**December 5, 2015**

# Another Kind of Power: Labor Market Outcomes and Antitrust Legislation:

*By* NITI BHUTANI*

Abstract

Large corporate entities that dominate the business world often make it difficult for their relatively smaller and local counterparts to compete. In this scenario, if the smaller player (operating independently) shuts down business and opts to work or produce under contract for the larger firm, it is the reduced profitability of the smaller firm that will constitute the benchmark against which the contract is designed. This benchmark - that is, the reservation utility, is typically taken to be exogenously given in economic theory and it is the possibility of reservation utility being endogenous that this paper formally explores. This is done by allowing the larger firm to undertake investments that not only reduce its own costs but also induce lower profitability for the smaller player. The analysis specifically highlights the labor market channel through which economic power of large corporations is manifested and the design of antitrust law from the point of view of organizational and distributional justice.

*Key words:* antitrust law, contract theory, labor economics, endogenous reservation utility, ecommerce, mom and pop stores, institutions

Jel: D86, K21, O12, Q13, L40

* Department of Economics, Hindu College, University of Delhi, India (Email: niti.bhutani@hindu.du.ac.in).
This paper is based on the author's Ph.D. dissertation submitted to the University of Maryland, College Park, under the lead supervision of Professor Robert G. Chambers. Research on this paper was further supported by the Ann G. Wylie Dissertation Fellowship and feedback received from participants at the Annual International Conference on Law, Economics, and Politics, Oxford, UK.

# 1 Introduction

Reservation utility, or the amount that an agent gets in his next best alternative use, is a vital component of all principal-agent models. Any contract, in theory, must offer the agent at least his reservation expected utility, in order for it to be accepted. This then forms the basis for the individual rationality constraint or the participation constraint in economic modeling. Contracting models, however, typically take this reservation utility as exogenously given. The possibility of reservation utility being endogenous has been explored formally in a seminal paper by Basu (1986), as also in Chambers and Quiggin (2000). These papers are interesting in that they attempt to incorporate qualitative issues such as influence and power that tend to get marginalized in conventional economic modeling. Specifically, these papers examine issues of power and influence in the framework of triadic relationships - relationships where two parties interact with each other both directly, and indirectly, through a third party (Basu, 1986).

Unlike the existing literature that emphasizes the emergence of endogenous reservation utility in triadic relationships (involving, for instance, a landlord, a laborer, and a merchant), this paper illustrates that such a possibility may emerge even in a dyadic setting where parties interact pairwise. Dyadic settings that provide a suitable backdrop for the analysis in this paper include large retail chains (in relation to mom and pop stores), ecommerce (in relation to offline "real" stores) and modern-day contract farming (in relation to independent farming).

Among the large retail chains, Wal-Mart, for instance, is well-known for having acquired a key competitive advantage by not only investing heavily in cutting-edge technology but doing so faster than any of its competitors. Wal-Mart's strength lies in the relatively low prices that it charges as compared to its competitors comprising supermarkets and local "mom and pop" stores. Its low cost culture reflects a market philosophy that can be attributed to several factors such as purchasing goods in bulk directly from manufacturers instead of relying on wholesalers, constantly innovating and improving its IT infrastructure, and so on. Overall, low prices can be attributed to the scale and scope efficiencies that Wal-Mart has invested in. (Friedman, 2005; Basker, 2007)

However, low prices charged by Wal-Mart and other retail chains have also received considerable attention on account of the difficulty they pose for the small players to compete. The company has also come under scrutiny for its low wages and benefits. The demise of several mom and pop stores has been attributed to their inability to match Wal-Mart prices. Goetz and Swaminathan (2004) suggest that one of the options available to such storeowners (and their employees) once they shut down is to work for Wal-Mart itself. If contracts pay no more than the reservation utility, the Wal-mart contract with this former store owner or employee will offer him no more than the new reduced income that results from the store's inability to compete. A similar situation can be envisaged for e-retail vis-à-vis real offline firms.

Another case in point is modern-day contract farming that involves a food processing company that contracts with farmers to grow a particular crop or grow slaughter animals to market weight. Such companies have also been able to exploit new scale economies through significant cost-reducing investments. What has emerged under modern-day contract farming is a factory style of farming under highly controlled environments. The advantage of this factory style of farming is that it enables a uniform product quality to be brought to the market at relatively low market prices. While this is beneficial for consumers, this also means reduced returns for smaller, independent producers who cannot charge similar competitive prices and cannot undertake similar cost-reducing investments (Macdonald, 2006).

An illustration of the inability of smaller producers to compete with the larger players is the case study 'A contract on hogs: A Decision Case' by Swinton and Martin (1997) that describes the factors underlying a Michigan farm couple's decision to go for contract production with the company "Pork Partners". This is a couple that was operating independently - raising hogs outdoors and selling them to an agent of Michigan Livestock Exchange. However, declining hogs prices in the late 1980s and the inability to earn the premium offered on the production of leaner hogs (hogs raised outdoors tend to be fatter) were among the important factors adversely affecting their profit margins, eventually leading them to opt for contract production with Pork Partners.[1]

The above facts suggest that the inability to compete with bigger operations reduces the profitability of independent production for smaller players. And, in this scenario, if the smaller player opts for contract production under the bigger player, it is the reduced profitability under the independent production arrangement that will constitute the benchmark against which contracts will be designed.

[1] Leanness or the muscle-fat ratio is an indicator of quality in the meat industry. Consumers these days tend to prefer lean meat for health reasons and there is, therefore, a premium attached to producing leaner animals.

It may be noted here that investments of bigger operations may be undertaken primarily to reduce costs and become more competitive vis-à-vis other players. The activities need not be directly and "consciously" targeted towards ultimately getting the smaller players to work under contract. However, the linkages in the economy may be such as to lead to an outcome of this kind and it is these linkages that this paper explores.

Power and influence have been examined by Basu(1986) in the context of triadic relationships involving, for instance, a village landlord, a laborer and a merchant. In this setting, a labor contract offered by the landlord to the laborer is accompanied by a threat where, in the event of this contract not being accepted by the laborer, the landlord ensures that the merchant will also refuse to trade with him. Basu brings out the exploitative nature of the exchange by showing that such a transaction that involves a threat may actually leave the laborer with a negative utility. Chambers and Quiggin (2000) examine a similar set-up in a state-contingent contractual framework where a landlord can affect a peasant's reservation utility through political or other extra-contract exploitative means. In particular, they show that the equilibrium reservation utility falls with a reduction in the cost of exploitation and with an increase in the crop price. Hart and Holmstrom (1987) too recognize that reservation expected utility will be endogenous when ex-ante competition is imperfect so that the parties involved will bargain over the ex-ante surplus in the contract.

In the light of the discussion above and in what follows formally in this paper, endogenous reservation utility:

a. is seen to emerge in a dyadic setting where parties interact pairwise in a strategic manner. As a matter of fact, the scenario in Basu can also be seen in terms of a dyadic relationship if, for example, one allows for the landlord to "legally" enter into a partnership with the merchant (or even take over the merchant's business) and then offer his contract and the merchant's goods to the laborer as a package. Even though the outcome will be the same as that in Basu's story, the means to achieving that outcome seem part of normal economic behavior!

b. may not be a consequence of a "coercive" threat but may be a consequence of the exertion of economic power (or, in more extreme situations, economic coercion). Moreover, it is pre-contract (before the contract is signed) or outside-of-contract interactions that influence the reservation utility in this paper as opposed to the existing literature where extra-contract means within an existing contractual framework are used to examine the issue of endogeneity.

The question is wether the situation is threatening and therefore subject to antitrust legislation. This is a subjective issue and depends on the legal and/or moral evaluation of the situation by the adjudicating authority. There is one view influenced by the Chicago School of Economics that emphasizes consumer welfare so that greater efficiency of large firms achieved through economies of scale and passed on to consumers through lower prices is a good thing. However, there are other viewpoints that emphasize that consumer benefits have to be seen together with company size and number of competitors and antitrust laws framed accordingly.

The approach of the paper is production-theoretic and the state-contingent approach that incorporates fundamental principles of production theory under uncertainty is used for the purpose of modeling. The state-contingent approach builds on the idea of state-contingent commodities in the tradition of Arrow and Debreu. A state-contingent commodity is one whose "delivery is contingent on the occurrence of a particular state of nature" (Chambers and Quiggin, 2000). Overall, this production-theoretic state-contingent approach has the advantage of allowing for a sufficiently general and rational representation of the production technology with multiple inputs and state-contingent outputs, in contrast to the existing mainstream literature on contracts and institutions. For a formal exposition to this approach and its comparison with the mainstream approach based on a parameterized distribution formulation, see Chambers and Quiggin (2000).

The rest of the paper is organized as follows. The next section provides a model overview for the equilibrium determination of the reservation utility and a description of the production technology. Section 3 develops and examines the model for the determination of reservation utility in a strategic Cournot duopoly setting. This is followed by Section 4 that provides an analysis of contract production with endogenous reservation utility. Section 5 concludes.

## 2 Model Overview and the Production Technology

Suppose there are two players - firms I and II, and currently firm II works under contract as the agent for firm I, the principal firm. This is the status quo preceded by both players operating as independent producers. While the contract is such that it pays II no more than his reservation utility, this reservation utility is no longer exogenous as is the case in standard moral hazard models. In particular, it is assumed that the reservation utility of the agent in this model is determined in a strategic Cournot duopoly setting where both firms I and II make their production decisions simultaneously and independently. It is further assumed that firm I is the relatively larger, more competitive and more cost-effective firm. Both firms produce a single output ($z$) which is assumed to be homogeneous. The output could be measured in terms of weight in contract farming, and number of units produced in the case of a manufacturing firm. For a retail chain, number of units sold assuming that it sells only one broadly defined product, say, "stationery" or "food", with individual items measured in the same unit. [2]

Irrespective of the production arrangement, the production process or business in general requires $M$ fixed inputs denoted by $\mathbf{h} \in \Re_{+}^{M}$ (e.g. land area devoted to production), and $N$ variable inputs with the variable input vector represented by $\mathbf{x} \in \Re_{+}^{N}$. The non-stochastic inputs are committed prior to the resolution of uncertainty. Uncertainty entails 'Nature', a neutral player, making a choice from among two mutually exclusive states. Let the set of states of nature be represented by $\Omega = \{1, 2\}$. Such a set serves to highlight the uncertain aspects of production. Let $\pi_1$ and $\pi_2$ be the probabilities with which states 1 and 2 occur, respectively. Moreover, the following assumption is made:

**Assumption 1**

*It is assumed, without loss of generality, that state* 1 *is the good state.*

The sequence of moves that govern production on the "field" is as follows: A firm, given $\mathbf{h}$, first commits a vector $\mathbf{x}$ of non stochastic inputs to production that allows it to produce a vector of state-contingent outputs, $(z_1, z_2) \in \Re_{+}^{2}$, with the typical element being $z_s$, where $z_s$ represents the amount of output that is realized in state s ($s = 1, 2$). Nature then makes a draw from $\Omega$ which, along with $\mathbf{x}$ and $\mathbf{h}$, determines the output $z_s$, corresponding to the state $s$ that materializes. For the complete structure and timing of the game, see Section 4.2.

The production technology is described in terms of the input correspondence $X(z_1, z_2, \mathbf{h})$ that consists of the sets of variable inputs that can produce a particular state-contingent output vector $\mathbf{z} = (z_1, z_2) \in \Re_{+}^{2}$ given a vector of fixed inputs ($\mathbf{h}$). It is assumed that both firms are cognizant of the technology and each other's preferences.

[2] Alternatively, $z$ could also be interpreted as output quality with the two firms competing on the quality dimension of output.

# 3 Determination of reservation utility in a Cournot Setting

The reservation utility of the agent is determined by what he gets in his next best alternative use which is characterized here by the agent operating independently as firm II, and competing with firm I (that, under contract, acts as the principal). The situation outside of the contract is modeled in terms of a state-contingent Cournot duopoly model where the parties concerned are assumed to engage in independent production of a homogeneous product and act simultaneously and non-cooperatively.

To see the exact mechanism under which the firms interact, denote firm $i's$ production by $(z_1^i, z_2^i)$, $i = I, II$, corresponding to the two states of nature. Let $z_1^I + z_1^{II} = Z_1$ and $z_2^I + z_2^{II} = Z_2$ with $Z_s$ representing the total production of the two firms taken together in state $s$, $s = 1, 2$. Suppose, the market price is given by the inverse demand function $p(Z_s)$ for state $s$. In particular, $p(Z_s)$ is assumed to be linear and is given by $p(Z_s) = 1 - Z_s$, $s = 1, 2$.

Firm $i$ $(i = I, II)$ receives a gross amount $r_s^i = p(Z_s)z_s^i$ in state $s$, $s = 1, 2$. It is assumed that firm I is risk neutral and its preferences over $\mathbf{r}$ are of the linear form $\pi_1 r_1^I + \pi_2 r_2^I$. Player II's preferences over '$\mathbf{r}$' represented by $W$ are assumed to be constant risk averse (CRA) preferences so that:

$$W(\mathbf{r}^{II}) = \bar{r}^{II} - \kappa\sigma[\mathbf{r}^{II}],$$

where $\bar{r}^{II}$ is player II's mean income equal to $\pi_1 r_1^{II} + \pi_2 r_2^{II}$, $\kappa$ is an index of risk aversion ($\kappa > 0$), and $\sigma$ is the standard deviation associated with $\mathbf{r}^{II}$. The preference function $W(\mathbf{r}^{II})$ exhibits both constant absolute and constant relative risk aversion (Safra and Segal, 1998; Chambers and Quiggin, 2000).[3] Therefore, using the assumption that state 1 is the good state:[4]

[3] Note that CRA preferences are consistent with the expected utility model only under risk neutrality.

[4] Note that (suppressing the firm subscript):

$$\begin{aligned}
\sigma^2[\mathbf{r}] &= \sum_s \pi_s (r_s - \bar{r})^2 \\
&= \pi_1(r_1 - \pi_1 r_1 - \pi_2 r_2)^2 + \pi_2(r_2 - \pi_1 r_1 - \pi_2 r_2)^2 \\
&= \pi_1(\pi_2 r_1 - \pi_2 r_2)^2 + \pi_2(\pi_1 r_2 - \pi_1 r_1)^2 \\
&= \pi_1 \pi_2^2 (r_1 - r_2)^2 + \pi_1^2 \pi_2 (r_2 - r_1)^2 \\
&= \pi_1 \pi_2 (r_1 - r_2)^2 (\pi_2 + \pi_1) \\
&= \pi_1 \pi_2 (r_1 - r_2)^2 \quad (\text{since } \pi_2 + \pi_1 = 1)
\end{aligned}$$

The standard deviation associated with $\mathbf{r}$ is obtained by taking the positive square root of the expression above. Therefore,

$$\sigma[\mathbf{r}] = \sqrt{\pi_1 \pi_2} \mid r_1 - r_2 \mid$$

$$\begin{aligned} W(\mathbf{r}) &= \pi_1 r_1^{II} + \pi_2 r_2^{II} - \kappa\sigma[\mathbf{r}^{II}] \\ &= \pi_1 r_1^{II} + \pi_2 r_2^{II} - \kappa\sqrt{\pi_1\pi_2}[r_1^{II} - r_2^{II}], \\ &= \pi_1 p(Z_1) z_1^{II} + \pi_2 p(Z_2) z_2^{II} - \kappa\sqrt{\pi_1\pi_2}[p(Z_1) z_1^{II} - p(Z_2) z_2^{II}] \end{aligned}$$

Let $g^i(\mathbf{x}^i) : \Re_+^N \to \Re$ be the effort-evaluation function for firm $i$ ($i = I, II$) under independent production.[5] The function $g^i(\mathbf{x}^i)$ gives firm $i's$ ($i = I, II$) evaluation over a particular input bundle $\mathbf{x}^i \in \Re_+^N$ chosen by him. It is assumed that $g^i(\mathbf{x}^i)$ is nondecreasing, continuous, and convex for all $\mathbf{x}^i$ (Chambers and Quiggin, 2000). Let $C^i(z_1, z_2)$ represent firm $i's$ variable cost function that reflects the (ex ante) minimum cost of producing a given state contingent $(z_1, z_2) \in \Re_+^2$ given $\mathbf{h}$. It reflects the firm's cost minimizing choices of $\mathbf{x}$, and is defined as:

$$C^i(z_1, z_2) = \min_{\mathbf{x}^i} \{g^i(\mathbf{x}^i) : \mathbf{x}^i \in X(z_1, z_2, \mathbf{h})\},$$

if there is an input vector $\mathbf{x}^i \in \Re_+^N$ that can produce a given $\mathbf{z}$, and $\infty$ otherwise. In particular, I assume a linear cost function that is characterized by constant returns to scale so that:

$$\begin{aligned} C^I(z_1^I, z_2^I) &= c_1 z_1^I + c_2 z_2^I \text{ for firm I, and} \\ C^{II}(z_1^{II}, z_2^{II}) &= d_1 z_1^{II} + d_2 z_2^{II} \text{ for firm II.} \end{aligned}$$

It is assumed that firm $I$ is the more cost-effective firm and has a distinct cost advantage so that $c_1 < d_1$, and $c_2 < d_2$.

The model below examines strategic interaction between two players - (1) Firm I producing

That is, $\sigma[\mathbf{r}]$ can be written as:

$$\begin{aligned} \sigma[\mathbf{r}] &= \sqrt{\pi_1\pi_2}(r_1 - r_2) \quad \text{if } r_1 \geq r_2 \\ &= -\sqrt{\pi_1\pi_2}(r_1 - r_2) \quad \text{if } r_1 < r_2 \end{aligned}$$

[5] The effort evaluation function under independent production namely, $g^i(\mathbf{x}^i)$, reflects a cost structure that is different from the one that is outlined in the second part of the main model that characterizes contract production. The case where the cost structures coincide is a special case within this more generalized set-up that allows for different cost structures.

independently either as an individual firm or by contracting with firms other than firm II, and (2) Firm II that is an individual firm producing independently. The players make their output decisions simultaneously and independently in a state-contingent Cournot framework. In each state, each firm maximizes expected returns and chooses its optimal output based on its conjecture of what the other player does.[6] This then determines a reaction curve for each firm, and the reaction curves for the two firms simultaneously determine the mutual best response in state-contingent outputs that constitute the Nash equilibrium. The state-contingent market price is then determined by the inverse demand function, assuming that demand equals the total quantity produced by the two firms.

Firm $II$'s optimization problem, given the state-contingent output choices of firm $I$, can be stated as:[7]

$$\max_{z_1^{II}, z_2^{II}} \pi_1(1-z_1^I-z_1^{II})z_1^{II}+\pi_2(1-z_2^I-z_2^{II})z_2^{II}-\kappa\sqrt{\pi_1\pi_2}[(1-z_1^I-z_1^{II})z_1^{II}-(1-z_2^I-z_2^{II})z_2^{II}]-d_1z_1^{II}-d_2z_2^{II}.$$

Assuming an interior solution, the first order conditions are:

$$\begin{aligned} z_1^{II} &: \quad (\pi_1-\kappa\sqrt{\pi_1\pi_2})(1-z_1^I-2z_1^{II})-d_1=0 \\ z_2^{II} &: \quad (\pi_2+\kappa\sqrt{\pi_1\pi_2})(1-z_2^I-2z_2^{II})-d_2=0. \end{aligned}$$

The reaction functions for firm II corresponding to states 1 and 2, respectively, as derived from the first order conditions above, are represented as:

$$1-z_1^I-2z_1^{II}=\frac{d_1}{\pi_1-\kappa\sqrt{\pi_1\pi_2}} \tag{1}$$

$$1-z_2^I-2z_2^{II}=\frac{d_2}{\pi_2+\kappa\sqrt{\pi_1\pi_2}} \tag{2}$$

[6] In particular, each firm acts as the monopolist over its residual demand.

[7] It is assumed that for both firms, the joint evaluation over the input vector $\mathbf{x}$, and over the receipts $\mathbf{r}$ are separable.

Now, looking at firm I's maximization problem, we get:

$$\max_{z_1^I, z_2^I} \pi_1(1 - z_1^I - z_1^{II})z_1^I + \pi_2(1 - z_2^I - z_2^{II})z_2^I - c_1 z_1^I - c_2 z_2^I.$$

The corresponding state-contingent reaction functions for firm I in states 1 and 2, respectively, are obtained from:

$$1 - 2z_1^I - z_1^{II} = \frac{c_1}{\pi_1} \tag{3}$$

$$1 - 2z_2^I - z_2^{II} = \frac{c_2}{\pi_1} \tag{4}$$

Solving (1) and (3) simultaneously for the optimal state-contingent outputs corresponding to state 1 gives:

$$z_1^{I*} = \frac{1}{3} - \frac{2c_1}{3\pi_1} + \frac{d_1}{3(\pi_1 - \kappa\sqrt{\pi_1 \pi_2})}, \tag{5}$$

$$z_1^{II*} = \frac{1}{3} + \frac{c_1}{3\pi_1} - \frac{2d_1}{3(\pi_1 - \kappa\sqrt{\pi_1 \pi_2})} \tag{6}$$

As can be seen from the results above, firm $II's$ optimal state-contingent output is decreasing in its own marginal cost in state 1, and increasing in firm $I's$ marginal cost $c_1$. The same kind of argument holds for firm $I$ but we are concerned here with firm $II$ and its returns in each state, as its expected returns from this game determine its reservation utility under contract.

Similarly, by solving (2) and (4) simultaneously, we get the optimal production levels corresponding to state 2 for firms I and II, respectively:

$$z_2^{I*} = \frac{1}{3} - \frac{2c_2}{3\pi_2} + \frac{d_2}{3(\pi_2 + \kappa\sqrt{\pi_1 \pi_2})} \tag{7}$$

$$z_2^{II*} = \frac{1}{3} + \frac{c_2}{3\pi_2} - \frac{2d_2}{3(\pi_2 + \kappa\sqrt{\pi_1 \pi_2})} \tag{8}$$

Substituting the results obtained in (5) - (8) into the expression for firm $II's$ expected payoff gives:

$$\pi_1(1-z_1^{I*}-z_1^{II*})z_1^{II*}+\pi_2(1-z_2^{I*}-z_2^{II*})z_2^{II*}-\kappa\sqrt{\pi_1\pi_2}[(1-z_1^{I*}-z_1^{II*})z_1^{II*}-(1-z_2^{I*}-z_2^{II*})z_2^{II*}]-d_1 z_1^{II*}-d_2 z_2^{II*}$$

The expression above is the expected reservation utility of firm II if it decides to produce under contract for firm I and is represented as[8]:

$$E(c_1,c_2)=(\pi_1-\kappa\sqrt{\pi_1\pi_2})[\frac{1}{3}+\frac{c_1}{3\pi_1}-\frac{2d_1}{3(\pi_1-\kappa\sqrt{\pi_1\pi_2})}]^2+(\pi_2+\kappa\sqrt{\pi_1\pi_2})[\frac{1}{3}+\frac{c_2}{3\pi_2}-\frac{2d_2}{3(\pi_2+\kappa\sqrt{\pi_1\pi_2})}]^2 \tag{9}$$

Taking the derivative of $E(c_1, c_2)$ in (9) with respect to $c_1$, I get:

$$\frac{2}{3\pi_1}(\pi_1-\kappa\sqrt{\pi_1\pi_2})z_1^{II*}>0 \quad \text{if } (\pi_1-\kappa\sqrt{\pi_1\pi_2})>0)$$

Similarly, the derivative of $E(c_1, c_2)$ with respect to $c_2$ is:

$$\frac{2}{3\pi_2}(\pi_2+\kappa\sqrt{\pi_1\pi_2})z_2^{II*}>0$$

This then leads us to the following proposition:

**Proposition 1**

*A reduction in firm $I'$s marginal cost in state 1 and/or state 2 causes a decline in firm $II'$s expected payoff and therefore its expected reservation utility.*

The expressions for the state-contingent prices established in equilibrium are:

$$p^*(Z_1)=\frac{1}{3}+\frac{c_1}{3\pi_1}+\frac{d_1}{3(\pi_1-\kappa\sqrt{\pi_1\pi_2})} \text{ in state 1, and}$$

$$p^*(Z_2)=\frac{1}{3}+\frac{c_2}{3\pi_2}+\frac{d_2}{3(\pi_2+\kappa\sqrt{\pi_1\pi_2})} \text{ in state 2.}$$

That is, the equilibrium market price is nondecreasing in the firms' state-contingent marginal costs. The situation illustrated here is different from that described in the context of the traditional landlord who takes the market price as given with a fall in market price (*within* the contract setting) causing him to decrease his exploitative activities and leading to a rise in the peasant's reservation utility. In particular, for the case in question, a fall in price (now endogenously determined) through, say, a reduction in firm I's marginal costs $c_1$ and/or $c_2$ is associated with a fall in reservation utility. However, note that the market price that drives the result here is the ex post price that results from

[8]Note that firm I's expected profits equal:

$$\pi_1[\frac{1}{3}-\frac{2c_1}{3\pi_1}+\frac{d_1}{3(\pi_1-\kappa\sqrt{\pi_1\pi_2})}]^2+\pi_2[\frac{1}{3}-\frac{2c_2}{3\pi_2}+\frac{d_2}{3(\pi_2+\kappa\sqrt{\pi_1\pi_2})}]^2 \tag{4.10}$$

the strategic interaction between the two economic players while they are producing independently and can be viewed as the outside-of-the-contract market price. This price need not be the same as the price that results from contract production with the larger firm as the residual claimant. Overall, this analysis shows that any cost-reducing investments of the larger firm will bring about a reduction in the expected reservation utility of the agent through a fall in the market price. That is, the same outcome - a fall in the expected reservation utility - may result even when a firm is not engaging in unproductive exploitative activities.

**Corollary 1.1**

*A decline in firm $II'$s expected payoff and therefore its expected reservation utility is associated with a reduction in the equilibrium outside-of-the-contract market price on account of a reduction in firm $I'$s marginal cost in either state or both states.*

## 4 Contract Production with Endogenous Reservation Utility

Firm II may decide to produce under contract for firm I if its expected reservation utility $E(c_1, c_2)$ falls below a certain threshold. This threshold is a subjective measure and may be a function of player II's perception of a certain standard of living and/or how other firms are doing as contract producers in the local region. Once firm $II$ decides to produce for firm $I$ under contract, the relationship between the two firms changes from one involving strategic interaction in a Cournot duopoly to one where firm $I$ is the principal and firm $II$ becomes the agent, as is the case in a principal-agent problem. With the main competitor having become the agent, firm $I$ now acts as a monopolist in the market. Note that while the players acting in an independent capacity compete noncooperatively outside of the contract situation, the game under contract is such that the agent (firm $II$) now makes his decisions in light of the decisions made by the principal or the provisions outlined under the formal contract. Thus, the nature of the game switches from a non-cooperative game to a leader-follower game with firm $I$ being the leader and firm $II$ the follower.

The game is assumed to span two periods. That is, inputs committed today (time $t$) produce state-contingent output $z_s^{t+1}$ in the next period corresponding to state $s$. For the ensuing analysis, the time superscripts associated with $z_s^{t+1}$ will not be written explicitly unless it is necessary to do so. Moreover, both the principal and the agent are assumed to have the same subjective discount factor $\eta$.

The model in this paper allows for the possibility that firm II under contract may continue to carry out production on its own facilities as is very often seen in practice, particularly in modern-day contract farming and subcontracting relationships. In this scenario, the main production decisions may be controlled by the principal firm through the provision of certain key inputs. In contract farming, for instance, the company may provide the farmer the feed, antibiotics, and the chicks or hogs (in the case of chicken and pork) and the seed, agrochemicals (such as fertilizers and pesticides) and also certain farm equipment (in the case of crops). In addition, the company may also provide production advice, credit, transport, and undertake or help in soil preparation, sowing, and harvesting of crops.

The task of growing crops until they are ready for harvest or, in the case of livestock, raising animals to market weight, is performed by the farmers. The farmer, on his part, provides labor, land, and the building (chicken house or hog barn in livestock). Sowing, plant protection, harvesting and transport of the harvested crop are the responsibilities of the farmer unless the contract specifically has a clause that requires the company to perform these tasks. Broiler and hog farmers are further required to make proper provisions for utilities (electricity, heat and water), adequate ingress and egress, manure management and dead animal disposal for the duration of the contract. (Olesen, 2003; Tsoulouhas and Vukina, 1999; inputs received from growers of the Eastern Shore; contract samples available at www.fao.org).[9]

To allow for the possibility of different patterns of input provision, the vector of inputs devoted to production under contract $\mathbf{x} \in \Re_+^N$ is decomposed into two components - the inputs provided by the agent, and the inputs provided by the integrator-principal. Let $\mathbf{x}^A \in \Re_+^N$ and $\mathbf{x}^P \in \Re_+^N$ denote the input bundles contributed by the agent and the principal, respectively, with $\mathbf{x}^A + \mathbf{x}^P = \mathbf{x}$. If the principal firm does not provide any inputs, $\mathbf{x}^P = 0$. It is further assumed that all the inputs provided by the principal are contractible. For the analysis of a situation where some inputs in $\mathbf{x}^P$ may not be contractible, see Bhutani (2010).

[9] Food and Agriculture Organization of the United Nations. *Contract Samples, Contract Farming Resource Center.* http://www.fao.org/ag/ags/contract-farming/toolkit/contract-links/en/

## 4.1 Preference and Return Structure of the Principal and the Agent

From the point of view of the principal, the observables in this problem are the inputs provided by him ($\mathbf{x}^P$), if any, and the output $z$. While $\mathbf{x}^P$ and $z$ constitute the observables, the state of nature and the agent's decisions with respect to the self-provided inputs cannot be observed. Thus, it is only the agent who can observe the conditions under which production takes place once (and if) the inputs are delivered to him by the principal. It is assumed that the agent is a rational cost minimizer and that the principal has no direct preferences over the agent's decision variables in $\mathbf{x}^A$. That is, what the principal cares about are the cost minimizing choices of $\mathbf{x}^P$ and his return from $z$.

The principal is assumed to be risk neutral and maximizes his expected return. The production structure that he wants to implement is $(\mathbf{z}, \mathbf{x}^P)$,that is, $(z_s, \mathbf{x}^P)$ in a particular state $s$. Let $g^P(\mathbf{x}^P) : \Re^N_+ \rightarrow \Re$ be the effort-evaluation function for the principal that gives his evaluation over a particular input bundle $\mathbf{x}^P \in \Re^N_+$ directly chosen by him. It is assumed that $g^P(\mathbf{x}^P)$ is nondecreasing, continuous, and convex for all $\mathbf{x}^P$ (Chambers and Quiggin, 2000). The market price is given by the inverse demand function $p(z_s)$ for state $s$, assumed to be linear and given by $p(z_s) = 1 - z_s$, $s = 1, 2$. Thus, the principal's gross return from $z$ and $\mathbf{x}^P$ in state $s$ (gross of payments made to the agent) is given by $p(z_s)z_s - g^P(\mathbf{x}^P),\ s = 1, 2$.

The ex post payments made by the principal to the agent (firm II) under contract are represented by $r^A_1$ and $r^A_2$ for states 1 and 2, respectively. To simplify the notation, I use $r_1$ and $r_2$ to represent the agent's state-contingent receipts. Thus, $r_s$ represents the agent's gross return when $(z_s, \mathbf{x}^P)$ is realized. It is assumed that the agent's joint evaluation at time $t$ over self-provided inputs and contract payment received in period $t + 1$ is given by:

$$\eta W(\mathbf{r}) - g^A(\mathbf{x}^A; \mathbf{x}^P),$$

where $\eta$ is the agent's subjective discount factor that captures impatience ($\eta > 0$), $g^A(\mathbf{x}^A; \mathbf{x}^P)$ represents the agent's effort-evaluation function after allowing for the possibility of input provision, and $W(\mathbf{r})$ represents the preference function over $\mathbf{r}$. The agent's preference structure, is constant risk averse of the form:

$$\begin{aligned} & \overline{r} - \kappa\sigma[\mathbf{r}] \\ = \quad & \pi_1 r_1 + \pi_2 r_2 - \kappa\sqrt{\pi_1\pi_2}(r_1 - r_2), \end{aligned}$$

The agent's variable cost function under contract production $C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h})$ that reflects the (ex ante) minimum cost of producing a given state contingent $(z_1, z_2) \in \Re^2_+$ given $\mathbf{x}^P$ and $\mathbf{h}$ is defined as:

$$C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) = \min_{\mathbf{x}^A}\{g^A(\mathbf{x}^A; \mathbf{x}^P) : \mathbf{x} \in X(\mathbf{z}, \mathbf{h})\},$$

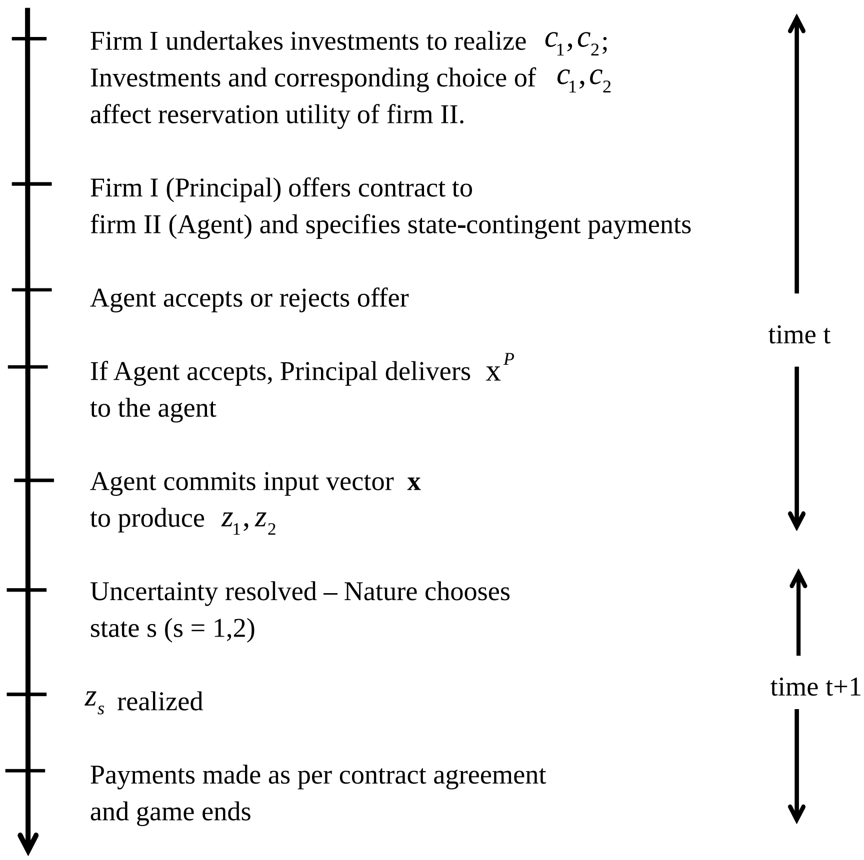
if there is an input vector $\mathbf{x}^A \in \Re^N_+$ that can produce a given $\mathbf{z}$ and $\infty$ otherwise. It is assumed that the production technology is such that it guarantees the existence of a cost function that is twice continuously differentiable, strictly increasing and strictly convex in state-contingent outputs (Chambers, 2002). To facilitate the analysis, I make the following assumption:

**Assumption 2**

*Suppose that* $C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h})$ *is positively linearly homogeneous in the state-contingent outputs.*

## 4.2 Game Structure and Timing

The timing of the game is as follows:




The timeline of the game shown above indicates that as an independent producer, firm $I$ makes investments (included in its vector of fixed inputs $\mathbf{h}$) that affect:

(a) its state-contingent marginal costs $c_1$ and $c_2$ as an independent producer,

(b) its costs under contract (specified as a function of $c_1$ and $c_2$, and incorporated formally in the model below). In particular, let the function $f(c_1, c_2)$ represent the benefits from firm $I$'s investments that are carried over into contract production through the parameters $c_1$ and $c_2$, in the form of, say, economies of scale. The function $f(.)$ is assumed to be monotonically decreasing and concave in the state-contingent marginal costs so that $c_1' > c_1$ and $c_2' > c_2$ implies that $f(c_1', c_2') < f(c_1, c_2)$ everywhere, and

(c) firm $II$'s reservation utility that is also a function of $c_1$ and $c_2$, as reflected in equation (9). That is:

$$E(c_1, c_2) = (\pi_1 - \kappa\sqrt{\pi_1\pi_2})[\frac{1}{3} + \frac{c_1}{3\pi_1} - \frac{2d_1}{3(\pi_1 - \kappa\sqrt{\pi_1\pi_2})}]^2 + (\pi_2 + \kappa\sqrt{\pi_1\pi_2})[\frac{1}{3} + \frac{c_2}{3\pi_2} - \frac{2d_2}{3(\pi_2 + \kappa\sqrt{\pi_1\pi_2})}]^2$$

In both (b) and (c), the impact of the investments is indirect and is channeled through (a). This is because investments affect $c_1$ and $c_2$ which, in turn, impact both costs under contract and the agent's reservation utility. Thus, the technology allows for a direct mapping from a fixed long-term investment onto the variables $c_1$ and $c_2$, and investments are made accordingly. For instance, the kind of mass production that companies engage in today has been made possible by considerable research and development undertaken by them. Investment decisions taken prior to the production stage have also been examined by Laffont and Tirole (2002) although in their analysis these investments (contractible and noncontractible) are undertaken by the agent.

Once the investments are in place, firm $I$, in its capacity as the principal, offers firm $II$ - the agent, operating independently prior to contracting - a take-it-or-leave-it contract that specifies the state-contingent payments. Based on the offered state-contingent payments, the agent accepts or rejects the contract. If the agent accepts the offer, the principal delivers the contractible inputs $\mathbf{x}^P$. Once the inputs are delivered by the principal, the agent commits the input vector $\mathbf{x} = \mathbf{x}^A + \mathbf{x}^P$ to produce $(z_1, z_2)$. At time $t+1$, Nature makes a draw from one of the two states that, along with $\mathbf{x}$, determines a vector of state-contingent outputs, $z_s$, corresponding to the state $s$ that Nature chooses. The principal is the residual claimant or the legal owner of the product produced by the agent.

The model is solved as a three-stage game where firm $I$ first undertakes investments to choose and realize a cost structure defined by $c_1$ and $c_2$.[10] Firm $I$ then, in the capacity of a principal offers a contract to firm $II$ (the agent) and chooses the state-contingent payments $r_1$ and $r_2$, given $c_1$ and $c_2$, corresponding to outputs $z_1$ and $z_2$ that are to be produced by the agent. Finally, given $r_1$ and $r_2$ (and $c_1$ and $c_2$), the firm chooses inputs $\mathbf{x}^A$ and $\mathbf{x}^P$, and the state contingent output vector $(z_1, z_2)$. In all stages, the optimal choices are made so as to maximize net returns of the party concerned.

[10] The analysis in terms of a three stage game is similar to the Grossman and Hart (1983) formulation of the moral hazard problem as a two stage game.

I solve backwards to characterize equilibrium behavior. Thus, in the first stage, the principal chooses optimal $r_1$ and $r_2$, subject to the participation and incentive constraints, to minimize the present discounted value of the expected payment associated with implementing a given $z_1, z_2$, and $\mathbf{x}^P$. The second stage involves the optimal choices of $z_1, z_2$, and $\mathbf{x}^P$ that are to be implemented through the contract, given the solution from the first stage. The third and final stage uses the solutions from the first and the second stages to examine the principal's optimal choice of $c_1$ and $c_2$ (reflecting his fixed investments) which, in turn establishes the optimal level of the agent's reservation utility.

### 4.3 Analysis of the Agency Problem

The second-best agency problem can be stated in terms of the following maximization problem for the principal:

$$\left\{ \begin{array}{cc} \underset{\mathbf{r},\mathbf{z},\mathbf{x}^P,c_1,c_2}{max} \quad \eta[\pi_1(p(z_1)z_1 - r_1) + \pi_2(p(z_2)z_2 - r_2)] - g^P(\mathbf{x}^P) + Bf(c_1, c_2) & \\ subject\ to: & \\ \eta(\pi_1 r_1 + \pi_2 r_2) - k\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_2, \mathbf{h}) \geq E(c_1, c_2) & (IR) \\ (z_1, z_2, \mathbf{x}^P) \in \arg\max\{\eta(\pi_1 r_1 + \pi_2 r_2) - k\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_2, \mathbf{h})\} & (IC), \end{array} \right\} \quad [A]$$

where $E(c_1, c_2)$ is the expected reservation utility obtained from (9), and $p(z_1) = 1 - z_1$, and $p(z_2) = 1 - z_2$ with firm $I$ acting as the monopolist and total output being determined by what is produced under contract. The function $f(c_1, c_2)$ represents the benefits from firm $I$'s investments that are carried over into contract production through the parameters $c_1$ and $c_2$, in the form of economies of scale. Once these benefits of investments are accounted for, the principal's costs represented by $g^P(\mathbf{x}^P)$ get scaled down by $Bf(c_1, c_2)$, with $B > 0$. That is, the parameter $B$ represents a benefit scale factor that scales up benefits of contracting indicated by $f(c_1, c_2)$ by a strictly positive amount.

The $IR$ constraint, as before, states that the agent must receive at least his expected reservation utility in order for him to accept the contract. The constraints as outlined by $(IC)$ are the incentive constraints, and ensure that the agent finds it privately rational to choose the state-contingent output vector that the principal would like to implement. In what follows, an alternative but equivalent specification to the agency problem is employed as nonlinear programming methods can then be used to facilitate the desired comparative statics associated with the main issue being addressed (see Chambers and Quiggin, 2000). This alternative representation of the agency problem requires the principal to pay to the agent an amount $r_1$ if $z_1$ is realized, $r_2$ if $z_2$ is realized, and if any output other than $z_1$ or $z_2$, or any input vector other than $\mathbf{x}^P$ is reported by the agent, an arbitrarily large fine is imposed on him.

In the alternative specification, the principal's maximization problem is formally stated as:

$$\max_{\mathbf{r},\mathbf{z},\mathbf{x}^P,c_1,c_2} \quad \eta[\pi_1(p(z_1)z_1 - r_1) + \pi_2(p(z_2)z_2 - r_2)] - g^P(\mathbf{x}^P) + Bf(c_1, c_2)$$

subject to:

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq E(c_1, c_2) \qquad (IR)$$

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq \eta r_1 - C(\mathbf{x}^P, z_1, z_{1,}\mathbf{h}) \qquad (IC_1)$$

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq \eta r_2 - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h}) \qquad (IC_2)$$

$$\eta(\pi_1 r_1+\pi_2 r_2)-\kappa\eta\sqrt{\pi_1\pi_2}(r_1-r_2)-C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq \eta(\pi_1 r_2+\pi_2 r_1)-\kappa\eta\sqrt{\pi_1\pi_2}(r_2-r_1)-C(\mathbf{x}^P, z_2, z_{1,}\mathbf{h}) \qquad (IC_3)$$

where $(IR)$ represents the agent's individual rationality constraint or his participation constraint. The incentive compatibility constraints that make it incentive compatible to choose the state-contingent output vector as desired by the principal are given by $(IC_1) - (IC_3)$.

To see that this specification leads to the same solution as the one given in [A], suppose the solution to the second best problem in [A] is given by $(z_1^*, z_2^*, \mathbf{x}^{P*})$.Now, if the solution $(z_1^*, z_2^*, \mathbf{x}^{P*})$ is anything other than the vector $(z_1, z_2, \mathbf{x}^P)$ that the principal would like to implement as is true for the alternative specification, the agent would have to bear the arbitrarily large penalty. Assuming that the penalty approaches $\infty$, and that the agent's utility associated with this infinitely large penalty approaches $-\infty$, it will never be rational for the agent to choose anything but $(z_1, z_2, \mathbf{x}^P)$ that coincides with $(z_1^*, z_2^*, \mathbf{x}^{P*})$.

### 4.3.1 The First-Stage Problem and Agency Cost functions

In the first stage, the principal chooses $r_1$ and $r_2$ to minimize the discounted expected payment made in time period $t+1$:

$$\{\eta(\pi_1 r_1 + \pi_2 r_2)\}$$

subject to

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq E(c_1, c_2) \qquad (IR)$$

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq \eta r_1 - C(\mathbf{x}^P, z_1, z_{1,}\mathbf{h}) \qquad (IC_1)$$

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_2, \mathbf{h}) \geq \eta r_2 - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h}) \qquad (IC_2)$$

$$\eta(\pi_1 r_1 + \pi_2 r_2) - \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq \eta(\pi_1 r_2 + \pi_2 r_1) - \kappa\eta\sqrt{\pi_1\pi_2}(r_2 - r_1) - C(\mathbf{x}^P, z_2, z_{1,}\mathbf{h}) \quad (IC_3)$$

The $(IR)$ constraint for the agent holds with an equality so that the contract, at the optimum, pays the agent exactly the value of his reservation utility. To see this, consider the $IC$ constraints expressed as:

$$\eta(\pi_2 + \kappa\sqrt{\pi_1\pi_2})(r_2 - r_1) \geq C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_1, z_{1,}\mathbf{h}) \qquad (IC_1')$$

$$\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})(r_1 - r_2) \geq C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h}) \qquad (IC_2')$$

$$\eta(\pi_1 - \pi_2 - 2\kappa\sqrt{\pi_1\pi_2})(r_1 - r_2) \geq C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_2, z_{1,}\mathbf{h}) \quad (IC_3')$$

The constraints $(IC_1') - (IC_3')$ are illustrative of the fact that they are invariant to the principal reducing payments by an equal amount in both states. Thus, if the $(IR)$ constraint does not bind, the principal can reduce payments in both states until it does bind, and increase his own expected return without affecting any of the $(IC)$ constraints.

The solution to the first stage problem defines the second-best agency cost function $Y(z_1, z_2; \pi_2, c_1, c_2)$ that gives the principal's minimum cost of implementing a given state-contingent output vector

$(z_1, z_2)$ by the agent subject to the condition that the $(IR)$ and the $(IC)$ constraints be satisfied. Since the agent's participation constraint binds exactly, the information from this constraint can be used to define a lower bound to the principal's objective function. To see this, consider the binding $(IR)$ constraint expressed as:

$$\eta(\pi_1 r_1 + \pi_2 r_2) = E_2(c_1, c_2) + C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) + \kappa\eta\sqrt{\pi_1\pi_2}(r_1 - r_2)$$

This, in turn, implies,

$$\eta(\pi_1 r_1 + \pi_2 r_2) \geq E_2(c_1, c_2) + C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h})$$

The above inequality then establishes $E(c_1, c_2) + C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h})$ as the lower bound to the principal's objective function.

In what follows, I show that among the $(IC)$ constraints, $(IC_1)$ and $(IC_3)$ are satisfied by an $(IC_2)$ that holds with an equality. To see this, suppose $(IC_2)$ binds exactly. This then implies:

$$r_1 - r_2 = \frac{C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h})}{\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})} \tag{10}$$

To see if $(IC_1)$ is satisfied, consider the following inequality implied by $(IC_1)$:

$$r_1 - r_2 \leq \frac{C(\mathbf{x}^P, z_1, z_{1,}\mathbf{h}) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h})}{\eta(\pi_2 + \kappa\sqrt{\pi_1\pi_2})}$$

Substituting for $r_1 - r_2$ from (10) gives:

$$\frac{C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h})}{\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})} \leq \frac{C(\mathbf{x}^P, z_1, z_{1,}\mathbf{h}) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h})}{\eta(\pi_2 + \kappa\sqrt{\pi_1\pi_2})}$$

that is,

$$\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P, z_1, z_{1,}\mathbf{h}) + \eta(\pi_2 + \kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) \geq 0 \tag{11}$$

Thus, $(IC_1)$ will be satisfied by a binding $(IC_2)$ if the inequality in (11) is satisfied. This relationship indeed holds - Multiplying $(IC_1)$ by $\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})$ and $(IC_2)$ by $\eta(\pi_2 + \kappa\sqrt{\pi_1\pi_2})$, and adding the terms, shows that (11) is implied by $(IC_1)$ and $(IC_2)$.

Now, multiplying $(IC_1)$ by $\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})$ and $(IC_2)$ by $\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})$, and adding the terms, gives:

$$\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})r_1+\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})r_2-C(\mathbf{x}^P,z_1,z_{2,}\mathbf{h})\geq\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})r_1+$$

$$\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})r_2-\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_1,z_{1,}\mathbf{h})-\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_2,z_{2,}\mathbf{h})$$

Clearly, the left hand side of the above inequality is the same as those for any one of the $(IC)$ constraints as it is generated as a linear combination of $(IC_1)$ and $(IC_2)$. Thus, if both $(IC_1)$ and $(IC_2)$ hold, $(IC_3)$ should also be satisfied provided that:

$$\begin{aligned}&\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})r_1+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})r_2-\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_1,z_{1,}\mathbf{h})\\&-\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_2,z_{2,}\mathbf{h})\\\geq\;&\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})r_1+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})r_2-C(\mathbf{x}^P,z_2,z_{1,}\mathbf{h})\end{aligned}$$

That is, $(IC_3)$ is satisfied if:

$$\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_1,z_{1,}\mathbf{h})+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_2,z_{2,}\mathbf{h})\leq C(\mathbf{x}^P,z_2,z_{1,}\mathbf{h}) \quad (12)$$

Since $(\pi_2+\kappa\sqrt{\pi_1\pi_2})=1-(\pi_1-\kappa\sqrt{\pi_1\pi_2})$, the left hand side of (12) is nothing but a convex combination of $C(\mathbf{x}^P,z_1,z_{1,}\mathbf{h})$ and $C(\mathbf{x}^P,z_2,z_{2,}\mathbf{h})$. Also, convexity of the effort-cost function in $\mathbf{z}$ implies:

$$\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_1,z_{1,}\mathbf{h})+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})C(\mathbf{x}^P,z_2,z_{2,}\mathbf{h})\leq$$

$$C(\mathbf{x}^P,\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})z_1+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})z_2,\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})z_1+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})z_2,\mathbf{h}) \quad (13)$$

Further, it follows from Assumption 2 where $C$ is positively linearly homogeneous in state-contingent outputs that:

$$C(\mathbf{x}^P,\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})z_1+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})z_2,\eta(\pi_2+\kappa\sqrt{\pi_1\pi_2})z_1+\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})z_2,\mathbf{h})\leq C(\mathbf{x}^P,z_2,z_{1,}\mathbf{h}) \quad (14)$$

In words, it is less costly to produce the same output $\eta(\pi_2 + \kappa\sqrt{\pi_1\pi_2})z_1 + \eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})z_2$ in each state than to report $z_2$ in state 1 and $z_1$ in state 2. Then, (13) and (14) together imply that (12) will also be satisfied.

Given that $(IR)$ and $(IC_2)$ bind exactly, the second-best agency cost function can now be obtained by solving $(IR)$ and $(IC_2)$ simultaneously for $r_1$ and $r_2$. In particular, the expressions for $r_1$ and $r_2$ are:

$$r_1 = E(c_1, c_2) + C(\mathbf{x}^c, z_2, z_{2,}\mathbf{h}) + \frac{C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h})}{\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})}$$

and,

$$r_2 = E(c_1, c_2) + C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h})$$

Thus, the expression for the second-best agency cost function is given by:

$$Y(z_1, z_2; \pi_2, c_1, c_2) = \eta\{E(c_1, c_2) + C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h}) + \frac{\pi_1}{\eta(\pi_1 - \kappa\sqrt{\pi_1\pi_2})}[C(\mathbf{x}^P, z_1, z_{2,}\mathbf{h}) - C(\mathbf{x}^P, z_2, z_{2,}\mathbf{h})]\} \tag{15}$$

**Proposition 2**

*The second-best agency cost function $Y(z_1, z_2; \pi_2, c_1, c_2)$ is strictly increasing and linear in the expected reservation utility $E(c_1, c_2)$, with $Y_E = \eta$, so that the minimum cost of implementing a given state-contingent output vector increases with an increase in $E(c_1, c_2)$, by the discount factor $\eta$.*

### 4.3.2 The Second-Stage Problem

The second stage of the principal's optimization problem is formulated as:

$$U(c_1, c_2, \pi_2) = \underset{\mathbf{z},\mathbf{x}^P}{Max}\{\eta[\pi_1 p(z_1)z_1 + \pi_2 p(z_2)z_2] - g^P(\mathbf{x}^P) - Y(z_1, z_2; \pi_2, c_1, c_2)\}$$

Substituting the expression for the second-best agency cost function from equation (15) into the objective function above gives:

$$\underset{\mathbf{z},\mathbf{x}^P}{Max}\{\eta[\pi_1(p(z_1)z_1+\pi_2(p(z_2)z_2]-g^P(\mathbf{x}^P)-\eta\{E(c_1,c_2)+C(\mathbf{x}^c,z_2,z_{2,}\mathbf{h})+$$
$$+\frac{\pi_1}{\eta(\pi_1-\kappa\sqrt{\pi_1\pi_2})}[C(\mathbf{x}^c,z_1,z_{2,}\mathbf{h})-C(\mathbf{x}^c,z_2,z_{2,}\mathbf{h})]\}\ \}$$

The following proposition then follows from the envelope theorem:

**Proposition 3**

*For a given $E(c_1, c_2)$, the optimal value of the second-stage agency problem $U(c_1, c_2, \pi_2)$ is strictly decreasing and linear in the expected reservation utility of the agent.*

#### 4.3.3 The Final-Stage Problem and the Equilibrium Determination of State-Contingent Marginal Costs

In the final stage of the contracting problem, the principal chooses the optimal levels of state-contingent marginal costs as an independent firm which, in turn, impact the expected reservation utility. The principal's optimization problem is stated as:

$$\underset{c_1,c_2}{Max}\{U(c_1,c_2,\pi_2)+Bf(c_1,c_2)\}$$

where $U(c_1, c_2, \pi_2)$ is the optimal value of the second-stage objective function. Suppose, the optimal values in this stage of the optimization problem are given by $\mathbf{c}(A)$ defined as:

$$\mathbf{c}(A)\in\arg\max\{U(c_1,c_2,\pi_2)+Bf(c_1,c_2)\}$$

Employing standard comparative static techniques yields:

$$[A^\circ-A][f(c_1(B^\circ),c_2(B^\circ))-f(c_1(B),c_2(B))]\geq 0$$

That is, if $B^\circ \geq B$, then $f(c_1(B^\circ), c_2(B^\circ)) \geq f(c_1(B), c_2(B))$. In other words, as the benefit scale factor $B$ increases, the principal will have a stronger incentive to undertake higher initial investments so as to realize a lower $c$ in each state. This follows from the assumption that the function $f$ is monotonically decreasing in $\mathbf{c}$.

**Proposition 4**

*An increase in the benefit scale factor leads to a fall in the marginal cost in each state for the independently operating principal which, in turn, leads to a fall in the expected reservation utility for the agent.*

The proposition above and proposition 2 can be used to infer the following, formally stated as a corollary:

**Corollary 4.1**

*A reduction in the expected reservation utility $E(c_1, c_2)$ unambiguously works to the advantage of the principal, all other things remaining the same. It is, therefore, in his interest, to adopt measures that enable him to realize a fall in $E(c_1, c_2)$.*

A natural fall-out of the principal's effort (in terms of his fixed investments) to reduce his variable costs as an independent operator is a decline in the agent's expected reservation utility. And, once an independent firm opts for contracting, the principal's optimal decisions of $c_1$ and $c_2$ then accrues to the principal as indirect benefits through (a) a fall in the principal's expected payment, and (b) a rise in the principal's optimal net expected returns. This result holds as long as the parameter $A$ has no direct impact on the principal's expected payment and his net optimal expected returns. Formally, it follows from propositions 2,3, and 4 that:

**Corollary 4.2**

*(a) The expected payment to the agent is nonincreasing in the benefit scale factor $B$. Moreover, (b) the principal's optimal net expected returns $U(c_1, c_2, v, \pi)$ from the second-stage problem are nondecreasing in $B$.*

## 4.4 The Agency Problem and the Possibility of a Hold-up

A possibility of a hold-up or an asset specificity problem for firm I may arise once its fixed investments are in place. Hold-ups or asset specificities arise in situations where an installed asset may become so specialized to suit the requirements of a particular party that it may have little or no value in an alternative use. An illustration, in this context, is a situation where firm I undertakes investments but the agent under contract may decide to hold up the principal by refusing to deliver unless certain demands, say, an increase in payment, are met. If the principal is not able to find other suitable agents that have made the necessary arrangements to undertake production as per his requirements, he then faces a hold-up problem.[11]

A hold-up situation may be factored into the problem by considering the hold-up case as the outcome of a particular state of nature. That is, there are four possibilities that arise in the framework of the given model. These are given by the cartesian product of the sets {state 1, state 2} as described by the model above, and {hold-up, no hold-up) - that is, (state 1, hold-up), (state 1, no hold-up), (state 2, hold-up), (state 2, no hold-up). The possibility of a hold-up is, therefore, a part of the uncertain portfolio that is associated with any production problem and this needs to be reflected in the optimization problem. Moreover, since a hold-up is related to fixed assets in which firm I invests, this aspect is tackled in terms of the benefit scale factor $B$. In particular, I define a hold-up situation as one that is associated with $B$ (and therefore $Bf(c_1, c_2)$) approaching $-\infty$. This then leads to a modification of the principal's optimization problem where his expected payoff becomes $-\infty$ in the event of a hold-up. In this scenario, the principal can be assumed to take recourse to legal measures, or one can even allow for renegotiation, or else the principal can look for alternative outlets for undertaking contract production. In any case, the outcome is $-\infty$. And, if no hold-up occurs, the principal's expected return is determined by the solution to the program as outlined originally:

$$\left\{ \begin{array}{c} \underset{\mathbf{r},\mathbf{z},\mathbf{x}^P,c_1,c_2}{max} \{\eta[\pi_1(p(z_1)z_1 - r_1) + \pi_2(p(z_2)z_2 - r_2)] - g^P(\mathbf{x}^P) + Bf(c_1, c_2)\} \\ subject\ to: \\ IR, IC_1 - IC_3 \end{array} \right\} \qquad [B]$$

**Proposition 5**

*The solution to the second-best agency problem is represented by: (a) the optimal value to the program [B], if no hold-up occurs, and (b) $-\infty$, if a hold-up occurs.*

# 5 Conclusion

This paper examines the role of outside-of-contract dyadic interactions in the equilibrium determination of reservation utility. Prior to or outside contracting, the agent and the principal compete as independent producers, and investment decisions taken by the principal (as the larger, more

[11] Firm II, in the capacity of the agent, also faces a potential hold-up problem if for instance the principal refuses to accept the output. Theoretically, this situation may be reflected in the agent's optimization problem in the same manner as what is described for the principal below in Proposition 5.

competitive firm) to reduce its own costs adversely impact the smaller player's expected returns. This works to the advantage of the principal as it is the reduced returns of the smaller player that form the benchmark against which any contract will be designed in the event of the smaller player deciding to produce under contract for the larger player. Benefits of initial investments undertaken by the larger producer also get carried over into contracting in the form of economies of scale. The higher these benefits, the stronger is the incentive for the principal to decide in favor of higher initial investment levels in order to realize a more competitive position vis-a-vis the smaller producer.

This paper also highlights one of the channels through which firms can exert their influence in the market by virtue of their size. Low prices are made possible due to the cost-reducing investments that these firms undertake. While the consumers clearly stand to benefit from the lower prices, the question is whether this price benefit (and associated quality) can be sustained in the long run. This is particularly true if smaller competitors close shop leading to a monopolization of a market by the larger player. In order to encourage innovation also, a healthy degree of competition is desirable.

It is not easy to ascertain which side is right in antitrust matters (Atkinson and Audretsch, 2011). What this paper does is to flag certain areas of concern relating to competitiveness associated with large firm size vis-à-vis relatively small firms. The equilibrium outcome predicted by the contracting model is second-best efficient with all players in the model rationally responding to incentives to maximize their self-interest. However, the underpinnings of power cannot be ignored. Low wages, unsatisfactory work conditions, and inadequate health care are often complaints that one hears from workers in large stores. And, people in such positions (highlighted by the model in the paper as well) usually don't have the bargaining power to negotiate better work conditions. However, the model shows that labor market outcomes can be used as a mechanism to gauge the extent of competition in the market. This then provides a justification for the design of antitrust law while keeping in mind considerations of organizational and distributional justice.

## References


[1] **Atkinson Robert D. and David B. Audretsch** (2011): "Economic Doctrines and Approaches to Antitrust," The Information Technology and Innovation Foundation.

[2] **Basu, Kaushik.** 1986. "One Kind of Power," *Oxford Economic Papers* 38(2): 259-82.

[3] **Basker, Emek**. 2007. "The Causes and Consequences of Wal-Mart's Growth," *Journal of Economic Perspectives* 21(3): 177-98.

[4] **Chambers, Robert G. and John Quiggin.** 2000. *Uncertainty, Production, Choice, and Agency.* Cambridge University Press.

[5] **Friedman, Thomas L.** 2005. *The World is Flat: A Brief History of the Twenty-first Century.* New York: Farrar, Straus and Giroux.

[6] **Goetz, Stephan and Hema Swaminathan.** 2006. "Wal-Mart and County-Wide Poverty," *Social Science Quarterly* 87(2): 211-26.

[7] **Grossman, Sanford J. and Oliver D. Hart** (1983): "An Analysis of the Principal-Agent Problem," Econometrica, 51(1), 7-45.

[8] **Hart, Oliver and Bengt Holmstrom.** 1987 "The Theory of Contracts," *Advances in Economic Theory Fifth World Congress*, edited by T.F. Bewley, Cambridge University Press.

[9] **Laffont, Jean-Jacques and Jean Tirole.** 2002. "Cost-Reimbursement Rules," *A Theory of Incentives in Procurement and Regulation,* London, England: The MIT Press.

[10] **Macdonald, James M.** 2006 "Agricultural Contracting, Competition, and Antitrust," *American Journal of Agricultural Economics* 88(5): 1244-50.

[11] **Martinez, Stephen W. and Kelly Zering.** 2004. "Pork Quality and the Role of Market Organization," Economic Research Service (USDA), Agricultural Economic Report Number 835.

[12] **Naqvi, Nadeem and Frederick Wemhöner.** 1995. "Power, Coercion, and the Games Landlords Play," *Journal of Development Economics* 47(2): 191-205.

[13] **Safra, Zvi and Uzi Segal.** 1998. "Constant Risk Aversion," *Journal of Economic Theory* 83: 19-42.

[14] **Tsoulouhas, Theofanis and Tomislav Vukina.** 1999. "Integrator Contracts with Many Agents and Bankruptcy," *American Journal of Agricultural Economics* 81(1): 61-74.