Optimal Economic Governance with Incomplete Contracts and Search Frictions∗

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Abstract

This article studies the interaction between incomplete contracts and a decentralized input market on the make-or-buy decision in a vertical industry relationship, considering both contractual and matching frictions. The downstream manufacturer trades off the cost of inefficient investments against the option value of continued search. It is costly to search because the production has inefficient input levels. It is beneficial to continue searching because the manufacturer can be matched with a better supplier. The model predicts that vertically integrated firms are more productive than non-integrated firms, and a sample of ex-ante identical manufacturers can choose different governance structures. Furthermore, the model predicts integration should be more prevalent in markets with larger matching frictions and with older manufacturers.

Keywords: Economic governance, Holdup problem, Incomplete contracts, Search.


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1 Introduction

Vertically integrated firms tend to be more productive than non-integrated firms. Still, different governance structures coexist to produce the same good in the same market, at the same point in time, and in the same geographical region (Atalay, Hortacsu, and Syverson, 2014; Bartelsman, Haltiwanger, and Scarpetta, 2013; Hortacsu and Syverson, 2007; Forbes and Lederman, 2010).1 How can firms find it optimal to organize the production in different ways, when one alternative is more favorable? Complementarity in the activities within the firm or the firms’ ability to take advantage of scale economics can potentially be explanations for the observed productivity differences. Yet, controlling for firm employment and number of establishments (i.e., scale), and the number of industries firms operate in (i.e., activities), Atalay, Hortacsu, and Syverson (2014) use establishment-level data on a range of industries from the Economic Census and document 5.1% higher labor productivity and 0.7% higher total factor productivity among integrated firms relative to non-integrated ones. A recent literature in organizational industrial organization, which combines organization models of the firm with analysis of industry behavior, also emphasizes the relation between ownership structures and industry performance (see Legros and Newman (2014) for a survey). However, they suggest market conditions outside of the firm can shape organizational choices, and organizational choices can in turn affect firm conduct and market performance. If we understand how contract and market characteristics shape the governance decision of firms, we may better understand the prevalence of persistent productivity differences within industries. This article show that when market contracts are incomplete and the manufacturer must search for available suppliers, different governance structures with different performance can coexist.

Formally, I study an infinite-horizon one-sided search model with one downstream manufacturer and many upstream suppliers with different production costs. The manufacturer decide whether to make or buy the input necessary for production. There is no centralized market place for the inputs so finding a supplier is costly. The transaction can take place in the market, but it is prohibitively costly to write a state-contingent contract. The firms bargaining over the surplus ex post which implies inefficient investment levels because the inputs are not verifiable by a third-party. The manufacturer can search for a better supplier next period. Alternatively, the transaction can happen

within the firm, where integration aligns incentives. However, the manufacturer loses the possibility of continued search.\(^2\) This interlinkage between the holdup problem and the option value of continued search is the center of my model. The profit maximizing governance rule for the supplier-relationship trade off the cost of inefficient investment levels against the option value of continued search. The higher the cost of inefficient investment, the more likely is integration. Moreover, the higher the option value of continued search, the more likely is a market contract.

The optimal governance rule is determined by the distribution of available suppliers in the economy, and the patience of the manufacturer. If either (i) the manufacturer is sufficiently patient, or (ii) there are sufficiently many low-cost suppliers relative to high-cost suppliers, then the optimal governance structure is the following. For \(c \geq R\), then the manufacturer should use a market contract. For \(c \leq R\), then the manufacturer should integrate. When the inefficient investments from the contractual incompleteness outweights the option value of continued search, then the manufacturer integrates with the supplier. This optimal search rule is an economic governance version of the optimal search rule derived in Burdett (1978) for the labor market. Burdett (1978) studies quit rates and wages over a tenure profile in a labor search model. He accounts for workers without interim unemployment spells between different jobs by letting workers search while they work. The adoption of the model to a frictional input market to study optimal governance structure and productivity differences, and the emphasis on the interplay between the holdup problem and the option value of continued search makes the present analysis different.

In a sample of ex-ante identical firms, solving the same problem, different ways of organizing production may coexist and the vertically integrated firms are more productive than non-integrated firms (i.e., have lower costs). The suppliers function as stepping stones, creating a governance ladder with market contracts at the bottom, manufacturers using better suppliers to move upwards, and vertical integration at the top. Hence, the interplay between incomplete contracts and search frictions can jointly explain within-industry differences in governance structures and productivity.

Two features of the model allow for this result. First, suppose the market is centralized, so there is no option value in waiting. If contracts are complete, then integration and a market contract align incentives and both types coexists with the same cost level. If the contracts are incomplete, then vertical integration is preferred because it aligns

\(^2\)This no-search assumption is relaxed in one extension by offering the manufacturer to pay a fixed cost for continued search after integration. If this cost is bounded on an interval, the coexistence result still holds. See the discussion section for more details.
incentives. Next, suppose the market is decentralized, so there is an option value in waiting. If contracts are complete, then both structures align incentives. However, a market contract maintains the option value without the holdup problem. Hence, there should only be market contracts. Last, if contracts are incomplete, then the market contract maintains the option value of searching, but involves a holdup problem. Integration aligns incentives, but loses the option of continued search.

**Road map.** The structure of this article proceeds as follows. First, the next section discusses the related literature and section 2 explains the setup of the model. Section 3 contains the analysis of the optimal governance structure. The final section consists of a discussion of the modeling setup and three extensions where different assumptions of the model are relaxed. All the proofs are given in the appendix.

### 1.1 Related literature

First, this article contributes to the literature on organizational industrial organization which studies how variables such as control-right allocations and firms boundaries can be the main determinants of firm conduct and market performance, see Legros and Newman (2014) for a survey. The closest related articles are perhaps Grossman and Helpman (2002) and Ishiguru (2010) who look at differences in governance structure between markets and industries in markets with search- and contract-frictions. In Grossman and Helpman (2002) firms decide between integration with higher production costs, or specialize production with search frictions and incomplete contracts. Competition in the final goods market alters the equilibrium surplus within the chain. Their model is a two-sided search model, so specialized firms also compete for partners on the other side of the market. In Ishiguru (2010) firms decide between non-delegation with higher production costs, or delegation with lower costs and incentive problem. The wage paid under non-delegation reflects outside options, while the wage paid under delegation reflects the agents informational advantage based on internal factors. Although search frictions and incentive problems are present in the models, the mechanisms are very different. In Grossman and Helpman’s model matching- and contract-frictions serve as a tradeoff for the governance structure, whereas competition between firms and the size of the fixed costs drives the results. In Ishiguru’s model the tradeoff for the governance structure is either high production costs or low production costs and incentive provision, whereas the probability to integrate drives the result for multiplicity of equilibrium. In my model, search frictions and incomplete contracts are the driving force. Moreover,

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3 Assuming that the manufacturer chooses market contract when indifferent at the lower bound of the cost distribution.
the tradeoffs within the firm are different (i.e., option value of continued search versus the cost of inefficient investments) and emphasis on coexistence of different governance structures within the same industry and market.

Legros and Newman (2012) propose a price theory of vertical and lateral integration where they adopt the organizational model of Hart and Holmstrom (2010) in a perfectly competitive economy to study how the market price affects the governance structure, and in turn how the governance structure affects the market performance. The optimal decision between nonintegration and integration depends on the market price. Since the organizational structure varies with the price, so does the output. The market equilibrium gives the usual price-quantity tradeoff and the organizational design. For a generic set of demand schedules they find coexistence of integrated and nonintegrated firms.

The article also contributes to the literature on make-or-buy problem of the firm, with an emphasis on the interplay of forces which gives cost and benefits of integration; see Gibbons (2005) for a discussion of the theoretical aspects and Lafontaine and Slade (2007) for a review of the empirical evidence. Vertical integration, or the use of more elaborate vertical restraints, is a means to align incentives within the production chain. In the current article, the market contract is incomplete and involves a holdup problem (i.e., Williamson (1971, 1979)), but the ex post bargaining is efficient in the spirit of Grossman and Hart (1986) and Hart and Moore (1990). As in previous work integration aligns incentives by centralizing the decision rights. Contrary to previous articles the cost of integration is losing the option value of continued search. The tradeoff between the holdup problem and continued search are represented in level, rather than marginal effects from investments.

Next, this article is also related to the literature on productivity differences. Some firms are persistently more productive than other firms (Hsieh and Klenow, 2009; Bartelsman, Haltiwanger, and Scarpetta, 2013; Restuccia and Rogerson, 2013). One possible explanation is that resources are misallocated among heterogeneous firms in the industry (Bartelsman, Haltiwanger, and Scarpetta, 2013). Brynjolfsson and Milgrom (2013) and Callander and Matouschek (2014) explain persistent productivity differences with complementaries in the activities of the firm or information friction regarding what the best-practice within an industry constitutes so the firms must experiment. The present article show that full information about the characteristics of the governance choices can also generate productivity differences. When the governance characteristics are known, the trade off between contractual incompleteness and search frictions is one reason for the observations in the data.
2 Model

Consider the following environment. Time is discrete and the economy consists of two types of infinitely lived agents: one downstream manufacturer and many upstream suppliers. Both types are risk neutral, seek to maximize the present value of their own expected profits, and discount the future with a discount factor $\beta \in (0, 1)$. The manufacturer operates an asset which generates revenue from a frictionless final-goods market. The revenue depends on the input levels. The production technology makes a perishable inputs which are lost after one period. All agents have the same structure in the production of the inputs, $a_i$, given as

$$C_i(a_i) = \frac{c_i}{2} a_i^2 \quad \forall i$$

The slope of the marginal cost, $c_i$ is normalized to 1 for the manufacturer. The suppliers have different values for the slopes of the marginal cost, $c_i$, which are drawn from a distribution $F(c)$. The cost distribution is bounded on $[\underline{c}, \bar{c}]$.

**Assumption 1** $\underline{c} > 0$, $F(\underline{c}) = 0$ and $F(\bar{c}) = 1$.

The manufacturer starts with a supplier with cost level $c$, and has two ways of organizing the production: use a market contract or integrate with the supplier.

2.1 Market contract - option value, but a holdup problem

First, the manufacturer can agree use arm-lenghts production with the supplier governed by an incomplete contract. Following Williamson (1971) inputs are ex-ante describable and the compatibility of an input depends on a state of nature. It is prohibitively costly to write a state-contingent contract, so the two firms within a match allow the state to be realized and bargain over the surplus ex-post. Inputs are not verifiable ex-post by a third-party (e.g., an arbitrator or judge). The non-verifiability assumption and the lack of storage of the input leads to a holdup problem ex post for the two firms in a match. Furthermore, the frictional input market and the perishability of the input makes the actions transaction-specific.

The two parties engage in ex post efficient bargain over the split of the surplus, with threat point set to zero (Grossman and Hart, 1986). The two parties each control one of the input factors. No ex post surplus can be made without combining the two inputs. The suppliers are specialized and each supplier has a cost parameter $c_i$. A supplier with a cost parameter less than 1 has lower production costs than the manufacturer.
downstream manufacturer (D) solves the following maximization problem

$$\max_{a_1>0} \Pi_D^{S} = \alpha(a_1 + a_2) - \frac{1}{2}a_1^2 + \frac{1}{2c}$$  

where \(\alpha \in (0, 1)\) denotes the bargaining share of the manufacturer. The first component is the return. It represents a reduced-form market profit from a frictionless market, it is separable in the two actions to make it easy to move between complete and incomplete contracts. The second component is the cost of production. The third component represents a contractible aspect of using a supplier for which there is no problem in contracting. The manufacturer gets this profit independently of the "completeness of the market contract", and independently of whether the organization is market contract or integration. The component make the costs of the supplier matter both in a complete and incomplete world. The first-order condition has \(a_1^* = \alpha\). An upstream supplier (U), with a cost parameter \(c\), solves the following optimization problem

$$\max_{a_2>0} \Pi_U^{S}(c) = (1 - \alpha)(a_1 + a_2) - \frac{c}{2}a_2^2$$  

The first-order conditions has \(a_2^* = \frac{(1-\alpha)}{c}\). The corresponding profits for the downstream manufacturer and the upstream supplier, respectively, are

$$\Pi_D^{S} = \frac{2\alpha(1 - \alpha) + \alpha^2c + 1}{2c}, \quad \Pi_U^{S} = \frac{(1 - \alpha)^2 + 2\alpha(1 - \alpha)c}{2c}$$  

A lower cost parameter implies higher profits.

Next, if contracts were complete, then the manufacturer and supplier would face the following optimization problems

$$\max_{a_1>0} \Pi_D^{C} = a_1 - \frac{1}{2}a_1^2 + \frac{1}{2c}$$  

$$\max_{a_2>0} \Pi_U^{C}(c) = a_2 - \frac{c}{2}a_2^2$$  

The first-order conditions has \(a_1^{FB} = 1\) and \(a_2^{FB} = \frac{1}{c}\). Hence, with incomplete contracts there is underinvestment in effort. The corresponding profits are

$$\Pi_D^{C} = \frac{1}{2} + \frac{1}{2c}, \quad \Pi_U^{C} = \frac{1}{2c}$$  

Let the parameter \(\gamma \in (0, 1)\), represent the completeness of a contract and let it denote the weight in the convex combination between an incomplete and a complete
contracting setting. The corresponding profits for the downstream manufacturer and the upstream supplier from a contract, are respectively given as

\[
\Pi^D_S = \gamma \left( \frac{1}{2} \right) + (1 - \gamma) \left( \frac{2\alpha(1 - \alpha) + \alpha^2c}{2c} \right) + \frac{1}{2c}
\]

\[
= 2\alpha(1 - \alpha)(1 - \gamma) + c[\alpha^2(1 - \gamma) + \gamma] + 1
\]

\[
\Pi^U_S = \gamma \left( \frac{1}{2c} \right) + (1 - \gamma) \left( \frac{(1 - \alpha)^2 + 2\alpha(1 - \alpha)c}{2c} \right)
\]

\[
= \gamma + (1 - \gamma)(1 - \alpha)(1 - \alpha + 2\alpha c)\]

The first component is the profit from a complete contract, and the second component is the profit from an incomplete contract. When \(\gamma = 1\) contracts are complete, and when \(\gamma = 0\) contracts are incomplete.

Each period the manufacturer meets a new supplier with probability \(\lambda\). The realizations of the match are drawn from a known distribution, are independent and identically distributed, and there is no recall. Following McCall (1970) and Burdett (1978) the manufacturer solves a one-sided sequential-search problem in a frictional input market. The Bellman equation for the manufacturer from a contract \((S)\) is then

\[
S(c) = \frac{2\alpha(1 - \alpha)(1 - \gamma) + c[\alpha^2(1 - \gamma) + \gamma] + 1}{2c} + \beta \left[ (1 - \lambda)S(c) + \lambda \int_c^{\bar{c}} \max\{S(c), S(c'), M(c')\} dF(c') \right].
\]

The first component consist of the period flow profit from the contract. The second element consists of the expected benefit from searching again, only accepting someone with a lower cost than the current supplier.

### 2.2 Vertical Integration - align incentives, but not option value

The manufacturer can alternatively buy the supplier and control both input factors. The manufacturer has to pay a per-period fee, denoted \(\Phi(c)\), to integrate with a supplier. A more efficient supplier is more costly to acquire. Vertical integration is a centralization of the decision rights over the input levels to the manufacturer so integration aligns
incentives. The integrated firm solves the following maximization problem

\[
\max_{a_1 > 0, a_2 > 0} \Pi_I = (a_1 + a_2) - \frac{1}{2} (a_1 + ca_2^2) + \frac{1}{2c} - \Phi(c),
\]

s.t. \( \Phi(c) \geq \gamma + (1 - \gamma)(1 - \alpha)(1 - \alpha + 2\alpha c) \) \( \frac{2c}{c} \) (10)

The integration fee ensures that the supplier agrees to the action by the manufacturer. The first-order conditions has \( a_1^* = 1 \) and \( a_2^* = \frac{1}{c} \), which are the efficient levels of investments. The profit of the vertically integrated firm (i.e., the manufacturer after integration) at the optimum is

\[
\Pi_I^* = \frac{1 + (1 - \gamma)\alpha(2 - \alpha) + c[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2c}
\]

The supplier earns the period integration fee, \( \Phi(c) \). The Bellman equation for the downstream manufacturer becomes

\[
M(c) = \frac{1 + (1 - \gamma)\alpha(2 - \alpha) + c[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2c} + \beta M(c)
\]

The first term is the period flow profit, net the integration fee. A manufacturer within a vertically integrated structure cannot search again, and the merger lasts forever represented by the continuation value in the second term. Vertical integration aligns incentives because all the surplus goes to the one with the control, but is costly since it takes away the option of finding a better match.

### 2.3 Timing

In the beginning of every period, the manufacturer produces within the existing governance structure. The manufacturer searches sequentially for a new supplier. Upon finding a new supplier the manufacturer decide on the optimal structure given the trade-offs. Any contractual payments happen in the beginning of the next period. Any actions are performed before there is bargaining, so each party face a hold-up problem. All aspects of the setup are common knowledge to all the agents.

### 3 Analysis

This section characterizes the optimal governance structure for the manufacturer. First, the characteristics of the environment simplifies the manufacturer’s problem. Second, the optimal governance at the lower bound of the suppliers’ cost distribution is established.
Next, the reservation cost levels between integration and a contract. The components jointly characterizes the optimal governance rule for the manufacturer.

First, consider the properties of the problem from the environment. The arrival of suppliers is a sequence of random draws from a known distribution function $F(c)$. The bargaining power is the same across all suppliers, so the relevant decision variable is the production cost parameter of the supplier. Following Burdett (1978) the manufacturer wants a sequence of decision rules that determines whether to use a contract or integrate. Suppose there is a match in period $t$. The associated cost of search is sunk. If the manufacturer searches again, the current benefit from the match is also lost because there is no recall. This implies that each period is like starting the problem all over again. Hence, the problem is time-invariant.

A stopping rule is a rule that tells the manufacturer the amount of observations he should sample before stopping. Search for a new match is costly because the manufacturer face a holdup problem which gives inefficient input levels. Therefore, an optimal stopping rule minimizes the number of observations collected in order to maximize the expected discounted lifetime profits. The optimal stopping rule for the downstream manufacturer is to use a reservation cost level (McCall, 1970; Burdett, 1978). The optimal stopping rule consists of a threshold value on the costs, with a corresponding governance choice for the different segments.

The intuition behind this stopping rule is based on Bellman’s principle of optimality. Suppose the manufacture holds a supplier with cost parameter $c$ in his hand. By using an optimal rule going forward it can at most get the expected benefits from continuing. The manufacturer should accept the supplier with cost parameter $c$ if the associated discounted profit is greater than the expected profit from searching. This optimality principle gives the indifference condition for the optimal stopping problems. For $c \leq c'$ integrated and for $c > c'$ use a market contract with the supplier. The level of the cutoff points for accepting the supplier, combined with the optimal choice at the lower bound of the cost distribution determines the optimal governance rule.

### 3.1 Lower Bound of the Cost Distribution

This section gives conditions for the preferred governance choice at the lower bound of the cost distribution. Lemma 1 describes the relationship between the level of the lower bound of the suppliers’ cost distribution and the preferred governance structure at the lower bound.
Lemma 1. Integration is preferred to a contract at the lower bound of the suppliers cost distribution.

At the lower bound of the suppliers’ cost distribution, $c$, the value of continued search is zero because there are no better matches. There is no benefit to future search, so the manufacturer is deciding between centralization of the decision rights net a integration fee, and a holdup problem.

Proof of Lemma 1. If the period flow profit from integration is greater than the market contract, then the manufacturer prefers integration at the lower bound of the cost distribution. Hence,

$$\Pi^I(c) = \frac{1+(1-\gamma)\alpha(2-\alpha)+c[1-(1-\gamma)2\alpha(1-\alpha)]}{2c} > \frac{2\alpha(1-\alpha)(1-\gamma)+c\alpha^2(1-\gamma)+\gamma}{2c} + 1 = \Pi^D_S(c)$$

which holds since $(1-\gamma)(1-\alpha)^2c + \alpha^2 > 0$.

3.2 Integration vs. market contract

This section characterizes the cutoff point for when the manufacturer prefers to integration over a market contract. The manufacturer wants a reservation cost level which determines when to integrate or use a contract. Consider a supplier with costs $c$. The manufacturer must decide whether to integrate or use a market contract. The Bellman equation is

$$S(c) = \max_{\text{integrate, market}} \left\{ \frac{1+(1-\gamma)\alpha(2-\alpha)+c[1-(1-\gamma)2\alpha(1-\alpha)]}{2c(1-\beta)} \right\}$$

$$+ \frac{\beta\lambda}{1-\beta(1-\lambda)} \int \max\{S(c), S(c'), M(c')\} dF(c')$$

The first expression is the net present value from integration with a supplier with costs $c$. The second expression is the net present value of using a market contract, and taking the optimal path ahead.

By the optimality principle, the reservation cost level is the cost level that sets the net present value of integrating at $R$ equal to the optimal behavior going forward if the manufacturer does not integrate today. The manufacturer will then earn a flow
profit from the contract, and meet a new supplier. If the supplier has sufficiently low production costs, the manufacturer will integrate. If not, then the manufacturer searches again. The two net present values must be equal at the reservation value, $R$.

The reservation cost level which makes the manufacturer indifference between integration and a contract is determined implicitly by the following equation

$$1 + (1 - \gamma)\alpha(2 - \alpha) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]$$

$$+ \frac{\beta \lambda}{1 - \beta(1 - \lambda)} \int_{\xi}^{R} \frac{1 + (1 - \gamma)\alpha(2 - \alpha) + c'[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2c'(1 - \beta)} dF(c')$$

$$+ \frac{\beta \lambda}{1 - \beta(1 - \lambda)} \int_{\xi}^{\bar{c}} \frac{1 + (1 - \gamma)\alpha(2 - \alpha) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2R(1 - \beta)} dF(c') = \frac{2\alpha(1 - \alpha)(1 - \gamma) + R[\alpha^2(1 - \gamma) + \gamma] + 1}{2R[1 - \beta(1 - \lambda)]}$$

The left hand side is the net present value of a merger at the indifference cost level, denoted $R$. The right hand side is equal to the flow profit from a contract at the cost level $R$, and the expected value from an optimal plan forward. If the new supplier has production costs between $\xi$ and $R$, the manufacturer will integrate. If the costs are above the reservation cost level, then the manufacturer will continue with the contract and search again next period. At the reservation value, the net present value of a contract is equal to the net present value of integration. Rearranging the indifference equation gives

$$1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)] - \frac{(1 - \gamma)2\alpha(1 - \alpha) + R[\gamma + (1 - \gamma)\alpha^2] + 1}{2R}$$

$$= \frac{\beta \lambda}{1 - \beta} \int_{\xi}^{R} \left(1 + (1 - \gamma)\alpha(2 - \alpha) + c'[1 - (1 - \gamma)2\alpha(1 - \alpha)]\right) dF(c')$$

$$- \frac{\beta \lambda}{1 - \beta} \int_{\xi}^{\bar{c}} \left(1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]\right) dF(c')$$

Discounted expected marginal benefit of search

See the appendix for details. The reservation value is set such that the marginal cost of searching, when the current supplier has cost $R$, is equal to the expected discounted marginal benefit of searching (McCall, 1970). The marginal cost is the period flow profit from integration net the period flow profit from contract, evaluated at the current cost.
level $R$. It is costly to wait for one period because the manufacturer produces within an incomplete contracting framework with inefficient input levels. The marginal benefit is the discounted expected improvement from waiting one period and integrating with a better match. This improvement is the difference between integration at marginal cost level $c'$ and at $R$. By searching one more time, the profit for the manufacturer can be improved because it might meet a better supplier. To ease further treatment of the indifference condition it is rewritten as

$$\left(1 - \gamma \right) \left( \frac{\alpha^2 + R(1 - \alpha)^2}{1 + \alpha (2 - \alpha)(1 - \gamma)} \right) = \frac{\beta \lambda}{1 - \beta} \int_{c}^{R} \left( \frac{R - c'}{c'} \right) dF(c')$$  \hspace{1cm} (17)

See the appendix for details.

Lemma 2 establishes existence and uniqueness of a reservation cost level for $R \in [\bar{c}, \bar{c}]$ which satisfies the indifference condition between a contract and vertical integration.

**Lemma 2 (Existence and uniqueness)** There exists a unique reservation cost level on $[\bar{c}, \bar{c}]$ that satisfies the indifference condition between a contract and vertical integration.

**Proof of Lemma 2.** To establish existence and uniqueness of the reservation cost level first evaluate the left- and right-hand side of equation (17) for a given cost level, $c$, and denote them $h$ and $n$ respectively, i.e.,

$$h(c) = \left(1 - \gamma \right) \left( \frac{\alpha^2 + c(1 - \alpha)^2}{1 + \alpha (2 - \alpha)(1 - \gamma)} \right), \quad n(c) = \frac{\beta \lambda}{1 - \beta} \int_{c}^{\bar{c}} \left( \frac{c - c'}{c'} \right) dF(c').$$  \hspace{1cm} (18)

$h$ is strictly positive at the lower bound of the suppliers cost distribution, and it is linear and increasing in $c$. $n$ is zero at the lower bound of the suppliers’ cost distribution (i.e., $n(\bar{c}) = 0$). Furthermore, by Leibniz’s rule we have

$$n'(c) = \frac{\beta \lambda}{1 - \beta} \left[ \frac{c - \bar{c}}{c} f(c) \times 1 - \frac{c - \bar{c}}{\bar{c}} f(\bar{c}) \times 0 + \int_{\bar{c}}^{c} \frac{1}{c} f(c')dc' \right]$$

$$= \frac{\beta \lambda}{1 - \beta} \int_{\bar{c}}^{c} \frac{1}{c'} f(c')dc' > 0$$  \hspace{1cm} (19)

$$n''(c) = \frac{\beta \lambda}{1 - \beta} \left[ \frac{1}{c} f(c) \times 1 - \frac{1}{\bar{c}} f(\bar{c}) \times 0 + \int_{\bar{c}}^{c} 0 \times dc' \right] = \left( \frac{\beta \lambda}{1 - \beta} \right) \left( \frac{f(c)}{c} \right) > 0$$  \hspace{1cm} (20)

Figure 1 is a graphical illustration of the indifference condition and the unique reservation cost level. At the lower bound of the cost distribution $h(\bar{c})$ is positive, and the $n(\bar{c})$
Figure 1: Indifference point: The reservation cost level, $R$, that makes the manufacturer indifferent between a contract and integration.

function is zero. The $h$-function is increasing and linear, and the $n$-function is increasing and convex. Hence, there is a unique reservation value that satisfies the indifference condition between a contract and vertical integration.

3.2.1 Comparative statics

To evaluate comparative statics of the exogenous primitives on the reservation cost level for integration consider the left- and right-hand side of the indifferent condition, given by equation (17). Lemma 3 describes the relation between the reservation cost level and the discount factor, the probability of finding a match, and the characteristics of the suppliers’ cost distribution.

**Lemma 3 (Comparative statics)** The reservation cost level between integration and a contract decreases in the discount factor and in the probability of finding a match. Furthermore, the reservation cost level decreases when the density of the suppliers cost distribution is shifted towards the lower bound.

First, consider an increase in the discount factor, $\beta$. The left hand side is unchanged, whereas the right-hand side increases. So the reservation cost level goes down. As the discount factor increases, the manufacturer becomes more patient and emphasizes the
expected benefits from finding a better match. Second, consider an increases in the probability of finding a match, $\lambda$. When a manufacturer is more likely to meet a supplier next period, the expected benefits of continued search improves. Hence the manufacturer demands a better match (i.e., lower costs) when a potential improvement is more likely to arrive in the next period.

Last, consider a shift of the density in the cost distribution. As density in the cost distribution shifts towards the lower bound, then the economy consists of more low-cost relative to high-cost suppliers. The manufacturer is more likely to meet a low-cost supplier, conditional on finding a match. The expected benefit of waiting and searching one more time becomes higher, and the marginal cost of searching is unchanged. When the density shifts towards the lower bound then the reservation cost level decreases. See the appendix for a numerical example illustrating this intuition.

Summing up the preceding discussion, the reservation cost level for integration is lower if (i) the manufacturer is more patient, (ii) the probability of a match is higher, or (iii) the match is more likely to be with a low-cost supplier.

3.3 The optimal governance rule

This section combines the previous results to determine the optimal governance rule. The following result is the main result of the article. Result 1 combines Lemma 1 - 3 to give conditions for the governance rule between integration and a market contract.

**Result 1 (Optimal governance rule)** If the manufacturer is sufficiently patient, or there are sufficiently many low-cost suppliers relative to high-cost suppliers (e.g., $\theta > \hat{\theta}$ for the scale parameter of a Gamma distribution), then the optimal governance choice is the following. First, for $c \leq c \leq R$, the manufacturer integrates. Second, for $R < c \leq \bar{c}$, the manufacturer uses a contract.

First, at the lower bound of the cost distribution there is no option value to continue search, hence the manufacturer prefers integration at the lower bound. Second, there is a unique reservation cost level. Which for sufficiently patient manufacturer or sufficiently high expected value of searching, $R < \bar{c}$, i.e., on the interval. From the comparative statics we know that as the discount factor increases, the manufacturer puts more emphasis on the future, so the discounted expected benefit from search becomes higher, and the reservation cost level for integration becomes smaller. There is a threshold $\hat{\beta}$, such that $\beta > \hat{\beta}$, where the reservation cost level for integration is below the upper bound of cost level (i.e., $R < \bar{c}$). As more density shifts towards the lower bound of the support,
the reservation cost level for integration goes down. Hence, there is a threshold of the density towards the lower bound (e.g., \( \theta > \hat{\theta} \) for the Gamma distribution) such that the reservation cost level for integration is below the upper bound of the cost distribution (i.e., \( R < \bar{c} \)).

The result states that for an economy with either a sufficiently patient manufacturer, or sufficiently many low-cost relative to high-cost suppliers, the optimal search rule implies a governance ladder: market contract at the bottom, improved contracts as stepping stones, and integration at the top. Hence the optimal governance choices depends on the quality of the supplier (i.e., the cost parameter). The intuition behind the result is the following. The manufacturer starts out with a supplier with a low quality in a market contract, then the manufacturer continues to search for a new match. The manufacturer only accepts better matches. Next, if a supplier has costs where the the loss of profit from the contractual incompleteness dominates the expected gains from finding a better supplier, then the manufacturer integrates.

**Corollary 1** If either (i) the manufacturer is sufficiently impatient, (ii) it is sufficiently unlikely to meet a supplier, or (iii) the market is inhabitet by sufficiently many high-cost suppliers, then the manufacturer integrates with the first supplier it meets (i.e., \( R = \bar{c} \)). The expected marginal benefits of searching would not be sufficient to outweigh the marginal cost of the inefficient investment level in the current match.

### 3.4 Implications for firm performance

This result has a direct implications for firm performance. In a sample of ex-ante identical manufactures, solving the same problem, different governance structures can coexist and the integrated firms have lower costs than non-integrated firms. The current governance choice of a firm is a function of its previous realizations of matches. Search frictions and incomplete contracts lead to different governance choices depending on the quality of the supplier.

**Corollary 2** The optimal stopping rule imply that a vertically integrated firm have lower costs (i.e., higher productivity) than a non-integrated firm.

Hortacsu and Syverson (2007) use plant-level data from Census of Manufacturers in the cement and ready-mixed concrete industry, control for firm sales, and document 10.2% higher labor productivity among integrated firms relative to nonintegrated ones. Forbes and Lederman (2010) inspect the relationship between performance measures and ownership structures of regional airlines by large U.S. airlines. Regional routes in
a network may be operated by a major airline, or contracted out to an independent supplier. Integrated majors experience 5.6 minutes shorter average departure delays than nonintegrated ones, controlling for weather conditions.

**Corollary 3** Markets with more matching frictions should have more integration and less market contracts, relative to markets with less matching frictions.

When the probability of meeting a supplier becomes smaller, then the reservation cost level for integration increases. The manufacturer is more likely to integrate with the supplier. With more matching frictions the option value of search becomes lower, and the manufacturer is more likely to integrate to align incentives. Bernard, Moxnes, and Saito (2016) use the opening of new stations along the high-speed train route in Japan to study the effect of firm performance of reducing search costs. Firms near the new stations improve their performance. Furthermore, firms located near new stations experience increase sourcing locations and a larger share of their suppliers are located near the new stations. In their paper opening a station reduces search costs, so we should see less integration. If you are located next to a station, you experience an increase in sourcing locations and the share of suppliers located near new stations

**Corollary 4** Older manufactures are more likely to be integrated than young manufactures

A general feature from considering the governance choice of firms within a sequential search framework is that firms with more draws are more likely to have a good supplier. Hence, older firms are more likely to be integrated. The probability that a manufacturer accepts a supplier in a given period is given as the probability of a match times the probability of integrating with the supplier, \( \lambda \times F(R) \), where \( \lambda \) assigns the probability of a match, and \( F(R) \) assigns the probability that the supplier is accepted. Consider two firms A and B, respectively 2 and 3 years old. The probability that a firm is in the market contract in the current period equals the probability of rejecting \( d - 1 \) offers and then accepting, which is

\[
Pr\{B \text{ unmatched}\} = [1 - \lambda F(R)]^2 \lambda F(R) < [1 - \lambda F(R)] \lambda F(R) = Pr\{A \text{ unmatched}\}
\]

Since the hazard rate is the same in every period, the inequality follows from \( \lambda F(R) > 0 \).
4 Discussion and extensions

This section discuss some of the initial consideration on the setup of the model and evaluates three extensions of the model. The discussion centers on alternative modeling approaches. The first extension looks at how of variations in compatibility affects the optimal governance structure. The second extension characterize the optimal governance when the merged entity can pay a fee in order to search again. The third extension inspects what happens with the optimal search rule if there is an exogenous probability of exit from the economy.

To simplify notation, suppose the manufacturer always meets a new match, let the bargaining power be symmetric, and suppose the contracts are not complete (i.e., $\lambda = 1$, $\alpha = \frac{1}{2}$, and $\gamma = 0$).

4.1 Discussion

First, the suppliers can alternatively be modeled with different product quality rather than costs. Suppose the differences in quality leads to higher willingness to pay for the product. The quality approach is then equivalent to the present cost approach.

Next, both firms in a bilateral relationship can search, and the search protocol may involve randomized fixed-sample search as well if there is a deadline aspect to the search. There are also general equilibrium effects from the strategic interactions between competitors on both sides of the market (e.g., Bolton and Whinston (1993) for supply assurance in multilateral relationships). The one-sided search model is convenient because it isolates the decision of economic governance from strategic interactions with other firms. It also allow for a close fit with the classical papers by Williamson (1971), Grossman and Hart (1986) and Hart and Moore (1990) who study bilateral relationships and how the characteristics of the trade determines the organization of the transaction.

Furthermore, Tirole (1999) and Maskin and Tirole (1999) suggest Maskinian elicitation mechanisms, (e.g., option contracts or auctions) to redeem the incompleteness of the contract. Moreover, Aghion, Dewatripont, and Rey (1994) argue for the use of a more comprehensive renegotiation design to achieve first-best outcomes. Lerner and Malmendier (2010) inspect research agreements between pharmaceutical companies and research labs. 97% of the research agreements include a purchasing-clause by the pharmaceutical company, making it an option contract. I assume such options are not available, and accept incomplete contracts as a natural part of doing business.

Last, the supplier is paid a fee to make the supplier indifferent between integration and the market contract, given by the individual rationality constraint. This fee is equal
to the per period profit for the supplier from a market contract. This is a simplification. The manufacturer can meet a better supplier and replace the current one, so a contract does not consists of a certain payoff every period for the supplier. Hence, the manufacturer can offer to pay less than the per period profit and still make the supplier indifferent, in particular,

\[ \Phi(c) \geq \mu \left( \frac{\gamma + (1 - \gamma)(1 - \alpha)^2 + (1 - \gamma)2\alpha(1 - \alpha)c}{2c} \right) \]  

where \( \mu \equiv \frac{(1 - \beta)}{(1 - \beta)|\mu'(c)|} < 1. \) See the appendix for details. The analysis uses the more stringent fee for tractability.

4.2 The compatibility of a match may vary

Finished, but not edited.

4.3 Searching after integration

Finished, but not edited.

4.4 Exogenous probability of exit

Last, exit and entry of firms are important factors which drive resource allocations (e.g., Hopenhayn (1992); Caves (1998)). It therefore important to allow for exit when determining the optimal search rule. Suppose the manufacturer exit the economy with an exogenous probability, denoted \( \delta. \) Furthermore, the exit payoff is normalized to zero, and the probability of exit is independent of the governance structure.

**Lemma 4** When there is a positive probability of exiting the economy the manufacturer becomes more impatient (i.e., \( \beta' \equiv \beta(1 - \delta) < \beta. \))

**Proof.** Consider first the value function from using a contract is

\[ S(c) = \frac{6 + c}{8c} + \beta(1 - \lambda)(1 - \delta)S(c) + \beta\lambda(1 - \delta)\int_{x}^{\bar{c}} \max\{S(c), S(c'), M(c')\}dF(c') \]  

Next consider the integration value. The net present value from integrating is then

\[ M(c) = \left( \frac{\alpha(2 - \alpha) + (2\alpha^2 - 2\alpha + 1)c}{2c} \right) + \beta(1 - \delta)M(c) \]
Let the discount factor be denoted $\beta' \equiv \beta(1 - \delta)$. ■

The exogenous exit probability reduces the value of waiting for a potentially better match. The manufacturer becomes less picky when accepting a supplier for integration compared to the baseline model. The only effect is adjusting the discount factor down.

5 Conclusion

This article show that search frictions and incomplete contracts can jointly give rise to an optimal search rule that is empirically consistent with ex-ante identical firms choosing different governance structures, where vertically integrated firms are more productive than non-integrated firms (i.e., have lower costs of production). Contractual incompleteness in the market transaction and the absence of a centralized input market imply that the optimal search rule trades off the cost of inefficient investment levels against the option value of continued search.

This article illustrates how the interaction between incomplete contracts and matching frictions can be one alternative explanation of different governance structures within the same market, with heterogeneous performance results. However, the current model is silent about the supply side of inputs. The cost distribution and match probability can be made endogenous with a free entry condition and a match-specific productivity. In addition, the current model has not dealt with learning within matches. Nor how the matching protocol may alter the trading mechanism. These aspects can provide new insights into the match formation and tenure, and the dynamic development of production chains. Hence, equilibrium models where learning or choice of trading mechanism is modeled more explicitly (e.g., Jovanovic (1979) for learning, or Eeckhout and Kircher (2010) for endogenous trading mechanisms) may be an interesting avenue for further research.

A Appendix

This appendix contains derivations and proofs omitted from the text.

Indifference condition between market contract and integration
The indifference condition is given as

\[
1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]
\]

\[
= \frac{1}{1 - \beta(1 - \lambda)} \left( (1 - \gamma)2\alpha(1 - \alpha) + R[\gamma + (1 - \gamma)\alpha^2] + 1 \right)
\]

\[
+ \frac{\beta\lambda}{1 - \beta(1 - \lambda)} \int_{\xi}^{\tilde{c}} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + c'[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2c'(1 - \beta)} dF(c')
\]

\[
+ \frac{\beta\lambda}{1 - \beta(1 - \lambda)} \int_{\tilde{c}}^{R} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2R(1 - \beta)} dF(c').
\]

(25)

Multiply both sides with \((1 - \beta)\) and adding an integral decomposition to the L.H.S.

\[
1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)] \left( \int_{\xi}^{\tilde{c}} dF(c) + \int_{\tilde{c}}^{R} dF(c) \right)
\]

\[
= \frac{1}{1 - \beta(1 - \lambda)} \left( (1 - \gamma)2\alpha(1 - \alpha) + R[\gamma + (1 - \gamma)\alpha^2] + 1 \right)
\]

\[
+ \frac{\beta\lambda}{1 - \beta(1 - \lambda)} \int_{\xi}^{\tilde{c}} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + c'[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2c'} dF(c')
\]

\[
+ \frac{\beta\lambda}{1 - \beta(1 - \lambda)} \int_{\tilde{c}}^{R} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2R} dF(c').
\]

(26)

Collecting terms of the integrals on the L.H.S. and moving the integral from \(\xi\) to \(R\) to the R.H.S. we have

\[
\frac{1 - \beta}{1 - \beta(1 - \lambda)} \int_{\tilde{c}}^{R} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2R} dF(c)
\]

\[
= \frac{1}{1 - \beta(1 - \lambda)} \left( (1 - \gamma)2\alpha(1 - \alpha) + R[\gamma + (1 - \gamma)\alpha^2] + 1 \right)
\]

\[
+ \frac{\beta\lambda}{1 - \beta(1 - \lambda)} \int_{\xi}^{\tilde{c}} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + c'[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2c'} dF(c')
\]

\[
- \int_{\xi}^{\tilde{c}} \frac{1 + \alpha(2 - \alpha)(1 - \gamma) + R[1 - (1 - \gamma)2\alpha(1 - \alpha)]}{2R} dF(c).
\]

(27)
Next, divide by \(\frac{1-\beta}{1-\beta(1-\lambda)}\), and then add \(\int_{\xi}^{R} \frac{1+\alpha(2-\alpha)(1-\gamma)+R[1-(1-\gamma)2\alpha(1-\alpha)]}{2R} dF(c)\) to both sides we get

\[
1 + \alpha(2-\alpha)(1-\gamma) + R[1-(1-\gamma)2\alpha(1-\alpha)]
= \frac{(1-\gamma)2\alpha(1-\alpha) + R[\gamma + (1-\gamma)\alpha^2] + 1}{2R} + \frac{\beta\lambda}{1-\beta} \int_{\xi}^{R} \frac{1 + \alpha(2-\alpha)(1-\gamma) + c'[1-(1-\gamma)2\alpha(1-\alpha)]}{2c'} dF(c')
\]

(28)

Collecting terms and simplifying gives

\[
\frac{1 + \alpha(2-\alpha)(1-\gamma) + R[1-(1-\gamma)2\alpha(1-\alpha)]}{2R} - \frac{(1-\gamma)2\alpha(1-\alpha) + R[\gamma + (1-\gamma)\alpha^2] + 1}{2R} = \frac{\beta\lambda}{1-\beta} \int_{\xi}^{R} \frac{1 + \alpha(2-\alpha)(1-\gamma) + c'[1-(1-\gamma)2\alpha(1-\alpha)]}{2c'} dF(c')
\]

(29)

Simplifying the L.H.S and the R.H.S. gives the reservation cost equation

\[
(1-\gamma)\left(\frac{\alpha^2 + R(1-\alpha)^2}{2R}\right) = \frac{\beta\lambda}{1-\beta} \int_{\xi}^{R} \frac{(R-c'[1+\alpha(2-\alpha)(1-\gamma))}{2Rc'} dF(c')
\]

(30)

Simplifying and dividing by \([1 + \alpha(2-\alpha)(1-\gamma)]\) gives

\[
(1-\gamma)\left(\frac{\alpha^2 + R(1-\alpha)^2}{1+\alpha(2-\alpha)(1-\gamma)}\right) = \frac{\beta\lambda}{1-\beta} \int_{\xi}^{R} \frac{R-c'}{c'} dF(c')
\]

(31)

**Proof of Lemma 3.** First, consider an increase in the discount factor.

\[
\frac{\partial h(c)}{\partial \beta} = 0; \quad \frac{\partial n(c)}{\partial \beta} = \frac{\lambda}{(1-\beta)^2} \int_{\xi}^{c} \left(\frac{c-c'}{c'^2}\right) dF(c') > 0
\]

(32)
Next, consider an increase in the probability of finding a match.

\[
\frac{\partial h(c)}{\partial \lambda} = 0; \quad \frac{\partial n(c)}{\partial \lambda} = \frac{\beta}{1 - \beta} \int_{c}^{c'} \left( \frac{c - c'}{c'} \right) dF(c') > 0
\]  \hspace{1cm} (33)

**Numerical example illustrating a shift of the density in the cost distribution.**

Suppose the suppliers’ cost levels are distributed according to a Gamma distribution, with shape parameter \( k = 2 \), and varying scale parameter \( \theta = \{1, 2, 4, 5\} \). The Gamma distribution is attractive because it is easy to shift density by letting the scale parameter vary, and the distribution nests many of the standard distributions as special cases. The probability density function of the cost distribution is then given by

\[
f(c) = \frac{\theta}{\Gamma(2)} \left( \theta c \right)^{2 - 1} e^{-\theta c} = \theta^2 c e^{-\theta c}
\]  \hspace{1cm} (34)

where \( \Gamma(2) = 2 - 1)! = 1 \) is the Gamma function. The left panel in figure 2 is a graphical representation of the probability density function of the suppliers’ costs. Next, consider the indifference condition between integration and a contract, as derived in equation (17). Substitute in for the Gamma probability density function given by equation (34), the indifference condition is

\[
(1 - \gamma) \left( \frac{\alpha^2 + R(1 - \alpha)^2}{1 + \alpha(2 - \alpha)(1 - \gamma)} \right) = \frac{\lambda \beta}{1 - \beta} \int_{c}^{R} (R - c') \theta^2 c e^{-\theta c'} dc'.
\]  \hspace{1cm} (35)

This equation implicitly defines the reservation cost level, \( R \), which makes the manufacturer indifferent between integration and a contract. I solve the equation numerically to show how the reservation cost level is affected by a shift in the density of the distribution of suppliers (i.e., shifts in the scale parameter, \( \theta \)). First, define a function \( g(R) \) such that

\[
g(R) \equiv (1 - \gamma) \left( \frac{\alpha^2 + R(1 - \alpha)^2}{1 + \alpha(2 - \alpha)(1 - \gamma)} \right) - \frac{\lambda \beta}{1 - \beta} \left[ e^{-\theta R} + e^{-\theta c}(\theta(R - c) - 1) \right]
\]  \hspace{1cm} (36)

Second, find the point \( R \) so that \( g(R) = 0 \). The right panel in Figure 2 show the development of the reservation cost level as the density of the cost distribution shifts towards the lower bound of the cost distribution. As the economy consists of more low-cost relative to high-cost suppliers, the reservation cost level for integration goes towards
Figure 2: Left: The probability density function of the Gamma-distribution, as density shifts towards the lower bound. Right: The reservation cost level $R$ that solves our condition, $g(R) = 0$. As $\theta$ increases, the reservation cost level decreases. The parameter values for the illustration is, $c = 0.01$ (lower bound of the cost distribution), $\alpha = \frac{1}{2}$ (bargaining power), $\beta = 0.9$ (discount factor) $\lambda = 1$ (the probability of finding a match), and $\gamma = \frac{1}{2}$ (completeness of contract).

The integration fee

The value function for a supplier in a contract is

$$\Psi(c) = \Pi_s^U(c) + \beta \left[ (1 - \lambda)\Psi(c) + \lambda [F(c) \cdot 0 + [1 - F(c)]\Psi(c)] \right]$$  \hspace{1cm} (37)$$

The first component is the per period profit. Next, with probability $(1 - \lambda)$, the manufacturer does not meet a new supplier, so the match continues. With probability $\lambda$, the manufacturer meets a new supplier. $F(c)$ is the probability that the new supplier has a cost level which is lower than the current one. The manufacturer will then replace the supplier. With complimentary probability $[1 - F(c)]$, the new supplier has a cost level which is higher than the current supplier and the manufacturer continues with the current match. Collecting terms, the net present value of a contract for a given supplier with production costs, $c$, is

$$\Psi(c) = \frac{\Pi_s^U(c)}{1 - \beta[1 - \lambda F(c)]}$$  \hspace{1cm} (38)$$

The value function for a supplier in integration is

$$\Omega(c) = \Phi(c) + \beta \Omega(c), \quad \Rightarrow \quad \Omega(c) = \frac{\Phi(c)}{1 - \beta}$$  \hspace{1cm} (39)$$
In each period, the supplier receives the integration fee, $\Phi(c)$, and the match continues forever. The fee which ensures individual rationality for the supplier must make the supplier indifferent between the two alternatives, i.e.,

$$\frac{\Phi(c)}{1-\beta} \geq \frac{\Pi_U^S(c)}{1-\beta[1-\lambda F(c)]}$$

(40)

So, the period fee the manufacturer needs to pay is

$$\Phi(c) \geq \mu \Pi_U^S(c), \text{ where } \mu \equiv \frac{(1-\beta)}{1-\beta[1-\lambda F(c)]} < 1.$$  

(41)

A manufacturer that integrates can therefore offer to pay a fee which is less than the per period profit from a contract.

References


