INFORMATION AGGREGATION, STRATEGY, AND INVESTMENT DECISION IN BUYER-SUPPLIER RELATIONSHIPS

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ABSTRACT: This paper examines whether aggregated cost information provided by suppliers to buyers can mitigate the hold-up problem that occurs with idiosyncratic investments. Hold-up implies that, given the opportunity, buyers pursue a self-interested strategy and do not reimburse suppliers for their idiosyncratic investment. In essence, buyers seek to maximize their own trade surplus at the expense of suppliers. However, evidence suggests some firms pursue a fair strategy. With such firms, research suggests that hold-up can be avoided. I propose and provide empirical evidence that the level of aggregation of the supplier-provided cost information (i.e., fine or coarse) will interact with buyer strategy (i.e., self-interested or fair) to affect investment in idiosyncratic assets and trade opportunism. Results show that coarse information leads to an increase in (no change in) self-interested (fair) buyers' offers and in an increase in suppliers' investments. Thus, suppliers are better off when they disclose coarse rather than fine cost information. Findings also suggest that buyers will benefit from requesting coarse instead of fine cost information from suppliers.

KEYWORDS: Hold-up, aggregation, firm strategy, opportunism, idiosyncratic investment, supply-chain

I. INTRODUCTION

Firms enter into collaborative arrangements that span their boundaries to improve the efficiency of their value chain. Often, a collaborative arrangement presents an opportunity for one firm to make an investment that only has value with a specific trading partner, i.e., an idiosyncratic investment. This investment creates a surplus that needs to be divided between the trading partners. Fair division of this surplus is an important concern of collaborating firms (Kumar 1996; Dekker 2003). However, the information sharing necessary to collaborate (Helper 1991; Cooper and Slagmulder 2004) leaves firms vulnerable to the potential of self-interested behavior by their counterpart (Anderson and Dekker 2005; Das 2006). More specifically, following an idiosyncratic investment by the supplier, a more powerful buyer might choose to appropriate the surplus generated by the investment, thus leaving the supplier worse off than before his investment. Anticipating the self-interested behavior of the buyer during trade, the seller chooses not to make the socially optimal investment (i.e., hold-up problem) (Williamson 1985).

I examine, first, whether, in the context of supplier idiosyncratic investment, supplying aggregated[1] instead of disaggregated cost information to the buyer can help curtail the self-interested behavior of the buyer during trade. If the supplier provides disaggregated information about marginal production costs and sunk investment cost, then an opportunistic buyer can divide the joint surplus in such a way that only the marginal production costs are reimbursed. However, if the supplier provides only aggregated costs by combining marginal and investment

[1] Ijiri (1975, 109) suggests, "Generally, the reduction of n-dimensional data x = {x1, x2, ...,xn} into m-dimensional data y = {y1, y2, ...,ym} by a function y = f(x) is called aggregation when m < n." In the simple hold-up example I use in this study, aggregation reduces cost information from two dimensions (investment cost and marginal production costs) to one dimension (total cost).

costs, the buyer will find it more difficult to pursue a self-interested strategy since he is uncertain about the marginal production costs incurred. As a result, the supplier should invest and the joint surplus increases. Second, I examine how the buyer's firm purchasing strategy (i.e., buyer follows a self-interested or fair purchasing strategy)[2] affects buyer trade offers and whether a signal sent to the supplier about the buyer's strategy will increase the likelihood of investment.

Hence, I address the following two research questions that span trade and investment. First, does aggregated supplier-provided cost information mitigate the hold-up problem? Second, how does the level of aggregation of the supplier-provided cost information (i.e., fine or coarse) interact with buyer firm strategy (i.e., self-interested or fair) to affect buyer trade offers and supplier investment in idiosyncratic assets?

Although reducing the fineness of information is often considered by accounting research as a source of moral hazard and agency conflicts, it can also serve as a means to reduce the risk of opportunistic behavior in a bilateral monopoly.[3] I build on the stream of accounting research that views aggregation as a way of limiting opportunism when the investor cannot be confident *ex ante* that the non-investor will not behave in a self-interested manner *ex post* (cf. Arya et al. 2000; Baiman and Rajan 2002b) and examine whether increasing the level of aggregation of supplier-provided cost information helps mitigate the hold-up problem. My research differs from Arya et al. (2000) and Baiman and Rajan (2002) in so far as the investment decision I examine is followed by a trade decision and relates to an idiosyncratic asset with disclosure of cost instead of know-how information. I predict that aggregation of supplier-provided cost information

[2] I define as fair a purchasing strategy that instructs buyers to reimburse the marginal production and investment costs incurred and to share the net surplus. Conversely, I define as self-interested a strategy that instructs buyers to only reimburse marginal production costs. I do not propose to investigate the firm's motivations for choosing a fair or self-interested strategy in this paper.

[3] Whilst most analytical hold-up research conducted in the field of accounting assumes no private information between the parties, Arya et al. introduced private information in the form of aggregation to this stream of research.

reduces the potential for self-interested behavior because aggregation removes information (namely, exact marginal production costs) that self-interested buyers might opportunistically use during trade. Thus, aggregation of the cost information disclosed to the buyer results in higher offers. Accordingly, I propose that suppliers are more likely to invest and hold-ups are mitigated when aggregated instead of disaggregated cost information is provided to buyers.

Additionally, practice and supply chain literature suggest that the hold-up problem can be eliminated by trading with a partner who has a reputation for following a fair strategy instead of a self-interested strategy (Parkhe 1993; Henke 2006). I build on this stream of investigation and relax the assumptions of self-interested behavior made by analytical accounting papers to examine how firm purchasing strategy affects hold-ups and interacts with aggregation of information. I predict that buyers with a fair (self-interested) purchasing strategy will cover (not cover) the suppliers' marginal production costs and investment cost and will share (not share) the net surplus with suppliers. Since suppliers anticipate the surplus they generate by investing will not be appropriated (be appropriated) by fair (self-interested) buyers, suppliers choose to make (do not choose to make) the socially optimal idiosyncratic investment. Additionally, I propose that the level of aggregation of supplier-provided cost information (i.e., fine or coarse) interacts with the firm purchasing strategy of the buyer (i.e., self-interested or fair) to affect hold-ups.

To investigate the questions of interest, first, the buyer learns the supplier's idiosyncratic investment cost and expected marginal production costs either disaggregated (i.e., fine information) or aggregated (i.e., coarse information). The buyer's trade decision is guided by his firm purchasing strategy. An ultimatum game, with the buyer making a take-it-or-leave-it offer to the supplier, is used to divide the surplus generated by the investment. Second, the supplier receives a signal of the buyer's firm strategy and learns the fineness of the cost information given

to the buyer. Then, the supplier makes his investment decision. I find that supplying buyers with aggregated (disaggregated) cost information results in buyers with self-interested firm strategy making higher (the same) offers and suppliers investing more than (the same as) predicted by economic models. As a result, giving buyers aggregated cost information results in an increase of the joint surplus. I also document an interaction between aggregation of cost information and buyer's firm strategy.

The remainder of this paper is structured in five sections. Following the introduction, Section II, a literature review, introduces the various mitigating mechanisms that have been investigated highlighting their limitations. Out of those mitigating mechanisms, I focus on buyer-supplier information difference and trading with buyers with a reputation for following a fair strategy to conclude the literature review. The third section develops hypotheses. Section IV presents the research design. Experimental methods and results are described in Section V. The paper concludes with a discussion, limitations of this research and suggestions for future development.

II. LITERATURE REVIEW

This section presents, first, the various mitigating mechanisms of the hold-up problem that have been investigated by economics, accounting and marketing, highlighting their limitations. Second, I suggest how investigation of aggregation of supplier-provided cost information and of buyer strategy can help inform the search for a remedy to hold-up problems.

The hold-up problem presented by transaction cost economics theory is based on the premise that, given the right circumstances and buyer's lack of commitment not to behave opportunistically, self-interested behavior is likely to occur during the trade that follows an

idiosyncratic investment (i.e., trade opportunism) (Williamson 1975, 1985). Importantly, all the mechanisms discussed below have been proposed as a means to encourage idiosyncratic investment by reducing the likelihood that buyers behave opportunistically during trade.

Limits of Vertical Integration, Contracts and Reputation

Vertical integration (e.g., Heide and John 1990; Anderson, Glenn, and Sedatole 2000), contracts (e.g., Klein 1980; Joskow 1985; Edlin and Reichelstein 1995, 1996), and reputation (e.g., Anderson and Weitz 1992) have been presented as potential ways to encourage investment as they help protect investors' return on investment against opportunistic behavior.

Although the protection mechanisms discussed above can be effective in many circumstances, they also suffer from limitations. Specifically, hold-ups can also exist between divisions of a same firm (cf. Baldenius 2000), costs of implementing those mechanisms might exceed the potential benefits, contracts are inherently incomplete, and opportunistic trade behavior might not affect reputation. Since vertical integration, contracts, or reputation do not offer full protection from hold-ups, economics literature has recently turned to increasing the information difference between supplier and buyer as a mechanism to alleviate trade opportunism, and consequently encourage idiosyncratic investments.[4]

Increasing Information Difference between Supplier and Buyer

To limit the potential for trade opportunism by buyers, Gul (2001) proposes that suppliers can augment their bargaining power by increasing the information difference between supplier and buyer instead of disclosing all the supplier's information (Truthful reporting by the supplier is assumed.). This can be achieved in two ways. It can be accomplished, first, by not

[4] Importantly, as with other mitigating mechanisms, increasing the information difference is not always effective. For instance, buyers might have other means of obtaining suppliers' private information or increasing the information difference might result in loss of benefits that could be derived from knowing the suppliers' marginal production costs.

communicating whether an idiosyncratic investment was made, or, second, by supplying buyers with aggregated information. Both types of private information are detailed below.

Building on Tirole's investigation of unobservable investments (1986), Gul (2001) analyzes whether not communicating that the supplier made an idiosyncratic investment mitigates the hold-up problem. When investment is unobservable by the buyer, the supplier can extract information rents from his private information. As a result, investment inefficiency[5] is reduced. Conversely, unless negotiation is costless, trade inefficiency[6] increases because, since the buyer does not know whether an investment was made, he does not know the supplier's reservation price. As a result, the supplier does not benefit from his private information and overall efficiency does not improve. In other words, keeping the existence of idiosyncratic investments private does not mitigate hold-ups. However, Gul suggests that keeping other information private might solve the hold-up problem.

Accounting research has suggested that some information can be kept private through aggregation (Baiman 1975). Baiman and Rajan's (2002b) and Arya et al.'s (2000) models show that, by curtailing *ex post* opportunistic behavior, aggregation of investor-provided information can encourage investment. In their models, aggregation of information is presented as a way to tie up the hands of the non-investor who no longer has the information necessary to appropriate the surplus generated by the investment. Moreover, Drake and Haka (2007) provide empirical evidence that subjects with aggregated cost information are more likely than subject with

[5] Investment efficiency occurs when the supplier makes an investment that maximizes the potential surplus from trade net of investment costs.

[6] In this paper, trade inefficiency occurs when negotiations breakdown because only one round of negotiation is conducted. Conversely, trade is efficient if trade occurs (i.e., a joint benefit to the dyad is created and at least one party benefits). Alternatively, lengthy negotiations are another form of trade inefficiency when several rounds of negotiations are conducted.

disaggregated cost information to share their information with their counterpart when such information-sharing could benefit both parties.

This paper extends accounting literature's investigation of aggregation of information as a safeguard against hold-ups. This study contributes to extant literature in so far as I extend Baiman and Rajan's contribution and examine aggregation of cost information in the context of a relationship-specific investment[7] (instead of aggregation of know-how associated with a non-idiosyncratic investment). Second, this study is associated with trade between a buyer and supplier instead of monitoring of project search effort, thus providing different insights from Arya et al. Third, this paper also differs from Drake and Haka (2007) as the two stages of the hold-up problem (investment and trade) are the focus of this study whereas Drake and Haka examine the choice to share and its impact on trade efficiency. Finally, I manipulate the buyers' behavior via their firm purchasing strategy. Accordingly, I can assess whether aggregation of cost information affects the buyers who follow a fair strategy differently from those who follow a self-interested strategy.

Trading with Buyer with Fair Firm Strategy

Whilst analytical literature on hold-ups assumes self-interest and opportunistic behavior (Schmitz 2001; Baiman and Rajan 2002), trading with fair buyers has been proposed as a way to avoid hold-ups. Two streams of literature have investigated the effect of fairness on hold-ups. Supply chain and accounting literature, the first stream of research, examine firm strategies in the context of repeated exchanges (e.g., Ring and Van De Ven 1992; Dyer 1997). Supply chain and accounting research observe the existence of arm's length strategies focused on purchasing

[7] Such aggregation is likely to be possible when idiosyncratic investments take the form of investments in human capital or R&D. With these types of investment, it might be too costly for the information system to disaggregate the marginal and investment cost information. Hence, even a powerful buyer might not be able to obtain disaggregated cost information. It would, however, be more difficult if the supplier invested in relationship-specific equipment.

products for the lowest price possible (i.e., self-interested strategy), as well as more collaborative purchasing strategies (Bensaou 1999; Doz and Baburoglu 2000) characterized in part by considerations of fairness (i.e., fair strategy) (Helper 1991; Carr and Ng 1995; Kumar 1996). In general, a firm with a fair purchasing strategy will not leave its supplier worse off than before the investment was made and will share the benefits created by the relationship with the supplier (cf. Sako 2004; Cooper and Slagmulder 2004). Thus, investment in idiosyncratic assets should be encouraged by fair strategies.[8] Importantly, the repeated nature of exchanges between the firms seems to provide the impetus for choosing fair strategies.

Experimental economics, the second stream of research, conducts one-period experiments to examine the outcomes of individuals' idiosyncratic investment decisions and to observe the outcome of the trade decision that ensues. In the laboratory, experimental economics researchers (e.g., Berg, Dickhaut, and McCabe 1995; Ellingsen and Johannesson 2004a; 2004b) observe that, in contradiction with economic predictions, investment in relationship-specific assets is significantly greater than zero and offers from the party who benefited from the sunk investment are greater than marginal production costs. Because of the one-shot nature of the experiments, the offers made suggest that individuals' behavior is motivated by social norms rather than expectation of future benefits[9] and that expectations of reciprocity play a role in individuals choosing to invest (Fehr and Gachter 2000). The extent of fair behavior observed in the laboratory had led researchers such as Ellingsen and Johannesson (2004a) to question the seriousness of the hold-up problem. Still, an important limitation of this stream of research is that

[8] Henke (2006) provides practice evidence of the effect of firm strategy on investment in idiosyncratic assets: Henke shows that American automobile suppliers do not make idiosyncratic investment in R&D for American Original Equipment Manufacturers (OEMs), but invest in R&D for Japanese OEMs because they expect that the latter will reimburse suppliers for their investment and will share some of the profits generated by the investment.

[9] Alternatively, buyers might offer more than marginal production costs and covered the investment cost not for fairness reasons, but because they suffer from the sunk cost bias, intend to signal competitors, or have other strategic reasons (Parayre 1995; Diekmann et al. 1996; Troeger 2002).

it abstracts from the fact that the hold-up problem occurs at the firm level and that firms might induce self-interested behavior through corporate culture and strategies.

Firm strategies exist to guide managers' actions (e.g., Floyd and Wooldridge 1992; Bourgeois and Brodwin 1984). Clear communication of the strategy and use of performance measurement and incentive compensation facilitate implementation of firm strategies (Kaplan and Norton 1996). Furthermore, Liedtka (1989) finds that most managers surveyed comply with a strategy even when they experience some conflict with their values provided the strategy is strong. Thus, there is some evidence that a strong firm strategy that is clearly communicated might induce employees to follow the firm strategy instead of their own preferences. As a result, when an employee, who has individual preferences for fairness (self-interest), is guided by a self-interested (fair) strategy, it is likely that he will follow the guidance provided by the firm instead of his own preference. In this paper, I present experimental evidence that a clearly communicated firm strategy can induce subjects to behave in a self-interested or fair manner, thus resulting in exacerbating or mitigating hold-ups.

Increasing Information Difference in the Presence of Different Firm Strategies

Building on extant experimental economics research, Sloof, Oosterbeek, and Sonnemans (2007) examine the interaction between private information in the form of unobservable investment, and fair behavior of individuals. Sloof et al. observe that private information does not boost investment when the surplus is large enough for buyers to exercise some reciprocity. Additionally, consistent with Gul's predictions, Sloof et al. find that the combined inefficiency of investment and trade is not alleviated by making investment unobservable as unobservability boosts investment, but simultaneously worsens trade efficiency as a result of the supplier's private information. Importantly, Sloof et al. do not provide measures

of buyer's preferences for fairness, but base their conclusions on the outcome of the trade negotiation. As a result, considerations of risk and returns could also explain why suppliers refrain from investing when investment cost is high.

Aggregation provides another form of information asymmetry. Yet, we know little about how purchasing strategies might interact with accounting system characteristics such as aggregation to affect individuals' investment and trade decisions.[10] Still, findings presented by Baiman and Rajan (2002b) and Arya et al. (2000) lead me to propose that, with buyer-supplier relationships, an information difference that arises from aggregated supplier-provided cost information might reduce the likelihood of buyer self-interested behavior, hence encouraging idiosyncratic investment. Additionally, observations from behavioral economics (cf. Sloof et al. 2007) suggest that the effect of aggregation of supplier-provided cost information (i.e., fine and coarse) on trade and investment is likely to depend on buyer strategy (i.e., self-interested or fair).

III. HYPOTHESIS DEVELOPMENT

In this section, I develop the intuition behind the predictions first for the trade decision (as expectations from trade drive suppliers' investment decisions), then for the investment decision.[11]

Important assumptions follow. First, I examine a one-period transaction and do not take into account reputation considerations associated with repeated exchanges. Importantly, one-period games are appropriate to examine hold-ups because, in many alliances, one partner has a short-term horizon (Das 2006) and because, as a result of technological or environmental

[10] Accounting literature has pointed to the importance of adaptability of the accounting system to generic firm strategies such as those presented by Gupta and Govindarajan (1984) or Porter (1985) (e.g., Langfield-Smith 1997). However, little focus has been given to more specific firm-wide strategies such as strategies for dealing with suppliers.

[11] Detailed calculations are available from the author.

uncertainty, it is often difficult to assess whether future benefits will derive from current transactions. Second, I assume that the buyer-supplier contract is incomplete and renegotiation cannot be avoided. Third, buyers have greater bargaining power than suppliers and buyers are risk averse. The following two assumptions are not central to this analysis, but are made for expositional purposes. Suppliers are assumed to be self-interested, i.e., to accept any offer that at least covers marginal production costs. This simplifying assumption was made because informing buyers that they will be dealing with self-interested suppliers removes their strategic uncertainty about what constitutes an offer that will be acceptable to the supplier and assures buyers that offers that cover marginal production costs will not be rejected.[12] Finally, consistent with other experimental and analytical research on hold-ups, neither supplier, nor buyer has an outside option should disagreement about trade occur.

The timeline illustrating the various stages of the hold-up problem is detailed in Figure 1.

[Insert Figure 1 about here]

Figure 1 shows a contract is negotiated at time 0 for a predetermined quantity of a product. The product price cannot be specified with certainty *ex ante* because it depends on the resolution of certain parameters that cannot be predicted (e.g., success of R&D efforts). At time 1, the supplier must decide whether to make a non-contractible idiosyncratic one-period investment that will create a potential surplus from trade. Time 1 represents the investment stage. The self-interested supplier is motivated to maximize his payoff from trade (i.e., buyer's offer less marginal and investment costs) and his investment decision is based on expectations of his share of the surplus from the trade to be conducted at time 3. In other words, the supplier uses backward induction to make the investment decision. The buyer learns the supplier's cost

[12] Brenner and Vriend (2006, 629) provide empirical evidence that proposers in ultimatum games are unable to learn their part of the subgame perfect equilibrium even after 100 iterations "unless the players…behave exactly as in the subgame perfect equilibrium without ever rejecting any offer."

information at time 2. At time 3 (trade stage), an ultimatum game, where the buyer makes a take-it-or-leave-it offer, is used to divide the net surplus from trade. The various outcomes of this two-stage game are detailed below and shown in Figure 2.

[Insert Figure 2 about here]

Let G represent the gross surplus generated by the supplier's idiosyncratic investment (i.e., gross surplus from trade), M the predicted marginal production costs, and F the supplier's investment cost. $G > M + F$. In other words, investment is socially efficient. Let I represent the supplier's investment decision: $I = 1$ if investment takes place, $I = 0$ otherwise. X_i represents the net monetary payoffs of player i. At time 3, the gross surplus from trade is as follows:

$$\begin{cases} G & \text{if } I = 1 \\ 0 & \text{if } I = 0 \end{cases}$$

Let T equal the trade offer of the buyer to the supplier. I normalize the costs incurred by the buyer (beyond the offer he makes to the supplier) to zero. The supplier and buyer monetary payoffs are respectively X_s and X_b with:

$$X_s = \begin{cases} T - F - M & \text{if } I = 1 \text{ and supplier accepts buyer's offer} \\ - F & \text{if } I = 1 \text{ and supplier rejects buyer's offer} \\ 0 & \text{if } I = 0, \end{cases}$$

and

$$X_b = \begin{cases} G - T & \text{if } I = 1 \text{ and supplier accepts buyer's offer} \\ 0 & \text{otherwise} \end{cases}$$

I propose that buyers follow a self-interested or a fair strategy. I define as self-interested a strategy that instructs buyers to cover only marginal production costs and as fair a strategy that instructs buyers to reimburse suppliers for marginal production costs and investment cost, and to

share the net surplus created by the investment. Firm strategies are instituted to guide the actions of individual decision makers. Accordingly, a self-interested (fair) strategy should lead to self-interested (fair) behavior. Thus, I conduct the analysis at the individual level.

Recall that supplier's expectation of self-interested behavior by the buyer during trade drives the hold-up problem. This suggests that reducing the likelihood that the buyer behaves in a self-interested manner should encourage investment in idiosyncratic assets. I examine two ways of mitigating hold-ups (namely, providing buyers with aggregated supplier-provided cost information and trading with buyers with fair firm strategy) and how they interact to affect buyer trade offers and supplier investment decisions.

Trade Predictions – H1a-d

First, I examine the effect of the level of aggregation of supplier-provided cost information. Williamson's (1985) predictions suggest that the *self-interested buyer* who knows the supplier's marginal production costs, M, and past idiosyncratic investment cost, F, (i.e., *fine information*) will offer just enough to cover marginal production costs plus ε (or M + ε) as presented in Figure 3 under item A. below. Anticipating that his investment cost will not be reimbursed, the supplier will not make the socially optimal idiosyncratic investment.

[Insert Figure 3 about here.]

I propose that a self-interested buyer who possesses *coarse cost information c* in the form of the sum of the supplier's marginal production costs and past idiosyncratic investment cost (i.e., $(F + M)_c$) will offer more than a self-interested buyer who possesses fine cost information. Knowing that a self-interested supplier has an acceptance threshold of M, a self-interested buyer would like to offer M + ε so as to maximize his payoff from trade, but he is uncertain about the supplier's true marginal production costs, M, or investment cost, F. Moreover, being risk averse,

the buyer does not want to risk losing his share of the surplus from trade (i.e., G - T) by making an offer that does not cover marginal production costs. As a result, a self-interested buyer who only possesses coarse cost information will include a substantial portion of the cost of the supplier's past investment in his offer and offer close to $(F + M)_c$. Thus, in the self-interested/ coarse condition, the buyer's predicted offer is $(F + M)_c - \delta + \varepsilon$[13] with $(F + M)_c - \delta > M$ as shown in Figure 3 item B. In sum, the information loss associated with coarse information limits the buyer's potential self-interested behavior and results in higher offers than fine information.

Second, I examine the effect of buyer strategy on the trade decision**.** Cooper and Slagmulder (2004) suggest that following a fair strategy implies sharing the incremental value created by the relationship and not leaving the other party worse off than before the transaction took place. In other words, buyers who follow a fair strategy are expected to reimburse marginal production costs and investment cost, and to share some of the net surplus from trade. Thus, buyers who follow a fair strategy do not need to identify investment cost, F, and marginal costs, M, separately.

Consequently, offers of buyers assigned a fair strategy should not be affected by whether investment cost and marginal production costs are disclosed disaggregated (in the form of F and M) or aggregated (in the form $(F + M)_c$). As a result, the offers made by buyers with fair firm strategy who have supplier-provided coarse cost information are not expected to be significantly different from the offers made by buyers who possess fine cost information. As presented in

[13] δ represents the buyer's expected value of F reduced by the adjustment the buyer makes for his uncertainty. The higher the buyer's uncertainty about M and F's true values, and the higher the potential surplus from trade, the lower δ.

Figure 3 (items C. and D.), offers are predicted to be up to G/2 + F/2 + M/2.[14] Accordingly, contrary to the case of unobservable investment presented above (cf. Gul 2001; Sloof et al. 2007), private information that takes the form of aggregated cost information is not expected to lead to greater trade inefficiency than fine information.

In sum, I propose that buyers will make the following offers as shown in Figure 3:

(i) With *fine information*, *buyers assigned a self-interested strategy* will offer $M + \varepsilon$, whereas *buyers assigned a fair strategy* will offer up to G/2 + F/2 + M/2.

(ii) With *coarse information*, *buyers assigned a self-interested strategy* will offer $(F + M)_c - \delta + \varepsilon$ with $(F + M)_c - \delta > M$, whereas *buyers assigned a fair strategy* will offer up to G/2 + F/2 + M/2.

As detailed above, an ordinal interaction between level of aggregation of supplier-provided cost information and buyer strategy is predicted. Thus, I propose that coarse information increases the offers of buyers with a self-interested strategy, but does not change the offers of buyers who follow a fair strategy. This prediction leads to the following hypotheses:

H1a: An interaction between level of aggregation of supplier-provided cost information and assigned buyer strategy is predicted to affect buyers' offers.

The specific predictions associated with this interaction are detailed in the hypotheses below.

H1b: When buyers are assigned a self-interested strategy, buyers who possess coarse cost information make, on average, higher offers than buyers with fine cost information.

H1c: When buyers are assigned a fair strategy, the offers of buyers do not change based on the level of aggregation of the cost information they possess.

H1d: When buyers possess coarse cost information, the mean offer of buyers assigned a

[14] G/2 + F/2 +M/2 = M + F + (G - M - F)/2. In other words, it is equivalent to reimbursing marginal production costs and investment costs and sharing the net surplus. I cap the sharing of the net surplus at half of the net surplus as I assume that buyers do not want to earn less than suppliers.

fair strategy is greater than that of buyers assigned a self-interested strategy.

Hypotheses H1a-d are summarized in Table 1**.**

[Insert Table 1 about here]

In sum, providing buyers with coarse instead of fine cost information can serve, for the supplier, as a protection against the buyer's potential trade opportunism. H1a-d suggest that suppliers who are somewhat uncertain about whether they will be dealing with a buyer who has a fair or self-interested firm strategy are better off disclosing only coarse cost information.

Recall that the hold-up problem has two dimensions: investment and trade. The supplier's investment decision is examined below.

Investment Predictions – H2 and H3a-d

I predict that reducing the likelihood that buyers behave in a self-interested manner will lead suppliers to invest. Suppose that, since buyers cannot commit to not behave opportunistically, suppliers do not know the buyers' strategy (i.e., self-interested or fair) with certainty, but can assign probabilities to each strategy. The expected utility of self-interested suppliers includes the expected offer net of marginal production costs and idiosyncratic investment cost.

(i) When the buyer possesses *fine cost information*, the supplier expects to receive $M + \varepsilon$ from a buyer assigned a self-interested strategy, and up to $G/2 + F/2 + M/2$ from a buyer assigned a fair strategy (see Figure 3). The supplier will invest if his expected utility is positive. I predict that that the higher the probability of the buyer strategy being self-interested and the higher the investment cost, the less likely it is the supplier will invest.

(ii) When the buyer possesses *coarse cost information*, the supplier expects to receive $(F + M) - \delta + \varepsilon$ from a buyer assigned a self-interested strategy, and up to $G/2 + F/2 + M/2$ from

a buyer assigned a fair strategy (see Figure 3). δ is predicted to be significantly smaller than the supplier's investment because of the risk aversion of the buyer.

Accordingly, the expected utility of a supplier in the coarse information condition is greater than the expected utility of a supplier in the fine information condition. Consequently, the supplier is more likely to invest in the coarse than in the fine information condition.

H2: Suppliers are more likely to make idiosyncratic investments when buyers possess supplier-provided coarse cost information than when buyers possess fine cost information.

An example illustrates supplier's expected utility calculations and the above predictions. Assume the supplier believes there is a 75% chance that the buyer has a self-interested strategy and surplus from trade, G, equals170 for an idiosyncratic investment, F, of 40 and marginal production costs, M, of 10. With *fine cost information*, supplier's expected utility calculation is as follows:

.25 * (170/2 + 10/2 + 40/2) + .75 * 10 - 40 - 10 = -15. Since the supplier's expected utility is negative, he will not invest.

With *coarse cost information*, supplier's expected utility calculation is as follows:

.25 * (170/2 + 10/2 + 40/2) + .75 * (10 + 40 - δ) - 40 - 10 = 15 - .75δ. The supplier's expected utility will be positive if δ is smaller than 20. Hence, the supplier invests if he expects that the offer made by the buyer will be greater than 30 (i.e., 50 - 20). The supplier should invest because, as a result of the buyer's risk aversion, δ is predicted to be small.

Additionally, H1b-c suggest that increasing the level of aggregation of supplier-provided cost information results in an increase in the offers made by buyers with self-interested strategies, but does not change the offers of buyers with fair strategies. Since expectations of

trade behavior drive suppliers' investment decisions, an interaction between level of aggregation of supplier-provided cost information and buyer strategy is also predicted in relation to investment. H3a-d follow.

H3a: An interaction between level of aggregation of supplier-provided cost information and buyer strategy is predicted to affect supplier's investment in idiosyncratic assets.

The specific predictions associated with this interaction are detailed in the hypotheses below.

H3b: When suppliers know they are likely to be matched with a buyer who has a self-interested strategy, increasing the level of aggregation of the cost information provided to buyers will, on average, result in significantly larger supplier investment.

H3c: When suppliers know they are likely to be matched with a buyer who has a fair strategy, supplier's mean investment does not change based on the level of aggregation of the cost information buyers possess.

Importantly, H1d predicts buyers with a fair firm strategy will make higher offers than buyers with a self-interested firm strategy when buyers possess coarse cost information. Because of this, I predict that buyers with coarse information cover a substantial portion of the marginal production costs and investment costs.[15] Accordingly, suppliers matched with buyers in the self-interested/coarse condition do not expect that buyers will be able to appropriate the entire surplus generated by their investment. It follows that suppliers in the self-interested/coarse condition are likely to invest. H3d follows.

H3d: When buyers possess coarse cost information, the mean investment of suppliers who know they have a higher probability of being matched with buyers who have a fair strategy is equal to the mean investment of suppliers who have a higher probability of

[15] In the coarse/self-interested condition, the buyer's predicted offer is $(F + M)_c - \delta + \varepsilon$ as shown in Figure 3 item B.

being matched with buyers who have a self-interested strategy.

Hypotheses H2 and H3a-d are summarized below in Table 2.

[Insert Table 2 about here.]

IV. RESEARCH DESIGN

Following protocol studies, pre-pilot tests, and pilot tests, 106 students (88 MBAs, two Master students and 16 undergraduate students) were recruited on a voluntary basis from managerial accounting classes (see Table 3 for additional descriptive statistics of the participants). Participants received performance contingent compensation in addition to a $5 participation fee. Overall payoffs ranged from $5 to $15 with an average compensation of $10 for a thirty-minute session.

[Insert Table 3 about here.]

Experimental Design and Variables

A 2 x 2 between-subject design was used for the investment and trade tasks. Two separate experiments were conducted, one for buyer subjects in the trade task and the other for the suppliers' investment decision. Two levels of aggregation of cost information disclosed to the buyer (viz. coarse or fine information) and two levels of buyer strategy (viz. self-interested or fair) were used.

In the fine cost information condition, buyers knew the marginal production costs and the past idiosyncratic investment cost of the suppliers separately. Coarse cost information was operationalized by giving buyers only the sum of the suppliers' marginal production costs and past idiosyncratic investment cost.

Firm purchasing strategy provided the means for manipulating buyer behavior. A strategy that instructs buyers to cover only the supplier's marginal production costs (i.e., self-interested

strategy) encourages buyers to behave in a self-interested manner. Conversely, a purchasing strategy that instructs buyers to cover marginal production costs and investment cost and to share the net surplus from trade[16] (i.e., fair strategy) encourages fair behavior.

Recall that expectations that buyers will appropriate the surplus generated by the investment drive the hold-up problem. Since the surplus from trade is fixed once the investment has been made, the offer made by the buyer is a measure of how the surplus is divided. Accordingly, buyers offer is the main dependent variable of interest for the trade task and H1a-d.

Likelihood of investing and mean investment level are the criteria of interest for the investment task. The instructions suggest that making an idiosyncratic investment is socially optimal. Accordingly, consistent with recent experimental economics hold-up papers (e.g., Ellingsen and Johannesson 2004a; 2005; Sloof et al. 2007), participants made a binary choice. They could choose between investing \$0 and a specified amount F (chosen so that $M + F < G$). The likelihood of investing is the criterion for H2, and investment level is the criterion for H3 a-d. They are measured by suppliers' investment choice and the resulting investment amount.

Experimental Materials and Procedure

The trade and the investment tasks were run as separate experiments to facilitate backward induction.[17] The intent of this study is not to capture how well suppliers can do backward induction. Instead, first, I test the effects of the level of aggregation of the supplier-provided cost information and the buyer's firm strategy on buyer's offer in the trade stage. Second, I measure how the knowledge of the buyer's condition affects suppliers' investment

[16] Instructions suggested that buyers should share the surplus equally to remove noise. Instructing buyers to share the surplus equally was chosen to be consistent with prior research (Camerer and Loewenstein 1993).

[17] Additionally, since it is predicted that suppliers in the fine condition do not invest (thus, trade does not occur), the effect of the level of aggregation of cost information on the trade negotiation could not be assessed for all conditions if an investment decision were to be followed by a trade decision.

decision in the investment stage. Fifty-two subjects took part in the trade task. Fifty-four subjects participated in the investment task. Subjects were randomly assigned to conditions for both tasks.

Trade Task

Participants were assigned the role of buyer. Consistent with prior hold-up research (e.g., Gul 2001; Ellingsen and Johannesson 2004a), an ultimatum game represented the trade stage. Each buyer learned he would make a take-it-or-leave-it offer to purchase parts from a self-interested supplier who had already made an idiosyncratic investment. Although no participant was actually assigned to the role of supplier in this experiment, any offer that covered marginal production costs was deemed to be accepted because self-interested suppliers would derive positive utilities from such offers. The participants knew the supplier's cost information (i.e., fine or coarse) and the expected revenue they could obtain from selling the product to the outside market. Their offer was to be guided by their firm strategy (i.e., self-interested or fair).

Introductory materials detailed the buyer and supplier payoffs calculations from trade. The calculation of incentive compensation as a percentage of the buyer's share of the net surplus from trade was also included. Following an example, pre-trade decision questions were administered to gauge the participants' understanding of the key elements in the materials as detailed in Table 4, Panel A.

[Insert Table 4 about here.]

After returning the pre-experiment questionnaire, participants made an offer decision. Then, participants completed a post-experiment questionnaire that included manipulation checks and questions designed to help understand their decision process and help eliminate alternative explanations. Finally, participants' personal preference for fairness were elicited with an instrument created by Messick and McClintock (1968) and updated by Liebrand (1984).

Investment Task

For the investment task, participants were assigned the role of supplier. Participants were presented with a scenario where they could purchase, on behalf of their firm, an idiosyncratic machine to manufacture parts for a specific buyer. Before making their investment decision, participants learned that, subsequent to the purchase of the machine, the buyer would make a take-it-or-leave-it offer for the parts. Participants knew their costs and had complete knowledge of the level of aggregation of the buyer's information (i.e., whether buyer had fine or coarse supplier cost information). The materials further explained the potential effect of buyer's firm strategy on trade by means of examples detailing supplier and buyer potential payoff calculations and incentive compensation.

Following pre-investment decision questions similar to those of the trade task (see Table 4, Panel B), participants were asked to make a one-time investment decision faced with a 75% chance of working with a buyer who has a self-interested (fair) firm strategy and a 25% chance of working with a buyer who has a fair (self-interested) firm strategy. As in the trade task, post-experiment questions followed. Finally, the buyer's actual strategy was selected by drawing from the distribution specified in the instructions; thus, determining suppliers' payoffs and resulting incentive compensation.

V. RESULTS

Manipulation Checks

Level of aggregation of cost information possessed by buyers was measured with post experiment questions by asking participants about their perception of the buyer knowledge of exact marginal production costs. Perceived buyer knowledge of exact marginal cost was rated

significantly higher in the fine information condition than in the coarse information condition as detailed in Table 5, Panel A for both trade and investment tasks ($t = 7.78$, $p < .001$ and $t = 4.64$, $p < .001$, respectively).

[Insert Table 5 about here.]

Additionally, participants were asked to state their understanding of the buyer strategy. As detailed in Table 5, Panel B, participants in the self-interested strategy condition were more likely to agree with the statement that buyers would offer just enough to cover marginal production costs than participants in the fair strategy condition for both trade and investment tasks ($t = 9.32$, $p < .001$ and $t = 2.74$, $p < .01$, respectively).

Descriptive Statistics

Economic theory predicts that buyers who follow a self-interested strategy will offer just enough to cover marginal production costs plus ε. The offers of buyers in the self-interested/fine information condition are consistent with this prediction: Based on marginal production costs of $10,000 in this experiment, Table 6, Panel A and Figure 4 show that offers ranged from $10,000 to $55,000 (mean $16,857 and mode $11,000). In the self-interested/coarse information condition, offers ranged from $13,500 to $90,000 (mean $38,625 and mode $30,000).[18]

[Insert Table 6 about here.]

[Insert Figure 4 about here.]

Additionally, economic predictions suggest that self-interested suppliers paired with buyers who are assigned a self-interested strategy will not make the socially optimal idiosyncratic investment (i.e., investment of $40,000 per experimental instructions). In the self-

[18] Responses from one participant were omitted from the analysis. One participant in the coarse information condition used the incentive compensation formula and his estimate of the incentive pay to calculate the exact marginal production costs (in essence resulting in fine information).

interested/fine information condition, two out of fourteen (or 14%) suppliers invest and mean investment amount is $5,714 as detailed in Table 6, Panel B. On the other hand, twelve out of fourteen (or 86%) suppliers invest in the self-interested/coarse information condition with a mean investment amount of $34,285.

In essence, the observed behavior of participants in the self-interested strategy and fine information conditions is broadly consistent with economic predictions[19] (i.e., offers of $10,000 and no investment). Conversely, participants in the self-interested strategy and coarse information conditions make significantly higher offers and investment inefficiency is significantly lower than predicted by economic models.

Hypotheses Tests

Trade Decisions -- H1a-d

H1a predicts that the effect of level of aggregation of supplier-provided cost information on buyer offers depends on buyer strategy. To test H1a, the interaction between level of aggregation of cost information and firm strategy is examined. ANOVAs are run on buyers' offers with aggregation level and buyer strategy as between-subject factors. As detailed in Table 7, Panel A, the interaction between aggregation level and buyer strategy is significant ($F = 5.42$, $p = .02$).[20] I conducted additional tests to determine whether results were driven by the buyer strategy specified in the instructions or by personal preferences of the participants for fairness. Personal preference for fairness was measured by using an instrument that uses decomposed

[19] Importantly, these results differ from prior empirical research (cf. Berg et al. 1995; Ellingsen and Johannesson 2004a; 2004b; Sloof et al. 2007) because, in those experiments, buyer and supplier types were neither manipulated nor measured. Additionally, prior research did not inform participants of their counterparts' type (i.e., self-interested or fair). Hence, in these studies, sharing of the surplus was commonly observed as participants did not know the acceptance threshold of their counterparts.

[20] Results remain qualitatively the same when demographics variables are included as a covariate (gender: $F = 5.06$ and $p = .029$, GPA: $F = 4.86$ and $p = .033$, nationality: $F = 5.53$ and $p = .023$).

games to measure social value orientation and classify individuals as self-interested or fair (Messick and McClintock 1968; Liebrand 1984; De Dreu and van Lange 1995). Whether these preferences matched the buyer strategy was used as a covariate in the analysis and results were substantially the same ($F = 4.89$, $p = .032$). Hence, I conclude that the effect of level of aggregation of cost information on buyer offers depends on buyer strategy.

[Insert Table 7 about here.]

I used planned contrasts to test H1b through H1d by examining pairwise mean comparisons. As detailed in Table 7, Panel B, when buyers are assigned a self-interested strategy, the mean offer in the coarse condition is statistically significantly greater than the mean offer in the fine condition ($t = 3.18$, $p = .002$ one-tailed). Thus, H1b is supported. Additionally, the mean offer difference between fine and coarse information is not significant for buyers in the fair strategy condition ($t = .32$, $p = .75$); thus, results are consistent with H1c. Finally, when buyers possess coarse cost information, the mean offer of buyers in the fair strategy condition is statistically significantly greater than the mean offer of buyers in the self-interested strategy condition ($t = 8.06$, $p < .001$). Thus, H1d is supported. In sum, providing buyers with coarse cost information increases the offers made by buyers with a self-interested strategy, but does not change the offers of buyers with a fair strategy.

Investment Decisions -- H2 and H3a-d

H2 predicts a main effect of level of aggregation of cost information on suppliers' investment decision. As predicted and detailed in Table 8, Panel A, results from a logistic regression provide evidence that suppliers who knew they were paired with buyers who possessed coarse cost information were more likely to invest than suppliers who knew they were paired with buyers with fine cost information (Wald statistic: 7.68, $p = .006$).

[Insert Table 8 about here.]

H3a predicts that the effect the level of aggregation of cost information of the buyer has on the supplier idiosyncratic investment depends on buyer strategy. To examine the interaction ANOVAs are run on investment level with level of aggregation of cost information and buyer strategy as between-subject factors. Results provide evidence of an interaction ($F = 16.30$, $p < .001$). Thus, H3a is supported as detailed in Table 8, Panel B and Figure 5.

[Insert Figure 5 about here.]

I used planned contrasts to test H3b through H3d by examining pairwise mean comparisons. Results are presented in Table 8, Panel C. When suppliers are likely to be matched with buyers with a self-interested strategy, the mean investment for the coarse information condition is statistically significantly greater than the mean investment in the fine information condition ($t = 5.20$, $p < .001$). Thus, H3b is supported. Additionally, the mean investment difference between fine and coarse information is zero when buyers have a higher probability of being assigned a fair strategy and all participants invest. Thus, H3c cannot be rejected. Finally, when buyers possess coarse information, the mean investment when buyers have a higher probability of being assigned a fair strategy is not statistically significantly different than the mean investment when buyers are more likely be assigned a self-interested strategy ($t = .53$, $p = .60$). Thus, H3d cannot be rejected.

Supplementary Analysis

Trade efficiency (i.e., trade agreement) cannot be directly measured since no participant takes on the role of supplier in the trade task. However, trade efficiency is of concern because aggregation is a form of private information and it has been proposed (Gul 2001) and observed (Sloof et al. 2007) that private information (in the form of unobservable investment) impairs

trade efficiency. In this paper, suppliers are assumed to be self-interested. Accordingly, given that the idiosyncratic investment is sunk, any trade offer that is greater than marginal production costs (i.e., $10,000 herein) is deemed to be acceptable and accepted by self-interested suppliers (i.e., efficient trade). In the self-interested/coarse cost information condition, the lowest offer observed was $13,500. In other words, since all buyers offered more than suppliers' marginal production costs, the results of this experiment are consistent with efficient trade despite the private information of the supplier. Additionally, $30,000 is the modal offer observed. Interestingly, based on the figures used in this experiment, $30,000 is also the lowest offer that provides sufficient incentives for a self-interested supplier to invest when he is faced with a 75% chance of being paired with a buyer with a self-interested strategy.

It was proposed earlier that, in the coarse information condition, self-interested *buyers' offers* would be equal to $(F + M)_c - \delta + \varepsilon$ with $\delta \geq 0$ and δ significantly smaller than the investment cost. Thus, buyers' trade offers should be significantly greater than marginal production costs and close to the sum of marginal and investment costs for participants in the self-interested/coarse information condition. The mean offer of buyers in the self-interested/coarse information condition (i.e., $38,625) is not significantly different than the sum of marginal and investment costs (i.e., $50,000) ($t = 1.60$, $p = .14$). Thus, results provide evidence that buyers who possess coarse cost information make offers close to the sum of marginal and past investment costs, even when they are instructed to only cover marginal production costs and to maximize their firm surplus (i.e., self-interested strategy condition).

Hypotheses 2 and 3a-d above rely on the prediction that suppliers would *anticipate receiving higher offers,* from buyers who are likely to have a self-interested strategy, in the coarse information condition than in the fine information condition. Consistent with this

prediction, suppliers matched with buyers who possess fine cost information expect, on average, offers of $26,946 whilst suppliers matched with buyers with coarse cost information expect, on average, offers of $47,278. The mean difference is significant (t = 1.93, one-tailed p = .033). Additionally, the expectations of suppliers who had a higher probability of being matched with buyers with a fair strategy do not change with the level of aggregation of information (t = .22, p = .827). In sum, the prediction that the level of aggregation of the information possessed by buyers with a self-interested strategy affects suppliers' trade expectations is supported.

Post-experiment questions help eliminate the *sunk cost bias* as a potential explanation for the buyers' offers being higher than predicted by economic theory. Results from post-experiment questions show that participants do not believe that past investments costs should be reimbursed when buyers follow a self-interested strategy. This finding confirms that offers that are greater than marginal costs are not the result of the sunk cost bias of participants.

VI. DISCUSSION AND CONCLUSIONS

Successful alliances, networks and other types of close buyer-supplier relationships are often characterized by extensive sharing of information (Baiman and Rajan 2002a; Kulmala 2002). Management accounting information plays an important role in this information sharing as exchange of cost information has helped firms diagnose problems, reduce costs and improve performance (Carr and Ng 1995; Kumar 1996; Seal et al. 1999; Dekker 2003). Yet, contracts are incomplete and suppliers who disclose their cost information to more powerful buyers cannot use contract terms to protect themselves fully against the potential self-interest of their counterpart. Anticipating *ex post* self-interested behavior from their counterpart, firms have, *ex ante*, avoided to make idiosyncratic investments that would be socially optimal (i.e., hold-up problem)

(Williamson 1985).

This research investigates the effects of the level of aggregation of supplier-provided cost information (i.e., fine or coarse) and of trading with buyers with certain firm strategies (i.e., self-interested or fair) on the hold-up problem. Results provide empirical evidence that aggregating idiosyncratic investment and marginal production costs provided to non-investors helps investors overcome their reluctance to invest in idiosyncratic investments. In essence, buyers' information loss associated with coarse cost information helps curtail buyers' self-interested behavior during trade and, consequently, provides investment incentives for suppliers. Additionally, increasing the level of aggregation of cost information does not change the trade offers of buyers with a fair strategy or the investment decision of suppliers who are likely to be matched with them.

Although requiring suppliers to only disclose aggregated costs benefits buyers as it encourages suppliers to make socially optimal investments, suppliers might also be able to resist pressure to disaggregate costs by indicating to buyers that it is costly to disaggregate the cost information provided by the accounting system. The ease with which this argument might be accepted by buyers is likely to depend on the type of idiosyncratic investment to be made by the supplier. More specifically, suppliers might arguably be better able to use aggregation as a tool against trade opportunism when they invest in human capital assets and R&D than when they invest of in fixed assets.

Laboratory testing allows simplification of the context, identification of optimal behavior and manipulation and controlling of the buyer strategy (i.e., self-interested or fair), but it also suffers from the limitations associated with any experimental work. Additionally, coarsening cost information might reduce the potential benefits of providing cost information. Thus, it is important to examine the cost-benefit tradeoffs of coarsening cost information prior to

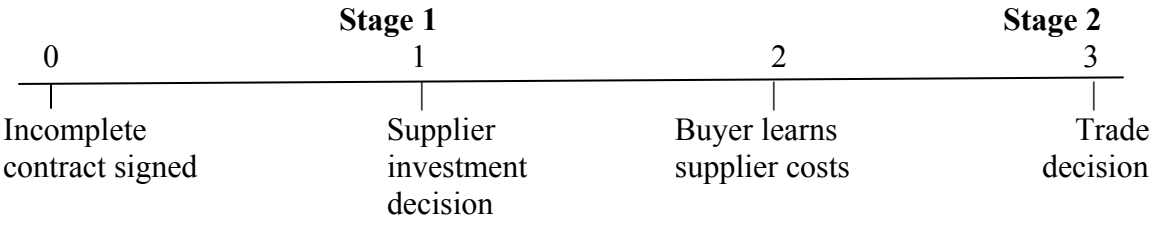
implementing this mitigating mechanism.

This research contributes to the literature on hold-ups by intentionally abstracting from communication or any reputation concerns associated with close buyer-supplier relationships. As a result, this paper contributes to the literature on incomplete contracting and opportunism in buyer-supplier relationships by providing evidence that aggregated supplier-provided cost information provides suppliers with incentives to make a socially optimal idiosyncratic investment in the context of small numbers bargaining. Finally, my research contributes by isolating and manipulating buyer strategy. By assigning buyers a firm strategy to guide their actions, this paper successfully induces trade offers consistent with economic predictions when there is no private information and buyers are assigned a self-interested strategy.

I assume that the level of aggregation of supplier-provided cost information is exogenous. Letting suppliers decide whether they would like to disclose fine or coarse information, and the effect of their decision on the relational contracting aspect of their relationship with buyers warrants further investigation. Additionally, to complement this research, the effect of other types of private information (e.g., through mechanisms such as reduced precision) on inter-firm relationships could be investigated.

Figure 1

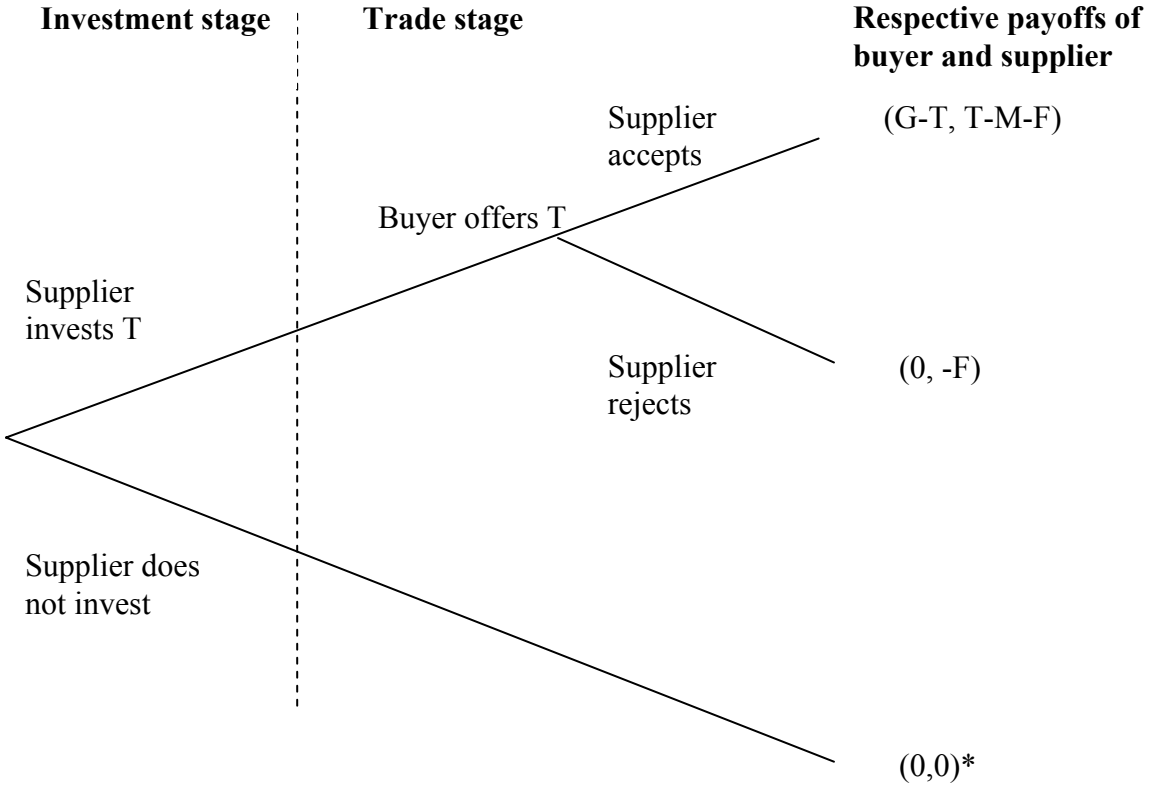
Timeline of the Hold-up Problem



Adapted from Hart and Moore (1988)

Figure 2

Investment and Trade Stages

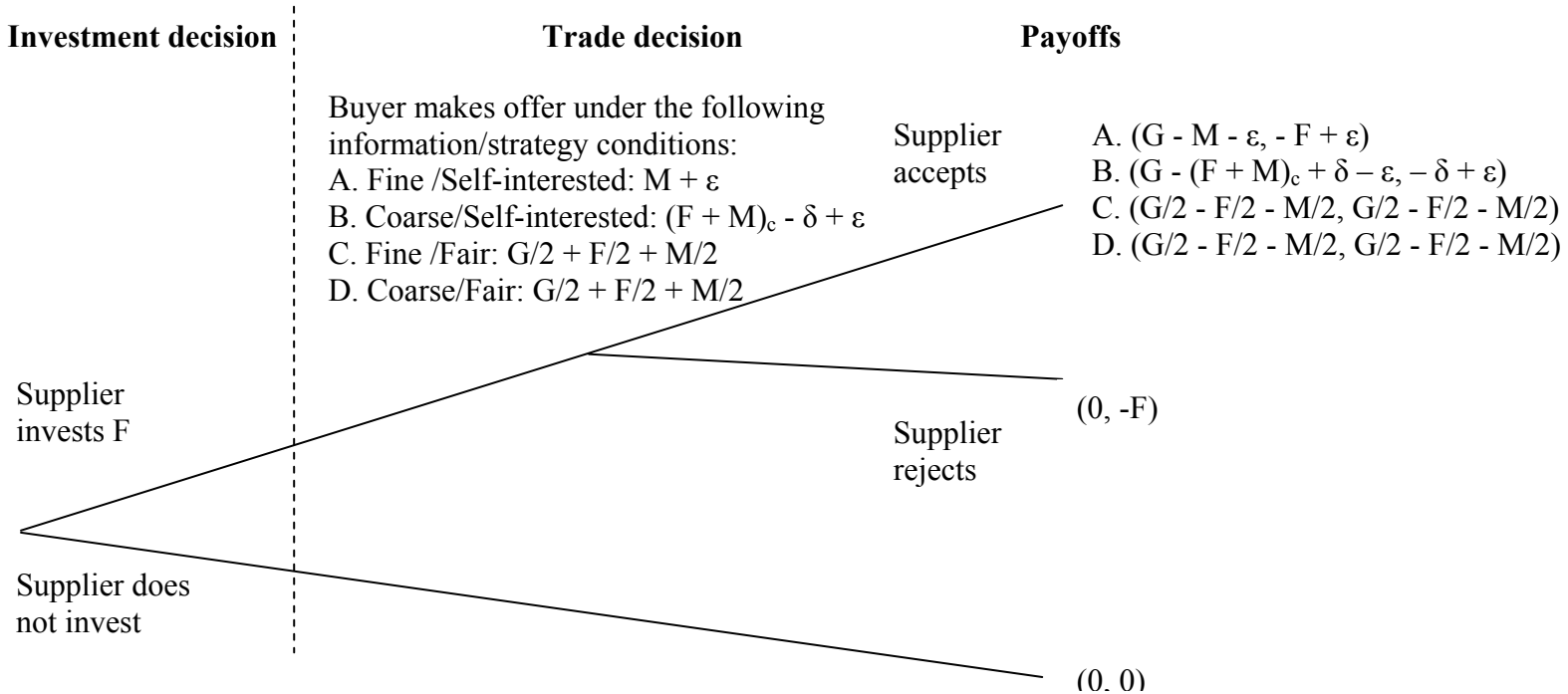


Where F = Investment cost
T = Buyer trade offer
G = Gross surplus from trade such that G > M + F
M= Marginal production costs

* Whilst most papers (e.g., Berg et al. 1995; Ellingsen and Johannesson. 2004a, 2004b; Cox 2004) assume that trade does not take place if the supplier does not invest, a few papers (e.g., Sloof et al. 2007) assume that trade occurs when the supplier does not invest and that a smaller surplus is divided.

Figure 3

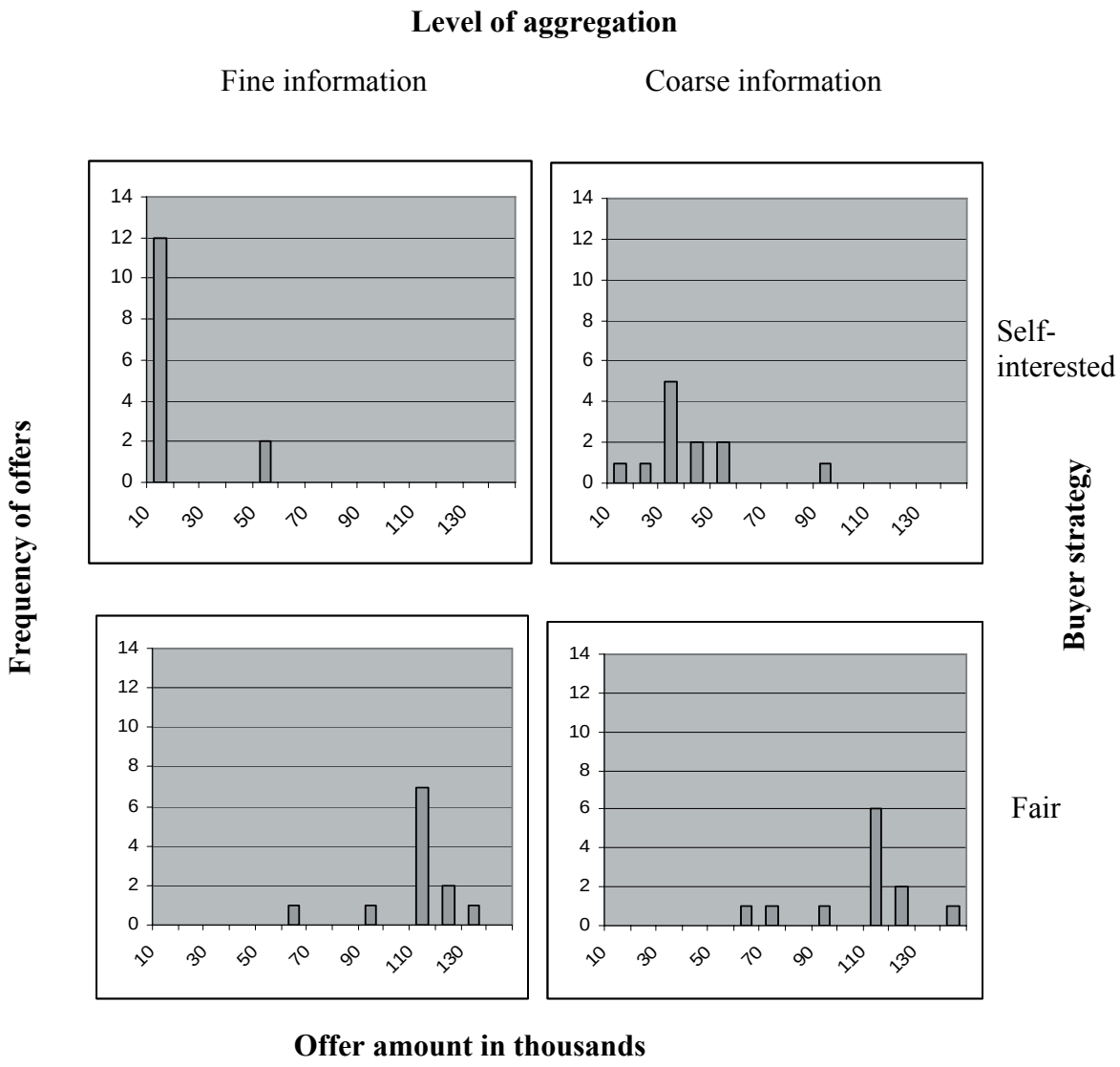
Predicted Outcomes under Various Information and Strategy Conditions



Where F = Investment cost
G = Gross surplus from trade
M= Marginal production costs
ε = Immaterial amount offered such that supplier is not indifferent between accepting and rejecting offer
δ = Buyer's expected value of F reduced by buyer's adjustment for uncertainty

Figure 4[*]

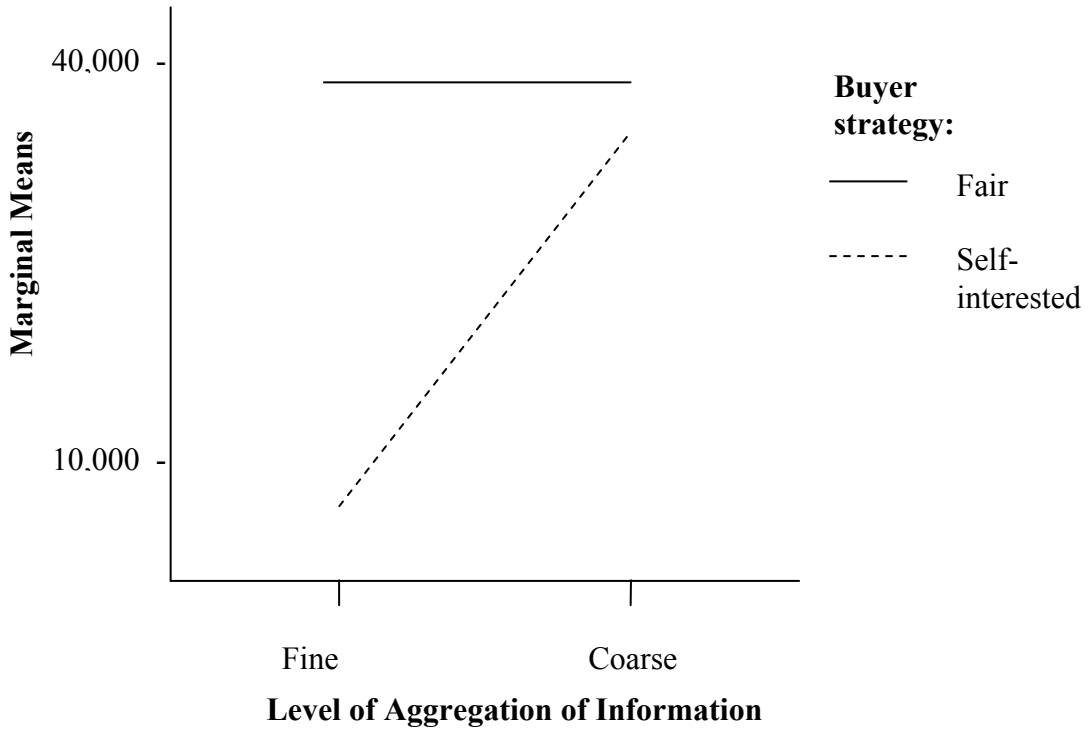
Distribution of Buyer Offers



[*] Variables are defined in Table 5.

Figure 5*

Suppliers' Mean Investment



* Variables are defined in Table 5.

Table 1

Summary of H1a-d

Buyer trade offer	Self-interested strategy	Fair strategy
Fine information	A	B
Coarse information	C	D

Predictions:
H1a: Information x Strategy
H1b: Coarse information > Fine information if Self-interested strategy C > A
H1c: Coarse information = Fine information if Fair strategy B = D
H1d: Fair strategy > Self-interested strategy if Coarse information D > C

Table 2

Summary of H2 and H3a-d

Supplier investment	Self-interested strategy	Fair strategy
Fine information	A	B
Coarse information	C	D

Predictions:

H2: Coarse information > Fine information C + D > A + B

H3a: Information x Strategy

H3b: Coarse information > Fine information if Self-interested strategy C > A

H3c: Coarse information = Fine information if Fair strategy B = D

H3d: Fair strategy = Self-interested strategy if Coarse information D = C

Table 3

Sample Demographics

Panel A: Frequency

	*Frequency - Trade Task**	*Frequency – Investment Task*
Male	38	39
Female	13	15
Undergraduate	16	0
Graduate	35	54
North America	35	34
Europe	1	2
Asia	14	12
Other	1	6

*One observation missing

Panel B: Mean Comparisons of Demographics between Conditions

	Self-interested Strategy		**Fair Strategy**		**Overall Mean**	**T-tests**
	Fine	**Coarse**	**Fine**	**Coarse**		
Trade Task						**Expectation: No significant difference among cells at .05 (ns)**
Grade point average	3.52	3.63	3.55	3.65	3.59	ns*
Number of managerial accounting courses taken	1.07	2.45	1.17	.83	1.35	ns
Investment Task						**Expectation: No significant difference among cells at .05 (ns)**
Grade point average	3.59	3.66	3.58	3.49	3.59	ns
Number of managerial accounting courses taken	1	.69	1	.92	.91	ns

*ns: No significant difference at .05

Table 4

Test of Subjects' Comprehension of Experimental Setting

Questions were measured on a 9-point Likert scale with 1 representing strongly disagree and 9 representing strongly agree.

Panel A – Trade Decision	**Mean**
Q: My firm's purchasing strategy affects the cash I will derive from trade.	8.12
Q: The Seller can use the project-specific machine to make parts for another buyer.	2.17
Q: If the Seller rejects my offer, my incentive compensation will be $0.	7.87
Panel B – Investment Decision	**Mean**
Q: The Buyer's firm purchasing strategy affects the net cash I will derive from trade.	8.37
Q: I can use the project-specific machine to make parts for another buyer.	1.83
Q: If I do not purchase a project-specific machine, my firm's net cash is $0.	6.48

Table 5

Manipulation Checks*: Level of Aggregation of Information and Buyer Strategy

Panel A: Level of Aggregation of Information

Questions	Mean	
Trade decision	Fine	Coarse
Q: I knew exactly what Seller Z's expected production costs were. Q: I knew with certainty what was the lowest offer Seller Z would accept. Q: I knew the total of Seller Z's expected production costs and machine costs but did not know Seller Z's exact expected production costs (reverse coded).	6.67	2.93 (t = 7.78, p < .001)
Investment decision	Fine	Coarse
Q: I believed Buyer B knew exactly what my expected production costs were. Q: Even if Buyer B's firm policy was to offer just enough to cover production costs, there was a chance I might get reimbursed for the cost of the machine I purchased (reverse coded). Q: I believed Buyer B knew the total of my expected production costs and machine costs but did not know my exact expected production costs (reverse coded).	6.76	4.07 (t = 4.64, p < .001)

Panel B: Buyer Strategy

Questions	Mean	
Trade decision	Self-interested	Fair
Q: My firm's purchasing strategy is to offer sellers just enough to cover expected production costs. Q: My firm's purchasing strategy is to share the net cash from trade evenly between Seller and Buyer firms (reverse coded).	7.75	2.79 (t = 9.32, p < .001)
Investment decision	Self-interested	Fair
Q: Buyer B's firm purchasing strategy is to cover expected production costs. Q: Buyer B's firm purchasing strategy is to share the net cash evenly between both firms (reverse coded).	6.0	4.04 (t = 2.74, p < .01)

* Questions were measured on a 9-point Likert scale with 1 representing strongly disagree and 9 representing strongly agree. Responses to the questions in Panels A and B were averaged for each decision.

Self-interested strategy: Buyer's firm strategy is to cover supplier's marginal production cost.

Fair strategy: Buyer's firm strategy is to share the net surplus equally with the supplier and cover supplier's marginal production costs and investment cost.

Fine information: Buyer knows supplier's marginal production costs and investment cost.

Coarse information: Buyer knows the sum of supplier's marginal production costs and investment cost.

Table 6

Descriptive Statistics

Panel A: Mean (standard deviation) Buyer Offers

	Self-interested strategy	Fair strategy	Marginal means
Fine information	$16,857 ($15,341) n = 14	$107,500* ($17,650) n = 12	$58,692 ($48,815) n = 26
Coarse information	$38,625 ($19,609) n = 12	$105,000 ($21,409) n = 13	$73,140 ($39,381) n = 25
Marginal means	$26,904 ($20,348) n = 26	$106,200 ($19,326) n = 25	$65,775 ($44,599) n = 51

Panel B: Mean (standard deviation) Supplier Investment

	Self-interested strategy	Fair strategy	Marginal means
Fine information	$5,714 ($14,525) 2/14 or 14% invest	$36,923 ($11,094) 12/13 or 92% invest	$20,741 ($20,367) 14/27 or 52% invest
Coarse information	$34,285 ($14,525) 12/14 or 86% invest	$36,923 ($11,094) 12/13 or 92% invest	$35,556 ($12,810) 24/27 or 89% invest
Marginal means	$18,571 ($20,315) 14/28 or 50% invest	$36,923 ($10,970) 24/26 or 92% invest	$28,148 ($18,436) 38/54 or 70% invest

.

Table 7

Tests of H1a-d

Dependent variable: Buyer offer

Panel A -Trade Decision – ANOVA Test of H1a

Source	Sum of Squares	df	Mean Square	F-statistic	Significance of F	Eta squared
Aggregation level	1178495181	1	1178495181	3.42	.071	.068
Buyer strategy	78263973411	1	78263973411	226.82	.000	.828
Aggregation level x buyer strategy	1178495181	1	1178495181	5.42	**.024 Test of H1a**	**.**103
Explained	83240282242	3	27746760747	80.43	.000	.837
Error	16214263072	47	344984320			
Total	99454545314	50				

Adjusted R^2 = .827

Panel B – Trade Decision – Planned Contrast Tests

Hypothesis	Comparison	Statistic	df	p-value
H1b	Coarse versus Fine Information (Self-interested Strategy condition)	t = 3.18	24	.002 (one-tailed)
H1c	Coarse versus Fine Information (Fair Strategy condition)	t = .32	23	.75
H1d	Fair versus self-interested Strategy (Coarse Information condition)	t = 8.06	23	< .001

Level of aggregation of information:

Buyers know marginal production costs and investment cost separately (Fine Information), or know only the sum of marginal production costs and investment cost (Coarse Information).

Buyer strategy:

Buyer's firm strategy is to cover only supplier's marginal production cost (Self-interested Strategy), or Buyer's firm strategy is to share the net surplus equally with the supplier and cover supplier's marginal production costs and investment cost (Fair Strategy).

Table 8

Tests of H2 and H3a-d

Dependent variables: Supplier investment decision and investment amount

Panel A – Investment Decision* - Test of H2

Hypothesis	Wald Statistic	β	Significance
Main effect of aggregation level on likelihood of investing	7.68	2.0	.006

Panel B - Investment Decision* - ANOVA Test of H3a**

Source	Sum of Squares	df	Mean Square	F-statistic	Significance of F	Eta squared
Aggregation level	2751322751	1	2751322751	16.30	.000	.246
Buyer strategy	3860968660	1	3860968660	22.87	.000	.314
Aggregation level x buyer strategy	2751322751	1	2751322751	16.30	**.000 Test of H3a**	.246
Explained	9575254375	3	3191751458	18.91	.000	.53
Error	8439560439	35	168791208			
Total	18014814814	53				

Adjusted R^2 = .503

Panel C - Investment Decision* – Planned Contrast Tests of H3b-d

Hypothesis	Comparison	Statistic	df	p-value
H3b	Coarse versus Fine Information (Self-interested Strategy condition)	t = 5.20	26	< .001 (one-tailed)
H3c	Coarse versus Fine Information (Fair Strategy condition)	t = 1	24	1.0
H3d	Fair versus Self-interested Strategy (Coarse Information condition)	t = .53	25	.603

* Variables are defined in Table 7.

** Results from logistic regression are qualitatively equivalent (Wald statistic: 3.85 significant at .05 level).

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