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assets

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Summary

Supply chain coordination and collaboration in general requires dedicated investments by the members of the chain in order to decrease cost, increase capacity or mitigate risks. Common assumptions in the literature include predefined contractual structures, common information on capacity, costs and the value added through the intended action. On the other hand, evidence suggests that the extent of supply chain collaboration is still not as prevalent as theory would predict, indicating that true decision-makers may operate under different assumptions. In a stylized dyadic supply chain model we prove the existence of equilibria under which information asymmetry between supplier and manufacturer is preferred to information sharing when relation-specific investment information is involved. We use a Stackelberg model for the single-period interaction between two parties when the downstream party has to undertake a relationship-specific investment. Both parties have outside options to avoid monopsony-monopoly rents. The supplier uses his Bayesian belief regarding the relationship-specific investment cost, leading to a tradeoff between rent extraction and sharing of coordination benefits. We provide closed form results for the supplier's contract and resulting information rent distribution when the belief follows common distribution functions such as those with increasing failure rates. A numerical instance illustrates the results.

Keywords : Specific assets, contract design, asymmetric information, rent capture, Bayesian belief

JEL Classification: C44, C73, D86

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LOUVAIN SCHOOL OF MANAGEMENT WORKING PAPER

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SUPPLY CHAIN RENT DISTRIBUTION UNDER BAYESIAN BELIEF WHEN THE BUYER INVESTS IN SPECIFIC ASSETS

Xavier BRUSSET¹ and Per J. AGRELL²

March 2010

Abstract

Supply chain coordination and collaboration in general requires dedicated investment by the members of the chain in order to decrease cost, increase capacity or mitigate risks. Common assumptions in the literature include predefined contractual structures, common information on capacity, costs and the value added through the intended action. On the other hand, evidence suggests that the extent of supply chain collaboration is still not as prevalent as theory would predict, indicating that true decision-makers may operate under different assumptions. In a stylized dyadic supply chain model we prove the existence of equilibria under which information asymmetry between supplier and manufacturer is preferred to information sharing when relation-specific investment information is involved. We use a Stackelberg model for the single-period interaction between two parties when the downstream party has to undertake a relationship-specific investment. Both parties have outside options to avoid monopsony-monopoly rents. The supplier uses his Bayesian belief regarding the relationship-specific investment cost, leading to a tradeoff between rent extraction and sharing of coordination benefits. We provide closed form results for the supplier's contract and resulting information rent distribution when the belief follows common distribution functions such as those with increasing failure rates. A numerical instance illustrates the results.

Keywords: Supply chain management, contracts, contracts, hold-up.

JEL Classification: C44, C73, D86.

1 Introduction

Motivation for this research stems from the observation of the negotiations between the manufacturer and his supplier about the costs involved in setting up the systems and procedures as well as their managerial processes required to mesh their respective information systems and ERP . The manufacturer will often exaggerate the cost and difficulties to the supplier. The present paper tries to establish a rational reason for such behaviour.

Once the single processes have been optimized, further pressure for profitability for firms require coordinated efforts to maximize value and to minimize costs with the entire supply chain. To achieve coordination, firms exchange information about capacity, inventory, demand and allocation. Initiatives such as supply chain collaboration, e.g. Collaborative Forecasting, Planning and Replenishment (CPFR), the extended enterprise O'Neill and Sackett (1994) and, in general, supply chain coordination projects are described as “driving force[s]” Manthou et al. (2004) or “core capabilities” (idem) of firms. In practice, non-trivial application of supply chain collaboration involves some costly investments from concerned chain members, e.g. in common information systems, platforms, routines, tools, fixtures or product design constraints. Once undertaken and coordinated, these investments facilitate the decision-making and implementation of common policies within the chain at minimum cost. The relationship specific investments for coordination also include internal resources, such as capital and human resources within the organization, as well as opportunity costs, e.g. declined orders for devoted capacity, that are non-verifiable costs in the contracting sense. However, a large part of the return of these investments accrues to the firm that made them. Only exceptionally are these investments symmetric to size and scope across chain members. Hence, the deeper and more extensive the supply chain coordination and collaboration is intended, the harder it gets to write enforceable contracts for the financing of the necessary investments.

This model describes a two-player, pure-strategy, non-cooperative, Stackelberg game.

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We show how the supplier is able to extract extra rent from the manufacturer even when he is not fully informed about the manufacturer's other outside opportunities or investment cost. This rent transfer is the result of an evaluation based upon the supplier's belief about the manufacturer's real investment costs or outside opportunities and is not related to the potential revenue generated by the contract that is negotiated in a second step. To do so, we build a model comparing two possible situations according to the information available to the supplier.

The first case in section 3.1 constitutes the integrated benchmark under common information about the manufacturer's outside opportunities and relationship specific investments is common information. This case of common information can be found in centralized organizations where the supplier is one division and the manufacturer another. We also briefly present in this section the case where the supplier is completely ignorant of the manufacturer's costs and outside options.

In the second case presented in section 3.2, information about outside opportunities and relation specific investment cost is private to the manufacturer. This situation can be found in tenders organized by the manufacturer and where the supplier is not aware of the type of competition he is facing nor of the relationship-specific investments which the manufacturer must make in order to optimize the future relationship.

The model leads us to formulate some propositions regarding the rent transfer that occurs between the supplier and manufacturer under each scenario. In the following section, we give some elements of related literature on the subject. The third section describes the model. A numeric example presents an illustration in Section 4. We conclude in Section 5.

2 Literature review

In literature, the specific investments by partners in a supply chain in general are often dealt with using Transaction Cost Economics or relational exchange theory. When those investments are the subject of contracts, game, bargaining and contract theories are often used to explain the interactions. In the particular case of logistics, Knemeyer et al. (2003) has surveyed the outsourcing practice and shown that it involves investments in specific assets and non-retrievable commitments of resources from both partners.

The setting we present here is a single-period game version of the sequential bargaining or renegotiation of rental price with one buyer under asymmetric information about his willingness-to-pay presented in Fudenberg and

Tirole (1983). Fudenberg and Tirole (1983) characterize the set of equilibria of two-period bargaining games when the seller and buyer each have two potential types (two-sided incomplete information), when the seller makes the offers and when the players alternate making offers. But the setting does not include investments nor decisions to trade with one or other supplier. The single-buyer interpretation of this problem when the buyer is willing to trade and profitable mutual interaction is given has been looked into by Fudenberg et al. (1985) which demonstrate that a perfect Bayesian equilibrium exists. This results stands under the assumption that the buyer's type can follow a smooth bounded density.

The papers Tirole (1986) and Edlin and Reichelstein (1996) deal with investment in cost reduction by the seller which results in an advantage over the uninformed buyer. In the present model, it is the buyer who invests and the seller who is not informed of the size of the investment (the seller observes the reality of the investment ex post if he obtains the manufacturer's custom). In Tirole (1986), the seller obtains an information rent whereas in our model the buyer hides the size of the investment from the seller so as to mitigate the risk of being held up by the seller in future periods.

In the games theoretic literature, Joel Watson builds upon the standard contracting model using unverifiable rather than incomplete information, verifiable and unverifiable actions and with and without renegotiation. In Miyagawa et al. (2008), the folk theorem in repeated games where a player can buy information is presented. Dang (2008) investigates the use of endogenous information in bargaining and how it can help a buyer to capture the full trading surplus. In González (2004), the agent faces a hold-up situation while making a cost-reducing specific investment unobservable by the principal. To escape the hold-up, the agent randomizes the investment whereas the principal offers screening contracts. In Battaglini (2007), the model characterizes the optimal renegotiation-proof contract in a dynamic principal-agent model in which the agent can change types stochastically over time by means of contract menus offered by the principal.

The contribution of this paper is to focus on the case where interaction is voluntary and investigating the relationship between supply chain rent appropriation and information asymmetry on the downstream relationship-specific investment.

We consider that the supplier is a Bayesian rational player in the sense that he separates his beliefs from his preferences by quantifying the former with a subjective probability measure and the latter with a utility function and seeks to maximize his expected utility Selten (1975). The starting point for the modeling exercise is the standard contracting model with complete

but unverifiable information and “ex ante renegotiation” Maskin (1999), Maskin and Moore (1999), Watson (2006).

3 Model linking manufacturer and supplier under different information scenarios

A similar model has been presented in Brusset (2009) which examined the situation when information was common but the contract could be reopened several times. In the present case, the contract is binding and can not be reopened. Two scenarios are compared : in one, information about the manufacturer’s outside option and investment in relation-specific assets is private to the manufacturer and, in another, the carrier is informed of such data.

The manufacturer and a supplier set up a long term relationship and the manufacturer invests in specific assets with cost A (strictly positive) to enable their ongoing interaction. The manufacturer has some prior engagements to deliver some goods downstream which she must honour. Her objective is to minimize the cost C of the required inputs that she buys to manufacture these goods. The supplier’s objective is to maximize his partial profit function Π_s from selling the inputs either to the manufacturer or to some third party. The supplier is private to his costs and outside opportunities. In this model, the investments made by the manufacturer are unobservable and unverifiable by the supplier but accepting a contract and working with him are both observable.

In time (see figure 1), the sequence of events is the following: the supplier offers a contract in a way which shall be made clearer later. If the manufacturer rejects the offer, both turn to outside options: the manufacturer must find another supplier and the supplier must find another manufacturer (this option is not represented in figure 1). Setting up a relationship with another counterparty entails a cost in specific asset a (strictly positive) for the manufacturer and a_s (also strictly positive) for the supplier.

If, on the other hand, the manufacturer finds the offer of the supplier interesting, a contract is agreed upon and the manufacturer invests in the required specific assets. Demand is realized and revealed instantly to both. The manufacturer order the corresponding amount of inputs to the supplier. Delivery and payout take place.

The contract is named U . In case the contract is rejected, the strictly positive contract which the manufacturer may sign with some third party is labeled u . The supplier then also signs a strictly positive contract u_s

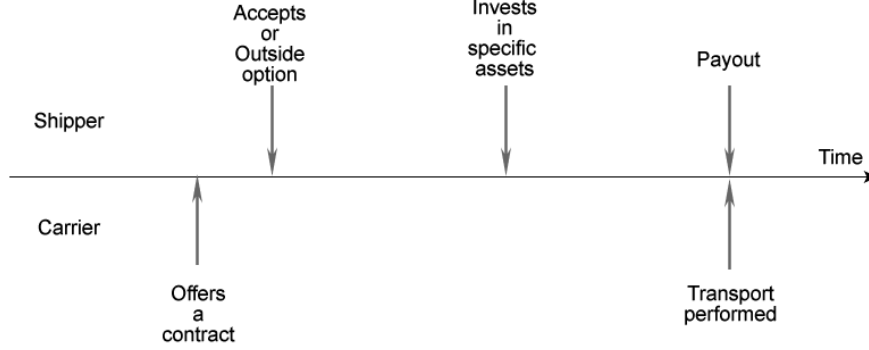


Figure 1: Timeline of events when manufacturer and supplier agree on a contract and to a new relationship. If the manufacturer does not agree to a contract, the timeline is stopped on this disagreement, each starts a new timeline (not represented here).

with a third party. The contracts are members of a finite set $\mathcal{P}$ which describes all relevant contracts. We call δ_m the manufacturer's participation decision variable which can take binary values: 1 if he accepts the contract, 0 otherwise. We present all the notation relative to this Chapter in table 1.

It is often seen in literature that the supplier, as Stackelberg leader, offers a menu of contracts. We shall assume here that the supplier makes an initial estimate using all the information at his disposal and makes *one* final offer that either the manufacturer accepts or rejects. We assume that no negotiation takes place.

3.1 Full information

In this case both parties wish to set up a contract for the first and only period because they agree to commit to its terms for any future period in the same way. The supplier's objective function is

$$\begin{aligned} \max \mathbb{E}(\Pi_s(U) | \delta_m) \\ \text{s.t.} \quad \begin{cases} \mathbb{E}(C_s | \delta_m = 1) \leq \mathbb{E}(C_s | \delta_m = 0), \\ \mathbb{E}(\Pi_s | \delta_m = 1) \geq \mathbb{E}(\Pi_s | \delta_m = 0), \end{cases} \end{aligned} \quad (1)$$

Table 1: Table of notations

Type	Notation	Definition
Manufacturer	A	Specific asset investment by manufacturer with the supplier
	a	Specific asset investment by manufacturer with outside option
	u	contract available to manufacturer from outside option
	U	contract offered by supplier to manufacturer
	$C(\cdot)$	manufacturer's transport cost for the manufacturer
Supplier	δ_m	binary decision variable, 1 when agreeing with supplier
	a_s	specific investment by supplier in outside option
	u_s	outside option contract available to supplier
	$\Pi_s(\cdot)$	supplier's profit function
Supplier beliefs	$f_Z(A), F_Z(Z)$	pdf and cdf of belief about $Z = u + a - A$
	$f_A(A), F_A(A)$	pdf and cdf of belief of A
	$f_a(a), F_a(a)$	pdf and cdf of supplier's belief of a
	p	parameter set characterizing belief distribution
	$f_A(A), F_A(A)$	pdf and cdf of supplier's revised belief of A

where $\mathbb{E}$ is the expectation sign. Given that we shall deal in all the following with expected outcomes, to alleviate the notation, we shall drop this expectation sign.

The manufacturer's objective function is to minimize her cost in terms of her decision parameter δ_m when the supplier presents his offer U

$$\min_{\delta_m} (C) = (U + A)\delta_m + (u + a)(1 - \delta_m). \quad (2)$$

So, in turn, the supplier must

$$\begin{aligned} \max_U \Pi_s(U) \mid \delta_m \\ \text{s.t. } \begin{cases} U + A \leq u + a, \\ U \geq u_s - a_s. \end{cases} \end{aligned} \quad (3)$$

The above constraints are in fact the two players' participation constraints. The supplier must offer the manufacturer a contract which at least offers the manufacturer the minimum cost which beats or equals the expected cost from her outside options, given her investment costs for both options. The supplier must be able to make more from supplying the manufacturer than his outside option u_s less the investment in relationship specific assets a_s . If his return from the contract with the manufacturer is higher than $u_s - a_s$, he will bear to work for the manufacturer. We represent in figure 2 the relative importance of the specific investments. In the dark

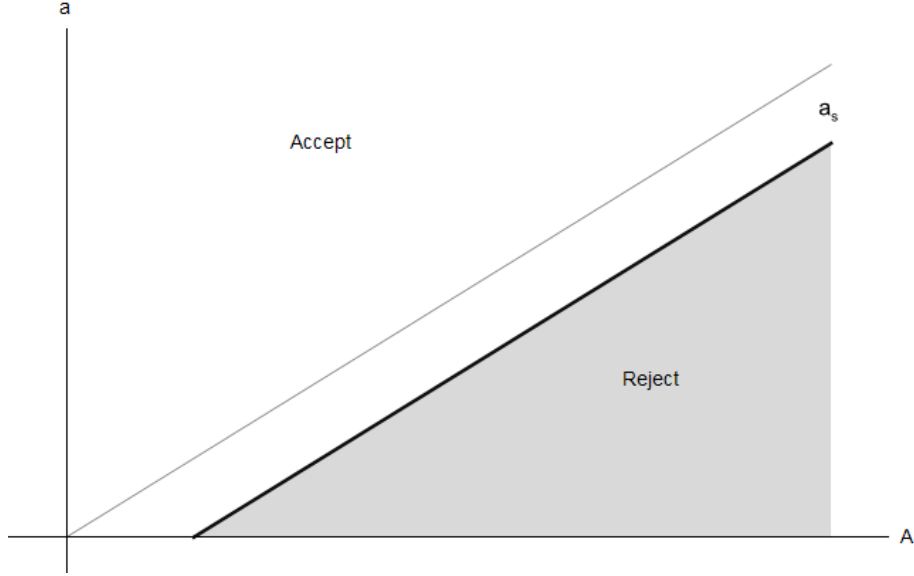


Figure 2: Representation of influence of the hierarchy of the specific investments in the decision to work together or not for the carrier and the shipper. The thick line represents $A - a_s$.

grey shaded area, the manufacturer rejects the supplier's offer. In the white areas, she agrees because $a + a_s > A$.

Proposition 1 *Full information*

Under full information and potential for mutual profitable interaction ($u + a - A \geq u_s - a_s$), the supplier's optimal contract is

$$U^1 = u + a - A. \quad (4)$$

Proof. The proof follows directly from the application of the first and second participation constraints in (3) as binding. ■

Remark 1 *Note that when the supplier has no information about the manufacturer's outside options or investment costs, he is bound to offer $U = u_s - a_s$ since that is his indifference offer. Hence the rent transfer in favour of the supplier is $a - A - a_s$. This expression may be negative: the manufacturer benefits from the ignorance of the supplier!*

In the following, we consider that the supplier elaborates a strategy which builds upon some information about the manufacturer's costs and outside opportunities.

3.2 Asymmetric information

In this case, the supplier forms a belief about the manufacturer's reservation contract and investment in relationship specific assets. Using this belief, he estimates a value Z , the distribution of which shall be the base of his offer to the manufacturer.

If the supplier had the corresponding information, he would offer, from equation (4),

$$Z = u + a - A. \quad (5)$$

As he does not have this information, the estimated distribution of Z follows a density function $f_Z(\cdot)$ and a cumulative density function $F_Z(\cdot)$ over a domain $[\underline{Z}, \bar{Z}]$ which we shall assume to be IFR (increasing failure rate) as defined in Barlow and Proschan (1965)¹. The cumulative density functions which enjoy this IFR characteristic include quite a large variety of classical statistical distributions such as the continuous uniform, the gamma, the Weibull, the modified extreme value, the truncated normal and the log normal for most types of common parameter sets as characterized in Barlow and Proschan (1965). The supplier maximizes his profit in terms of this belief by setting it at a certain threshold level which we shall now evaluate.

We demonstrate in the following that, if the supplier's belief distribution function is IFR, then there exist a unique threshold value which maximizes his expected profit from the offer he presents to the manufacturer.

The unique value Z^* maximizing the supplier's profit is solution to

$$Z^* - \frac{\overline{F_Z}(Z^*)}{f_Z(Z^*)} = u_s - a_s. \quad (6)$$

Proof. The *expected* profit function of the supplier in terms of this threshold level Z is written

$$\max_Z \left(\Pi_s(U^1, Z) | \delta_m^1 \right) = U^1 \overline{F_Z}(Z) + (u_s - a_s) F_Z(Z). \quad (7)$$

The supplier's profit function can be represented as in figure 3 when the supplier's Bayesian belief about the distribution of Z is IFR.

¹Note that in an IFR distribution $\overline{F_Z}(Z) \neq 0$ which leads to the notion that $F_Z(\bar{Z}) < 1$ but can be defined chosen such that it is arbitrarily close to 1.

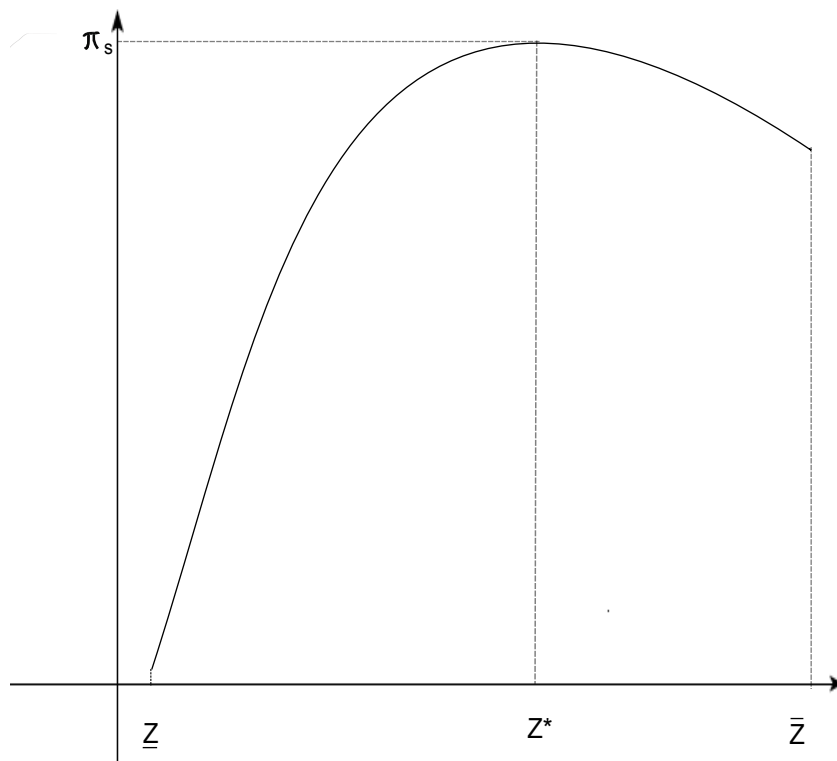


Figure 3: Supplier's profit function in terms of Z^* exhibits a maximum with an interior point when the distribution of F is IFR.

This function yields as first differential in Z

$$\frac{\partial \Pi_s(Z)}{\partial Z} = f_Z(Z)(u_s - a_s - Z) - F_Z(Z) + 1. \quad (8)$$

For threshold Z to be a maximizing one in terms of profit to the supplier, we must have as first order condition (FOC)

$$u_s - a_s - Z = -\frac{\overline{F}_Z(Z)}{f_Z(Z)}, \quad (9)$$

and as second differential, under the restriction that $f_Z(Z) \neq 0$,

$$\frac{\partial^2 \Pi_s(Z)}{\partial Z^2} = (u_s - a_s - Z)f'_Z(Z) - 2f_Z(Z) < 0. \quad (10)$$

If both conditions have to be realized, then, replacing $u - a_s - Z$ by its value in (9) in (10), we must verify that

$$f'_Z(Z)\frac{F_Z(Z) - 1}{f_Z(Z)} - 2f_Z(Z) < 0. \quad (11)$$

Since $f_Z(Z)$ is positive for all Z in the range $[\underline{Z}, \overline{Z}]$, we can restate this inequality as

$$f'_Z(Z)(F_Z(Z) - 1) - 2f_Z^2(Z) < 0. \quad (12)$$

However, we have assumed that the distribution of Z is IFR which means that the failure rate $r(Z) = f_Z(Z)/\overline{F}_Z(Z)$ is weakly increasing for those values of Z for which $F_Z(Z) < 1$. Then the first differential of the function r , which is written

$$\frac{\partial r(Z)}{\partial Z} = \frac{f'_Z(Z)(1 - F_Z(Z)) + f_Z(Z)^2}{(1 - F_Z(Z))^2} \quad (13)$$

must be positive or null, so

$$\frac{\partial r(Z)}{\partial Z} \geq 0 \Rightarrow f'_Z(Z)(F_Z(Z) - 1) - f_Z(Z)^2 \leq 0. \quad (14)$$

This last condition is stronger than the one spelt in (12) because $f_Z(Z)^2 > 0$.

This contract $U = Z^*$ is accepted with probability $\overline{F}_Z(Z^*)$ and yields the following cost to the manufacturer

$$C_s = Z^*\overline{F}_Z(Z^*) + (u + a)F_Z(Z^*). \quad (15)$$

■

Does this contract satisfy the manufacturer? For that, we must have $U \leq u + a - A$. The solution is very similar to the one spelt out in Proposition 1, except that this time the manufacturer may have some rent left. In effect,

$$u_s - a_s \leq U \leq u + a - A. \quad (16)$$

Using the optimal Z^* which solves the equation (6) as the optimal contract for the supplier, we can spell out the following proposition.

Proposition 2 *Asymmetric information*

Full information and commitment contract *Under asymmetric information about the manufacturer's outside opportunities and relationship specific investment costs, given conditions for mutual interaction potential, the optimal full commitment contract $U^1 = Z^*$ for the supplier is characterized by the following equation*

$$Z^* = u_s - a_s + \frac{\overline{F_Z}(Z^*)}{f_Z(Z^*)}. \quad (17)$$

Remark 2 *The link between Proposition 1 and this one is the precision of the information available to the supplier. This precision can be modeled as the variance of the distribution of the belief Z : the better the information, the lower the variance. In this way, when information becomes perfect, Z tends to $u + a - A$ from below. To get a better grasp of this link, we refer the reader to the figure 5 on page 15 in the numerical illustration in Section 4.2.*

To recapitulate, we find that the supplier offers a different contract according to the information in his possession:

No information : $U = u_s - a_s$,

Full information : $U = u + a - A$, under the participation

Asymmetric information : $U = u_s - a_s + \frac{\overline{F_Z}(Z^*)}{f_Z(Z^*)}$,

constraint $u_s - a_s \leq u + a - A$.

information in the supplier's possession increases, we obtain

$$\frac{\overline{F_Z}(Z^*)}{f_Z(Z^*)} \rightarrow (u - u_s) + (a - A + a_s). \quad (18)$$

Proof. This flows directly from the difference between the offer when the supplier has full information and the one when he does not in the above. ■

4 Numerical illustration

We illustrate the above information scenarios with a simple numerical instance. Suppose that a manufacturer and a supplier wish to work together. Let

$$\begin{aligned} a_s &= 55, & A &= 50, & u &= 100, \\ a &= 60, & u_s &= 80. \end{aligned} \tag{19}$$

4.1 Scenario of full information

In this first scenario, the supplier is informed of the manufacturer's investment A and outside opportunity u . Using the result outlined in Proposition 1, namely that $U = u + a - A$, we get $U = 110$.

This contract is accepted by the manufacturer and results in a cost for her of $C_s = 160$, equal to the cost of choosing her outside option. The supplier's profit is $\Pi_s = 110$, better than his outside option which equals 25. The results are presented together in table 3. When the supplier is totally uninformed about the relevant manufacturer's information, he can only offer $U = 25$.

The difference between both offers represents the price of information to the supplier.

4.2 Scenario of asymmetric information

Over just one period and when the supplier lacks the knowledge about the manufacturer's outside option, he has to estimate the distribution of this outside option. Let us represent this assumption as following a normal distribution $\mathcal{N}(\mu, \sigma)$ truncated at 0. Using the result in Proposition 2, we must calculate x such that

$$x - \frac{\overline{F_Z}(x)}{f_Z(x)} = 25. \tag{20}$$

The supplier's participation constraint is always met.

This equation yields $Z^* = 90.9$ when $\mu = 110$ and $\sigma = 20$, which is slightly less than the manufacturer would have paid if the supplier had known this information equal to 110. The manufacturer accepts the offer and the supplier still comes out ahead as compared to turning to his outside option. The thresholds Z^* vary according to μ , the expected mean of the

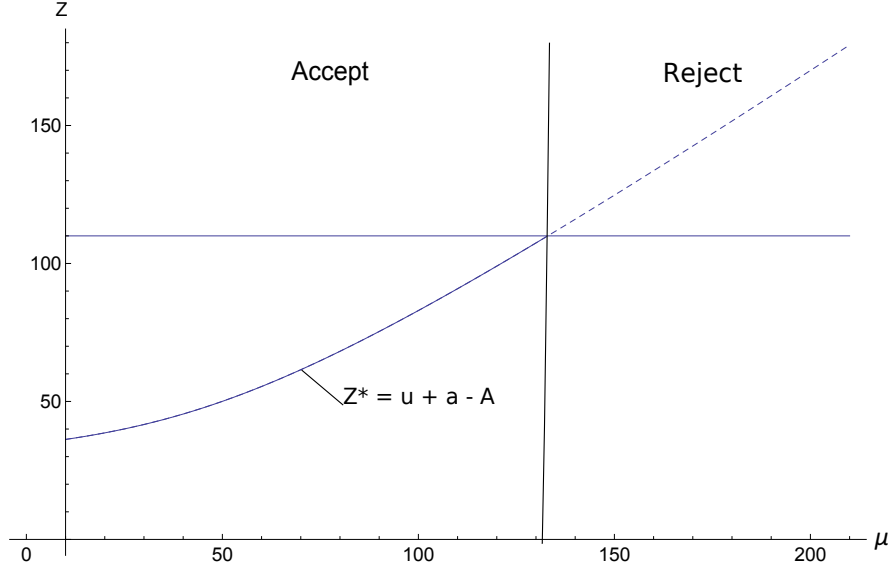


Figure 4: Evolution of Z^* when the expected demand μ increases from 10 to 210. The manufacturer rejects the offer when $\mu > 132$.

Table 2: Thresholds Z^* when the mean of the distribution of the belief about the outside option ranges between 50 and 210. When this mean is higher than 110, the manufacturer would refuse the contract.

μ	50	70	90	110	130	150	170	190	210
Z^*	50.0	61.5	75.4	90.9	107.4	124.7	142.6	160.7	179.2

distribution of Z . Table 2 presents some of the results when μ ranges between 50 and 210. For $\mu > 133$, the manufacturer would reject the contract since she would be better off by turning to her outside option (see figure 4).

So, an overestimate of the manufacturer's investment and outside option cost can lead to the supplier being turned down. An underestimate reduces the carrier's profit. We record the results in table 3.

We now turn to an evaluation of the impact of the precision of the information held by the supplier on the contract that he will offer.

To do so, we vary the degree of certainty of the information available to the supplier. We model this certainty as the standard deviation of the distribution function that the supplier builds to embody his belief. The higher the certainty of the information in his possession, the lower the standard

Table 3: The results from the different information scenarios in the numerical illustration. The last line presents the cost of the outside option to the manufacturer and of the no information case for the supplier. The $\Delta\%$ line presents the difference percentage-wise with the benchmark common information scenario.

Scenario	Shipper		Carrier	
	Cost		Profit	
	Min	Max	Min	Max
Common Info	160		110	
Asymmetric Info	100.0	155.4	50	95.4
$\Delta\%$	-37.5	-2.88	-54.5	-13.3
Outside option / No information	160		25	

deviation of the distribution function. When the standard deviation of the distribution is equal to 0, the supplier is perfectly informed about the true u , A and a . We present in figure 5 the change of Z^* when the standard deviation of the distribution of Z , truncated normal, varies from 0.1 to 100. As can be seen, when it goes from 23 to 0, Z^* approaches $u + a - A$ from below. The result presented in Proposition 1 of Section 3.1 represents the limit when σ goes to 0 of the result presented in Proposition 2 of Section 3.2.

Another interesting observation which can be made from this figure is the way that Z^* also increases when the standard deviation σ increases from 23 to 100. One interpretation would be that this is due to the fact that as the supplier's information becomes more approximative, he will have a tendency to overestimate the true value for $u + a - A$ and thus will expose himself to a refusal from the manufacturer. Here, with $\sigma > 68$, the manufacturer refuses the offer because it is cheaper for her to go with her outside option.

Table 3 tabulates the outcomes for manufacturer and supplier when information is common or asymmetric and compare it to the case where both turn to their outside options. According to the initial estimate formulated by the supplier, the cost or profit varies. In all cases, it can be seen that the asymmetric information scenario enables the manufacturer to keep part of the rent which the supplier strives to capture. Note how the cost to the shipper is equal under common information between outside option and working with the supplier as he is able to capture entirely the rent in question. The reader will also notice how the precision of information allows the supplier to increase his profit.

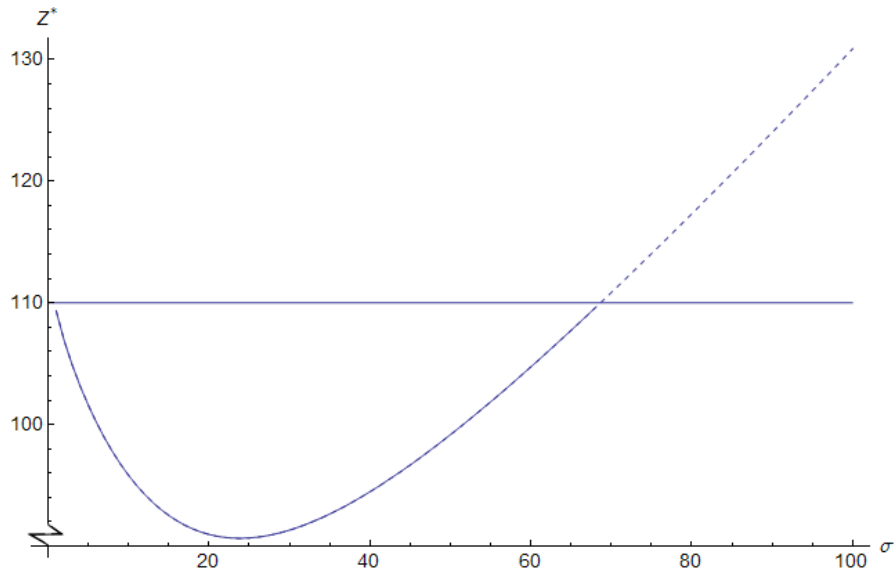


Figure 5: Evolution of Z^* when standard deviation of the distribution of the supplier's belief increases from 0.1 to 100. When $\sigma > 68$, the threshold Z^* is too high: the manufacturer turns down the offer.

5 Conclusion

We have presented in a stylized supply chain the way a supplier could benefit from information about the relationship-specific investment by his downstream partner and capture part of the supply chain rent and illustrated the results by a numeric illustration.

The model shows why (a) the manufacturer may retain information from his supplier about his outside opportunities and investment costs; (b) why he may refrain from making the most expensive investments (which may yield the most interesting return for the supply chain) because of the risk of being held up by the supplier. This model and attending results complement and extend research in pre-contractual situations in supply chain management collaboration and coordination. Such results can justify the observed lack of openness in downstream firms, especially as regards the exact extent of relationship-specific investments in connection with their upstream partners.

Future research will extend the present results to a multi-period scenario in the case that the supplier under-estimates the cost of the investments done by the manufacturer and thus has his offer turned down.

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