Quantitative Analysis of Coordinated Effects*

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Abstract

Mergers can affect the extent, probability, and payoffs from coordinated interaction among firms in an industry. Current analyses of coordinated effects typically provide little quantification of these effects; they ordinarily rely on arguments based on the number of firms, the Herfindahl Index, the ability to detect and punish deviations, ease of entry, and the influence of maverick firms. We offer an approach for quantifying the potential profits associated with post-merger collusion. If the potential profits from post-merger collusion are large, then coordinated effects are more of a concern. In addition, our approach helps identify which post-merger cartels are most likely, evaluate efficiency claims by the merging firms, and quantify the effects of post-merger collusion on consumer surplus. At its heart, our approach is an extension of existing unilateral effects analysis, so the burden of defending the applicability and robustness of the model is largely borne by the complementary unilateral effects analysis. We illustrate the implementation and value of this approach with an application to Hospital Corporation.

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1 Introduction

Mergers involving rival firms in concentrated markets tend to increase opportunities for coordinated behavior. This phenomenon is a longstanding focus of attention for merger control policy. The Horizontal Merger Guidelines (Guidelines) of the Federal Trade Commission (FTC) and Department of Justice (DoJ) recognize this possibility as a central concern. The Guidelines point to a need to understand the effects of a merger on the incentives for, payoffs from, and feasibility of coordinated behavior. They also point to a need to understand the effects of coordinated behavior on the deadweight loss associated with a merger, and perhaps more relevant from the perspective of social policy, the decrease in consumer surplus associated with a merger.

The Guidelines’ treatment of coordinated effects focuses on the capacity of a merger to increase coordination by firms that remain in the relevant market with respect to price, quality, or other dimensions of competition. Section 2.0 of the Guidelines states that “[c]oordinated interaction is comprised of actions by a group of firms that are profitable for each of them only as a result of the accommodating reactions of the others.” Successful coordination requires “reaching terms of coordination that are profitable to the firms involved.”

The Guidelines’ analysis of coordinated effects focuses chiefly on industry conditions that would facilitate the completion of three tasks—the formulation of a consensus, the detection of deviations from the consensus, and the punishment of cheaters—that are ingredients to successful coordination. To this end, the U.S. antitrust agencies “not only assess whether the market conditions for viable coordination are present, but also ascertain specifically whether and how the merger would affect market conditions to make successful coordination after the merger significantly more likely.” The assessment of post-merger performance outcomes “includes an assessment of whether a merger is likely to foster a set of common incentives among remaining

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1 See Andrew I. Gavil et al., Antitrust Law in Perspective: Cases, Concepts and Problems in Competition Policy 495-514 (2002) (discussing merger policy concern with coordinated effects); Marc Ivaldi et al., The Economics of Tacit Collusion: Implications for Merger Control, in The Political Economy of Antitrust 217 (Vivek Ghosal & Johan Sennek eds. 2007) (reviewing how merger policy accounts for possibilities of tacit collusion in post-merger period).
3 HMG at §2.1.
4 Id.
6 Commentary on HMG at 18.
rivals, as well as to foster their ability to coordinate successfully on price, output, or other
dimensions of competition.”

Like the Guidelines, our analysis is concerned with the incentives of firms, but with a
somewhat different emphasis. Our approach focuses on how a merger affects the profitability of
collusion, which affects firms’ incentives to solve the tasks (consensus building, detection, and
punishment) that are ingredients for successful coordination. Our approach assumes that firms
will try harder to solve the coordination tasks if the incremental profits from coordination are
higher and if the incremental profits from deviations are lower, so that attempts to coordinate are
more likely to succeed.

Firm behavior in an industry can range from the uncoordinated behavior associated with
one-shot non-cooperative interaction to explicit collusion where all the firms essentially function
as one entity. Intermediate behavior can involve collusion only among a subset of the firms. In
addition, colluding firms may be more or less successful at suppressing rivalry among themselves
and so cartels can have varying degrees of effectiveness. The probability and extent of collusion
among a particular subset of firms will depend on features of the firms, the industry, and the
market. For example, a merger that eliminates a “maverick” may increase the probability of
collusion among all the firms in the market. The Guidelines’ concern regarding coordinated
effects reflects the fact that when a merger changes the configuration of an industry, it can affect
the probability of collusion among various subsets of firms in the industry.

Current merger analysis of coordinated effects tends to focus on questions such as: Will the
merger cause the Hirschmann-Herfindahl index to rise substantially? Will the merger absorb a
“maverick” firm or otherwise negatively affect a “maverick” firm? Will the merger allow
conspirators to detect deviations by other conspirators more easily? Will the punishment of
deviators be easier or more effective? Although the HHI is easy to calculate, the change in the

\[7 \text{ Id.} \]
\[8 \text{ Much of the economics literature on collusion focuses on collusion among all of the firms in an industry. Notable exceptions include Graham and Marshall (1987), Graham, Marshall, and Richard (1990), Marshall, Meurer, Richard, and Stromquist (1994), and Marshall and Marx (2007) (analyzing collusion among subsets of bidders at an auction). Despite the theoretical focus on all-inclusive collusion, there are many significant real-world examples of cartels that included only a subset of the firms in the industry. For example, the International Vitamins Cartel was not all-inclusive for many vitamins (see the EC Decision in Vitamins). Other examples include the following cartels – carbonless paper, choline chloride, citric acid, copper plumbing tubes, carbon brushes, food flavor enhancers, industrial tubes, methionine, rubber chemicals, and sorbates. With the exception of copper plumbing tubes and carbon brushes, the EC decisions identify significant players in the market that are not included in the conspiracy. In addition, the Guidelines recognize the importance of maverick firms, which are portrayed as firms not wanting to join cartels. The emphasis on all-inclusive collusion may stem from the theoretical economics literature which largely emphasizes the all-inclusive cartel since in the equilibrium of simple models there are often no reasons for a cartel to be less than all-inclusive.} \]
Herfindahl from pre-merger to post-merger merely suggests the potential incremental coordinated and unilateral effects issues. Since there is no direct and unambiguous definition, empirical or otherwise, for a “maverick” firm in the Guidelines, the second question can be largely ambiguous. The last two questions, although rooted in the Folk Theorem and the repeated game literature, result in “dinner party” stories, where qualitative conclusions such as “fewer firms make coordinated interaction more likely” are the norm.

Coordinated effects analysis could benefit from further development of a systematic framework with quantifiable content that provides a foundation for predicting post-merger conduct. The economics literature on cartel formation and success (see footnote 5) does not focus on the changes in incremental incentives for coordinated behavior as a result of a merger. However, there is some literature that is directly applicable to merger analysis. Compte, Jenny, and Rey (2002) analyze mergers in an environment where excess capacity can increase sufficiently from a merger to make tacitly collusive equilibria feasible that were not feasible pre-merger. Vasconcelos (2005) analyzes cost asymmetries that are exacerbated by a merger to a point where tacitly collusive equilibria are no longer feasible. Each of these papers focuses on a discrete shift in the feasibility of tacit collusion associated with a merger. In this paper, we start from the premise that firms respond to incentives. Payoffs drive behavior. The larger are the

9 The Guidelines define “maverick” firms as “firms that have a greater economic incentive to deviate from the terms of coordination than do most of their rivals (e.g., firms that are unusually disruptive and competitive influences in the market).” It is unclear how one would formulate a statistical test for the null hypothesis that a given firm was a “maverick.” One aspect of a “maverick” is clear: if not part of the merger, the participation of such firms in post-merger coordinated interaction will be relatively low. The explicit mention of mavericks in the Guidelines suggests an explicit recognition that all-inclusive explicit collusion is far from the leading concern regarding post-merger coordinated interaction. HMG, supra note 2, at §2.12.


payoffs from coordinated behavior, the more likely are firms to incur the costs and risks associated with coordinating their behavior. From this perspective, quantifying the payoffs associated with post-merger collusion provides an important input into predicting the likelihood of coordinated effects.

There are difficulties in assessing the likely effectiveness of post-merger collusion. In the framework proposed in this paper, we avoid this issue by focusing on the potential profits associated with collusion, where those potential profits are the profits from a maximally effective post-merger cartel. Thus, we evaluate the profits for a cartel that is able to maximize the total profits of all of their members. Our calculation of the potential profits from collusion provides a measure of the incentive for collusion. Furthermore, we can calculate firms’ payoffs from deviations from “perfect” collusion, which provides a measure of the stability of a post-merger cartel. These calculations allow us to assess the likelihood and stability of collusion among various subsets of firms in an industry, both before and after a merger. Thus, the calculations we suggest provide information that is potentially valuable in assessing whether post-merger coordination is likely and which post-merger firms have the greatest incentive to coordinate.

Standard unilateral effects analyses of proposed mergers investigate, in a static context, the impact of the proposed decrease in the number of industry participants on interfirm interaction. As the Guidelines observe,\footnote{HMG at §2.2.} “[a] merger may diminish competition even if it does not lead to increased likelihood of successful coordinated interaction, because merging firms may find it profitable to alter their behavior unilaterally following the acquisition by elevating price and suppressing output.”

The typical unilateral effect analyses investigate the impact on pricing of the reduction in the number of market participants from \(n\) to \(n-1\).\footnote{There can be exceptions. In Arch Coal the proposed merger was coupled with a proposed divestiture. For this reason, the district court assumed that the proposed merger would not alter the number of firms in the relevant market. F.T.C. v. Arch Coal, Inc, 329 F. Supp. 2d 109 (D.D.C. 2004).} If the standard unilateral effects analyses are extended to investigate the impact of the reduction in the number of market participants from \(n-1\) to \(n-2\), then they can be used to analyze how the merger affects the incentives of two of the \(n-1\) post-merger firms to collude so that only \(n-2\) independent firms remain in the market. Furthermore, the analysis can consider all possible pairs of firms in the post-merger market to assess which two have the largest payoff from collusion. Collusion among larger groups of firms can be investigated as well. A comparison of these payoffs can inform authorities as to which
combinations of firms in the post-merger market pose the greatest threat of coordination. Augmenting standard unilateral effects analyses somewhat, we can also obtain measures of the stability of various cartels and evaluate efficiency claims associated with a merger.

In this paper, we propose a three-step process. The first is to select an appropriate model of competition. This might be quantity competition, differentiated products price competition, bidder competition within an auction or procurement, a discrete choice model, or some other model of competition that incorporates the salient features of a given industry. We do not mean to diminish the potential difficulty of this task, but the variety of well-studied models in the economics literature provides a range of choices, and in many cases one of these will provide a reasonable fit with the reality of the market in question. The second step is to fit and/or calibrate the model to the pre-merger market and the relevant features of the pre-merger firms, such as their market shares. Firms’ market shares will be endogenous to a market model and so the ability to fit a model to market shares provides a check on the overall usefulness of the model. Within the fitted and/or calibrated competitive framework, the final step is to calculate the merger’s effect and the effects of various post-merger explicit collusion scenarios. The potential profitability of collusion among various subsets of firms can be evaluated. Given a cartel structure, the profitability of deviations from collusion can be calculated under assumptions on the ability of the cartel to monitor the behavior of its members and the length and type of punishment associated with detected cheating. Measures of consumer surplus can be calculated. Bounds on the efficiency improvements required to offset unilateral and coordinated effects can be estimated.

We do not intend for our approach to displace any existing analysis. Instead, we envision it as a complement to existing unilateral effects analyses and non-quantitative coordinated effects analyses. Nevertheless, the value to merger analysis from quantifying coordinated effects is potentially large. As we show, a basic quantification of incentives of post-merger firms to collude and to cheat on a collusive agreement can be achieved without extensive additional economic modeling beyond that required for a quantitative unilateral effects analysis. The calculations we propose may reveal that coordinated effects are a significant concern, or they may reveal that there is little concern. In cases where coordinated effects are a significant concern, the calculations may point to a specific subset of firms that are at greatest risk for coordination.

Although the proposed analysis does not directly calculate a probability of collusion, it does quantify the potential incremental payoff to firms from collusion, which gives an indirect
measure of the probability of collusion. Similarly, we propose calculations of the payoffs to firms from unilateral deviations from collusion, which provide an indirect measure of the sustainability of collusion. In providing these measures, this approach can help satisfy the greater evidentiary demands that various courts have placed upon competition agencies which seek to block mergers based on coordinated effects theories.

Our approach focuses on incentives. Because our approach identifies cases in which the potential profits from collusion are large, it identifies cases in which firms have a strong incentive to find solutions to the difficulties that firms face in achieving successful coordination. Firms often can face formidable challenges not only in setting and monitoring fidelity to the terms of their plan, but also in coping with phenomena – such as defections by participants in the collaboration, competitive moves by non-participants, new entry, expansion by fringe firms, countermeasures by customers – that can place pressure on a collusive arrangement. The recitation of these obstacles obscures the willingness and diligence of firms to surmount them if the rewards are enticing. Moreover, recently published studies and other information about the operation of cartels old and new has demonstrated that the enormous energy and creativity that firms devote to solving coordination problems associated with the legal forms of cooperation (e.g., joint ventures) can be applied to solving coordination problems that arise in illegal collaborative endeavors (e.g., price fixing agreements). If the price is right, firms will have a go at it, and they will do so with a level of imagination and success that commentators generally have underestimated.

The paper proceeds in three parts. Section 2 provides an overview of our proposed analysis. We illustrate that analysis in detail in Section 3 through an application to a past merger case, Hospital Corporation. Section 4 concludes with some observations about the future development of merger policy.

2 Overview of the Proposed Analysis

In this paper, we attempt to provide some rigor to coordinated effects analysis using the

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insight that unilateral effects analysis can be used to measure the potential profitability of collusion. To illustrate, consider the case of 4 firms, A, B, C, and D, with A, B, and C producing similar products and D a more differentiated product. If A and B merge, the unilateral effects may be small, but the incentive of the combined A and B to collude with C (as measured by the potential profitability of that collusion) may increase substantially. The potential profitability of collusion between the merged firm A+B and C can be measured by doing a unilateral effects analysis of a hypothetical merger of A+B with C.

When using the measure of potential profitability to gauge the incentives of firms to collude, one must also consider the stability of the cartel in question. A merger that increases the potential profitability of collusion may simultaneously increase the incentives for firms to cheat on the collusive arrangement, implying that although collusion is potentially profitable, it may be unstable. For example, in the hypothetical example above, although firm C may have an increased incentive to collude with the combined firm A+B, it may also have an increased incentive to cheat on such a cartel. We show that some rigor can be introduced to this analysis as well. To the extent that a unilateral effects analysis of a hypothetical merger of A+B with C provides us with robust demand and cost estimates for a market consisting of firms A+B, C, and D, then one can use these estimates to calculate the change in profit to firm C if it merges with A+B versus if it agrees to behave as if merged but then cheats by behaving competitively vis-à-vis a firm A+B that is expecting it to behave as if merged. As with the calculation of the potential profits from collusion, this analysis requires the usual inputs and assumptions required of a quantitative unilateral effects analysis, but one must extend that analysis to a hypothetical merger of A+B with C rather than applying that analysis only to the merger at issue between A and B.

The development of a quantitative unilateral effects analysis typically requires data on demand and costs together with a variety of modeling assumptions. Given data and acceptable simplifying assumptions, one can use statistical (econometric) and analytic (economic theory) techniques to develop a quantitative model that is flexible enough to give estimates of prices, quantities, consumer welfare, and profits both before and after a proposed merger. It can be difficult to identify the most appropriate assumptions and model. Whenever such difficulties arise in unilateral effects analysis, they will also arise in our proposed extension of unilateral effects analysis to hypothetical mergers beyond the true merger being considered. Thus, our

proposed analysis is subject to all the usual caveats related to quantitative models of unilateral effects. Those are not problems we attempt to solve in this paper.

Our analysis calculates the “potential” profits from collusion, which are the profits that would obtain if the firms involved behaved so as to maximize their joint profits. Such “perfect” collusion may be far from what the firms can achieve through tacit means. Since the profits from tacit collusion tend to be large exactly when the profits from “perfect” collusion are large, our measure of “potential” profits provides a relevant benchmark for evaluating the importance of coordinated effects. Even in cases where the profits from tacit and explicit collusion diverge, the calculations we propose offer upper bounds on the profitability of tacit collusion among various subsets of firms. In cases where those bounds are small, one can have greater confidence that coordinated effects are not a significant issue.

This paper demonstrates how economic analysis can be applied to guide an analysis of coordinated effects under the Guidelines. However, the analyst will face difficult choices of assumptions to make along the way. In our approach to coordinated effects, the requirements for the appropriateness of assumptions are the same as those currently applied to a quantitative unilateral effects analysis. Because our approach is at its heart an extension of existing unilateral effects analysis, the burden of defending the underlying assumptions required for our proposed coordinated effects analysis should, to a large extent, be relieved by the robustness checks offered by the complementary unilateral effects analysis.

3 Application – Quantifying Coordinated Effects Using a Model of Differentiated Products Price Competition with an Application to Hospital Corporation

A significant coordinated effects case that illustrates our point is Hospital Corporation of America v. Federal Trade Commission. We illustrate our approach to quantifying coordinated effects within the context of this case. Our approach involves extending unilateral effects analysis to consider the effects of collusion.

The model within which the calculations are made should be appropriate for the application being considered, and different models can produce different results. For the Hospital Corporation case, we base our analysis on a model of differentiated products price competition.
This model allows us to capture interactions in a market where firms produce heterogeneous products and consumers make their purchase decisions based on the firms’ prices and quality levels.

Other models that allow the calculation of the equilibrium outcomes associated with various configurations of competition and cooperation among firms can be used in other cases as appropriate. The full range of models used in examining unilateral effects are candidates for use in the type of analysis we propose.

In Section 4.1, we provide some background on the Hospital Corporation case. In Section 4.2, we show how one can calibrate a model of differentiated products price competition to the relevant market in the Hospital Corporation case. In Section 4.3, we show how one can use the model to quantify the impact of coordinated effects. The results of this section take the appropriateness of the model as given, but of course all the usual robustness checks that would be applied to the market models used in a unilateral effects analysis would be required. In Section 4.4, we consider three extensions of the model and analysis. First, we allow for the possibility that the proposed merger results in quality improvements among the merging firms – in Hospital Corporation one issue was whether the merger of lower quality hospitals with higher quality hospitals might improve the quality of the lower quality ones. Second, we extend the model of Section 4.2, which for simplicity ignores possible differences in operating costs among the hospitals, to allow for differential costs. Third, we extend the model of Section 4.2, which for simplicity ignores capacity constraints, to allow for differential capacity constraints among the hospitals.

3.1 Background on Hospital Corporation

As presented in the court of appeals decision in Hospital Corporation, Hospital Corporation of America (HCA) acquired Hospital Affiliates International, Inc. and Health Care Corporation in the early 1980s. Before these acquisitions took place, HCA had owned one hospital in Chattanooga, Tennessee, and the acquisitions gave it ownership of two more. Pursuant to the terms of the acquisitions, HCA also assumed contracts that Hospital Affiliates International had made to manage two other Chattanooga-area hospitals. After the acquisitions, HCA owned or managed five of the eleven hospitals in the area. The FTC challenged the acquisitions as a

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17 807 F.2d 1381 (7th Cir. 1986).
violation of Section 7 of the Clayton Act. In particular, the FTC expressed concerns about the potential for post-acquisition coordination between HCA and the other three large hospitals in the area.

The acquisitions raised Hospital Corporation’s market share in the Chattanooga area from 14 percent to 26 percent. This made it the second-largest provider of hospital services in a market where the four largest firms together had a post-acquisition market share of 91 percent (as compared to 79 percent before the acquisitions).\(^{19}\) The FTC concluded that the acquisitions created a danger that the largest Chattanooga hospitals would collude.

Judge Richard Posner’s opinion for the U.S. Court of Appeals for the Seventh Circuit upheld the FTC’s decision to condemn the merger. The court first focused on the importance of reducing to four the number of major players in the relevant market:

The reduction in the number of competitors is significant in assessing the competitive vitality of the Chattanooga hospital market. The fewer competitors there are in a market, the easier it is for them to coordinate their pricing without committing detectable violations of section 1 of the Sherman Act, which forbids price fixing. This would not be very important if the four competitors eliminated by the acquisitions in this case had been insignificant, but they were not; they accounted in the aggregate for 12 percent of the sales of the market. As a result of the acquisitions the four largest firms came to control virtually the whole market, and the problem of coordination was therefore reduced to one of coordination among these four.\(^{20}\)

Judge Posner then addressed how other actual or potential market participants might respond to efforts by the four leading Chattanooga area hospitals to restrict output. An increase in price caused by the efforts of the four hospitals to curtail their own output might induce other firms to build new hospitals in the region. An important factor would be the degree to which the application of Tennessee’s certificate of need law might inhibit the expansion of hospital capacity in Chattanooga. Even though there was no evidence in the case that the Tennessee certificate of need law previously had prevented a hospital from carrying out an expansion program, Judge Posner observed that “the law might have some effect under the conditions that would obtain if

\(^{18}\) 807 F.2d 1381 (7th Cir. 1986).
\(^{19}\) Id. at 1384.
\(^{20}\) Id. at 1387.
the challenged acquisitions enabled collusive pricing of hospital services."  

Judge Posner explained:

Should the leading hospitals in Chattanooga collude, a natural consequence would be the creation of excess hospital capacity, for the higher prices resulting from collusion would drive some patients to shorten their hospital stays and others to postpone or reject elective surgery. If a noncolluding hospital wanted to expand its capacity so that it could serve patients driven off by the high prices charged by the colluding hospitals, the colluders would have not only a strong incentive to oppose the grant of a certificate of need but also substantial evidence with which to oppose it—the excess capacity (in the market considered as a whole) created by their own collusive efforts. At least the certificate of need law would enable them to delay any competitive sally by a noncolluding competitor.  

In two ways, the certificate of need law would serve as a useful tripwire for the colluding incumbent hospitals. First, “the certificate of need law would force hospitals to give public notice, well in advance, of any plans to add capacity.” This would enable the incumbents to mobilize to repel threats by cartel outsiders. Second, “[t]he requirement of notice makes it harder for the member of a hospital cartel to ‘cheat’ on the cartel by adding capacity in advance of other members; its attempt to cheat will be known in advance, and countermeasures taken.” Thus, the colluding firms would be alerted to an apparent defection by a member of its own ranks. Of course, the requirement of notice would not help the cartel to monitor cheating based on increases in the level or quality of service.

The court of appeals went on to note that, to justify its prediction of probable anticompetitive effects, the FTC had emphasized three other factors beyond structural considerations and the availability of mechanisms to forestall supply responses to the cartel’s output restrictions. The court observed that (1) demand for hospital services is highly inelastic; (2) “there is a tradition, well documented in the Commission’s opinion, of cooperation between

21 Id. at 1388.  
22 Id.  
23 Id.  
24 Id.
competing hospitals in Chattanooga;”\textsuperscript{25} and (3) hospitals benefit by presenting a united front in negotiations with third-party payors, particularly since hospitals are under great pressure from the federal government and insurance companies to cut costs.

### 3.2 Model of Differentiated Products Price Competition for Hospital Corporation

We present a model that allows us to quantify the benefits of coordination between HCA and the three other large Chattanooga-area hospitals, both before and after the acquisitions. This allows us to quantify the increase in incentives for coordination as a result of the acquisitions.

We consider a model of differentiated products price competition with 11 hospitals, where the services of the hospitals are assumed to be imperfect substitutes for one another.\textsuperscript{26} We consider a one-period version of the model for our basic analysis and then the more dynamic repeated-game version of the model to analyze incentives for cheating. We assume consumers choose the quantity of healthcare to purchase from each hospital based on the prices and characteristics of the hospitals. We can view the model as assigning each hospital $i$ an overall quality level $a_i$ and fixing the degree of substitutability $s_{ij}$ between the services of hospitals $i$ and $j$. Specifically, consumers are assumed to maximize their utility from hospital services minus their cost to purchase those services. In this formulation, which is based on Singh and Vives (1984), each hospital faces demand for its services that depends on its quality and price and the qualities and prices of its rivals. We assume firm $i$ has marginal cost $c_i$.

To elaborate, the model provides parameterized demand curves for each firm giving a firm’s quantity as a function of its price and the prices of the other firms in the market. The

\textsuperscript{25} Id. at 1388.

\textsuperscript{26} Consistent with Singh and Vives’ 1984 work, we assume a representative consumer that maximizes

$$U(q_1, \ldots, q_{11}) = \sum_{i=1}^{11} a_i q_i - \frac{1}{2} q_i^2 - \sum_{j \neq i} s_{ij} q_i q_j,$$

This utility function gives rise to a linear demand structure with inverse demands given by, for $i = 1, \ldots, 11$,

$$p_i = a_i - q_i - \sum_{j \neq i} s_{ij} q_j.$$  We assume firm $i$ has constant marginal cost marginal cost $c_i$ and zero fixed costs. We assume each firm chooses its price to maximize its profits given the prices of its rivals. Thus, we use the concept of Nash equilibrium to solve for equilibrium prices. These prices determine equilibrium quantities, profits, consumer surplus, and welfare. In this model, consumer surplus is $U(q_1, \ldots, q_{11}) - \sum_{i=1}^{11} q_i p_i$, and welfare is consumer surplus plus the sum of the firms’ profits. See Nirvikar Singh & Xavier Vives, *Price and Quantity Competition in a Differentiated Duopoly*, 15 RAND J. Econ. 546-554 (1984).
extent to which a firm’s quantity is affected by its price and the other firms’ prices depends on a model parameters that can be interpreted as the qualities of the firms’ offerings. A firm’s profit is thus determined by its choice of price together with the other firms’ price choices and the firm’s costs (and capacity limits if relevant). To determine the prices that would result from noncooperative price setting in this market, we solve for the Nash equilibrium of the price setting game, assuming firms maximize profits.

To calibrate the model, we refer to the Seventh Circuit’s opinion for information about the market shares of the Chattanooga hospitals. There were eleven hospitals in the market. HCA’s original hospital had a share of 14%. It acquired or took over management of four hospitals with a combined share 12%. The largest hospital had a share greater than 26%. HCA’s hospitals, with their aggregate share of 26%, when combined with the three other large hospitals, had a total share of 91%. Consistent with this information, we devise a hypothetical with eleven hospitals that broadly captures this observed market share structure. (See Figure 1.)

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Description</th>
<th>Target market share</th>
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<tbody>
<tr>
<td>1</td>
<td>HCA</td>
<td>14%</td>
</tr>
<tr>
<td>2, 3, 4, and 5</td>
<td>HCA acquired</td>
<td>3%</td>
</tr>
<tr>
<td>6</td>
<td>Largest</td>
<td>30%</td>
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<tr>
<td>7 and 8</td>
<td>Large</td>
<td>17.5%</td>
</tr>
<tr>
<td>9, 10, and 11</td>
<td>Small</td>
<td>3%</td>
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Figure 1: Target Market Shares

Within the context of our model, we seek a parameterization that mimics this conjectured market share structure. Given more information, one could calibrate the model to match a variety of other characteristics of the firms and the market, such as margins and the degree of substitutability among the firms.

We begin by considering a model in which marginal costs are zero, i.e., for all $i$, $c_i = 0$. We relax this assumption in Section 3.1.3. To allow for substantial, but not perfect, substitutability among the hospitals, we assume that for all $i$ and $j$, $s_{ij} = 0.9$ ($s_{ij}$ equal to zero corresponds to independent products and $s_{ij}$ equal to one corresponds to perfect substitutes).
More precise estimates of this parameter could be based, for example, on the distances between the hospitals and other measures of their substitutability. We then choose the quality measures $a_i$ so that the hospitals’ revenue shares in the model are equal to the target market shares shown in Figure 1 up to the first decimal place. The parameters produced by this calibration are:

$$a_1 = 0.887, \quad a_2 = a_3 = a_4 = a_5 = a_9 = a_{10} = a_{11} = 0.874, \quad a_6 = 0.898, \quad a_7 = a_8 = 0.890.$$  

### 3.3 Quantitative Coordinated Effects Analysis for *Hospital Corporation*

With a parameterized model that mimics the market share characteristics of the *Hospital Corporation* opinion, we can calculate the hospitals’ profits and consumers’ surplus under a variety of scenarios. The scenarios we consider are:

- **Pre-acquisition noncooperative**: all eleven hospitals behave noncooperatively;
- **Post-acquisition noncooperative**: firms 1–5 (HCA and its acquisitions) act as a single firm, but that firm and the other six hospitals behave noncooperatively with respect to one another;
- **Pre-acquisition cooperative**: the four largest hospitals in the pre-acquisition market, firms 1, 6, 7, 8 (HCA and its three largest rivals), act as a single firm, but that firm and the other seven hospitals behave noncooperatively with respect to one another; and
- **Post-acquisition cooperative**: firms 1–8 (HCA together with its acquisitions and three largest rivals) act as a single firm, but that firm and the remaining three hospitals behave noncooperatively with respect to one another.

For each scenario we can calculate the profit of each hospital and the combined profit of hospitals acting as a single firm. Figure 2 shows how the hospitals’ and various groups of hospitals’ profits change as a result of the acquisitions and as a result of cooperative behavior.

Notice that when HCA cooperates with the large hospitals without first making the acquisitions, the combined profits of those four hospitals increases by only 9%. But if HCA first acquires hospitals 2, 3, 4, and 5, then cooperation with the large hospitals increases the combined profits of HCA and the large hospitals by 65%, and it increases the combined profits of HCA, its acquired hospitals, and the other large hospitals by 67% relative to pre-acquisition noncooperative behavior.

Since we assume zero costs, the change in total profit for all the hospitals is equal to the change in total consumer expenditures, so the last row in Figure 2 shows how consumer
expenditures are affected in the different scenarios. As shown in the last row of the figure, the acquisitions together with coordination among the large hospitals results in a 92% increase in consumer expenditures.

<table>
<thead>
<tr>
<th>Firm</th>
<th>Post-acquisition noncooperative (1-5 as single firm)</th>
<th>Pre-acquisition cooperative (1,6,7,8 as single firm)</th>
<th>Post-acquisition cooperative (1-8 as single firm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12%</td>
<td>9%</td>
<td>73%</td>
</tr>
<tr>
<td>2, 3, 4, and 5</td>
<td>18%</td>
<td>38%</td>
<td>83%</td>
</tr>
<tr>
<td>6</td>
<td>10%</td>
<td>8%</td>
<td>57%</td>
</tr>
<tr>
<td>7 and 8</td>
<td>13%</td>
<td>9%</td>
<td>68%</td>
</tr>
<tr>
<td>9, 10, and 11</td>
<td>34%</td>
<td>38%</td>
<td>345%</td>
</tr>
<tr>
<td>1+2+3+4+5</td>
<td>15%</td>
<td>23%</td>
<td>78%</td>
</tr>
<tr>
<td>1+6+7+8</td>
<td>12%</td>
<td>9%</td>
<td>65%</td>
</tr>
<tr>
<td>1+2+3+4+5+6+7+8</td>
<td>13%</td>
<td>13%</td>
<td>67%</td>
</tr>
<tr>
<td>1+…+11</td>
<td>15%</td>
<td>15%</td>
<td>92%</td>
</tr>
</tbody>
</table>

Figure 2: Change in Profit Relative to Pre-Acquisition Noncooperative

The profit increases shown in Figure 2 occur because colluding firms increase their prices relative to their noncooperative levels. Specifically, the increases in prices relative to pre-acquisition noncooperative prices are shown in Figure 3.

Figure 3 shows that the acquisition itself induces HCA and the acquired hospitals to increase prices, but by less than 50% relative to the pre-acquisition noncooperative prices. However, the acquisition together with cooperation with the other large hospitals induces HCA to more than double its price and induces the acquired hospitals to more than triple their prices, which increase by 256% relative to the pre-acquisition noncooperative prices.
As a result of these price increases, the equilibrium output of the colluding hospitals decrease as shown in Figure 4. In response to the quantity restrictions of the colluding hospitals, the quantities of the non-colluding hospitals increase. In some cases, the quantities of the independent hospitals more than double relative to their pre-acquisition noncooperative levels.

As shown in the last row of Figure 4, the total quantity produced in the market decreases in each of the scenarios shown relative to the pre-acquisition noncooperative case. However, these decreases are not large because the quantity increases of the independent hospitals largely offset
the quantity decreases of the cooperating hospitals. In reality, regulation and capacity constraints may limit the ability of the independent hospitals to expand their output. To address this, in Section 3.1.3 we incorporate capacity constraints into the model.

Given the equilibrium prices and quantities in the various scenarios, we can calculate the change in consumer surplus as a result of the acquisition and subsequent coordination. These calculations show that, although consumer surplus decreases as a result of the acquisition, it decreases by eight times as much as a result of the acquisition plus coordination among HCA, the acquired hospitals, and the other large hospitals.

Although the analysis above has focused on a particular cartel in the post-acquisition market, namely the one consisting of hospitals 1–8, the approach can also provide insights into whether that is, in fact, the group of firms that is at greatest risk for cooperation. For example, Figure 5 shows that the commonly-owned hospitals 1–5 benefit from collusion with any of the other hospitals, but only the large hospitals 6, 7, and 8 find the coordination mutually beneficial. The smallest hospitals, hospitals 9, 10, and 11, have higher profits if they remain outside the cartel. Similarly, adding hospital 7 or 8 to a cartel of 1–6, and adding hospital 8 to a cartel of 1–7 generate additional profits for both the original cartel and for the added hospital. This suggests that it was appropriate for the FTC to focus on the post-acquisition cartel of hospitals 1–8, with the three smallest hospitals remaining outside the cartel.

One might have expected that it would be appropriate for the FTC to focus on the possibility of post-acquisition collusion among the large hospitals since it is a typical theoretical conclusion that the small firms benefit most if they stay outside the cartel. However, the quantification we suggest provides a more rigorous path to this conclusion and one that is tailored to the particulars of the market at issue rather than being based on a general theoretical understanding. Furthermore, our analysis provides a measure of how much greater the incentives for collusion are among the various large hospitals and, as we now discuss, allow quantitative measures of the stability of whether various collusive attempts.
Figure 5: Effects of Incremental Collusion

Although Figure 5 shows that the large hospitals 6, 7, and 8 would profit from collusion with HCA, one should also explore whether these hospitals would have strong incentives to cheat on such a cartel if it were formed.27 We can do this within the context of our model by calculating the increase in each hospital’s profit if it were to choose its price to maximize its profit while holding fixed the other cartel members’ prices at their collusive levels. Secret price cuts by a cartel member can potentially allow it to capture a short-term gain, although once such a deviation from collusive behavior is detected, one might expect a return to noncooperative pricing. Thus, we can construct a measure of the sustainability of collusion by calculating the increase in profit to a firm from cheating on the cartel and also the loss in profit as a result of the abandonment of the collusive agreement. We show these calculations in Figure 6.28 We provide unconstrained calculations and also the calculations imposing the constraint that hospitals cannot (in the short run) increase their output beyond their pre-acquisition noncooperative levels.

![Table](image)

Figure 6: Effects of Deviations from Collusion

27 See Stigler (1964) for the central cartel issue of the incentive for cheating on the agreement by member firms.
28 The details of the calculations are available from the authors upon request.
As shown in Figure 6, if we assume capacity constraints are binding for short-run deviations, as one might expect them to be, the one-shot gain from secret price cutting, 6% for firm 6 and 11% for firms 7 and 8, are modest relative to the loss of approximately 30% per period for all future periods as a result of a return to noncooperative behavior. These calculations suggest that collusion among the large hospitals in this market remains a concern even when incentives for unilateral deviations from collusion are considered.

Let us review the assumptions required in order to perform these calculations. First, as in a quantitative unilateral effects analysis, we need a model of the market. For our Hospital Corporation application, we use the differentiated products price competition model of Singh and Vives (1984). This model has a variety of demand and cost parameters, which we calibrate to the Chattanooga-area hospital market. We use general, publicly available information to calibrate the model, but in a litigation context one would expect access to much more detailed information, allowing for a more exacting calibration. Second, we need a conjecture as to the nature of collusion. Since we are focused on calculating the potential profits from collusion, we use the assumption that colluding firms act so as to maximize the joint profits of the colluding firms. Thus, given a set of colluding firms, we assume maximally effective collusion. (Note that the profit maximizing outcome for the cartel could potentially be achieved through either explicit or tacit collusion.) Third, in order to calculate the incentives for cheating on the cartel agreement, we need to make assumptions regarding the length of time before a deviation would be detected and the length of the form and length of the punishment that would be triggered. In our Hospital Corporation application, we assume one period is required for detection (one could calibrate this to a quarter or a year or some other length of time) and that the punishment involves reversion to non-cooperative play for the remainder of an infinite time horizon.

Relative to the assumptions required for a quantitative unilateral effects analysis, the additional assumptions required for our proposed analysis center on the monitoring technology of a cartel and its punishment strategy for dealing with defectors. The main assumptions involve the length of time before detection and the length of punishment. There is support in the theoretical literature and in cartel case studies for the use of reversion to non-cooperative play as the type of punishment.29 Sensitivity analysis can easily be performed on both the length of time before

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29 In the theoretical literature, see Green, Edward J. and Robert H. Porter (1984), "Noncooperative Collusion under Imperfect Price Information," *Econometrica* 52, 87-100. The use of reversion to pre-collusive play as a punishment for
detection and the length of punishment. To the extent that results are not sensitive to the details of the assumptions, their robustness can be established. The assumption on the length of time before detection can be informed by reporting practices in the industry. For example, the existence of a trade association providing quarterly feedback to its members are market activity would suggest one quarter as an assumption worth considering.

To conclude this section, we note that Malcolm Coate’s review of merger enforcement trends observes that “the standard Herfindahl index remains appropriate for coordinated interaction cases.”\(^{30}\) Coate also states that “a collusion case with a post-merger HHI of 3712 has a 50% chance of a challenge.”\(^{31}\) He notes that “[a]dding 1000 points to the Herfindahl statistics increases the probability of a challenge to 93%.”\(^{32}\)

As shown in Figure 7, in *Hospital Corporation*, the post-merger HHI is only 2114 if one assumes the firms behave non-cooperatively. Yet, if one assumes coordination among the top four post-merger firms, the HHI is 6326, well above the range Coate identifies. Thus, the common practice of using HHIs as a screen is consistent with the results of our analysis; however, the HHI is only appropriate as an initial screen as it lacks the ability to quantify the effects of coordination on profits, prices, quantities, and consumer surplus, and it does little to capture individual firms’ incentives.

<table>
<thead>
<tr>
<th>Pre-acquisition noncooperative</th>
<th>Post-acquisition noncooperative</th>
<th>Pre-acquisition cooperative</th>
<th>Post-acquisition cooperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1773</td>
<td>2145</td>
<td>5687</td>
<td>6414</td>
</tr>
</tbody>
</table>

Figure 7: Herfindahl Index

deviations from collusion is explicitly mentioned in Congressional testimony involving dyestuffs manufacturers (Patents: Hearings before the Committee on Patents, United States Senate, Seventy-Seventh Congress, Second Session, on S. 2303 and S. 2491, Part 5, May 13 and 16, 1942, United States Government Printing Office, 1942, p.2424). The testimony includes a letter from a foreign sales manager of a dyestuffs manufacturer stating: “You and your contemporaries should be in a position to establish market prices based upon definite strength determination of color, which prices should be followed by you if such an understanding is reached. But, if you have any indication that a contemporary is not adhering to such prices, then immediately revert to the prices prevailing before any arrangements were established.”


\(^{31}\) Id. at 299.

\(^{32}\) Id.
3.4 Extensions

We consider three extensions to our analysis above. In Section 3.1.3, we show how one might use the model to investigate claims regarding post-acquisition quality improvements. One could analyze claim of cost savings in a similar manner. In Section 3.1.3, we recalculate the above model to allow for positive marginal costs. Finally, in Section 3.1.3, we incorporate capacity constraints into the model.

3.4.1 Incorporating Quality Improvements

As an extension to the analysis described above, we can incorporate the potential for post-acquisition improvements in the quality of various hospitals into the analysis. In our model of the Hospital Corporation acquisitions, the hospitals are differentiated, with different hospitals receiving different weights in the representative consumer’s utility function. We can view hospitals that get a higher weight in the utility function as offering higher quality. In this sense, in the model described above, HCA is medium quality, the hospitals it acquires (firms 2–5) are poor quality, and hospital 6 is high quality.

Consider a claim by HCA that, as a result of its acquisition of hospitals 2–5, the quality of those hospitals will increase. In general, it might be hard to evaluate and quantify such a claim, but the model offers a way to do this. Specifically, if we just consider the merger and assume no coordinated effects, and if the quality of hospitals 2–5 increases up to the level of HCA, then consumer surplus is higher than the pre-acquisition noncooperative level. So, in the absence of coordinated effects, this type of quality improvement would offset the price increases associated with greater concentration. However, one can show that even if the quality of the four acquired hospitals increases to the level of the high-quality hospital 6, consumer surplus still falls as a result of the acquisitions plus coordinated effects (i.e., coordination among hospitals 1–8).

In our original analysis, the profits of the hospitals not involved in the acquisition increase as a result of the acquisition and the associated decrease in interfirm rivalry (see Figure 2). However, if we assume that the acquisition results in an increase in the quality of hospitals 2–5 to the level of HCA or greater, then the acquisition results in a decrease in profits for the remaining firms. In this case, the increased competitiveness of hospitals 2–5 dominates any reduction in rivalry. This is a case in which one might expect the hospitals not involved in the acquisition to
oppose it.  

3.4.2 Incorporating Positive Marginal Costs

Although the published opinions in the *Hospital Corporation* matter do not contain data on hospital costs or margins, we can illustrate how one might incorporate that information if it were available.

We show how one can recalibrate the model assuming positive marginal costs. We again choose parameters so that the equilibrium revenue shares match the target market shares, and we choose costs so that relative to HCA, the marginal cost of hospitals 2–5 and 9–11 is 5% higher, the marginal cost of hospital 6 is 10% lower, and the marginal cost of hospitals 7–8 is 5% lower. This captures the idea that the largest hospital 6 has the lowest cost, and the small hospitals 2–5 and 9–11 have the highest costs. Given our calibration, equilibrium price-cost margins in the pre-acquisition noncooperative case range from 4% to 30%, with HCA’s margin equal to 17% and hospitals 7 and 8’s margins equal to 21%.

In this version of the model, changes in the hospitals’ profit levels relative to pre-acquisition noncooperative are similar to those in the version of the model with zero costs, except that the profits of hospitals 2–5 decrease significantly and the profits of hospitals 9–11 increase dramatically in the post-acquisition cooperative case. As shown in Figure 8, the price increases as a result of the acquisition and cooperation are more modest than in the version of the model with zero costs.
<table>
<thead>
<tr>
<th>Firm</th>
<th>Post-acquisition noncooperative (1-5 as single firm)</th>
<th>Pre-acquisition cooperative (1,6,7,8 as single firm)</th>
<th>Post-acquisition cooperative (1-8 as single firm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2%</td>
<td>6%</td>
<td>19%</td>
</tr>
<tr>
<td>2, 3, 4, and 5</td>
<td>3%</td>
<td>2%</td>
<td>21%</td>
</tr>
<tr>
<td>6</td>
<td>1%</td>
<td>5%</td>
<td>17%</td>
</tr>
<tr>
<td>7 and 8</td>
<td>1%</td>
<td>6%</td>
<td>19%</td>
</tr>
<tr>
<td>9, 10, and 11</td>
<td>1%</td>
<td>2%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Figure 8: Change in Prices Relative to Pre-Acquisition Noncooperative with Positive Costs

Perhaps the most interesting difference between the version of the model with positive costs and the version with zero costs is in the equilibrium quantities. As shown in Figure 9, in the post-acquisition cooperative case, the colluding hospitals maximize their joint profits by essentially shutting down the high-cost members of the cartel, hospitals 2–5. The output of those hospitals falls 98% relative to the pre-acquisition noncooperative case.

The results that equilibrium quantities differ when we incorporate cost information and that a cartel might want to shut down high-cost members are standard in the theoretical literature. However, without a specific quantitative analysis tailored to the market in question, one cannot assess whether in this particular market there would be incentives for a cartel to shut down its high-cost members. One must assess whether their costs are sufficiently high relative to their contributions to profits to warrant eliminating their productive capacity. As we show, even with general information about the market, a calibration can be performed that provides insights into the shut-down decision. But with the more detailed cost information available in a litigation context, these calculations could be made far more precise. For example, merging firms making claims about cost savings and scale or scope economies associated with the merger would have to provide estimates of the relevant costs. If the option is available, detailed cost information can be requested in discovery. This data can be used to calculate estimates of firms’ marginal costs.
As in our model with zero costs, the overall quantity reduction is modest because of the quantity increases by non-colluding firms. In this model, each of hospitals 9–11 increases its output 214% in the post-acquisition cooperative case.

Although consumer expenditures increased 92% in the model with zero costs as a result of the acquisition plus coordination, in the model with positive costs, the price increases are smaller, and so the increase in consumer expenditures is only 13%. Nevertheless, with the decreases in quantities, the percentage decrease in consumer surplus is similar to that in the version of the model with zero costs. In fact, in the version of the model with positive costs, the changes in the HHI are smaller (see Figure 10).
Overall, the addition of positive costs to the model suggests that the impact of the acquisitions and any subsequent coordination may not be as great as suggested by the model with zero costs. However, the changes in quantities in the model with positive costs highlight the need to take into account capacity constraints, which the FTC argued were an important feature of the market in Hospital Corporation because of Tennessee’s certificate of need law. In the next section, we incorporate capacity constraints.

### 3.4.3 Incorporating Capacity Constraints

One might argue that the results of our previous models are not realistic because they allow hospitals to increase their output without bound. In this section, we amend the model with positive costs to include the constraint that a hospital’s output can be no more than 125% of its equilibrium output in the pre-acquisition noncooperative case. Our assumption of a 125% bound on output expansion is arbitrary and made for the purposes of demonstrating how the analysis would proceed. If one had information on the idle capacity held by various firms (in the case of hospitals, the number of unused beds and the ability to increase beds given the existing infrastructure), which should be readily available, one can tailor this assumption to the characteristics of the market in question.

When we add this constraint, the capacity limits bind on the non-colluding small hospitals in the two cooperative cases. One can see this from Figure 11, which shows changes in equilibrium quantities for this version of the model. In the pre-acquisition cooperative case, hospitals 2–5 and 9–11 are not included in the cartel, and the capacity constraint binds for each of them. In the post-acquisition cooperative case, hospitals 9–11 are not included in the cartel, and the capacity constraint binds for each of them.
Because non-colluding hospitals can no longer increase their output by as much in response to the price increases of the colluding hospitals, the price increases are larger (in the post-acquisition cooperative case, firm increase prices between 25% and 30% relative to the pre-acquisition noncooperative case), and the profit increases are larger (see Figure 12).

<table>
<thead>
<tr>
<th>Firm</th>
<th>Post-acquisition noncooperative (1-5 as single firm)</th>
<th>Pre-acquisition cooperative (1,6,7,8 as single firm)</th>
<th>Post-acquisition cooperative (1-8 as single firm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-3%</td>
<td>-13%</td>
<td>-4%</td>
</tr>
<tr>
<td>2, 3, 4, and 5</td>
<td>-30%</td>
<td>25%</td>
<td>-32%</td>
</tr>
<tr>
<td>6</td>
<td>3%</td>
<td>-4%</td>
<td>1%</td>
</tr>
<tr>
<td>7 and 8</td>
<td>4%</td>
<td>-9%</td>
<td>-2%</td>
</tr>
<tr>
<td>9, 10, and 11</td>
<td>21%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>1+2+3+4+5</td>
<td>-16%</td>
<td>5%</td>
<td>-17%</td>
</tr>
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<td>1+6+7+8</td>
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<td>-8%</td>
<td>-1%</td>
</tr>
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<td>-3%</td>
<td>-6%</td>
</tr>
<tr>
<td>1+...+11</td>
<td>-0.2%</td>
<td>-0.5%</td>
<td>-2.8%</td>
</tr>
</tbody>
</table>

Figure 11: Change in Quantities Relative to Pre-Acquisition Noncooperative with Positive Costs and Capacity Constraints
In contrast to our first model with zero costs, where the cartel of hospitals 1–8 could increase its profits by 67% as a result of the acquisitions plus coordination, and in contrast to the model with positive costs but no capacity constraints, where they could increase their profits by only 51%, in the model with positive costs and capacity constraints, hospitals 1–8 can increase their profits by 117%. In addition, relative to the pre-acquisition noncooperative case, the acquisitions plus cooperation result in an increase in consumer expenditures of 23% and a decrease in the total quantity supplied of 2.8%. As a result, consumer surplus decreases by more than 5%. Finally, when we incorporate capacity constraints, the picture painted by the HHI suggests great concern with the post-acquisition cooperative scenario (see Figure 13). These extensions show that modeling choices matter, but also that it is possible to incorporate the relevant features of a market into the model and explore their effects.

Which features are relevant will depend to some extent on the market at issue. But of course one can expect that among the relevant features will be: the characteristics of demand (e.g., overall size and elasticity), cost characteristics of the firms in the market, capacities of the firms in the market and the extent to which they are capacity constrained, and information flow among market participants. One can also bring in to the analysis information about firms’ past propensities for collusion and the possible maverick status of certain firms. It is difficult to
identify at a general level which features might be ignored at no loss to the analysis, but features not relevant for a unilateral effects analysis of a particular market are less likely to be relevant for the analysis we propose.

<table>
<thead>
<tr>
<th>Pre-acquisition noncooperative</th>
<th>Post-acquisition noncooperative</th>
<th>Pre-acquisition cooperative</th>
<th>Post-acquisition cooperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1769</td>
<td>2128</td>
<td>5532</td>
<td>7839</td>
</tr>
</tbody>
</table>

Figure 13: Herfindahl Index for the Model with Positive Costs and Capacity Constraints

4 Conclusion

Modern U.S. merger jurisprudence governing horizontal mergers shows a significant weakening of the structural presumptions that proved decisive in Supreme Court decisions of the 1960s and early 1970s. Our analytic approach to coordinated effects allows a direct quantification of the incremental payoffs to post-merger collusion. The assumptions required are, for the most part, those already required for a quantitative unilateral effects analysis. Other assumptions can be informed by theory and data and evaluated using sensitivity analysis.

Various levels of collusion can be investigated and specific firms, who might be mavericks, can be isolated. Calibration and estimation can be undertaken with guidance from pre-merger data so that the post-merger simulations are appropriately benchmarked. The analysis may flag specific subsets of firms who may earn extraordinary payoffs from post-merger collusion and, if the merger is approved, these subsets could be monitored for suspicious activities,35 or they could be enjoined ex ante from certain actions as part of merger approval.36

35 Many examples are possible, but to give a few: coordinated price announcements (see Robert C. Marshall, Leslie M. Marx, and Matthew E. Raiff (2008), “Cartel Price Announcements: The Vitamins Industry,” International Journal of Industrial Organization 26, 762-802); increased stability of market shares (see Stigler (1964)); establishment of an export trade association; and the expansion of the trade association to include special working groups or increased monitoring and/or reporting.

36 For example, firms could be enjoined from announcing price increases in advance of their effective dates. Such a prohibition was imposed on an association of sugar refiners in 1934 (US v. Sugar Inst., 15 F. Supp. 817, 830, 908 (S.D.N.Y. 1934)), but the Supreme Court reversed that portion of the district court order (Sugar Inst. v. US, 297 U.S. 553, 603 (1936)). More recently, a prohibition on advance price announcements was included in the 1967 consent
The case study provided in Section 3 contributes in a number of ways. First, the analysis is a direct outgrowth of a standard unilateral effects analysis. The models and estimation that have already been conducted for a unilateral effects analysis can be extended, at low cost, to address aspects of coordinated effects. The incremental analysis is low cost in the sense that the heavy lifting in terms of developing a sound model of the market and defending the underlying assumptions associated with a model must be done for a quantitative unilateral effects analysis. Our approach relies on using that same machinery to perform incremental calculations that can then inform authorities as to the level of concern they should attached to coordinated effects among various subsets of post-merger firms.

Any disquiet about the assumptions or modeling environment is not specific to the coordinated effects analysis and thus a single debate for both unilateral effects and coordinated effects modeling can take place. Second, the quantification presented here displaces nothing that is currently being done with coordinated effects analysis. It is a strict augmentation. Third, there are issues associated with the Guidelines, such as a direct quantification of the increased probability of coordination among remaining firms, that our proposed analysis does not address, but this just means, unsurprisingly, that the analysis does not accomplish everything that the Guidelines prescribe, which is the case for all existing coordinated effects analyses.

Overall, the analysis we propose for coordinated effects is, in our opinion, a Pareto improvement and should become part of standard practice for the economic review of all merger cases.

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