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The impact of forward contracting on tacit collusion: Experimental evidence☆

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ABSTRACT

This article reports the results of a laboratory experiment designed to examine the strategic impact of forward contracting on market power in infinitely repeated duopolies. Theory predicts that forward contracting can not only increase the likelihood of collusion but can also serve as a credible commitment device that minimizes firms' incentives to deviate from collusion. Focusing on strategic choices, the experimental design investigates the impact of forward contracting on collusion and contrasts it to the effect of adding one additional competitor. While the findings do not provide evidence that a forward market results in more collusion, the findings suggest that forward contracting can reinforce collusion when firms tacitly collude.

1. Introduction

Forward contracts are a prevalent instrument in hedging price risk (Carlton, 1984) – they allow buyers and sellers with fixed quantity commitments to limit or even offset unfavorable price movements in the spot market. For example, forward contracts play an important role as hedging instruments in wholesale electricity markets since electricity cannot be stored economically at a large scale (Wolak, 2000; Bessembinder and Lemmon, 2002).[1] However, even in the absence of risk and uncertainty, the possibility to contract production forward creates strategic incentives for firms which impacts market efficiency. On the one hand, forward markets can act like additional competitors and thereby increase market efficiency (Allaz and Vila, 1993; Bushnell, 2007). The intuition is as follows. The opportunity to sell forward creates a prisoner's dilemma.

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[1] Shawky et al. (2003) estimate forward risk premia for 6-month electricity futures of about 4% per month which is large compared to estimates for other commodities.

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Jointly, firms would be better off not contracting forward. Individually, however, firms can gain a strategic advantage by selling forward (Stackelberg leader). As a result, all firms end up contracting part of their production forward which increases market efficiency. On the other hand, forward contracts can serve as compelling commitment devices that allow firms to maintain collusion and thus decrease market efficiency (Liski and Montero, 2006). Two effects drive this theoretical prediction. First, forward contracting decreases the residual demand and thereby lessens the incentive to defect from collusion. Second, if collusion breaks up, firms' profits are lower in the presence of forward markets than in the standard Cournot game.

In this article, I investigate the strategic impact of forward contracting on collusion in infinitely repeated experimental duopoly markets. While the experiment is not the first to investigate forward markets in the laboratory, to the best of my knowledge, it is the first that tests the collusive supergame hypothesis. The experiment compares a standard duopoly to a two-stage duopoly with a single forward market opening, where players can contract part of their production forward. A third treatment with three sellers in the standard Cournot setting contrasts the welfare effect of one additional competitor to the welfare effect of the forward market. Using a fixed matching protocol, I employ a limited, discrete choice strategy space to create an environment that gives collusion a high chance of occurrence in all three treatments. Further, the limited strategy space allows me to implement strict forward-spot price parity (the price of a unit sold in the forward market equals the price of a unit sold in the spot market), which is necessary to test the collusive predictions. The forward-spot price parity eliminates any price risks and allows players to play collusive strategies that involve forward contracts. The limited strategy space design also allows for direct comparison of strategy choices across treatments.[2] Focusing on other aspects of forward markets, previous experiments do not implement strict forward-spot price parity and their findings indicate that forward markets can increase market efficiency (Le Coq and Orzen, 2006; Brandts et al., 2008; Van Koten and Ortmann, 2013; Ferreira et al., 2010).

The main result of this article is that forward contracting significantly decreases the likelihood of defecting, which makes it easier for firms to maintain collusion. This finding confirms Liski and Montero's prediction that forward contracting can serve as a credible commitment device that minimizes firms' incentives to deviate from collusion. However, I do not find evidence that the existence of the forward market leads to more collusion on aggregate than in the standard duopoly treatment. (In fact, subjects play the collusive strategy most frequently in both treatments. Although contracting forward is a (weakly) dominant strategy in the stage game, both duopolists abstain from contracting forward in about 40% of all market outcomes in the forward market treatment. Further, while subjects defect less frequently in the forward market treatment, they play the Cournot strategy more often than in the standard duopoly treatment.) In addition, contrary to previous findings, the existence of the forward market does not increase market efficiency (welfare) whereas one additional competitor significantly increases market efficiency. These results raise concerns about whether and to what extent forward contracting should be regulated. For example, the notion that forward markets increase market efficiency in electricity markets (Joskow, 2001, 2006) does not necessarily hold.

The organization of the remainder of the article is as follows. Section 2 reiterates the collusive predictions that guide the experimental design. Section 3 describes the experimental design and procedures and points out the differences between this study and previous experiments. Section 4 presents the results of the article, and Section 5 discusses the main findings.

2. Theoretical framework

Liski and Montero give two reasons why forward contracting can increase the likelihood of tacit collusion in the infinitely repeated setting (supergame). The punishment strategy is more costly than in the standard Cournot setting; and forward contracting can act as a commitment device to refrain from defecting. In the following, I briefly state the general conditions of subgame-perfect collusion in the infinitely repeated supergame, then I describe the setup of the forward-spot stage-game, and finally, I reiterate the two effects that make collusion more likely in the forward-spot supergame (for details see Liski and Montero (2006)).

Consider an infinitely repeated duopoly with symmetric firms that compete in quantity. The duopolists can maintain cooperative subgame-perfect outcomes if they are sufficiently concerned about future profits and possible future punishment. For sufficiently high discount factors, δ, both duopolists jointly selling the monopoly quantity is a subgame-perfect equilibrium strategy (Friedman, 1971). In particular, assume firms adopt the following symmetric trigger strategies. In any given period, each firm plays the collusive subgame strategy if both firms played the collusive subgame strategy in every preceding period. Otherwise, each firm plays the stage-game Nash equilibrium strategy in perpetuity.[3]

[2] The limited strategy space also reduces the extent of learning effects that are common in oligopoly experiments (Huck et al., 1999).

[3] Playing the stage-game Nash equilibrium strategy is one of many cooperative, subgame-perfect trigger strategies.