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# Introduction to Stigler's Theory of Monopoly

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# Introduction to Stigler's Theory of Oligopoly

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This article introduces the reprint of George Stigler's *A Theory of Oligopoly*, first published in 1964. Stigler's article was a landmark in the theory of industrial organization and in the practice of antitrust. For industrial organization economists it focused attention on the sorry state of oligopoly theory and, using information theory, proposed a theory that could explain the deviations of oligopoly pricing from competitive pricing. For antitrust practitioners the article came to have an important impact on the application of antitrust law, especially in the merger area. Indeed, it is not an overstatement to say that Stigler's theory of oligopoly remains a central pillar in merger policy in most, if not all, antitrust regimes around the world.

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## I. Introduction

Stigler's *A Theory of Oligopoly*<sup>1</sup> was a landmark in the theory of industrial organization and in the practice of antitrust. For industrial organization economists it focused attention on the sorry state of oligopoly theory and, using information theory, proposed a theory that could explain the deviations of oligopoly pricing from competitive pricing. For antitrust practitioners the article came to have an important impact on the application of antitrust law, especially in the merger area. Indeed, it is not an overstatement to say that Stigler's theory of oligopoly remains a central pillar in merger policy in most, if not all, antitrust regimes around the world.

Because Stigler was succinct in his article, we first discuss in Section II what exactly his article does. We turn next to a discussion of why this article is a landmark in industrial organization and explain how it influenced research in the field. We also note a waning of this influence as the literature on merger and antitrust seems to have swung back a bit toward the type of models Stigler complained about. Finally, we trace the importance of Stigler's paper on antitrust scholars and its influence on antitrust policy today.

INDEED, IT IS NOT AN UNDERSTATEMENT TO SAY THAT STIGLER'S THEORY OF OLIGOPOLY REMAINS A CENTRAL PILLAR IN MERGER POLICY IN MOST, IF NOT ALL, ANTITRUST REGIMES AROUND THE WORLD.

## II. A Guide to Stigler's Theory of Oligopoly

Imagine that you and 5 friends are passing some time gambling with an ordinary 6-sided die. Each of you is assigned a number from 1 to 6. Then each antes \$1, the die is cast, and the pot goes to the one whose number comes up. This isn't a very exciting game, because, so long as the die is fair, all of you will approximately break even if you play long enough. On average, you will win the \$6 pot once in 6 tosses (let's call 6 tosses "a round") and lose your ante the other 5 times. Exciting or not, you find the game a nice way to socialize with friends. So, you're happy to play so long as the die is fair.

But is the die fair? Even if it is, you will lose money in around 3 of every 10 rounds just by the luck of the draw. You break even because you make up for those lost rounds by a comparable proportion of rounds where you win more than once. You only win exactly once in less than half the rounds. And all of these properties of the game are averages. You shouldn't jump to conclusions about the fairness of the die if you drew blanks 4 times out the last 10 rounds, or if your number didn't turn up more than once or twice in those 10 rounds. You do like the company, and you do not want to alienate your host by accusing him of cheating if your losses in those 10 rounds are just random bad luck.

But what if you lose 20 of 50 rounds, instead of the 15 you might expect by chance? Or 40 of 100? Or 400 of 1000? At some point you would conclude that the die is unfair, and you may exit the game.

BUT THE ESSENCE OF THE THEORY LIES IN THE SAME PROBLEM—HOW TO DISTINGUISH GENUINE CHEATING FROM RANDOM BAD LUCK BY SIFTING THE NOISY AVAILABLE INFORMATION.

This simple example is at the heart of George Stigler's 1964 theory of oligopoly. His statistics are more embellished than this example, but the essence of the theory lies in the same problem—how to distinguish genuine cheating from random bad luck by sifting the noisy available information. To see where Stigler is going, change the friendly game we have just described

to a collusive agreement among 6 sellers. We have all agreed to set the monopoly price and divvy up the monopoly profits equally. As long as the agreement holds, the buyers would have no particular reason to favor one seller over the other. So, the buyers would pick sellers randomly, perhaps by tossing dice. For concreteness, say there are 60 buyers who shop for 1 unit per week (a week is a "round" in this version of the game) using their die to pick which seller will get their order. Each of us can then expect to average around 10 sales per week. But the monopoly price-cost wedge also gives each of my fellow colluders an incentive to cheat. A buyer may be attracted to a cheater by the lower price, and the cheating seller's profits will increase in the short run as long as that price is still above marginal cost.

How can I tell if one or more of my rivals gave into this temptation to cheat? The cheaters are not going to announce themselves. I may have to infer cheating by determining that my sales are abnormally weak. This isn't so easy. I expect to average 10 sales per week if we are all adhering to the agreement. But that means that half the weeks I'll get fewer than 10, and in this example the normal variability engendered by the dice being cast by buyers means that in about half of those weeks I won't even get 8 customers. I could easily have a bad run of several weeks of below average sales without any hanky panky going on. And I do not want to jump to conclusions prematurely. If I do so, not only will I lose friends but I also may touch off a costly price war. So I will have to wait and see if my sales averaged over many weeks are less than I should expect from mere bad luck. How long will this take? That depends on the normal variability of my weekly sales: the bigger it is, the longer I will have to wait to sift the truth from the noise.

We should pause here to note some aspects of Stigler's theory:

#### **A. IT IS A THEORY OF EQUILIBRIUM IN A DYNAMIC NON-COOPERATIVE GAME**

Most of the article is taken up with the problem of how rivals can detect cheating from an agreement. However, Stigler's ultimate interest is in whether a price

significantly above the competitive level—perhaps even one as high as the static monopoly level—can be sustained. This is made crystal clear in the second sentence: “The present paper accepts the hypothesis that oligopolists wish to collude to maximize joint profits.”<sup>2</sup> Just how they act on this wish is never made clear. The important issue for Stigler is that once a price is somehow agreed upon, there will be incentives for individual rivals to cheat on the agreement. Whether cheating occurs depends on weighing the profits from not cheating against the profits from cheating and then being detected and having competition break out. The main part of the paper, “The Methods of Collusion,” is really about the circumstances that make an agreement less susceptible to cheating, not the nitty gritty of where and how the agreement got made nor on exactly what happens when the cheating is discovered. Still, it is fair to say that Stigler has in mind a self-enforcing equilibrium where price is sustained above competitive levels over time—what game theorists today would call a dynamic non-cooperative equilibrium.

STIGLER’S MAIN POINT—AND ONE RELATED TO THE POINT BERTRAND HAD MADE MUCH EARLIER—IS THAT A RIVAL MAY STEAL CONSIDERABLE SALES BEFORE BEING DETECTED.

Until Stigler’s article, much oligopoly theory had been of the “non-cooperative” variety in a static game: What happens if there are a few sellers who each act in their own best interests, taking into account some assumed reaction from their rivals? Stigler does not follow this path, because he did not believe that static non-cooperative rivalry could capture some key features of oligopoly behavior such as the detection of deviations from non-competitive pricing. Stigler’s main point—and one related to the point Bertrand had made much earlier—is that a rival may steal considerable sales before being detected. That lag in detection creates an incentive to undercut any above-competitive price. However, the money being left on the table if price is at the competitive level, Stigler reasoned, would tempt the sellers or a subset of them to abandon the non-cooperation for a grab at the brass ring of joint-profit maximization. But any agreement among sellers cannot ignore the incentives to cheat provided by lags in detection. So understanding when a price elevated above the competitive level can be an equilibrium requires an analysis of the dynamic consequences of cheating versus not cheating. What Stigler calls “stable collusion” would today be described as a self-enforcing equilibrium in a dynamic non-cooperative game.

## B. IT IS A THEORY WRITTEN IN THE SHADOW OF ANTITRUST

Explicit or formal cooperation is, of course, illegal. Stigler recognizes this, but he does not take refuge in mealy-mouthed talk of informal collusion, which he thought was an overrated cop out. His stance here is that of the pioneer he also was in the economics of crime and punishment. Illegal collusion is a fact of business life, but its nature and frequency is shaped by antitrust enforcement. Thus he rules out of consideration or downplays some obvious solutions to the prob-

lem at the heart of his theory—the sifting of cheating from bad luck. For example, our six sellers could merge. That would directly get rid of the randomness in sales that creates the oligopolists' information problem. But “often merger will be inappropriate” in part because “it may be forbidden by law.”<sup>3</sup> Similar short shrift is given to such devices as cartel agreements or joint sales agencies.<sup>4</sup> Stigler's stance here is that the theory should recognize legal constraints within some kind of cost-benefit calculus. Rule out mergers and the like because they are so easy to detect and so obviously sanctionable. Do not rule out the proverbial smoke-filled room, but do be skeptical of agreements that need frequent renegotiation. Frequent meetings or, in general, frequent communications among sellers raise the probability of getting caught. Therefore the emphasis is on sellers having to rely mainly on their own sales records rather than any shared information to enforce infrequently negotiated agreements.

### C. THE THEORY IS ABOUT EQUILIBRIUM, NOT HOW YOU GET THERE

In the language of game theory, Stigler's theory is looking for a “dominant strategy.” In his formulation there are two alternatives: joint profit maximization or something like Bertrand competition. Stigler does not discuss alternatives, such as an equilibrium in which a high price is set for a while, then occasional cheating leads to price competition and, finally, a collusive price is reestablished, though the ingredients to construct such a result are clearly there.

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Instead, the question is framed in terms of whether or not joint profit-maximizing-collusion yields a meaningful and durable departure from competition. To find the answer we have to play a mental game of first imagining that there is an agreement to set a price above the competitive level and then asking if the conditions are right for the agreement to be or not to be undermined by the incentive to cheat.

If the agreement will be undermined substantially and quickly it will not be entered into in the first place. An agreement is costly, legally and in other ways, and needs substantial rewards to justify contemplating it. So the logical structure of Stigler's theory is similar to that of the famous “prisoner's dilemma” of game theory. Either collusion is a dominant strategy (everyone adheres to the agreement) or it is not. If it is not, there is no agreement (or, equivalently, everyone violates it before the ink dries or the smoke clears) and the equilibrium, as Stigler sees it, is trivially different from textbook competition. The theory is about figuring out the circumstances in which collusion is more or less likely to be the dominant strategy. And those circumstances depend crucially on the quality of information available to the players (sellers).<sup>5</sup>

Play out the mental game sketched above under circumstances where a cheater can expect substantial short-run profits and/or can expect to keep them for a

long time, because it is difficult for the honest firms to quickly filter the cheating from random bad luck. In such a world, competition is the dominant strategy. In this kind of a world, everyone wants to be the first cheater, so collusion cannot work. But where cheating can be detected and perhaps punished (in ways Stigler doesn't specify) very quickly, it will not occur in the first place. The hypothetical and potential first cheater would, in effect, compare the present values of two alternative cash flows. If he doesn't cheat, then no one will; remember, you always want to be the first cheater. So the no-cheating wealth will be the present value of the steady stream of this firm's share of industry profits resulting from a price set above the competitive level. If he does cheat, he gets a cash flow that starts out higher than this, but now, with rapid detection and response, the cash flows would quickly drop below the steady no-cheating cash flows. Our hypothetical potential first cheater now calculates that the present value of cheating is worse than remaining faithful to the agreement—no one cheats and collusion is the dominant strategy.

So there is, in principle, a tipping point determined by the size and durability of hypothetical cheating profits. If they move to the bigger/longer side of the line, the present value of cheating exceeds that of adherence, and cheating dominates. If otherwise, the agreement is stable. On which side of this border will we find ourselves in any particular case? Stigler's theory gives a simple answer: it depends on the normal variability of a seller's sales. The bigger this is, the harder for the seller to detect cheating and therefore the greater the likelihood that cheating will be the dominant strategy.

Now that we have summarized Stigler's theory and given it some context, we should note some of the richness of its implications. The theory essentially tells us to look for meaningful departures from competition by connecting the structure and institutions of the marketplace to the normal variability of firm sales—more variability equals less worry about departures from competition and, of course, vice versa. To illustrate, we pick up our example of the 6 firms randomly selected by 60 buyers, and note that competition depends on, among other things:

1. The number of firms. Say we have only 4 firms instead of 6. Then, keeping everything else the same, average sales will be 15 per firm and normal variability is smaller relative to this average.<sup>6</sup> Hence, collusion is more likely to be stable.
2. Concentration. Say we still have 6 sellers, but 3 of them merge. Think of this as if 1 firm now will get a sale any time a buyer throws a 1 or a 2 or a 3. There is less competition now, because some of the random bad luck of a 1 losing a customer to a 2 or a 3, etc. has been eliminated. The big firm can more easily detect cheating by any of the little ones.

THE THEORY ESSENTIALLY TELLS US TO LOOK FOR MEANINGFUL DEPARTURES FROM COMPETITION BY CONNECTING THE STRUCTURE AND INSTITUTIONS OF THE MARKETPLACE TO THE NORMAL VARIABILITY OF FIRM SALES.

3. Buyer loyalty. Suppose that instead of throwing a die, in most weeks buyers tend to buy from some preferred seller. This reduces any one seller's normal variability (to zero in the extreme case of a fixed number of buyers with unvarying weekly demands each completely loyal to a specific seller). Result: less competition. Buyer loyalty is not rewarded with more competition. You can also begin to understand the corollary: Smart buyers spread the business around so as to exacerbate the sellers' information problem.
4. Buyer size. Say we have 30 buyers, each taking two per week, instead of 60 taking one. Normal sales variability is higher here, because two sales are riding on each roll of the die instead of one. Ergo, competition is stronger in this case. The notion of large buyers having "clout" or "power" acquires a certain precision in Stigler's theory.
5. Overall demand variability. Say the buyers come to market with big orders some weeks and none in others, instead of having a steady weekly demand. Or suppose the total number of buyers moves around in ways that are hard for any one seller to detect. Then normal sales variability will be higher and competition will, therefore, be stronger.

This ability of the theory to connect a variety of circumstances to a unifying theme explains why, as we describe in the next section, Stigler's article had such a large influence on competition law. Take any set of circumstances and ask what are the implications for a seller's normal sales variability. According to the theory, you have an important clue about the ultimate ability of the firms to sustain

a price above the competitive level. This is not the only question you would ask, but it is likely to be a recurring and important one.

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Another question the theory suggests you would ask is whether some arrangement at issue helps or hinders the seller in cutting through the

normal variability to a faster separation of truth from noise. The answers here sometimes have a paradoxical more-is-less ring to them. For example, would you, as an industrial buyer, want to know what your competitors paid for the same item? The instinct is to say "yes, and if I learn I paid more than them it is ammunition I can use in negotiating a better deal." But not so fast. If you can easily find out what other buyers paid, then the sellers probably can also find out. If each seller can quickly learn others' prices, the prospective speed of response to hypothetical cheating increases and cheating is less likely to be a dominant strategy.

Unlike what you learned in Econ 101, more information is not necessarily better (for buyers). As a corollary, some ways in which small number buyer-seller markets differ from, say, retail markets become intelligible. For example, consider the jealous guarding of transaction prices by buyers or the negotiation of discounts from a published list price that is never actually charged. Information is being

obscured and time is taken up with haggling. But consider the implications if the transaction prices are revealed or, equivalently, the list prices are never discounted. The quick revelation of transaction prices in this case would stabilize collusion. Ergo, competition works sometimes to obscure information; the sand in the wheels signals the buyer that the seller is not colluding.<sup>7</sup> Again, we have a simple benchmark question for competition policy to ask of a particular practice—does it speed up or slow down the dissemination of transaction prices and quantities? And we have a broadly applicable answer—more (speed) is less (competition).

### III. Why the Contribution is a Landmark

#### A. INDUSTRIAL ORGANIZATION

The study of oligopoly has vexed scholars because the range of observed behavior seems to be quite varied. It had long been observed that the behavior in some, though not all, concentrated industries was not well described by the model of competition. How should one model this type of oligopoly behavior? One tradition looked to industry structure (numbers, concentration) as the source of deviations from competition. If there were sufficiently few significant firms, rivals could no longer ignore each other in their decision-making. The way firms competed was often described by various types of models that assumed a particular type of interaction among firms. So, for example, firms could play a Cournot game in which one firm assumed that its rivals' output was unchanging as it varied its own output, or a Bertrand game in which one firm assumed that its rivals' price remained unchanged as it varied its price. Or one firm could have a "conjectural variation" in which it assumed that if it varied its output by, say, one unit, its rivals would increase their collective output by some assumed amount,  $\theta$ . In today's terminology, these are static games.

It was of course recognized that these types of static models greatly oversimplified actual oligopolies by relying on static concepts. Some earlier work (e.g., Chamberlin<sup>8</sup> and Fellner<sup>9</sup>) had emphasized the importance of uncertainty and dynamic considerations in understanding how competitive oligopolies could be.

Despite the prior contributions such as Chamberlin's and Fellner's, it took Stigler's article to shake the foundation of the prevailing beliefs about oligopoly at that time. Basically, Stigler said that the assumptions in the literature about how firms interact with each other (e.g., conjectural variation type assumptions) come out of thin air and there is no reason to believe them: "A satisfactory theory of oligopoly cannot begin with assumptions concerning the way in which each firm views its interdependence with its rivals. . . . [B]ehavior is no longer something to be assumed but rather something to be deduced."<sup>10</sup> Stigler sought to identify the exogenous conditions that would determine how each firm would interact with its rivals and thereby determine the degree to which each industry would wind up with prices that differ from the competitive ones.

As the previous section illustrates, Stigler used the theory of information (which he had pioneered three years earlier) to explain how any attempt to set prices above competitive levels for any buyer would create incentives for one rival to try to steal its rivals' customers. If such stealing was hard to detect and

STIGLER USED THE THEORY OF INFORMATION (WHICH HE HAD PIONEERED THREE YEARS EARLIER) TO EXPLAIN HOW ANY ATTEMPT TO SET PRICES ABOVE COMPETITIVE LEVELS FOR ANY BUYER WOULD CREATE INCENTIVES FOR ONE RIVAL TO TRY TO STEAL ITS RIVALS' CUSTOMERS.

was very profitable, it would be worth trying as long as the penalty—some form of price competition—was not too severe. As our previous discussion illustrates, Stigler emphasized the heterogeneous nature not just of the sellers—which provides the firms with different incentives as to what price to set and what risks to take in trying to undercut a rival's price—but also the heterogeneous nature of buyers.

Specifically, large buyers are worth a lot when price is above marginal cost and they will be attractive targets for rivals. Moreover, buyers differ a lot in the frequency and predictability of their buying behavior. The effect of all these characteristics on the likelihood of cheating can be analyzed by seeing how they affect the expected profitability of a price cut. This profitability will depend upon the ease of detecting an attempt by one rival to steal another's customer by undercutting price and, if undetected, the profitability of stealing a rival's customer, and, if detected, the decrease in profits from the retaliatory competition. The analysis suggests that small buyers are more likely than large buyers to pay high prices, and that in industries where detection of undercutting is hard (such as where new big buyers come and go frequently) or where it is hard to get information on what your rivals are doing, one expects to see lower prices, *ceteris paribus*. The insights that heterogeneity of buyers fosters competition, that increases in competition follow from ease of customer switching, and that the ability to use long-term contracts to lock in a big buyer at a discounted price without having to worry that a rival will steal back the customer are all insights that emerge effortlessly from the theory.

Stigler goes on to test his theory empirically, but the tests that he describes as “fragments of evidence” do not really test the theory very well. Instead, his tests are based upon showing the positive relation of price to concentration—exactly the kind of tests done in the structure-conduct-performance literature that Stigler disliked so much. Stigler recognizes the limitation of his empirical tests, which fail to test the novel aspects of his theory. It was not new in 1964 to say that concentration affects prices, but it was new to use information theory to identify under what conditions detection of price-cutting would be difficult. Stigler ends his article by asking for more tests as better data become available. Interestingly, the one variable that Stigler focuses most on in his empirical tests—concentration (or number of competitors)—is one variable that the sub-

sequent literature in industrial organization has established may not, in many contexts, be appropriate to regard as exogenous.<sup>11</sup>

Stigler's insights are quite remarkable, especially given that they occur before the game theory revolution in industrial organization. Game theorists, just like Stigler had done, have subsequently demolished the literature on conjectural variations as baseless on theoretical grounds, though they fail to explain which variables are the strategic ones on which there is competition (e.g., price or quantity).

Stigler's article did have a large impact on how industrial organization economists subsequently studied oligopoly. For example, Stigler focuses attention on what are the sources of information used to detect cheating or undercutting any agreed-upon price. These sources of information are likely to vary by industry. In some industries, quantities are easily observed, but not prices, while the reverse may be true in other industries. The information set will influence what methods firms use to compete in an oligopoly equilibrium. For example, Carlton<sup>12</sup> showed that delivered pricing is a great way to collude if only price information is available, but not so great if only quantity information is available (in which case, fob ("free-on-board") pricing is the better way to collude since it neatly allocates customers to firms).

Stigler's theory can perhaps best be roughly described as a dynamic formulation of a non-cooperative game in which detection of price-undercutting triggers some reaction that results in a lower price as a result of the detection. Stigler's theory implies that whatever level a

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current price is set at will influence the incentive of others to cheat, as will the ability to detect any price cut and the consequences of such detection on subsequent pricing. This insight led to the use of dynamic game theory to model Stigler's set-up. Green & Porter<sup>13</sup> and Porter<sup>14</sup> attempted to operationalize Stigler's theory by assuming that firms follow a trigger strategy: Once a low price is observed, that low price triggers a price war for some period, after which the firms revert to charging a high price. Though trigger pricing has been criticized for the implication that price wars occur even in the absence of cheating, these papers capture much of the flavor of Stigler's paper. Moreover, this formulation allows one to test what happens as demand unexpectedly changes and whether, as Stigler predicts, this leads to price-cutting. The answer is yes.<sup>15</sup>

Unfortunately, many authors of subsequent empirical (and theoretical) literature in industrial organization have lost interest in the determinants of the behavior of oligopolists. For example, investigating the effect of buyer heterogeneity on competition has become increasingly rare. Instead, much of the

recent empirical literature in industrial organization has focused on detailed econometric estimation of demand systems.<sup>16</sup> The improved demand estimation is all to the good. But these papers tend to gloss over the oligopoly interactions. This interaction seems frequently to be cast in terms of static Bertrand or, in more complicated papers using dynamic game theory, some Markov perfect equilibrium whose believability might be questioned. The “Folk Theorems” that game theorists have produced say that any price equilibrium can be supported in a dynamic game. This may square with the observation that we observe lots of different oligopoly behavior, but we think it renders economics quite useless for understanding oligopoly behavior. We need to understand better why those theorems fail.

Stigler asked that we figure out why some equilibrium persists in one industry but not another, and to understand how the underlying industry characteristics influence that equilibrium. Some work along these lines has been done. For example, Genesove & Mullin<sup>17</sup> use Bresnahan's concept of a behavior parameter to estimate what that behavior parameter<sup>18</sup> depends on. Unfortunately, such a set-up relies on a static conjectural variation game (see Corts<sup>19</sup>) so it cannot really be said to implement Stigler's model.<sup>20</sup> Some of the recent empirical work based on the work of Maskin & Tirole<sup>21</sup> makes some progress by investigating how the interaction among firms changes as the time period over which prices remain fixed changes. If one could make the period endogenous based on switch-

ing probabilities and transaction cost, perhaps one could make some additional progress in pursuing Stigler's research agenda.<sup>22</sup>

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However, our own sense of the literature is that it is not proceeding down the path Stigler wanted to go. It has veered off, especially in merger studies. Too much attention is being paid to merger simulations based on static

Bertrand assumptions. We think the profession would do well to reread Stigler and resume his quest for understanding the determinants of oligopoly in which the desire to get a rival's customer by price-undercutting is a constant feature of oligopoly behavior, and in which the frequency of such undercutting will depend in part on information availability.

## B. ANTITRUST

Stigler's article has had, and continues to have, a profound effect on the understanding of oligopoly in antitrust and is used heavily in merger analysis around the world. This influence is clear in Posner's 1976 edition of *Antitrust Law*.<sup>23</sup> This book, together with Bork's *The Antitrust Paradox*,<sup>24</sup> pioneered the application of economics to antitrust. Posner's exposition of the oligopoly problem draws heavily on Stigler's article. He explains that Stigler's “alternative approach that is at once subtle and simple”<sup>25</sup> provides the way to understand how oligopolies

behave. Posner's lucid exposition—much clearer, especially for a non-technical reader than Stigler's—goes through a laundry list of factors that, according to Stigler's theory, will lead to more rather than less competitive behavior. In the several editions of their textbook, *Modern Industrial Organization*, Carlton & Perloff go through much the same list, also relying on Stigler.<sup>26</sup>

To illustrate the extent to which Stigler influenced his followers, we note one curiosity. One can measure concentration in an industry in different ways. For example, one could use the share of sales accounted for by the top four firms (CR4) or one could use the HHI index (the sum of squares of individual market shares). Empirically, these two measures are correlated across industries and therefore it is unlikely that an empirical finding will depend on which measure is used. (Indeed, even Stigler's own empirical analysis in his article noted that, for the industries where he had data, the correlation of CR4 with HHI was .94).<sup>27</sup> Stigler's theory about detection used a highly stylized example of inference to show that the ability to detect cheating depends on the HHI. Stigler does not show that this translates into a price effect that is related to the HHI. However, Stigler's admirers often mention the superiority of the HHI over CR4 for measuring industry concentration even though that proposition had not been demonstrated empirically.<sup>28</sup> We suspect that it was William Baxter's admiration for Stigler's economic insights that led him to use HHI, not CR4, in the Merger Guidelines of 1982 when he was Assistant Attorney General in the Antitrust Division.

The Department of Justice Merger Guidelines issued in 1982 illustrate the enormous influence of Stigler's article on antitrust policy, especially merger policy. These Guidelines are widely viewed as a watershed event in the history of antitrust and represent the use of sophisticated economics as the foundation of antitrust policy. Section III "Horizontal Mergers" subsection C "Other Factors" goes through many of the factors identified in the Stigler article, and the entire tone of the discussion makes clear that the Department of Justice understood and endorsed Stigler's emphasis that information about price is key to understanding the likelihood of non-competitive pricing. This section of the Guidelines is expanded a bit in the 1984 revision of the Merger Guidelines in Section 3.4 "Other Factors."

Probably the clearest illustration of Stigler's influence comes in the 1992 Horizontal Guidelines where an entire section (Section 2.1) is devoted to describing the way in which "coordinated interaction" works. That section reads as a summary of Stigler's article.<sup>29</sup> That description makes clear that "coordinated interaction entails reaching terms" on such matters as price, an ability to monitor price or output in

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order to detect deviations from the terms, and an ability to punish. These are exactly the ingredients that Stigler laid out in his article.

Interestingly, that version of the Guidelines also highlighted what is called “unilateral” conduct in which the merged firm by itself has sufficient market power to raise prices of the products involved in the merger. The distinction between unilateral and coordinated effects as ways in which a merger can harm consumers has led to a curious result. It has diverted attention away from studying coordinated effects to studying “unilateral effects” which, in practice, involves a merger simulation under an assumption of static Bertrand competition. Carlton<sup>30</sup> has criticized this distinction between unilateral and coordinated conduct, but our point here is that the attention to “unilateral effects” in the 1992 Guidelines has led to a shift in research focus away from the topic Stigler identified as crucial for understanding oligopoly behavior, namely the derivation of the competitive behavior in an industry from the exogenous facts of the industry.

The 2010 Horizontal Merger Guidelines that were recently issued devote an entire section to “coordinated effects” (Section 7) and reiterate much of the prior Guidelines’ discussion. It is hard to imagine a more fitting tribute to the insightfulness of an article than to have it remain a key building block of antitrust policy almost 50 years after being published.

## IV. Conclusion

Stigler never chose to enter the government and influence policy from the inside. Instead he believed that he could have much more influence from the outside through his academic articles. There is no question that his article on oligopoly was a first rate scholarly contribution that has had an enormous impact on policy. ▼

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1 George J. Stigler, *A Theory of Oligopoly*, J. POL. ECON. (1964) reprinted in 6(2) COMPETITION POL’Y INT’L at 253 (Autumn, 2010).

2 *Id.* at 44.

3 *Id.* at 45.

4 Whereby the six of us set up a single order taker who then parcels out 10 sales to each. This kind of arrangement came under legal attack soon after passage of the Sherman Act.

5 Indeed Stigler’s oligopoly theory comes three years after, and is an application of his path-breaking theory of information. See George J. Stigler, *The Economics of Information*, J. POL. ECON. 69, 213-25 (1961).

6 In statistics jargon, the coefficient of variation—the standard deviation divided by the mean—is the crucial variability measure for Stigler’s information problem.

- 7 An interesting example of this dimension of competition lies in the response of the trucking and rail-road industries to deregulation. Previously they were required to adhere to published tariffs approved by their regulator. Since deregulation, the majority of freight has moved under confidential tariffs, i.e., individually negotiated prices that are not publicly revealed.
- 8 EDWARD H. CHAMBERLIN, *THEORY OF MONOPOLISTIC COMPETITION* (1933).
- 9 WILLIAM FELLNER, *COMPETITION AMONG THE FEW* (1949).
- 10 Stigler, *supra* note 1 at 44.
- 11 See JOHN SUTTON, *SUNK COSTS AND MARKET STRUCTURE* (1991) and JOHN SUTTON, *TECHNOLOGY AND MARKET STRUCTURE* (1998).
- 12 Dennis W. Carlton, *A Reexamination of Delivered Pricing Systems*, *J. L. ECON.* 26, 51-70 (1983).
- 13 Edward J. Green & Robert H. Porter, *Noncooperative Collusion Under Imperfect Price Information*, *ECONOMETRICA* 52, 87-100 (1984).
- 14 Robert H. Porter, *A Study of Cartel Stability: The Joint Executive Committee, 1880-1886*, *BELL J. ECON.* 14, 301-14 (1983) and Robert H. Porter, *Optimal Cartel Trigger Price Strategies*, *J. ECON. THEORY* 313-38 (1983).
- 15 Porter, *A Study of Cartel Stability, Id.*
- 16 See Liran Einav & Jonathan Levin, *Empirical Industrial Organization: A Progress Report*, *J. ECON. PERSP.* 24, 145-62 (2010).
- 17 David Genesove & Wallace P. Mullin, *Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914*, *RAND J. ECON.* 29, 355-77 (1998).
- 18 See Timothy F. Bresnahan, *Empirical Studies of Industries with Market Power*, *THE HANDBOOK OF INDUSTRIAL ORGANIZATION*, VOL. II (Richard Schmalensee & Robert Willig eds.) (1989).
- 19 Kenneth S. Corts, *Conduct Parameters and the Measurement of Market Power*, *J. ECONOMETRICS* 88, 227-50 (1999).
- 20 This is not quite right as Bresnahan, *supra* note 18, points out. If one forces a dynamic game into a static model, then one may be better off allowing for a conduct parameter in a static game if one wants to use the estimated model for prediction. But, see Corts, *id.*
- 21 Eric Maskin & Jean Tirole, *A Theory of Dynamic Oligopoly, I: Overview and Quantity Competition with Large Fixed Costs*, *ECONOMETRICA* 56, 549-69 (1988) and Eric Maskin & Jean Tirole, *A Theory of Dynamic Oligopoly, II: Price Competition, Kinked Demand Curves, and Edgeworth Cycles*, *ECONOMETRICA* 56, 571-99 (1988).
- 22 See, e.g., Wang for some work showing how Maskin & Tirole's theory can be tested when the fixed period varies. Zhongmin Wang, *(Mixed) Strategy in Oligopoly Pricing: Evidence from Gasoline Price Cycles Before and Under a Timing Regulation*, *J. POL. ECON.* 117, 987-1030 (2009).
- 23 RICHARD A. POSNER, *ANTITRUST LAW: AN ECONOMIC PERSPECTIVE* (1976).
- 24 ROBERT BORK, *THE ANTITRUST PARADOX* (1978).

25 POSNER, *supra* note 23 at 47.

26 DENNIS W. CARLTON & JEFFREY M. PERLOFF, MODERN INDUSTRIAL ORGANIZATION (1990) (1994) (2000) (2004).

27 See Stigler, *supra* note 1 at 57, footnote 15.

28 See, e.g., POSNER, *supra* note 23 at 55, footnote 26.

29 Indeed, one of us (Carlton) assigns this section to his graduate class when he teaches Stigler's article.

30 Dennis W. Carlton, *Revising the Horizontal Merger Guidelines*, J. COMPETITION L. ECON. (forthcoming).