determine the breadth of the implied antitrust market if one is in fact suggested. Nor can the analyst know that the market so identified is the smallest antitrust market; the smallest such market may not involve the two products a and b even if they are in some larger market and have correlated prices as a result. The information needed to make these judgments is found in the reduced form price equation. If the analyst is willing to import such information into the price correlation analysis, he can use that information for market definition.³⁵ However, he could employ that same information more efficiently

³⁵For example, if one were willing to assume that (a) all price variation for product a and substitutes for it arises from changes in input prices and other cost shift variables, and no price variation arises from movements in demand shift variables, and (b) random price variation for each product has the same variance, then prices of substitute products will be less correlated with product a as the other goods become less close substitutes. This would occur because the two goods would share fewer cost shift variables in their reduced form price equations as they become more distant substitutes. Yet even with these strong assumptions, equivalent to applying a substantial amount of outside information, the price correlation approach would not substitute for a residual demand analysis because it would not compel the line in the observed chain of substitutes that would define a market boundary.

and systematically by estimating the reduced form price equation directly and using it for market definition.

E. Price Difference Correlations

The potential for misleading market definition inferences is similar if price differences rather than price levels are correlated. This approach to market definition was first advocated by Horowitz.³⁶

Define differences across products or regions D_t by the expression $(P_t^a - P_t^b)$. Then, assuming the structural representations of the reduced form price equations specified in equations (7) and (8):

$$(14) \quad D_t = (a_0 - b_0) + (a_1 - b_1)R_t + a_2S_t - b_2T_t + (e_t - v_t)$$

The equivalent form (14') can be derived from (7') and (8'), assuming each exogenous variable evolves according to the stationary first order autoregressive processes defined previously.

$$(14') \quad D_t = (a_0 - b_0) + (a_1 - b_1)c_0g(c_1) + a_2d_0g(d_1) - b_2e_0g(e_1) \\ + (a_1 - b_1)h(c_1, \theta_t) + a_2h(d_1, \mu_t) - b_2h(e_1, \phi_t) + e_t - v_t,$$

$$\text{where } g(x) = (1 + x + x^2 + x^3 + \dots),$$

$$h(x, \pi_t) = (\pi_t + x\pi_{t-1} + x^2\pi_{t-2} + \dots)$$

The typical market definition study employing price differences estimates a linear relationship between current and past price differences:

$$(15) \quad D_t = \alpha_0 + \alpha_1 D_{t-1} + \tau$$

³⁶Horowitz (1981); see Uri, Howell & Rifkin (1985).

Here the α 's are parameters and τ is a stochastic term.

Those employing price difference correlation analysis for market definition interpret the regression (15) in the following way. If the products a and b are in the same market, the price difference correlation analyst argues that changes in D_t reflect the adjustment of prices to a new equilibrium following shocks. Under this view, if equation (15) correctly specifies the dynamics of equilibration, then the long run equilibrium price difference between p^a and p^b is $\alpha_0/(1-\alpha_1)$.³⁷ Further, under this view the parameter α_1 will lie in the open interval $(-1,1)$ if the adjustment process to long run equilibrium is stable. The closer $|\alpha_1|$ is to unity, the speedier the adjustment.³⁸

The regression suggested by Horowitz, equation (15), will be reinterpreted on the assumption that equation (14') holds. This interpretation of the evolution of D_t is sensible so long as the reduced form equations (7') and (8') characterize the evolution of equilibrium prices. This reinterpretation will demonstrate, in contrast to what is generally presumed in the literature based on Horowitz, that it is not necessary to postulate that any, some, or most market transactions reflect temporary disequilibria in order for equation (15) to constitute a stable empirical regularity.

The analysis begins with the presumption that equation (14') is correct, and uses that equation to interpret equation (15).

³⁷If $ED_t = ED_{t-1}$, then $ED_t = \alpha/(1-\alpha_1)$.

³⁸See generally, Uri, Howell & Rifkin (1985).

As all the stochastic terms in (14') have means of zero, $ED_t = ED_{t-1}$. Therefore, the parameter α_0 in equation (15) will approximate $(1-\alpha_1)(ED)$, where ED is the mean (expected value) of D_t .³⁹ Hence, there is only one piece of independent information in the two estimated coefficients of equation (15). Therefore, the remaining analysis will be limited to the slope parameter, α_1 .⁴⁰

Equation (14) can be used to demonstrate that the proposed market definition test, based on whether α_1 is in the open interval $(-1,1)$, is subject to the possibility of substantial error because α_1 will likely lie in that interval regardless of whether the two products whose price differences are correlated are in the same or different antitrust markets. The slope coefficient α_1 will be estimated by the ratio of the covariance of D_t and D_{t-1} with the variance of D_{t-1} . The large sample properties of this expression, derived from equation (14'), are

³⁹This conclusion is robust to a variety of plausible model specifications in addition to the first order autoregressive processes underlying equation (14'). It holds so long as each exogenous variable in the economy evolves according to any moving average process, not merely the specific processes assumed in equations (9'), (10'), and (11'). It also holds whenever the price series P_t^a and P_t^b are filtered to remove their time trends before equation (15) is estimated, regardless of the process by which the exogenous variables evolve.

⁴⁰Alternatively, if the price series P_a and P_b are first differenced before the regression is run, and if they have been filtered to remove their time trend as suggested by Uri, Howell, and Rifkin (1985), then ED will equal zero by construction so α_0 will be estimated as zero regardless of the estimate of α_1 , and regardless of whether product a and b are in the same antitrust market. This point provides further justification for concentrating the analysis on the parameter α_1 , ignoring α_0 .

indicated by equation (16).

$$(16) \quad \text{plim } \alpha_1 = \frac{[(a_1^2 + b_1^2)c_1f(c_1)\sigma_\theta^2 + a_2^2d_1f(d_1)\sigma_\mu^2 + b_2^2e_1f(e_1)\sigma_\phi^2]}{[(a_1^2 + b_1^2)f(c_1)\sigma_\theta^2 + a_2^2f(d_1)\sigma_\mu^2 + b_2^2f(e_1)\sigma_\phi^2 + \sigma_e^2 + \sigma_v^2]}$$

where $f(x) = (1 + x^2 + x^4 + \dots)$

As with the analogous discussion of price level correlations, any sign or size coefficient for α_1 is consistent with both hypotheses between which the analyst wishes to discriminate: that products a and b are in the same antitrust market or that they are in different markets. An analysis of equation (16) will demonstrate that α_1 can never provide information about the crucial market definition parameters a_1 and b_1 . Even if it could, antitrust market definition would also require that the analyst know that the common variable affecting both prices is a cost shift variable, and that this variable is a market defining variable.

If random fluctuations (as might be created by instability of the oligopoly solution concept or fluctuations in transaction lot size or product quality) are the source of most price movement, so the expression $(\sigma_e^2 + \sigma_v^2)$ is large, then $\text{plim } \alpha_1$ will tend toward zero regardless of whether the two products a and b are in the same antitrust market.

If price changes largely result from variation in the innovations to the product individuated demand or cost shift variables S and T, so either σ_μ^2 or σ_ϕ^2 is large, then α_1 tends toward estimating the parameters d_1 or e_1 , respectively. These

parameters reflect the first order autocorrelation in S and T, so will lie in the open interval $(-1,1)$ whenever S and T are stationary time series. In this case, the price difference analyst will conclude that α_1 satisfies the necessary condition for stability of equation (15) whenever S and T are stationary, a condition that is unrelated to the market definition question. For example, if d_1 or e_1 are less than but near to one, as is likely if the sample period is short and the time series of the exogenous variables exhibits stationarity, then α_1 will be estimated near one. Products a and b will meet the conditions postulated by Horowitz for competing in the same market regardless of whether they in fact compete in the same market.

Finally, if price changes result primarily from fluctuations in the common variable R, so that σ^2_{θ} is large, then estimates of α_1 will tend toward c_1 . Again, the price difference correlation measures stationarity of the time series for the common variable, not whether the common variable is a cost or demand shift variable. Even if the common variable is a cost shift variable, stationarity of its time series has no necessary or consistent connection with whether a and b are in the same antitrust market. Rather, it is necessary to know what the relevant variable R is and to determine whether R is a market defining variable before antitrust market definition can be undertaken with this information. Again, if c_1 is less than but near one, as is likely if the sample period is short, products a and b will pass the Horowitz test regardless of whether they truly compete in the

same antitrust market.

Although the empirical literature on the Horowitz market definition algorithm is extremely limited, what does exist suggests that the problems with the price correlations approach described here are serious: the Horowitz test can readily produce inconsistent, misleading, or incorrect antitrust market definitions.⁴¹

E. Conclusion

This paper created a simple model in which price correlations, whether of levels or differences, provide little information on the extent of antitrust markets, as defined by the DOJ Guidelines. Errors can readily lie in either direction, improperly excluding products from the market or improperly concluding that an overbroad market is the smallest collusive group. Only when the source of the correlation is a market defining cost shift variable, affecting the costs of a small group of firms comprising a plausible market only, does the correlation provide information relevant to antitrust market definition. Unfortunately, the price correlation technique provides no way of discovering the source of the correlation; additional information, as from a residual demand analysis of

⁴¹Rogowsky & Shugart (1982), pp. 12-14. I understand that the antitrust enforcement agencies have obtained inconsistent results in applying the Horowitz approach to defining markets during law enforcement investigations: close substitutes may appear to be in different markets while distant substitutes appear to be in the same market.

market definition, must be employed. This demonstration suggests that antitrust market definition analyses based upon price correlation information, including the analyses advocated by Stigler and Sherwin (1985) and by Horowitz (1982), should not be relied upon. The best systematic (econometric) approach to antitrust market definition is the residual demand elasticity approach, which directly operationalizes the DOJ Guidelines definition.

Appendix

Reduced Form Equations and Residual Demand Curves for a Linear Duopoly Model

This appendix defines a linear duopoly model and uses it to derive linear reduced form equations for price and quantity and a residual demand curve.⁴² The derivation of the reduced forms makes plausible the linear functional form for the reduced form equations used in the analysis of price correlations tests in the main body of this paper. Further, this Appendix derives the relation between the residual demand curve and the corresponding reduced form price equation in the linear model.

1. Derivation of Reduced Form Equations

⁴²The model presented here is a special case of the general analysis of Baker & Bresnahan (1984). Unlike the present example, the model in that paper allows any number of firms, does not impose symmetry or linearity on demand or cost functions, and is not tied to any specific oligopoly solution concept.

Assume that a two firm industry sells differentiated products. The firms have symmetric demand curves, marginal cost curves that are linear in factor prices, and no fixed costs. The oligopoly solution concept is Nash in prices.

Let Q^a and Q^b represent firm outputs, and P^a and P^b represent prices. Y is a demand shift variable such as income, affecting both products. H and J are exogenous firm-individuated demand shift variables, perhaps related to consumer tastes.⁴³ The two structural demand curves have linear functional forms:

$$(A.1) \quad Q^a = \alpha_0 - \alpha_1 P^a + \alpha_2 P^b + \alpha_3 Y + \alpha_4 H$$

$$(A.2) \quad Q^b = \alpha_0 - \alpha_1 P^b + \alpha_2 P^a + \alpha_3 Y + \alpha_4 J$$

Each firm employs two variable factors of production: a common factor with price X , and a firm-individuated factor with price W (for firm 1) or Z (for firm 2). The two marginal cost curves are linear in factor prices but do not vary with output:

$$(A.3) \quad C^a = \beta_0 + \beta_1 X + \beta_2 W$$

$$(A.4) \quad C^b = \beta_0 + \beta_1 X + \beta_2 Z$$

Each parameter α_i and β_i is assumed to be a positive number. Further, the own price effect on demand is assumed to dominate the cross price effect: $|\alpha_1| > |\alpha_2|$.

Firm 1 earns profits equal to $(P^a - C^a)Q^a$. The behavior of a profit maximizing firm playing a Bertrand game can be determined by setting equal to zero the derivative of firm a's profits with

⁴³ H and J could represent the effect of firm advertising if that variable is statistically exogenous, as appears to be true for demand curves in the U.S. brewing industry. Baker & Bresnahan (1984), pp. 32-34.

respect to price, assuming no price reaction by firm b. The resulting first order condition, equating marginal revenue with marginal cost, and its analogue for firm b, appear below.⁴⁴

$$(A.5) \quad \alpha_0 - 2\alpha_1 P^a + \alpha_2 P^b + \alpha_3 Y + \alpha_4 H = \alpha_1(\beta_0 + \beta_1 X + \beta_2 W)$$

$$(A.6) \quad \alpha_0 - 2\alpha_1 P^b + \alpha_2 P^a + \alpha_3 Y + \alpha_4 J = \alpha_1(\beta_0 + \beta_1 X + \beta_2 Z)$$

Equations (A.5) and (A.6) solve for the two reduced form equations for price, written in terms of the parameters, the exogenous cost shift variables X, W, and Z, and the exogenous demand shift variables Y, H, and J. These equations define the equilibrium for the model.

$$(A.7) \quad P^a = [(2\alpha_1 + \alpha_2)(\alpha_1\beta_0 - \alpha_0) + (2\alpha_1 + \alpha_2)\alpha_1\beta_1 X + 2\alpha_1^2\beta_2 W + \alpha_1\alpha_2\beta_2 Z - (2\alpha_1 + \alpha_2)\alpha_3 Y - 2\alpha_1\alpha_4 H - \alpha_2\alpha_4 J]/D$$

$$(A.8) \quad P^b = [(2\alpha_1 + \alpha_2)(\alpha_1\beta_0 - \alpha_0) + (2\alpha_1 + \alpha_2)\alpha_1\beta_1 X + 2\alpha_1^2\beta_2 Z + \alpha_1\alpha_2\beta_2 W - (2\alpha_1 + \alpha_2)\alpha_3 Y - 2\alpha_1\alpha_4 J - \alpha_2\alpha_4 H]/D$$

$$\text{where } D = \alpha_2^2 - 4\alpha_1^2$$

Comparable reduced form equations for quantity are derived by substituting equations (A.7) and (A.8) into structural demand curves (A.1) and (A.2). The resulting reduced form equation for the output of firm a appears as equation (A.9).⁴⁵

$$(A.9) \quad Q^a = [\alpha_0 + ((\alpha_2 - \alpha_1)(2\alpha_1 + \alpha_2)(\alpha_1\beta_0 - \alpha_0)/D) + [(\alpha_2 - \alpha_1)(2\alpha_1 + \alpha_2)(\alpha_1\beta_1)/D]X$$

⁴⁴The second order conditions for an interior maximum require $\alpha_1 > 0$. For price and quantity to be positive, it is necessary that $|\alpha_1| > |\alpha_2|$. These conditions are satisfied by assumption.

⁴⁵In this model the reduced form quantity equation, unlike the reduced form price equation, excludes the firm-individuated cost shift variable for the other firm.

$$\begin{aligned}
& + [(\alpha_1\alpha_2^2\beta_2 - 2\alpha_1^3\beta_2)/D]W \\
& + [(\alpha_1^2\alpha_2\beta_2)/D]Z \\
& + [\alpha_3 + ((\alpha_1 - \alpha_2)(2\alpha_1 + \alpha_2)\alpha_3)/D]Y \\
& + [\alpha_4 + \alpha_4(2\alpha_1^2 - \alpha_2^2)/D]H
\end{aligned}$$

The reduced form equations for price and quantity are noteworthy because they are linear in factor prices and income. In this way, a duopoly model with linear demand and with marginal cost linear in factor prices produces a linear reduced form equation for price. The text exploits the linearity of these reduced forms, but does not impose other restrictions resulting from the specific model solved here. In particular, cross equation restrictions on the reduced form equations -- generated as a result of the symmetry assumptions, specific functional forms assumed, and the oligopoly solution concept chosen -- are not imposed.

2. Derivation of Residual Demand Curve

Baker and Bresnahan (1984) have shown that the conceptual experiment of raising firm-individuated costs identifies the residual demand curve for the single firm. This section of the Appendix will rederive that result for the linear duopoly model in order to analyze the relationship between the reduced form price equations and the residual demand curves. That relationship is employed in the text to assess the relationship between the two market definition tools compared: price correlation tests and residual demand analysis.

The residual demand curve for firm a is defined as the demand curve that takes into account the response of the firm's rivals. As a result, it takes into account all the market mechanisms imposing competitive discipline on a firm's ability to exercise market power: the effect of demand substitutability to products outside the provisional market, the nature of rivalry among producers in that market, and the tempering effect of the prospect of new entry on the behavior of incumbent producers. In the linear duopoly model, the residual demand curve for firm a is derived from the structural demand curve for firm a, equation (A.1), by substituting in the reactions of firm a's rival:

$$(A.10) \quad Q^a = \alpha_0 - \alpha_1 P^a + \alpha_2 P^b(P^a, C^b) + \alpha_3 Y + \alpha_4 H$$

In equation (A.10), the expression $P^b(P^a, C^b)$ is implied by equation (A.6), the first order condition defining the behavior of firm b.⁴⁶ Therefore, the residual demand curve facing firm a

⁴⁶This definition of the residual demand curve incorporates the second firm's actual reaction function. That function will not equal the first firm's perception of that reaction unless the first firm is a Stackelberg leader with respect to its environment. Baker & Bresnahan (1984) show that the residual demand elasticity allows the inference of markup if the distinction between perceived and actual reactions can be ignored. When that distinction is important, a residual demand curve with downward slope implies the presence of market power, but does not allow the inference of markup. In the linear duopoly model solved above, the two firms achieve a Bertrand equilibrium, so the difference between perceived and actual reaction functions is important. As a result, the residual demand elasticity, that is, the elasticity of quantity with respect to price in equation (A.11), will not allow the inference of firm a's behavior (markup). If instead firm a were a competitor, were a dominant firm, were in an industry characterized by extreme product differentiation, or were in an industry which has achieved a Consistent Conjectures Equilibrium, firm a's markup could have been inferred from the elasticity of residual demand.

can be written

$$(A.11) \quad Q^a = [a_0 + ((a_0 - a_1\beta_0)a_2)/(2a_1)] \\ + [-a_1 + (a_2^2)/(2a_1)]P^a \\ + a_3Y - [(a_2\beta_1)/2]X - [(a_2\beta_2)/2]Z + a_4H$$

The slope of the firm a's residual demand curve, which defines whether that firm possesses market power, is $[-a_1 + (a_2^2)/(2a_1)]$, the coefficient of own price in equation (A.11). If this expression grows (negative) without limit, then the combined efforts of consumer demand substitution and rival response force firm a to act as a price taker. If the expression is a finite negative number, firm a faces a downward sloping demand curve even after these competitive forces are taken into account.

This example demonstrates an important relation between the reduced form price equation and the residual demand curve relied upon in the text: the slope of the residual demand curve (A.11) equals the ratio of the partial derivative of the reduced form equation for quantity (A.9) with respect to the firm-individuated exogenous cost shift variable W , or $(\delta Q^a/\delta W)$, to the partial derivative of the reduced form equation for price (A.7) with respect to W , or $(\delta P^a/\delta W)$. As an econometric matter, this procedure for identifying the slope of the residual demand curve works because W is an excluded exogenous variable from the point of view of estimating the residual demand curve (11).⁴⁷

⁴⁷This econometric identification issue is considered in detail in Baker & Bresnahan (1984). The residual demand curve model is completed, and equilibrium defined, by a supply relation

of the form $P^1 = C^1(Q^1) - [P^1(Q^1) - MR^1(Q^1)]$, where $P^1(Q^1)$ is the residual demand curve and $MR^1(Q^1)$ is marginal to the residual demand curve. (This supply relation is a transformation of the familiar equilibrium condition equating marginal revenue with marginal cost.) As the supply relation depends upon both marginal revenue and marginal cost, it incorporates all exogenous variables found in either the demand or cost curve.

As Y, H, J, Z, and X are not excluded exogenous variables from the point of view of estimating the residual demand curve for firm a, the ratio of derivatives of the two reduced form equations with respect to these variables will not identify the slope of the residual demand curve. For example, H, an exogenous demand shift variable, does not identify the slope of the residual demand curve. Rather, equations (A.7) and (A.9) imply that $[\delta Q^1 / \delta H] / [\delta P^1 / \delta H] = \alpha_1$. (This expression contains no parameters of the marginal cost curve because the example of this Appendix presumes that marginal cost does not depend on output.)

When the residual demand curve (A.11) is estimated directly, consistent estimates of the coefficient of P^1 can be obtained in the usual way, by using the firm-individuated cost shift variable W as an instrumental variable, without need to estimate the two reduced form equations and take the ratio of the appropriate coefficients.

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EXHIBIT C

AN ANALYSIS OF PRICE-BASED TESTS OF ANTITRUST MARKET DELINEATION

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ABSTRACT

There are well-known theoretical concerns regarding the use of price correlations to determine antitrust markets. However, this has not deterred their use or the application of Granger causality, stationarity, and cointegration tests in the determination of antitrust markets. In this paper, we explore the empirical performance of these various tests. In particular, we want to know whether these tests are capable of generating the correct inference both when two products are in the same relevant market and when they are not. Our results imply that, in the absence of common shocks, simple price correlations may be capable of providing reliable evidence on market delineation. However, in samples sizes similar to those currently available, the performance of other commonly employed price-based tests suggests that they provide little economically meaningful information to antitrust practitioners.

I. INTRODUCTION

Market definition is the foundation of antitrust analysis. To understand the competitive effects of merger and nonmerger cases, antitrust agencies must first determine the extent of the relevant antitrust market, which will in turn provide an indication of the degree of market power. To determine the scope of an antitrust market, antitrust agencies rely on the “hypothetical monopolist test.” This determines a group of products and geographic areas in which a sole supplier (hypothetical monopolist) would be able to exert significant market power.¹ A properly defined antitrust market will determine the set of products such that market shares are reflective of market power. If the market is defined too broadly, then the degree of market power will be

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¹ See Commissioner of Competition, *Merger Enforcement Guidelines*, September 2004: Part 3, and U.S. Department of Justice and Federal Trade Commission, *Horizontal Merger Guidelines*, April 1997: §1.0. In Canada, significant market power is considered to be the ability to impose and sustain a significant (5 percent) and nontransitory (one year) price increase.

underestimated. Likewise, if market definition is too narrow, then the degree of market power will be overestimated.

Although the hypothetical monopolist approach is theoretically appealing, it can be difficult to implement empirically. Scheffman and Spiller (1987) develop an econometric analysis of residual demand that is consistent with the determination of an antitrust market. However, this approach is very data-intensive, requiring data on prices, quantities, and costs. The problem with this is that the appropriate data may not be available in the initial stages of an inquiry, and in some cases, may not be available at all.² To work around this problem, antitrust practitioners have suggested the use of price-based approaches to determine the scope of the antitrust market. The four most common price-based approaches are (i) price correlations, (ii) Granger causality tests, (iii) stationarity (unit root) tests, and (iv) cointegration tests. For a discussion of these tests and examples of their use in antitrust cases, see the U.K.'s Office of Fair Trading (1999) publication "Quantitative Techniques in Competition Analysis."

The basic idea behind all of these tests is that, if two goods are in the same antitrust market, then we would expect to see some relationship between their prices as consumers substitute between them in response to good-specific price shocks. On the other hand, if consumers do not view the two goods as substitutes, then shocks to the price of one good will not have an impact on the price of the other good. One concern with using these tests is that, although they may be useful in identifying economic markets (areas in which prices are linked together through arbitrage), they may not identify relevant antitrust markets. Because the objective of defining an antitrust market is to identify market power, whether or not two products are in the same economic market does not determine whether the existence of one product mitigates the market power of the other. These price-based tests are based on cross-price effects and do not provide information about the own-price elasticity. Thus, they do not provide information regarding the key antitrust question, which is, "How much does demand decrease in response to a price increase?"³ However, despite the fact that these approaches do not distinguish between economic and antitrust markets, they are still commonly employed in antitrust analysis, see, for example, Forni (2004) or Werden and Froeb (1993).

A second concern stems from the critique that price correlations are subject to spurious correlation; that is, the prices of two products may be correlated due to having common costs, even though the products are not

² A further shortcoming of this methodology is that it requires a stable structure for demand and a stable structure of oligopoly. See Scheffman and Spiller (1996), p. 166. However, they note that the demand and oligopoly structure can be adequately captured with the use of appropriate exogenous data.

³ See critiques by Baker (1987), Scheffman and Spiller (1987), Werden and Froeb (1993), Hosken and Taylor (2004), and Genesove (2004). For a detailed discussion of economic versus antitrust markets, see Church and Ware (2000), pp. 601-603.

substitutable.⁴ However, the question of whether similar limitations apply to the other main price tests has not received as much attention. Furthermore, the counterfactuals provided in the critiques of price correlations are based on outcomes from actual data and therefore can be problematic. For example, Werden and Froeb (1993) look at high-fructose corn syrup and sugar and note fairly high price correlations even though the U.S. government and court of appeals concluded that these goods were not in the same antitrust market.⁵ However, Sherwin (1993) argues that, for at least part of Werden and Froeb's sample, many consumers were switching from sugar to high-fructose corn syrup and so high price correlations are not surprising.

The purpose of this paper is to explore the empirical performance of the four main price-based tests in market delineation. To do so, we use synthetic data generated by a differentiated product model in which the model's parameters are chosen such that two products are in, and one product is out, of the relevant antitrust market as defined by the hypothetical monopolist test. Thus, we can determine whether these tests are capable of generating the correct inference both when products are in the same relevant market and when they are not. We prefer synthetic data to actual data for this exercise as it allows us complete control over the data-generating process. This means that we can avoid the sort of ambiguity over the interpretation of results illustrated by the sugar and high-fructose corn syrup example. Furthermore, by using synthetic data we can examine the empirical performance of the price-based tests with respect to the degree of substitutability between the products, the structure of cost shocks, the timing of firms' pricing decisions, and sample size.

We find that, in the absence of common cost shocks, price correlations can do a good job of determining which goods belong to the same market and which goods do not. On the other hand, in the presence of common cost shocks, price correlations do not perform as well, and not surprisingly tend to be over-inclusive (the relevant market is defined too broadly). However, even in the absence of common shocks, other price-based tests perform poorly. We find that, when the data is generated from a standard model of product differentiation, Granger causality, stationarity, and cointegration tests are unable to distinguish between the case where two goods are in the same market, and the case where they are not. In fact, our simulation results suggest that these tests provide absolutely no meaningful information to antitrust practitioners. We also generate data from a modified product differentiation model in which firms do not have perfect information regarding each other's costs and so respond to a rival firm's cost shocks with a delay. In this case, we find that the Granger causality, stationarity, and cointegration tests perform slightly better. However, in samples similar in size to

⁴ See Baker (1987) and Werden and Froeb (1993).

⁵ See also Hosken and Taylor (2004).

those currently available to antitrust practitioners, these remain tests of very limited power.

In the next section, we provide a brief discussion of the four main price-based tests. Section III presents the product differentiation model used to generate the synthetic data. In Section IV, we calibrate that model, generate synthetic data, and examine the empirical performance of the price-based tests in defining relevant markets. Section V concludes.

II. PRICE-BASED TESTS

The idea behind price-based tests is that products should be grouped together into a single market if their prices move together. The reason is that price differentials greater than transportation costs provide the opportunity for profitable arbitrage. As Church and Ware (2000) point out, “if two markets are linked by arbitrage, then a disturbance—either a cost or demand shock—that changes the price in one will also change the price in the other, implying price correlation.”⁶ The various price-based tests provide different methodologies for determining whether such a relationship exists. The four most common price-based tests are: (i) correlations; (ii) Granger causality tests; (iii) stationarity tests; and (iv) cointegration tests.⁷ We now discuss each of these approaches in turn.

A. Correlations

Stigler and Sherwin (1985) argue that, if two goods can be considered to be part of the same market, then their price movements should be correlated.⁸ For example, if a cost shock were to raise the price of good i , then consumers would substitute away from this good into good j . This increase in demand pushes up the price of good j , and so we observe a positive correlation between the changes in the prices of the two goods.

The most common argument against using price correlations to determine antitrust markets is the problem of spurious correlation. In this case, price correlation is the result of common influences (such as a common cost shock), rather than product substitutability. However, this is not the only concern with using price correlations. Werden and Froeb (1993) argue that price correlations can provide misleading results due to individual cost variation, individual demand variation, and variation in the price of other

⁶ See Church and Ware (2000), p. 613.

⁷ See Stigler and Sherwin (1985) on price correlations; Uri et al. (1985), Uri and Rifkin (1985) and Slade (1986) on Granger causality tests; Forni (2004) on stationarity tests and Ardeni (1989) and Walls (1994) on cointegration tests.

⁸ The correlation coefficient between goods i and j is given by $\rho_{ij} = \text{cov}(p_i, p_j) / (\sigma_i \sigma_j)$, where $\text{cov}(p_i, p_j)$ is the covariance between the prices of goods i and j , and σ_i and σ_j are the standard deviations of the prices of goods i and j , respectively.

products. They go on to conclude that “more generally, the various economic forces that affect both price correlations and monopoly markups do not affect the two in quite the same way, so correlations can be misleading.”⁹ However, Baker (1987, pp. 26–27) argues that price correlations can be informative for determining antitrust markets if the price correlation is due to cost shocks that only occur for firms in the same antitrust market. It should be noted that Baker also points out that, if there is enough information to determine that the cost shock only affects the firms within the relevant antitrust market, then there is probably enough information to perform a residual demand analysis.

B. Granger Causality Tests

In addition to problems associated with common factors, price correlations can be uninformative if the price adjustment across goods takes place with a delay. Suppose the supply shock that raises the price of a good only has an effect on the price of a substitute good in the following period. In this case the contemporaneous correlation between the price changes will be equal to zero even if the goods are very close substitutes. Slade (1986) makes this point and advocates the use of Granger causality tests to explore the possibility that the prices of two goods may be related, but that feedback is not instantaneous. Granger causality tests ask whether lagged values of one variable contain marginal predictive content for another variable above and beyond what is contained in that variable’s own lags. More specifically, variable 1 is said to Granger cause variable 2 if lagged values of variable 1 are statistically significant in a regression for variable 2, which also contains lagged values of variable 2.

A convenient way to conduct these tests is in the context of a vector autoregression (VAR). Let $\Delta \mathbf{p}_t$ be an $N \times 1$ vector containing the first differences of the natural logarithm of the prices of N goods at time t . A VAR can be used to describe the dynamic behavior of these prices and relates the vector $\Delta \mathbf{p}_t$ to its own lags, and can be written as

$$\Delta \mathbf{p}_t = \sum_{k=1}^K \psi_k \Delta \mathbf{p}_{t-k} + \mathbf{e}_t \tag{1}$$

where ψ_k are $N \times N$ matrices containing parameters that describe the dynamic relationships between prices. The lag order of the VAR, given by K , is chosen to ensure that the residuals \mathbf{e}_t are serially uncorrelated. A test for

⁹ Werden and Froeb (1993), p. 334.

Granger (non)causality from Δp_i to Δp_j requires testing the null hypothesis:

$$\psi_{ij,1} = \psi_{ij,2} = \dots = \psi_{ij,K} = 0 \quad (2)$$

where $\psi_{ij,k}$ refers to element i,j of matrix ψ_k . If this null hypothesis is rejected in favor of the alternative that at least one of these parameters is nonzero, then Δp_i is said to Granger cause Δp_j .

C. Unit Root Tests

Simple arbitrage predicts that, if two goods belong in the same market, there is a limit as to how far their prices can diverge from one another. Forni (2004) exploits this to suggest the use of unit root tests in determining whether two goods are in the same market. If two goods are in the same market then a shock that raises the price of one good relative to the other can only have transitory effects. As consumers begin to substitute away from the good that has become more expensive, the price of that good falls and the price of the other good rises. Eventually the relative price returns to some long-run equilibrium value. If this is the case then the relative price is said to be stationary. On the other hand, if two goods are not in the same market then shocks will have permanent effects on the relative price, which is then said to be nonstationary.

Suppose that the log of the relative price of goods i and j can be written as a first-order autoregressive process, that is:

$$p_{i,t} - p_{j,t} = \rho(p_{i,t-1} - p_{j,t-1}) + e_t \quad (3)$$

where e_t is a serially uncorrelated, mean-zero random variable and ρ measures the persistence of innovations to the relative price series.¹⁰ If we repeatedly lag equation (3) and substitute the result back into (3) we can write the relative price as an initial value plus a moving average of past and current e_t , that is:

$$p_{i,t} - p_{j,t} = \rho^t(p_{i,0} - p_{j,0}) + \sum_{h=0}^{t-1} \rho^h e_{t-h}. \quad (4)$$

The partial derivative of (4) with respect to e_{t-h} measures the effect of a shock at time $t-h$ to the relative price at time t . Notice that when $-1 < \rho < 1$ this partial derivative tends to zero as the horizon, h , tends to infinity. In other words, shocks have purely transitory effects. However, when $\rho = 1$ the partial derivative is equal to 1 for all h and so shocks have permanent effects.

¹⁰ More generally this equation can include an intercept and a deterministic trend to represent a nonzero equilibrium relative price as well as additional lags of the dependent variable.

The most common unit root test is the augmented Dickey–Fuller (ADF) test. This involves testing the null hypothesis that $\phi = 0$, where $\phi = \rho - 1$, against the alternative that $\phi < 0$ using the regression:

$$\Delta(p_{i,t} - p_{j,t}) = \phi(p_{i,t-1} - p_{j,t-1}) + \sum_k^K \varphi_k \Delta(p_{i,t-k} - p_{j,t-k}) + e_t \quad (5)$$

where K is chosen to ensure that e_t is serially uncorrelated.¹¹ A failure to reject the null hypothesis implies that shocks to the relative price are permanent and therefore that the two goods are in separate markets. On the other hand, if the two goods are in the same market then the null hypothesis should be rejected in favor of the alternative that the relative price is stationary.

An important caveat applies here. If both $p_{i,t}$ and $p_{j,t}$ are stationary, then the ratio $p_{i,t} - p_{j,t}$ is also stationary regardless of whether the two goods are in the same market. Therefore, if this is the case, a rejection of the null hypothesis of $\phi < 0$ does not necessarily imply that the two goods are in the same market. In our simulation exercise, we are able to sidestep this issue by constructing our price series such that they are individually nonstationary. Therefore, in our synthetic data a finding that the relative price is stationary implies that the two goods belong to the same market.

D. Cointegration Tests

Closely related to unit root tests are cointegration tests. Two nonstationary time series are said to be cointegrated if a linear combination of those two series is stationary. If the two price series are cointegrated then there exists a stable long-run relationship between the two series described by $p_{i,t} - bp_{j,t} = 0$.¹² In this case, p_i and p_j are said to be cointegrated with cointegrating vector $(1 - b)$. A test for cointegration is then a test that $p_{i,t} - bp_{j,t}$ is stationary.¹³ If the null hypothesis that the two series are not cointegrated cannot be rejected, then the implication is that there is no long-run relationship between the two price series and the two goods are in separate markets. On the other hand, if the null hypothesis is rejected in favor of the alternative that the two prices are cointegrated, then this is consistent with the two goods being in the same market.¹⁴ The two most commonly employed tests for cointegration are the Engle and Granger (1987) two-step procedure and

¹¹ In practice, the ADF regression typically contains an intercept and, when applicable, a deterministic trend. In an unpublished appendix to this paper, we also present results for alternative unit root tests. This appendix is available from us on request.

¹² Again, more generally, this long-run relationship can contain a constant term and deterministic trend.

¹³ Note that when $b = 1$ this is equivalent to a unit root test on the relative price.

¹⁴ Note that, as with the unit root test on the relative price, if both $p_{i,t}$ and $p_{j,t}$ are stationary then $p_{i,t} - bp_{j,t}$ will also be stationary, even if the goods are in separate markets.

the Johansen (1991) procedure. We examine the performance of both of these methods in Section IV.

III. A MODEL OF PRODUCT DIFFERENTIATION

In this section, we outline the model of product differentiation that we use as a data-generating process. In the next section, we discuss parameter values, use this model to generate synthetic data, and perform the tests of market delineation discussed in the previous section.

A. Demand

Consider a representative consumer with a quadratic utility function defined over three differentiated goods:¹⁵

$$U(\mathbf{Q}) = \alpha\mathbf{Q} - (1/2)\mathbf{Q}'\Gamma\mathbf{Q} \quad (6)$$

where

$$\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix}, \quad \mathbf{Q} = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \end{bmatrix}, \quad \text{and} \quad \Gamma = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix}. \quad (7)$$

For analytical ease we will assume symmetric two-way substitutability between goods.¹⁶ In other words, consumers view the degree of substitutability of good 1 for good 2 the same as good 2 for good 1 and so we assume $\gamma_{12} = \gamma_{21}$, $\gamma_{23} = \gamma_{32}$ and $\gamma_{31} = \gamma_{13}$. The inverse demands follow from the first-order conditions of the consumer's utility maximization problem and are given by

$$P_i = \frac{\partial U_i}{\partial Q_i} \quad (8)$$

for $Q_i > 0$ and $i = 1, 2, 3$. Therefore, the inverse demand system is given by

$$P(\mathbf{Q}) = \alpha - \Gamma\mathbf{Q}. \quad (9)$$

¹⁵ For a detailed discussion of the representative consumer model, see Chapter 6 of Vives (2001).

¹⁶ However, two-way substitutability is not necessary for two goods to be in the same antitrust market. Two goods can be in the same antitrust market with one-way substitutability.

The direct demand system is determined by inverting the inverse demand system (9), which yields

$$D(\mathbf{P}) = \Gamma^{-1}(\alpha - \mathbf{P}), \tag{10}$$

where

$$\Gamma^{-1} = \begin{bmatrix} \frac{\gamma_{22}\gamma_{33} - \gamma_{23}^2}{\Delta} & \frac{\gamma_{23}\gamma_{13} - \gamma_{33}\gamma_{12}}{\Delta} & \frac{\gamma_{12}\gamma_{23} - \gamma_{22}\gamma_{13}}{\Delta} \\ \frac{\gamma_{23}\gamma_{13} - \gamma_{33}\gamma_{12}}{\Delta} & \frac{\gamma_{11}\gamma_{33} - \gamma_{13}^2}{\Delta} & \frac{\gamma_{12}\gamma_{13} - \gamma_{11}\gamma_{23}}{\Delta} \\ \frac{\gamma_{12}\gamma_{23} - \gamma_{22}\gamma_{13}}{\Delta} & \frac{\gamma_{12}\gamma_{13} - \gamma_{11}\gamma_{23}}{\Delta} & \frac{\gamma_{11}\gamma_{22} - \gamma_{12}^2}{\Delta} \end{bmatrix} \tag{11}$$

and $\Delta \equiv \gamma_{11}\gamma_{22}\gamma_{33} + 2\gamma_{12}\gamma_{23}\gamma_{13} - \gamma_{13}^2 - \gamma_{11}\gamma_{23}^2 - \gamma_{22}\gamma_{13}^2 - \gamma_{33}\gamma_{12}^2 > 0$.¹⁷ Furthermore, we define \mathbf{B} to be the diagonal matrix consisting of the absolute value of the slopes of the direct demands ($\partial D_i(\mathbf{P})/\partial P_i$), which is the diagonal of $-\Gamma^{-1}$

$$\mathbf{B} = \begin{bmatrix} \left| \frac{\gamma_{22}\gamma_{33} - \gamma_{23}^2}{\Delta} \right| & 0 & 0 \\ 0 & \left| \frac{\gamma_{11}\gamma_{33} - \gamma_{13}^2}{\Delta} \right| & 0 \\ 0 & 0 & \left| \frac{\gamma_{11}\gamma_{22} - \gamma_{12}^2}{\Delta} \right| \end{bmatrix}. \tag{12}$$

Thus, the diagonal of matrix \mathbf{B} is simply the own-price elasticities of demand.

B. Pricing

There exist three firms that each produce one of the goods, with marginal cost $M_i < \alpha_i$, $i = 1, 2, 3$. We assume Bertrand competition with firm profits given by

$$\pi_i = P_i D_i(\mathbf{P}) - M_i D_i(\mathbf{P}). \tag{13}$$

Each firm maximizes profit by choosing the price of the good that it produces. This yields the following first-order conditions for each firm i

$$(P_i - M_i) \frac{\partial D_i(\mathbf{P})}{\partial P_i} + D_i(\mathbf{P}) = 0. \tag{14}$$

¹⁷ Note that $\Delta > 0$, $\gamma_{11}\gamma_{22} - \gamma_{12}^2 > 0$ and $\gamma_{11} > 0$ are necessary conditions for $U(\mathbf{Q})$ to be strictly concave.

Using (10) and (12), the system of first-order conditions can be rewritten as

$$-\mathbf{B}(\mathbf{P} - \mathbf{M}) + \Gamma^{-1}(\alpha - \mathbf{P}) = \mathbf{0} \quad (15)$$

where

$$\mathbf{P} = \begin{bmatrix} P_1 \\ P_2 \\ P_3 \end{bmatrix} \quad \text{and} \quad \mathbf{M} = \begin{bmatrix} M_1 \\ M_2 \\ M_3 \end{bmatrix}. \quad (16)$$

Solving (15) for \mathbf{P} , yields the following Bertrand–Nash equilibrium prices and quantities

$$\mathbf{P}^* = (\mathbf{I} + \Gamma\mathbf{B})^{-1}(\alpha - \mathbf{M}) + \mathbf{M} \quad (17)$$

and

$$\mathbf{Q}^* = (\Gamma + \mathbf{B}^{-1})^{-1}(\alpha - \mathbf{M}). \quad (18)$$

C. Hypothetical Monopolist Test

In the United States the Department of Justice and Federal Trade Commission, and in Canada the Competition Bureau use the hypothetical monopolist test to define the relevant antitrust market. The *Merger Enforcement Guidelines* state:¹⁸

The market definition analysis begins by postulating a candidate market for each product of the merging parties. For each candidate market, the analysis proceeds by determining whether a hypothetical monopolist controlling the group of products in that candidate market would be able to impose a five per cent increase assuming the terms of sale of all other products remained constant. If the price increase would likely cause buyers to switch their purchases to other products in sufficient quantity to render the price increase unprofitable, the postulated candidate market is not the relevant market, and the next-best substitute is added to the candidate market. . . . The smallest set of products in which the price increase can be sustained is defined as the relevant product market.

Provided that the next-best substitute can be identified unambiguously, the *Merger Enforcement Guidelines* define a unique relevant antitrust market.¹⁹ In the simulation exercises that follow, we choose parameter values that satisfy

¹⁸ Commissioner of Competition, *Merger Enforcement Guidelines*, September 2004, at ¶3.5, footnotes removed.

¹⁹ Note that this procedure is also used in nonmerger cases. The only difference is that the reference price for determining the magnitude of the price increase is not the prevailing market price. In nonmerger cases, the competitive price is used to avoid the problems related

the hypothetical monopolist test such that goods 1 and 2 are in the same antitrust market and good 3 is not.

IV. CALIBRATION AND SIMULATION

As mentioned above, we calibrate the model of the previous section so that consumers regard goods 1 and 2 as substitutes, but not good 3. We then use this model to generate synthetic price data for all three goods. Using this synthetic data we calculate correlation coefficients, estimate bivariate VARs, and perform Granger causality tests for each price pair. We also test for a unit root in each (log) relative price and test for cointegration between each (log) price pair. We then examine the extent to which the results of these tests differ across the three price pairs and therefore the extent to which these tests provide useful information about the extent of the relevant market to the antitrust practitioner.

A. Calibration

We calibrate the model to match the spaghetti sauce data used by Capps *et al.* (2003). In particular, we choose parameter values such that the prices of the three goods have similar properties to the prices of Classico and Newmans in the Capps *et al.* dataset. We begin by discussing the demand parameters. We set $\gamma_{ii} = 0.4$ for all three goods. In our baseline calibrations, we set $\gamma_{12} = 0.1$ and $\gamma_{13} = \gamma_{23} = 0$. These parameter values imply own-price elasticities of -2.67 for goods 1 and 2 and -2.50 for good 3, as well as a cross-price elasticity of 0.67 between goods 1 and 2. The own-price elasticities are within the ranges estimated by Capps *et al.*; the cross-price elasticity is higher than their estimates. We also experiment with values of $\gamma_{12} = 0.25$ and $\gamma_{12} = 0.3999$. The first of these implies own-price elasticities for goods 1 and 2 of -4.1 and a cross-price elasticity of 2.6 ; the latter is the case where goods 1 and 2 are almost perfect substitutes.²⁰ We set $\alpha_i = 4$ for $i = 1, 2, 3$. These figures in combination with our initial conditions for the marginal cost processes imply initial prices similar to the means reported for Classico and Newman in Table 1 of Capps *et al.*

Given the marginal cost processes we describe below and in the absence of any cost shocks, when $\gamma_{12} = 0.1$ the equilibrium prices are $p_1^* = p_2^* = 2.29$ and $p_3^* = 2.50$. If a hypothetical monopolist produces goods 1 and 2, conditional on $p_3^* = 2.50$, then the equilibrium prices for goods 1 and 2 increases

to the *Cellophane Fallacy*. We follow the merger application and use the prevailing market price as the reference price.

²⁰ A value of $\gamma_{12} = 0.4$ implies goods one and two are perfect substitutes and so their prices would be equal to the higher of their two marginal costs.

to 2.50, a 9 percent increase. If a hypothetical monopolist produces all three goods then the equilibrium price of all three goods remains at 2.50 and so goods 1 and 2 are in the same antitrust market, but good 3 is not.

As discussed earlier, when two price series are stationary then a linear combination of those two series will also be stationary. Therefore, to interpret the unit root and cointegration tests as tests of market definition, it is important that the two (log) price series are individually nonstationary. In our synthetic data, we ensure that this is the case by allowing shocks to the (log) marginal cost processes to be permanent. To do this we assume a random walk for the log of the marginal cost process (m_{it}) of each firm

$$m_{i,t} = m_{i,t-1} + \varepsilon_{it} \quad (19)$$

where ε_{it} is the shock to the marginal cost process of firm i at time t .²¹ We assume that this shock can be decomposed into two orthogonal components, a common shock U_t , which affects all three firms, and a firm-specific shock $U_{i,t}$, which only affects firm i . Both of these shocks are drawn from zero-mean normal distributions with standard deviations given by σ_U and $\sigma_{u_i} = \sigma_u$ for all i . In our first set of experiments, we focus on firm-specific shocks only and so set $\sigma_U = 0$. In the second set of experiments, we allow for both a common shock and a firm-specific shock. In this case, we set $\sigma_U = \sigma_u$ so that the common and firm-specific shock contribute equally to price volatility. In either case, we set σ_u in order that the standard deviations of Δp_1 and Δp_2 in our synthetic data are close to those of Classico and Newman in the Capps *et al.* data.²² Finally, we set initial conditions for the marginal cost processes at $M_1 = M_2 = M_3 = 1$ in order that the initial observation in the synthetic price data matches the sample means of the Capps *et al.* data in the case where $\gamma_{12} = 0.1$.

B. Simulation

Using these parameter values we generate 10,000 samples of length $T + 200$ and then discard the first 200 observations to minimize the influence of starting values. Given that we have calibrated our model to the Capps *et al.* dataset, which is weekly, we consider values of $T = 26, 52, 104, 260, 520,$ and 2600 , which imply datasets of length 6 months and 1, 2, 5, 10, and 50

²¹ We also perform simulations in which we model marginal costs as an AR(2) and therefore introduce first-order serial correlation in the first difference of our synthetic (log) price data. The results from these sets of experiments are essentially the same as those reported in the paper and so are omitted to save space. They are reported in the unpublished appendix.

²² The values of σ_u that do this vary with the other parameters of the model and so we report these in the notes to each table. We also experiment with higher values of σ_u and therefore more volatile synthetic price data. Again there is little improvement in the empirical performance of these tests and these results appear in the unpublished appendix.

years. Our impression is that most empirical studies using price data have sample sizes in the range of 1–2 years, however shorter samples are occasionally used. The figures $T = 260$ and $T = 520$ represent possible upper bounds on the amount of data currently available in price-based studies. We include $T = 2600$ to gauge the extent to which potential poor performance of these empirical tests is related to small sample issues. For each sample of synthetic data we calculate the correlation coefficient for each pair of Δp . We then estimate a bivariate VAR for each price pair (again in first differences of logs) and perform Granger causality tests. Finally, we also test for a unit root in the (log of) each relative price and for cointegration between each pair of (log) prices.

If these tests are to provide useful information to antitrust practitioners, then they should be able to distinguish between the three different price pairs. Goods 1 and 2 are substitutes and so we expect to see a high correlation coefficient for Δp_1 and Δp_2 , but not for Δp_1 and Δp_3 or Δp_2 and Δp_3 . Similarly, if Granger causality tests are to provide useful information we should see a rejection of the null hypothesis of no Granger causality between Δp_1 and Δp_2 , but not for the other two pairs. We should also see a rejection of a unit root hypothesis in relative price $p_2 - p_1$, but not in the relative prices $p_3 - p_1$ and $p_3 - p_2$. Finally, we should see a rejection of the null hypothesis of no cointegration between p_1 and p_2 , but not the other two (log) price pairs.

1. Firm-Specific Cost Shocks Only

Table 1 shows results for which the data-generating process contains only firm-specific cost shocks and $\gamma_{12} = 0.1$. The first three rows of this table show the mean values of ρ_{12} , ρ_{13} , and ρ_{23} across the 10,000 samples of synthetic data; the remaining rows show rejection rates across the 10,000 samples for various hypotheses based on a nominal size of 0.05.

The first thing to note from Table 1 is that in the absence of common shocks, price correlations do a reasonable job of differentiating between goods that are in the same market and those that are not. For example, consider a sample size of $T = 104$. Here the average correlation coefficient between Δp_1 and Δp_2 , ρ_{12} is 0.53, and the averages for ρ_{13} and ρ_{23} are essentially zero. This marked difference in mean correlation coefficients is true across all sample sizes. The ability of the price correlation approach to differentiate between the different cases is well illustrated by Figure 1, which shows the distributions of ρ_{12} and ρ_{13} constructed using estimates from the 10,000 samples of synthetic data (again $\gamma_{12} = 0$ and $T = 104$).

However, probably the most striking thing to take from Table 1 is how poorly the other price-based tests of market delineation perform in our simulations. For each of these tests the null hypothesis is consistent with the two goods being in separate markets, the alternative is consistent with the

Table 1. Simulation results: firm-specific cost shocks only and $\gamma_{12} = 0.1$

	$T = 26$	$T = 52$	$T = 104$	$T = 260$	$T = 520$	$T = 2600$
<i>Means</i>						
ρ_{12}	0.514	0.521	0.532	0.568	0.606	0.732
ρ_{13}	-0.003	-0.001	0.001	0	0.001	0
ρ_{23}	-0.001	0.003	0.003	0	0	0
<i>Rejection rates (nominal size 0.05)</i>						
GC_{21}	0.067	0.058	0.057	0.061	0.064	0.087
GC_{31}	0.065	0.063	0.053	0.049	0.056	0.057
GC_{12}	0.072	0.059	0.053	0.058	0.062	0.089
GC_{32}	0.074	0.058	0.056	0.050	0.053	0.058
GC_{13}	0.068	0.062	0.056	0.054	0.051	0.057
GC_{23}	0.064	0.057	0.055	0.057	0.055	0.060
ADF_{12}	0.064	0.064	0.064	0.070	0.087	0.164
ADF_{13}	0.068	0.063	0.056	0.062	0.066	0.089
ADF_{23}	0.067	0.063	0.059	0.064	0.065	0.092
EG_{12}	0.060	0.057	0.064	0.084	0.117	0.253
EG_{13}	0.055	0.051	0.055	0.063	0.072	0.117
EG_{23}	0.054	0.055	0.057	0.062	0.076	0.119
TR_{12}	0.362	0.279	0.219	0.208	0.222	0.337
TR_{13}	0.372	0.262	0.224	0.203	0.212	0.302
TR_{23}	0.367	0.265	0.215	0.203	0.212	0.303

These results are based on 10,000 replications of the simulation exercise described in the text. The synthetic data are constructed such that the marginal cost process for each firm contains a unit root and the first difference of each of the price series is serially uncorrelated. The standard deviations of the cost shocks are set such that the standard deviation of the first difference of the log of the synthetic price data for firms 1 and 2 approximately matches those of Classico and Newman in the spaghetti sauce data of Capps et al. (2003). This means that the calibrated value of σ_v differs with γ_{12} . Here, when $\gamma_{12} = 0.1$ we set $\sigma_v = 0.09$. Our calibrations are based on weekly data and so our values of T correspond to samples of 6 months and 1, 2, 5, 10, and 50 years. ρ_{ij} is the correlation coefficient between the first differences of the log of prices of goods i and j . The figure reported is the mean correlation coefficient over the 10,000 replications rounded to three decimal places. Mean correlations that are less than 0.0005 in absolute value appear as zeros. GC_{ij} is the Granger causality test statistic for the null hypothesis that Δp_i does not Granger cause Δp_j based on the estimation of an unrestricted VAR for Δp_i and Δp_j . ADF_{ij} is the augmented Dickey–Fuller test for a unit root in the log of the price of good i minus the log of the price of good j . Finally, EG_{ij} and TR_{ij} are the Engle–Granger and Trace statistics for cointegration between the logs of the prices of goods i and j .

goods being substitutes and in the same market. What we see from Table 1 is that rejection rates for each null hypothesis differ very little across pairs of goods. That is, the rejection rates involving good 3 (which is not in the relevant market) tend to be just as high as that for goods 1 and 2, which are in the same relevant market.

Table 1 reveals that, assuming the data-generating process of the previous section, the Granger causality tests are unable to identify which goods are in the same market with rejection rates being similar regardless of whether the

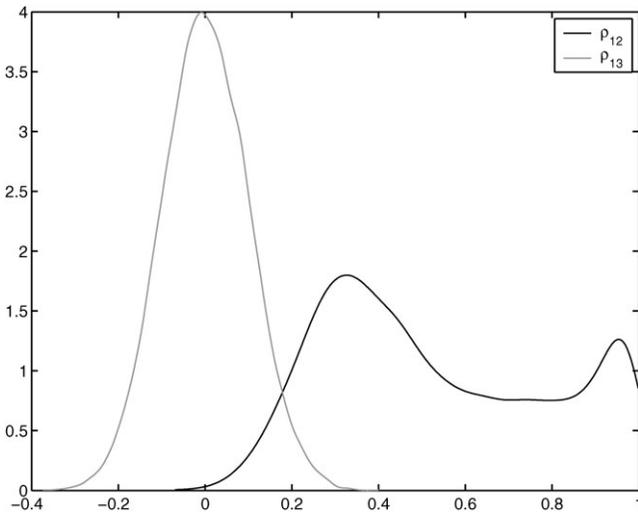


Figure 1. Distributions of ρ_{12} and ρ_{13} : $\gamma_{12} = 0.1$ and $T = 104$.

underlying null hypothesis is true or false.²³ To be fair, given our data-generating process, this poor performance is not surprising. The use of Granger causality is motivated by the fact that price adjustment may take place with a delay and therefore, although prices may not be correlated contemporaneously, there may be correlation between the current price of one good and lagged prices of another good in the same market. This is not the case in our data-generating process in which firm i sets in price in time t using current information on the marginal costs of other firms and is therefore able to respond to the cost shocks of other firms immediately. We explore this issue further later in this section by building sluggish price adjustment into our data-generating process.

The next three rows of Table 1, show rejection rates for the null hypotheses that the relative prices $p_{2,t} - p_{1,t}$, $p_{3,t} - p_{1,t}$, and $p_{3,t} - p_{2,t}$ contain a unit root against the alternatives that they are stationary. The test employed here is the standard augmented Dickey–Fuller test.²⁴ These figures show a very similar story to the Granger causality tests, with the rejection rates showing a slight tendency to over-reject the true null hypothesis and very little difference between rejection rates across relative prices. Here the rejection rates are between 5 and 10 percent for $p_{3,t} - p_{1,t}$ and $p_{3,t} - p_{2,t}$ and typically less than a percentage point higher for $p_{2,t} - p_{1,t}$. It is only when we raise the sample size to $T = 2600$ that we see any significant difference between the

²³ Overall there is a slight tendency to over-reject the null when it is true with type 1 error rates being in the range 0.05–0.09, when nominal size is 0.05.

²⁴ Results for the DF-GLS of Elliot et al (1996) and KPSS test of Kwiatkowski (1992) are very similar and are reported in the unpublished appendix.

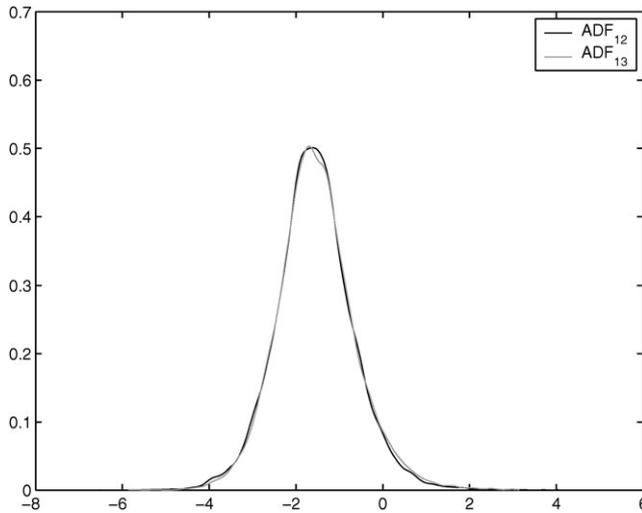


Figure 2. Distributions of DF_{12} and DF_{13} ; $\gamma_{12} = 0.1$ and $T = 104$.

rejection rates. Even then the false null hypothesis (that the relative price of goods 1 and 2 is nonstationary) is rejected in only 16 percent of our samples. Figure 2 shows the distributions for the ADF statistics for the null hypotheses that $p_{2,t} - p_{1,t}$ and $p_{3,t} - p_{1,t}$ contain unit roots for the sample size $T = 104$. Although the null hypothesis is true for $p_{3,t} - p_{1,t}$ and false for $p_{2,t} - p_{1,t}$, these distributions are almost indistinguishable from one another. The implication is that, under this data-generating process, this test provides little economically meaningful information to the antitrust practitioner.

The last six rows of Table 1 show that the cointegration tests do slightly better than the Granger causality and unit root tests in samples of $T \geq 260$. However, they still yield very little economically useful information even in these large samples. We consider two cointegration tests, the Engle and Granger (1987) two-step and Johansen's (1991) trace statistic.²⁵ The rejection rates for the null of no cointegration between $p_{1,t}$ and $p_{2,t}$ are higher than those for the other two price pairs. However, as in the previous cases the differences do not inspire confidence in the ability of these tests to provide reliable inferences. For example when $T = 260$ the rejection rate for the Engle and Granger test using $p_{1,t}$ and $p_{3,t}$ is 0.062; for $p_{1,t}$ and $p_{2,t}$ the figure is only slightly higher at 0.088. Figure 3 shows the distributions of the Engle and Granger test statistics for the null hypothesis that $p_{1,t}$ and $p_{2,t}$ are not cointegrated and the null hypothesis that $p_{1,t}$ and $p_{3,t}$ are not cointegrated for the sample size $T = 104$. Again these are almost identical and

²⁵ We obtain very similar results when using Johansen's maximum eigenvalue statistic and so omit these in the interest of space. They are reported in the unpublished appendix.

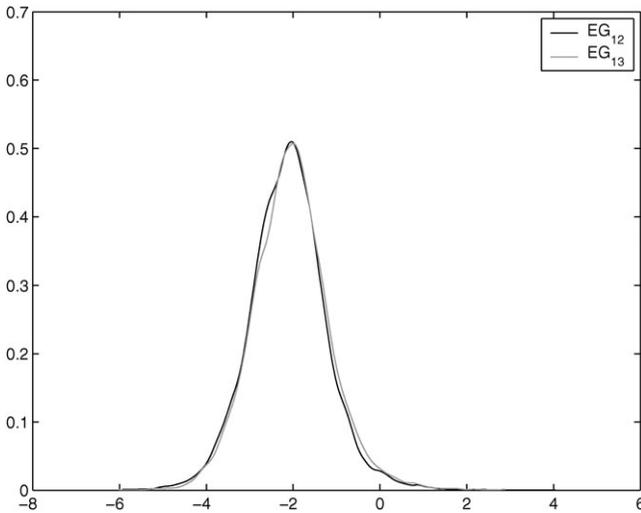


Figure 3. Distributions of EG_{12} and EG_{13} : $\gamma_{12} = 0.1$ and $T = 104$.

indicate that these tests are not capable of revealing useful information about the underlying data-generating process.

The rejection rates for the Johansen trace statistics imply a level of performance that is even worse than that of the Engle–Granger test. That is, we see a tendency to over-reject the null hypothesis when it is true and only slightly higher rejection rates when the null hypothesis is false, even for the case where $T = 2600$. Across sample sizes and combinations of prices we see higher rejection rates for the trace statistics than the Engle–Granger statistic and as with the Engle–Granger test, the rejection rates increase with T . However, as illustrated in Figure 4 for the case where $T = 104$, our results suggest that this test provides very little useful information to policymakers.

2. Closer Substitutes

One might argue that the inability of these tests to distinguish between the two cases is driven by the fact that the degree of substitutability between goods 1 and 2 implied by $\gamma_{12} = 0.1$ is relatively low. To explore this issue we raise the parameter γ_{12} to 0.25. This has the effect of increasing the own-price elasticities of goods 1 and 2 to -4.1 and the cross-price elasticity between goods 1 and 2 to 2.56. Table 2 shows that this has little effect on the empirical performance of the various tests of market delineation. While there is an increase in the mean of ρ_{12} , there is little change in the rejection rates of the Granger causality, ADF, Engle–Granger, and Trace tests. We also experiment with a value of $\gamma_{12} = 0.3999$, which implies that goods one and two are almost perfect substitutes. Even in this case there is little improvement in the ability of these tests to distinguish between the various

Table 2. Simulation results: firm-specific cost shocks only and $\gamma_{12} = 0.25$

	$T = 26$	$T = 52$	$T = 104$	$T = 260$	$T = 520$	$T = 2600$
<i>Means</i>						
ρ_{12}	0.742	0.751	0.760	0.776	0.800	0.873
ρ_{13}	0.002	-0.002	0.002	0.001	0	0
ρ_{23}	0.002	-0.001	0.001	0	-0.001	0
<i>Rejection rates (nominal size 0.05)</i>						
GC_{21}	0.071	0.058	0.055	0.056	0.049	0.060
GC_{31}	0.069	0.060	0.057	0.056	0.056	0.054
GC_{12}	0.071	0.059	0.053	0.052	0.053	0.064
GC_{32}	0.068	0.059	0.057	0.054	0.054	0.054
GC_{13}	0.072	0.061	0.058	0.050	0.052	0.052
GC_{23}	0.075	0.058	0.050	0.047	0.048	0.050
ADF_{12}	0.067	0.055	0.062	0.069	0.078	0.139
ADF_{13}	0.076	0.060	0.059	0.056	0.056	0.066
ADF_{23}	0.068	0.055	0.057	0.052	0.055	0.067
EG_{12}	0.059	0.049	0.058	0.073	0.099	0.205
EG_{13}	0.056	0.051	0.055	0.050	0.058	0.082
EG_{23}	0.057	0.050	0.055	0.053	0.060	0.086
TR_{12}	0.359	0.254	0.203	0.173	0.171	0.228
TR_{13}	0.355	0.265	0.206	0.183	0.179	0.233
TR_{23}	0.356	0.264	0.206	0.186	0.181	0.238

See notes to Table 1. In this case with $\gamma_{12} = 0.25$ we set $\sigma_v = 0.07$.

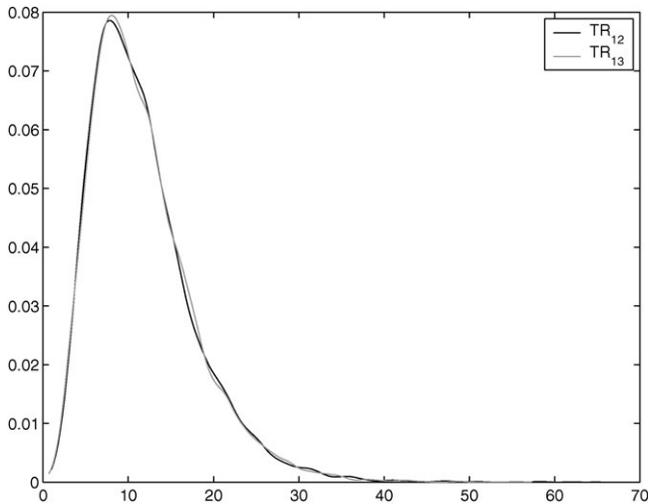


Figure 4. Distributions of TR_{12} and TR_{13} ; $\gamma_{12} = 0.1$ and $T = 104$.

price pairs.²⁶ Therefore, it seems that, regardless of our choice of γ_{12} , these tests seem incapable of distinguishing between two goods that are in the same market and two goods that are not. This suggests that the results of this paper may be of interest to those studying market definition more generally and not just antitrust practitioners.

3. Firm-Specific and Common Cost Shocks

The most common criticism of the price-based approach to market definition is that the presence of common shocks can lead to an incorrect conclusion that two goods are in the same market. In Table 3, we explore this possibility by allowing the marginal cost process of each firm to be subject to a common shock and a firm-specific shock.²⁷ In this case with $\gamma_{12} = 0.10$, the introduction of common shocks raises the mean correlations between goods 1 and 3 and goods 2 and 3 from approximately zero to numbers in the range 0.40 to 0.50. The performance of the Granger causality, unit root, and cointegration tests is essentially unaffected by the presence of common shocks. That is, it remains very poor.

Although the mean values of ρ_{13} and ρ_{23} are still below the mean values of ρ_{12} , which are now in the range 0.70–0.80, they do reflect the fact that the presence of common shocks makes the interpretation of correlation coefficients as tests of market definition problematic. This point is illustrated in Figure 5, which shows two distributions of correlation coefficients for the case where $\gamma_{12} = 0.1$ and $T = 104$. The first is the distribution for goods 1 and 2, which are imperfect substitutes for the case where cost shocks are completely firm-specific.²⁸ The second is the distribution of the price correlation for goods 1 and 3 (which have a cross-price elasticity of zero) when the data generating process is such that the cost shock has a common component. Clearly both of these distributions have a substantial amount of mass in the range of 0.35–0.65, indicating that there is a reasonable chance that a correlation in this range could come from either data-generating process. Therefore, unless the antitrust practitioner has detailed knowledge of the cost structure of the two firms under investigation it is not clear how he or she should interpret a correlation in this range.

4. Sluggish Price Adjustment

The data-generating process that we have used so far in this paper assumes that firm 1 is able to respond to the price set by firm 2 immediately, and vice-versa. In this section we relax that assumption. This is potentially important for two reasons. First, Granger causality tests are employed in conjunction with price correlations when there is the possibility that price

²⁶ The results for these experiments are reported in the unpublished appendix.

²⁷ As discussed earlier, we assume that the standard deviations of these shocks are equal.

²⁸ This is the same distribution that appears in Figure 1.

Table 3. Simulation results: firm-specific and common cost shocks, $\gamma_{12} = 0.1$

	$T = 26$	$T = 52$	$T = 104$	$T = 260$	$T = 520$	$T = 2600$
<i>Means</i>						
ρ_{12}	0.730	0.730	0.736	0.741	0.750	0.790
ρ_{13}	0.521	0.521	0.514	0.500	0.479	0.413
ρ_{23}	0.522	0.520	0.515	0.498	0.479	0.412
<i>Rejection rates (nominal size 0.05)</i>						
GC_{21}	0.075	0.064	0.067	0.082	0.094	0.140
GC_{31}	0.073	0.064	0.068	0.078	0.097	0.122
GC_{12}	0.071	0.063	0.067	0.083	0.093	0.136
GC_{32}	0.070	0.065	0.066	0.078	0.094	0.122
GC_{13}	0.071	0.063	0.066	0.077	0.094	0.122
GC_{23}	0.072	0.062	0.065	0.077	0.093	0.122
ADF_{12}	0.067	0.063	0.065	0.073	0.086	0.172
ADF_{13}	0.070	0.062	0.066	0.073	0.088	0.139
ADF_{23}	0.067	0.064	0.066	0.077	0.079	0.141
EG_{12}	0.063	0.060	0.062	0.080	0.112	0.254
EG_{13}	0.055	0.054	0.059	0.069	0.093	0.181
EG_{23}	0.057	0.055	0.062	0.080	0.089	0.178
TR_{12}	0.372	0.270	0.218	0.210	0.227	0.373
TR_{13}	0.359	0.264	0.219	0.210	0.235	0.366
TR_{23}	0.361	0.276	0.231	0.218	0.236	0.367

See notes to Table 1. In this case with $\gamma_{12} = 0.1$, we set $\sigma_v = \sigma_V = 0.06$.

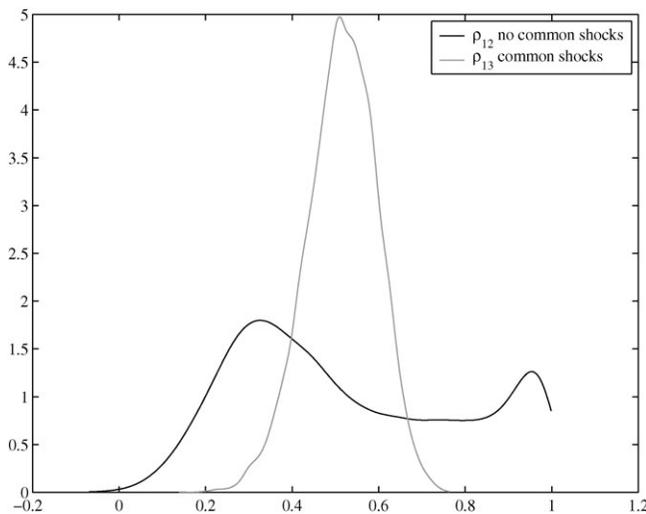


Figure 5. Distributions of ρ_{12} with no common cost component and ρ_{13} with a common cost component: $\gamma_{12} = 0.1$ and $T = 104$.

adjustment does not occur instantaneously. They test for correlation between one price and lags of other prices. In our data-generating process of the previous section, there is no such correlation as firm 1 responds to firm 2's period t cost shock in period t . Therefore, we would not expect a rejection of the null hypothesis that the coefficients on lagged values of $\Delta p_{2,t}$ in a regression for $\Delta p_{1,t}$ are equal to zero. Second, the unit root and cointegration tests of market delineation ask whether shocks to the relative price are permanent. In the model that we currently use to generate data adjustment to a new equilibrium following a marginal cost shock occurs instantly and so these shocks do not have even transitory effects on the relative price of substitutes. Therefore, it would be interesting to know whether these tests also do a poor job of market delineation when shocks have transitory effects on the relative price of goods in the same antitrust market.

It is reasonably straightforward to modify the model of the previous section to allow for such an effect. We now assume that at the beginning of each period each firm sets its price without observing the marginal cost shock of the other firms. This price is then fixed until the beginning of the following period when the firm then sets a new price. Therefore, when firms set their prices they now do so using expected marginal costs of the other firms and the vector of prices at time t is now given by:

$$\mathbf{P}_t = \begin{bmatrix} (2\alpha_1 \gamma_{11} \gamma_{22} - \alpha_2 \gamma_{11} \gamma_{12} - \alpha_1 \gamma_{12}^2 + 2\gamma_{11} \gamma_{22} M_{1,t}^e \\ + \gamma_{11} \gamma_{12} M_{2,t}^e) / (4\gamma_{11} \gamma_{22} - \gamma_{12}^2) \\ (2\alpha_2 \gamma_{11} \gamma_{22} - \alpha_1 \gamma_{22} \gamma_{12} - \alpha_2 \gamma_{12}^2 + 2\gamma_{11} \gamma_{22} M_{2,t} \\ + \gamma_{22} \gamma_{12} M_{1,t}^e) / (4\gamma_{11} \gamma_{22} - \gamma_{12}^2) \\ (\alpha_3 + M_{3,t}) / 2 \end{bmatrix} \quad (20)$$

where $M_{i,t}^e$ is the expected marginal cost of firm i formed by the other firms. Note, at the beginning of period t firms can infer past realizations of other firms' marginal cost processes from the past prices that they set. Therefore, if we also assume that firms know the structures of the processes for the other firms' marginal costs (in this case a random walk), then their rational expectation of the (log) marginal costs of firm i is given by:

$$m_{i,t}^e = m_{i,t-1}. \quad (21)$$

Now, a shock to the marginal cost processes of firm i at time t still has an effect on the price of firm i at time t . However, it does not affect the price of other firms in the same market at time t . Instead other firms are able to infer the realization of this shock at the end of period t and use that information when setting their price at time $t + 1$. Therefore, the adjustment of the relative price of two goods in the same antitrust market takes place with a delay.

Table 4 presents results when data is generated using this modified version of the differentiated product model and for the case where $\gamma_{12} = 0.1$.

Table 4. Simulation results—imperfect information regarding marginal costs, firm-specific cost shocks only and $\gamma_{12} = 0.1$

	$T = 26$	$T = 52$	$T = 104$	$T = 260$	$T = 520$	$T = 2600$
<i>Means</i>						
ρ_{12}	-0.021	-0.010	-0.005	-0.002	-0.002	0
ρ_{13}	0	-0.002	0.002	0.001	0	0
ρ_{23}	0	0.002	0.002	0.001	0	0
<i>Rejection rates (nominal size 0.05)</i>						
GC_{21}	0.326	0.389	0.456	0.563	0.624	0.735
GC_{31}	0.071	0.061	0.055	0.052	0.054	0.060
GC_{12}	0.318	0.385	0.460	0.553	0.630	0.734
GC_{32}	0.073	0.057	0.055	0.052	0.057	0.061
GC_{13}	0.069	0.059	0.053	0.051	0.053	0.058
GC_{23}	0.070	0.057	0.056	0.052	0.053	0.059
ADF_{12}	0.131	0.137	0.159	0.187	0.234	0.579
ADF_{13}	0.060	0.058	0.057	0.065	0.066	0.090
ADF_{23}	0.066	0.060	0.063	0.062	0.063	0.090
EG_{12}	0.223	0.281	0.325	0.401	0.475	0.736
EG_{13}	0.057	0.056	0.055	0.065	0.072	0.122
EG_{23}	0.059	0.051	0.055	0.060	0.074	0.118
TR_{12}	0.557	0.526	0.523	0.572	0.631	0.860
TR_{13}	0.355	0.254	0.221	0.205	0.215	0.306
TR_{23}	0.360	0.258	0.221	0.201	0.219	0.301

See notes to Table 1.

Not surprisingly, the mean contemporaneous correlations for goods 1 and 2 are now close to zero, reflecting the fact that firms do not respond contemporaneously to each others' cost shocks. On the other hand, we now see a difference in the rejection rates for the Granger causality tests across price pairs. For example, when $T = 104$ the false null hypothesis that the change in the log of the price of good 2 does not Granger cause the change in the log of the price of good 1 is rejected in 45.6 percent of samples; the true null that the change in the log of the price of good 3 does not Granger cause the change in the log of the price of good one is rejected in only 5.5 percent of our samples. However, although these results are more encouraging than others in this paper, they still indicate that this is at best a test of modest power. Even when the sample size is raised to $T = 2600$, the false null is rejected in only about 75 percent of samples.

We also see some improvement in the performance of the unit root and cointegration tests. When $T = 104$ the ADF test rejects the false null hypothesis that shocks to $p_{1,t} - p_{2,t}$ are permanent in about 16 percent of samples, compared with the figure of 6 percent in Table 1. However, as Figure 6 demonstrates, this still implies a test of very modest power. For the cointegration tests the results are slightly better, but again do not inspire

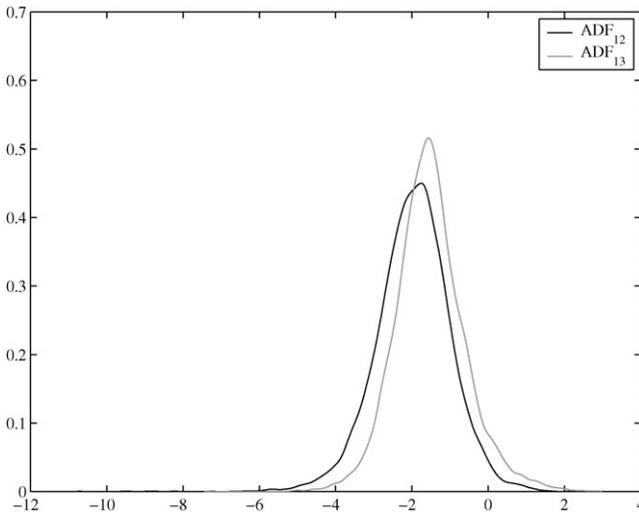


Figure 6. Distributions of ADF_{12} and ADF_{13} from sluggish adjustment model: $\gamma_{12} = 0.1$ and $T = 104$.

confidence given the sample sizes currently available to antitrust practitioners. For example, when $T = 104$ the rejection rate for goods 1 and 2 for the Engle-Granger test is still only 33 percent, implying a test of limited power. Although the performance of these tests does improve with sample size, power is still well below 95 percent even when we raise T to 2600. For the ADF unit root test the rejection rate for goods 1 and 2 when $T = 2600$ is still only 58 percent, for the Engle-Granger test it is 74 percent.²⁹ We also generate data from this modified version of the product differentiation model when goods 1 and 2 are closer substitutes. Not surprisingly, we find that the performance of the Granger causality, ADF, and EG-ADF tests improves further as goods 1 and 2 become closer substitutes. However, even in these cases power does not approach 95 percent until the sample size reaches $T = 2600$. In samples sizes similar to those available to antitrust practitioners these remain tests of modest power.³⁰

V. CONCLUSIONS

Price-based tests of market delineation remain popular for preliminary work in antitrust cases despite existing criticisms. In this paper we explore the extent to which these tests can provide antitrust practitioners with useful

²⁹ Even then, size-adjusted power will be below these figures because, as the rejection rates involving good 3 demonstrate, these tests tend to over-reject the null when it is true in these samples. This is particularly true for the Trace statistic where the type 1 error rate exceeds 20 percent.

³⁰ Again, these results appear in the unpublished appendix.

information. We generate synthetic data from a three-good product differentiation model in which two goods are in the same market but a third is not. We then apply a number of price-based tests using this synthetic data. In general, we find that even in the absence of common shocks only simple price correlations or (to a lesser extent) Granger causality tests are capable of generating correct inference regarding which goods are in the same antitrust market. When we generate samples similar in size to those currently available to antitrust practitioners we find that the distributions of unit root and cointegration test statistics are essentially identical regardless of whether or not the two goods being studied are in the same market. Therefore, our results suggest that the application of these tests may not be a fruitful avenue of research in antitrust analysis.

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EXHIBIT D

PROPHYLACTIC MERGER POLICY

Herbert Hovenkamp*

I. Introduction

An important purpose of the antitrust merger law is to arrest certain practices in their “incipiency,” by preventing business firm mergers that are likely to facilitate them. Many decisions involving both mergers and other practices had recognized this idea as an important purpose of the Clayton Act as early as the 1920s.¹ The Supreme Court doubled down on the incipency idea in its *Brown Shoe* merger decision, where it expressed concern about a “rising tide of economic concentration” and attributed to Congress a desire to halt this trend “at its outset and before it gathered momentum.”² Speaking of the legislative history of the 1950 Celler-Kefauver amendments to the merger statute,³ the Court attributed to Congress a “provision of authority for arresting mergers at a time when the trend to a lessening of competition in a line of commerce was still in its incipency,” before they would “justify a Sherman Act proceeding.”⁴ The importance of *Brown Shoe* was not its

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¹*See, e.g.,* United States v. E.I. DuPont de Nemours, & Co., 353 U.S. 586, 588 (1957) (merger case: “...it is the purpose of the Clayton Act to nip monopoly in the bud.”). Even earlier the Supreme Court made similar observations about the Federal Trade Commission Act. *See* FTC v. Motion Picture Advert. Serv. Co., 344 U.S. 392, 394-95 (1953) (exclusive advertising contracts: “It is also clear that the Federal Trade Commission Act was designed to supplement and bolster the Sherman Act and the Clayton Act – to stop in their incipency acts and practices which, when full blown, would violate those Acts, as well as to condemn as ‘unfair methods of competition’ existing violations of them.”); *Fashion Originators’ Guild v. FTC*, 312 U.S. 457, 466 (1941) (ascribing incipency purpose to FTC Act in boycott case); *FTC v. Raladam Co.*, 283 U.S. 643, 647-648 (1931) (consumer protection decision attributing incipency test to Clayton Act). *See also* *Hamilton Watch Co. v. Benrus Watch Co.*, 206 F.2d 738 (2d Cir. 1953) (noting incipency rationale in merger case). *Cf.* *Corn Prods. Refining Co. v. FTC*, 324 U.S. 726, 738 (1945) (ascribing incipency rationale to price discrimination provision of §2 of the Clayton Act, as amended in 1936 by the Robinon-Patman Act); *Standard Fashion Co. v. Magrane-Houston Co.*, 258 U.S. 346, 356 (1922) (applying Clayton Act incipency to exclusive dealing under §3 of the Clayton Act).

²*Brown Shoe Co. v. United States*, 370 U.S. 294, 317-318 (1962).

³Celler-Kefauver Act, Pub. L. No. 81-899, 64 Stat. 1125 (1950) (codified as amended at 15 U.S.C. § 18 (2012)).

⁴*See* S. REP. NO. 1775, 81st Cong., 2d Sess. 4-5 (1950) (“The intent here ... is

recognition of an incipency rationale as such, which was already well established, but rather its reading of the legislative history of the 1950s amendments as giving Congress' imprimatur on a particular theory linking merger policy to market concentration.

Today *Brown Shoe's* particular application of an incipency test seems excessive and ill conceived. The merger in question increased the defendant's market share from 5.6% to 7.2%,⁵ in an unconcentrated market and would not receive so much as a second glance from the antitrust enforcement Agencies today. As one commentator later observed, this incipency test permitted the government "to halt mergers well before any adverse economic effects could be discerned through econometrics or other empirical techniques."⁶

Most importantly, the Court did not explain why an incipency test would be necessary to address the particular problem it identified. In the future, merger law could always be brought to bear if the relevant numbers became larger, and market share numbers are readily available. That is, once structural thresholds for identifying problematic mergers are identified there is no need to condemn mergers that fall below that threshold. There is no principle of either law or fact that precludes the courts from enjoining a merger once the threshold has been exceeded.⁷

This does not mean that incipency tests are unimportant. They have a proper place, but it is not the one that the Supreme Court identified in *Brown Shoe*.⁸ The appropriate use of incipency tests is to prevent certain bad outcomes early when antitrust rules make it difficult or impossible to prevent them later.

to cope with monopolistic tendencies in their incipency and well before they have attained such effects as would justify a Sherman Act proceeding.")

⁵ *Brown Shoe*, 370 U.S. at 345.

⁶ Stephen M. Axinn, *In search of Congruence Between Legislative Purpose and Administrative Policy*, 2003 COLUM. BUS. L. REV. 431, 436. An analogous criticism can be applied to some of the pre-*Brown* decisions involving practices other than mergers. See, e.g., Justice Frankfurter's dissent in *Motion Picture Advertising*, *supra*, 344 U.S. at 398-399, complaining that the exclusive contracts in question ran for one year and covered only about 6% of the country's theaters; as a result, they caused no competitive harm.

⁷Writing in response to the Celler-Kefauver Act, but prior to *Brown Shoe*, see Chicago School Professor Ward S. Bowman, Jr., *Incipency, Mergers and the Size Question: Section 7 of the Clayton Act*, 1 ANTITRUST BULL. 533 (1955) (objecting that the incipency test threatened to be overdeterrent).

⁸On the proper way to evaluate market structure in merger cases, see Herbert Hovenkamp and Carl Shapiro, *Horizontal Mergers, Market Structure, and Burdens of Proof*, 127 YALE L.J. 1996 (2018).

The language of the merger statute, §7 of the Clayton Act, is very broad. It prevents mergers whose effect “may be substantially to lessen competition, or to tend to create a monopoly.”⁹ The thing that triggers it is an acquisition of either equity shares or productive assets.¹⁰ Section 7 has no agreement requirement, such as limits enforcement of §1 of the Sherman Act.¹¹ Nor is it limited by the severe constraints that the law has quite properly placed on the use of antitrust law to limit single firm conduct,¹² which includes conduct that seeks to enforce the patent laws.¹³ Beyond that, §7 of the Clayton Act shares the general antitrust goal of identifying and preventing business mergers that enable the post-merger firm to reduce market wide output and impose higher prices on consumers. Its effects test is indifferent to the mechanisms by which a merger lessens competition, provided that the anticompetitive effect can be attributed to the merger.¹⁴

Incipiency tests for mergers are most valuable in cases where a merger is likely to lead to conduct or behavior that is both anticompetitive but also is difficult or impossible for antitrust law to reach once the merger has occurred. This can happen in a variety of situations, some of which have been recognized while others have not.

Antitrust merger law does not have a “regulatory” mandate, and this makes incipiency tests particularly important. Nothing in the statute or its legislative history suggests that Congress believed the federal courts should use ongoing supervision of post-merger firms in order to limit anticompetitive conduct that might occur later on. Some merger consent decrees have lost sight of this by seeking to control conduct that might occur long after the merger was consummated.¹⁵ Consent decrees are contracts and can specify whatever the parties want, provided the parties’ agreements are not independently unlawful. Nevertheless, such decrees can blur the important line between antitrust and regulation, sometimes thrusting general jurisdiction Article III courts into roles for which they are not well suited.

⁹ 15 U.S.C. §18.

¹⁰5 PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW ¶1201 (4th ed. 2016)

¹¹15 U.S.C. §1 (2012) (reaching “contracts, combinations, and conspiracies...”). See 6 & 7 PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW, Ch. 14 (4th ed. 2017)

¹² 15 U.S.C. §2 (2012). See 3, 3A, & 3B, *Id.*, Ch. 7 (4th ed. 2015).

¹³ *Id.*, Ch. 7B.

¹⁴ “...where ... the effect of such acquisition may be substantially to lessen competition, or to tend to create a monopoly.” 15 U.S.C. §18 (2012).

¹⁵ E.g., *United States v. Comcast Corp.*, Civil Case No. 11-106 (RJL) (D.D.C. Sep. 1, 2011) (consent decree).

The language of §7 authorizes courts to *condemn* mergers whose effect may be substantially to limit competition. It does not authorize them to supervise the behavior of post-merger firms as if they were public utilities.

Today most mergers are challenged before they occur.¹⁶ As a result, the feared post-merger conduct has not occurred either and courts are limited to evidence of predicted rather than actual effects. This fact makes it important to place some limits on merger law's prophylactic reach. First, the language of §7 requires causation. It prohibits mergers "where the effect may be" substantially to lessen competition. This requires a showing that the merger is what is likely to facilitate that feared anticompetitive conduct. Second, we need to be satisfied that this conduct, if it should occur, will be both anticompetitive and difficult to reach through direct application of the antitrust laws. Third, the merger must raise a significant risk that the conduct will occur. Finally, as with all merger cases, there must not be offsetting gains that serve to justify the merger notwithstanding these threats to competition.¹⁷

The range of behaviors for which merger law's prophylactic reach can be relevant includes the following:

1. A horizontal merger might facilitate coordinated interaction, which would be either difficult to detect as collusion, or difficult to challenge given the "agreement" requirement contained in §1 of the Sherman Act.¹⁸
2. A horizontal merger might create either a monopoly or else enable a post-merger firm to increase its price, or engage unilaterally in some other output limiting practice that is unreachable under §2 of the Sherman Act, given antitrust's broad tolerance for unilateral conduct.¹⁹
3. A vertical merger might facilitate a post-merger unilateral price increase, price discrimination, refusal to deal, or other exclusion that would be very difficult to reach when the conduct in question is that of a single firm.²⁰

¹⁶ See 15 U.S.C. §18a (2012) (Hart-Scott-Rodino premerger notification).

¹⁷ On this point, see Herbert Hovenkamp, *Appraising Merger Efficiencies*, 24 GEO. MASON L. REV. 703 (2017).

¹⁸ See discussion *infra*, text at notes 32-39.

¹⁹ See discussion *infra*, text at notes 40-52.

²⁰ See discussion *infra*, text at notes 53-84.

4. An IP acquisition, particularly of a patent developed by an outside inventor, might result in exclusionary enforcement that would be impossible for antitrust to reach unless the patent is invalid or unenforceable.²¹
5. Acquisitions of small but highly innovative startups might enable a large firm to continue its domination of a market in the face of entry threats, but in ways that are not reachable as unilateral conduct.²²

This paper discusses the legitimate and illegitimate rationales for incipency tests, as well as important limitations. First it looks at some improper uses of such tests. Then it discusses appropriate uses, beginning with those that are relatively well recognized in the case law and literature and moving on to those that are largely unrecognized.

II. Improper Uses of Incipency Tests

Merger incipency tests are not justified in two situations. One is when we are unable to predict with sufficient confidence that a certain anticompetitive outcome will occur and that it can be attributed to the merger. The other is when the feared post-merger anticompetitive conduct is readily remedied by the antitrust laws if it should occur. In both these cases, concerns about possible anticompetitive outcomes down the road must give way to the promise of merger efficiencies.

Most mergers are lawful because they are thought to generate cost savings from economies of scale, integration, elimination of market transactions, or some other efficiency.²³ To be sure, once a prima facie case against a merger is established, efficiency defenses are very difficult to prove. But the assumption that many mergers produce efficiencies is built into our prima facie case to begin with.²⁴ As a result, we do not want to condemn a merger based on mere speculation that it might lead to some anticompetitive outcome. Nor do we want to condemn a merger when some practice, which may or may not occur later, is readily remedied at that time.

²¹See discussion *infra*, text at notes 85-107; and *Walker Process Equipment, Inc. v. Food Mach. & Chem. Corp.*, 382 U.S. 172 (1965).

²²See discussion *infra*, text at notes 108-117.

²³See IVA PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW*, Ch. 9E (4th ed. 2016); Hovenkamp, *Appraising Merger Efficiencies*, *supra* note 17.

²⁴*Id.*, 24 *GMU L. Rev.* at 708-711.

Post-merger predatory pricing is a good example of a practice that does not become likely merely because a merger may make it structurally conceivable. Only a dominant firm can succeed in monopolistic predatory pricing as condemned by the Sherman Act.²⁵ But that hardly means that every firm with a minimum sufficient market share is likely to engage in predatory pricing. Predatory pricing is a risky strategy even for a dominant firm and very likely is relatively uncommon.²⁶ As a result, a merger should not be condemned merely because it creates a firm with a sufficiently large market share to make predatory pricing factually plausible.²⁷ The same thing is true about a firm's acquisition of a patent portfolio that is likely to contain some weak patents. Ownership of an invalid or unenforceable patent is a prerequisite to *Walker Process* liability for filing an infringement action based on a worthless patent.²⁸ Nonetheless, the mere acquisition of a portfolio that contains such patents hardly suggests that the acquiring firm intends to do just that.

The other set of circumstances when prophylactic rules are

²⁵ *American Academic Suppliers, Inc. v. Beckley-Cardy, Inc.*, 922 F.2d 1317 (7th Cir. 1991) (Posner, j.) (only monopolist can engage in predatory pricing); 3 PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶¶725-727 (4th ed. 2015) (structural requirements of predation). Non-monopolistic predatory pricing intended to shore up a faltering oligopoly could be condemned under the Robinson-Patman Act, were it not for the severe constraints imposed by *Brooke Group v. Brown & Williamson Tobacco Corp.*, 509 U.S. 209, 226 (1993). See 3 *ANTITRUST LAW, Id.*, ¶726.

²⁶ One attempt to test for its frequency is Kenneth G. Elzinga & David E. Mills, *Testing for Predation: Is Recoupment Feasible?*, 34 *ANTITRUST BULL.* 869, 889-93 (1989) (finding predator pricing to be relatively rare).

²⁷ *Cf. Cargill, Inc. v. Monfort of Colo. Inc.*, 479 U.S. 104, 119 (1986) (refusing to condemn a merger on theory that post-merger firm would engage in aggressive pricing).

²⁸ *Walker Process Equipment, Inc. v. Food Mach. & Chem. Corp.*, 382 U.S. 172 (1965) (finding basis for antitrust liability in patentee's suit on a patent known to be invalid). Antitrust liability can also attach when the patent is valid but the infringement plaintiff knows that the defendant is not infringing. See, e.g., *United States v. Besser Mfg. Co.*, 96 F. Supp. 304, 312 (E.D. Mich. 1951), *aff'd*, 343 U.S. 444 (1952) (infringement plaintiff did not have good reason to believe that infringement defendant's technology infringed); *Moore USA, Inc. v. Standard Register Co.*, 139 F. Supp. 2d 348 (W.D.N.Y. 2001) (refusing to dismiss Sherman §2 counterclaim allegation that patentee filed infringement claim while knowing that counterclaimant's product did not infringe); *Ecix Corp. v. Exabyte Corp.*, 95 F. Supp. 2d 1155 (D. Colo. 2000) (for purposes of filing antitrust claim, infringement defendant was entitled to discovery of factual basis for infringement allegations).

unnecessary and counterproductive is when the feared post-merger practice is readily remedied with a more direct antitrust rule if it should occur. A good example here is the use of §7 to condemn mergers on the theory that they might condemn anticompetitive tying or reciprocity.²⁹ Most of the case law suggests that unlawful tying requires a minimum market share in the range of 30% - 40%.³⁰ So a horizontal merger might create the requisite minimum market share to make unlawful tying possible.³¹ Alternatively, a nonhorizontal merger, such as a union of complements, might create an opportunity for tying two products together.³² Anticompetitive tying and reciprocity are readily detected, however. They cannot be done secretly, because the person upon whom these restraints are imposed, and a likely plaintiff, must be aware of it. Further, very few people would argue that the existing rules for addressing these practices are underdeterrent. In addition, many instances of tying and reciprocity are competitively benign. As a result, condemning a merger on the theory that it might later lead to tying or reciprocity is doubly overdeterrent. First, it condemns a merger without knowing whether this particular conduct will occur and, secondly, without knowing whether it will be anticompetitive if it does occur.

III. Mergers Threatening Horizontal Coordinated Interaction

Merger incipency analysis is most fully developed for the traditional

²⁹ Reciprocity resembles tying except that the two products move through the market in opposite direction. For example, a firm that both processes chickens and produces chicken feed might purchase chickens from growers only on the condition participating growers use its feed. *See* *FTC v. Consolidated Foods Corp.*, 380 U.S. 592 (1965) (condemning merger on theory that it would facilitate compelled reciprocity). *See* HERBERT HOVENKAMP, *FEDERAL ANTITRUST POLICY: THE LAW OF COMPETITION AND ITS PRACTICE* §13.3a (5th ed. 2015).

³⁰ *E.g.*, *Jefferson Parish Hosp. Dist. No. 2 v. Hyde*, 466 U.S. 2, 9 (1984) (30% insufficient). *See* 10 PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶¶1735-1736 (4th ed. 2018).

³¹ A merger that created a firm with a 30% market share could result in a post-merger HHI [define?] under 1500, provided other firms in the market were small. That would make the post-merger market “unconcentrated” under the 2010 Horizontal Merger Guidelines and the merger would be approved with “no further analysis,” even though the 30% share could make anticompetitive tying possible. *See* United States Department of Justice and Federal Trade Commission, 2010 Horizontal Merger Guidelines §5.3 (2010), available at <https://www.ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf>.

³² *E.g.*, *Spartan Grain & Mill Co. v. Ayers*, 581 F.2d 419 (5th Cir. 1978); *Betaseed, Inc. v. U & I*, 681 F.2d 1203 (9th Cir. 1982). *See* 5 PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶1143 (4th ed. 2015).

horizontal merger that makes an industry more concentrated, thus increasing the likelihood of collusion or collusion-like behavior. If a merger of two competitors reduces the number of firms in a market from, say, four to three, the three-firm post-merger market might be more susceptible to traditional price fixing, or the firms might be in a better position to engage in coordinated interaction that permits them to raise their prices. Because collusion is done in secret, it is not always detected and can be difficult to prove. Further, collusion-like behavior can be condemned only if the conduct satisfies the “agreement” requirement of §1 of the Sherman Act. Many instances of acknowledged conscious parallelism do not.³³

In this case, the Government Agencies’ 2010 Horizontal Merger Guidelines recognize the danger. They state their purpose as interdicting mergers that might “create, enhance, or entrench market power or facilitate its exercise.”³⁴ They also articulate the incipency concern that some mergers might facilitate collusion-like practices that are “not otherwise condemned by the antitrust laws.”³⁵

³³ *E.g.* *Valspar Corp. v. E.I. Du Pont de Nemours & Co.*, 873 F.3d 185 (3d Cir. 2017) (Sherman Act §1 did not reach acknowledged oligopoly pricing, including inter-firm communication, in a concentrated market for a fungible chemical); *In re Text Messaging Antitrust Litig.*, 782 F.3d 867 (7th Cir. 2015), cert denied, 136 U.S. 524 (2015); (conscious parallelism insufficient to establish conspiracy under §1 of the Sherman Act); *Williamson Oil Co. v. Philip Morris U.S.A.*, 346 F.3d 1287 (11th Cir. 2003) (same); *Clamp-All Corp. v. Cast Iron Soil Pipe Institute*, 851 F.2d 478 (1st Cir. 1988), cert. denied, 488 U.S. 1007 (1989) (same)

³⁴ United States Department of Justice and Federal Trade Commission, 2010 Horizontal Merger Guidelines §1 (Aug. 19, 2010), available at <https://www.ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf>.

³⁵ *See id.*, §7.0:

Coordinated interaction includes a range of conduct. Coordinated interaction can involve the explicit negotiation of a common understanding of how firms will compete or refrain from competing. Such conduct typically would itself violate the antitrust laws. Coordinated interaction also can involve a similar common understanding that is not explicitly negotiated but would be enforced by the detection and punishment of deviations that would undermine the coordinated interaction. Coordinated interaction alternatively can involve parallel accommodating conduct not pursuant to a prior understanding. Parallel accommodating conduct includes situations in which each rival’s response to competitive moves made by others is individually rational, and not motivated by 24 retaliation or deterrence nor intended to sustain an agreed-upon market outcome, but nevertheless emboldens price increases and weakens competitive incentives to reduce prices or offer customers better terms. Coordinated interaction includes conduct not otherwise condemned by the antitrust laws.

Horizontal merger law would be more difficult to justify if every anticompetitive instance of collusion-like behavior could be detected and remedied promptly when it occurred. In that case the better approach for many cases would be to wait and see. We could permit the merger to go forward, which would allow whatever efficiencies the merger creates, confident that if collusive behavior should ever occur the courts would be able to detect and prevent it. Robert Bork, who believed that oligopoly existed only in economics textbooks, held this view and thus absolutely rejected an incipency test for horizontal mergers.³⁶

By contrast, Judge Posner believed that an incipency test was essential to antitrust policy against horizontal mergers. In *Hospital Corp. of America v. FTC*,³⁷ He observed that a concentration-increasing merger among hospitals in Chattanooga Tennessee increased the likelihood of coordination leading to lower output and higher prices. If such collusion should occur it might be both difficult to condemn and difficult to prosecute, given antitrust law's "agreement" requirement. Further,

Section 7 does not require proof that a merger or other acquisition has caused higher prices in the affected market. All that is necessary is that the merger create an appreciable danger of [collusive practices] in the future. A predictive judgment, necessarily probabilistic and judgmental rather than demonstrable, is called for.³⁸

That "appreciable danger" formulation seems to state the threat about right. "Certainty" is too strict; "possibility" is not strict enough.³⁹ Collusion

³⁶ROBERT H. BORK, *THE ANTITRUST PARADOX: A POLICY AT WAR WITH ITSELF* 131 (1978) (incipency test for mergers has "no value whatsoever"). See also *id.* at 221 (doubting that oligopoly behavior existed "outside of economics textbooks").

³⁷*Hospital Corp. of Am. v. FTC*, 807 F.2d 1381, 1387, 1389 (7th Cir. 1986) cert. denied, 481 U.S. 1038 (1987) ("The reduction in the number of competitors is significant in assessing the competitive vitality of the Chattanooga hospital market. The fewer competitors there are in a market, the easier it is for them to coordinate their pricing without committing detectable violations of section 1 of the Sherman Act, which forbids price fixing").

³⁸ *Id.* at 1389.

³⁹As one recent district court decision put it:

By using "the words 'may be substantially to lessen competition' " in Section 7, Congress indicated "that its concern was with probabilities, not certainties." Although certainty of harm is not necessary to prove a Section

or collusion-like behavior is much more likely to result from a concentration-increasing merger than is a practice such as predatory pricing.⁴⁰ Mergers significantly increasing the likelihood of such behavior represent a realistic threat of post-merger anticompetitive conduct that the antitrust laws will not be able to discipline effectively in many instances.

An incipency test for coordination-facilitating mergers should thus attempt to identify situations where market structure or other features make anticompetitive coordination profitable, difficult to detect, difficult to prove under Sherman §1 legal standards, or difficult to remedy at an early stage. Taking these factors seriously will likely result in increased scrutiny of coordination-facilitating mergers, particularly when the number of substantial firms in the market prior to the merger exceeds three, where entry barriers as historically measured are not all that high, or where efficiencies might otherwise be thought to tip the scale in favor of the merger.

The main problem is that numerous Sherman Act §1 decisions involving tight oligopoly industries have rejected price fixing allegations, essentially by concluding that conspiracies are more difficult to prove in such markets than in those that are more competitively structured. This outcome, which is completely perverse from an enforcement perspective, is that the very factors that make unspoken coordinated interaction more likely also undermine many types of evidence of a qualifying “contract,” “combination,” or “conspiracy,” as the Sherman Act requires.⁴¹ The 2017 Third Circuit *Valspar* decision was particularly candid:

In non-oligopolistic markets, “[p]arallel behavior among competitors is especially probative of price fixing because it is the *sine qua non* of a price fixing conspiracy.” But in an oligopolistic market, parallel behavior “can be a necessary fact of life,” and “[a]ccordingly, evidence of conscious parallelism cannot alone create a reasonable inference of a conspiracy.” Therefore, to prove an oligopolistic conspiracy with proof of parallel behavior, that

7 violation, neither is the “mere possibility” of harm sufficient. Rather, to grant injunctive relief under the Clayton Act, the Court *must* conclude that the Government has introduced evidence sufficient to show that the challenged “transaction is likely to lessen competition substantially.” As part of satisfying that burden, Section 7 “demand[s] that a plaintiff demonstrate that the substantial lessening of competition will be ‘sufficiently probable and imminent’ to warrant relief.”

United States v. AT&T, Inc., 310 F.Supp.3d 161, 190 (D.D.C. 2018).

⁴⁰ See discussion *supra*, text at notes 25-26.

⁴¹ 15 U.S.C. §1.

evidence “must go beyond mere interdependence” and “be so unusual that in the absence of an advance agreement, no reasonable firm would have engaged in it.”⁴²

In sum, it becomes much easier to prove a “conspiracy,” and thus obtain Sherman Act liability, in a less concentrated market, or one that is not conducive to coordinated interaction for other reasons, than in a market that is highly prone to noncompetitive performance.

In *Valspar* the relevant product was titanium dioxide, a chemical sold in an acknowledged oligopoly. Five firms sold most of the product, although there were others.⁴³ In the *Chocolate* case the Third circuit

⁴²*Valspar Corp. v. E.I. Du Pont De Nemours & Col.*, 873 F.3d 185, 193 (3d Cir. 2017) (citations omitted). *See also In re Flat Glass Antitrust Litigation*, 385 F.3d 350 (3d Cir. 2004):

... [T]his Court and others have been cautious in accepting inferences from circumstantial evidence in cases involving allegations of horizontal price-fixing among oligopolists. The theory of interdependence posits the following: In a market with many firms, the effects of any single firm's price and output decisions “would be so diffused among its numerous competitors that they would not be aware of any change.” In a highly concentrated market (i.e., a market dominated by few firms), however, any single firm's “price and output decisions will have a noticeable impact on the market and on its rivals.” Thus when a firm in a concentrated market (i.e., an “oligopolist”) is deciding on a course of action, “any rational decision must take into account the anticipated reaction of the other [] firms.”

The result, according to the theory of interdependence, is that firms in a concentrated market may maintain their prices at supracompetitive levels, or even raise them to those levels, without engaging in any overt concerted action.

Id. at 359, quoting PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶ 1429, at 206 (2d ed.2000). *See id.*, ¶¶1428-1436 (4th ed. 2017) (summarizing the law). For a good discussion of a broad range of cases, *see* William H. Page, *Tacit Agreement Under §1 of the Sherman Act*, 81 *ANTITRUST L.J.* 593 (2017). For attempts to get around the problem by substituting a more economic understanding of agreement, or eliminating the common law agreement requirement, *see* Louis Kaplow, *Direct versus Communications-Based Prohibitions on Price Fixing*, 3 *J. LEGAL ANALYSIS* 449 (2011); Louis Kaplow, *On the Meaning of Horizontal Agreements in Competition Law*, 99 *CALIF. L. REV.* 683 (2011); Louis Kaplow, *An Economic Approach to Price Fixing*, 77 *ANTITRUST L.J.* 343 (2011); Robert H. Porter, *Detecting Collusion*, 26 *REV. INDUS. ORG.* 147, 147-48 (2005); Richard A. Posner, *Oligopoly and the Antitrust Laws: A Suggested Approach*, 21 *STAN. L. REV.* 1562 (1969).

⁴³*See Valspar Corp. v. E.I. Du Pont de Nemours*, 152 F.Supp.3d 234, 238-239

reached essentially the same conclusion in a market dominated by three companies that controlled 75% of the market.⁴⁴ The same thing was true of *Baby Food*, where four firms controlled about 98 percent of the market.⁴⁵ Several other cases involved markets with similar structures.⁴⁶

So one important trigger for horizontal merger enforcement should be a market, as the *Valspar* case suggests, where existing Sherman §1 case law would be unlikely to infer a §1 violation from parallel conduct in the post-merger market. This makes more aggressive merger enforcement necessary to limit the number of such situations.

Further, merger law permits mergers to be challenged prior to their occurrence and thus before the harm from coordinated interaction has materialized. Once again, this is particularly valuable in situations where coordinated interaction is difficult to detect and remedy directly under §1 of the Sherman Act.

IV. Horizontal Mergers Facilitating Unilateral Anticompetitive Effects

A small but important subset of mergers create a monopoly or dominant firm in the affected market.⁴⁷ Once such a firm has been created, its unilateral dealing and pricing decisions are virtually out of reach of the antitrust laws.⁴⁸

A much larger subset of mergers falls into the general category of anticompetitive “unilateral effects” actions. Today the Agencies analyze

(D. Del. 2016) (identifying DuPont, Huntsman, Kronos, Millennium, and Tronox as the largest firms).

⁴⁴*In re* Chocolate Confectionary Antitrust Litig., 801 F.3d at 383, 391 (3d Cir. 2015)

⁴⁵*In re* Baby Food Antitrust Litig., 166 F.3d 112, 116 (3d Cir. 1999).

⁴⁶*Williamson Oil Co., Inc. v. Philip Morris USA*, 346 F.3d 1287, 1291 (11th Cir. 2003) (four largest cigarette manufacturers produced more than 97% of cigarettes sold in the United States); *in re* Flat Glass Antitrust Litigation, 385 F.3d 350 (3d Cir. 2004) (five firms); *Reserve Supply corp. v. Owens-Corning Fiberglas Corp.*, 971 F.2d 37 (7th Cir. 1992) (3 firms held 85-90% of market); *Kleen Prods, LLC v. Int’l Paper*, 276 F.Supp.3d 811 (N.D.Ill. 2017) (approximately five rivals).

⁴⁷ E.g., *FTC v. Phoebe Putney Health Sys.*, 568 U.S. 216, 222 (2013) (merger gave one firm virtual monopoly in affected market); *Northern Securities Co. v. United States*, 193 U.S. 197, 322 (1904) (union of parallel railroad lines create monopoly).

⁴⁸ *See* discussion *infra*, text at notes 82-84.

more mergers under unilateral effects theories than they do under traditional coordinated effects theories. According to one paper by insiders, unilateral effects investigations at the FTC account for about three-fourths of the total.⁴⁹ The most frequently used of these theories applies when the merging firms offer relatively close substitutes in a product differentiated market. The merger facilitates a price increase by eliminating competition between them, forcing consumers either to pay more or else select a more remote substitute.⁵⁰ The price effects are said to be unilateral because only the post-merger firm charges the higher price; other firms in the market are generally unaffected. The theory does not require conjectures about what type of interdependent pricing the post-merger firm might engage in with other firms in the market.

The theory for predicting a unilateral price increase from a merger is at least as robust as the theory for predicting price increases likely to result from coordinated interaction. While the link between market concentration and the dangers of coordinated interaction are well established, the precise mechanism that the firms will employ is typically unknown at the time the merger occurs. For example, a merger that reduces the number of firms in a market from four to three creates an “appreciable danger” of collusion-like behavior,⁵¹ but until it occurs we would not know how this coordination might occur, or whether that behavior would satisfy §1’s agreement requirement.

Significantly, however, merger policy does not require the court to know the precise strategy causing competitive harm. This is because the Clayton Act states an “effects” test – where “the effect of the acquisition may be substantially to lessen competition, or to tend to create a monopoly.”⁵² For unilateral effects cases the inference is more direct than in the case of coordinated effects. One hypothesizes a price increase of a given magnitude and then uses information about margins and cross elasticity of demand between the two merging firms as well as closer, non-merging substitutes. From this, one can estimate the post-merger firm’s profit-maximizing output

⁴⁹ See Malcolm B. Coate & Shawn W. Ulrick, *How Much Does the Choice Between Collusion and Unilateral Effects Matter in Merger Analysis* (FTC working paper, Nov. 15, 2017), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2995679.

⁵⁰ On the theory, see 4 PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶¶914-915 (4th ed. 2015).

⁵¹ See *Hospital Corp.*, *supra*, 807 F.2d at 1389.

⁵² 15 U.S.C. §18 (2012). On the merger law’s statement of a test that requires only a showing of harmful effects, see Fiona Scott-Morton and Herbert Hovenkamp, *Horizontal Shareholding and Antitrust Policy*, 127 *YALE L.J.* 2026(2018).

and price.⁵³

One of the most important justifications for prophylactic merger policy occurs when the feared anticompetitive conduct is that of a single firm. This is true both in cases involving merger to monopoly and those causing anticompetitive unilateral effects. Under United States antitrust law, a firm acting unilaterally has very little obligation to deal with either rivals or customers.⁵⁴ Further, unilaterally set prices are beyond antitrust's reach, provided they are not predatory,⁵⁵ and price discrimination is virtually never an antitrust violation.⁵⁶ While the Robinson-Patman Act may reach the simple practice of charging two dealers different prices, the statute is not designed to pursue most kinds of price discrimination, and does not even reach price discrimination in the provision of services such as video content.⁵⁷ In any event, the focus of unilateral effects merger policy is on mergers that threaten simple price increases, and these are unreachable under antitrust law when they are being imposed by a single firm.

Two rationales are offered to justify the lenient rules that antitrust applies to single firm conduct under the Sherman Act. First, in most cases a firm's unilateral pricing practices are not anticompetitive. That is, they do not create or enhance a firm's market power but rather reflect power that already exists. For that reason, the United States has never had a rule of no fault monopolization.⁵⁸ If a firm has market power, the antitrust laws permit it to set its profit maximizing price or any other nonpredatory price it pleases, provided that it is acting unilaterally.

The second rationale for antitrust tolerance of a firm's unilateral pricing decisions as well as refusals to deal is at least as compelling. Administratively, it is very difficult to develop remedies against unilateral

⁵³The approach is laid out in Carl Shapiro, *The 2010 Horizontal Merger Guidelines: From Hedgehog to Fox in Forty Years*, 77 ANTITRUST L.J. 49 (2010); Joseph Farrell & Carl Shapiro, *Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition*, 10 B.E. J. THEORETICAL ECON. 1, art. 9, 14-15 (2010).

⁵⁴E.g., *Verizon Communic., Inc. v. Law Offices of Curtis V. Trinko, LLP*, 540 U.S. 398 (2004) (monopolist has no antitrust duty to interconnect with rival); *United States v. Colgate*, 250 U.S. 300 (1919) (firm has right to refuse to deal). See PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW ¶¶770-774 (4th ed. 2015).

⁵⁵*Id.*, ¶720.

⁵⁶*Id.* at ¶721. On the Robinson-Patman Act, see 14 HERBERT HOVENKAMP, ANTITRUST LAW, Ch. 23 (3d ed. 2012).

⁵⁷Coverage of the Robinson-Patman Act is limited to "commodities." See *id.*, ¶2314.

⁵⁸See 3 PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW ¶¶630-638 (4th ed. 2015).

conduct that do not involve ongoing regulation of the firm in question. For example, a dealing order would require a judge to determine with some precision not only the price, but also precisely which assets must be shared and with whom. If costs or technology change in subsequent years, then the order would have to be adjusted. Such a dealing order requires ongoing supervision that virtually turns the firm into a public utility, except that it is regulated by a court of general jurisdiction rather than an agency.⁵⁹

This is where merger policy can assist, under the same prophylactic rationale that justifies the antitrust concern with mergers that facilitate coordinated interaction. While antitrust is powerless to regulate a single firm's prices, it can interdict a merger that is likely to put the firm into a position where it is able profitably to increase its prices above the competitive level.⁶⁰

V. Inciency and Vertical Acquisitions

A vertical merger involves a buyer and a seller rather than two competitors. At least since the 1970s, the antitrust enforcement agencies have not challenged as many vertical mergers as horizontal ones, and over the last three decades have been much less enthusiastic about doing so.⁶¹ For example, the most recent revision of the vertical merger Guidelines was 1984,⁶² while the horizontal merger Guidelines have been revised regularly through 2010.⁶³ That failure very likely contributed to the Government's district court loss in the 2018 AT&T/Time-Warner litigation.⁶⁴

⁵⁹ See 3B *Id.*, ¶771.

⁶⁰ See, e.g., *FTC v. Sysco Corp.*, 113 F.Supp.3d 1, 62-64 (D.D.C. 2015) (merger would eliminate bidding competition between closest competitors, thus permitting post-merger firm unilaterally to increase its price); *United States v. H & R Block, Inc.*, 833 F.Supp.2d 36, 81-82 (D.D.C. 2011) (similar, although ultimately concluding that analysis of unilateral effects was unnecessary).

⁶¹ Prior to the district court's decision in *United States v. AT&T, Inc.*, 310 F.Supp.3d 161 (D.D.C. 2018), the last fully litigated case on the merits was *Fruehauf Corp. v. FTC*, 603 F.2d 345 (2d Cir. 1979), which the Federal Trade Commission lost on appeal.

⁶² See United States Department of Justice, *Merger Guidelines* (1984), available at <https://www.justice.gov/sites/default/files/atr/legacy/2007/07/11/11249.pdf>. Vertical acquisitions are addressed in these Guidelines as "Non-Horizontal Mergers." See §§4, 4.2.

⁶³ See Department of Justice and Federal Trade Commission, *Horizontal Merger Guidelines* (2010), *supra* note 33.

⁶⁴ *United States v. AT&T, Inc.*, 310 F.Supp.3d 161 (D.D.C. 2018). The decision is currently on appeal to the D.C. Circuit. See <https://www.justice.gov/atr/case-document/file/1085516/>.

The 1984 Guidelines were drafted at a time when antitrust policy was dominated by a Chicago School analysis that saw vertical mergers as rarely creating competitive problems. The purely vertical transaction itself does not make either the buyer's or the seller's market more concentrated, and does not increase the market share of either of the merging firms. In the longer run, a transaction that reduces the firm's costs may increase market share at either or both levels, but that shift in market share would usually be accompanied by an output increase and lower prices, rather than vice-versa. In any event, it is not the purpose of the antitrust laws to condemn cost-savings.

Today most vertical mergers are analyzed under an approach that looks for instances of anticompetitive foreclosure or discrimination, or in some cases constraints on the development of innovative technologies. In general, foreclosure refers to mechanisms by which a vertically related firm can raise the costs of rivals in the downstream market by reducing the availability of inputs or raising their price. Econometric techniques have been developed for analyzing these price effects.⁶⁵ As in the case of horizontal mergers, these methodologies try to identify the pricing strategies that will maximize the post-merger firm's prices. Cost savings tend to lower the post-merger firm's profit maximizing prices, while input foreclosure tends to increase them. The ultimate question is whether the vertical acquisition is likely to lead to higher consumer prices. This methodology is objective in the sense that it is based on predictions about what will be profit-maximizing for the firm subsequent to the merger. Evidence of intent can be relevant as well.⁶⁶

If a vertical merger is anticompetitive under an input foreclosure or discrimination theory, the incipency rationale applies. That rationale is the same as for unilateral effects from horizontal mergers; namely, antitrust rules do not typically reach a single firm's decisions about the price of its products or its willingness to share them with rivals. A coherent approach to vertical merger policy is therefore to condemn vertical mergers that are reasonably likely to facilitate a refusal to deal, price discrimination, or price increases that would be lawful if undertaken subsequently by a single firm.

In addition, the challenger must show that this refusal to deal or

⁶⁵ See Serge Moresi & Steven C. Salop, *VGUPPI: Scoring Unilateral Pricing Incentives in Vertical Mergers*, 79 ANTITRUST L.J. 185 (2013) (VGUPPI stands for "vertical gross upward pricing pressure indices"); Michael H. Riordan, *Competitive Effects of Vertical Integration*, in *The Handbook of Antitrust Economics* 145, 155-59 (Paolo Buccirossi, 2008 ed.).

⁶⁶ See, e.g., *AT&T/Time-warner*, ___ F.Supp.3d at ___[p. *28] (noting that the government had presented such evidence).

pricing practice would likely cause competitive harm if it occurred. Many instances of vertical integration by merger result in refusals to deal. For example, a manufacturer of lawn mowers that acquires its own dealer in a community is very likely to sell mowers through its newly acquired dealership, refusing to sell mowers to local independent dealers. Although this vertical merger might facilitate this refusal to deal, that does not establish that the refusal is anticompetitive. As a general matter we expect manufacturers who own dealerships to sell through their own dealers.⁶⁷

The fact that anticompetitive foreclosure or discrimination is not automatic does not mean that it never occurs, however. For example, a broadband internet provider that acquires substantial programming assets may be in a position to deny that programming to distributors on rival internet providers, or else charge them a higher price. The effect of the higher price could be either to increase consumer prices or else to induce them to switch away from a competitor's broadband service to that of the post-merger firm. These were essentially the government's allegations in the *AT&T/Time Warner Merger* case.⁶⁸ The government alleged mainly that the merger between AT&T, an internet provider whose assets include DirecTV, and Time Warner (TW) would enable the post-merger firm to force rival distributors of TW programming to pay a higher price than TW's current position would permit.⁶⁹ The complaint also alleges that the merger would slow the development of "disruptive," procompetitive innovations such as direct online video distribution. This includes Sling TV and other "skinny" bundles that offer programming directly over the internet rather than traditional cable.⁷⁰ The court dismissed the complaint, not because it rejected these theories on principle, but rather did not find them adequately supported by the facts.

The 2011 merger between Comcast Corp. and NBC reflected

⁶⁷ For several years vertical mergers were brought under the now largely defunct theory that the post-merger firm would favor its own subsidiaries at the expense of rivals. See *Fruehauf Corp. v. FTC*, 603 F.2d 345 (2d Cir. 1979) (rejecting this theory); *United States v. E.I. Du Pont De Nemours & Co.*, 353 U.S. 586 (1957) (accepting government's acquisition that vertical ownership relationship between Du Pont and General Motors Corp would incentivize GM to favor Du Pont when it purchased seat cover fabrics and automobile paint, both of which were manufactured by both Du Pont and other firms.

⁶⁸*United States v. AT&T, Inc.*, 310 F.Supp.3d 161 (D.D.C. 2018).

⁶⁹Complaint, ¶¶5-6, *United States v. AT&T, Inc.*, Case 1:17-cv-02511 (D.D.C., Filed Nov. 20, 2017).

⁷⁰*Id.*, ¶¶8-9 ("AT&T/DirecTV perceives online video distribution as an attack on its business that could, in its own words, 'deteriorate[] the value of the bundle.'")

analogous concerns about denial of access to programming.⁷¹ The Comcast merger was resolved by a consent decree that permitted the merger but required the post-merger firm to share its programming and grant access to rival programming on fair and reasonable terms. The decree set up an arbitration mechanism to resolve disputes. Judge Richard Leon, the same judge currently presiding over the *AT&T* case, expressed considerable doubt about whether the arbitration scheme would work,⁷² and there is evidence that it did not work all that well.⁷³ Nevertheless, Judge Leon approved the consent decree.

Although it was not discussed in the *AT&T/Time-Warner* decision, the Federal Communications Commission's December, 2017 decision rolling back net neutrality should increase antitrust scrutiny on such vertical mergers in this industry, at least if they involve a broadband provider.⁷⁴ The net neutrality rules that had been in place might have prohibited at least some of the vertical exclusion and discriminatory treatment that can result from a vertical telecommunications acquisition.⁷⁵

The argument that post-merger *AT&T/TW* will favor its own customers and discriminate against the customers of rivals may sound a little like rejected arguments from the 1970s. The concerns stated in earlier cases were that vertical mergers gave a firm's own customers preferential treatment over the customers of rivals.⁷⁶ There is one very important difference, however, although it is specific to communications mergers and perhaps a

⁷¹*See* *United States v. Comcast Corp.*, Civil Case No. 11-106 (RJL) (D.D.C. Sep. 1, 2011) (consent decree).

⁷² *Id.* at 6-7.

⁷³*See* Jonathan Berr, "Regulators in *AT&T-Time Warner* Deal Try to Avoid Repeating Past Mistakes," *FORBES*, Nov. 21, 2017, available on line at <https://www.forbes.com/sites/jonathanberr/2017/11/21/regulators-in-att-time-warner-deal-try-to-avoid-repeating-past-mistakes/#5a57a95614e0>.

⁷⁴*See* <https://www.fcc.gov/document/fcc-takes-action-restore-internet-freedom> (Dec. 14, 2017).

⁷⁵*See* Tim Wu, *Why Blocking the AT&T-Time Warner Merger Might Be Right*, *NEW YORK TIMES* (Nov. 9, 2017), available at <https://www.nytimes.com/2017/11/09/opinion/att-time-warner-merger-fcc.html?mtrref=www.google.com&assetType=opinion> (arguing that erosion of net neutrality will increase anticompetitive potential of the merger). *See also* Jon Brodtkin, "Comcast Accused of Violating NBC Merger Commitment and Net Neutrality Rule," *ARS TECHNICA* (March 3, 2016), available at <https://arstechnica.com/information-technology/2016/03/comcast-accused-of-violating-nbc-merger-commitment-and-net-neutrality-rule/>.

⁷⁶*E.g.*, *Fruehauf Corp. v. FTC*, 603 F.2d 345 (2d Cir. 1979). *See also* *United States v. E.I. Du Pont De Nemours & Co.*, 353 U.S. 586 (1957).

few others. The “favoritism” arguments in those earlier cases involved durable goods for which there was a naturally finite supply.⁷⁷ For example, in *Fruehauf* the FTC argued that in time of short supply the post-merger firm would favor its own subsidiary at the expense of rivals.⁷⁸ But in most cases we would expect a truck manager to use its wheel and brake subsidiary exclusively, and harm to competition would be exceptional.

By contrast, licensed films and television programming are nonrivalrous. Once a TW asset such as *Wonder Woman* or the *Harry Potter* films has been created, the digital files can be licensed an indefinite number of times. If post-merger AT&T/TW decides not to license *Wonder Woman* to a competing cable company or to charge it a higher price, it is manifestly not because *Wonder Woman* is in short supply and must be allocated among potential customers.

To think of this a little differently, an unintegrated programmer that owned *Wonder Woman* and nothing else would maximize revenue by licensing to all comers.⁷⁹ Each sale increases profits and there are no shortages to be allocated, for *Wonder Woman* can be licensed out an infinite number of times. As soon as DirecTV, an AT&T asset, comes to own *Wonder Woman*, however, the post-merger firm has different incentives. Now it can withhold or threaten to withhold *Wonder Woman* from the customers of competing internet providers as an inducement to get customers to switch to DirecTV as their carrier, or charge them higher prices. The result can be the creation or perpetuation of “silos” in which each internet provider gives preferred or exclusive access to its own internet customers. This results in reduced quality or variety of programming, which is a qualifying output reduction under antitrust’s consumer welfare principle.

⁷⁷*E.g., Fruehauf, id.* (heavy duty truck wheels and antiskid brakes); *Du Pont, id.* (automobile fabrics and finishes).

⁷⁸The FTC argued:

that the merger violated §7 with respect to the truck trailer market solely on the theory that in the event of a shortage ... Kelsey would give Fruehauf a substantial competitive advantage over other trailer manufacturers by diverting to Fruehauf wheels that would otherwise go to Kelsey's other customers, some of which are trailer manufacturers.

Fruehauf, 603 F.3d at 354.

⁷⁹ Although it might be prevented from doing so by most-favored nation and similar agreements that are common in the industry. See Erik Hovenkamp & Neel U. Sukhatme, Vertical Mergers and the MFN Thicket in Television, *Antitrust Chronicle* (2018), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3213884.

The Comcast consent decree referred to above⁸⁰ reflects a mechanism of resolving antitrust disputes in communications markets with a combination of antitrust and ongoing control. It has also been used in monopolization cases, such as the consent decree that broke up the AT&T telephone monopoly in the early 1980s.⁸¹ That decree resolved an antitrust case by a combination of a structural remedy that broke the phone company into seven “Baby Bells,” and ongoing oversight of interconnection disputes by a federal district judge.⁸² This lasted until passage of the 1996 Telecommunications Act.⁸³

As this history of antitrust regulation by consent decree suggests, antitrust and regulation represent alternative approaches to competition issues that should not be confused.⁸⁴ Notwithstanding Judge Harold Greene’s heroic work administering the AT&T breakup, antitrust is not a good vehicle for imposing ongoing regulatory restrictions on a firm’s behavior. The “breakup” provision of the 1982 AT&T consent decree was very much an antitrust remedy, but the portion of the decree requiring ongoing supervision of interconnection disputes was not, and in the 1996 Telecommunications Act it was more realistically assigned over to the Federal Communications Commission and state telecommunications regulators.

The one important difference between the AT&T telephone case and the more recent vertical mergers is that AT&T was a single firm to begin with, and the action against it had been brought under §2 of the Sherman

⁸⁰United States v. Comcast Corp., Civil Case No. 11-106 (RJL) (D.D.C. Sep. 1, 2011) (consent decree). *See* note 15.

⁸¹United States v. AT&T, 552 F. Supp. 131 (D.D.C. 1982), *aff’d mem. sub nom. Maryland v. United States*, 460 U.S. 1001 (1983). A similar consent decree terminated the Government’s big §2 case against Microsoft. *United States v. Microsoft Corp.*, 231 F. Supp. 2d 144 (D.D.C. 2002); *State of New York v. Microsoft Corp.*, 231 F. Supp. 2d 203 (D.D.C. 2002) (approving settlement).

⁸²The late Honorable Harold Greene. *See* Joseph D. Kearney, *From the Fall of the Bell system to the Telecommunications Act: Regulation of Telecommunications Under Judge Greene*, 50 HASTINGS L.J. 1395 (1999).

⁸³Telecommunications Act of 1996, Pub. L. No. 104-104, 1996 U.S.C.C.A.N. (110 Stat.) 56 (codified in scattered sections of 47 U.S.C.).

⁸⁴*See* Daniel A. Crane, *Bargaining in the Shadow of Rate-Setting Courts*, 76 ANTITRUST L.J. 307 (2009) (recalling, among other things, the history of rate setting under the ASCAP and BMI consent decrees that established what became the copyright royalty tribunal; also observing that even when a consent decree contemplates managed rates the parties are able to negotiate them in a significant majority of cases). *Accord* Daniel A. Crane, *Intellectual Liability*, 88 Tex. L. Rev. 253 (2009).

Act.⁸⁵ This made Clayton Act incipency irrelevant. The AT&T consent decree expresses what antitrust can accomplish without a legislative assist in an action against a single firm. Eventually, however, Congress acted. The interconnection components of the consent decree were replaced by a regulatory provision that transferred these obligations away from a federal court and to federal and state agencies.⁸⁶

Merger consent decrees with behavioral conditions are an attempt to avoid or at least soften the implications of the incipency test by expanding the scope of antitrust so as to do things that antitrust could not accomplish on its own. Consent decrees are contracts, and as such they can impose much more specific and far reaching rules on the parties than would occur through ordinary antitrust litigation.⁸⁷ The one thing that they have difficulty providing, however, is closure.⁸⁸ Rather, they create ongoing obligations that need to be enforced until the decree expires or is withdrawn.⁸⁹

This does not mean that every unlawful merger must be completely blocked. Select, targeted spinoffs are in fact structural forms of relief that ordinarily do not require ongoing judicial supervision. If a particular asset is likely to be a bottleneck, the appropriate solution may be to condemn the merger unless the firms agree to divest that bottleneck asset to a third party who will maintain it as a viable competitive presence. Or in the case of partial asset acquisitions that leave both merging partners as separate ongoing concerns, the government might simply object to some asset transfers, leaving them with the original owner.⁹⁰ But in either case the goal is to leave

⁸⁵ The breakup occurred after one of the rare instances in which a court found a unilateral duty to deal, in this case under the “essential facility” doctrine, which the Supreme Court has never approved. *See* MCI Communications Corp. v. AT & T Co., 708 F.2d 1081 (7 Cir.), cert. denied, 464 U.S. 891 (1983).

⁸⁶ Telecommunications Act of 1996, Pub. L. No. 104-104, 1996 U.S.C.C.A.N. (110 Stat.) 56 (codified in scattered sections of 47 U.S.C.).

⁸⁷ *See, e.g.,* Flying J, Inc. v. Comdata Network, Inc., 405 F.3d 821, 835-836 (10th Cir. 2005) (contract principles rather than substantive antitrust law controlled in interpretation of antitrust consent decree); *United States v. Microsoft Corp.*, 147 F.3d 935, 945-947 (D.C.Cir. 1998) (same).

⁸⁸ The problem is not a new one. *See* Note, *Flexibility and Finality in Antitrust Consent Decrees*, 80 HARV. L. REV. 1303 (1967) (noting problem of ongoing supervision in merger consent decrees).

⁸⁹ On antitrust consent decrees generally, *see* 2A PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW ¶327 (4th ed. 2015); on the history, *see* Eric J. Branfman, *Antitrust Consent Decrees—A Review and Evaluation of the First Seven Years Under the Antitrust Procedures and Penalties Act*, 27 ANTITRUST BULL. 303 (1982).

⁹⁰ For example, the recently proposed union of 21st Century Fox and Walt

a market structure that will sustain competition without the need for government oversight.

Another workable solution, although it superficially sounds more behavioral than structural, is insistence that certain IP rights be nonexclusive in perpetuity rather than exclusive. Nonexclusive rights give a firm everything it needs to operate its own business, enabling it to take advantage of expansion opportunities and up-to-date technology. The one thing that they do not grant is the right to prevent competitors from using that technology.⁹¹ For example, the consent decree that broke up the telephone company provided for the compulsory licensing of AT&T patents on a nonexclusive, nondiscriminatory basis.⁹² Antitrust consent decrees that require nondiscriminatory licensing of patents are not uncommon,⁹³

In applying §7's incipiency test to a vertical merger the challenger needs to show four things, or in a few cases five. *First*, that the acquisition makes particular behavior possible; *second*, that the post-acquisition market and the position of the firm creates a reasonable likelihood that this behavior

Disney Company is a partial asset acquisition, in which Fox will sell some but not all of its assets to Disney. If a particular transfer is found to be anticompetitive, the result may be to force Fox to retain that particular asset, leaving the rest of the merger to proceed. Fox may, of course, later sell that asset to some other firm. On the merger, *see* "Disney Buys Much of Fox in Megamerger That Will Shake World of Entertainment and Media," at https://www.washingtonpost.com/news/business/wp/2017/12/14/disney-buys-much-of-fox-in-mega-merger-that-will-shake-world-of-entertainment-and-media/?utm_term=.5b25155cc07c.

The 2010 Horizontal Merger Guidelines have a section on partial acquisitions, but it is devoted largely to partial stock acquisitions, which raise very different issues. *See* 2010 Horizontal Merger Guidelines, *supra* note 33, § 13.

⁹¹*See* United States Department of Justice and Federal Trade Commission, Antitrust Guidelines for the Licensing of Intellectual Property (2017), available at <https://www.justice.gov/atr/IPguidelines/download> §4.1.2 ("A non-exclusive license of intellectual property that does not contain any restraints on the competitive conduct of the licensor or the licensee generally does not present antitrust concerns").

⁹²United States v. AT&T, 552 F. Supp. 131, 135 (D.D.C. 1982), *aff'd mem. sub nom.* Maryland v. United States, 460 U.S. 1001 (1983). *See also id.* at 176 (explaining why it was now appropriate to eliminate compulsory nonexclusive licensing requirements in a previous antitrust consent decree entered in 1956).

⁹³*See, e.g.* United States v. Nat'l Lead Co., 332 U.S. 319, 328 (1947) (approving elaborate consent decree requiring licensing of patent on nondiscriminatory terms); *accord* United States v. Miller Industries, Inc., 2001-1 Trade Cas. ¶ 73,132 (D.D.C. 2000); United States v. Cookson Group plc, 1994-1 Trade Cas. ¶ 70,666 (D.D.C. 1993).

will occur; *third*, that the behavior will be anticompetitive if it does occur, with the presumptive measure being lower output, higher prices, or reduced innovation; and *fourth*, that once the merger has occurred and the conduct has become that of a single firm, it will be much more difficult for antitrust law to detect and discipline. A possible fifth query, as noted above in the discussion of net neutrality, would be whether non-antitrust regulatory provisions are present and will police the feared conduct in a satisfactory manner.⁹⁴

As the first two elements indicate, the fact finder must show not only that a merger makes certain conduct possible, but also that the post-merger firm would be likely to engage in it. In merger analysis this is ordinarily an objective exercise, querying whether a practice such as refusal to deal or price discrimination would be profitable for the firm in question. This is the way we analyze the analogous problem for horizontal mergers – that is, by querying whether a change in market position has increased the post-merger firm’s profit maximizing price when measured against pre-merger levels.⁹⁵

To give a simple example, subsequent to the merger between AT&T and Time-Warner, the post-merger firm owns both DirecTV, which was an AT&T asset, and *Wonder Woman*, which was a TW asset. At that point it would be in a position to license *Wonder Woman* exclusively to DirecTV subscribers, thus excluding subscribers who obtain their programming from Comcast, Verizon, Dish Network, Mediacom, or several other suppliers of cable or wireless internet services. It might also deny access to video streamers such as Netflix or Amazon. Subsequent to the merger, this refusal to license would be an ordinary unilateral refusal to deal, however, and antitrust law would presumably not require the post-merger firm to share *Wonder Woman* with anyone else.⁹⁶

While the merger makes this refusal to license possible, however, it does not necessarily make it profitable. *Wonder Woman* promises to be a very high margin product, producing high license fees even though the marginal cost of distributing an already produced film is very low. Further *Wonder Woman* is presumably not worth more to existing DirecTV subscribers simply because subscribers to rival services are not able to get it. If the strategy of refusing to supply *Wonder Woman* is to be profitable, the profits must come from somewhere else. For example, *Wonder Woman* might be

⁹⁴In the context of a Sherman Act §2 case, see *Verizon Communic., Inc. v. Law Offices of Curtis V. Trinko, LLP*, 540 U.S. 398, 313 (2004) (declining antitrust liability because a regulator was present and its regime “was an effective steward of the antitrust function.”).

⁹⁵See the articles cited in note 45, *supra*.

⁹⁶See 3B PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW ¶¶770-774 (4th ed. 2015).

used as a lever to induce customers of other services to switch to DirecTV. It is also possible that post-merger AT&T/TW might either refuse to license or else raise internet access costs of video streamers, including firms such as Netflix. Whether that is profitable behavior is an empirical question.

There are also other dangers. For example, a world of concentrated cable and internet companies who are also vertically integrated into programming might lead to an oligopoly of “silos” in which each firm shares less content than it would if content were independently owned. In more traditional markets for physical goods such silos are a natural result of vertical integration. For example, the major automobile manufacturers sell through their own dealerships. In the case of video programming, however, the result could be that people would receive less programming from a particular service. Unless these firms agree with each other not to share programming, the practice would not be reachable under §1 of the Sherman Act unless the parties entered into a provable contract or conspiracy, but merger policy could prevent the situation from occurring in the first place. Absent that, the result could be that each internet service provider offers a smaller range of programming than it otherwise would, injuring customers by loss of variety.

VI. Anticompetitive Acquisitions of Patents or other IP Rights

A patent, or other intellectual property right,⁹⁷ creates a power to exclude, whether or not the exclusion creates a product market monopoly.⁹⁸ The exclusion right is of course inherent in patent law and is the mechanism by which patenting encourages invention. If a patent, or even a portfolio of patents, should create a product monopoly antitrust nevertheless must keep its hand off, except in the situation where the patent owner attempts to enforce a patent that it knows or should know is invalid or unenforceable.⁹⁹

However, patent law does not recognize a right to create a market

⁹⁷On anticompetitive use of copyrights, *see* *Professional Real Estate Investors, Inc. v. Columbia Pictures Indus., Inc.*, 508 U.S. 49 (1993) (PREI) (copyrighted motion pictures).

⁹⁸On the relationship between patents or other IP rights and market power, *see* 2B PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶518 (4th ed. 2015). In *Illinois Tool Works, Inc. v. Independent Ink, Inc.*, 126 S. Ct. 1281 (2006), the Supreme Court held that market power in an antitrust tying challenge could not be inferred from the existence of a patent or copyright, but must be proven.

⁹⁹*E.g.*, *Walker Process Equipment, Inc. v. Food Mach. & Chem. Corp.*, 382 U.S. 172 (1965) (patent infringement suit brought by patentee who knew the patent was unenforceable could violate §2 of the Sherman Act). Cf. *Oskar Liivak, Overclaiming is Criminal*, 49 ARIZ. ST. L.J. 1417 (2017) (arguing for similar liability for excessively broad claims).

monopoly through means other than those contemplated in the patenting process itself. The problem can arise when a firm assembles a market monopoly by acquiring patents from outside inventors, or perhaps by acquiring firms holding large patent portfolios.¹⁰⁰ If a process can be accomplished by two competing (i.e., substitute) patent portfolios, the Patent Act authorizes whatever amount of market power is created when one of those portfolios is created by invention. It does not authorize the amount of additional monopoly that is created, however, when the two portfolios of existing but competitively owned patents come under common ownership.

Maintaining that line is particularly important because in most cases the threat of market monopoly by means of merger is far greater than the threat of market monopoly through internal invention and patenting. While a very strong, market shifting patent can create a monopoly, most do not.¹⁰¹ A merger, by contrast, is a simple act of transaction, not of invention. If three groups of assets, patents or otherwise, collectively dominate a market a simple set of purchases can turn them instantly into a market monopoly.

A firm can thus threaten competition by buying up all of the patents necessary for production in a particular line of commerce.¹⁰² For example, suppose that two inventors have developed the only two alternative processes for producing a particular type of microprocessor chip. Both are covered by portfolios of patents, each developed by the two inventors independently. These two owners could then either use the portfolios themselves or license them to others. Assuming that the manufacturers are not colluding and that the two alternatives are equally effective, the market could perform as competitively as we might expect from a two-firm market. It might be even more competitive if the two firms licensed their portfolios to third parties.

¹⁰⁰See discussion *infra*, text at notes 90-95. Cf. *United States v. Winslow*, 227 U.S. 202 (1913), in which Justice Holmes wrote the Court's opinion approving the merger of firms owning three complementary technologies for producing shoes (lasting machines, welt-sewing machines, and outsole-stitching machines), including their patents. The result was the creation of the United Shoe Machinery monopoly, which lasted roughly a half century. See CARL KAYSEN, *UNITED STATES V. UNITED SHOE MACHINERY CORP.: AN ECONOMIC ANALYSIS OF AN ANTI-TRUST CASE* (1956).

¹⁰¹See HERBERT HOVENKAMP, *FEDERAL ANTITRUST POLICY: THE LAW OF COMPETITION AND ITS PRACTICE* §3.9d (5th ed. 2015).

¹⁰²See Erik N. Hovenkamp & Herbert Hovenkamp, *Buying Monopoly: Antitrust Limits on Damages for Externally Acquired Patents*, 25 *TEX. INTEL. PROP. L.J.* 39 (2017). Cf. *Trebro Mfg., Inc. v. Firefly Equip., LLC*, 748 F.3d 1159 (Fed. Cir. 2014) (permitting firm to acquire a patent from an outside inventor, keep it unused, but then obtain an injunction against a competitor).

Suppose, however, that the owner of one of these competing patent portfolios should acquire the portfolio held by the other. This owner then continues to use its existing portfolio of patents but keeps the acquired portfolio unused. Alternatively, a non-practicing entity might acquire both portfolios and then license one or both of them. In both of these cases the acquisition would have created a market monopoly over the processes for making this chip, and in a way that is not authorized by the Patent Act. That is, the Patent Act authorizes inventors to patent their inventions and obtain whatever amount of exclusion the patent provides.¹⁰³ One patentee may also purchase or license patents from another.¹⁰⁴ However, there is no right in the Patent Act to make an acquisition that creates a monopoly.¹⁰⁵ While competitively harmless patent acquisitions are authorized by the Patent Act, patents are also “assets” that are subject to the merger laws.¹⁰⁶ In addition, if one firm acquires another firm with a substantial patent portfolio, that merger is subject to condemnation under the merger laws.¹⁰⁷

In *Intellectual Ventures* the district court dismissed a §7 lawsuit that

¹⁰³35 U.S.C. §271 (defining scope of patent infringement).

¹⁰⁴35 U.S.C. §261 (granting right to assign and license).

¹⁰⁵That is, the right to acquire a patent does not entail a right to do so anticompetitively. See Herbert Hovenkamp, *Antitrust and the Patent System: A Reexamination*, 76 OHIO ST. L.J. 467 (2015).

¹⁰⁶*Automated Building Components v. Trueline Truss Co.*, 318 F. Supp. 1252 (D. Or. 1970) (acquisition of various assets including patent applications covered by § 7); *Dairy Foods, Inc. v. Farmers Co-op Creamery*, 298 F.Supp. 774 (D.Minn. 1969) (patent acquisition subject to §7); *Western Geophysical Co. v. Bolt Assoc.*, 305 F. Supp. 1248 (D. Conn. 1969) (exclusive patent license with an obligation to develop sublicenses after two years could be covered by Clayton Act § 7). See also Premerger Notification; Reporting and Waiting Period Requirements (“Notice of Final Rulemaking”), 78 Fed. Reg. 68,705-07 (Nov. 15, 2013) (FTC’s revised requirement of reporting of significant acquisitions of exclusive rights in pharmaceutical patents). See *Pham. Research & Mfrs. Of Am. V. FTC*, 2015 WL 3556040 (D.C.Cir. June 9, 2015) (applying *Chevron* deference and approving FTC rule). On patents as “assets” covered by §7 of the Clayton Act, see United States Department of Justice and Federal Trade Commission, *Antitrust Guidelines for the Licensing of Intellectual Property* (2017), available at <https://www.justice.gov/atr/IPguidelines/download> §5.7 (2017); HERBERT HOVENKAMP, MARK D. JANIS, MARK A. LEMLEY, CHRISTOPHER LESLIE, AND MICHAEL CARRIER: *IP AND ANTITRUST* §14.01 (3d ed. 2016).

¹⁰⁷*FTC v. CCC Holdings, Inc.*, 605 F.Supp.2d 26 (D.D.C. 2009) (enjoining acquisition combining two firms whose principal assets were patented, specialized software). See also *FTC, To Promote Innovation: The Proper Balance of Competition and Patent law and Policy* 2-3 (2003), available at <http://www.ftc.gov/os/2003/10/innovationrpt.pdf>.

raised these issues.¹⁰⁸ Intellectual Ventures (IV), a non-practicing entity, had acquired from third party inventors substantially all of the patents covering certain types of transactions in financial services industries. At the time the value or validity of the patents was largely undetermined, although some were later found invalid.¹⁰⁹ The antitrust challenger alleged that IV's strategy was to obtain patent ownership blanketing the entire market, making it impossible for banks to do business in this market without licensing IV's patents.¹¹⁰ For purposes of this strategy the acquired patents would have to be treated as substitutes, or competitors, so this was a horizontal merger.¹¹¹

In rejecting an antitrust merger challenge by the infringement defendant, the court reasoned that once the merger occurred and IV owned all the patents in question, then it would have a legal right to enforce them. This right would be limited only by the restraints that antitrust or patent law impose on the bringing of infringement actions on unenforceable patents.¹¹² Since the only way competition could be lessened by the merger was through the bringing of infringement suits, the court reasoned, the merger was lawful because that right was protected by the *Noerr Pennington* doctrine, which creates a right to bring a lawsuit reasonably believed to be meritorious.¹¹³ While *Walker Process* can condemn a lawsuit on a patent known to be unenforceable, both the Patent Act¹¹⁴ and the First Amendment petitioning right recognized in *Noerr-Pennington* permit suits on patents reasonably believed by the enforcer to be valid and infringed.¹¹⁵

¹⁰⁸ *Intellectual Ventures I, LLC v. Capital One Financial Corp.*, 2017 WL 5970720 (D. Md. Nov. 30, 2017).

¹⁰⁹ *See Intellectual Ventures, LLC v. Capital One Financial Corp.*, 850 F.3d 1332 (Fed. Cir. 2017) (finding patents in question invalid as directed toward abstract ideas).

¹¹⁰ *Intellectual Ventures, supra*, 2017 WL 5970720 (“Capital One characterizes IV's business model as comprised of three components: *accumulate* a vast portfolio of patents purportedly relating to essential commercial banking services, *conceal* the details of those patents so that the banks cannot determine whether their products infringe any of IV's patents, and serially *litigate* to force the banks to capitulate and license the portfolio at exorbitant cost”).

¹¹¹ Portfolios of patent would naturally include both substitutes and complements, but a strategy of eliminating alternatives would naturally apply to their competitive relationship.

¹¹² *Intellectual Ventures I, LLC v. Capital One Financial Corp.*, 2017 WL 5970720, *11 (D. Md. Nov. 30, 2017).

¹¹³ *Ibid.*

¹¹⁴ *See* 35 U.S.C. §271 (d)(3).

¹¹⁵ *See* *Eastern R.R. Presidents Conf. v. Noerr Motor Freight, Inc.*, 365 U.S. 127 (1961); *United Mine Workers v. Pennington*, 381 U.S. 657 (1965). On the use of the doctrine in antitrust litigation, *see* PHILLIP E. AREEDA & HERBERT HOVENKAMP,

Factually, of course, that is true. Once someone owns a portfolio of patents it has a right to enforce any or all of them. But under the incipency test, that is a reason for condemning the merger, not for permitting it. The Patent Act permits both the invention of monopoly-creating technologies and the transfer of patents; however, it does not permit the creation of monopoly by means of transfer rather than invention. Here the merger incipency test is essential because, once the anticompetitive acquisition has occurred, the infringement lawsuits will be treated as the conduct of a single firm. In that case, an antitrust court is powerless to intervene except in the very narrow circumstances defined by the *Walker Process* doctrine.

Indeed, if given precedential effect, the district court's holding would effectively prohibit application of §7 of the Clayton Act to virtually any acquisition of rights in intellectual property. The mechanism by which such an acquisition "lessens" competition will always be the power to assert the acquired right against infringers, a right that the *Noerr-Pennington* doctrine protects.¹¹⁶

It is worth noting that the right to enforce traditional property rights in court is also protected by the First Amendment petitioning immunity. For example, it protects the land owner's right to file a complaint against trespassers.¹¹⁷ But that hardly means that all acquisitions of plant and equipment are immune from §7 simply because these property rights, once acquired, can be legally enforced.

The problem of anticompetitive patent or other IP acquisitions can often be best addressed by insisting that IP acquisitions that would otherwise violate §7 be limited to nonexclusive licenses. The acquisition of a non-exclusive license gives a firm, whether monopolist or not, all it needs to produce in the market in question, thus enabling it to use acquired patents to stay up to date with technology. What it does not do, however, is give the dominant firm a right to shut down or otherwise challenge the technology of

ANTITRUST LAW ¶¶201-208 (4th ed. 2014).

¹¹⁶See Brief for the United States and Federal Trade Commission as Amici Curiae in Support of Neither Party, *Intellectual Ventures I, LLC v. Capital One Financial Corp.*, at 20-21 (Fed. Cir., Case 18-1367, May 11, 2018) (quoting this paragraph and concluding "Likewise, *Noerr-Pennington* does not protect anticompetitive patent acquisitions from antitrust liability simply because the patent holder subsequently engages in protected litigation activity.>").

¹¹⁷See, e.g., *Venetian Casino Resort, LLC v. NLRB*, 793 F.3d 85 (D. C. Cir. 2015) (casino owner's summoning of police officers to enforce state law of trespass to land protected by *Noerr*, provided that the walkway in question was really a part of casino owner's private property).

others, as in the *Intellectual Ventures* litigation. The acquisition problem is doubly serious when the patents in question are not merely acquired from an outside inventor, but when they are acquired and *unused*.¹¹⁸ The principal value of a patent license is to enable a firm to produce using the licensed technology. A nonexclusive license is all it needs for this purpose. Recognizing this, several merger decrees, both litigated and by consent, have conditioned acquisitions on the parties' agreement to turn patent assignments or exclusive licenses into nonexclusive licenses.¹¹⁹

To be sure, such an approach very largely undermines the *Intellectual Ventures* business model whenever the acquisitions in question are anticompetitive. But that hardly means that the original patent owners in question are left without a remedy. To return to the hypothetical situation of two competing patent portfolios for making a microprocessor,¹²⁰ a producer would still have to acquire licenses to one of these two portfolios, but it would have the right that is consistent with both patent law and antitrust law, which is to acquire that right in a competitive market in which the rival patentees could bid for that manufacturer's licensing business.

To summarize, a patent gives its owner the right to profit from the patented technology by either practicing it or licensing it out in whatever market the patentee finds itself. It does not, however, create a right to create market monopoly by transfer as opposed to invention. The merger incipency rule gives effect to this limitation.

VII. Acquisitions of Small but Highly Innovative Firms

A large firm's acquisition of a small, highly innovative firm can raise serious long run competition issues, even if the two firms are not competitors at the time of the acquisition. Such an acquisition may not have an immediate impact on price. Further, many of them have an important efficiency

¹¹⁸ On this problem, see Erik Hovenkamp & Thomas F. Cotter, *Anticompetitive Patent Injunctions*, 100 MINN. L. REV. 871 (2016). On the history of dominant firm strategies of filing infringement suits on externally acquired by unused patents, see Herbert Hovenkamp, *The Emergence of Classical Patent Law*, 58 ARIZ. L. REV. 263, 285-289 (2016).

¹¹⁹ E.g., *Great Lakes Chem. Corp.*, 103 F.T.C. 467, 461 (1984) (consent decree; applying §7 to a patent acquisition and requiring a nonexclusive license as the remedy). See also *in re Ciba-Geigy/Sandoz*, 1996 WL 743359 (FTC #961-0055) (requiring merged firms to license several gene therapy patents to a different firm); *in re Boston Scientific Corp.*, 60 Fed. Reg. 12,948 (1995) (conditioning merger approval on royalty free license in order to avoid abuse of dominant position).

¹²⁰ See discussion *supra*, text at notes 91-92.

justification – namely, that adding a complementary technology to the acquiring firm’s product is good for consumers. For example, Facebook’s 2014 acquisition of WhatsApp enabled it to expand its profile in the chat market, augmenting the value of its primary product.¹²¹ Google’s 2016 acquisition of Orbitera enabled it to compete more effectively with Amazon in the management of cloud-based software.¹²² Since their founding the large internet tech firms, including Facebook, Alphabet (Google), Microsoft, and Apple have made more than 500 such acquisitions.¹²³

While many of these acquisitions are economically beneficial, a few pose serious competitive risks,¹²⁴ but assessing them is difficult. Small, highly innovative firms can grow into larger ones, offering more competition in the market in question, but their acquisition by large incumbents eliminates that possibility.¹²⁵ The 2010 Horizontal Merger Guidelines contain a brief

¹²¹See <https://techcrunch.com/2015/02/19/crazy-like-a-facebook-fox/>.

¹²² See <https://www.ciodive.com/news/google-acquires-orbitera-to-help-encourage-multi-cloud-environments/424071/>.

¹²³Wikipedia maintains lists of smaller firms acquired by large tech. companies – eg., Facebook, at https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Facebook (65 listed acquisitions as of Dec. 2017); Alphabet (Google), at https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Alphabet#List_of_mergers_and_acquisitions (more than 200); Microsoft, at https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Microsoft (more than 200); Apple, at https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Apple#Acquisitions (92 listed acquisitions as of Dec. 2017). In addition, eBay has acquired some 40 companies, https://en.wikipedia.org/wiki/List_of_acquisitions_by_eBay; Yahoo! has acquired 114, https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Yahoo!; Twitter has acquired more than 50, https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Twitter; and IBM has acquired several hundred, https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_IBM#Acquisitions_since_2000.

¹²⁴ See Remarks of FTC Commissioner Terrell McSweeney, *Understanding Innovation and its Role in U.S. Merger Review* (March 16, 2017), available at https://www.ftc.gov/system/files/documents/public_statements/1176893/berlin_international_conference_on_competition_final.pdf.

¹²⁵See, e.g., *United States v. Bazaarvoice, Inc.*, 2014 WL 203966 (N.D. Cal. Jan. 8, 2014) (enjoining acquisition of innovative competitor, although there were also concerns about elimination of price competition in a highly concentrated market); Complaint, *In the Matter of Verisk Analytics, Inc., and EagleView Technology Corp.*, Dkt. No. 9363 ¶ 40 (Dec. 16, 2014),

discussion of the issue, recognizing two dangers. First, an acquired firm might be involved in introducing "new products that would capture substantial revenues from the acquiring firm."¹²⁶ Second is a "long-run effect" that might occur "if at least one of the merging firms has capabilities that are likely to lead it to develop new products in the future that would capture substantial revenues from the other merging firm."¹²⁷

Limiting acquisitions to nonexclusive licenses may be a workable antitrust solution in some cases, but not all. Such a license would permit the acquiring firm to take advantage of the acquired firm's technology, thus improving its own product or range of products, but without giving it a right to exclude others. Offsetting this, of course, is that many small firms will be worth much less if they are unable to transfer exclusive rights in their innovative technologies to a dominant firm. Further, acquisition of a nonexclusive license is necessarily a partial asset acquisition, leaving the selling firm with the untransferred assets. As a result, such acquisitions may not provide the selling firms with an attractive means of exiting from the market.

Nevertheless, as noted before,¹²⁸ the right to transfer a patent does not entail the right to create a market monopoly. Acquisitions of innovative startups are valuable to society because they enable the acquiring firm to improve its product or keep up with technological change. However, when a large firm acquires a highly innovative small firm and then either shuts that firm down or fails to deploy its technology, this opportunity for gain is lost. In that case the principal consequence of the acquisition is to prevent the acquired firm's technology from reaching the market at all. As a result, antitrust law should give close scrutiny to acquisitions of small firms whose assets are unlikely to be deployed into the market. Also deserving scrutiny

<http://www.ftc.gov/system/files/documents/cases/141216veriskcmpt.pdf>.

(challenge to merger of highly innovative new entrant that could have offered greater competition to established firm).

¹²⁶2010 Horizontal Merger Guidelines, *supra* note 33 at §6.4. *See also* EU Guidelines on the Assessment of Horizontal Mergers under the Council Regulation on the Control of Concentrations Between Undertakings ¶¶8, 20, 38, 45 (2004).

¹²⁷2010 Horizontal Merger Guidelines, *supra*, note 33, §6.4. *See* Gordon M. Phillips & Alexei Zhdanov, R&D and the Incentives from Merger and Acquisition Activity, NBER Working Paper #18346 (2013), available at <http://www.nber.org/papers/w18346> (data suggests that the prospect of acquisition induces smaller firms to innovate more in hope of selling out, but larger firms to innovate less because they would prefer to obtain new technology by merger rather than internal development).

¹²⁸ *See* discussion *supra*, text at note 104.

are acquisitions of small firms whose product serves to duplicate the acquiring firms product rather than providing a valuable complimentary extension. The most prominent explanation of such an acquisition is elimination of the acquired firm's anticipated competition.

One solution with more promise, in at least some situations, is post-acquisition challenges. Some mergers might not be anticompetitive at the time of the transaction but become so later on. Further, a government action for an injunction is not governed by the Clayton Act's four year statute of limitation, but rather by the equitable, judge-made doctrine of laches, which can permit such a lawsuit long after the merger has occurred.¹²⁹ The traditional rule is that the doctrine of laches as a limitation on equitable relief, as opposed to damages, does not run against the government, although it may bear on the type of relief to which the government is entitled. The courts generally look at the overall situation, shortening the period where it seems clear that the challenger could have acted earlier but did not do so, or lengthening it when the anticompetitive threat did not emerge until years after the acquisition occurred.¹³⁰ For example if a merger presents a competitive threat only several years after an acquisition, then the government should be excused for not bringing its action earlier. In all events, it must be clear that the emergent competitive threat was caused by the merger, and this will not necessarily be easy when the challenge follows the merger by many years. On the other hand, it should be relatively clear when the the firm's use of the

¹²⁹See *California v. Am. Stores, Co.*, 495 U.S. 271, 295-296 (1990) (government could bring equity challenge to merger even though time period for plaintiff had expired). Justice Kennedy concurred, but objected to the majority conclusion that laches might run more slowly against the government. *Id.* at 298. On the judge-made doctrine of laches governing equity suits in antitrust cases, see 2 PHILLIP E. AREEDA & HERBERT HOVENKAMP, *ANTITRUST LAW* ¶320g (4th ed. 2013).

¹³⁰*United States v. Pullman Co.*, 50 F. Supp. 123, 127 (E.D. Pa. 1943), *aff'd*, 330 U.S. 807 (1947) (noting that laches does not run against the government, but doubting that full remedial relief would be appropriate where the acquisition had occurred a half century earlier). See also *United States v. E.I. DuPont de Nemours & Co.*, 353 U.S. 586, 622-624 (1957) (Burton, j., dissenting) (noting traditional position that laches does not run against the government). Laches does apply to private plaintiffs. See, e.g., *Midwestern Machinery Co., Inc. v Northwest Airlines, Inc.*, 392 F.3d 265 (8th Cir. 2004) (laches barred eight-year delay in challenge to acquisition, at least where the transaction was known to plaintiff since it occurred); *Ginsburg v. InBev NV/SA*, 623 F.3d 1229, 1235 (8th Cir. 2010) (applying laches to completed merger where "the hardship and competitive disadvantage resulting from forced divestiture would be both dramatic and certain"). Cf. *Julius Nasso Concrete Corp. v. Dic Concrete Corp.*, 467 F. Supp. 1016, 1024 (S.D.N.Y. 1979) (laches serves to bar a claim only if the delay prejudices a defense that was otherwise available).

acquired asset is the source of the harm.

Conclusion

Government equity suits against mergers seem to require the courts to peer into a crystal ball. Most mergers today are challenged before they occur, but even after they have occurred certain effects may take years to materialize. As a result, there is a degree of long range prediction in merger litigation that goes far beyond what is common or perhaps even justifiable in other areas of law.

The need to predict the future would not be particularly important if every practice that a merger threatens could readily be detected and condemned should it occur later. In that case we could rest easy, permitting the merger to attain whatever efficiencies it is likely to produce, knowing that anticompetitive consequences can be interdicted if and when they materialize.

But too many anticompetitive practices do not fall into that category. Often post-merger conduct is likely to be anticompetitive but antitrust law has inadequate tools for dealing with it directly. This is particularly true of two classes of cases. One is coordinated, interdependent pricing that threatens reduced output or higher prices, but that is not readily reachable under antitrust law's "agreement" requirement.¹³¹ The other is conduct that, once the merger occurs, becomes unilateral and is able to take advantage of antitrust law's general toleration for unilateral price setting and refusals to deal.¹³²

Finally, the extent to which a court in a merger case must predict a probabilistic future varies with the situation. In traditional merger cases concerned about collusion-like conduct, the feared impact could occur very soon after the merger transaction is completed. That is also true for most unilateral effects horizontal merger cases. Foreclosure from vertical acquisitions may take somewhat longer to materialize, and patent infringement suits based on monopolistic combinations of externally acquired patents may have an even longer timeline. The longest latency period is very likely the acquisition of small but highly innovative firms, which absent the acquisition might take several years to grow into meaningful rivals, assuming they ever do.

Offsetting this is that the government equity action calls for no other remedy than a preemptive injunction against the acquisition. There are no

¹³¹See discussion *supra*, text at notes 10-11.

¹³²See discussion *supra*, text at notes 40-44.

prison sentences, large fines, private damages actions or other costly remedies other than prevention of the transaction itself.¹³³ Further, in the latter two sets of cases involving patent rights and highly innovative firms, acquisition of non-exclusive rights may provide the full set of economic benefits that the acquiring firm requires.

¹³³ On the importance of defining the breadth of the offense inversely to the permissible remedy, see 2 AREEDA & HOVENKAMP, ANTITRUST LAW, *supra* note 116, ¶303c.

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I hereby certify that on September 17, 2018, I filed the foregoing document electronically using the FTC's E-Filing System, which will send notification of such filing to:

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