ARTICLES

ANALYZING MERGERS IN INNOVATION MARKETS

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I. INTRODUCTION

The innovation-market approach to merger analysis represents the first systematic attempt by the antitrust enforcement agencies to come to terms with the effect of technological change on market structure and performance. By including the prospect of new and improved products in their evaluation of consumer welfare, the agencies have significantly broadened their view of cognizable harm to competition. Originally introduced in the context of licensing agreements for intellectual property,[1] innovation markets have recently been enlisted in a fundamental "realignment of merger review from static structural models toward an examination of the effect of a transaction on future competition."[2]

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1. *See* U.S. Department of Justice and Federal Trade Commission, *Antitrust Guidelines for the Licensing of Intellectual Property* (1995), *reprinted in* 4 Trade Reg. Rep. (CCH) at 20,738 [hereinafter *Intellectual Property Guidelines*].

2. Thomas N. Dahdouh, *The Shape of Things to Come: Innovation Market Analysis in Merger Cases*, 64 ANTITRUST L.J. 405 (1996).

Not surprisingly, these developments have proven controversial, attracting harsh criticism from outside the agencies[3] and equally vigorous responses from within.[4] To date, however, the battle has not been fully joined. Since 1994, the agencies have filed a series of complaints[5] challenging mergers in industries that were viewed as amenable to innovation-market analysis.[6] These complaints have alleged, *inter alia*, harms to competition in innovation markets and in future goods markets in violation of Section 7 of the Clayton Act. Since none of these cases has gone to trial, however, the courts have yet to rule on whether Section 7 extends to these types of markets.[7] Thus, the debate over the merits of the agencies' allegations has largely remained confined to the academy.

The legal relevance of the innovation market debate has also been constrained by the lack of a framework for analyzing the various factual claims underlying the agencies' approach. Critics have rightly pointed out that the innovation-market approach adds considerable factual uncertainty to the already complex problem of antitrust merger analysis.[8] However, factual uncertainty is an inherent part of most adjudication, and merger review is no exception.[9] If, as

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3. *See, e.g.*, George A. Hay, *Innovations in Antitrust Enforcement*, 64 ANTITRUST L.J. 7 (1995); Robert J. Hoerner, *Innovation Markets: New Wine in Old Bottles?*, 64 ANTITRUST L.J. 49 (1995); Richard T. Rapp, *The Misapplication of the Innovation Market Approach to Merger Analysis*, 64 ANTITRUST L.J. 19 (1995).

4. *See, e.g.*, Dahdouh, *supra* note 2; Richard J. Gilbert, *Defining the Crossroads of Intellectual Property and the Antitrust Laws: The 1995 Antitrust Guidelines for the Licensing of Intellectual Property*, ANTITRUST, Summer 1995, at 6; Richard J. Gilbert & Steven C. Sunshine, *Incorporating Dynamic Efficiency Concerns in Merger Analysis: The Use of Innovation Markets*, 63 ANTITRUST L.J. 569 (1995); 1 OFFICE OF POLICY PLANNING, FEDERAL TRADE COMMISSION, ANTICIPATING THE 21ST CENTURY: COMPETITION POLICY IN THE NEW HIGH-TECH, GLOBAL MARKETPLACE ch. 7 (1996) (visited June 11, 1997) <http://www.ftc.gov/opp/global/report/global1.htm> [hereinafter FTC POLICY REPORT].

5. The Federal Trade Commission has been more active than the Department of Justice in applying the innovation-market approach to merger analysis. *See infra* Part III.

6. *See* FTC POLICY REPORT, *supra* note 4, at 33 ("[W]e advocate a conservative approach to the use of innovative market analysis . . ."); *id.* at 38 ("[T]hese cases typically involved circumstances where regulatory processes permitted identification of the potential entrants and relatively secure conclusions that they would be unable to constrain anticompetitive conduct.").

7. The law is not settled on this question. However, it is clear that antitrust liability may extend to mergers in markets where no goods are currently being produced. *See* Dahdouh, *supra* note 2, at 432-33 & n.105 (citing United States v. Penn-Olin Chemical Co., 378 U.S. 158 (1964)).

It is possible that the forthcoming decision in *Federal Trade Commission v. Staples Inc.* will address this issue. Although the FTC did not explicitly advance the innovation-market concept, the idea of incorporating efficiency gains from innovation into a market definition is implicit in its theory of the case. *See* Karen Donovan, *Back to 'Brown Shoe'? Superstores Are Major FTC Target; New Antitrust Theory Says They're a Distinct Submarket*, NAT'L L.J., Apr. 21, 1997, at A1.

8. *See, e.g.*, Hay, *supra* note 3, at 14-15 (noting that innovation-market approach entails factual assumptions about firms' incentives to reduce costs); Rapp, *supra* note 3, at 26-27 (noting that approach depends on factual assumptions about relationship between market structure and innovation).

9. *See* Andrew Chin, Note, *Antitrust By Chance: A Unified Theory of Horizontal Merger Doctrine*, 106 YALE L.J. 1165, 1167 (1997) (reinterpreting horizontal merger doctrine as internally consistent framework of statistical inference).

a reviewer of the innovation market debate has concluded, the controversy lies "in the facts, not the theory,"[10] then it is appropriate to inquire whether a particular set of facts pertaining to an innovation market proves a likelihood of anticompetitive effect.

The purpose of this Article is to present a probabilistic framework for this analysis. Within this framework, an innovation market is construed as a potential product or service market in which each firm in the analysis has a certain probability of membership, and mergers are challenged based on the expected anticompetitive effect on this probabilistically defined market.[11] In incorporating and accounting for factual uncertainty, the purpose of the framework is not to refute the criticisms of the innovation-market approach, but to invite both sides to debate the facts and probabilities in common terms that implicate antitrust liability.

A simple example illustrates the difference between the proposed probabilistic framework and the current approach. Suppose that an agency alleges that two firms currently involved in research and development ("R&D") each have an 80% probability of successful innovation. The current approach constructs an innovation market so that each firm's share is proportional to its probability of successful innovation[12]—in this case, each firm is assigned a share of 50%—and then challenges a merger based on its structural effect on this innovation market. I argue that the innovation market should instead be construed as a potential market in which each firm has an 80% probability of membership.

This Article will show that the probabilistic framework is preferable to the current approach in four ways. First, it more thoroughly accounts for the uncertainty inherent in definitions of innovation markets and in allegations of anticompetitive effects on innovation markets. Second, it more accurately measures the structural effects of a merger on a market that faces the prospect of technological change. Third, it separates the fact-specific allegation that a merger will reduce the probability of successful innovation from the controversial general proposition that mergers hamper innovation. Finally, it construes innovation markets in a way that clearly falls within the cognizance of Section 7 of the Clayton Act.

Part II of this article reviews the current innovation-market approach to merger analysis and a number of the agencies' recent enforcement actions involving innovation markets. Part III shows that the probabilistic construction of innovation markets, unlike the current approach, provides a unified analytical

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10. Robert M. Brunell, *Symposium: A Critical Appraisal of the "Innovation Market Approach," Editor's Note*, 64 ANTITRUST L.J. 1, 6 (1995).

11. This framework follows a "traditional" analytical approach suggested by George Hay. *See* Hay, *supra* note 3, at 15 ("[E]ach of the firms is a potential entrant into the market. . . . I can think of no analytical or policy reason why such future markets cannot be relevant markets for antitrust purposes. . . .").

12. *See infra* text accompanying notes 27-28.

framework that incorporates the uncertainty inherent in every step of the analysis. This framework is more accurate than the current approach in measuring the effect of a merger on innovation-market structure and innovation output. Part IV reviews the debate over the relationship between market structure and innovation, and explains how the probabilistic construction of innovation markets separates fact-specific allegations about the structure-innovation relationship from the controversial general proposition that mergers hinder innovation. Part V shows that the probabilistic construction of innovation markets can be used to identify likely anticompetitive harms cognizable under Section 7 of the Clayton Act. Part VI provides a case study that illustrates the application of the probabilistic framework to the review of various mergers in a hypothetical five-firm market and suggests discrete classes of mergers for which innovation-market-based challenges are most likely to be successful.

II. THE CURRENT APPROACH TO INNOVATION MARKET ANALYSIS

A. Merger Review

A merger that significantly increases concentration in a highly concentrated market is presumptively illegal under Section 7 of the Clayton Act.[13] Structural merger analysis therefore begins with identification of the relevant market and calculation of the pre- and post-merger levels of concentration in the market.[14] The agencies also review countervailing factors in assessing the potential anticompetitive effects of a merger, including the likelihood of market entry by new firms[15] and the efficiencies that may be derived from the merger.[16]

The innovation-market approach to merger analysis, originally conceived by Richard J. Gilbert and Steven C. Sunshine, applies an analogous review procedure to a set of R&D activities "directed to particular new products and processes."[17] The analysis identifies a relevant innovation market and assesses the pre- and post-merger levels of concentration in innovation activity.[18] The agencies also take into account countervailing factors such as alternative sources

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13. *See, e.g.*, United States v. Philadelphia Nat'l Bank, 374 U.S. 321, 363 (1963); FTC v. Univ. Health, Inc., 938 F.2d 1206, 1218 (11th Cir. 1991); United States v. Baker Hughes Inc., 908 F.2d 981, 983 (D.C. Cir. 1990).

14. *See* Department of Justice & Federal Trade Commission 1992 Horizontal Merger Guidelines, 57 Fed. Reg. 41,552, 41,558 (1992) [hereinafter *Merger Guidelines*].

15. *See id.* at 41,561.

16. *See id.* at 41,562-63. Section 4 of the *Merger Guidelines* was revised on Apr. 8, 1997, to clarify how the agencies analyze claims that a merger is likely to achieve efficiencies. *See* Revised 1992 Merger Guidelines (visited June 15, 1997) <http://www.ftc.gov/bc/docs/horizmer.htm>; Department of Justice, Antitrust Division, *Justice Department and Federal Trade Commission Announce Revisions to Merger Guidelines*, News Release, Apr. 8, 1997, 1997 WL 166798.

17. Gilbert & Sunshine, *supra* note 4, at 595.

18. *See id.* at 596.

of R&D (following the Merger Guidelines' procedure for evaluating demand substitution and the likelihood of market entry)[19] and the efficiencies in R&D that may be derived from the merger.[20]

1. *Market Definition*

In defining a relevant innovation market for merger analysis, the agencies follow the procedure outlined in the *Intellectual Property Guidelines*:

> An innovation market consists of the research and development directed to particular new or improved goods or processes, and the close substitutes for research and development. The close substitutes are research and development efforts, technologies, and goods that significantly constrain the exercise of market power with respect to the relevant research and development, for example by limiting the ability and incentive of a hypothetical monopolist to retard the pace of research and development. The Agencies will delineate an innovation market only when the capabilities to engage in the relevant research and development can be associated with specialized assets or characteristics of specific firms.[21]

The agencies have looked to the market definition framework in the Merger Guidelines to elaborate the meaning of "close substitutes" for the purpose of merger review.

Thus, the definition of an innovation market begins with the set of overlapping R&D activities of the merging firms that may have a significant impact on a downstream product market.[22] Next, following the Merger Guidelines framework,[23] this set is successively augmented to include other firms' activities that are reasonable substitutes for the activities already in the set. These alternative activities include all foreseeable responses to a small but significant and nontransitory reduction in R&D by the merging firms. Thus, the innovation market extends to all firms that currently possess or could be expected to acquire the specialized assets necessary to pursue R&D directed to the same downstream product market.[24]

2. *Measurement of Market Concentration*

Given the difficulty in even identifying potential innovators, it is understandable that the agencies have not provided a specific procedure for measuring the concentration of an innovation market. The *Intellectual Property Guidelines* state that the agencies "will take into account all relevant evidence," including

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19. *See id.* at 595-96.
20. *See id.* at 596.
21. *Intellectual Property Guidelines*, *supra* note 1, at § 3.2.3.
22. *See* Gilbert & Sunshine, *supra* note 4, at 595.
23. *Merger Guidelines*, *supra* note 14, at § 1.3.
24. *See* Gilbert & Sunshine, *supra* note 4, at 595-96.

available market share data, buyers' and market participants' assessments, shares of specialized assets, shares of R&D expenditures, and shares of related products.[25] The guidelines, however, do not indicate how these data should be factored into the calculation to determine the "competitive significance" of each firm.

Noting that "[t]he proper measure of the merged firm's share of innovation activity will depend on individual circumstances,"[26] Gilbert and Sunshine suggest two approaches. If R&D budgets for the relevant new products or processes can be identified, then shares can be calculated based on those expenditures. Otherwise, the agencies should infer from the available evidence "the probability that a firm will be a successful innovator,"[27] and then translate these probabilities directly into market shares. For example, firms with an equal likelihood of successful innovation are assigned equal market shares.[28]

3. *Measurement of Entry*

In analyzing potential competition, the innovation-market approach defines likely market entrants as those firms that could acquire the assets necessary for the relevant R&D within two years "in response to a small but significant and nontransitory reduction in R&D."[29] This definition follows the framework of traditional antitrust entry analysis, which quantifies market entry in response to "a 'small but significant and nontransitory increase' in price."[30] Unlike an increase in price, however, a competitor's reduction in R&D is only indirectly related to a potential entrant's profitability. In particular, the secret and speculative nature of R&D may undermine efforts to predict and measure innovation-market entry by competitors. The secrecy of R&D efforts in some industries may make it impossible for a potential entrant to base an entry decision on a reduction in its competitors' innovation efforts.[31] In addition, some speculative innovation efforts, particularly those directed toward capturing and supplanting an entire existing market, are undertaken without regard to the conduct of competitors.[32]

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25. *See Intellectual Property Guidelines, supra* note 1, at § 3.2.3.

26. Gilbert & Sunshine, *supra* note 4, at 597.

27. *Id.*

28. *See id. Cf. Intellectual Property Guidelines, supra* note 1, at § 3.2.3 ("When entities have comparable capabilities and incentives to pursue research and development that is a close substitute for the research and development activities of the parties to a licensing arrangement, the Agencies may assign equal market shares to such entities.").

29. *Intellectual Property Guidelines, supra* note 1, at § 3.2.3.

30. *Merger Guidelines, supra* note 14, at § 1.11.

31. Dennis A. Yao & Susan S. DeSanti, *Innovation Issues Under the 1992 Merger Guidelines*, 61 ANTITRUST L.J. 505, 519-20 (1993).

32. FTC POLICY REPORT, *supra* note 4, at 37.

The Federal Trade Commission concedes that "the mechanisms that induce firms to enter into new innovation efforts" are not adequately understood,[33] but maintains that entry analysis is reasonable and appropriate in certain market settings. Consider the following examples. First, the FTC has focused on industries such as biotechnology and pharmaceuticals, "where regulatory processes permitted identification of the potential entrants and relatively secure conclusions that they would be unable to constrain anticompetitive conduct."[34] Second, in markets where firms are unaware of, or indifferent to, competing innovation efforts, the FTC is likely to conclude that "entry would not deter or counteract any anticompetitive conduct."[35] Third, in industries (e.g., biotechnology) where R&D efforts are well-publicized through issued patents and scientific journals, the FTC may have a factual basis for identifying firms with the ability and incentive to enter an innovation market.[36]

4. *Identification of Efficiencies*

As in the burden-shifting framework of the Merger Guidelines,[37] when the agencies apply the innovation-market approach to research joint ventures, they regard efficiencies as a claim to be raised in rebuttal by defendants:

> If the joint venture creates a significant risk of anticompetitive effects in the innovation market, the agency would proceed to consider efficiency justifications for the venture, such as the potential for combining complementary R&D assets in such a way as to make successful innovation more likely, or to bring it about sooner, or to achieve cost reductions in research and development.[38]

The agencies' lack of attention to the problem of identifying and assessing R&D efficiencies indicates that this part of the merger analysis will be left to the creativity of the defense lawyers. None of the merger challenges citing innovation markets thus far has suggested the existence of R&D efficiencies, and in two months of hearings on innovation and competition policy, the Federal Trade Commission never specifically considered the evaluation of efficiencies in the context of innovation markets.[39]

B. Merger Challenges

The Department of Justice preceded the Federal Trade Commission in introducing the innovation-market approach to merger analysis not only in the

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33. *Id.* at 38.
34. *Id.*
35. *Id.*
36. *Id.* at 38-39.
37. *See Merger Guidelines, supra* note 14, at § 3.3 (describing cognizable claims of efficiencies).
38. *Intellectual Property Guidelines, supra* note 1, at § 3.2.3.
39. *See* FTC POLICY REPORT, *supra* note 4, at 39.

antitrust literature[40] but also in the courts, through two complaints filed in 1993 and 1994. More recently, however, the FTC has been more active in pursuing and refining the approach. Since 1994, the FTC has filed various complaints alleging harms to competition in innovation markets on theories of coordinated interaction, unilateral effects, and elimination of potential competition.

1. *Department of Justice Complaints*

The first antitrust complaint to describe an innovation market appeared in *United States v. General Motors Corp.*,[41] a 1993 case in which the Antitrust Division challenged the sale of GM's Allison Transmission Division to ZF Friedrichshafen AG, a German company. The complaint alleged that the acquisition would substantially reduce competition in three markets:

> the manufacture and sale of automatic transmissions for transit buses in the United States; the manufacture and sale of automatic transmissions for heavy refuse trucks in the U.S.; and *worldwide technological innovation in the design and production of automatic transmissions* for medium and heavy duty commercial and military vehicles.[42]

The complaint used shares of the product market as proxies for shares of the innovation market. Noting that Allison and ZF designed a combined 89% of such transmissions currently sold, the complaint concluded that they were "by far the two dominant competitors" in the innovation market.[43] The alleged effect of the proposed acquisition would be to "reduce technological innovation that Allison and ZF currently conduct on an independent and competing basis" in designing medium and heavy automatic transmissions.[44] This complaint was never adjudicated; instead, the transaction was abandoned.[45]

In 1994, the Antitrust Division filed suit in *United States v. Flow Int'l Corp.*[46] to enjoin a merger of the two major manufacturers of ultra-high pressure waterjet pumps. In addition to preventing a monopoly in the product market, Assistant Attorney General Anne Bingaman said that the suit was "necessary to protect competition in development and improvement of waterjet technology."[47] Recently, however, even the proponents of innovation-market analysis have conceded that the anticompetitive effect on R&D alleged in this case was "largely

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40. *See* Gilbert & Sunshine, *supra* note 4.

41. Civ. No. 93-530, 6 Trade Reg. Rep. (CCH) ¶ 45,093, at 44,660 (D. Del. Nov. 16, 1993).

42. *Id.* (emphasis added).

43. *Id.*

44. *Id.*

45. N. Stoll & S. Goldfein, *The Justice Department and FTC: A Departure*, N.Y. L.J., April 19, 1994, at 3, col. 2.

46. Civ. No. 94-71320, 6 Trade Reg. Rep. (CCH) ¶ 45,094, at 44,682 (E.D. Mich. Apr. 4, 1994).

47. *Id.*

derived from the effect on markets for currently existing goods."[48] Again, the innovation market theory remained untested, as the merger was abandoned before the case proceeded to trial.[49]

2. *FTC Complaints*

a. Coordinated Interaction

Advocates of the innovation-market approach have argued that mergers, by reducing the number of innovating parties, may make it easier for the remaining firms to agree to limit their research and development efforts.[50] A theory of coordinated interaction was advanced in the FTC's *American Home Products*[51] complaint, which alleged, *inter alia*, that a merger would increase the likelihood of collusion or coordinated interaction in the innovation market for developing a rotavirus vaccine.[52] Since the merged firm would still have faced competition from a third firm to produce the new vaccine,[53] however, it is not clear why the innovators would have had an incentive to collude.

Two FTC attorneys have argued that the facts of the *Sensormatic*[54] complaint raised concerns of collusion.[55] The merger challenged in *Sensormatic* involved producers of anti-shoplifting labels and surveillance systems used in retail stores. The companies in the market were developing new disposable labels that would be affixed by manufacturers rather than retailers. According to the collusion theory, innovators had an incentive to agree to prevent the development of new label technologies that would be incompatible with the installed base of surveillance systems.[56] By reducing the number of firms in the market, the merger would have made successful coordination more likely.[57]

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48. Dahdouh, *supra* note 2, at 433 & n.106.

49. 6 Trade Reg. Rep. (CCH) ¶ 45,094 at 44,682.

50. Dahdouh, *supra* note 2, at 427 ("Logically, it is far easier for two or three innovators to agree successfully to pursue research over only one technology base, for example, than it would be for five or six innovators to do so.").

51. American Home Prods. Corp.; Proposed Consent Agreement with Analysis to Aid Public Comment, 59 Fed. Reg. 60,807 (1995).

52. *Id.*

53. Dahdouh, *supra* note 2, at 425 ("American Home Products and the acquired firm, American Cyanamid, were two of only three firms that had rotavirus drugs in or near the clinical trial stage.").

54. Sensormatic Electronics Corp.; Proposed Consent Agreement with Analysis to Aid Public Comment, 60 Fed. Reg. 5,428 (1995).

55. Dahdouh, *supra* note 2, at 426-27.

56. *Id.* at 427.

57. *Id.*

b. Unilateral Effects

The complaint in *Glaxo*[58] challenged a merger between Glaxo and Wellcome, two pharmaceutical firms that were competing to develop a new class of oral medications for treating migraine attacks.[59] The complaint alleged that the market for research and development of these new drugs was highly concentrated, and that market entry was difficult because of FDA regulation and the uncertainty "that a viable commercial product will result."[60] According to the complaint, the elimination of competition between Glaxo and Wellcome would allow Glaxo to reduce R&D efforts unilaterally, thereby reducing the likelihood of eventual output. The complaint also alleged that the merger would probably lead to a reduction in the number of research tracks pursued by firms in the innovation market.

A similar theory of unilateral restriction was alleged in *Upjohn,*[61] which challenged a merger between two of the "very small number of firms" developing a certain class of drugs for colorectal cancer. The FTC complaint alleged that the merged firm would abandon one of the two research tracks.[62] As in *American Home Products*, however, it is not clear why the merged firm would have an incentive to reduce its innovation efforts unilaterally when other competitors remained in the market. Nevertheless, the firms entered into a consent order requiring them to divest one of the research efforts to a competing third firm.[63]

c. Elimination of Potential Competition

Two FTC complaints addressed mergers between a leading firm in a current product market and a potential competitor in a future product market. In each case, the potential competitor was not a participant in the current product market but was attempting to develop a next-generation product that would displace the current one.

The complaint in *Wright Medical Technology*[64] challenged the proposed acquisition by Wright, the leading manufacturer of orthopaedic finger-implants, of Orthomet, a potential producer of a next-generation finger-implant. Because Orthomet was neither a participant nor a potential entrant in the current-generation product market,[65] the transaction would not have been a horizontal

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58. Glaxo plc.; Proposed Consent Agreement with Analysis to Aid Public Comment, 60 Fed. Reg. 16,139 (1995).

59. *Id.*

60. *Id.*

61. The Upjohn Co. and Pharmacia Aktiebolag; Consent Agreement with Analysis to Aid Public Comment, 60 Fed. Reg. 56,153 (1995).

62. *Id.*

63. *Id.*

64. Wright Medical Technology, Inc., et al.; Proposed Consent Agreement with Analysis to Aid Public Comment, 60 Fed. Reg. 460 (1995).

65. Although the complaint alleged that Orthomet was a potential competitor in the current-generation product market, the FTC's evidence showed that Orthomet's research effort was directed

merger in the classical sense. Nevertheless, the FTC alleged that the acquisition would reduce competition in both the current market and the market to develop next-generation products.[66] The case terminated in a consent order preventing Wright for ten years from acquiring any firm conducting, or intending to conduct, finger-implant research.[67]

A subsequent case, *Boston Scientific*,[68] presented a similar fact pattern. Boston Scientific, a manufacturer of intravascular ultrasound (IVUS) imaging catheters, attempted to acquire its leading competitor in the current IVUS market, as well as another firm that was not currently in the market but was expected to produce future-generation IVUS catheters within two to three years. The FTC challenged the first acquisition on traditional antitrust grounds and the second acquisition on potential competition and innovation-market theories similar to those advanced in *Wright Medical Technology*.[69] The resulting consent order required divestiture, as well as licensing of Boston Scientific's IVUS technology to competitors designated by the FTC.[70]

The FTC's complaint in *Hoechst*[71] alleged that the merger between two pharmaceutical companies, Hoechst and Marion Merrill Dow, had harmed competition in three product markets. In each of these markets, one of the merging firms was a major participant, while the other was a potential competitor. The resulting consent order required Hoechst to divest to a third party either the current product or the drug being developed. The FTC also ordered Hoechst to drop its patent infringement lawsuit against one of Marion Merrill Dow's former research partners, alleging that the suit would create a barrier to entry in a fourth product market.[72]

III. THE PROBABILISTIC CONSTRUCTION OF INNOVATION MARKETS

The Federal Trade Commission's recent complaints and policy documents suggest that any future merger challenge using the innovation-market approach will be based on a fact-specific analysis of the relationship between market

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toward next-generation products that "would destroy the market for the current products." *See* Dahdouh, *supra* note 2, at 429-30.

66. *Id. See also* FTC POLICY REPORT, *supra* note 4, at 13 n.43 ("The merged firm's incentives would resemble those of Kenneth Arrow's hypothetical monopolist, whose incentives to innovate are muted when the innovation would merely substitute for an existing product on which monopoly profits already are earned.").

67. *Id.*

68. Boston Scientific Corp.; Proposed Consent Agreement with Analysis to Aid Public Comment, 60 Fed. Reg. 12,948 (1995).

69. *Id.*

70. *Id.*

71. Hoechst AG; Proposed Consent Agreement with Analysis to Aid Public Comment, 60 Fed. Reg. 49,609 (1995).

72. *Id.*

structure and innovation. This fact-specific strategy recognizes the disparate competitive dynamics in markets involving different technologies,[73] but offers no guidance toward a general merger policy.

The probabilistic construction of innovation markets provides a more comprehensive way of addressing various propositions about the relationship between market structure and innovation. By requiring allegations to be quantified in terms of the pre- and post-innovation market structures and the pre- and post-merger probabilities of successful innovation by each firm, the courts can move away from an overall ruling on the merits of the innovation-market approach toward a particularized and rigorous evaluation of the facts presented.

A. Merger Review

The probabilistic construction of innovation markets provides a unified analytical framework for formulating a merger challenge that quantifies and incorporates the uncertainty inherent in the factual findings from each step of the merger review process.

1. *Market Definition*

In agency challenges to mergers, innovation markets have been defined by identifying the firms that allegedly possess the specialized assets necessary to produce a class of new or improved goods.[74] Ultimately, the FTC has noted, the definition of an innovation market "lead[s] back to the potential existence of a good."[75] In other words, each innovation market is associated with a market for a potential product, and a firm is included in an innovation market if there is a significant probability that it will be a participant in the associated downstream market. Grounding R&D competition in a potential line of commerce thus provides a basis for liability under Section 7 of the Clayton Act.

Critics of the innovation-market approach have emphasized that the identification of participants in potential markets is speculative and prone to error. For example, it may be impossible to identify the specialized assets necessary for an innovation before the innovation actually takes place.[76]

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73. *See infra* Part V for a review of the literature on the relationship between market structure and innovation.

74. *See* FTC POLICY REPORT, *supra* note 4, at 34 & n.118 (citing *General Motors* complaint, *supra* note 41, as an example of "specialized assets" approach to innovation market definition in merger analysis); *cf. Intellectual Property Guidelines*, *supra* note 1, at § 3.2.3 (requiring "specialized assets" approach for innovation market definition in analysis of licensing agreements).

75. FTC POLICY REPORT, *supra* note 4, at 34.

76. *See* Gilbert & Sunshine, *supra* note 4, at 596 ("In many market circumstances there is so much serendipity in research and development that it is impossible to predict the sources of innovation with reasonable certainty."); Rapp, *supra* note 3, at 37 ("The hard question is: What constitutes a 'specific asset?'").

To a large extent, the agencies can blunt this criticism by using the probabilistic construction of innovation markets. Uncertainty about the strategic posture of a firm or the relevance of its research assets with respect to an innovation market can be reflected in the probability estimate. Explicit estimates of each firm's probability of successful innovation can be used to distinguish among firms with varying R&D capabilities and their potential competitors. Most importantly, the probabilistic approach to innovation market definition acknowledges that each firm is only a potential participant in the downstream product market and, indeed, that the very existence of the downstream product market itself is an uncertain proposition.[77]

2. *Measurement of Concentration*

Several commentators have criticized the use of R&D budgets as proxies for innovation-market shares, pointing out that the relationship between the level of R&D expenditure and the likelihood of successful innovation is often tenuous. As Gilbert and Sunshine concede, R&D expenditure is only an input to innovation, so that any structural analysis based solely on R&D effort will probably be inadequate.[78] In addition, a merger may create efficiencies in the innovative process by eliminating duplicative research tracks.[79] Since the agencies have acknowledged these possibilities in their guidelines for innovation-market analysis,[80] it is unlikely that a court would sustain allegations about innovation-market concentration that were based solely on levels of R&D expenditure.

The agencies' other current method of assigning market shares in proportion to the estimated probability of successful innovation has not been specifically addressed by the critics of innovation markets. The probabilistic construction of innovation markets exposes two flaws in this second method of the agencies.

First, the probability of successful innovation by a firm represents the likelihood that it will appear in the downstream market, but it does not necessarily bear a functional relationship to the share it will occupy in that market.[81]

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77. *Cf.* Dahdouh, *supra* note 2, at 420 ("[E]xperience has shown that the certainty in defining an innovation market increases as the R&D effort gets closer to producing an ultimate product.").

78. *Cf.* Gilbert & Sunshine, *supra* note 4, at 597 ("It is clearly not sufficient to end the evaluation with a determination only of the likelihood that the combination will reduce R&D effort. The relevant competitive concern is whether the combination will have an adverse impact on innovation, for which R&D is only an input.").

79. Critics have also pointed out that the agencies might err in evaluating such efficiencies by misinterpreting them as collusive behavior. *See* Rapp, *supra* note 3, at 30 ("Neither does theory offer any guidance for distinguishing between the rationalizing R&D cutbacks two merging firms might make and those intended to reduce R&D to subcompetitive levels.").

80. *See Intellectual Property Guidelines*, *supra* note 1, at § 3.2.3 (noting that agencies will consider efficiency justifications for licensing joint ventures).

81. Noting that detailed information on competing R&D efforts may make it impossible to quantify their relative significance, Bryan Dunlap has suggested a more refined "transaction-specific

There is no reason to expect that the concentration of a market given by the Herfindahl-Hirschman Index (HHI)[82] will be measured correctly when the downstream market shares are distributed proportionally to the probabilities of successful innovation. Thus, Gilbert and Sunshine's second approach may understate or overstate the expected effect of a merger on market concentration. For example, consider an innovation market consisting of two equal-sized firms A and B, which are estimated by the agencies to have independent probabilities of successful innovation of 20 and 5%, respectively. As indicated in Table 1,[83] the expected HHI of the market is 6150, not 6800 as calculated using Gilbert and Sunshine's approach.[84] This error understates the expected effect on concentration of a merger between firms A and B.

Table 1. Erroneous Understatement of Structural Effect of Merger

Probability	Successful Innovation By		Market Shares	Herfindahl-Hirschman Index (HHI)	
	Firm A	Firm B		Pre-Merger	Post-Merger
0.76	No	No	(50,50)	5000	10000
0.19	No	Yes	(0,100)	10000	10000
0.04	Yes	No	(100,0)	10000	10000
0.01	Yes	Yes	(50,50)	5000	10000
Expected HHI Values				6150	10000
HHI Values Using Current Approach				6800	10000

composite that grades the significance of the R&D contenders according to each available comparative factor," including R&D expenditures, market surveys, and planned product launches. Bryan R. Dunlap, *A Practical Guide to Innovation Markets*, ANTITRUST, Summer 1995, at 21, 23-24. Even this more careful approach is directed toward estimating probabilities of successful innovation, and should not be misinterpreted as a calculation of innovation-market shares.

82. The *Merger Guidelines* use the Herfindahl-Hirschman Index (HHI) to measure market concentration, which is calculated by summing the squares of the market shares held by the respective firms. For example, an industry consisting of two firms with market shares of 70% and 30% has an HHI of 70^2+30^2, or 5800. *See generally* Richard A. Miller, *The Herfindahl-Hirschman Index as a Market Structure Variable: An Exposition for Antitrust Practitioners*, 27 ANTITRUST BULL. 593 (1982) (explaining calculation and interpretation of HHI).

83. In each of these calculations, we have assumed that in the case where both firms successfully innovate, they occupy an equal share in the downstream market. This assumption is not necessary: regardless of the value of the pre-merger HHI for this case, the first example understates, and the second example overstates, the expected effect of the merger on concentration.

84. The expected value of a statistic is the average of the values that can be taken by that statistic, weighted by their probabilities. Thus, in Table 1, the expected pre-merger HHI is calculated by summing the products of the probabilities of each case with the pre-merger HHI for each case: (.76)(5000) + (.19)(10000) + (.04)(10000) + (.01)(5000) = 6150.

Second, even if downstream market shares happen to be equal to innovation probabilities, Gilbert and Sunshine's second approach will generally overstate the effect of a merger on market concentration. This is because there is a positive probability that even without the merger, exactly one of the parties would have succeeded in innovating and entering the downstream market. For example, consider an innovation market consisting of two equal-sized firms C and D, each estimated by the agencies to have a 50% probability of successful innovation. As indicated in Table 2,[85] the probability of a monopoly is ½ and the probability of a duopoly is 1/2. Despite this, Gilbert and Sunshine's approach would always infer a duopoly, assigning each firm a 50% market share. This error overstates the expected effect on concentration of a merger between firms C and D. To avoid these errors, the agencies' estimates of the likelihood of successful innovation should be used to define the innovation market probabilistically.

Table 2. Erroneous Overstatement of Structural Effect of Merger

Probability	Successful Innovation By		Market Shares	Herfindahl-Hirschman Index (HHI)	
	Firm C	Firm D		Pre-Merger	Post-Merger
0.25	No	No	(50,50)	5000	10000
0.25	No	Yes	(0,100)	10000	10000
0.25	Yes	No	(100,0)	10000	10000
0.25	Yes	Yes	(50,50)	5000	10000
Expected HHI Values				7500	10000
HHI Values Using Current Approach				5000	10000

Calculating the expected level of concentration in the downstream market requires assumptions about the downstream market share of each firm, contingent on its success in innovation.[86] This aspect of the "competitive significance" of a firm is not functionally related to the firm's probability of successful innovation, but must be inferred from the same available evidence. The case study in Part VI will illustrate two of many possible approaches: assuming equal downstream market shares and assuming downstream market shares proportional to current market shares.

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85. *See supra* note 83.

86. In Table 2, the expected pre-merger HHI is calculated by summing the products of the probabilities of each case with the pre-merger HHI for each case: (.25)(5000) + (.25)(10000) + (.25)(10000) + (.25)(5000) = 7500. *See supra* note 84.

3. *Measurement of Entry*

The FTC describes how the competitive significance of a potential entrant to an innovation market may be quantified in terms of its likelihood of successful innovation, both in absolute terms and relative to the prospects of the merged firm:

> The "sufficiency" of likely and timely entry should similarly be evaluated in a pragmatic way. Whether the entering innovator's effort would be "sufficient" to deter or counteract a merger-induced loss of innovation competition might depend on factors such as whether the potential entry would involve the same or a different research track from that of the merged firm, and whether the potential entry would involve resource commitments sufficient to make the innovation effort likely to succeed.[87]

The agencies have provided no guidance as to how this probability of successful innovation by an entrant should be balanced against the increase in innovation-market concentration caused by a merger.[88] In contrast, the probabilistic construction of innovation markets provides a unified framework that can incorporate the likelihood of successful innovation by a potential competitor.

The probabilities of successful innovation by competing firms may be either independent or interdependent. For example, the economics literature has analyzed the tendency of competing firms to pursue research along similar tracks.[89] Firms pursuing an innovation along the same research track may be expected to succeed or fail together more often than firms taking different research tracks. The resulting positive correlation of probabilities of successful innovation is of public concern because too much similarity in research projects may result in socially wasteful duplication of effort.[90] The probabilistic construction of innovation markets reflects this concern by accounting for the joint dependence of success probabilities among the merging and non-merging firms. The case study in Part VI of this Article considers three of many possible simplifying assumptions: full dependence (single research track); full independence (independent research tracks); and patent race (at most one firm succeeds).

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87. FTC POLICY REPORT, *supra* note 4, at 39.

88. This failure to provide guidance in balancing the factors of market concentration and ease of entry also occurs in traditional antitrust analysis as expressed in the *Merger Guidelines* and subsequent caselaw. *See* Chin, *supra* note 9, at 1185-87; Victor Hsu, *The Ease of Entry Doctrine in Merger Law: Managing the Waste of* In re Echlin, 20 PAC. L.J. 75, 80 (1988).

89. *See, e.g.*, S. Bhattacharya & D. Mookherjee, *Portfolio Choice in Research and Development*, 17 RAND J. ECON. 594 (1986).

90. *See* JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION 397 (1993) ("[W]hen a firm moves away from its rival in the space of research projects, the first firm increases the probability that when it is unsuccessful its rival will be successful—which is socially desirable.").

4. *Identification of Efficiencies*

The probabilistic construction of innovation markets makes explicit the factual claim implicit in the agencies' omission of an analysis of efficiencies. It is roughly equivalent to the assumption that the probability of successful innovation by the merged firm will not exceed the probability that at least one of the parties would have succeeded without the merger.

This assumption is only one of many about the relationship between the pre- and post-merger probabilities of successful innovation by the merging parties. A merger need not result in reduced innovation output; indeed, it may enhance the efficiency of innovation efforts through economies of scale, complementarity of research assets, and rationalization of duplicative research efforts. Accordingly, the case study in Part VI of this Article will consider three possible relationships: no change (the probability of successful innovation by the merged firm is equal to the pre-merger probability of successful innovation by at least one of the merging parties), reduced probability of successful innovation, and enhanced probability of successful innovation.

B. Merger Challenges

Each of the merger challenges reviewed in Section II.B of this Article specifically alleged that the merger would harm consumers by reducing the overall likelihood of successful innovation. The agency complaints alleged that innovation output would be reduced following a merger, either because of coordinated or unilateral action by the merging parties to restrict R&D efforts or because the merger would eliminate a potentially competing R&D effort.

In their leading article on the innovation-market approach to merger analysis, Gilbert and Sunshine used the facts of the *General Motors* case[91] to illustrate the Antitrust Division's theory of harm. Where "there are evidentiary reasons to believe that if the two firms merge, the innovation either will not occur or will occur at a much later date," the loss of innovation competition will independently result in a performance/price loss in the downstream product market.[92] However, Gilbert and Sunshine do not suggest a procedure for combining evidence about the innovation efforts of the merging parties with evidence about innovation-market structure to conclude that the merger would reduce the overall likelihood of innovation.

The probabilistic construction of innovation markets requires that the agencies explicitly state their factual allegations in terms that, if accepted, would allow a court to determine the effect of a merger on the overall likelihood of successful innovation. This requirement may raise high and complex standards

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91. United States v. General Motors Corp., Civ. No. 93-530, 6 Trade Reg. Rep. (CCH) ¶ 45,093, at 44,660 (D. Del. Nov. 16, 1993).

92. Gilbert & Sunshine, *supra* note 4, at 583-84.

of proof for the agencies, but these are not insurmountable. Each step in the current innovation-market approach to merger analysis yields factual findings relevant to the probabilistic construction of an innovation market. The case study in Part VI of this Article shows how a complaint based on the probabilistic construction of an innovation market could contain facts sufficient to yield a presumption of anticompetitive effect.

IV. THE MARKET STRUCTURE-INNOVATION RELATIONSHIP

Despite the structural resemblance between the traditional merger review framework and the current innovation-market approach, the theory of antitrust injury underlying the Merger Guidelines does not immediately transfer to innovation-market analysis. It is not clear that concentration in innovation markets tends to result in the harmful exercise of market power. To the contrary, the causal relationship between market concentration and the level of innovative activity has been a matter of controversy in the economic literature for several decades.

Joseph Schumpeter in 1942 is credited with first suggesting that market concentration was positively correlated with innovative activity. Because large-scale businesses could afford to pay the costs and bear the risks of R&D, he argued, they served as "the most powerful engine of progress" in the industrial age.[93] For Schumpeter, this hypothesis found historical support in the modernization of agriculture:

> As soon as we go into details and inquire into the individual items in which progress was most conspicuous, the trail leads not to the doors of those firms that work under conditions of comparatively free competition but precisely to the doors of the large concerns—which, as in the case of agricultural machinery, also account for much of the progress in the competitive sector—and a shocking suspicion dawns upon us that big business may have had more to do with creating that standard of life than keeping it down.[94]

Schumpeter's claim that market power stimulates innovation has been widely rejected in favor of more nuanced descriptions of the relationship between market structure and the incentive to innovate.[95] The innovation-market approach to merger analysis, insofar as it presupposes that market power may retard innovation efforts in at least some cases, also rejects Schumpeter's thesis. Even so, it is an exaggeration to regard the approach as a "'reverse' Schumpeterian

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93. JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY 106 (1942).

94. *Id.* at 82.

95. *But see* Franklin M. Fisher & Peter Temin, *Returns to Scale in Research and Development: What Does the Schumpeterian Hypothesis Imply?* 81 J. POL. ECON. 56 (1973) (criticizing research on Schumpeter's hypothesis as too narrowly focused on relationship between market power and innovation).

campaign,"[96] because, as this Article makes clear, it does not require a wholesale antitrust policy against concentration in innovation markets.

In a game-theoretic analysis, Partha Dasgupta and Joseph Stiglitz developed an influential theory of the structure-innovation relationship.[97] By their account, firms in a structurally competitive market have a greater incentive to race for a patent monopoly in a future product market than firms that already enjoy a monopoly over current products.[98] The situation is different, however, if technology is moving slowly, so that the structure of the post-invention market is expected to be similar to that of the current market. In this case, a monopolist has a greater expectation of profits in the new market than a small competitor has, and a relatively high level of concentration may be expected to be most conducive to innovation efforts.[99] Subsequent empirical studies have supported the Dasgupta-Stiglitz hypothesis that the relationship between innovative effort and market concentration has the shape of an "inverted-U,"[100] with higher optimal market concentrations observed in traditional, slow-moving technologies.[101]

Attempting to provide a single description of the relationship between market structure and innovation, F.M. Scherer and David Ross have reported that "[t]echnical progress thrives best in an environment that nurtures a diversity of sizes,"[102] which corresponds to some intermediate level of optimal market concentration.[103] This rather ambiguous conclusion reconciles the disparate competitive dynamics in fast- and slow-moving technologies, but can offer little insight toward a coherent merger policy.

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96. Editor's Note, *Symposium: A Critical Appraisal of the "Innovation Market Approach,"* 64 ANTITRUST L.J. 1, 2 (1996).

97. Partha Dasgupta & Joseph Stiglitz, *Uncertainty, Industrial Structure, and the Speed of R&D*, 11 BELL J. ECON. 1 (1980).

98. *Id.* at 25.

99. *Id.*

100. *See* Reinhard Angelmar, *Market Structure and Research Intensity in High-Technological Opportunity Industries*, 34 J. INDUS. ECON. 69 (1985); Richard C. Levin *et al.*, *R&D, Appropriability, and Market Structure: New Evidence on Some Schumpeterian Hypotheses*, 75 AM. ECON. REV. 20 (1985). *But see* Zoltan J. Acs & David B. Audretsch, *Innovation in Large and Small Firms: An Empirical Analysis*, 78 AM. ECON. REV. 678 (1988) (finding negative correlation between industry-wide innovation and concentration).

101. *See* F.M. SCHERER & DAVID ROSS, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 647-48 (1990).

102. *Id.* at 654.

103. *See id.* at 660. Reviewing the empirical and theoretical literature on the relationship between market structure and innovation effort, Scherer and Ross conclude:

> Viewed in their entirety, the theory and evidence suggest a threshold concept of the most favorable climate for rapid technological change. A bit of monopoly power in the form of structural concentration is conducive to innovation, particularly when advances in the relevant knowledge base occur slowly. But very high concentration has a positive effect only in rare cases, and more often it is apt to retard progress by restricting the number of independent sources of initiative and by dampening firms' incentive to gain market position through accelerated R&D.

Id.

Instead of assuming a simple relationship between market structure and innovation, the probabilistic construction of innovation markets requires that the relevant structure-innovation relationship for a particular merger be quantified in terms of the pre- and post-invention market structures and the pre- and post-merger probabilities of successful innovation by each firm. Within this framework, a race for a patent monopoly may present particular hypotheses about post-invention market structure (monopoly), the correlation between pre-invention market concentration and the probability of successful innovation by at least one firm (negative[104]), and the joint probabilities of successful innovation by more than one firm (zero[105]). On the other hand, the premise that technological advances are occurring slowly may correspond to the hypotheses that pre- and post-innovation market structures will be similar, and that the probabilities of successful innovation are highly interdependent and positively correlated with market share.[106] Furthermore, a patent monopoly race and competition consisting of small incremental advances represent only two points on a continuum of possible relationships between market structure and innovation, all of which can be expressed similarly in terms of market structure and probabilities of successful innovation.

A complaint may also allege specific facts about an innovation market that may bear on the structure-innovation relationship. For example, within the probabilistic framework, the collusion theory in *Sensormatic*[107] could have been used to justify a finding that concentration in the market for new security label technologies would cause a reduction in the probability of successful innovation.

The probabilistic construction of innovation markets would challenge both sides of this debate to refine the factfinding process. It would require the agencies to be more specific and quantitative in alleging harms to innovation. For their part, critics of innovation markets would be required to address their arguments about the uncertain relationship between market structure and innovation output to fact-specific allegations that already incorporated a degree of uncertainty. The probabilistic construction of innovation markets thus provides terms for the ensuing debate that should be acceptable to both sides.

V. THE THEORY OF HARM UNDER SECTION 7 OF THE CLAYTON ACT

The agencies' merger challenges have suggested two main theories linking increased concentration in innovation markets to anticompetitive reductions in

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104. This follows from the Dasgupta-Stiglitz hypothesis relating to patent races. *See supra* text accompanying note 98.

105. That is, at most one firm can win the patent race.

106. This follows from the Dasgupta-Stiglitz hypothesis relating to competitions for innovation in slow-moving technologies. *See supra* text accompanying note 99.

107. Sensormatic Electronics Corp., 60 Fed. Reg. 5,428 (1995).

innovation activity: "unilateral effects" and "coordinated interaction."[108] These theories draw upon analogies to the established economic models of oligopoly pricing that underlie the Merger Guidelines and recent merger jurisprudence.

In the Cournot model, each firm in a concentrated market can unilaterally restrict its output below the competitive level, because (by assumption) its competitors will not attempt to increase their outputs in response.[109] Analogously, a firm can unilaterally curtail its own innovation efforts if it can be confident that no other competitor will be able to overtake it in the race to innovate.[110] In the Stigler model, a cartel is more likely to enforce collusive pricing in a concentrated market, because price-cutting is easier to detect when fewer firms are setting prices.[111] Similarly, an agreement to restrict the number of research and development tracks is more likely to succeed in a concentrated market, because it is easier for each firm to detect and punish cheating—by cross-licensing agreements, for example.[112]

These analogies are both descriptively and prescriptively weak. Whereas the Cournot and Stigler theories are based on the incentive for firms to maximize profits, innovation-market analysis must assert the far less obvious incentive for firms to restrict innovation.[113] Furthermore, while standard analysis demonstrates the welfare loss from supracompetitive pricing and subcompetitive output, it is much more difficult to assess the harm (if any) that would result from the reduction in innovative efforts. Thus, while the Cournot and Stigler models provide general theoretical support for antitrust enforcement in concentrated product markets[114] (for example, by justifying the Herfindahl index of market concentration as a proxy measure for the likely extent of anticompetitive harm[115]), innovation-market analysis has power only in particular cases.

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108. *See supra* Part III; Dahdouh, *supra* note 2, at 423, 425.

109. *See* A. COURNOT, RECHERCHES SUR LES PRINCIPES MATHÉMATIQUES DE LA THÉORIE DES RICHESSES (1838); JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION 218-23 (1988).

110. *See* Dahdouh, *supra* note 2, at 423-25.

111. *See* George J. Stigler, *A Theory of Oligopoly*, 72 J. POL. ECON. 44, 48-56 (1964).

112. *See* Dahdouh, *supra* note 2, at 427.

113. Gilbert and Sunshine concede that the incentive to restrict innovation is not universal and cannot support a theory of collusion "especially if an innovation would be likely to have a significant impact on existing competitive relationships." Gilbert & Sunshine, *supra* note 4, at 597.

114. Of the significance of the Stigler model in justifying the *Merger Guidelines*, Richard Rapp writes:

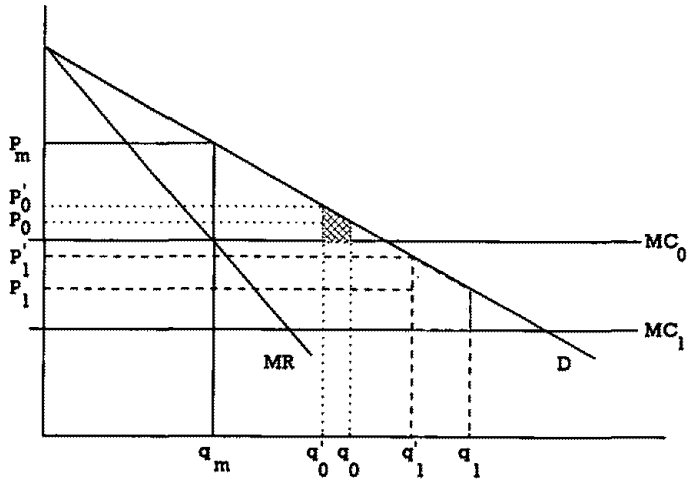
> It is an overstatement to say that the 1992 *Horizontal Merger Guidelines* are simply an application of George Stigler's theory of oligopoly. This assertion ignores refinements concerning single-firm market power and the influence of conditions of entry. Nevertheless, the theoretical nexus that ties the HHIs in relevant markets—defined by substitution criteria—to the preservation of price competition is Stigler's well-accepted idea that more pricing voices make it harder to enforce cartel discipline.

Rapp, *supra* note 3, at 29 n.36. The Cournot model, together with refinements concerning conjectural variation, is another theory of oligopoly that supports the application of the *Merger Guidelines*. *See* Alan A. Fisher et al., *Price Effects of Horizontal Mergers*, 77 CAL. L. REV. 777, 794-809 (1989).

115. *See* John E. Kwoka, Jr., *The Herfindahl Index in Theory and Practice*, 30 ANTITRUST

In summary, the theories of harm offered by the innovation-market approach depend upon specific facts relating to (1) the pre- and post-merger probabilities of successful innovation by the firms in the market and (2) the economic value of the innovation. The proposition that a particular merger will cause a reduction in innovative output can be expressed in terms of probabilities of successful innovation, and the economic significance of an innovation can be represented by a reduction in the marginal cost of a product.[116] These factual claims are necessarily implicit in every merger challenge that invokes the concept of innovation markets: to support the challenge, the innovation must be worth having, and the merger must make it less likely that the innovation will occur.

Figure 1. Theory of Anticompetitive Harm Under the Conventional and Innovation-Market Approaches to Merger Analysis



By requiring that these factual claims be made explicit, the probabilistic framework fills the gaps in the analogy between oligopoly pricing theory and innovation market analysis. Figure 1 illustrates how the innovation-market approach can supply the information necessary to identify an anticompetitive threat that would have evaded conventional merger analysis. Under the Cournot and Stigler models, a merger in a moderately concentrated product market is expected to increase the equilibrium price, say from P_0 to P_0', and to decrease the quantity produced from q_0 to q_0'. The effect of an innovation that reduces the unit cost of the product from MC_0 to MC_1 would be to reduce the pre-merger equilibrium price from P_0 to P_1. If, as in Figure 1, the changes in costs and

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BULL. 915, 925-31 (deriving Herfindahl index from Cournot and Stigler theories). The *Merger Guidelines* use threshold values of the Herfindahl index to confer a presumption of illegality on mergers between sufficiently large firms in concentrated markets. *See Merger Guidelines*, *supra* note 14, at § 1.51.

116. *See* Gilbert & Sunshine, *supra* note 4, at 583 (describing a hypothetical innovation that reduces unit cost of aluminum ingot).

prices are substantial, a merger may harm consumers in the post-innovation, downstream market in two new ways. First, if the merger discourages innovation efforts, it will reduce the likelihood that the reduction in unit cost actually occurs. Second, even if the innovation occurs, the increase in the expected concentration of the downstream market due to the merger may result in a greater deadweight welfare loss (corresponding to a price increase from P_1 to P_1') than would have been detected by traditional merger analysis. These harms should be found cognizable under Section 7 of the Clayton Act.[117]

VI. CASE STUDY

A challenge under Section 7 of the Clayton Act should be based on facts that show that a merger would be a probable[118] but-for cause of higher consumer prices in a product market.[119] By modeling the expected effects of mergers on prices in potential future goods markets, we can formulate a theory of likely anticompetitive harm based on the probabilistic construction of innovation markets.

In this analysis, we will adopt the following notations:

$\|\eta\|$	elasticity of demand
n	number of firms in pre-merger, pre-innovation market
s_i	market share of firm i ($1 \le i \le n$)
A_i	event of successful innovation[120] by firm i ($1 \le i \le n$)
p_i	value of $Prob(A_i)$ before the merger; i.e., pre-merger probability of innovation success by firm i ($1 \le i \le n$)
p	pre-merger probability that at least one firm successfully innovates
p_i'	value of $Prob(A_i)$ after the merger; i.e., post-merger probability of innovation success by firm i ($1 \le i \le n$)
p'	post-merger probability that at least one firm successfully innovates
P_0	equilibrium price in pre-merger market without innovation
MC_0	marginal cost without innovation
h_0	Herfindahl index of pre-merger market without innovation ($h = HHI/10000$, $0 \le h \le 1$)
P_1	equilibrium price in pre-merger market, accounting for possible innovation
MC_1	marginal cost after innovation

117. *See supra* note 11.

118. *See generally* Chin, *supra* note 9 (describing the *Merger Guidelines*' implicit reliance on probabilistic facts and statistical inference).

119. The consumer price standard of antitrust enforcement is equivalent to the output standard when demand is sufficiently elastic, and is consistent with the legislative intent of Section 7 of the Clayton Act, as well as the Sherman Act's prohibition against anticompetitive "restraint of trade." *See* Fisher et al., *supra* note 114, at 780-81 & nn.10-11.

120. In the case of a patent race, we will understand "successful innovation" by a firm to mean that the firm succeeded in obtaining a patent monopoly on the innovation.

h_1 Herfindahl index of pre-merger market, accounting for possible innovation ($h = HHI/10000$, $0 \le h \le 1$)

P_0' equilibrium price in post-merger market without innovation

h_0' Herfindahl index of post-merger market without innovation ($h = HHI/10000$, $0 \le h \le 1$)

P_1' equilibrium price in post-merger market, accounting for possible innovation

h_1' Herfindahl index of post-merger market, accounting for possible innovation ($h = HHI/10000$, $0 \le h \le 1$)

For simplicity, I will confine my analysis to the Cournot model of oligopoly pricing. Although the Cournot assumption that firms do not respond to their competitors' output choices is considered extreme, the model provides a simple linear relationship between supracompetitive pricing and the Herfindahl index of market concentration. The analysis can be generalized in a straightforward way by adding conjectural variations in each firm's output in response to those of its competitors.[121]

According to Cournot pricing theory:

$$P_0 = \frac{MC_0}{1 - h_0/|\eta|}$$

Suppose that each firm i, $1 \le i \le n$, is engaged in R&D that provides a probability p_i of reducing its marginal cost to some constant $MC_1 < MC_0$. If any firms succeed in their innovation efforts, all unsuccessful firms must exit the market.

We will consider two alternative hypotheses about the post-innovation market structure:

Prop.: The post-innovation market is distributed in proportion to the successful firms' pre-innovation market shares.

Unif.: The post-innovation market is distributed uniformly among the successful firms.

Taking into account the probability p that a post-innovation market will replace the pre-innovation market, the expected value[122] of the Cournot price is given by:

$$E(P_1) = p \cdot E\left(\frac{MC_1}{1 - h_1/|\eta|}\right) + (1 - p)P_0 \qquad (*)$$

121. *See* Fisher et al., *supra* note 114, at 820-21.

122. *See supra* note 84.

The calculation of p and the distribution of the random variable h_1 requires not only the n probabilities $p_1, \ldots, p_n$, but also the joint success probabilities of all $2^n - 1$ subsets of firms. We will consider three possible simplifying assumptions:

"Single research track": $p_i \leq p_j$ implies $A_i \Rightarrow A_j$.
"Independent research tracks": The p_i are independent.
"Patent race": $A_i \Rightarrow \neg A_j$ for all $j \neq i$ (i.e., at most one firm can successfully innovate).

As the result of a merger between firms i and j, a firm with market share $s_i + s_j$ and some probability of successful innovation p_m' replaces the two firms. We will consider three alternative simplifying assumptions, each of which assumes that the success probabilities do not change for the non-merging firms:

Restr.: "Anticompetitive restriction": $p_m' = (0.5)Prob\{A_i \vee A_j\}$.[123]
Unch.: "No change": $p_m' = (1.0)Prob\{A_i \vee A_j\}$.
Effic.: "Efficient enhancement": $p_m' = \min\{(1.5)Prob\{A_i \vee A_j\}, 1\}$.

By making the necessary substitutions for s_i and p_i in (*), we can calculate the percentage change in $E(P_1)$, which we will call the *expected price effect of the merger*.

The calculation of an expected price effect may be illustrated most simply for the example given in Table 2. This hypothetical merger involved two equal-sized firms, each with an independent probability of successful innovation of 50%. It was further specified that if both firms successfully innovated, they would have equal shares in the post-innovation market. For this calculation, we will further assume that there is no change in the overall probability of innovation as a result of the merger, and that $|\eta|=2$, $MC_0=2$, and $MC_1=1$. We then have:

$$E(P_1) = p \cdot E\left(\frac{MC_1}{1 - h_1/|\eta|}\right) + (1-p)P_0$$

$$= (0.75) \cdot \left((1/3)\frac{1}{1 - (0.5)/2} + (2/3)\frac{1}{1 - 1/2}\right) + (0.25) \cdot \frac{2}{1 - (0.5)/2}$$

$$= 2$$

$$E(P_1') = p' \cdot E\left(\frac{MC_1}{1 - h_1'/|\eta|}\right) + (1-p')P_0'$$

$$= (0.75) \cdot \frac{1}{1 - 1/2} + (0.25) \cdot \frac{2}{1 - 1/2}$$

$$= 2.5$$

123. Notation: $X \vee Y$ ("X-inclusive-or-Y") is the event that X, or Y, or both, occur.

It follows that the expected price effect of the merger is [(2.5)/2]−1, or an increase of 25%. This is lower than the 50% price increase that would have been found under traditional Cournot analysis.[124] The result indicates that the agencies should not attempt to apply the innovation-market theory in challenging this merger.

Because of the complexity of the calculations, closed-form conditions for any given price effect threshold are beyond the scope of this Article. By performing the analogous numerical calculation for all possible combinations of the assumptions we have outlined in a particular five-firm market,[125] it may be possible to identify the most important factual elements of an innovation-market-based theory of anticompetitive effect. With the aid of a spreadsheet program, we have considered mergers between four different pairs of firms in a hypothetical market consisting of five firms A, B, C, D, and E with shares of 5, 5, 10, 40 and 40%, respectively. This share distribution was chosen because it provided a wide variety of firm and merger sizes. As in the above example, we have assumed $|\eta| = 2$ and $MC_1/MC_0 = 1/2$. The four alternative mergers considered were between:

AB: A and B;
BC: B and C;
CD: C and D;
DE: D and E.

Each such merger was considered under four alternative hypotheses regarding the pre-merger probabilities of innovation success:

Prop.: "Competitive significance proportional to current market share": $p_i = s_i/2$ for all i.
Unif.: "Uniform competitive significance": $p_i = 0.1$ for all i.
Only2: "The only two significant innovators are merging": $p_i = 0.2$ for the merging firms; $p_i = 0.02$ for the non-merging firms.
2of3: "Two of the three significant innovators are merging": $p_i = 0.2$ for the merging firms and the remaining firm with the smallest market share; $p_i = 0.02$ for the two remaining firms.

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124. Under traditional Cournot analysis, the merger would be found to increase the price from 2/(1−(0.5)/2)=8/3 to 2/(1−1/2)=4, or an increase of 50%.

125. The five-firm case is of interest in part because of a hypothetical example presented by Dennis Yao and Susan DeSanti in the first article that suggested the application of innovation-market analysis to mergers. The authors considered an industry in which five companies had significant R&D programs relating to a given technology and proceeding along independent research tracks. The unilateral effect of the merger might include an incentive for the merged firm to restrict its own innovation efforts, thereby causing a reduction in the industry's overall innovation output. *See* Yao & DeSanti, *supra* note 31, at 517-18. This hypothetical is among the scenarios analyzed in this section (see the cases for uniform pre-merger probability of successful innovation, restricted post-merger probability of successful innovation, and independent research tracks).

The results of these calculations are presented in Table 3. Note that since the price effect of a merger in the current market without innovation is the same with respect to all of the hypotheses about innovation success probabilities and post-innovation market structure, it is listed only once for each merger. Similarly, since the patent race assumption corresponds to its own hypothesis about post-innovation market structure, the price effect is listed only once across both market-structure hypotheses.

Table 3. Expected Price Effects of Illustrative Mergers

Merger	Probability of Successful Innovation		Post-Innovation Market Structure	Expected Price Effect of Merger			
				Current Market	Post-Innovation Market		
	Pre-Merger	Post-Merger			Single Track	Indep. Tracks	Patent Race
AB	Prop.	Restr.	Prop.	0.3%	0.5%	2.7%	0.6%
AB	Prop.	Restr.	Unif.		-0.5	2.9	
AB	Prop.	Unch.	Prop.		1.2	1.5	0.2
AB	Prop.	Unch.	Unif.		-0.3	0.2	
AB	Prop.	Effic.	Prop.		1.2	-0.7	-0.3
AB	Prop.	Effic.	Unif.		-0.3	-2.4	
AB	Unif.	Restr.	Prop.		-1.1	**8.5**	1.1
AB	Unif.	Restr.	Unif.		-2.8	**12.1**	
AB	Unif.	Unch.	Prop.		0.3	0.3	0.2
AB	Unif.	Unch.	Unif.		-2.5	0.3	
AB	Unif.	Effic.	Prop.		-2.3	-6.3	-0.8
AB	Unif.	Effic.	Unif.		-5.3	-11.5	
AB	Only2	Restr.	Prop.		**5.6**	**16.9**	2
AB	Only2	Restr.	Unif.		**5.4**	**28.5**	
AB	Only2	Unch.	Prop.		0.1	0	0.2
AB	Only2	Unch.	Unif.		-0.6	0.3	
AB	Only2	Effic.	Prop.		-5.4	-16.8	-1.7
AB	Only2	Effic.	Unif.		-6.6	-27.9	

Merger	Probability of Successful Innovation		Post-Innovation Market Structure	Expected Price Effect of Merger			
				Current Market	Post-Innovation Market		
	Pre-Merger	Post-Merger			Single Track	Indep. Tracks	Patent Race
AB	2of3	Restr.	Prop.		0	**22.9**	2
AB	2of3	Restr.	Unif.		-1	**28.5**	
AB	2of3	Unch.	Prop.		0.3	0.2	0.1
AB	2of3	Unch.	Unif.		-0.8	0.3	
AB	2of3	Effic.	Prop.		-5.2	-14.5	-1.8
AB	2of3	Effic.	Unif.		-6.8	-27.9	
BC	Prop.	Restr.	Prop.	0.6	0.9	4.3	1
BC	Prop.	Restr.	Unif.		-0.3	4.5	
BC	Prop.	Unch.	Prop.		1.1	1.1	0.3
BC	Prop.	Unch.	Unif.		-0.2	0.5	
BC	Prop.	Effic.	Prop.		1.3	-2	-0.4
BC	Prop.	Effic.	Unif.		-0.1	-3.6	
BC	Unif.	Restr.	Prop.		-0.6	**9.2**	1.3
BC	Unif.	Restr.	Unif.		-2.6	**12.4**	
BC	Unif.	Unch.	Prop.		0.6	0.5	0.3
BC	Unif.	Unch.	Unif.		-2.3	0.6	
BC	Unif.	Effic.	Prop.		-2	-6.1	-0.6
BC	Unif.	Effic.	Unif.		-5	-11.2	
BC	Only2	Restr.	Prop.		**5.7**	**16.9**	2.2
BC	Only2	Restr.	Unif.		**5.7**	**28.9**	
BC	Only2	Unch.	Prop.		0.2	0.1	0.4
BC	Only2	Unch.	Unif.		-0.3	0.6	
BC	Only2	Effic.	Prop.		-5.3	-16.8	-1.5
BC	Only2	Effic.	Unif.		-6.4	-27.7	

Merger	Probability of Successful Innovation		Post-Innovation Market Structure	Expected Price Effect of Merger			
				Current Market	Post-Innovation Market		
	Pre-Merger	Post-Merger			Single Track	Indep. Tracks	Patent Race
BC	2of3	Restr.	Prop.		0.2	**23.1**	2.2
BC	2of3	Restr.	Unif.		-0.7	**28.9**	
BC	2of3	Unch.	Prop.		0.8	0.9	0.2
BC	2of3	Unch.	Unif.		-0.6	0.6	
BC	2of3	Effic.	Prop.		-4.7	-13.9	-1.7
BC	2of3	Effic.	Unif.		-6.5	-27.7	
CD	Prop.	Restr.	Prop.	5	5.3	**18.7**	5.7
CD	Prop.	Restr.	Unif.		3.5	**20.9**	
CD	Prop.	Unch.	Prop.		3	8.8	2.8
CD	Prop.	Unch.	Unif.		0.4	3.7	
CD	Prop.	Effic.	Prop.		-4.2	3.8	-0.2
CD	Prop.	Effic.	Unif.		-7.7	-13.6	
CD	Unif.	Restr.	Prop.		4	**14.3**	3.9
CD	Unif.	Restr.	Unif.		1.5	**17.4**	
CD	Unif.	Unch.	Prop.		4.6	4.4	2.8
CD	Unif.	Unch.	Unif.		1.8	5.1	
CD	Unif.	Effic.	Prop.		1.9	-2.5	1.6
CD	Unif.	Effic.	Unif.		-1.2	-7.3	
CD	Only2	Restr.	Prop.		**10.3**	**22**	5.3
CD	Only2	Restr.	Unif.		**10.1**	**34.6**	
CD	Only2	Unch.	Prop.		4.5	4.4	3
CD	Only2	Unch.	Unif.		3.6	5	
CD	Only2	Effic.	Prop.		-1.2	-13.2	0.6
CD	Only2	Effic.	Unif.		-2.9	-24.5	

Merger	Probability of Successful Innovation		Post-Innovation Market Structure	Expected Price Effect of Merger			
				Current Market	Post-Innovation Market		
	Pre-Merger	Post-Merger			Single Track	Indep. Tracks	Patent Race
CD	2of3	Restr.	Prop.		3.4	**26.3**	4.5
CD	2of3	Restr.	Unif.		3.2	**34.6**	
CD	2of3	Unch.	Prop.		3.5	2.8	2
CD	2of3	Unch.	Unif.		3.4	5.1	
CD	2of3	Effic.	Prop.		-0.6	-9.9	-0.4
CD	2of3	Effic.	Unif.		-3.1	-24.5	
DE	Prop.	Restr.	Prop.	23.8	21.9	**47.1**	21.8
DE	Prop.	Restr.	Unif.		20	**54.7**	
DE	Prop.	Unch.	Prop.		8.4	32.7	13
DE	Prop.	Unch.	Unif.		2.8	16.1	
DE	Prop.	Effic.	Prop.		-5.1	18.3	4.1
DE	Prop.	Effic.	Unif.		-14.3	-22.6	
DE	Unif.	Restr.	Prop.		21.1	**32.6**	15.2
DE	Unif.	Restr.	Unif.		18.7	**38.3**	
DE	Unif.	Unch.	Prop.		21.8	20.9	13
DE	Unif.	Unch.	Unif.		19	23.8	
DE	Unif.	Effic.	Prop.		18.6	12.7	10.8
DE	Unif.	Effic.	Unif.		15	9.3	
DE	Only2	Restr.	Prop.		28.9	**42.3**	18.3
DE	Only2	Restr.	Unif.		28.8	**58.6**	
DE	Only2	Unch.	Prop.		22.1	21.7	13.9
DE	Only2	Unch.	Unif.		28.2	23.8	
DE	Only2	Effic.	Prop.		15.4	1.1	9.5
DE	Only2	Effic.	Unif.		11.6	-11	

Merger	Probability of Successful Innovation		Post-Innovation Market Structure	Expected Price Effect of Merger			
				Current Market	Post-Innovation Market		
	Pre-Merger	Post-Merger			Single Track	Indep. Tracks	Patent Race
DE	2of3	Restr.	Prop.		23.3	**51.6**	14.1
DE	2of3	Restr.	Unif.		19.8	**58.6**	
DE	2of3	Unch.	Prop.		20.9	19.5	9.6
DE	2of3	Unch.	Unif.		19.9	23.8	
DE	2of3	Effic.	Prop.		14.1	1.3	5.1
DE	2of3	Effic.	Unif.		11.4	-11	

Table 3's implications for the innovation-market approach to merger analysis can be derived by considering a threshold price effect for antitrust enforcement[126] and determining the combinations of hypotheses that would be expected to give rise to a violation. In particular, we may focus on price effects in Table 3 that are significantly greater than those found under traditional Cournot theory. We have highlighted in bold a slightly underinclusive set of these price effects that yields several parsimonious conclusions.

The first conclusion that can be drawn from Table 3 is that innovation market analysis is not likely to add much to a challenge against a merger that is already presumed illegal under the Merger Guidelines. The price effects from the mergers between the largest firms, D and E, calculated under the innovation-market theory were not much greater, and in many cases much less, than those calculated without accounting for innovation.

Second, innovation market analysis is not likely to help a merger challenge in a market where firms are racing to capture a patent monopoly over the successor market. Since the post-innovation market will be a monopoly whether or not the firms merge, harm can result only if the merged firm has the power to block innovation altogether. A few fringe innovators are sufficient to minimize this harm.

Third, when different firms are pursuing an innovation along a single track, innovation market analysis can contribute substantially to a merger challenge only if (a) the merging firms are the only two significant innovators in the market

126. Even in recent years, the agencies have been ambivalent as to whether mergers have been reviewed under an efficiency standard or a price standard. *See* Fisher et al., *supra* note 114, at 791 n.51. To the extent that a price standard has been used, available evidence suggests that the Justice Department moved from a 5% test to a 10% test in the mid-1980s. *Id.* at 790 n.48.

and (b) the merged firm is likely to restrict innovation. In particular, these conditions require that all of the significant innovators be identifiable with a high degree of confidence and that an incentive for anticompetitive behavior be shown.

Finally, innovation market analysis may be most helpful in challenging mergers in markets where firms are pursuing an innovation along independent research tracks, because a merger in such markets *per se* reduces the diversity of innovation sources. The innovation-market approach can be constructive provided that it can be shown that the merged firm is likely to restrict its own innovative output.

These conclusions suggest that the agencies should try to focus their use of innovation-market analysis on industries where innovation policy has not been preempted by patent law and where diverse innovation sources need to be protected. In each case, the agencies when relying on the innovation-market theory should provide specific support for the allegation that the merged firm will have an incentive to restrict innovation.

The probabilistic construction of innovation markets calls upon both sides of the debate over the innovation-market approach to merger analysis to elaborate the specific facts of each case in quantitative terms relevant for assessing antitrust liability. In particular, it requires the agencies to allege the innovation-market theory in a way that neither overstates nor understates the structural effect of a merger. While the analytical framework presented here does not resolve the factual uncertainty that is inherent in the innovation process, it can supply the necessary guidance for the courts to evaluate mergers fairly in light of that uncertainty.