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Entry, imperfect competition, and futures market for the input[☆]

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ABSTRACT

We analyze firms' entry, production and hedging decisions under imperfect competition. We consider an oligopoly industry producing a homogeneous output in which risk-averse firms face an entry cost upon entering the industry, and then compete in Cournot with one another. Each firm faces uncertainty in the input cost when making production decision, and has access to the futures market to hedge the random cost. We provide two sets of results. First, under general assumptions about risk preferences, demand, and uncertainty, we characterize the unique equilibrium. In contrast to previous results in the literature (without entry), both production and output price depend on uncertainty and risk aversion. Specifically, when entry is endogenized and the futures price is not actuarially fair, access to the futures market does not lead to *separation*. Second, to study the effect of access to the futures market on entry and production, we restrict attention to constant absolute risk aversion (CARA) preferences, a linear demand, and a normal distribution for the spot price. In general, the effect of access to the futures market on the number of firms and production is ambiguous.

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1. Introduction

Recent financial literature on firms' risk management of market risk has focused on the determinants of hedging and the economic value of financial coverage. The two main questions in this literature are: *Why do firms hedge?* and *Does hedging increase the economic value of the firms?* Firms' hedging is explained by managerial risk aversion (Stulz, 1990; Tufano, 1996) or market imperfections such as corporate income taxation (Graham and Rogers, 2002; Graham and Smith, 1999; Smith and Stulz, 1985), financial distress costs (Smith and Stulz, 1985), corporate governance (Dionne and Triki, 2013), investment opportunity costs (Froot and Stein, 1998; Froot et al., 1993), and information asymmetries (DeMarzo and Duffie, 1991). The empirical effect of hedging on firm value is rather mixed (Campello et al., 2011; Hoyt and Liebenberg, 2011).

Another strand of the literature analyzes the joint production and hedging decisions of the firm under uncertainty about output price (Feder et al., 1980; Holthausen, 1979). The main result from this literature is that optimal output production is independent of the probability distribution of the output price and the manager's risk aversion. Both the distribution of the output price and risk aversion have an effect only on firms' involvement in future trading. Hence, with access to the futures market, uncertainty does not introduce any efficiency loss in production. The same separation result is obtained under perfect competition and input price uncertainty (Holthausen, 1979; Katz and Paroush, 1979; Paroush and Wolf, 1992). Paroush and Wolf (1992) show, however, that the separation result does not hold in the presence of basis risk, while Anderson and Danthine (1981) obtain a similar negative result with production uncertainty. Different extensions have been proposed by considering multiple risky inputs, background risk, and joint output price and input price uncertainty.[1]

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[1] See Viaene and Zilcha (1998) for instance. See also Alghalith (2008) for a review of the literature with competitive markets.

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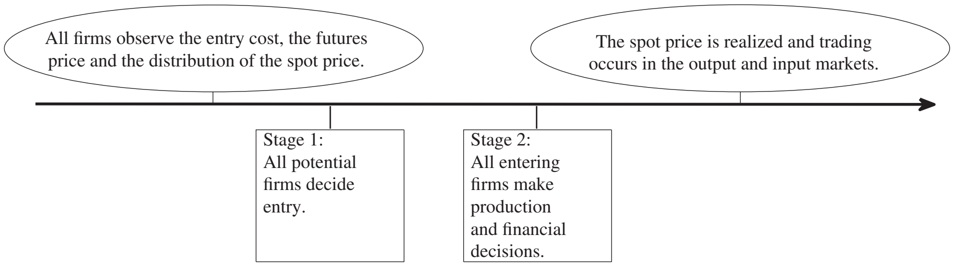
All firms observe the entry cost, the futures price and the distribution of the spot price.
The spot price is realized and trading occurs in the output and input markets.
Stage 1: All potential firms decide entry.
Stage 2: All entering firms make production and financial decisions.

Fig. 1. Timeline.

Although there are many contributions regarding firms' hedging in both literatures, to our knowledge there are few analyses of firms' hedging behavior under imperfect competition, and none that considers entry in the output market.[2] We propose to fill the gap by analyzing firms' entry, production and hedging decisions under imperfect competition. Specifically, we consider an oligopoly industry producing a homogeneous output in which risk-averse firms face an entry cost upon entering the output industry, and, then, compete in Cournot with one another.[3] Each firm faces uncertainty in the input cost when choosing production, and has access to the futures market to hedge the random cost. There is only one source of risk in our analysis.[4] One application of our model is the airline market for which it has been verified in empirical investigations of the U.S. airline industry that Cournot competition is present (Brander and Zhang, 1990; Fisher and Kamerschen, 2003). In this market, airline companies face future fuel price uncertainty when they make their optimal route decisions for the next few months, and purchase futures contracts for jet fuel (Morrell and Swan, 2006).[5] Here, entering or exiting the output market is mainly interpreted as route decisions.

We provide two sets of results. First, under general assumptions about risk preferences, demand, and uncertainty, we show that there exists a unique equilibrium in which a finite number of firms enter the market as long as the entry cost is not too high (the standard case) or not too low. Indeed, if the cost of entry in the output industry is too low, an infinite number of firms may enter the output industry and engage in speculation in the futures market, which yields the competitive outcome in the real sector. That is, the price of the output is equal to the marginal cost and the firms only make profits from speculating on the input market. We also show that, in contrast to previous results in the literature, production and output price depend on uncertainty and risk preferences. In particular, production and output price depend on the distribution of the spot price and risk aversion. The key element is that the entry decision coupled with a non-actuarially fair futures price limits the ability of the firms to adjust their production decisions, which implies that output is no longer independent of uncertainty and risk aversion. One implication is that access to the futures market alters the comparative analysis. If there is no access to the futures market, either a mean-preserving increase in risk or an increase in risk aversion induces each firm to produce less. If there is access to the futures market, such changes imply an increase (rather than a decrease) in per-firm production.[6]

The second set of results concern the effect of access to the futures market on entry, production, and prices. To study this effect, we restrict attention to constant absolute risk aversion (CARA) preferences, a linear demand, and a normal distribution for the spot input price. The effect of access to the futures market on the number of firms is ambiguous depending on the value of the futures price and the parameters of the model. Further, the equilibrium number of firms is convex in the futures price when the firms partially hedge. In particular, an increase in the futures price of the input can yield an increase in the number of firms in the output sector. This is due to the fact that an increase in the futures price induces firms to produce less, which reduces the market externality in a Cournot game and induces more firms to enter while hedging their cost. Moreover, hedging induces each risk-averse firm to produce more.

As noted, very few articles study the interaction of real and financial activities when the firms exert market power. One exception is a recent paper by Léautier and Rochet (2012) which studies the effect of committing to a hedging strategy on production or pricing strategies. Specifically, Léautier and Rochet (2012) consider a two-stage game in which each firm commits to a hedging strategy in the first stage and then chooses production or pricing strategies in the second stage. As in our model, the firms have market power in the output sector but are perfectly competitive in the input market. There are however main differences in the setups as well as in the issues studied. Regarding the model, Léautier and Rochet (2012) consider a market with a fixed number of firms, each one committing to a hedging strategy before production or pricing strategies. In our model, entry is a decision variable in the first stage whereas hedging and production are chosen simultaneously in the second stage.

Beyond the differences in modeling, we study different and complementary aspects of the link between real and financial activities when the firms exert market power. Léautier and Rochet (2012) show that strategic hedging (when used as a strategic commitment device) has a profound effect on the real decisions of the firms. Specifically, under actuarially fair pricing, when the firm commits to a hedging strategy, hedging toughens quantity competition, but softens price competition. We also consider issues related to risk management and real activities but of different nature. Specifically, we show that the separation result does not hold in the long-run when market structure is

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[2] There are three notable exceptions for imperfect competition. First, Eldor and Zilcha (1990) study the hedging behavior of an oligopoly under uncertainty in the output sector. However, while the spot price is endogenous (and the firms exercise market power under uncertainty), the futures (or forward) price is exogenous and fixed. In other words, the firms exercise market power in the spot output market, but behave perfectly competitively for the futures market of the same good. In addition, Eldor and Zilcha (1990) do not consider entry, which is our main focus in this paper. Second, in a very different setting, Allaz and Villa (1993) isolate the strategic reasons for using futures contracts. By selling futures contracts, Cournot firms attach a lower value to a high spot price and commit to aggressive behavior on the spot price yielding more production at a lower price in equilibrium, which benefits consumers but not producers. Third, the effect of strategic hedging on Cournot and Bertrand competition is studied in Léautier and Rochet (2012). We compare Léautier and Rochet (2012) model with our model and results later in the introduction.

[3] In this study, we assume that the firms have a concave payoff due to managerial risk aversion. Concavity can be explained by different market imperfections. See (Froot et al., 1993) for a discussion.

[4] For the case of two types of risk (e.g., a risk that can be hedged through a financial derivative and a risk that can be insured by an insurance contract), see Rochet and Villeneuve (2011).

[5] Fuel cost represents about 15% of the airlines' costs. Other costs are usually less volatile so hedging fuel costs guarantees stable profits. Usually, airlines do not hedge business cycle risk. Airline companies can also purchase other derivative products such as options and even collars. These options would introduce more flexibility for the firm at a higher cost, but would not affect the main results of the paper.

[6] The result without financial access is consistent with classical results obtained in a static environment (i.e., without entry decision) for perfect competition (Batra and Ullah, 1974; Sandmo, 1971) and quantity-setting monopoly (Leland, 1972).

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