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On the Role of Authority in Just-In-Time Purchasing Agreements

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Abstract

This paper analyzes buyer-supplier relationships where the supplier can hand over partial control over his firm to the manufacturer. We show that standard just-in-time purchasing agreements can yield optimal levels of investment in flexible production. If investments in flexibility are socially valuable then it is optimal for the supplier to give up control over the delivery schedule. In this case, schedules of higher volatility chosen by the manufacturer induce more efficient investment incentives on the part of the supplier. Consequently, the supplier deliberately gives up partial control over his firm in order to reach an outcome which is preferred by both supplier and manufacturer.

JEL-Classification: L 22

I. Introduction

This paper combines two strands of literature: The economic literature on ownership and authority and the management literature on just-in-time (JIT) manufacturing. The first line of research is concerned with the concept of authority as defined by Simon (1951) and that of ownership formalized by Grossman and Hart (1986). The second line of literature, represented for example by Schonberger (1982) and Hall (1983), focuses on the by now well-known management techniques of just-in-time manufacturing and purchasing, which aim at improving both cost structure and product quality in the complete production process. In this paper, we investigate the optimality of simple contracts observed in real-life buyer-supplier relationships and describe circumstances that favor just-in-time purchasing agreements.

Just-in-time purchasing in vertical buyer-seller relationships is considered as an effective method to reduce inventory levels on the part of the buyer. This is desirable since inventories cause costs from both running the inventory and paying interest on the capital bound in form of stocks. But at the same time, just-in-time purchasing is commonly seen to be done against the suppliers' interests. According to a recent survey of U.S. and Japanese automotive suppliers by Helper and Sako (1995), more than half of all mailed suppliers in the United States and about one-third of all mailed Japanese suppliers agreed with the statement that "JIT only transfers inventory responsibility from customers to suppliers." A manufacturer adhering to the just-in-time philosophy will ask the supplier for a more flexible form of delivery. Ideally for him, inputs in form of materials, parts and other intermediate products are delivered just when they are needed in his production process. For the supplier, this implies a high frequency of delivery in conjunction with small, variable batches. Since optimal batch sizes in a supplier's production adapted to conventional purchasing and delivery conditions, are usually significantly larger than those needed by the manufacturer, the supplier will either have to produce sub-optimal lot sizes or stockpile inventory. (See Helper and Sako (1995) for more empirical evidence.)

Just-in-time purchasing is implemented usually by so-called call-forward delivery systems. In such a system, the buyer is given the right to order different quantities at different times, and to do so very frequently. The stream of goods between seller and buyer, or as will say, the delivery schedule is therefore planned and controlled to a large extent by the buyer. Put differently, a call-forward contract allocates the authority over the delivery schedule to the manufacturer. In a classical purchasing agreement, however, the manufacturer is given far less freedom in choosing his orders. Usually, he faces restrictions like minimal and maximal order quantities or minimal delivery times. Moreover, he is obliged to keep his internal production running. Thus, although the buyer still orders the goods from the seller, he controls the delivery of the goods only to a small degree. Hence, in classical agreements, authority over the delivery schedule is primarily given to the seller. Accordingly, in the model, the parties are endowed with the possibility to allocate the authority over the delivery schedule to either the supplier or the buyer. We show that the agreed-upon allocation influences the incentives to invest in flexible production and that transferring the authority over the delivery schedule to the buyer is optimal if this investment is socially important.

The model is designed to encompass the case of integrated production. By this, we mean the delivery of goods from either a shop or work center of one department to another department. Under integrated production, the residual control right over the assets of the first department is transferred to the manager of the second department. In contrast, non-integrated production means that the supplier of a good is an autonomous firm, and the residual rights of control over the supplier's assets lie in the hands of the supplier's manager. Again, the allocation of control has an impact on the investment incentives of the departments' managers and either integration or non-integration is optimal. However, we will show that under certain assumptions, it will be optimal to give partial control over a non-integrated supplier to the manufacturer.

A second objective pursued through the installation of just-in-time systems is the improvement of product quality. Crémer (1995) shows that product quality is in fact improved in just-in-time delivery systems since, given the impossibility of repairs, the supplier has higher incentives to produce goods of a high quality. For reasons of simplicity, we abstract from quality aspects in the model.

The rest of the paper is organized as follows. In section II, we introduce the basic model and derive the conditions for the socially efficient investment decisions. Section III analyzes the optimality of simple contractual agreements under different assumptions. Section IV concludes. The appendix contains technical details of the proofs.

II. The Basic Model

We consider a trade relationship between a supplier and a manufacturer, both of which are administered by a respective manager. We shall concentrate on the decisions to be taken by the supplier’s manager and abstract from those taken by the manufacturer’s manager. To run his factory, the supplier’s manager has to make two decisions. The first decision is a specification of the delivery schedule, which we envisage as very complex. The costs incurred to supplier and manufacturer by different schedules, however, are assumed to depend solely on the schedule’s "volatility", which is denoted by $f \in [0,1]$. High values of f indicate a high volatility in the sense that the delivery frequency and the variability of the (small) batch sizes are high. However, a low value of f denotes a non-frequent delivery of large batches of almost identical size.

The second decision of the supplier covers all other choices except for the choice of the delivery schedule. We assume again that all payoff-relevant aspects of the second decision can be represented by a variable $q \in [0,1]$, which we shall refer to as the policy variable. To understand the precise nature of q, suppose that the supplier's policy can be adapted to the respective manager's objectives. Suppose furthermore that the higher the value of q the better the supplier's policy is adapted to the manufacturer's aims. $q = 1$ then means that the supplier's policy is most adapted to the manufacturer's purposes, while $q = 0$ denotes a completely supplier-oriented policy. Consequently, we assume conflicting interests with respect to the supplier's policy. Summing up, from a cost-benefit perspective, the decisions to be taken by the supplier's manager may be summarized by the pair (f, q).

We shall assume that the managers obtain non-alienable benefits as follows. For the manufacturer, there is a total value $V(q)$ of the traded units that increases in q, i.e. the better the supplier's policy is adapted to the manufacturer's purposes the higher is the manufacturer's value of the product to be delivered. In addition, the manufacturer has to carry convex inventory costs $L(f)$ decreasing in f. If the price for the total trade is denoted by p, the manufacturer's manager obtains $V(q) - L(f) - p$. The cost of the supplier's manager consists of a policy dependent cost component $C_q(q)$ increasing in q and a volatility-dependent cost component $C_f(f)$ increasing in f. Thus, his benefit is given by $p - C_q(q) - C_f(f)$. Efficient decisions q^* and f^* maximize total benefit

$$V(q) - L(f) - C_q(q) - C_f(f). \qquad (1)$$

We suppose that the supplier's manager can reduce his cost components by early specific investments i_q and investment in the flexibility of production i_f. More precisely, an investment i_q leads to sunk costs $K_q(i_q)$ and reduces absolute cost C_q for a given policy q. We assume $\partial^2 C_q / \partial q \partial i_q > 0$ and that C_q is convex in (q, i_q). Similarly, an investment i_f leads to sunk costs $K_f(i_f)$ and reduces absolute cost C_f for a given volatility f. In addition, we suppose that investment in the reduction of the volatility-dependent cost component reduces also marginal costs, i.e. $\partial^2 C_f / \partial f \, \partial i_f < 0$. Finally, we assume that C_f is convex in (f, i_f).

Figure 1 depicts the time structure.

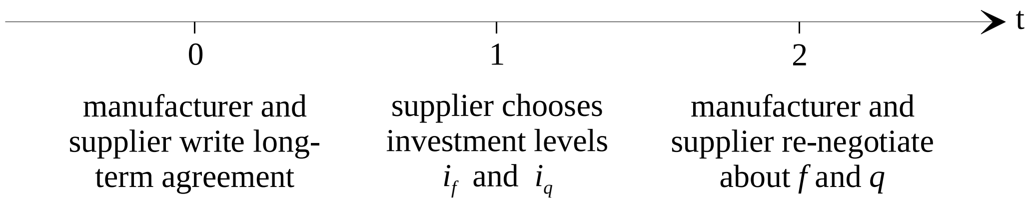

Figure 1. Time structure

Efficient investment levels i_f^*, i_q^*, and decisions q^*, f^*, maximize the total ex ante benefit

$$V(q) - L(f) - C_q(i_q, q) - C_f(i_f, f) - K_q(i_q) - K_f(i_f). \tag{2}$$

The corresponding first-order conditions are given by

$$-\frac{\partial C_f}{\partial i_f}\left(i_f, f^*(i_f)\right) = K_f'(i_f), \tag{3}$$

$$-\frac{\partial C_q}{\partial i_q}\left(i_q, q^*(i_q)\right) = K_q'(i_q). \tag{4}$$

III. Optimal Contracts

Long-term trading relations naturally involve high transaction costs, e.g. for writing and evaluating nearly complete contracts. Accordingly, long-term contracts like just-in-time purchasing agreements tend to be highly incomplete. (Cf. Schonberger (1982) for a description of Japanese and U.S. contracts.) Economic theory emphasizes that in the presence of transaction costs, the allocation of authority and property rights will serve as a substitute for overly detailed contracts. We will therefore determine optimal contracts between supplier and manufacturer under the restriction that contracts can only specify residual control rights.

We will assume that ex ante investments i_q and i_f are not contractible at all. Moreover, we suppose that the supplier's delivery schedule and policy are not contractible ex ante in the sense that the parties are just able to allocate the corresponding control rights. Therefore, a contract written by the parties before investments are undertaken contains the total payment p, and specifies the allocation of the residual control right over q and that of the authority over f. If the individually rational decision of at least one party results in an inefficient choice of the pair $\left(\hat{q},\hat{f}\right)$ then the parties will gain from re-negotiation and therefore write a new contract that specifies ex post efficient decisions $q^*\left(i_q\right)$ and $f^*\left(i_f\right)$. We will assume that

$$V(q)-L(f)\geq C_q\left(i_q,q\right)+C_f\left(i_f,f\right) \tag{5}$$

for all q, f, i_q and i_f, i.e. we suppose that trade is always socially efficient. Then the re-negotiation surplus from re-negotiation to (q,f) is non-negative and given by

$$\begin{aligned}RS\left(q,f,\hat{q},\hat{f}\right)=&V(q)-L(f)-C_q\left(i_q,q\right)-C_f\left(i_f,f\right)\\&-\left\{V(\hat{q})-L(\hat{f})-C_q\left(i_q,\hat{q}\right)-C_f\left(i_f,\hat{f}\right)\right\}.\end{aligned} \tag{6}$$

We assume that the surplus is shared among the parties such that the supplier obtains a fraction α . When choosing his individually rational levels of investment, the supplier anticipates re-negotiation. He therefore maximizes

$$p - C_q\left(i_q, \hat{q}\right) - C_f\left(i_f, \hat{f}\right) + \alpha \cdot RS\left(q^*\left(i_q\right), f^*\left(i_f\right), \hat{q}, \hat{f}\right), \tag{7}$$

where the pair $\left(\hat{q}, \hat{f}\right)$ may depend on the allocation of control rights specified in the initial contract. Using the Envelope Theorem, the corresponding first-order condition on i_f is given by

$$-(1-\alpha)\frac{\partial C_f}{\partial i_f}\left(i_f, \hat{f}\right) - \alpha \frac{\partial C_f}{\partial i_f}\left(i_f, f^*\left(i_f\right)\right) = K_f'\left(i_f\right). \tag{8}$$

The interpretation of this formula is as follows. The right-hand side mirrors the marginal cost of investment, the left-hand side the marginal reduction in cost. The two components of the left-hand side represent the two effects of an investment i_f . Firstly, a marginal investment lowers the cost C_f in the case when re-negotiation fails. This has two implications. On the one hand, the threat point in the bargaining process will shift down by $-\partial C_f / \partial i_f \left(i_f, \hat{f}\right) > 0$. On the other hand, the re-negotiation surplus $RS\left(q^*\left(i_q\right), f^*\left(i_f\right), \hat{q}, \hat{f}\right)$ increases by the same amount, but only a share α of it is given to the supplier. As a second effect investment influences the re-negotiation surplus by decreasing the actual cost $C_f\left(i_f, f^*\left(i_f\right)\right)$, and, as above, a share α is given to the supplier.

In the same way we can derive the first-order condition with respect to i_q as

$$-(1-\alpha)\frac{\partial C_q}{\partial i_q}\left(i_q, \hat{q}\right) - \alpha \frac{\partial C_q}{\partial i_q}\left(i_q, q^*\left(i_q\right)\right) = K_q'\left(i_q\right). \tag{9}$$

The interpretation of this formula is similar to that of equation (8). Thus, since a different allocation of control rights in general influences the choice of $\hat{q}$ and $\hat{f}$, it can be seen from formulas (8) and (9) that the incentives to invest for the supplier depend on these allocations. There are two control rights to be allocated by the contract which will be treated separately.

The control over the delivery schedule. If the supplier controls f then he will choose f as low as possible since a high volatility increases his production cost. Thus, in this case, $\hat{f} = 0$. As figure 2 shows, this change in the threat point distorts the incentives to invest such that $i_f < i_f^*$.

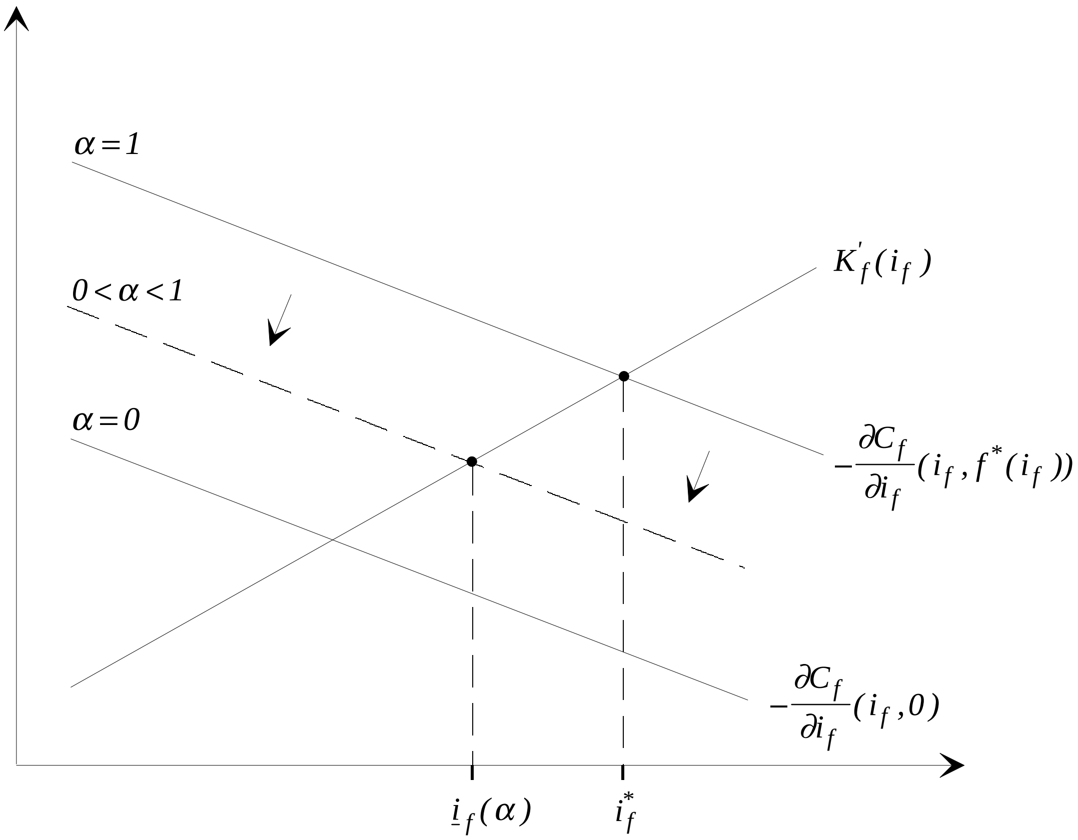

Figure 2. Under-investment in case of supplier control over the delivery schedule

We give a formal proof of this and the following assertions in the appendix. If the manufacturer controls the delivery schedule, then he will avoid inventory costs by choosing $\hat{f} = 1$. The supplier's incentives to make specific investments will again be distorted but in the opposite direction. See figure 3 for a graphical illustration of this effect. In sum, supplier control of f will generally lead to under-investment in flexibility while manufacturer control will result in over-investment.

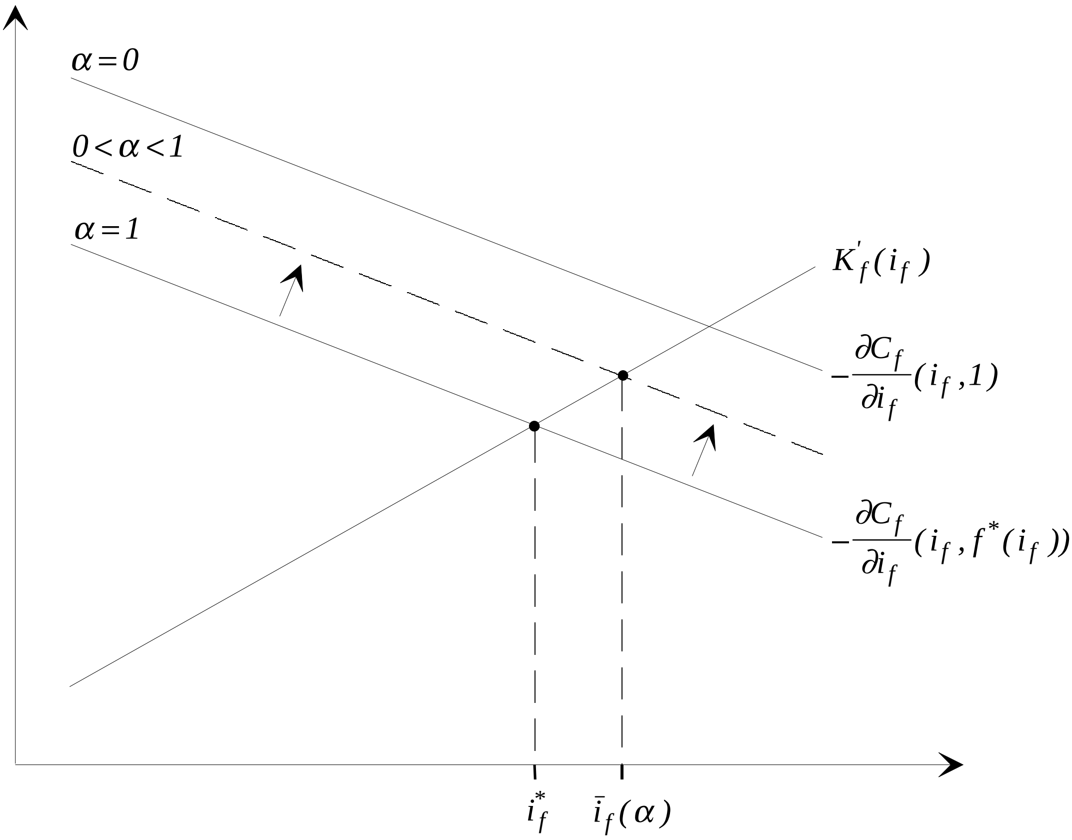

Figure 3. Over-investment in case of manufacturer control over the delivery schedule

Proposition 1. *If the manufacturer controls the delivery schedule then the supplier has a higher incentive to invest in flexible production. Thus, if a too high level of investment in flexibility is socially less harmful than a too low level, then the manufacturer's manager should control the delivery schedule.*

The control over the supplier's policy. As before the supplier's policy may be controlled by either the supplier's manager himself or by the manufacturer's manager. Similar to the analysis above, there will be distorting effects on the investment incentives of the supplier's manager.

Proposition 2. (Grossman-Hart) *If the manufacturer controls the supplier's policy then the supplier has a lower incentive to make specific investments than under non-integration . Thus, if a too low level of relationship-specific investments* i_q *in the policy* q *is socially more harmful than a too high level, then the supplier's manager should have control over the supplier's policy.*

The contracts to be written may be of four types (see table 1).

	Manufacturer controls f	Supplier controls f
Manufacturer controls q	Integrated Production	Buffered Integrated Production
Supplier controls q	Call-forward Delivery System (Just-in-Time Purchasing)	Classical Purchasing Contract

Table 1. Types of contracts between supplier and manufacturer.

Corollary 1. *If specific investments as well as investments in flexibility are important, then the parties will choose a just-in-time purchasing agreement.*

IV. Conclusion

The paper investigated the role of authority and control in the special case where suppliers can hand over partial control over their firm to the manufacturer. We have shown that standard just-in-time purchasing agreements can lead to optimal incentives to invest in flexible production. The reason underlying this effect is that if investments in flexibility are socially important then it may be optimal for the supplier to give up control over the delivery schedule since this leads to schedules of higher volatility chosen by the manufacturer. This in turn causes more efficient investment incentives on the part of the supplier. Thus, in this case, the supplier deliberately gives up partial control over his firm in order to reach an outcome that both supplier and manufacturer prefer.

For reasons of tractability, the model used to derive our results neglects the complicated time structure of order and delivery in manufacturing. A desirable dynamic extension of the model meets resistance. For example, one could want to include that the parties re-negotiate repeatedly over the per-period delivery schedule instead bargaining once and for all over the delivery schedule's volatility f. This would mean to model explicitly the periodical planning of the supplier's production, given incomplete information about future orders by the manufacturer. However, this by itself is already an intricate optimization problem (cf. Holt et al. (1960)).

Appendix

We give a proof for proposition 1. (The proof of proposition 2 is almost identical and is therefore dropped.) We show that giving the control rights about f to the supplier lowers the investment level $\underline{i}_f(\alpha)$ defined as the solution to

$$-(1-\alpha)\frac{\partial C_f}{\partial i_f}\left(i_f,\hat{f}\right)-\alpha\frac{\partial C_f}{\partial i_f}\left(i_f,f^*\left(i_f\right)\right)=K_f'\left(i_f\right). \tag{A1}$$

Note first that if $\alpha=1$, equation (A1) is identical to equation (3) that characterizes the socially efficient i_f^*. Thus, it suffices to show that $\underline{i}_f(\alpha)$ decreases in α. Total differentiation of (A1) with respect to i_f and α yields

$$\frac{d\underline{i}_f}{d\alpha}(\alpha)=\frac{-\frac{\partial C_f}{\partial i_f}\left(i_f,\hat{f}\right)+\frac{\partial C_f}{\partial i_f}\left(i_f,f^*\left(i_f\right)\right)}{\alpha\left\{\frac{\partial^2 C_f}{\partial i_f^2}\left(i_f,f^*\left(i_f\right)\right)+\frac{\partial^2 C_f}{\partial i_f\partial f}\left(i_f,f^*\left(i_f\right)\right)\frac{\partial f^*}{\partial i_f}\left(i_f\right)\right\}+(1-\alpha)\frac{\partial^2 C_f}{\partial i_f^2}\left(i_f,\hat{f}\right)+K_f''\left(i_f\right)}. \tag{A2}$$

Since $\partial^2 C_f/\partial i_f\partial f<0$, the numerator is positive for $\hat{f}=0$ and negative for $\hat{f}=1$. We show that the denominator is positive. For this, consider the first-order condition characterizing $f^*\left(i_f\right)$, i.e.

$$-\frac{\partial L}{\partial f}\left(f^*\left(i_f\right)\right)=\frac{\partial C_f}{\partial f}\left(i_f,f^*\left(i_f\right)\right). \tag{A3}$$

Total differentiation of (A3) with respect to i_f and f^* yields

$$\frac{df^*}{di_f}\left(i_f\right)=-\frac{\frac{\partial^2 C_f}{\partial f\partial i_f}}{\frac{\partial^2 L}{\partial f^2}+\frac{\partial^2 C_f}{\partial f^2}}. \tag{A4}$$

Thus, since C_f is convex the expression in parentheses in the denominator of (A2) is positive. Hence, the denominator of (A2) is positive, proving the assertion. Q.E.D.

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