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GEOGRAPHIC COMPETITION AND COLLUSION IN DUOPOLY

Charles H. Steen* and Kevin S. Marshall**

I. INTRODUCTION

The division of geographic markets into exclusive territories by horizontally competitive firms is a per se violation of the Sherman Act, and under some circumstances, even invites criminal sanctions.¹ Conventional...
antitrust policy also precludes mergers that might allow firms to monopolize geographic markets. While the underlying rationale driving per se liability may be appropriate in cases involving most "naked restraints of trade," such a conclusive presumption may be inappropriate in oligopoly and duopoly markets, given the realities of their interdependent natures. Under reasonable assumptions, one can demonstrate that market division agreements may actually enhance societal surplus in a market driven by producer interdependence. Under such limited and constrained assumptions, collusion (whether tacit or explicit) to divide geographic markets may result in a welfare increasing Nash equilibrium.

II. THE PER SE RULE AGAINST TERRITORIAL COLLUSION

The Supreme Court applies per se prohibitions to "agreements or practices which, because of their pernicious effect on competition and their lack of any redeeming virtue, are conclusively presumed to be unreasonable and therefore illegal, without elaborate inquiry as to the

per se unlawful); United States v. Koppers Co., 652 F.2d 290, 293 (2d Cir. 1981) (dicta); Engine Specialties v. Bombardier Ltd., 605 F.2d 1, 7-11 (1st Cir. 1979) (holding market division agreement between manufacturer of minicycles and potential entrant per se unlawful); Gainsville Utils. Dept. v. Florida Power & Light Co., 573 F.2d 292, 300 (5th Cir. 1978) (holding geographic market division between two utilities covering wholesale power unlawful per se); United States v. Consol. Laundries Corp., 291 F.2d 563, 574 (2d Cir. 1961) (holding horizontal customer allocation scheme among linen supply companies per se unlawful); Agencies v. Blue Cross & Blue Shield United, No. 88-C20265, 1993 U.S. Dist. LEXIS 3446, at *72 (N.D. Ill. Feb. 26, 1993) (holding territorial division agreement among otherwise competing health insurers unlawful per se); Bascom Food Prods. Corp. v. Reese Finer Foods, 715 F.Supp. 616, 630-632 (D.N.J. 1989) (holding market arrangement unlawful notwithstanding some doubt about whether the arrangement was really horizontal).

2. In addressing the rationale for a per se rule of liability with respect to a "naked restraint of trade," the Supreme Court has made it clear that a commercial practice will be condemned where it 1) usually results in significant adverse competitive effects; 2) is rarely justified by significant redeeming virtues; and 3) when there are often less restrictive alternatives available. See ROBERT PITOFSKY ET AL., TRADE REGULATION 228 (5th ed. 2003). See also Northwest Wholesale Stationers, Inc. v. Pac. Stationery & Printing Co., 472 U.S. 284 (1985); FTC. v. Superior Court Trial Lawyers Ass'n, 493 U.S. 284 (1985); Cont'l TV, Inc. v. GTE Sylvania, Inc., 433 U.S. 36 (1977).

3. See AREEDA & HOVENKAMP, supra note 1, § 14.07 at 471 (defining "one firm's actions [as] interdependent with those of another when their utility depends on the other firm's response. If firm A has any influence on market price, it knows that its price change will affect rivals and that its gain from changing price depends upon rival reactions." Similarly, if firm A directs its competitive efforts into a territory, it knows that such effort will affect rivals and that its gain from such efforts will depend upon its rival's reactions).
precise harm they have caused or the business excuse for their use." The classical applications of *per se* prohibitions have been to cases involving price fixing cartels.

In *United States v. Topco Associates, Inc.*, the Supreme Court held that the division of geographic markets into exclusive territories by horizontal competitors, like price fixing, constituted a *per se* violation of Section 1 of the Sherman Act. In *Topco*, the Supreme Court went so far as to state that the law was then long-settled because the activity constituted a horizontal restraint with no purpose other than to reduce competition; the justices therefore deemed territorial collusion *per se* illegal. Notwithstanding the *Topco* Court's emphatic statement on this point, the cases relied upon by the Court to support its ruling do not establish a *per se* rule against horizontal territorial collusion. Since *Topco*, meanwhile, the wisdom of

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4. Cont'l T.V., 433 U.S. at 50 (applying the standard from N. Pac. R. Co. v. United States, 356 U.S. 1, 5 (1958), to abolish the *per se* prohibition against vertically motivated territorial restraints).

5. See, e.g., *United States v. Trenton Potteries Co.*, 273 U.S. 392 (1927) (rejecting the appellate court's rule of reason analysis, and holding that price fixing agreements among horizontal competitors are unlawful *per se*).

6. *United States v. Topco Assocs., Inc.*, 405 U.S. 591, 608-12 (1972) (Marshall, J.) (stating without citation, "One of the classic examples of a *per se* violation of §1 is an agreement between competitors at the same level of the market structure to allocate territories in order to minimize competition" and holding that an agreement by horizontal competitors to divide geographic markets into exclusive territories is a *per se* violation of Section 1 of the Sherman Act, 15 U.S.C. §1).

7. In *Topco*, Justice Marshall reasoned: (1) horizontal agreements are unlawful *per se*; (2) the division of geographic markets presented in *Topco* was a horizontal agreement; and (3) therefore, the agreement was unlawful *per se*. *Topco*, 405 U.S. at 608-12. Justice Marshall cited numerous cases wherein various varieties of horizontal restraints were held to be unlawful *per se*; however, none of those cases actually made geographic collusion alone—absent an agreement to fix prices, for example—unlawful *per se*. *Id.*

8. Justice Marshall wrote, "This Court has reiterated time and time again that '[h]orizontal territorial limitations . . . are naked restraints of trade with no purpose except stifling of competition.'" *Topco*, 405 U.S. at 608 (quoting White Motor Co. v. United States, 372 U.S. 253, 263 (1963)). However, *White* involved exclusive territories in distribution contracts (vertical restraints). White Motor Co., 372 U.S. at 267 (Brennan, J., concurring) ("But . . . territorial restraints were imposed [vertically]."). To the extent *White* can be read as involving a horizontal agreement, its *per se* rule was derived from *Timken Roller Bearing Co. v. United States*, 341 U.S. 593 (1951). But, although *Timken* clearly involved geographic allocations, the Court was equally clear that its objections, and application of the *per se* rule, ran to an aggregation of trade restraints, including price fixing. *Timken*, 341 U.S. at 597-98. Thus, *Timken* does not establish that simple territorial collusion, absent price fixing, suffered *per se* illegality before *Topco*, despite Justice Marshall's apparent certainty to the contrary.
applying *per se* illegality to horizontal restraints has been undermined generally, both in legal commentary and case law. Nevertheless, the *per se* rule against geographic collusion continues in full force and effect.

The model proffered below demonstrates the danger in applying a *per se* rule of liability in all market division cases. It also illustrates the merits of a *rule of reason analysis* applied to geographic sub-competitive environments of oligopoly and duopoly where welfare enhancement may be a remedial concern.

### III. Federal Merger Policy’s Concern with Geographic Concentration

Federal horizontal merger policy is primarily concerned with geographic concentration. Under the standard analysis of a horizontal merger, whether challenged by federal authorities or private litigants, the essential foci include: (1) geographic market delineation, typically determined according to the well-known Elzinga-Hogarty test; and (2)

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9. Rothery Storage & Van Co. v. Atlas Van Lines, Inc., 792 F.2d 210, 226 (D.C. Cir. 1986) (Bork, J., joined by Ginsburg, J.) ("to the extent that *Topco* and *Sealy* stand for the proposition that all horizontal restraints are illegal *per se*, they must be regarded as effectively overruled."), *cert. denied*, 479 U.S. 1033 (1987). In his carefully reasoned opinion, Judge Bork surveyed the emergence and evolution of *per se* illegality under the Sherman Act, and reasoned that based upon the Supreme Court’s reformation of the law of horizontal restraints in *Broadcast Music, Inc. v. Columbia Broadcasting System*, 441 U.S. 1 (1979), and *National Collegiate Athletic Association v. Board of Regents*, 468 U.S. 85 (1984), and other post-*Topco* cases, the general applicability of *per se* illegality to horizontal restraints was neither a wise nor workable approach to antitrust law and policy. See also Martin B. Louis, *Restraints Ancillary to Joint Ventures and Licensing Agreements: Do Sealy and Topco Logically Survive Sylvania and Broadcast Music?*, 66 VA. L. REV. 879 (1980).


11. Merger challenges typically proceed under Section 7 of the Clayton Act, 15 U.S.C § 18 (making unlawful any merger the effect of which may be substantially to lessen competition), and/or Section 1 of the Sherman Act, 15 U.S.C. § 1 (making unlawful contracts and combinations in restraint of trade). Recent cases generally have concluded that mergers challenged under either statute should receive the same substantive treatment. See, e.g., *United States v. Rockford Mem’l Corp.*, 898 F.2d 1278 (7th Cir. 1990) (Posner, J.).

pre- and post-merger concentration levels within the geographic market, typically measured by the Herfindahl-Hirschman Index (HHI). The stock argument against horizontal mergers is that as concentration within a geographic market increases, it becomes easier for firms to collude and thereby harm consumers in violation of the antitrust laws. The premise of this argument is fairly uncontroversial: by merging, firms can normally coordinate their activities at lower costs. The argument's conclusion, however, requires a logical leap. Specifically, it is not obvious that dividing geographic markets into exclusive territories harms consumers. Thus, like the per se rule against agreements to divide geographic markets into territories, federal merger policy rests in large part on intuition that is not necessarily supported by a well-specified theory of geographic competition.

IV. THE INTERDEPENDENT NATURE OF OLIGOPOLY AND DUOPOLY

It has long been proffered that "antitrust policy, as expressed in our present statutes, cannot properly be guided by any other goal than


14. The Merger Guidelines provide, in pertinent part: Other things being equal, market concentration affect the likelihood that one firm, or a small group of firms, could successfully exercise market power. . . . If collective action is necessary for the exercise of market power, as the number of firms necessary to control a given percentage of total supply decreases, the difficulties and costs of reaching and enforcing an understanding with respect to the control of that supply might be reduced.

Merger Guidelines, supra note 13, § 2.0. See also William M. Landes & Richard A. Posner, Market Power in Antitrust Cases, 94 HARV. L. REV. 937, 973-74 (1981) ("But a horizontal merger is more likely to facilitate collusion by reducing the number of firms that must agree for collusion to be effective, and thus the transaction costs of agreement, than it is to create a dominant firm . . . .")

consumer welfare.” Conventional economic theory provides that perfectly competitive markets are “socially optimal” (under the right conditions) in that “the aggregate economic welfare of consumers and producers is maximized.” Thus, antitrust analysis has necessarily turned to applied economic theory in assessing anticompetitive conduct, competitive injury and remedial alternatives. As a practical matter, the perfectly competitive model provides insight as to the type of conduct that may constitute a “restraint of trade” (i.e., conduct that jeopardizes or threatens any of the model’s underlying assumptions). The model also provides insight as to whether such conduct results in competitive injury (i.e., sub-optimal efficiencies as defined in terms of consumer and producer welfare).

A. COMPETITION V. OLIGOPOLY—STRUCTURAL DISTINCTIONS

An implicit condition of the perfectly competitive market is its endogenous independent character. Perfect competition requires numerous buyers and sellers such that no one buyer or seller can affect a product’s price. Generally, each buyer and seller consumes and/or produces such a negligible amount in relation to the market’s total output that his or her respective market behavior will have no affect on the price of any product. An alternative way of stating the price-taking assumption is that

17. EDWIN MANSFIELD & GARY YOHE, MICROECONOMICS: THEORY AND APPLICATIONS 324 (11th ed. 2004). See also STEVEN E. LANDSBURG, PRICE THEORY AND APPLICATIONS 230 (6th ed. 2005) (“In a competitive equilibrium, the sum of all the gains to all the market participants is as large as possible.”); ROBERT S. PINDYCK & DANIEL L. RUBINFELD, MICROECONOMICS 574 (5th ed. 2001) (“[T]he allocation in a competitive equilibrium is economically efficient.”).
18. MANSFIELD & YOHE, supra note 17, at 290 (“[P]erfect competition requires that each participant in the market, whether buyer or seller, be so small in relation to the entire market that he or she cannot affect the product’s price.”) See also PINDYCK & RUBINFELD, supra note 17, at 252 (“Because each individual firm sells a sufficiently small proportion of total market output, its decisions have no impact on market price.”); LANDSBURG, supra note 17, at 180 (“Ordinarily, firms are competitive when they serve a small part of the market. As long as you are small, you can greatly increase your output and still find customers at the going price. By contrast, firms with large market shares typically must lower their prices to attract more customers.”); STEPHEN A. MATHIS AND JANET KOSCIANSKI, MICROECONOMIC THEORY, AN INTEGRATED APPROACH 325 (2002) (“Since there are so many sellers and buyers, with each respectively producing and consuming an imperceptively small amount of the marketwide output of a homogeneous good, no one seller or buyer has the ability to exert any direct control over the price of the product.”); MICHAEL E. WETZSTEIN, MICROECONOMIC THEORY, CONCEPTS AND CONNECTIONS 258 (2005) (“Every firm in the market is so small, relative to the market as a whole, it cannot exert a perceptible influence on price. Each firm is a price taker.”).
there are many independent firms and independent consumers in the market all of whom believe—correctly—that their decisions will not affect prices.”\textsuperscript{19} Obviously, coordinated behavior among market participants jeopardizes this condition. For example, “producers acting together to change output will certainly affect price, but any producer acting alone cannot do so.”\textsuperscript{20} Accordingly, economic theory suggests that commercial activities coordinated through an explicit market division agreement directly threatens the independent nature of perfect competition. To the extent these coordinated activities result in the reduction of output with a simultaneous affect on price, such activities are counterintuitive with respect to the welfare maximization principles of the perfectly competitive model.

One should bear in mind that perfect competition is a model, and as such it “abstracts from reality and can be used as a basis for evaluating more realistic structures.”\textsuperscript{21} Few, if any, markets conform to the perfectly competitive market model for achieving welfare maximization. For example, the interdependent nature of oligopoly and duopoly market structures (as opposed to perfect competition’s independent nature) threatens the perfectly competitive model’s price-taking assumption mentioned above.

An oligopolistic market is composed of a relatively small number of interdependent firms.\textsuperscript{22} If there are only two firms in the market, it is called a duopoly.\textsuperscript{23} Since oligopoly contains a small number of rivals, any change in a firm’s price or output has a direct influence on the sales and profits of its competitors.\textsuperscript{24} Consequently, “each oligopolist formulates its policies strategies with an eye to their effects on its rivals.”\textsuperscript{25} In fact, economic

\begin{itemize}
\item \textsuperscript{19} Pindyck & Rubinfeld, supra note 17, at 252 (“Another way of stating the price-taking assumption is there are many independent firms and independent consumers in the market all of whom believe—correctly—that their decisions will not affect prices”) (emphasis added).
\item \textsuperscript{20} Mansfield & Yohe, supra note 17, at 290.
\item \textsuperscript{21} Wetzstein, supra note 18, at 259.
\item \textsuperscript{22} Id. See also Mansfield & Yohe, supra note 17, at 426 (“[T]he supply side of an oligopoly market is composed of very few firms.”); Pindyck & Rubinfeld, supra note 17, at 429 (“In oligopolistic markets . . . only a few firms account for most or all of total production.”); Landsburg, supra note 17, at 401 (“An oligopoly is an industry in which the number of firms is sufficiently small that any one firm’s actions can affect market conditions.”).
\item \textsuperscript{23} Wetzstein, supra note 18, at 482.
\item \textsuperscript{24} Mansfield & Yohe, supra note 17, at 426.
\item \textsuperscript{25} Id. See also Wetzstein, supra note 18, at 482 (“oligopoly markets are characterized
theory instructs that "for almost any major economic decision a firm makes—setting price, determining production levels, undertaking a major promotion campaign, or investing in new production capacity—it must try to determine the most likely response of its competitors."

B. EQUILIBRIUM IN OLIGOPOLY

In competition, a market is in equilibrium when all firms are doing the best they can (i.e., each maximizing their profits) and have no reason to change their price or output. In perfect competition, firms are indifferent with respect to their rival's behavior because each firm is assumed to be a price-taker; that is, they "regard their demand curve fixed in the short-run and determined by impersonal and anonymous market forces." In oligopoly, however, "each firm is forced to formulate its own price and output decisions on the basis of its assumptions about what its rivals will do, and it knows who those rivals are." Consequently, the concept of equilibrium as it applies to oligopoly markets is modified somewhat to take into consideration oligopoly's structural characteristics.

In oligopoly, "each firm will want to do the best it can given what its competitors are doing." And each firm will assume that its "competitors will do the best they can do given what that firm is doing." In short, "[e]ach firm, then, takes its competitors into account, and assumes that its competitors are doing likewise." This situation is commonly referred to as a Nash equilibrium.

by mutual dependence. It is necessary for each firm to consider the reactions of its competitors."); MATHIS AND KOSCIANSKI, supra note 18, at 445 ("the competition among firms comprising an oligopoly is quite personal, since each firm's profit is affected by the price and output behavior of other firms in the market."); PINDYCK AND RUBINFELD, supra note 17, at 429 ("In [competitive] markets, each firm could take price or market demand as given and largely ignore its competitors. In an oligopolistic market, however, a firm sets price and output based partly on strategic considerations regarding the behavior of its competitors.").

26. PINDYCK & RUBINFELD, supra note 17, at 429.
27. Id. at 430.
28. MANSFIELD & YOHE, supra note 17, at 428.
29. Id. at 426.
30. PINDYCK & RUBINFELD, supra note 17, at 430.
31. Id.
32. Id.
33. MANSFIELD & YOHE, supra note 17, at 428. See also PINDYCK & RUBINFELD, supra note 17, at 430.
C. A HYPOTHETICAL NASH EQUILIBRIUM IN DUOPOLY

Conceivably, one can imagine an oligopoly situation consisting of two firms in a Nash equilibrium whereby each firm has refrained from entering the geographic markets of the other. Each firm is doing the best it can, given what its competitor is doing, and vice versa. Each firm is likely to assume that should it enter the geographic market of the other, such entry will be met with resistance resulting in a competitive engagement that could be ruinous for either. Although the entry payoff may be great for either firm, the losses may be devastating and perhaps even terminal for the losing firm. Consequently, a Nash equilibrium may be reached with both firms producing in adjacent geographic markets which abut one another, with each refraining from entry into the other’s geographic market. In such a scenario, a Nash equilibrium is reached not by collusive conduct, but by each firm’s strategic decision seeking to maximize its respective utility given the interdependent nature of the oligopoly market.

Under the current state of the law, any collusive decision to allocate territories (whether tacit or explicit) between the two firms will likely constitute a per se violation of Section 1 of the Sherman Antitrust Act. However, as explained below, such a collusive agreement may nonetheless have welfare enhancing effects as well as result in a Nash equilibrium. And it is from this perspective that one should question the propriety of a per se approach to antitrust liability with respect to explicit market division agreements.

V. A WELFARE ENHANCING MODEL OF COLLUSION IN DUOPOLY

Assume there are two identical firms located on a geometric plane, each producing identical goods which they sell to homogeneous and uniformly distributed consumers. Further assume that initially these firms are sufficiently distant from one another such that they do not compete for customers; each is a monopolist over its own geographic market circle. Imagine next, that each firm expands its sales in the direction of the other, resulting in their individual markets moving closer and closer together. As the distance between these firms decreases, their potential market circles—that is, consumers to whom these firms could sell at a profit—begin to overlap, thus delineating a set of consumers who can potentially turn to either firm for their purchases.
Conventional economic wisdom suggests that, in general, firms in such geographic proximity that do not collude will produce more output and sell it at a lower price than they would if they colluded. This intuition forms the foundation for both the per se rule against territorial collusion, and federal merger policy against the monopolization of geographic markets. However, the underlying rationale driving this convention may be flawed in strategic, interdependent markets of oligopoly and duopoly. As careful analysis reveals, these policies probably are not justified on efficiency grounds.

VI. THE BASIC FRAMEWORK FOR DUOPOLY MODELING IN THREE DIMENSIONS

The specific problem considered is geographic competition among firms located on a plane populated by uniformly distributed consumers. Firms’ potential marketing areas are confined by the interplay of consumer reservation prices and transportation costs (technology). Examples of the kinds of products to which the models presented here might apply are truck-delivered concrete and home-delivered pizza. These products tend to be both produced and consumed in geographically confined markets. The models presented here are likely inapplicable to products like software or wholesale computer chips because such products are readily shipped over long distances. For ease of exposition, the models are restricted to simple monopoly and duopoly.

A. GEOGRAPHIC MARKETS VERSUS GEOGRAPHIC COMPETITION

For expositional clarity, it is important to first define key terms, at least to the level of working definitions. Consistent with antitrust jurisprudence, a geographic market is defined as an identifiable set of sellers to whom an identifiable set of consumers may, as a practical matter, turn for their supplies. Indeed, for antitrust purposes, this definition delineates a market generally, and not merely a geographic market. Geographic competition concerns firms within a geographic market that compete for turf. It refers to the decisions of producers and consumers within a geographic market, and the economic consequences of

34. Federal Trade Comm’n v. Elders Grain, Inc., 868 F.2d 901, 907 (7th Cir. 1989) (Posner, J.) (applying the rule from Tampa Elec. Co. v. Nashville Coal Co., 365 U.S. 320, 328 (1961) and United States v. Philadelphia Nat’l Bank, 374 U.S. 321, 358-61 (1963)). Indeed, for antitrust purposes, this definition delineates a market generally, and not merely a geographic market. However, because the models presented here assume a homogeneous product market, this definition delineates a geographic market. See generally Landes & Posner, supra note 14, at 964. The definition of geographic market used in the Merger Guidelines §1.2 et seq. is to the same in effect.
their decisions. The models presented here explore geographic competition by divining strategies firms may use to capture their optimal geographic sales areas, in light of their rivals' expected best responses.

B. A SIMPLE MODEL OF GEOGRAPHIC MONOPOLY

The geographic monopolist's problem is depicted in Figure 1. In its simplest formulation, a geographic monopolist is a firm that, due to its remoteness from other producers, has within its area of potentially profitable sales only consumers who cannot turn to another producer for their supplies at or below their reservation price. To fix the notation to be used and the basic contours of the models, consider first a single-price, quantity-choice monopolist located on a market plane of homogeneous and uniformly distributed consumers, each of whom has a linear inverse demand function for the firm's wares. Assume this firm produces a single homogeneous product, with no fixed costs and constant marginal costs. Without loss of generality, marginal costs are set to zero. Assume transportation costs are positive, constant, equal to one per unit of distance and borne by consumers. Assume each consumer has a delivered reservation price of one and is willing to purchase one unit of output per period. Thus, the firm faces an inverse demand function of the form \( z = 1 - p \) where \( p \in [0,1] \) is the radius of the firm's circle of actual sales. Because the firm's quantity choice also determines its circle of actual sales, profit maximization may be represented conveniently as a choice among feasible cylinders within a cone having a height and radius of one. Thus, the monopolist's problem is to choose \( p \) to maximize \( \pi p^2 (1 - p) \), which has as its solution \( p = 2/3 \).
VII. Competition in a Geographic Duopoly

A. SPECIFICATION OF A GEOGRAPHIC MARKET

Keeping the technology and other market parameters assumed above, consider next a duopoly comprised of Firms i and j. Assume Firm i is located at the origin of the x,y market plane, and that Firm j is located at (δ, 0). If δ ≥ 4/3, Firms i and j cannot be said to compete geographically in any economically meaningful way. Rather for, δ ≥ 4/3, each firm would simply choose a market radius of 2/3, and thereby produce and profit as independent stand-alone monopolists. Accordingly, δ < 4/3 is assumed.

To complete the notation, let p and r denote respectively Firms i and j’s decision variables.

As depicted in Figure 2, when δ < 4/3 and p + r ≥ 4/3, the sales areas of Firms i and j overlap and delineate a lens-shaped set of consumers who may—within the bounds of their reservation price—choose between Firms i and j for their supplies. That is, Firms i and j comprise the set of producers to whom a set of consumers may, as a practical matter, turn for their supplies. Thus, we have specified a geographic market.

![Figure 2](image-url)
B. THE EQUI-PRICE FRONTIER

Consistent with the usual tenets of consumer choice, consumers within the lens depicted in Figure 2 will purchase from the firm having the lower delivered price. This implies the existence of a demarcation curve within the lens such that to the left of the curve, consumers within the lens will purchase from Firm $i$ (because its delivered price is less than Firm $i$'s), while to the right of the curve consumers within the lens will purchase from Firm $j$ (because its delivered price is less than Firm $j$'s). Consumers located precisely along the curve will be indifferent between Firms $i$ and $j$ because their delivered prices will be equal. Accordingly, this curve is called the equi-price frontier. The formal derivation of the equi-price frontier can be found in the Appendix.

Figure 3 shows a representative configuration of the equi-price frontier for $p < r$. Note that the equi-price frontier describes how consumers within a lens created by circles of radii $p$ and $r$ will allocate their purchases between Firms $i$ and $j$. Stated differently, the equi-price frontier identifies those consumers whose purchases a firm can capture from (lose to) its rival by unilaterally increasing (decreasing) its output and clearing it from the market at a lower (higher) price.

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35. For example, consumers will purchase from the firm with the lowest delivered price. Given the geographic location of both the firm and the consumer, consumers located to the left of the equi-price frontier will purchase from Firm $i$ because the cost of delivery is less than the cost of delivery associated with a purchase from Firm $j$. Likewise, consumers located to the right of the equi-price frontier will purchase Firm $j$ because the cost of delivery is less than the cost of delivery associated with a purchase from Firm $i$. Along the equi-price frontier, consumers are indifferent because the cost of delivery is equal with respect to either firm.
C. Market Forces in Geographic Competition

Stated formally, the equi-price frontier is the set of all \((x, y) \in \mathbb{R}^2\) such that

\[
x = \frac{\delta^2 + 2(p-r)\sqrt{x^2+y^2} - (p-r)^2}{2\delta}.
\]

Note if \(p = r\), then \(x = \delta/2\), implying that under symmetry the equi-price frontier is a vertical line midway between the two firms. Figure 3 shows a representative configuration of the equi-price frontier for \(p < r\).

Specifying the equi-price frontier helps identify two competing forces that bear on a firm's production choice, given its rival's responsive strategy. These are (1) sales to be gained (lost) by increasing (decreasing) output, including implications of the equi-price frontier; and (2) market spoilage from increasing (decreasing) output, which, according to the inverse demand function, necessarily decreases (increases) price. Thus, as in ordinary quantity-choice models, choosing one's output in geographic competition requires trading off marginally profitable sales against spoilage, in light of the expected response of one's rivals. However, geographic competition differs from ordinary quantity-choice models in important ways. For example, as we show below, because a firm's quantity choice is actually an area, and not just an amount, spoilage enters the profit maximization calculus raised to the second power as compared to ordinary quantity-choice models. In other words, firms in geographic competition do not merely face spoilage—they face spoilage squared. It is because of this squaring that standard economic intuition should not be trusted.

Letting \(c = \sqrt{x^2+y^2}\) denote the distance from the origin to each point on the equi-price frontier, and substituting \(p \cos t\) for \(x\), the expression for the equi-price frontier can be expressed in polar form as

\[
c(t) = \frac{2\delta p \cos t - \delta^2 + (p-r)^2}{2(p-r)}.
\]

Assume Firms \(i\) and \(j\) do not attempt to prevent their sales from crossing the equi-price frontier. Instead, Firms \(i\) and \(j\) simply choose \(p\) and \(r\), respectively, to maximize their own profits, each in light of the other's best response. That is, they choose the amounts they will produce, and
then let their output clear the market. In this case, Firm i’s profit is given by

\[ (1 - p) \left[ p^2 (\pi - \theta) + \int_{0}^{\theta} \frac{2 \delta \cos t - \delta^2 + (p-r)^2}{2(p-r)} \, dt \right], \]

where \( \theta \) is the angle subtended from the x axis to the intersections of the circles having radii of \( p \) and \( r \) by the equi-price frontier. Note that the profit function is the product of price \( (1 - p) \), times the sum of two areas, implying a strong penalty, relative to ordinary quantity-choice models, from spoilage due to unilaterally increasing output. Note also that as \( \theta \) is determined, \( p \) is determined. Specifically, \( p = p(\theta) \) and \( \frac{dp}{d\theta} = \frac{p \sin \theta}{\cos \theta} \).

Thus, Firm i can choose \( \theta \) to maximize its profit. The first order conditions for profit maximization are

\[
0 = p^6 \left( 24 \pi - 18 \theta \right) \sqrt{-r^4 + 2r^2(p^2 + \delta^2) - p^4 + 2\delta^2 p^2 - \delta^4 + 25\delta^2} \\
+ p^5 \left( 46r \theta + 12 \theta + \pi(-72r - 16) \right) \sqrt{-r^4 + 2r^2(p^2 + \delta^2) - p^4 + 2\delta^2 p^2 - \delta^4} \\
+ \delta^2 (-79r - 10) \\
+ p^4 \left( -28r^2 \theta - 32r \theta + \pi(72r^2 + 48r) \right) \sqrt{-r^4 + 2r^2(p^2 + \delta^2) - p^4 + 2\delta^2 p^2 - \delta^4} \\
+ \delta^2 r(94r + 32) - 6\delta^4 \\
+ p^3 \left( -12r^3 \theta + 24r^2 \theta + \pi(-24r^3 - 48r^2) \right) \sqrt{-r^4 + 2r^2(p^2 + \delta^2) - p^4 + 2\delta^2 p^2 - \delta^4} \\
+ \delta^2 r^2(-50r - 44) + \delta^4(50r - 12) \\
+ p^2 \left( \delta^2(8r \theta - 12r^2 \theta) + 14r^4 \theta - 2\delta^4 \theta + 16r^3 \right) \sqrt{-r^4 + 2r^2(p^2 + \delta^2) - p^4 + 2\delta^2 p^2 - \delta^4} \\
+ \delta^2 r^3(9r + 32) + \delta^4(-22r - 24) - \delta^6 \\
+ p \left( \delta^4(4r - 2r \theta) - 2r^5 \theta - 4r^4 \theta + 4\delta^2 r^3 \theta \right) \sqrt{-r^4 + 2r^2(p^2 + \delta^2) - p^4 + 2\delta^2 p^2 - \delta^4} \\
+ \delta^4 r^4(r - 10) + \delta^2 r^2(2r + 12) + \delta^4(4 - 5r) \\
+ 2\delta^6 r.
\]
For \( r = p \), the real-valued extrema are given by

\[
0 = 4\theta \delta^3 p \left( -2p^3 + 2p^2 - \delta^2 p + \delta^2 \right) \sqrt{4p^2 - \delta^2} + 12\delta^4 p(1-p) \left( 3\delta - 2p^2 \right)
\]

which has the roots

\[
\begin{bmatrix}
  p = 0, & p = 1, & p^2 = -\frac{2\delta^2 \theta \sqrt{4p^2 - \delta^2} + 3\delta^3}{4\theta \sqrt{4p^2 - \delta^2} - 12\delta}
\end{bmatrix}
\]

By applying several trigonometric identities these can be rewritten as

\[
\begin{bmatrix}
  p = 0, & p = 1, & \theta = \frac{3 \cos \theta \sin \theta}{2 \cos^2 \theta + 1}
\end{bmatrix}
\]

The third root shown has only one real solution, \( \theta = 0 \). Thus, the equilibrium extrema are

\[
\begin{bmatrix}
  p = 0, & p = 1, & \theta = 0
\end{bmatrix}
\]

Note that when \( \theta = 0 \), then \( p = r = \delta/2 \), implying positive profits, and that otherwise profits at the extrema are zero.\(^{36}\) This means that in simple geographic competition Firms \( i \) and \( j \) retreat from one another, resulting in circular sales areas that are tangent at the point \((\delta/2,0)\), as depicted in Figure 4.

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\(^{36}\) The second derivative of the profit function with respect to \( \theta \) evaluated at \( \theta = 0 \) is negative, assuring that \( \theta = 0 \) is a maximum.
The equilibrium condition $\theta = 0$ can be interpreted as follows. If Firm $i$, for example, unilaterally increases (decreases) its production relative to $\theta = 0$, its output will clear the market by taking sales away from (sacrificing sales to) Firm $j$, according to the corresponding change in the equi-price frontier, and the quantity choice response of Firm $j$. Firm $j$'s response will be to increase (decrease) its production above (below) $\theta = 0$, although by a smaller amount than did Firm $i$. Countervailing against any increase in Firm $i$'s profit is the squared effect of market spoilage. Taken together, Firm $i$ receives a lower profit relative to not having undertaken a change from $\theta = 0$. Thus, in light of the competitive and spoilage forces bearing on its production decision, Firm $i$ prefers $\theta = 0$ to all other possible choices.

Note that when $\delta \geq 4/3$, $\theta = 0$ implies that Firms $i$ and $j$ each will produce as simple, stand-alone, geographic monopolists. However, when $\delta < 4/3$, which is the range over which geographic competition has economic meaning, $\theta = 0$ implies that Firms $i$ and $j$ will each produce less than they would as geographic monopolists. It is also interesting to note that for $\delta < \sqrt{2}(2/3)$, which represents most of the range over which Firms $i$ and $j$ will compete, the combined output of both firms is less than that of a single, stand-alone monopolist, and the prevailing mill price is relatively higher.

In the preceding model, Firms $i$ and $j$ could not inquire as to a prospective purchaser's location. Rather, each firm simply produced its output for sale to whomever might want it at the firm's mill price, plus shipping. Indeed, as shown below, it is precisely because neither firm could restrict its output from crossing the $x = \delta/2$ line that both firms were restrained from increasing output, and thereby inducing a rivalrous response.

VIII. TERRITORIAL COLLUSION IN A GEOGRAPHIC DUOPOLY

This section presents a collusive model in which firms enter into agreements fixing each firm's exclusive sales territory. Specifically, firms enter into agreements requiring each firm to decline sales outside its own (agreed) market territory.

As Figure 2 suggests, in territorial collusion Firms $i$ and $j$ will divide
the market plane along the vertical line $x = \delta/2$, with each taking half of the plane as its exclusive marketing territory. Firms $i$ and $j$ will divide the market plane along $x = \delta/2$ because any other equal-area division requires Firms $i$ and $j$ to accept relatively unprofitable destinations in lieu of relatively profitable ones, thus leaving each worse off relative to agreeing to $x = \delta/2$. When the market plane is divided along $x = \delta/2$, total profits for both firms together are

$$2\left\{(1 - p)\left[p^2(\pi - \theta) + \left(\frac{\delta}{2}\right)\sqrt{p^2 - \left(\frac{\delta}{2}\right)^2}\right]\right\}.$$

With $\frac{dp}{d\theta} = \frac{p \sin \theta}{\cos \theta}$, the first order conditions for profit maximization are

$$\theta = \frac{\left(\frac{\delta}{2}\right)\sqrt{p^2 - \left(\frac{\delta}{2}\right)^2} + \pi p(3p - 2)}{p(3p - 2)}.$$

We interpret this result as follows.

Note that for $p = 2/3$, $\theta$ is undefined. This is because when $\delta = 0$ (both Firms $i$ and $j$ are located at the origin), the joint maximization problem is the same as the stand-alone monopolist's problem, with each firm taking half the profit cylinder depicted in Figure 1. That is, when $\delta = 0$, $\theta$ is not defined and $p = 2/3$.

To interpret the expression for optimal $\theta$ when $p \neq 2/3$, consider the general expression for total sales area under collusion

$$2\left\{p^2(\pi - \theta) + \left(\frac{\delta}{2}\right)\sqrt{p^2 - \left(\frac{\delta}{2}\right)^2}\right\}.$$

Substituting the expression for optimal $\theta$ into the general expression for total sales under collusion reveals the optimal area of collusive sales

$$\frac{2\delta(1 - p)\sqrt{p^2 - \left(\frac{\delta}{2}\right)^2}}{2 - 3p},$$
which, when positive, implies \( p > \delta/2 \). Thus, relative to geographic competition (that is, \( p = \delta/2 \)), profit maximization under collusion implies that Firms \( i \) and \( j \) will: (1) increase output, (2) clear it from the market at a lower price, and (3) earn a larger profit, as depicted in Figure 5.

**Figure 5**

Figure 2 indicates that the collusive profit maximization problem is equivalent to the individual firm's profit maximization problem, subject to the constraint that no sales are made across the vertical boundary \( x = \delta/2 \). In other words, relative to the competitive allocation, either firm can increase its production and profits without threatening its rival's sales, and without invoking a competitive response, if it restricts its sales from crossing the \( \delta/2 \) line. This, of course, would require not only restricting one's own sales from export, but would also require not selling to independent resellers. However, if Firm \( i \) adopts such policies, it can increase its production to the collusive level without inducing a rivalrous
response. Accordingly, it is unilaterally profitable to adopt such a strategy irrespective of whether one's rival also adopts such a strategy. This result is summarized as a single-stage game in Figure 6 where \( V \) denotes profit, and \( c \) and \( t \) denote competitive and territorial strategies, respectively. Note that \( V^t > V^c \) for both Firms \( i \) and \( j \).

As depicted in Figure 6, whether Firm \( j \) chooses to adopt a competitive or territorial strategy, Firm \( i \) will choose a territorial strategy. Similarly, irrespective of Firm \( i \)'s choice, Firm \( j \) will adopt a territorial strategy. Thus, tacit geographic collusion is a Nash equilibrium.

![Figure 6](image)

**Figure 6**

**X. CONSUMER SURPLUS IMPLICATIONS**

Figure 1 depicts consumer surplus in the case of monopoly as the volume of the firm's demand cone lying above the profit cylinder. By inspection, Figure 1 also reveals that consumer surplus increases as sales increase and price falls. This proposition also holds in the competitive and collusive models because, as depicted in Figure 2, price and actual sales generally vary inversely. Thus, a comparison of Figures 4 and 5 reveals that consumer surplus is greater under collusion than competition, as are total profits. It follows that total welfare under collusion is greater than under competition.
XI. CONCLUSIONS, ANTITRUST POLICY IMPLICATIONS AND TOPICS FOR FURTHER RESEARCH

A. CONCLUSIONS AND ANTITRUST POLICY IMPLICATIONS

The preceding models demonstrate that under reasonable assumptions both producers and consumers are better off if firms are not prohibited from colluding explicitly or tacitly to divide geographic markets. That tacit collusion is a Nash equilibrium suggestive of Adam Smith’s invisible hand: left to their own devices, firms will conduct their affairs in ways that ultimately benefit consumers. This is not to say that there are no circumstances under which territorial collusion is harmful to social welfare. However, the models do question whether a per se prohibition against geographic collusion is justified on efficiency grounds.

The models have implications for merger policy in that a merger between horizontal competitors is in many respects a license to internalize collusion. Conventional merger policy demands that a merger between Firms $i$ and $j$ should draw close scrutiny from the antitrust authorities. The models presented here, however, suggest that current antitrust enforcement practices probably chill efficiency enhancing agreements to divide geographic markets through horizontal mergers. Therefore, the per se rule and federal merger policy should be reconsidered.

B. TOPICS FOR FURTHER RESEARCH

The models presented here are special cases: simple geographic monopoly and duopoly. They offer only limited insight regarding markets comprised of more than two firms. For example, consider a market of three firms: Firms $i$, $j$ and $k$, each located at the vertex of an equilateral triangle.

38. If the assumptions in the models are changed so that all consumers are located at the point $(5/2,0)$, the problem degenerates to the standard Cournot model.
39. For a merger between Firms $i$ and $j$, the pre-merger HHI is 5000, and the post-merger HHI is 10000, making the increase in HHI due to the merger 5000. Under the Merger Guidelines, this merger would almost certainly be challenged. Merger Guidelines §1.51 (post-merger HHI above 1800 and an increase in HHI of more than 100 creates a presumption that a merger will create market power or facilitate its exercise).
In this case, geographic competition would result in an equilibrium analogous to the geographically competitive duopoly model because solving Firm i’s competitive dispute with Firm j simultaneously resolves its dispute with Firm k. (A square market is similar.) When firms are not equidistant from one another—such as when Firms i, j and k are each located at a vertex of an isosceles, right or scalene triangle (or four firms are located at the corners of a non-square rectangle, or trapezoid)—each firm’s competitive sales area will depend primarily on geographic competition with its nearest neighbor. As depicted in Figure 7, in a scalene-triangular market the two firms that are closest together will mimic a geographic duopoly, leaving the third to choose a larger sales area tangent to its nearest neighbor’s sales area (or to choose a monopoly sales area if that is more profitable).

Obviously, the duopoly models presented above say little about geographic collusion in Figure 7. It is interesting to note, however, that although Firms i, j and k all employ the same technology, Firm k has the largest sales area—it is the market’s “dominant firm”—primarily because of the relative proximity of Firms i and j, and secondarily because of Firm k’s proximity to Firm i. This suggests that market share and so-called “market power” may be economically unrelated, a proposition which cuts to the very heart of conventional antitrust merger analysis. Thus, Figure 7 and a host of other such examples suggest that geographic competition and collusion, and their merger counterparts, offer a rich and as yet unexploited area for further research.

Figure 7

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40. See supra note 10 and sources cited therein.
A. GEOMETRY OF THE EQUI-PRICE FRONTIER

Figure 8 illustrates how the equi-price frontier is determined.

Consider a hypothetical consumer located at point D, having distances $h_i$ and $h_j$ from Firms $i$ and $j$ respectively. Such a consumer faces delivered prices of $P_i^D(h_i) = P_i(p) + h_i$ and $P_j^D(h_j) = P_j(r) + h_j$. D is on the equi-price frontier if a consumer located there is indifferent between Firms $i$ and $j$. That is, the equi-price frontier is the locus of consumers (points) such that $P_i^D = P_j^D$. For example, B is on the equi-price frontier because $P_i^D(p) = P_j^D(r) = 1$ by construction.
Proposition: Referring to Figure 8, and letting $\ell$ denote the linear distance of a line segment, D is on the equi-price frontier if and only if $\ell(ED) = \ell(DF)$. Proof: From the definitions of $P^D_i$, $P^D_j$ above, and the inverse demand functions $z_i = (1-p)$ and $z_j = (1-r)$, it follows that $P^D_i(h_i) = 1 - \ell(DF)$ and $P^D_j(h_j) = 1 - \ell(DE)$. Therefore, $P^D_i(h_i) = P^D_j(h_j)$ if and only if $\ell(ED) = \ell(DF)$. Q.E.D. The equi-price frontier is the locus of all such points. In Figure 8, the equi-price frontier includes points B, D and H.

B. THE EQUI-PRICE FRONTIER AS AN IMPLICIT FUNCTION

The equi-price frontier may be written as an implicit function. By the Pythagorean theorem, $\ell(AD)^2 = \ell(AG)^2 + \ell(GD)^2$ and $\ell(DC)^2 = \ell(GD)^2 + \ell(GC)^2$. Subtracting the second expression from the first and rearranging terms yields

[ONE] $\ell(AD)^2 + \ell(GC)^2 = \ell(AG)^2 + \ell(DC)^2$.

Note that $\ell(AC) = \ell(AG) + \ell(GC) = \delta$. Now, $\ell(AD) = \rho - \ell(DF)$ and $\ell(DC) = r - \ell(DE)$. Subtracting the second expression from the first, then noting that $\ell(DF) = \ell(DE)$, and rearranging terms yields $\ell(DC) = \ell(AD) - (\rho - r)$. Squaring both sides yields

[TWO]

Also, $\ell(GC) = \delta - \ell(AG)$, so squaring both sides yields

[THREE] $\ell(GC)^2 = \delta^2 + \ell(AG)^2 - 2\delta \ell(AG)$.

Substituting (2) and (3) into (1) yields
\[
\ell(\overline{AG})^2 + \delta^2 + 2\delta \ell(\overline{AG}) = \ell(\overline{AG})^2 + \ell(\overline{AD})^2 + (\rho - \tau)^2 - 2\ell(\overline{AD})(\rho - \tau)
\]
which simplifies to become

\[
\delta^2 - 2\delta \ell(\overline{AG}) = (\rho - \tau)^2 - 2\ell(\overline{AD})(\rho - \tau).
\]

Expression (5) can be rearranged to become

\[
\ell(\overline{AG}) = \frac{\delta^2 + 2\ell(\overline{AD})(\rho - \tau) - (\rho - \tau)^2}{2\delta}.
\]

Substitution of \(x = \ell(\overline{AG})\) and \(\sqrt{x^2 + y^2} = \ell(\overline{AD})\) into (6) reveals the equi-price frontier as an implicit function:

\[
x = \frac{\delta^2 + 2(\rho - \tau)\sqrt{x^2 + y^2} - (\rho - \tau)^2}{2\delta}.
\]

Q.E.D.
***.

.