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DISCUSSION PAPER

Forward Contracting and the Welfare Effects of Mergers

By

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Abstract

I extend the oligopoly model of Allaz and Vila (1993) to explore how forward contracting affects the adverse welfare consequences of horizontal mergers. I derive a welfare statistic that, within the context of the model, is free of structural parameters. The statistic allows for conclusions that generalize across different cost and demand conditions. I then show that exogenous forward contracting mitigates welfare loss but that endogenous forward contracting exacerbates welfare loss provided the relevant industry is sufficiently concentrated.

1 Introduction

Firms in some industries engage in forward contracting, prior to competition in a spot market, through which they commit to supply some amount of output to the spot market at a locked-in price. A long-standing result in the theoretical literature, due to Allaz and Vila (1993), is that such forward contracting leads to greater output and lower prices in the spot market. In this paper, I explore the related topic of whether (and when) forward contracting exacerbates or mitigates the adverse welfare effects of horizontal mergers.

To that end, I extend the oligopoly model used in Allaz and Vila (1993) and, more recently, in Bushnell (2007). The model features firms that supply undifferentiated output to a spot market and that can commit, via forward contracting, to at least some level of output. I derive a welfare statistic that, within the context of the model, is free of structural parameters. The statistic allows for conclusions that generalize across different cost and demand conditions. I then show that the welfare loss caused by horizontal mergers is diminished by forward contracting, provided that forward contracting is treated as exogenous and fixed.

The model provides more nuanced results when forward contracting is endogenized. Indeed, it is derived in Bushnell (2007) that the level of forward contracting consistent with sub-game perfect equilibrium decreases in the level of industry concentration. In the context of the model, then, horizontal mergers reduce forward contracting and lessen an economic inducement for spot market production. I show that when industries are sufficiently concentrated this effect dominates and forward contracting exacerbates rather than mitigates the adverse welfare effects of horizontal mergers.

In particular, mergers-to-monopoly have greater adverse welfare consequences with endogenous forward contracting than with no forward contracting at all. Likewise, both mergers-to-monopoly and mergers-to-duopoly have greater adverse welfare consequences with endogenous forward contracting than with exogenous forward contracting fixed at 50 percent of spot market output. While these thresholds are specific to the model, and in particular to the mechanism that generates forward contracting as an equilibrium strategy, I anticipate that the results generalize qualitatively to other settings. If a merger makes the exercise of market power more profitable but for some limiting constraint then it also introduces an incentive for firms to relax the constraint.

The results have obvious implications for policy-makers in the merger review process. They also advance the large literature on competition in the electricity generation industry. The closest paper to this one is Bushnell, Mansur and Wolak (2013), which estimates an empirical model of forward contracting similar in some respects to theoretical model employed here, and simulates the effects of a recent electricity merger cleared by the U.S. Department of Justice.[1] Other research develops theoretically how forward contracting affects market outcomes (e.g., Powell (1993), Newberry (1998), Green (1999)), establishes empirically the importance of forward contracting (e.g., Wolak (2000), Bushnell (2007), Bushnell, Mansur and Savaria (2008)) or incorporates forward contracting into empirical models of oligopoly competition (e.g., Hortaçsu and Puller (2008)). I refer readers to Bushnell (2007) for a more complete review of the extant literature.

The paper proceeds in three parts. Section 2.1 develops the economics of the spot market and how forward contracting affects equilibrium output. Section 2.2 examines the forward market and shows the level of forward contracting that is consistent with sub-game perfect equilibrium, within the context of the model. Section 2.3 derives the welfare measures and examines the welfare effects of horizontal mergers.

2 Theoretical Model and Results

2.1 The spot market

Let $n = 1 \dots N$ firms supply undifferentiated output to a spot market. The firms face a constant marginal cost c. Denote the output of firm n as q_n. Price is determined by total market output according to the inverse demand curve $P(Q) = \frac{\beta_0 - Q}{\beta_1}$, where $P(\cdot)$ is the market price, $Q = \sum_n q_n$ is total production, and the demand parameters are β_0 and β_1. Permit the firms to engage in forward contracting, through which each firm can commit to supply at least some level of production q_n^f in the spot market. Let the forward position of each firm be common knowledge and taken as given in the spot market. The profit that firm n obtains in the spot market equals the obtained markup times production in excess of that already committed:

$$\pi_n^s(q_n, q_{-n}, q_n^f) = (P(Q) - c)(q_n - q_n^f). \tag{1}$$

The equilibrium concept is Nash-Cournot. Each firm acts in the spot market to maximize profit taking as given its forward position and the output of its competitors.

Bushnell (2007) derives that total production in this spot market, conditional on the

[1] The merger is that of Exelon Corporation (Exelon) and Constellation Energy Group (CEG), which closed on March 12, 2012.

forward positions, is given by

$$Q^*(N, q^f) = (\beta_0 - \beta_1 c + q^f)\frac{N}{N+1}. \tag{2}$$

where $q^f = q_n^f$, for all n, due to the symmetry of the model. For the calculations that follow it will be useful to define the "hedge rate," $h \equiv q^f/q$, to be the proportion of output in the spot market equilibrium that is committed via forward contracting. Then equation (2) can be re-expressed as

$$Q^*(N, q^f) = (\beta_0 - \beta_1 c)\frac{N}{N+1-h}. \tag{3}$$

The derivation is provided in an appendix. Total output increases with the hedge rate. If $h = 1$ the perfectly competitive level of output, $\beta_0 - \beta_1 c$, is obtained regardless of the number of firms. If instead $h = 0$ then the standard Nash-Cournot oligopoly solution is obtained.

2.2 The contract market

The following contract market provides a tractable mechanism through which mergers can affect the incentive to engage in forward contracting. Suppose that each firm n can engage in forward contracting. This entails a commitment to produce some level of output q_n^f in the spot market at a fixed forward price. Impose that the forward price equals the subsequently realized spot price, which eliminates arbitrage opportunities and follows from rational expectations and risk neutrality assumptions. Bushnell (2007) derives the hedge rate that is consistent with sub-game perfect equilibrium:

$$h^*(N) = \frac{N-1}{N}. \tag{4}$$

Monopolists do not participate in the contract market. Provided $N > 1$, forward contracts serve to partially deter spot market production on the part of competitors. In the limit, as the number of firms grows large, all spot market production is pre-committed in the contract market at the perfectly competitive price.

2.3 Forward Contracting, Welfare and Mergers

I now extend the findings of Bushnell (2007) to examine the welfare implications of horizontal mergers. First, welfare can be expressed as a function of the number of firms and the hedge rate:

$$W(N,h) = \int_0^{Q^*(N,\,q^f)} \left(\frac{\beta_0 - x}{\beta_1} - c\right) dx$$

$$= \frac{(\beta_0 - \beta_1 c)^2}{\beta_1}\left[\frac{N}{N+1-h} - \frac{1}{2}\left(\frac{N}{N+1-h}\right)^2\right]. \tag{5}$$

With $h = 1$ this reduces to the perfectly competitive level of welfare

$$W(N,1) = \frac{1}{2}\frac{(\beta_0 - \beta_1 c)^2}{\beta_1}, \tag{6}$$

and with $h = h^*(N)$ welfare equals

$$W(N,h^*) = \frac{(\beta_0 - \beta_1 c)^2}{\beta_1}\left(\frac{N^2}{N^2+1} - \frac{1}{2}\left(\frac{N^2}{N^2+1}\right)^2\right). \tag{7}$$

The ratio of welfare, for a given hedge rate, to the perfectly competitive level of welfare is a useful metric that is free of demand and cost parameters and thereby facilitates generalizations across different industry conditions:

$$\frac{W(N,h)}{W(N,1)} = 2\left[\frac{N}{N+1-h} - \frac{1}{2}\left(\frac{N}{N+1-h}\right)^2\right] \tag{8}$$

Figure 1 plots this "welfare ratio" for the strategic hedge rate given by $h^*(N)$, as well as for four different fixed hedge rates, across industry structures with $N = 1, 2, 3, 4$. Several relationships are apparent: (i) the welfare ratio increases with the magnitude of the fixed hedge rate for any given industry structure; (ii) the welfare ratio increases with the number of firms faster with smaller fixed hedge rates; (iii) relative to fixed hedge rates, the strategic hedge rate adds "curvature" to the welfare-concentration relationship such that the welfare ratio increases faster with N for small N but slower for large N. This final result follows directly from Equation (4).

[Figure 1 about here.]

A horizontal merger can be modeled as a reduction in the number of firms by one.[2]

[2]Whether endogenous forward contracting is sufficient to make such mergers profitable is an unexplored

Figure 2 plots the change in the welfare ratio ("merger harm") due to horizontal mergers with initial $N = 2, 3, 4, 5$, for the strategic hedge as well as for two different fixed hedge rates. Again the relevant results are apparent: (i) merger harm decreases in the fixed hedge rate; (ii) merger harm is greater in more concentrated industries; (iii) merger harm is greater with the strategic hedge than with the fixed hedges for small N but smaller than with the fixed hedges for large N. The last result arises because horizontal mergers reduce the optimal level of the strategic hedge (by Equation (4)) and thereby lessen an economic inducement for spot market production. When N is small this effect dominates the counter-force that merger harm is lessened for any fixed hedge rate. Inspection of the figure show that mergers-to-monopoly have greater adverse welfare consequences with endogenous forward contracting than with no forward contracting at all. Likewise, both mergers-to-monopoly and mergers-to-duopoly have greater adverse welfare consequences with endogenous forward contracting than with exogenous forward contracting fixed at 50 percent of spot market output.

[Figure 2 about here.]

This demonstrates the main result of the paper: forward contracting diminishes welfare loss if it is exogenous but can exacerbate welfare loss provided that it is endogenous and the relevant industry is sufficiently concentrated. I anticipate that the result, developed within the context of specific modeling choices, generalizes qualitatively to other economic environments. For instance, suppose that the primary motivation for hedging is to lessen price risk rather than to deter competitor production, that firms maximize profit, and that hedging is partial (i.e., spot market output exceeds forward commitments). Then the pre-merger hedge rate reflects a balancing of risk and profit, the latter obtained from the exercise of market power. Horizontal mergers make the exercise of market power more profitable and create an incentive for firms to accept more risk. Specific results in this alternative setting are less tractable, however, and I leave them to future research.

topic, to my knowledge.

A Derivation of Equation (3)

Bushnell (2007) derives that

$$Q^* = \frac{(\beta_0 - \beta_1\alpha_0 + q^f)N}{N + 1 + \beta_1\alpha_1}.$$

Substituting hq^* for q^f yields

$$Q^* = \frac{(\beta_0 - \beta_1\alpha_0 + hq^*)N}{N + 1 + \beta_1\alpha_1},$$

which further obtains

$$Q^* = \frac{(\beta_0 - \beta_1\alpha_0)N + hQ^*}{N + 1 + \beta_1\alpha_1}.$$

Here the Q^* appears on both sides of the equation. Collecting the terms and solving yields Equation (3).

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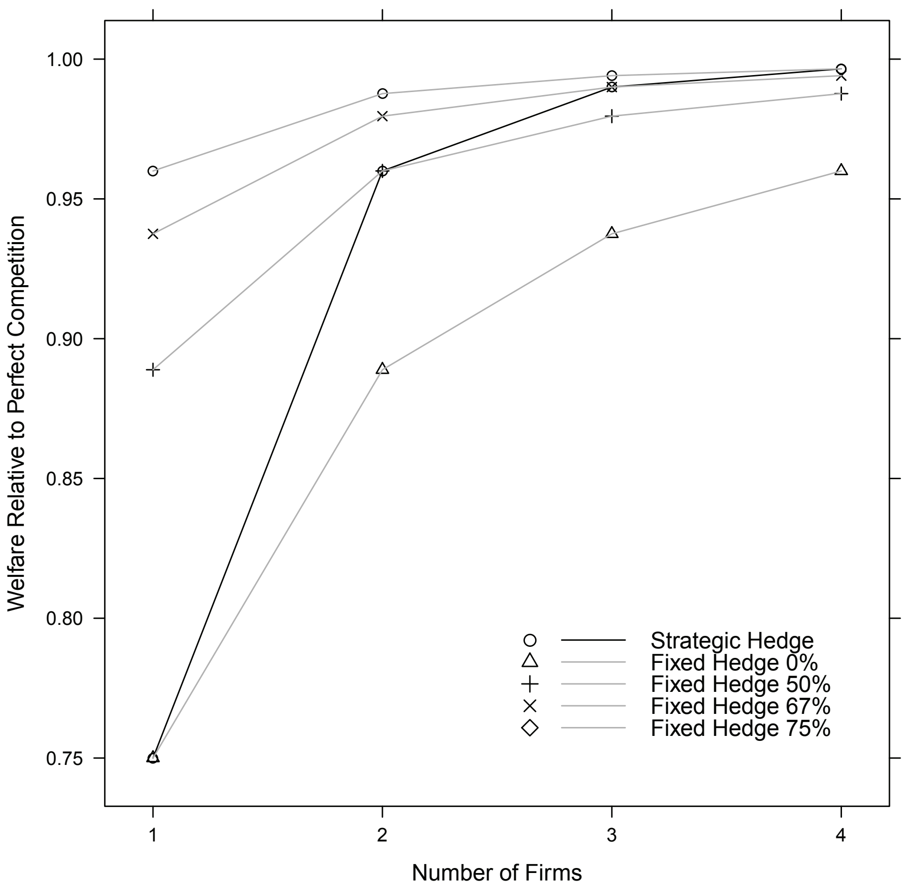

Figure 1: Welfare with Forward Contracting

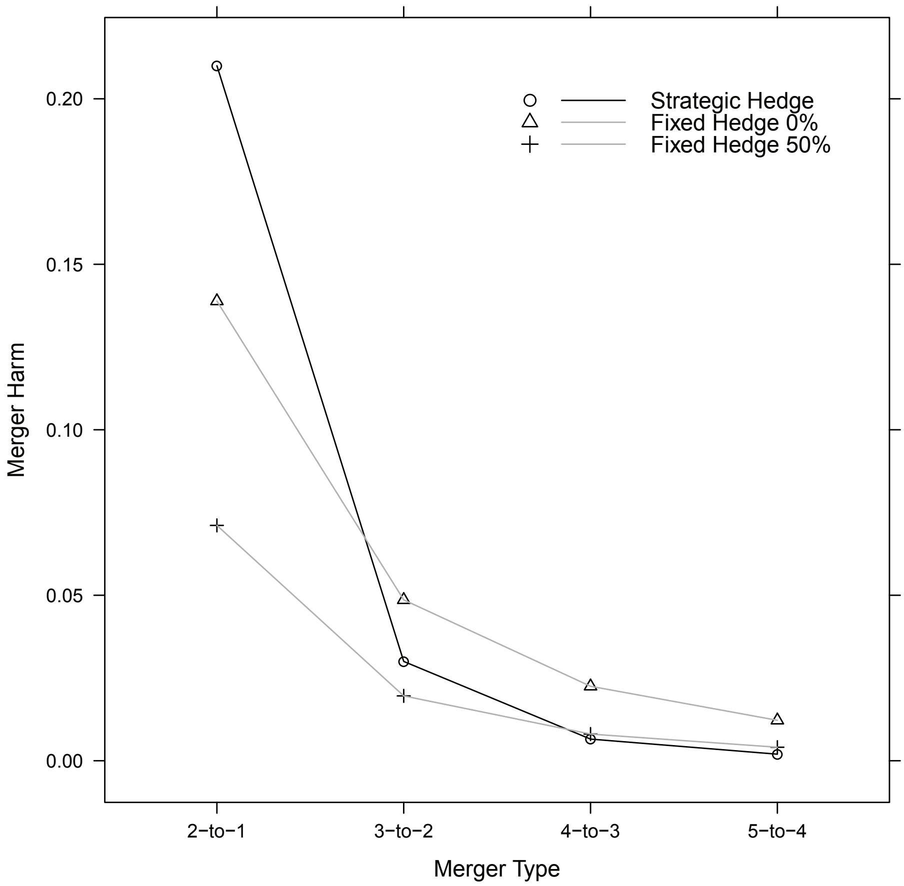

Figure 2: Loss of Welfare due to Horizontal Mergers