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by

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Private versus Social Incentives for Backward Integration by Food Processors under Input Supply and Output Demand Uncertainty

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Abstract:

Previous studies have attempted to explain the growing trend towards vertical integration in the food industry in terms of gains in private efficiency. These studies typically assume a bilateral setting and hence overlook the impact that vertical mergers may have on other players in the market, and hence on social welfare. In this paper, we use a simple multilateral setting to examine the divergence that may arise between social and private incentives to vertically integrate when processing firms face input supply and output demand uncertainty. Here backward integration provides the integrating firm better protection against these two types of uncertainties while making the unintegrated competitor more vulnerable. The integrated firm therefore has greater incentives than the unintegrated firm does to increase final product valuation. Given the oligopolistic setting that characterizes the food manufacturing industry today, our results suggest that an integrated firm is likely to invest beyond the socially optimal level in product differentiation, which in turn, leads to greater market concentration. Earlier studies have looked at the growing trends towards vertical integration, product differentiation and concentration in isolation. Our study suggests that, under certain conditions, there might be a synergistic link between these variables that needs to be explored further.

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I. Introduction

Recent studies in the food industry literature have identified a number of reasons to explain why farmers and processors might enter into different forms of vertical coordination (such as contracting and vertical integration) as opposed to operating on open markets. Thus, for instance, farmers may enter into contracts to reduce price risks, to get access to capital and new technology, and to assure an outlet for their final produce (Knoeber, Rhodes, Barry *et al,* Hayenga.). On the other hand, processors may enter into contracts to assure consistent quality and quantity of inputs to run their processing plants efficiently (Hennesey, USDA 1996a).). It has also been suggested that processors may integrate backwards into agriculture to internalize the deadweight loss associated with market distortions which are internalized by integration (Henderson, Mitra et al.).[1]

The focus of this strand of literature has been to "explain" these institutional changes as a result of the private efficiency gains they entail in an environment of pervasive risks and imperfect information. Interestingly, there has been very limited investigation into the welfare implications of these alternative institutional forms. It is well known, however, that even if institutions perform certain important economic functions, they may not perform these functions optimally. In particular, as Stiglitz points out, pair-wise efficiency of contractual arrangements may not suffice to ensure social efficiency.

This possibility of a divergence between bilateral versus social efficiency has been overlooked largely because most of the analysis here is based on the assumption of a bilateral relationship, where a single seller produces some input for use by a single buyer. Casual observation, however, suggests that multilateral relationships in which a processing firm buys inputs from a number of farmers and /or a farmer supplies inputs to a number of processing firms, are far more widespread. In such a multilateral setting it becomes important to understand the "third party effects" of a merger between an upstream and a downstream firm. For instance,

[1] Perry in his survey in the Handbook of Industrial Organization suggests that vertical integration in this last case is "a relatively drastic solution to what is essentially a pricing problem" (p. 192). Tying arrangements, output or sales royalty and lump sum fee entry can all be used by the monopolist to eliminate and internalize the efficiency loss from simple monopoly pricing.

consider the case of a processing firm that faces high costs if its plant is not operated close to capacity. In the face of input supply uncertainty, vertical integration with the input supplier is likely to reduce this firm's supply assurance concerns while aggravating the supply assurance concerns of its competitors (Carlton). This is particularly true when the integrating firm has considerable market power in the either the upstream or the downstream market.

Some recent theoretical papers, such as Bolton and Whinston and Hart and Tirole, have used a simple multilateral setting to examine the effect of vertical integration on competition in the upstream and downstream market. However, apart from a recent study by Love and Burton on captive supplies in the beef industry, we are not aware of any study in the food industry literature that uses a multilateral setting to examine the motivation for and impact of vertical integration. Love and Burton examine how backward integration by a dominant processing firm may affect other processing firms by changing the spot market price for the common input but again they focus on the private efficiency gains from captive supplies and do not specifically examine its impact on social welfare. Also they assume a perfectly deterministic environment while, as we show in this paper, uncertainty in upstream input supply and in the demand for the final product play an important part in explaining why vertical integration emerges.

Understanding the "third party effects" of vertical integration within a multilateral setting is critical in the analyzing a number of concerns raised in recent years regarding vertical integration in agriculture. The beef packing industry, in particular, provides a good example. Over the past decade or so, cattle packers have increasingly made use of production contracts and vertical integration to obtain "captive supplies of cattle."[2] This has caused a lot of concern amongst unintegrated cattle feeders who have consistently complained that these captive supplies restrict their choice of sale outlets for cattle and depress prices received for fed cattle in the spot market (Martinez and Reed, USDA 1996a). Some industry observers also fear that large beef packers may use vertical coordination arrangements as a "means of blocking their small competitors from

[2] Captive supply takes the following forms: packer-owned cattle, formula cattle, futures cattle and custom-fed cattle.

sources of supply."(USDA, 1996a). Similar concerns have been raised in other food sectors also, notably the hog sector, where vertical coordination is increasing.

These concerns have led some states to enact corporate farming laws that restrict processor involvement in farming activities (Barkema). One of the arguments often given in favor of such legislation is that vertical merges and other forms of vertical coordination may amplify the potential for exercise of market power and hence are inefficient. However, this is highly controversial.[3] As Hart and Tirole point out

Few people would disagree that horizontal mergers have the potential to restrict output and raise consumer prices, but there is much less agreement about the anti-competitive effects of vertical mergers. Some commentators have argued that a purely vertical merger will not affect a firm's monopoly power, because the merger of an upstream and a downstream firm, each of which controls, say, 10 percent of its market, does not change market shares: other firms continue to possess 90 percent of each market. (p.205)

In the food industry literature, a number of studies provide evidence of a trend towards greater vertical integration and greater concentration (at both the farm level and processing stage) over time (Barkema et al., Reimund et al.) . These studies seem to implicitly suggest that vertical integration leads to market concentration but it is not very clear how this happens and what are its effects on social efficiency. A recent study initiated by the Packers and Stockyards Administration of USDA on "Concentration in the Red Meat Packing Industry" found the effect of captive supplies on short run prices paid for cattle to be negative, but very small. The study did not obtain any definitive results about the possible use of market power and attributes this largely to the several data and methodological difficulties encountered in examining the impact of vertical coordination and market concentration (USDA, 1996a: vii).

[3] This is very well illustrated by the controversy associated with the case of the Brown Shoe Company vs. United States. Brown Shoe Company was manufacturing shoes and wanted to integrate with a shoe retailer. The Supreme court ruled the merger to be illegal on the premise that the share of the market represented by the acquiring firm was no longer available to competing manufacturers, and hence was anti-competitive (Bolton and Whinston). Bork has been amongst the strongest critics of this anti-competitive doctrine. His main argument is that after integration, the acquiring manufacturing firm would attempt to maximize the profits of the integrated unit. Thus it would never force the acquired retailer to carry only its brands because any possible benefits from such an action to the acquiring firm would be offset by the loss to the acquired firm.

The above discussion points to the need to further explore the efficiency implications of vertical coordination in agriculture, both conceptually and empirically. In the present paper, we start with a somewhat modified version of the multilateral setting in the Bolton and Whinston (BW) paper and expand on it to clarify some of the issues raised above. In our model there is one upstream and two downstream production plants. The downstream plants use a common input, which is essential for production and used in fixed proportion. In any production period there is a positive probability that a shortage would arise for this input. This input supply uncertainty coupled with demand uncertainty for the final product, play a central role in our model in explaining the benefits to a downstream processing firm of integrating backwards into agricultural production. Using this model we address the following questions. First, what is the impact of such backward integration on the two merging parties and on the other unintegrated downstream firm in the market? In particular, how does vertical integration affect the investment decisions made by the integrated and the unintegrated downstream firm? Second, how do investment levels under non integration and vertical integration differ from what is socially optimal? Third, what is the mechanism through which backward integration by a processing firm affects concentration in the final product market? The results from our theoretical model also suggest a few hypotheses on how vertical integration, market concentration and product differentiation may be linked and we illustrate these linkages through some examples from the food manufacturing industry.

The rest of the paper is organized as follows. In section II, we discuss why input supply assurance concerns are an important motivation for processors to integrate backwards. In section III, we use some of these insights to develop a theoretical model on vertical integration in a multilateral setting. In section IV, the empirical implications of the main results from this model together with examples from the food manufacturing industry are discussed. Finally, in section V, we conclude.

II. Input Supply Assurance Concerns

The recent controversy, regarding the effects of captive supplies in the beef packing industry, provides a useful starting point to understand why input supply assurance concerns play a central role in our theoretical model. It has often been argued that captive supplies of fed cattle do not have any significant effect on short-run prices in the spot market because if through captive supplies, 20 percent of the demand for fed cattle is removed, so also is 20 percent of the supply. Hence, it is argued, the net effect on the market is zero (USDA, 1996b). While this argument seems convincing at first sight, the Minority Committee on "Concentration in Agriculture" made an interesting observation to counter this argument which we use as a stylized fact in the construction of our theoretical model. The report points out that the above argument is flawed because "captive supply ***cuts the tops off the market***, by assuring that the packers never get truly desperate for cattle, or ***"close to the knife"*** in industry terms. The packers have the flexibility to use the cattle they control when they want them without ever getting into the bidding wars that are the occasional salvation of feeders" (USDA, 1996b:30, emphasis added).

This suggests that to understand the motivation for and impact of vertical coordination, one must not just look at the total level of demand and supply, but more importantly at how fluctuations in these magnitudes affect and are affected by vertical coordination. An important motivation often given for why processors integrate backwards into agricultural production is that it provides them greater assurance regarding a smooth flow of inputs. Operating costs in many modern processing plants rise sharply if processing lines are not operated at optimal speed and so processing firms need a constant supply of inputs of consistent quality. However, this is often difficult, given the seasonality and uncertainty associated with agricultural production. Moreover, the perishable nature of many food products implies that storage may be a highly imperfect instrument for smoothing out the inter-temporal variability in farm production. The USDA study on "Role of Captive Supplies in Beef Packing" found that plant utilization is an important determinant of captive supplies for both large and small packing plants, with a relatively larger impact on small

plants, reflecting high costs of slaughter levels below full capacity. The study also found that variability in cash market prices led to an increase in use of captive supplies (Ward et al.).

Thus the need to run processing plants close to capacity in an environment characterized by large uncertainty in input supply provides an important motivation for vertical coordination by processing firms. Vertical coordination can occur in various different forms, ranging from marketing and production contracts to strategic alliances, partnerships and vertical integration. Some previous studies have examined the rationale for the choice between these alternative forms (Williamson, Klien et al, Frank and Henderson). These studies suggest that vertical integration is most likely to be observed when it is difficult to write complete contracts that induce efficient relation-specific investments. In a recent theoretical paper, based on a bilateral setting, Wiggins shows that this situation is most likely to occur when the downstream firm faces both highly uncertain (input) cost conditions and (output) demand conditions. Here backward integration allows for greater flexibility and superior communication between the two stages of production. In the model presented in the next section we incorporate both these types of uncertainties to explain why vertical integration emerges and its impacts.

III. Theoretical Model

Consider the following simple vertical setting. There is one upstream production plant (U) and two downstream plants (D_i ; $i = 1, 2$).[4] We assume that the output of the upstream plant (e.g. the grown up animal) constitutes an essential input in the production process of the downstream plants (e.g. the packing or processing plants). Each downstream plant requires one unit of this input (in combination with other inputs) to produce one unit of the output. Randomness in the production of the upstream plant leads to supply assurance concerns for the downstream plants in the following way. Assume that there is a probability, λ, that the upstream plant can produce only one unit of

[4] The basic multilateral framework presented here is based on Bolton and Whinston. However, since the bargaining assumptions we make here are different from what they assume, the results regarding investment levels under alternative ownership patterns are different from what they get. Also in their model, the downstream firms do not directly compete in the final product market.

output and a probability $(1-\lambda)$ that it can produce two units. In other words, there is some probability λ that a shortage would arise for the input required by the downstream plants.[5] The marginal costs of production of the upstream plant are fixed. To simplify the presentation, we assume these to be zero. With respect to the market for the final product, we consider two cases. We begin with the assumption that the two downstream firms do not directly compete in the final product market. This case serves as a useful benchmark. Later we consider the implications of relaxing this assumption.

III.1 No competition in the downstream market

Here we assume that the two downstream plants do not directly compete in the final output market. This may be because these firms sell in two segregated regions or because their products are not related in consumption. Each of these downstream firms has a single customer who demands at most one unit of the product. Let v_i denote the valuation of D_i 's output, net of D_i 's cost (except for the cost of input provided by U). We assume that v_i is randomly related to the level of unobservable investment, I_i, by D_i in the following way

$$v_i = v_i(I_i, s) \qquad i = 1, 2 \qquad (1)$$

where s is the state of nature. We assume that v_i is observable and is a differentiable, non-decreasing and concave function of I_i. The cost of this investment is given by $C_d(I_i)$, where $C_d(.)$ is an increasing and convex function of I_i. We assume that everyone observes the realized value of upstream production capacity and the downstream product valuation.

In this highly stylized setting there are three different (non-human) assets: one upstream and two downstream processing plants. Given these assets, the following types of ownership structures can arise

i) Non Integration (NI): all the three plants have different owners.

[5] Here we model supply assurance problem in the form of uncertainty regarding the production level of the upstream firm. However, supply assurance problem may take the form of uncertainty regarding the supply of any other attribute considered to be valuable by the processing plant such as the proportion of fat in market hogs or the amount of pesticide applied to a crop.